CSEWG & USNDP
2004

Summary of the

54th Cross Section Evaluation Working Group Meeting
November 2 - 4, 2004

and

U.S. Nuclear Data Program Meeting
November 3 - 5, 2004

Held at
Brookhaven National Laboratory
Upton, NY 11973

Edited by Pavel Oblozinsky
National Nuclear Data Center

www.nndc.bnl.gov/proceedings/2004csewgusndp

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Note

The present document along with many presentations and reports given at both the CSEWG and USNDP meetings can be found at www.nndc.bnl.gov/proceedings/2004csewgusndp

Preface

This year, for the second time, Cross Section Evaluation Working Group (CSEWG) and U.S. Nuclear Data Program (USNDP) Annual Meetings were held together. Although logistics of such a combined CSEWG-USNDP meeting is fairly complex, the benefits are worth the effort. The combined meeting means less traveling and thus savings for a number of participants, it creates synergy due to much needed interaction between the two groups, and it provides rare opportunity to organize useful common sessions.

The week of November 1 – 5, 2004 was the BNL nuclear data week, with 3 meetings held in a row. First, Nuclear Data Advisory Group of the DOE Criticality Safety Program met in the closed meeting, followed by CSEWG meeting and then USNDP meeting, with a common CSEWG-USNDP session on Nuclear Data for Homeland Security.

A pleasant surprise was a strong participation. Altogether as many as 65 nuclear data developers and nuclear data users registered, including representatives of national laboratories, Universities, nuclear industry from both the United States and Canada, as well as representatives of data centers operated by IAEA Vienna and NEA Paris. Out of a total of 65 registered participants, 48 attended CSEWG, 34 attended USNDP and 17 attended Criticality Safety meeting.

The present document contains the summary of CSEWG and USNDP meetings. Using a format adopted for the first time in 2003, the document includes:

- Summary of the CSEWG Annual Meeting,
- Summary of the USNDP Annual Meeting, and
- Summary of the Common Session on Nuclear Data for Homeland Security.

This Summary is produced both as a hardcopy and in electronic form but the presentations and the reports are available electronically only. A reader should go to www.nndc.bnl.gov/proceedings/2004csewgusndp for a full set of CSEWG-USNDP 2004 meeting documents.

December 28, 2004

Pavel Oblozinsky
CSEWG chair
USNDP chair

Agenda

CSEWG & USNDP Annual Meetings, November 2-5, 2004

Underlined items are available at
www.nndc.bnl.gov/proceedings/2004csewgusndp

Nov 2, 2004, Tuesday (CSEWG Meeting)

- **8:30-8:40, Berkner B:** ***CSEWG Opening, P. Oblozinsky***

- **8:45-10:45, Berkner B:** ***Formats and Processing (M. Greene, chair)***

I. Format Issues for ENDF/B-VII (1 h)
1. Status report on the compact covariance matrix format, Larson
2. Status report on the Reich-Moore extended format, Larson
3. WPEC format proposals, Trkov
4. Format for Post-fission Beta-delayed Photons, Brown

II. Processing Codes (45')

5. NJOY, MacFarlane
6. AMPX, Dunn
7. LLNL Codes, McNabb
8. ANL Codes, McKnight

III. Other Items (15')

9. Corrections and Revisions to ENDF-102, Dunford and others
10. Status of Checking Codes, Dunford
11. New Nuclear Data Format, McNabb
12. Current Projects of IAEA, Trkov

- **8:45-10:45, Berkner C:** ***Measurements and Basic Physics (D. Smith, chair)***

1. Status report on U.S. experimental work from contributing labs (1 h)
   - Argonne National Laboratory, Kondev (10')
   - Los Alamos National Laboratory, Haight (15')
   - National Institute for Standards and Technology, Carlson (10')
   - Rensselaer Polytechnic Institute, Danon (10')
   - Other reports (10')
2. Report on fusion research and related meetings, Cheng (15')
3. Recent measurement activity for the standards, Carlson (10')
4. A proposed new facility at GANIL for neutron measurements, D. Smith (5')
5. Nuclear data for helium production in fusion, D. Smith (15')
6. Covariances for Evaluated Cross Sections, D. Smith (5')

- **11:00-12:30, Berkner B:** ***ENDF/B-VII Evaluations and Validation (M. Chadwick, chair)***

    1. Conversion of ENDF/B-VI.8 to ENDF/B-VII (Dunford, 10')
    2. ENDF/B-VII status (Herman, 10')
    3. Neutron cross section standards (Carlson, 50')

- **13:00-14:00, Berkner A*: Working Lunch of the CSEWG Executive Committee***

    1. *ENDF/B-VII release*
    2. *ENDF/B-VII paper*
    3. *WPEC matters*
    4. *Next meeting*
    5. *Minutes*

- **14:00-17:30, Berkner B:** ***ENDF/B-VII Evaluations & Validation ctn'd (M. Chadwick, chair)***

    4. Actinides
        - 238-U evaluation and data testing
            - LANL improvements for nn' and capture (Chadwick)
            - ORNL resonance analysis just completed (Leal and Courcelle)
            - Summary of WPEC Subgroup 22 (Lubitz and Courcelle)
            - Preliminary data testing on latest 238-U (MacFarlane)
            - Benchmark Testing of Various 238-U Cross Sections (Weinman)
            - Others on data testing (Huria, ...)
            - Delayed neutrons issues? (Wilson, McKnight)
        - 235-U evaluation
            - Status of evaluation (Chadwick, Leal)
            - Questions on 235-U capture in 10-100 keV range (Kawano)
            - 235-U Data Testing with ICSBEP Benchmarks (Kahler)
            - Data testing (MacFarlane, ...)
            - Delayed neutrons issues?
        - 239-Pu evaluation
            - Status of evaluation, plans for nn' (Chadwick et al.)
            - Data testing
            - Delayed neutrons issues?
        - Am evaluation
            - Status of 241-Am evaluation (Kawano)
            - Status and plans for 242,243-Am evaluation (Talou)
            - Critical assembly testing of 241-Am capture (MacFarlane)

Nov 3, 2004, Wednesday (CSEWG Meeting, USNDP Meeting)

- **8:30-12:30, Berkner B:** ***ENDF/B-VII Evaluations & Validation ctn'd (R. McKnight, chair)***

5. Actinides continued (Chadwick)
    - Other U evaluations, especially 233-U (all)
    - 237-Np critical assembly tests (all)
    - 237-Np evaluation (all)
    - ENDF/B-VI and Preliminary ENDF/B-VII Results for the MCNP Criticality Validation Suite (Mosteller and Little)
6. Fission products (Oblozinsky)
    - Status of WPEC FP library (Dunford)
7. Other evaluations
    - Light nuclei reactions, update (Page, Hale)
    - A-8 reactions, charged particle reactions (Page)
    - Status of photonuclear library (MacFarlane, White)
        - New 240,242-Pu and 238-U GNASH calculations (Chadwick)
    - Putting new 89-Y and 191,193-Ir and 169-Tm into B-VII? (Chadwick, Kawano, Talou, Herman)
    - Deuterium issue (Little, MacFarlane, Hale)
    - Revision of ENDF-202 (McKnight)
    - ICSBEP Handbook 2004 DVD (Briggs)
    - Miscellaneous Benchmark Results with Preliminary ENDF/B-VII (Naberezhnev)
    - LLNL Contributions to ENDF/B-VII (Brown)
    - Fixes to LANL 232, 237, 239-U(n,γ), (n,f) and (n,2n) cross section evaluations (Brown)

- **14:00-14:10, Berkner B:** ***USNDP Opening, P. Oblozinsky***

- **14:15-17:30, Berkner B:** ***ENDF/B-VII Other Topics (R. McKnight, chair)***

1. Decay Data (Wilson, 15')
    - Comment by Reich
    - Comment by Sonzogni
2. Delayed Neutrons (Wilson, 10')
3. Fission Yields (Wilson, 10')
4. Thermal Neutron Scattering (MacFarlane, 10')
5. Testing of Delayed Neutrons (Schaefer, 15')
6. Covariances (Kawano, 20')
7. Elemental evaluations (Herman, 5')
8. Paper on ENDF/B-VII (Oblozinsky, 5')

- **14:15-17:30, Berkner C:** ***USNDP Structure WG (C. Baglin, chair)***

I. Status reports (5' - 10' each, except as noted):

1. NSR (Winchell)
2. XUNDL (Cameron for Singh)
3. ENSDF (Tuli)
4. DDEP (Browne)
5. ENSDF Analysis and Utility Codes (Burrows)
6. Implementation of Band/Raman conversion coefficient table (Burrows, 15')
7. NuDat (Sonzogni, 15')
8. Table of nuclear moments (Stone, 20')

II. Report on Minisymposium at October'04 DNP meeting (Winchell, 5')

III. Reports on evaluator recruitment and training efforts (Tuli, 10')

9. November 2003 training session (Trieste)
10. April 2005 training session (Trieste)
11. Mentoring activities

IV. Possibilities for ENSDF Editor software (Sonzogni, 20')

V. Formats/Procedures/J^{π} rules

12. Nomenclature for rotational bands and configurations (Kondev, 10')
13. Interactions between ENSDF evaluators, reviewers and editor (Cameron, 10')
14. Are A-chain responsibilities reasonably distributed? (Tuli, 10')
15. Should we recommend inclusion of cross section data in transfer reaction datasets for which there are no spectroscopic factor determinations? (5')
16. Consistency (or lack of it!) in treatment of multipolarity and J^{π} assignments in ENSDF for high-spin reaction data; what do our present rules really mean and what revisions should we make? (Baglin, 10')
17. Unpublished references (Tuli, 10')

Nov 4, 2004, Thursday (CSEWG Meeting, USNDP Meeting)

- **8:30-10:30, Berkner B:** ***Nuclear Data for Homeland Security (Common session of CSEWG + USNDP, D. McNabb, chair)***

  1. Nuclear Wallet Cards for Homeland Security (Tuli, 15')
  2. Photon production from Ge + n (Herman, 15')
  3. Neutron activation data for neutron interrogation applications (D. Smith, 15')
  4. p + ^{13}C => gamma source reaction for interrogation & photonuclear work (Page, 15')
  5. Neutron capture spectra and other nuclear data plans (McNabb, 15')
  6. Attribution work on Americium (Kawano, 15')
  7. Nuclear data for gamma-ray telescope simulations (Phlips, 15')
  8. Discussion of needs document (McNabb)

- **10:45-12:00, Berkner B:** ***Reaction Modeling & Astrophysics (Common Session of CSEWG EvalCom + USNDP Reaction WG, T. Kawano, chair)***

  1. Code PRECO (Kalbach, 5')
  2. Code EMPIRE (Herman, 5')
  3. Code McGNASH (Talou, 5')
  4. Summary of reaction code developments (Kawano, 5')
  5. Code TALYS, Monte Carlo and Covariances (Koning, 15')
  6. Structure models relevant for r-process (Moller, 10')
  7. Capture cross sections with DANCE for s-process (Kawano, 10')
  8. Computational infrastructure for Nuclear Astrophysics (M. Smith, 10')

- **12:00-12:30: CSEWG concluding session**, P. Oblozinsky

  1. ENDF/B-VII release
  2. Next meeting
  3. Minutes
  4. Other business

- **12:30 CSEWG adjourns**

- **10:45-12:30, Berkner C:** ***USNDP Structure WG (C. Baglin, chair)***

  1. Completion of discussion of previous afternoon's topics, if relevant
  2. Discussion of any structure/decay topics emerging from Homeland Security session
  3. Did this year's meeting schedule work or do we need a different schedule next year? (5')

- **13:00-14:00, Berkner A:** ***Working Lunch of the USNDP Coordinating Committee***

    1. *Reporting and planning: New format?*
    2. *New chairman of reaction WG*
    3. *Budget briefing*
    4. *ENSDF evaluations and related initiatives*
    5. *Format and date of the next meeting*

- **14:00-17:30, Berkner B:** ***USNDP Data Dissemination, Task Force and Lab Reports (P. Oblozinsky, chair)***

    I. Data Dissemination
    1. New NNDC Web service (Pritychenko, 15')
    2. Other contributions on dissemination

    II. Task Forces Reports for FY04, 5' each

    3. Nuclear Data for Astrophysics (M. Smith)
    4. Nuclear Data for RIA (Kawano)
    5. Nuclear Data for Homeland Security (McNabb)
    6. Impact of Nuclear Data on Society (Kelly)

    III. Laboratory Reports for FY04, 10' each

    7. NNDC report (Oblozinsky)
    8. ANL report (Kondev)
    9. Georgia Tech report (Wood)
    10. Idaho report (Reich)
    11. LANL report (Kawano)
    12. LBNL report (Baglin)
    13. LLNL report (McNabb)
    14. NIST report (Carlson)
    15. McMaster report (Cameron for Singh)
    16. ORNL report (M. Smith)
    17. TUNL report (Kelly)

Nov 5, 2004, Friday (USNDP Meeting)

- **8:30-12:00, Berkner B*: USNDP Concluding Session (P. Oblozinsky, chair)***

    1. Reporting, coordination and planning
        - Annual report FY04 (Dunford)
        - Workplan FY06 (Dunford)
        - Coordination
    2. Proposals
        - High Energy Nuclear Database (Brown, 10')
        - MINIT Initiative (M. Smith, 10')
    3. Budget briefing (Oblozinsky)
        - Issues
        - Initiatives
    4. Next meeting
    5. Minutes
    6. Other business

- **12:00 USNDP adjourns**

List of Participants

CSEWG Annual Meeting, November 2-4, 2004
USNDP Annual Meeting, November 3-5, 2004
Criticality Safety (Nuclear Data Advisory Group) Meeting, November 1, 2004

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Summary of the 54th Cross Section Evaluation Working Group Meeting

Held at
Brookhaven National Laboratory
November 2 - 4, 2004

Cross Section Evaluation Working Group

Chairman's Highlights

P. Oblozinsky
National Nuclear Data Center, BNL

A. CSEWG Annual Meeting

The 54th CSEWG meeting was held on November 2-4, 2004 and attended by 48 participants. Among them were 6 participants from the US nuclear industry (Knolls Atomic Power Laboratory, Bechtel Bettis and Westinghouse), and 5 participants from foreign laboratories including a representative of Atomic Energy of Canada, Ltd.

The meeting was organized adjacent to the US Nuclear Data Program annual meeting, with a common session on nuclear data for homeland security.

A central topic was development of a new version of the ENDF/B library, ENDF/B-VII. Time allocated to other topics was reduced to allow for an extended session of combined Evaluation Committee & Data Validation Committee.

Measurements and Basic Physics Committee

Several reports on measurement activities were given. Of special interest is the work reported by LANL on the Lead Slowing Down Spectrometer that would allow fission cross-section measurements using ultra-small samples. A new approach to produce covariance data was reported by ANL, a hot topic that has already triggered extensive discussions in nuclear data community.

Formats and Processing Committee

Two format proposals, extensively discussed in 2003, were approved this year. These are compact covariance format in the resonance region and extended Reich-Moore format also in the resonance region.

Evaluation Committee & Data Validation Committee

New and improved evaluations are produced primarily by LANL, followed by ORNL and BNL. Data validation is driven by LANL, with contributions from a number of other laboratories including nuclear industry, in particular Bechtel Bettis, Knolls Atomic Power Laboratory as well as Westinghouse.

Impressive progress was achieved in validation of actinides. In general, validation for fast critical assemblies shows excellent or good results. There are several remaining issues, primarily for thermal assemblies.

Important progress was achieved in neutron cross section standards. The work on new standard cross sections will be fully completed in 2004, with covariances to be finalized in 2005.

The original deadline for ENDF/B-VII release was confirmed. The schedule is as follows:
- May/June 2005, a small meeting at ANL to review progress on data validation.
- November 2005, CSEWG annual meeting, final review and approval of the new library.
- December 2005, ENDF/B-VII release by the NNDC.

Release of the library will be accompanied by an extensive paper on ENDF/B-VII (about 40-50 pages, most likely in Nuclear Science & Engineering). The principal author will be Chadwick, with drafting group including MacFarlane, McKnight, Leal, Oblozinsky and Young, and full authorship including most of the CSEWG.

Next Meeting

The next CSEWG meeting will be held at BNL on November 8-10, 2005 (Tuesday – Thursday), while adjacent USNDP meeting will be held on November 9-11 (Wednesday – Friday), 2005.

B. CSEWG Executive Committee Meeting

The Executive Committee met during lunch on November 3, 2004, with all members present. This included chair (P. Oblozinsky), four committee chairs (M. Chadwick, M. Greene, R. McKnight, D. Smith) as well as R. Block, A. Carlson, E. Cheng, L. Leal and D. McNabb.

Agenda

ENDF/B-VII Release

It was felt that CSEWG is making an excellent progress. In view of this, the original date for ENDF/B-VII release was confirmed – December 2005.

ENDF/B-VII Paper

It was decided that an extensive paper on ENDF/B-VII should be drafted in 2005 so that it can be submitted for publication shortly after the library is released. There should be a principal author, small drafting group and full authorship (CSEWG).

WPEC matters

The US delegation should be the same as in 2004 (P. Oblozinsky - head, R. McKnight, M. Greene and Don Smith; the meeting should be also attended by L. Leal). In future, it would be important to make sure that the chair of data evaluation committee (M. Chadwick) is official member of the US delegation. The next WPEC meeting should be held on April 8-9, 2005 at Antwerp, Belgium, adjacent to the Workshop on Nuclear Data Needs for Gen-IV Reactors (April 5-7, 2005).

Other business

Summary document from the CSEWG Annual Meeting should be prepared in the same format as in the last year (short hardcopy document, presentations and reports on Web). The next meeting should be held adjacent with the USNDP annual meeting, in November 2005.

Cross Section Evaluation Working Group

Measurement and Basic Physics Committee Report

Donald L. Smith, Chairman
Argonne National Laboratory

A. Executive Summary

The Measurement and Basic Physics Committee met for approximately two hours on the morning of November 2, 2004. This session was considerably shorter than had been the norm during previous years because of the need to adhere to a very tight schedule for the combined CSEWG and USNDP meetings as well as for the special joint CSEWG/USNDP session on Homeland Security. In general, the CSEWG meeting for 2004 is characterized by the devotion of a major portion of its time to reviewing individual evaluations for ENDF/B-VII (due for release in December 2005).

During the Measurement and Basic Physics session (held in parallel with the Formats and Processing session) there were formal experimental reports presented from four laboratories that traditionally are closely associated with CSEWG (ANL, LANL, NIST, and RPI).

In addition, there was a short, informal report on the status of the ORELA facility at ORNL.

The status of recent experiments that will have a major impact on the forthcoming international standards evaluation was presented by the NIST representative to CSEWG.

A short report was presented on a proposed new white-source neutron facility in Europe (SPIRAL-2 at GANIL, Caen, France) that will offer the potential for a wide range of neutron physics measurements. The goal is to bring this facility on line in 2009 if funding for its construction is approved.

Ongoing nuclear work in the fusion community related to the ITER program was presented. It was pointed out that with advent of the U.S. rejoining the ITER project, the focus of attention has turned away from nuclear technology issues toward more immediate concerns related to the design of ITER, e.g., to plasma related technologies. The status of neutron reaction data associated with helium production was reviewed in the context of the fusion materials development program. In particular, the impact of these data on development of the IFMIF materials test facility was discussed.

Finally, a short report was presented concerning a proposed approach for generating covariance matrices associated with vertical evaluations generated using nuclear models. There was lively discussion on all of the above mentioned topics.

B. Laboratory Experimental Reports

Representatives from four laboratories (ANL, LANL, NIST, and RPI) presented formal reports on experimental work performed during the past year at their facilities. These presentations can be obtained from the NNDC either in Powerpoint or PDF format. In addition, a representative from ORNL who attended the session giave an informal report on the status of the ORELA facility.

ANL

F. Kondev (ANL) was unable to attend this session to present his report due to travel delays. However, the slides for his talk were shown by the Chairman. The presentation dealt mainly with experiments conducted at the Argonne ATLAS heavy ion facility in collaboration with staff from the Argonne Physics Division. The emphasis of this work is mainly on studying the properties of high spin states and K-isomers in medium to heavier mass nuclei.

LANL

R. Haight (LANL) provided an overview of the extensive experimental work being carried out at six individual facilities at LANSCE (GEANIE, FIGARO, DANCE, N-Z Spectrometer, LSDS, and the Double Frisch-grid Fission Chamber) that are employed for both basic physics and applied research.

GEANIE is a multi-detector facility for gamma-ray measurements on neutron-induced reactions in the energy range 1-200 MeV. Emphasis during the year was on neutron reactions on isotopes of Ir, Au, Mo, Te, Ge, Cr, V, Ti, Fe, Sn, Ba, Er, W, and U. Data on partial cross sections derived from these measurements are frequently used in conjunction with nuclear model code calculations to generate evaluated estimates of full cross sections.

FIGARO is used for neutron emission studies associated with (n,xn+gamma) reactions. It consists of an array of neutron detectors positioned at various angles; it can be used over the energy range 1-200 MeV. Emphasis during the past year has been on fission neutron spectrum measurements for isotopes of U and Np and inelastic scattering spectrum measurements for isotopes of Si, Ni, Tc, and Pb. A comparison has been made between the measured fission-neutron spectra from U-238(n,f) as a function of neutron energy with results from the Los Alamos Model (Madland and Nix). Good agreement was observed at energies below 20 MeV, but deviations are evident at higher energies. The N-Z Spectrometer consists of several counter telescope detectors which can be positioned at a variety of angles to measure charged-particle emission spectra associated with (n,Z) reactions. During the past year work has been done on proton and alpha-particle emission from natural Fe, Cr, and Ta.

DANCE is a highly sensitive instrument used for neutron capture measurements involving very small samples of rare or radioactive material. During the past year measurements were performed on isotopes of Au, La, Sc, Mn, Co, Cu, V, Rb, Sr, Pd, Ni, Eu, Np, U, and Sm.

The LSDS (Lead Slowing Down Spectrometer) utilizes a 1.2-meter cubed block of lead to provide an intense source of moderate neutrons for low-energy-resolution (approximately 30%) fission cross sections measurements using ultra-small samples. During the past year attention was focused on procedures required to measure the fission cross section for 26-m U-235m. Measurements were also performed on Pu-239 neutron fission using sub-microgram samples of material.

Finally, work is in progress to develop a Frisch-grid fission ionization chamber for minor actinide measurements in support of the AFCI program. Measurements on the yield of spallation products from high energy protons were discussed briefly, with particular attention to the production cross section for Gd-148 which is an important poison that impacts on the usable lifetime of spallation targets.

NIST

Carlson presented a combined report on neutron cross section work at NIST and the status of recent neutron cross section experimental results (world-wide) that are contributing to the data base utilized in the international neutron standards evaluation project. This presentation focused on the following reactions:

- H(n,n)H: Measurements of the coherent scattering length have been performed at NIST. The Ohio University-NIST-LANL collaboration is measuring the angular distribution for this reaction in the vicinity of 15 MeV. Unfortunately, data on these distributions will not be available in time to be included in the international standards evaluation. The higher-energy angular distribution data available from Uppsala, Indiana University, and PSI were discussed and it was pointed out that unacceptable discrepancies still remain there in spite of this work.
- He-3(n,p): NIST has measured the coherent scattering length for this reaction. A NIST-Indiana University-LANL collaboration is measuring the reaction total cross section.
- Li-6(n,t): A recent NIST measurements for this reaction agrees very well with the result obtained by the international neutron standards evaluation project. Data on this reaction from Zhang that appeared to be widely discrepant with respect to other reported work has been withdrawn.
- B-10(n,alpha)Li-7: Recent cross section data from IRMM by Hambsch and by Georginis appear to resolve a discrepancy between early measurements from ORNL and the ENDF/B-VI evaluation. Discrepant data from Zhang have been withdrawn. In addition, the IRMM group has provided some angular distribution results for this reaction that are very useful in R-matrix analyses of this process.
- U-238 capture: The thermal value from Poenitz that was used in the ENDF/B-VI standards evaluation has been replaced by a more recent one provided by Trkov.

- U-235(n,f): The data from Nolte have been finalized for use in the international neutron standards evaluation. and coherent scattering data from Arif have been used to improve the K1 value.
- U-238(n,f): Problems at energies above 30 MeV persist due to unresolved discrepancies between the Nolte, Lisowski et al., and Schcerbakov et al. results.
- Pu-239(n,f): Discrepancies between results from Lisowskiet al., Staples and Morley, and Shcherbakov persist leading to large uncertainties in the evaluation at energies above 30 MeV. LANL is considering making new measurements in this energy range to try and resolve this problem.

RPI

During the past year, the experimental program at RPI focused on transmission and capture measurements in the thermal and epithermal energy regions for Rh, Mo, and Dy-164. Analyses of these data are planned in the upcoming year. A method to use the RPI multiplicity detector for alpha (capture-to-fission) measurements has been developed.

The first test measurements for U-235 have been completed and the results from this test will be used to design future experiments. Transmission and capture measurements are being planned for Re, Eu-153, and F. Transmission thermal and epithermal measurement were completed for U-236 with a sample having 89.2% enrichment. A 0.5-g sample, enriched to 99.8% in U-236, has been acquired and will be used for capture measurements. Alpha has been measured from thermal to about 50 eV for U-235.

Analysis of transmission and capture data for Nb, Gd, Rh, and Cd are being analyzed using the SAMMY resonance fitting code. Repairs and upgrades of the RPI accelerator facility continue with a focus this year on the injector upgrade and installation of a large neutron detector at the 100-m station for transmission measurements.

ORNL

No formal report was provided by ORNL. However, R. Westfall gave a brief informal report on the current status of the ORELA facility. Support for maintainance of this facility has been very uncertain during the past several years. As a consequence, the capabilities of this facility have deteriorated to a critical point. ORNL has indicated that support from the DOE Office of Science for maintainance and improvement of ORELA is not likely to be forthcoming. However, ORNL is making a case to preserve this premier U.S. white source facility because of its potential benefit for the Criticality Safety Program and other national security concerns, It has prepared a budget for that projects costs of approximately $1.6M required to satisfy this objective.

C. Special Reports

Fusion Research and Related Meetings

E. Cheng presented a report on the status of nuclear data needs pertinent to nuclear fusion. It was pointed out that since the U.S. rejoined the ITER project, the main emphasis of U.S. research activities in fusion have switched away from nuclear technologies to technologies more relevant to the immediate design of ITER, e.g., plasma physics problems. The limited nuclear activities in the U.S. are currently taking place at University of Wisconsin (Madison), UCLA, and TSI Research. The activities are as follows:

- UW (Madison): Research focuses on neutronics analyses in support of ITER test blanket modules (e.g., assessment of liquid coolant blankets, molten salts, and PbLi), development of a CAD-based version of MCNP for 3-D calculations related to fusion, and continued development of the activation code ALARA.
- UCLA: This laboratory is carrying out 2-D neutronics analyses using code DORT in support of ITER test blanket models (e.g, activation analysis of molten salt liquid blankets and design analyses of solid breeder and pebble-bed test blankets.
- TSI Research: TSI is looking at various applications for fusion neutrons and related topics (e.g., transmutation of spent fuel actinides, U-238 burning power plans, and performance of subcritical quantities of actinides in equilibrium in a fusion blanket).

Nuclear Data for Helium Production in Fusion

An international facility for fusion materials testing, known as IFMIF, is being considered. This facility would utilize 40-MeV deuteron beams on liquid lithium targets to produce an intense source of neutrons with a spectrum peaking in the 14-15 MeV range but extending from thermal to nearly 60 MeV in a broad peak. With this in mind, a survey of the status of cross section data for neutron reactions that generate helium at neutron energies up to 60 MeV has been conducted by D. Smith (ANL, retired). This survey has drawn information from the experimental and evaluated data files archived at the NNDC and IAEA-Nuclear Data Section.

It was concluded that the status of data for energies below 14 MeV is in reasonably good shape, but it is generally poor for higher energies, especially above 20 MeV where the existing information is based largely on nuclear model calculations. On the basis of this study it was proposed that direct measurements of helium production (by means of mass spectrometry) be performed using samples of candidate materials and neutron irradiation sources that generate 14-MeV neutrons (neutron generators) or spectra similar to the proposed IFMIF spectrum.

A New Neutron Facility at GANIL (SPIRAL-2)

D. Smith offered a brief report on a proposed new facility in Europe for basic nuclear physics studies in the areas of astrophysics, radioactive ion beams, and neutron reactions.

This facility, to be known as SPIRAL-2, would represent a major upgrade to the existing GANIL facility (Caen, France), and it would be used mainly for the production of exotic neutron-rich ion beams. However, a special beam line devoted to neutron experiments is being considered. Neutrons would be produced by 40-MeV deuterons on a rotating carbon target. Intensities on the order of 1 x 10^{15} neutrons/sec are anticipated, with a strong yield in the region above 1 MeV.

This facility could be used for certain materials testing applications and also as a white-spectrum, pulsed source of neutrons for cross section measurements by time-of-flight. A workshop dealing with potential uses of this facility for neutron measurements has been organized for December 2004 in Caen, France.

Covariances for Evaluated Cross Sections

D. Smith provided a brief description of a new approach to generating covariance information for vertical evaluations generated mainly from nuclear model calculations. This approach involves establishing ranges of values (uncertainty intervals) for all of the nuclear model parameters used, and then randomly varying the parameters within these ranges according to a Monte Carlo approach. This would generate a large number of comparable evaluations that correspond to "data" which can be used in a statistical analysis to generate not only central values for the evaluations but also covariance matrix elements.

This approach has been tested by A. Koning (NRG-Petten) and was shown to offer considerable potential. Results from his preliminary tests are presented in another session of the 2004 CSEWG meeting.

Cross Section Evaluation Working Group

Formats and Processing Committee Report

N. Maurice Greene, ORNL
Committee Chairman

The Formats and Processing Committee meeting was held on Tuesday morning, November 4 from 8:45 am until 10:45 am. The agenda is shown below:

1. Format Issues for ENDF/B-VII
    a. Status Report on Compact Covariance format, N. Larson
    b. Status Report on Extended Reich-Moore format, N. Larson
    c. WPEC Format Proposals, A. Trkov
    d. Format Proposal for Post-fission Beta-delayed Photons, D. Brown

2. Processing Codes
    a. LANL NJOY Status Report, R. MacFarlane
    b. ORNL AMPX Status Report, M. Dunn
    c. LLNL Codes, D. McNabb
    d. ANL Codes, R. McKnight

3. Other Items
    a. Corrections and Revisions to ENDF-102, C. Dunford and others
    b. Status of Checking Codes, C. Dunford
    c. Current Projects at IAEA-NDS, A. Trkov

Format Issues

N. Larson reported that the compact co-variance format has been implemented and is undergoing testing in the ERRORJ module, which is a Japanese modification to the ERROR module in NJOY. She mentioned that the coding seemed to produce the expected results, and that some future improvements are expected, such as using analytic expressions instead of numerical approximation for derivative values required in the co-variance analysis. This format had been tentatively approved at the 2003 CSEWG meeting, awaiting a demonstration of its usability. The format was officially approved at this meeting.

N. Larson reported that the new LRF=7 Reich-Moore formats that accommodate charged particle channels has been implemented by D. Cullen in one of his LLNL codes and by R. MacFarlane in NJOY. The format had been tentatively approved in 2003, and was officially approved this year, based on its successful implementation.

A. Trkov had reported that no new formats were being proposed by the WPEC community for this meeting, and that the unresolved region format based on Reich-

Moore procedures that had been sent back to its originators asking for some additional clarifications had not received any additional submissions.

A proposal for a new format to address post-fission beta-delayed photons was given by D. Brown. The format was not approved at this meeting, awaiting some fairly minor modifications to the write-ups that had been provided to show the necessary modifications required to ENDF-102. It is expected that these modifications will allow the format to be approved at the 2005 CSEWG meeting.

Processing Codes

R. MacFarlane reported that the modifications to NJOY during the previous year were relatively minor and primarily related to converting all coding to the FORTRAN 95 programming language.

M. Dunn presented some results from the data checking that had been done during the previous year that demonstrated the AMPX system was now producing reasonable results for a large suite of benchmarks. R. McKnight noted that these and other calculation results should also be reported in the Data Testing session.

The presentation by D. McNabb was devoted to the possibility of using more modern files structures for storing ENDF/B data. In particular, he revisited a topic that has been discussed in the Formats session of previous CSEWG meetings and discussed the advantages that could accrue from using XML. In particular, he noted that using XML could take advantage of a vast collection of readily available software for formatting, accessing, viewing, modifying, and transmitting data, and should make the construction of data processing codes much easier. He mentioned that LLNL is already involved in a pilot project for treating uncertainty data, which may demonstrate more advantages (and/or disadvantages) associated with the use of a much more modern approach for storing cross-section data.

R. McKnight reported that the codes at ANL were being modified to deal with new ENDF/B formats, but that some items, such as the compact covariance data format and the new Reich-Moore format still were not implemented.

Other Issues

A small number of corrections to the ENDF-102 manual were noted by A. Trkov. All participants were encouraged to submit corrections to M. Herman. Herman noted that the manual could now be downloaded in Microsoft Word format, which would make it very convenient for anyone to mark the corrections directly in the manual's text (for example, in color), thereby expediting the process of getting changes made.

C. Dunford noted that all of the checking codes had been converted to FORTRAN-95.

The "Current Projects of the IAEA-NDS" topic was not discussed, because the item was placed on the agenda very late without notifying the session chairman. Fortunately, the viewgraph is included in the meeting handbook. Here A. Trkov has noted IAEA contributions to the ENDF/B-VII Standards work that were reported elsewhere in the meeting. Next there is mention of a new Dosimetry file called IRDF-2002. New thermal scattering law evaluations for $H(H_2O)$, $H(Zr_x)$, and $D(D_2O)$ were announced. A new data collection of input parameters for nuclear model codes is called RIPL-III. Good progress is being made on a new evaluation for ^{232}Th, involving cooperation between the IAEA, LANL and ORNL. A new version of the FENDL data library called FENDL-2.1 is being prepared.

Cross Section Evaluation Working Group

Evaluation Committee & Data Validation Committee Report

Mark Chadwick, LANL
R. McKnight, ANL

A. Summary To Do List

1. **Carlson** will send new standard cross sections to LANL very soon. LANL **(Young, Talou, Kawano)** will build new actinide evaluations based on these standard fission (and capture cross sections) by the end of CY04. These will then be posted on the T2 website and announced as available for testing.

2. Chadwick will ask **Phil Young** to look at the Cl checking code comments, as Phil did these evaluations recently.

3. **Tokio Fukahori** should ask our JAERI colleagues to help fix the Hg isotope evaluation checking-code complaints.

4. **Carlson, Kawano, Young, Chadwick** will look into ^{238}U capture to make sure the **^{238}**U standard (which is based on just the standard ratio data) is reasonable. **Kawano** will provide insights based on the WPEC ^{238}U subgroup's conclusions. **MacFarlane** will help test the impact of any capture changes of ^{238}U on Bigten & other reaction rate integral validation tests. We'll resolve some differences in **MacFarlane and Mosteller** results for Bigten using the Carlson capture cross section.

5. **Hale** will give us feedback on the ^{16}O(n, alpha) cross section status, including the basis for the value for this based on the inverse channel measurement, and the integral testing.

6. Kahler noted the strange shape to nubar for ^{235}U, as a function of energy. We'll ask **Phil Young** to check this! (the decrease at 1-2 eV, and then the dip near 100 keV). Carlson says the standards group has a thermal value. (Check with Cecil that we should not use this).

7. U minor isotopes: **Young & Chadwick** will study Brown's peer-review, and may modify some LANL evaluations based on this feedback. ^{232}U has a kink at 2 keV. Brown proposed a change from 2 keV to about 0. 1 MeV. ^{237}U (n, gamma) has kink at about 0. 006 MeV, and this was smoothed out. Below 0. 01 MeV, **^{237}**U fission goes down in the LANL one, whereas LLNL keeps rising. For ^{239}U we need to use Phil's latest, which now matches the Younes data. Brown commented that this would probably also then improve the fix up in the ^{239}U capture he suggested.

8. The upgraded deuterium evaluation in ENDF/B-VI. 6 by Hale gives poorer performance in Mosteller's criticality testing. Also, CANDU reactor people say they prefer the earlier release-0**.** **Hale** will look into whether he feels the basis for his changes are still valid. **Kozier** will provide CANDU feedback. Little noted that there are also indirect indications from Stephanie's Li-D data testing that prefers the old D evaluation.

9. Dosimetry files: ^{89}Y, ^{191,193}Ir, ^{169}Tm. **Herman** will help integrate new LANL dosimetry evaluations into ENDF complete files – possibly via new ENDF evaluations he will make for these isotopes by running EMPIRE, or by making use of Koning automated ENDF files made by TALYS. He will use the LANL cross section information and combine with other info for distributions.

10. **Talou** and **Kawano**, will submit new $^{241, 242, 242\ m, 243}$Am evaluations.

11. **McNabb** will make their new (Hoffman) Livermore dosimetry files available for use, say as an MCNP dosimetry file.

12. **Herman, Oblozinsky, Dunford.** The fission products from BNL and the WPEC project. The testing of these will include NJOY testing and automated simple MCNP runs (as MacFarlane does routinely).

13. **MacFarlane** will send **Herman** the new **Hale** photonuclear Deuterium file.

14. **Hale** will confirm he adopted **McAninch/McNabb's** peer-review comments on the light nucleus work. (He found some minor clerical errors, and one substantive problem).

15. **Chadwick** will look for resources to try to get the GNASH photonuclear analyses for actinides (done with Marie Giacri) converted into full ENDF files (using RECOIL) with prompt and delayed fission data added from equivalent neutron files. (Could **Young** help here?)

16. **Chadwick/Talou/Kawano/Young** will look at their relatively recent Pb evaluation, especially elastic scattering for fast neutron energies. Will work with **MacFarlane, Kahler, Briggs, Koning,** to see if the LCT10 and other new benchmarks noted by Briggs can be improved.

17. **Hale and MacFarlane** will study n+^{9}Be nuclear data to see if cross section improvements can help with Be reflection and absorption in critical assemblies.

18. **Wilson** will enter new delayed neutron data into ^{235,238}U and ^{239}Pu evaluations by Dec 04. (not new spectra values by then!). **Schaefer** and **McKnight** will do additional data testing for the delayed neutron data.

19. **McKnight** will coordinate data testing, including possibly new benchmarks from Russia put in Brigg's handbook recently (eg new intermediate BigTen-like assemblies).

20. **Page/Hale** will submit finalized ENDF files for light nuclei, including A=8 system.

21. **MacFarlane** will do additional studies of the Mattes S(α,β) work to see whether it is worth adopting for ENDF/B-VII. His initial studies indicated that the changes were modest compared to her earlier work.

22. **Leal** and **Kawano** will complete Gd isotope (and maybe Re too) covariance evaluations by the next NDAG meeting (to be presented there). **Leal, Larson, etc, and Talou, Kawano** will aim to complete ^{235}U, ^{238}U and ^{239}Pu covariances by the end of FY05, for criticality safety and AFCI. These could then be released with ENDF/B-VII.

23. Summary ENDF/B-VII paper for NSE. A coordinating principal author list – **Chadwick, Oblozinsky, Leal, McKnight, Carlson, MacFarlane** – will take the lead on putting this together. Author list – CSEWG. **Chadwick** will start putting this together, based on ND2004 papers. **Chadwick & Oblozinsky** will contact Dan Cacuci from NSE to get his concurrence.

24. **MacFarlane** will send to BNL the electronic files of the presentations made at the Evaluation/Data Testing Committee meeting held at LANL in May 2004.

25. **McKnight** and **Chadwick** will set a time in Spring 2005 to hold an Evaluation/Data Testing Committee meeting at ANL.

B. Minutes

a) Overview Talk on Status of Preliminary ENDF/B-VII, Mike Herman

Total number of new evaluations for ENDF/B-VII is 236, including 56 neutrons, 10 protons, 5 deuterons, 3 tritons, 2 helium-3, and 160 photonuclear. Comments:

- Many new LANL evaluations. MacFarlane will send the new gamma + D evaluation.
- Oak Ridge resonance revaluations (^{19}F, ^{35,37}Cl, ^{241}Pu). Plus LANL/ORNL for ^{28}Si, ^{232,233,234,235,238}U.
- BNL fission product evaluations (with SG23 evaluations – up to 200 new evaluations)
- The 160 photonuclear evaluations have not been changed.

Mike noted many checking code complaints, for example, CHECKR and FIZCON complaints for Cl and Hg. Chadwick will ask Phil Young to look at the Cl comments, as Phil did these evaluations recently. We should ask our JAERI colleagues to help fix the Hg isotope evaluation checking-code complaints.

b) Standards, Allan Carlson

Carlson indicated that before the end of CY04, the Standards CRP group would finalize their standard cross sections (not covariances yet), and provide to LANL. This will allow us to use the new ^{235}U, ^{238}U, ^{239}Pu fission cross sections and ^{238}U capture cross sections.

Carlson, Kawano, Young, Chadwick will look into ^{238}U capture to make sure the ^{238}U standard (which is based on just the standard ratio data) is reasonable. Kawano will provide insights based on the WPEC ^{238}U subgroup's conclusions. MacFarlane will help test the impact of any capture changes.

c) ^{238}U Evaluation

LANL high energy evaluation

Chadwick described the latest advances to the LANL evaluation: a refined treatment of the inelastic scatterings, from 14 MeV (actually higher too) and down, with improved simulations of LLNL pulsed spheres; updated capture cross section based on Carlson's interim standard; updated fission cross section based on an early version of the standard.

Oak Ridge Resonance work for ^{238}U (Leal, Courcelle)

- Include Harvey transmission and Macklin capture data.
- ORNL2 = file released last year for testing
- ORNL3 = included by ND2004.
- ORNL4 = just completed and now merged with LANL high-energy file; refined analysis of 1-10 keV region. This is the one incorporated into the latest file for the CSEWG meeting, and tested.
- Thermal capture value is 2.683 b following Trkov work. (The ORELA direct analysis gave a similar value).
- Ongoing work on unresolved resonances in the 20-150, or 300 keV unresolved. This probably won't be completed until May.

Summary of NEA/WPEC Courcelle Subgroup, Cecil Lubitz

Many files use Froehner study, unresolved 10-150 keV. Explained rationale for a reduction in the thermal capture cross section by ~ 1%. Noted that in many cases, though, the impact is modest because ^{238}U is an epithermal capturer.

To do:

- Check ^{238}U capture is OK – Phil Young's plots show the bulk of differential cross section data lying above the standard evaluation near 0,25 MeV. Presumably this is because experts have concluded certain data sets (& ratio sets) are most accurate.
- Kawano noted that a NEA WPEC subgroup studied this, and its recommendations were (approximately at least) adopted by JENDL.
- MacFarlane noted that the BigTen result is just slightly worse – probably due to the lower capture from Carlson's preliminary standard value, so another look at this capture cross section is warranted.
- Young, Carlson & Kawano will check this.

^{16}O(n,α):

- ENDF/B-VI is almost twice ENDF/B-V, based on Hale's R-matrix use of Beer data. Perhaps this should be reduced. Cecil would like a new measurement (Geel?), but this will take a long time. A reduced (n,α) would increase the ^{238}U critical assemblies further to give better agreement – about a 0. 001 increase in k_{eff}, Cecil thinks.
- Some of the reactor community thinks the higher (n, α) is better. However, at present there doesn't appear to be conclusive evidence that would require us to change Hale's analysis.
- Hale will provide comments on this again to us.

d) ^{235}U Evaluation

Chadwick described the update to ^{235}U evaluation based on use of the interim ^{235}U standard fission cross section, and the new Young high-energy inelastic cross sections, for better pulsed-sphere performance.

Kahler has tested the latest ^{235}U put out by LANL (U235LA15B). ENDF/B-6. 8 gave k=0. 9996 (looks very good, based on earlier gains made for release 5). Now we have 0. 9994 with the latest set – has maintained the good performance.

Need to take a look at nu, from thermal to high energies, with decrease at 1-2 eV, and then the dip near 100 keV.

Alan noted that the standard evaluation for thermal nubar is on the high side, almost as high as ENDF/B-V.

e) ^{233}U Evaluation

Evaluation at ORNL uses differential and integral information (Westcott factor etc), up to 600 eV (unresolved up to 40 keV). Leal's talk presented the file given to LANL a year or two ago.

f) Other U isotopes, Chadwick and Brown

Chadwick summarized the new reaction rate data testing by MacFarlane of reactions like ^{238}U (n, 2n) and (n, gamma) using the radiochemistry data from MacInnes et al. Also noted upgrades to isotopes such as ^{234}U (a higher capture cross section), and our preliminary upgrades to ^{237,239}U based on Younes' fission cross sections from direct reactions. Used many of the LANL ENDF/B-VII evaluations.

David Brown at LLNL has used the LANL U isotope evaluations, but with some modifications in a few cases. These should be studied by LANL:

- ^{232}U has a kink at 2 keV. Brown proposed a change from 2 keV to about 0. 1 MeV.
- ^{237}U ng kink at about 0. 006 MeV, and this was smoothed out.
- Below 0. 01, ^{237}U fission goes down in the LANL one, whereas LLNL keeps rising. ^{239}U. We need to use Phil's latest, which now matches Younes data. David commented that this would probably also then improve the fix up in the ^{239}U capture he suggested.

g) ^{237}Np Evaluation

The ENDF/B-VII file will be same as ENDF/B-VI, but with fission cross section based on the new ^{235}U standard.

h) Mosteller data testing conclusions (presented by Bob Little)

Some benchmarks (for 233 say) that include thorium show problems. Solutions and fasts tend to perform well. No real swings in reactivity with reflectors.

Mosteller's BigTen results looks a bit better than MacFarlane's.

The B&W assembly, like reactor problems, is sensitive to ^{238}U and looks very good now.

Pu – all looks good, except for cases with thorium.

Thermal Pu is not particularly good. (Presumably it is no worse than for ENDF/B-VI).

Bias present in LEU-HEU δ-k swings against "intermediate energy fission fraction". Don't know which isotope is responsible for this (. 625 to 100 keV region ish?).

Np-HEU still poorly calculated at 0. 9922. We haven't yet analyzed the Np-Fe one. We do poorly for unknown reasons on the Pu-HEU assembly.

Deuterium: Uranyl nitrate in heavy water reflected by heavy water, and some unreflected ones too. D was changed at Release 6. The change made things worse by 0. 5%. Going back to Release 0 gave improvements.

14 MeV source with Li-D spheres, and also some U sphere surrounded by Li-D.

CANDU people say they prefer the earlier 6. 5== 6. 0 D set. We'll get data testing from them in the spring time to bear on this.

^{6}Li triton production? Li results are better when we use older deuterium, ^{7}Li tritium production has some deficiencies as a function of energy – but has a higher threshold than for ^{6}Li.

Pu nu-bar fluctuates with the resonances – the only case. Cecil says he thinks there are theoretical reasons why this fluctuation is reasonable. Eric Fort did this work.

i) Fission Products, Oblozinsky

Oblozinsky talked about the major effort to produce a suite of new FP evaluations, based on the international WPEC collaboration, SG21 and SG23.

At the Santa Fe SG23 meeting, ND2004, it was agreed that some data testing would be done by Mike Dunn, and by JEFF & by CEA. Dunford is optimistic that many of these will be available by ENDF/B-VII.

We agreed that these files should also be run through a basic NJOY processing and MCNP transport calculation (as MacFarlane does automatically), to ensure completeness for transport calculations.

j) Dosimetry Files

Y, Ir, Tm: Mike Herman will help integrate new LANL dosimetry evaluations into ENDF complete files – possibly via new ENDF evaluations he will make for these isotopes by running EMPIRE, or by making use of Koning automated ENDF files made by TALYS.

McNabb, Livermore will make their new (Hoffman) dosimetry files available, for use say as an MCNP dosimetry file.

k) Photonuclear Evaluations

Chadwick noted his hope to find time to make photonuclear evaluations for actinides, from his GNASH work with Marie Giacri. MacFarlane will submit Hale's new photo-Deuterium evaluation.

l) Blair Briggs, INEEL

Be benchmark data: Moderated (absorption), and also Be reflected systems. Also, ORNL benchmarks newly added (up t 11% absorption in Be). C/E is 1-2% high for these ORNL assemblies with ENDF/B-VI (ENDF/B-V was better).

Pb: Lead reflected data, and LLNL data. There is trend in increase of k_{eff} with reflection. LCT10 have lead reflected too, and problems are seen for ENDF data – Koning has had better results using his latest calculations for Pb isotopes. But Blair did some that are very sensitive to lead (lead on all 4 sides, and so is more sensitive than LCT10). Calculated result is 2-3% high using JEFF data (improved now by Koning), and presumably ENDF data.

Blair presented a large number of new benchmark descriptions of Russian measurements that have similarities to BIGTEN. It would be nice for us to test all our new data (especially ^{238}U) on these benchmarks.

m) Dimitri Naberezhnev, ANL

Naberezhnev performed testing using VIM (Monte Carlo) and TWODANT with the preliminary ENDF/B-VII files for some of the criticality safety benchmarks highlighted by Briggs (see previous item and Santa Fe ND2004 proceedings). Structural materials (Fe, Ni, Cr) seem to perform poorly. In general, only small changes were produced using the preliminary ENDF/B-VII (in particular, some results well predicted with ENDF/B-V data and poorly predicted with ENDF/B-VI data remained poorly predicted).

n) Wilson, LANL: Decay Data, Delayed Neutrons, and Fission Yields

A thorough review was presented of the evaluation process for these data for ENDF/B-VI by Tal England and co-workers. It was noted that none of these data are being re-evaluated for release of ENDF/B-VII. The delayed neutron data currently being evaluated by Wilson are obtained using fits with 6 families (unlike the recommendation of the WPEC subgroup on delayed data and the JEFF community which are now using 8 families). Time constants for the 6 families differ from the ENDF/B-VI values.

Decay data:

- **Ch. Reich, Idaho**, noted that there are several cases where second forbidden non-unique beta decay data are now available. He argued that it would be important to update these decay data in ENDF/B-VII, with impact on decay heat calculations.

- **A. Sonzogni, NNDC**, provided an analysis of the work to be done to update the current ENDF/B-VI decay data library. He noted that JEFF-3.1 should contain considerable more nuclides (~3,000) and more up-to-date data compared to ENDF/B-VI (~900 nuclides). A comparable update for ENDF/B-VII would require about 2 months effort, using the most recent versions of databases available at the NNDC, in particular Atomic Masses (Audi 2003), Nuclear Wallet Cards (new issue under preparation for 2005), BRICC Internal Conversion Coefficients (set up in 2004) and ENSDF (2004).
- No conclusion was reached on these suggestions due to limited interest by CSEWG.

o) David Brown, LLNL

- Not full evaluations though, just cross sections
  - $D+^{3}He$ should be compared with Hale
  - $D+^{6}Li$ should be compared with Hale/Page
  - $p+^{12}B$ reactions these may be new – but again, probably just cross sections
- Plus dosimetry evaluations from Hoffmann for many isotopes

p) Schaefer, ANL, Testing of the Delayed Neutron Data

ANL has calculated β_{eff} for only 2 of the ZPR benchmarks assemblies (ZPR-6 Assemblies 7 and 10). However, these two assemblies do test the delayed data for ^{235}U, ^{238}U, and ^{239}Pu. Schaefer first reported the initial ANL results obtained for ZPR-6/7 which had indicated a 10% change in β_{eff} were in error (resulting from a clerical error for the family 2 data for ^{239}Pu). Results for these 2 assemblies now indicate virtually no change in performance for ENDF/B-VII versus ENDF/B-VI.

q) MacFarlane, LANL, Thermal Scattering Data

S(α,β): MacFarlane is interacting with Europeans on his old data and their new data, and has made comparisons that show modest changes. He will work with Mattes, etc in the coming year to assess whether any changes should be made for ENDF/B-VII.

r) McKnight, ANL, ENDF-202

McKnight reported that ANL has converted the CSEWG Benchmark Specifications, ENDF-202 to electronic form (pdf and Word formats). Frankle and MacFarlane had provided some revisions to some of the benchmarks (in particular, inclusion of some gamma spectroscopy measurements). ANL will perform final editing and deliver to BNL.

Summary of the
U.S. Nuclear Data Program Meeting

Held at
Brookhaven National Laboratory
November 3 - 5, 2004

US Nuclear Data Program

Chairman's Summary

P. Oblozinsky
National Nuclear Data Center, BNL

A. USNDP Annual Meeting

The 7th Annual Meeting of the United States Nuclear Data Program was held on November 3-5, 2004 and attended by 34 participants. The meeting was held adjacent to the CSEWG Annual Meeting, with a common USNDP-CSEWG session on Nuclear Data for Homeland Security.

Nuclear Structure Working Group

The status of basic databases NSR, XUNDL and ENSDF was reviewed. An increase of evaluated mass chains submitted to ENSDF (20 evaluated mass chains in 2004 compared to 15 in 2003) was noted with satisfaction.

A successful training workshop was held at Trieste in November 2003, with key lecturers provided by BNL and LBNL. Active mentoring and training of non-US evaluators followed, primarily at BNL and McMaster, a very promising activity that already produced new mass-chain evaluations.

Nuclear Reactions

Nuclear reaction code development was discussed only briefly, presentations were kept short in view of recent extensive coverage of the topic at ND2004 Conference in Santa Fe, September 2004.

A. Koning (Petten, Netherlands) reported an interesting addition to his code TALYS. It seems feasible to use Monte Carlo approach to produce cross-section covariance data, following recent suggestion by Don Smith, ANL.

Data Dissemination

NNDC reported successful completion of its extensive database migration project. The new NNDC database computer system is based on DELL hardware, Linux operating system, Sybase relational database software and Java-based web interfaces. Entirely new NNDC web service was launched in April 2004, with very positive response from users (~46% increase in data retrievals in FY04 compared to FY03).

ORNL improved considerably its nucastrodata.org web page. It is expected that this web page will have very positive impact on ORNL data retrieval statistics.

USNDP Organization

Coordinating Committee, chair Pavel Oblozinsky, BNL

Standing Working Groups

- Nuclear Reactions Data WG, chair Toshihiko Kawano, LANL
- Nuclear Structure and Decay Data WG, chair Coral Baglin, LBNL

Task Forces

- Nuclear Data for Astrophysics, chair Michael Smith, ORNL
- Nuclear Data for Rare Isotope Accelerators (RIA), chair T. Kawano, LANL
- Nuclear Data for Homeland Security, chair Dennis McNabb, LLNL

The RIA Task Force will continue its work with the understanding that it should update its charter and membership. The Task Force chaired by John Kelly, TUNL (Impact of Nuclear Data on Society) completed its mission already a year ago. This TF may resume its function again later if deemed useful.

Planning and Reporting

Annual Report for FY04 should be issued in a usual format in December 2004. In February 2005, we should issue Workplan for 2006. The next budget briefing should be held in February 2005 as a preparation for FY07. Unless otherwise required by DOE, the budget briefing team will include Pavel Oblozinsky and WG chairs (M. Chadwick and C. Baglin).

It was noted that it would be most useful to include into the Annual Report short anecdotes that would illustrate usefulness and successes of the program. Such anecdotes should show a broad appeal, the target audience being managers responsible for funding on various levels.

It was noted that the term “deliverable” traditionally used in USNDP Workplan does not, in many instances, properly reflect the nature of our work. This term should be replaced by “planned activities”.

Next Meeting

The next USNDP annual meeting will be held at BNL on November 9-11, 2005 (Wednesday - Friday), with start on Wednesday morning. The adjacent CSEWG meeting will be held on November 8-10, 2005 (Tuesday – Thursday).

It was noted that November 11, 2004 (Friday) is a holiday at BNL (Veterans' Day). The conference services will not be available but other facilities should be fully available (Berkner Hall, cafeteria).

B. USNDP Coordinating Committee Meeting

The Coordinating Committee met at working lunchtime on Thursday, November 4, 2004. All 10 members attended the meeting, including P. Oblozinsky (chair), C. Baglin, A. Carlson, T. Kawano for M. Chadwick, J. Kelley, F. Kondev, D. McNabb, J. Cameron for B. Singh, Ch. Reich and M. Smith.

Agenda

Reporting and Planning

Three documents should be produced shortly, with no interim reports or updates:

- Summary of Annual Meeting 2004 (in December 2004),
- Annual Report 2004 (in December 2004), and
- Workplan 2006 (in February 2005).

New chairman of Reaction WG

Mark Chadwick stepped down as chairman of the USNDP Nuclear Reaction Working Group in view of his extensive new responsibilities at LANL. The Executive Committee expressed its deep appreciation for his outstanding services.

Mark's close collaborator at LANL, Toshihiko Kawano, was appointed as a new chair of the USNDP Nuclear Reaction Working Group. It is understood that Mark will continue to represent the USNDP at budget briefings.

Budget Briefing

The next USNDP budget briefing, expected to be held in February 2005, should address FY07 budget. The USNDP team should include P. Oblozinsky along with two WG chairs (M. Chadwick – reactions, C. Baglin – structure). In reference to generally anticipated budget cut in FY06, deep concern was expressed on its impact for USNDP. Although budget for FY06 is not yet known, a cut, or a flat-flat scenario, would have considerably negative impact on FY07 budget as well.

Format and dates of the next meeting

In view of positive experience with combined CSEWG-USNDP meeting arrangement, the traditional dates for USNDP meetings (April-May) will be definitely abandoned. The next Annual Meeting will be held in November 2005, adjacent to the CSEWG meeting.

US Nuclear Data Program

Minutes of Structure and Decay Data Working Group Meeting

2:15-6:00 pm, Wednesday November 3, 2004, and
11:00 am-1:00 pm, Thursday November 4, 2004

C. Baglin, LBNL (Chair)

Present: C. Baglin, S. Basunia (Thursday only), E. Browne, T. Burrows, J. Cameron, R. Haight, J. Kelley, D. Kulp, F. Kondev, B. Pritychenko, C. Reich, A. Sonzogni, N. Stone, J. Tuli, D. Winchell, J. Wood. Also, M. Smith was present for short segment of the meeting on Wednesday.

The following **Status Reports** were received:

- **NSR (D. Winchell):** Of the roughly 178,000 entries in this database, 4398 were added during 2003, and 3713 so far in 2004. For the vast majority of cases, the reference entry year and the publication year are identical. Future plans for NSR include an update of the coding manual, a review of subject indexing and improvements to the website. The *Recent References* issue of the Nuclear Data Sheets will probably be discontinued. Working Group members noted that it would be nice if NSR could provide automatic indexing to decay-daughter nuclei and the option to directly type in the whole reaction for a search.

- **XUNDL (J. Cameron for B. Singh):** This database now contains 1326 datasets, 226 of which were added in FY04. These datasets contain information from 1140 primary references and cover 915 nuclides spread over 221 A-chains. Most were prepared at McMaster by undergraduate students (currently, Joel Roediger) under the close supervision of Balraj Singh. Compilation of recent high-spin and low-spin papers is essentially current. This year, about 50 email communications between the McMaster compilers and authors were sent to NNDC so evaluators can access any additional data or clarification of data contained therein.

- **ENSDF (J. Tuli):** Currently, there are 20 mass chains in the production pipeline (cf. 15 last year). During the year, 20 mass-chain and 9 nuclide evaluations were submitted.

- **DDEP (E. Browne):** Of the 259 radionuclides selected for evaluation by the Decay Data Evaluation Project, 103 have been evaluated, 4 of them in FY04. Data for the latter were provided also for an IAEA-CRP. When ENSDF evaluators start using the recent Band *et al.* conversion coefficient calculations, DDEP evaluators will do likewise (so far, Rösel coefficients have been used). DDEP evaluations can be accessed *via* http://www.bnm-lnhb/DDEP.htm.

- **ENSDF Analysis and Utility Codes (T. Burrows):** (see separate report for details). All programs have now been converted to FORTRAN 95 but, except for NSDLIB and RULER, some in-house checking remains to be done prior to their distribution. Minor bugs were fixed and/or minor upgrades made in FMTCHK, GTOL and RULER. RULER needs to be rerun on datasets created in the last two years if they contain half-lives expressed as a limit. GTOL now permits up to 1000 levels and 4000 gammas. The major software achievement was the development and β release to evaluators of the BRICC package for calculation of the new Band *et al.* conversion coefficients (see below). Further testing remains to be done for 3rd and higher order unique forbidden transition calculations in LOGFT and the electron-capture data of Schönfeld, *et al.* has yet to be added. RADLST upgrades are also planned. In 2005, maintenance of OpenVMS versions will cease.

- **Implementation of BRICC (T. Burrows):** This package, analogous to the HSICC package for conversion coefficient calculations, was developed by an Australian-Russian-US collaboration and made available to evaluators for their comments prior to this meeting. As detailed elsewhere in this report, this provides conversion coefficients (all shells and/or subshells), electron-positron pair coefficients and electronic factors for E0 transitions. The published Band *et al.* table has been significantly expanded as a result of the inclusion of newly-calculated points which provide a finer grid in regions of steep gradient or resonance-like behavior and which extend transition energies to significantly lower and higher (6 MeV) values. Extensive comparisons of BRICC and HSICC results have already been made at NNDC and more are planned. These calculations do NOT take into account the effect of the hole and it was these that Raman *et al.* had advocated using; however, two cases are now known for which the calculation which accounts for the hole gives the better agreement with experiment (an E2 13.38-keV transition from a 2.9 μs level in ^{73}Ge and an M4 80.24-keV transition from a 10.53 d level in ^{193}Ir). The question arises, therefore, whether we should adopt the values from the 'hole' or from the 'no hole' calculations. Were we to choose the former, it would be straightforward to calculate the necessary values for the substitute table and to rebuild the direct access files. It was decided that, for the next several months, evaluators should continue to use HSICC in their evaluations but should also run BRICC for their datasets and notify Tom Burrows and/or Tibor Kibedi should they identify any cases where experimental data disagree significantly with the BRICC no-hole calculations. It was noted that a better understanding of the conditions under which one or the other type of calculation would be preferred is needed.

- **NuDat Upgrade (A. Sonzogni):** A greatly enhanced version of NuDat with interactive nuclide chart interface and expanded search capabilities was released last April and has been enthusiastically received. Its major features were summarized briefly and preliminary usage statistics presented. Soon, a newer version will be available providing better quality graphics, faster γγ coincidences,

nuclide selections based on evenness, and expanded RadList for ENDF. Additional enhancement possibilities are being investigated.

- **Table of Nuclear Moments (N. Stone):** A data listing, complete to the end of 2001, is available at the NNDC website. However, a listing current to mid-2004 has been completed and that table is also being prepared for publication in At. Data Nucl. Data Tables in 2005. The Recommended Value Table is still in preparation but evaluators can contact Nick Stone (n.stone@physics.ox.ac.uk) concerning specific nuclei on which they are working.

Mini-symposium on Nuclear Data at APS-DNP Meeting, October 2004 (D. Winchell): The session was chaired by D. Winchell and consisted of one invited talk on databases and networks (A. Nichols, IAEA) and twelve contributed talks. Three of the latter were from authors who are not connected with the USNDP or NSDD. Discussions were fairly active and the venture was considered well worth the effort.

New Evaluator Recruitment/Training/ Mentoring Efforts (J. Tuli): Following the resounding success of the one-week training workshop held as a pilot project in Vienna in 2002, a two-week workshop organized by IAEA and hosted by ICTP (Trieste) was held in November 2003. There were 24 participants from 12 countries and several participants have now performed some structure evaluation work; recently, two visited NNDC for further training and mentoring. Four USNDP evaluators conducted the ENSDF training and five other professionals provided nuclear theory and experimental techniques lectures. A similar two-week workshop involving many of the same instructors and co-sponsored by the IAEA and ICTP will take place in April 2005 in Trieste. These efforts have led to the establishment of new data centers in several countries and brought a number of new evaluators into the nuclear structure data evaluation effort.

Development of New ENSDF Editor Software (A. Sonzogni): The objective is to develop an editor which will minimize the impact of the ENSDF format on ENSDF evaluation work and which can be integrated with ENSDF checking and calculation codes. The editor under development capitalizes on recently-written NuDat software and is based on Java (free and platform independent). An interactive level and decay-scheme plotting tool is available and the present version has already been used successfully in three mass-chain evaluations. A mid-2005 release of the software package seems realistic.

Formats/Procedures/Jπ Rules:

- **Nomenclature for Rotational Bands and Configurations (F. Kondev):** (Item carried forward from last year's meeting.) After conferring with Balraj Singh on this matter, Filip Kondev presented his observations and suggestions. It would be desirable if ENSDF could be searched for specific configurations. As a first step, configurations need to be included in band statements in ENSDF whenever possible, giving Nilsson orbitals for the deformed region and using shell-model notation in the spherical/near-

spherical region; if possible, arguments for those assignments should also be included.

- **Interactions Between ENSDF Evaluators, Reviewers and Editor (J. Cameron):** Customarily, ENSDF reviewers and evaluators do not interact directly with one another. Consequently, reviewers don't see how the evaluators ultimately dealt with issues they raised in their reviews. It was thought that most reviewers did not wish to spend additional time looking over the post-review version of an evaluation. However, it was decided that any who wish to do so should, in future, let Jag Tuli know. Otherwise, the existing practice will continue.

At 5:55 pm, the meeting was adjourned until 11:00 am the following day.

- **Mass Chain Responsibilities (J. Tuli):** For many years, ORNL has been responsible for most of the mass chains with A>212. However, the manpower available at ORNL has steadily diminished. At last November's NSDD meeting, responsibility for 9 of those chains was transferred to LBNL, where E. Browne could provide expertise in this important region. Following Yurdanur Akovali's death last April, Michael Smith recruited Murray Martin to work part time on evaluations in ORNL's mass region. Jag Tuli reported that he has Murray's and Michael's agreement for ORNL to continue to take responsibility for A=241-249. The remaining 15 chains in the A=213-240 region, he wished to transfer to LBNL's responsibility and the 20 chains with A=172-193 (excluding McMaster's A=188, 190) for which LBNL has been responsible for many years he wished to transfer to BNL's responsibility to be distributed to new evaluators about to be integrated into the international network. A>249 would also be transferred to BNL's responsibility. Otherwise, data center responsibilities are unchanged.

- **Inclusion of Transfer-Reaction Cross-Section Data in ENSDF:** Some researchers in this field have, for some time, urged the inclusion of cross-section data in ENSDF. After some discussion, it was moved (C. Reich, J. Wood) that the guidelines for evaluators should now recommend that: in the absence of spectroscopic factor information from transfer reactions, cross-section data at one angle should be included in the suitably relabeled S field, and cross section data at additional angles should be included at the evaluator's discretion in comment records. Passed with no objection.

- **Inconsistent Treatment of Definite Multipolarity and Jπ Assignments from (HI,xnγ) Reactions in ENSDF:** C. Baglin presented a summary of the current strong rules (rules 37, 38, 39), B. Singh's tables of 'typical' $\gamma(\theta)$ and DCO ratio values on which rules 20 and 21 are based, and Notes 1 and 2 from Section J of the Evaluator's Guidelines concerning the assignment of multipolarity based on $\gamma(\theta)$ (and DCO ratio) data. Several evaluators had

observed that these rules are not being applied consistently throughout ENSDF. Is this because the current rules are no longer adequate or because they are not being followed? Should some arguments that are currently considered 'weak' become 'strong' arguments? While some evaluators would like to see parentheses used less often, others urged to err on the side of being conservative. The consensus of the meeting was that the current rules are indeed adequate and we should abide by them.

- **Inclusion of Secondary Reference Material in ENSDF (J. Tuli):** Currently, secondary sources are used extensively in ENSDF but we do not have a guideline for this topic. J. Tuli presented a summary of the various forms of secondary source information we encounter, along with suggestions about which should be accepted without reservation, which could normally be considered reliable and which required especially careful attention from the evaluator. After some debate concerning how reliable various sources might be, Jag decided to summarize his recommendations in an email on which we could comment further.

- **Treatment of Resonance Reaction Data in ENSDF:** Such data are particularly important for the lighter nuclei but do not seem to have been included in a consistent manner in ENSDF. The recommendation was that all information from unbound states that impacts bound state assignments should be included; thus, unbound levels with known radiations to bound levels or unbound levels whose Jπ impacts a bound level Jπ argument should be included.

- **Discussion of Homeland Security Session:** This year's Working Group meeting had started a half day earlier than usual to enable everyone to attend the Thursday morning Homeland Security Task Force's session. Unfortunately, that session ran far beyond its allotted time and we had leave before it concluded in order to resume our Working Group meeting. No structure/decay topics requiring our discussion had emerged from the presentations we had attended. Concern was expressed, however, that any proposals presented to DHS should be well thought out and tempered by realism. One small change in the draft document (scheduled for discussion after we had to leave the Homeland Security session) had already been conveyed to the Task Force Chair.

- **Schedule for Next Year's USNDP Meeting:** The consensus was that we should again start on the Wednesday. The possibility of including an evaluators' workshop session was discussed. Next June's NSDD meeting at McMaster is a logical time for such a session since that would include evaluators from outside the US network. However, some felt that a workshop at the USNDP meeting also would be useful. This would entail starting on Wednesday morning, necessitating that all Working Group members outside of BNL travel a day earlier than has traditionally been necessary. It was also

considered desirable to avoid splitting the Working Group meeting between two days.

The meeting closed at 1 pm.

US Nuclear Data Program

Nuclear Reaction Working Group Minutes

M.B. Chadwick (chair), LANL
T. Kawano (co chair), LANL

A. Nuclear Models

1. Model code development

Kalbach discussed her latest version of the exciton model code PRECO. Kalbach made some improvements to the complex particle emission, nucleon transfer, and isospin conservation. For complex particle induced reactions, a role of projectile break-up was also discussed.

Herman described recent developments of the EMPIRE code for nuclear data evaluation work. Complex-particle emission in the exciton model was improved by using the Iwamoto-Harada model. A new algorithm for calculation of exclusive spectra and recoil was adopted. A multi-modal and multi-humped fission was also developed.

Talou summarized a current status of the McGNASH code, and some test of the calculations was shown. The DDHMS code was incorporated into McGNASH as a pre-equilibrium module. He also announced the future plan. He also announced the plans for the development of the code in the coming year.

Koning described the nuclear reaction calculation code TALYS. The code was used for generation of covariances by Monte Carlo technique.

2. Computations relevant to astrophysics

Kawano reported his optical/statistical model code for astrophysical applications. The code was extended to utilize the coupled-channels model. Calculations were made for the capture cross sections on zirconium isotopes to support LANSCE/DANCE detector experiments.

Moeller presented the macro/microscopic nuclear mass model. The predicted nuclear properties can be used for r-process calculations.

Smith gave a talk on the computational infrastructure for nuclear astrophysics, which aims at getting the latest nuclear evaluations into astrophysical simulations.

B. Overlap of USNDP and CSEWG

1. Evaluated Reaction Data

- *ENDF/B-VII*

Herman summarized status of ENDF/B-VII. The total number of new evaluations is 236, including 56 neutron, 10 proton, 5 deuteron, 3 triton, 2 He-3, and 160 photonuclear evaluations. Many new evaluations are from LANL. ORNL evaluated new resonance parameters for F-19, Cl-35,37, and Pu-241. New evaluations for Si-28, U-232,233,234,235,238, and Pb-208 are also given by LANL and ORNL.

Herman noted that the CHECKR and FIZCON codes give an error or warning for many files, especially for Cl and Hg. LANL will fix this formatting problem when possible.

- *BNL/KAERI/JAERI FP evaluation*

A new set of fission product evaluations was submitted by BNL/JAERI (5 isotopes of Germanium). This complemented an earlier set of 24 FP evaluations by BNL/KAERI.

An international library of FP evaluations will be produced under the WPEC Subgroup 23. Up to 200 'best' available evaluations can be expected once this work is completed.

- *LANL high energy evaluation*

Chadwick described the latest advances to the LANL evaluation. In particular, a refined treatment of the inelastic scatterings in U-235, U-238 and Pu-239 led to a dramatic improvement in the MCNP simulations of LLNL pulsed spheres experiments.

Chadwick summarized the new reaction rate data testing by MacFarlane using the radiochemistry data from MacInnes et al. Chadwick also noted upgrades to isotopes such as U-234 (a higher capture cross section), and our preliminary upgrades to U-237, 239 based on Younes' fission cross sections from the surrogate technique.

Kawano and Talou reported recent upgrades of americium data. The nuclear data for Am-241 and Am-242m were submitted for ENDF/B-VII. The new americium data were tested against LANL criticality assemblies by MacFarlane.

- *ORNL resonance parameter evaluation*

Leal and Courcelle reported their latest resonance parameters for U-238, which contains refined analysis of 1-10 keV region. The thermal capture value is 2.683 barns following

Trkov's work. (The ORELA direct analysis gave a similar value). Analysis of the unresolved resonance range is also ongoing.

Leal also reported the resonance parameter evaluation for U-233 using differential and integral information (Westcott factor etc), up to 600 eV. The unresolved range is up to 40 keV.

- *Other evaluations*

Page reported the results of R-matrix analysis for A=8 reactions, and 12 reactions were compiled in the ENDF file. He also mentioned a plan to evaluate the proton-induced reaction on C-13.

Chadwick noted that new evaluations of photonuclear reaction for some actinides will be available. The GNASH calculations were made for Pu-240, Pu-242, and U-238, in collaboration with Giacri. Hale has completed the new photo-deuterium evaluation.

Cameron mentioned their astrophysics data activities reported in the McMaster University status report. The stellar reaction rates for Na-21 and Ne-18 were updated based on the recent experimental data from TRIUMF-ISAC.

2. Standards

Carlson indicated that the IAEA Standards CRP group finalized H(n,n), Li-6(n,t), Au-197(n, gamma), U-235(n, f), and U-238(n, f) cross sections, and the other standard cross sections would be finalized before the end of this year.

The new standards will allow us to use the new U-235, U-238, Pu-239 fission cross sections and U-238 capture cross sections. The U-238 capture is not a standard cross section. However, Carlson, Kawano, Young, and Chadwick will look into this cross section to make sure that the U-238 capture value by IAEA/CRP is reasonable.

Hale's new evaluation for H(n,n) has been completed up to 30 MeV. The new hydrogen data were used to renormalize all experimental data relative to the hydrogen standard.

Reports

A. Task Force Reports

Three short TF reports were provided. The report by M. Smith on data for astrophysics is available at www.nndc.bnl.gov/proceedings/2004csewgusndp. RIA Task Force was asked to renew its membership and charge, see attached draft.

- Task Force on Nuclear Data for Astrophysics (M. Smith)
- Task Force on Nuclear Data for Homeland Security (D. McNabb)
- Task Force on Nuclear Data for RIA (T. Kawano)

Rare Isotope Accelerators (RIA) Task Force

TF Membership and Charge
Drafted by T. Kawano, November 2004

Membership

Chair: Toshihiko Kawano (LANL)

Members: Peter Moller (LANL), Mark Chadwick (LANL), Patrick Talou (LANL), Filip Kondev (ANL), Michael Smith (ORNL), Dennis McNabb (LLNL), Mike Herman (BNL)

Charge

Interact with RIA research & development, understand RIA nuclear data needs and respond to these needs. Integrate nuclear data obtained by RIA into USNDP databases via compilation, code development and data evaluation. TF works on a voluntary basis and its actual activities are limited by available funding.

Explanation

We have collaborated and interacted with RIA researchers to ensure that code developments we make are integrated for use into RIA design calculations. We have also provided nuclear data needed for the RIA target design, which is one of our strongest capabilities to collaborate with the RIA researchers. Los Alamos has been working on the development of a reliable code to model light-ion-induced and proton-induced reactions at intermediate energies for RIA application. S. Mashnik has made dramatic

improvements to the predictive capability of the CEM2k intranuclear cascade code, and this improved code has been delivered to the MCNPX team.

Not only the code developments, USNDP can play a significant role by evaluating data that would be coming out from RIA, as well as from other rare-isotope facilitates around the world. Many of national laboratories and university groups will be strongly interested to contribute, especially on the nuclear structure and astrophysics side. These efforts may include nuclear data evaluations.

New evaluations of Ge isotopes were recently completed at BNL in collaboration with JAERI. These evaluated data would be of high-value to the developers of the next generation gamma-ray detector array (GRETA/GRETINA in US and AGATA in Europe) that is going to be used at RIA. The device will be based on the gamma-ray tracking technology that follows a quite different approach compared to the conventional spectroscopy technique used in conjunction with Ge detectors. The tracking requires a superior energy and position resolutions that are severely compromised by the presence of neutrons in accelerator applications.

Nuclear reactions on unstable isotopes with relevance to astrophysics are one of the overlapped activities between RIA and the nuclear data groups. Our modeling capability for nuclides off-stability may help to predict and to analyze the RIA data.

The models need to be able to provide calculated quantities for a large number of nuclei, also for currently unmeasured properties. The calculated quantities should be sufficiently accurate to be useful in applications such as nucleo-synthesis in stars and in modeling nuclear reactor operations. The latter application requires data for hundreds of fission products. This requirement means that for nuclear data applications more established, mature, well-understood, and well-tested theories are preferred and needed. However, these theories can be further developed by learning from data for nuclei far from stability that is now becoming available at a substantial pace. For example the half-life of 78Ni was recently measured. From such data we can learn about the behavior of spherical magic gaps, nuclear pairing, nuclear ground-state deformations, the spin-orbit strength, and other properties far from stability. No completely "fundamental" theory exists for these nuclear-structure features. But existing models can with a high probability describe such properties accurately also far from stability. Some theoretical work is required to assure that optimal enhancements are developed.

B. Laboratory Reports

Eleven reports on laboratory activities under US Nuclear Data Program were provided. All laboratory reports except for the report describing LLNL activities are available at www.nndc.bnl.gov/proceedings/2004csewgusndp.

- NNDC report (P. Oblozinsky)
- ANL report (F. Kondev)
- Georgia Tech report (J. Wood)
- Idaho report (Ch. Reich)
- LANL report (T. Kawano for M. Chadwick)
- LBNL report (C. Baglin)
- LLNL report (D. McNabb)
- NIST report (A. Carlson)
- McMaster report (J. Cameron for B. Singh)
- ORNL report (M. Smith)
- TUNL report (J. Kelley)

Cross Section Evaluation Working Group & US Nuclear Data Program

Nuclear Data for Homeland Security

Dennis McNabb, LLNL
Task Force Chair

A. Summary

Nuclear Data Security for Homeland Security was held as a common session of CSEWG & USNDP on November 4, 2004.

Presentations

Talks were given by 7 participants on nuclear data issues that they are encountering for homeland security programs and results on addressing these needs after the 2003 meeting.

1. Nuclear Wallet Cards for Homeland Security, Tuli (BNL)
2. Photon production from Ge + n, Herman (BNL)
3. Neutron activation data for neutron interrogation applications, D. Smith (ANL)
4. p+^{13}C → gamma source for interrogation & photonuclear work, Page (LANL)
5. Neutron capture spectra and other nuclear data plans, McNabb (LLNL)
6. Attribution work on Americium, Kawano (LANL)
7. Nuclear data for gamma-ray telescope simulation, Phlips (Naval Research Lab)

It was noted that Nuclear Wallet Cards of Radioactive Nuclides, targeted for DHS use was issued promptly after 2003 CSEWG-USNDP meeting. This useful booklet was already distributed to more than 2,000 users.

Data Needs

A draft document from the Task Force on Homeland Security Needs was distributed to the community and feedback has been received and continuing to come. Specific issues that were raised in terms of improving the needs document included:

- Jag Tuli to expand section on emergency response and border control needs
  - Con Beausang will be consulted as to his take on needs in this area
- Other detector materials needing photon production for modeling beside Ge detectors (Bi, Gd, etc.)
  - A comprehensive list was given in Phlips talk
  - Program leaders at LLNL and LANL will be consulted in this area as well
- Don Smith indicated that there were no needs in the area of understanding induced radioactivity from active interrogation

- A lot of discussion surrounded needs for neutron and photon source reactions.
  - Follow up on this area from BNL, ANL, LANL, LLNL will need to be made
  - Be(d,n), ^{13}C(p,gamma):
    - At LANL, there is X Division - Russian collaboration
    - At BNL, there is ongoing LDRD on use of 13C(p, gamma) to detect explosives via identification of 14N by photon resonance technology
  - Consult Jim Hall on program needs
  - Mike Todosow, BNL is interested in proton-induced photon sources for photon resonance technology. Some of these sources are used also in detector calibration (see forthcoming IAEA TecDoc on standards for gamma detector calibration).

McNabb has committed to submit a more final draft to the Task Force in a few months. The version of the draft as available on November 3, 2004 is reproduced below.

B. Nuclear Data Needs for National Homeland Security Programs

(Draft version, November 3, 2004)

Introduction

At the November 2003 USNDP session on Homeland Security it was agreed that a needs list for new nuclear data and new database capabilities should be developed. Through an informal survey of homeland security technical programs at LLNL and LANL and input from the US Nuclear Data Program community we have developed this document. Only items requested by currently funded research and development projects are listed; no attempt has been made at this point to prioritize these needs.

There appears to be two main program drivers for this needs list:

- Detection of radiological and nuclear materials being transported into or through the US or its concerns
- Monitoring, detection, and analysis of nuclear explosions and nuclear weapons proliferation through radio-nuclide monitoring and other detection capabilities.

Some related aspects of these programs drivers, including international treaty negotiations and emergency response, also have a few data needs.

Projects under these two program umbrellas typically encounter nuclear data issues when variant detection schemes or event scenarios are modeled using sophisticated simulation codes such as MCNP(X) or GEANT. These simulations are used to lay the groundwork for proposing and planning new projects and also to optimize the design or analysis of different configurations. Many calculations can be performed quickly, whilst individual experiments involving SNM require extensive authorization and are costly. Simulations

of fielded experimental interrogation configurations can be used to interpret the measured data. And very importantly, simulations can extensively explore "what if?" questions.

The simulation capabilities are built upon high-quality fundamental nuclear cross section and decay databases, in the ENDF nuclear data library. These evaluated databases incorporate the detailed information available from experiments and from nuclear models, and allow transport simulations to model the underlying physical phenomena accurately. Several of the projects surveyed had encountered the need for advances in simulation methods and in the underlying ENDF library. These needs range from particle correlations in energy, angle and multiplicity to improved data for photonuclear reactions to improved cross sections for neutron reactions involving unstable or rare isotopes to improved gamma-ray production data.

There were also many projects surveyed where nuclear decay, reaction and structure libraries as well as specific references were consulted to address or explore issues and ideas analytically. The resources used included the ENSDF nuclear structure library and NSR references library, and these resources were typically accessed through a variety of web-based dissemination projects -- the usefulness of these resources depends on the ease of use and the completeness and accuracy of the information present. In many cases the ENSDF and NSR resources were used as input to calculations to generate data for transport simulations or to generate physical constants used to assay a sample. Several of the projects surveyed indicated a need for better decay half-life and branching ratio information in specific cases, e.g. the spontaneous fission half-life of ^{240}Pu, and some had plans to make measurements to acquire the information they were missing, or to benchmark the data that is presently available in ENSDF and ENDF.

Correlated particle information from fissile materials

The timing data stream of neutron counts contains information that can be used to determine properties of the source of neutrons. For materials that support fission chains, a random event that spontaneously creates neutrons, such as a spontaneous fission or an (alpha, n) reaction, is followed by a correlated number of neutrons emitted by the fission chain. The rate of spontaneous fission events is proportional to the amount the spontaneous fission isotope. The length of the fission chain is related to the system multiplication. The number of neutrons emitted in an individual fission satisfies a probability distribution that is approximately Gaussian, with typically about three neutrons emitted on average, but with a reasonable probability that no neutrons are emitted or as many as eight neutrons are emitted. (The nuclear data for the neutron distributions has been tabulated by Holden and Zucker from Brookhaven.) In a multiplying medium this intrinsic fluctuation for each fission is amplified for a fission chain, with a very high probability the chain creates many more than the average number. The large fluctuations in the number of neutrons are a great advantage for detection and for assay. Similar large fluctuations in the number of fission gamma rays emitted are also likely to be advantageous.

Gamma ray timing also carries information about the fission chain. First, when neutrons are absorbed in an (n, gamma) process, the gamma continues the same information about the fission chain as the original neutron out from the absorber, especially as these are penetrating high-energy gammas. The timing of the (n, gamma) neutrons also carries the same information about the moderation process (~ 100 microsecond time scale) as the original neutrons. In addition, each fission in the chain emits a burst of gamma rays, the entire fission chain gamma cascade being prompt (~ 100 ns) compared to the moderation time scale.

Projects involving detection or assay schemes using particle correlations have lead to the following new data needs:

i) *The probability distribution for the number of prompt gammas created by an individual fission*

While the average number emitted is known it is the actual distribution is needed. Given the large number of decay channels the final distribution is likely nearly Gaussian by the central limit theorem, but the width is not known.

ii) *The correlation between the number of emitted neutrons and gamma rays*

When very few neutrons are emitted by a fission event, do there tend to be more gamma rays emitted? When there are eight neutrons emitted, is it more likely that there are fewer gammas emitted?

iii) *Energy - number correlation for gamma rays*

When many gammas are emitted, do there tend to many soft gammas after hard gamma emission? The gamma energy correlation is important because of the energy dependence of penetrability.

iv) *Delayed gamma distributions*

The fission fragments will beta decay on second time scales, long compared to diffusion time scales, but there will tend to be cascades. There will also tend to be a series of beta decays, each with a different cascade. How do the number distributions of the cascades change in the subsequent beta decays, both in number distribution and energy distribution?

v) *Non-fission gamma cascade number and energy distributions*

These cascades could, for example, follow (alpha, n gamma), (n, n' gamma) or (n, gamma). All of these processes emit multiple gamma ray bursts, on time scales short compared to time between subsequent scatterings in an event chain. Are there other time scales from metastable states? The gamma rays from these correlated processes are statistically distinguishable from

potentially large gamma ray backgrounds, both from the environment and from the alpha decay chain gammas. It is especially the large fission chain fluctuation bursts that contain the most information.

Gamma-ray production information

The gamma-ray lines emitted in radioactive decay or as an excited nucleus decays to its ground state provide a unique, characteristic signature of the decaying element or isotope. Provided that there is an external probe that can broadly induce such radioactive decay, such as a neutron or photon source, this information can be used to detect or assay materials. The rate of photon production is proportional to the amount of material being irradiated folded with the energy-dependent cross section for inducing the radioactive decay signature. The detection probability depends on the attenuation of the characteristic gamma-ray lines in surrounding absorbing material and the rate of background photon production. Detection works best when (1) the absorbing material has a low atomic number, e.g. hydrogenous materials, (2) the characteristic gamma-ray lines are higher in energy, and (3) there is a time or energy dependence to the signal which distinguishes it from background photons. For example, the detection of delayed gamma rays from fission with energies above 3 MeV has been proposed as a detectable signature of fissile materials interrogated with external sources. Assay works best when a detectable signal exists from all elements present. For example, the neutron capture gamma-ray spectrum is starting to gain favor as an assay method in a technique known as Prompt Gamma Ray Activation Analysis.

Projects involving detection or assay schemes using gamma-ray spectroscopy have lead to the following new data needs:

i) Delayed gamma-ray energies and half-lives from fission with half-lives ≈ 0.5 s and $E_\gamma > 3$ MeV

Data in this half-life range is sparse. However, if there is a penetrating radiation with significant yield at times greater than 100 ms, then it would effect design considerations for detection schemes for fissile materials.

ii) High resolution (≈ 1 keV) gamma-ray spectra from neutron capture ($E_n < 50$ keV) on all naturally-occurring materials

High-resolution spectroscopy can be used as an assay tool that is relatively broad based in that most elements except helium have a naturally occurring isotope with significant gamma-ray production following neutron capture.

iii) An event generator to source spectrally correlated gamma rays from decay cascades following neutron capture and other reactions

Investigations of detector response and backgrounds caused by naturally occurring or external neutron sources often require one to conserve energy and spectral shape on an event-by-event basis. This capability is generally not available in traditional transport codes.

iv) Improved representation of neutron scattering and subsequent photon production in germanium detectors, particularly inelastic scattering leading to "neutron bumps"

There are several instances where a promising signature is co-located with neutron bumps in germanium detectors. A better model of the processes involved will allow engineers to consider designs to minimize the interference via simulation.

Photonuclear data

Photon sources offer some possible advantages over neutron sources for active interrogation schemes: (1) the source can double as a radiograph source and (2) photons are more penetrating than neutrons for hydrogenous cargos. These advantages have led to some initial work to model photonuclear processes in transport simulation codes. For instance, new capabilities have been developed to model photonuclear and photofission reactions in MCNP(X), with an accompanying development of evaluated photonuclear cross section databases. A first demonstration capability was developed, and some initial comparisons with validation experiments were successful. However additional research is needed to improve the simulation tools. These include:

i) Development of photonuclear data for $\gamma + {}^{235,238}U$ and ${}^{239}Pu$

ii) Photofission delayed-neutron probabilities, energy spectra, and time-dependences for the delayed neutrons

With photon sources, the compound nucleus that fissions is different from neutron sources. Delayed neutron probabilities and energy spectra can vary widely from isotope to isotope.

iii) Development of nuclear data to support interrogation methods for conventional and nuclear explosives, using resonant photonuclear absorption on nitrogen and SNM.

Neutron cross sections on unstable and rare isotopes

One national goal is the ability to analyze chemical, biological, and nuclear materials, assemblies and/or debris and identify the origin and user of these materials. Radio-chemical signatures can often facilitate forensics work. Accurate nuclear cross sections are needed in this program, many involving nuclear species off stability that are hard to measure directly. The current focus with relevant nuclear data needs is on the development of new forensics signatures of actinide materials and debris. This is motivating some challenging nuclear theory and evaluation projects, and some new measurement efforts.

Current needs include:

i) Improved neutron-induced fission cross sections among U, Np, Pu, Am, and Cm; both long-lived and short-lived species are of interest, and these entail measurements and reaction modeling for $E_n < 20$ MeV.

ii) Improved neutron-induced capture cross sections on long-lived and short-lived actinides, with similar comments as above.

iii) Accurate (<10%) (n,2n) cross sections for ^{235,238}U and ^{239,240}Pu across the energy range of interest, and in particular within 1 MeV of thresholds.

iv) Accurate estimates of evaluated cross section uncertainties, including model uncertainties.

Other data needs

Feedback from emergency response personnel and the transport security administration indicates that they desire a simple way to associate radioactive decay signatures with their likely sources, e.g. medical radio-isotopes versus natural backgrounds, etc.

Cross Section Evaluation Working Group & US Nuclear Data Program

Appendix: List of Presentations and Reports Available on Web

www.nndc.bnl.gov/proceedings/2004csewgusndp

A. CSEWG Meeting, November 2-4, 2004

Formats and Processing

- Proposal for ENDF Formats that Describe Emission of Post-fission β-delayed photons (D. Brown, LLNL)
- NJOY Status (R.E. MacFarlane, LANL)
- ORNL Cross-Section Processing Status (M.E. Dunn, ORNL)
- New Nuclear Data Format Towards a Richer Representation (D. McNabb, LLNL)
- Current Projects of the IAEA-NDS (A. Trkov, IAEA-NDS, Vienna, Austria)

Measurements and Basic Physics

- Experimental Activities Report ANL Nuclear Data Program (F.G. Kondev, ANL)
- Nuclear Data Experiments at LANSCE: Highlights (R.C. Haight, LANL)
- Cross Section Measurements and Analysis at Rensselaer (R.C. Block, RPI)
- Fusion Neutronics Activities in USA (E.T. Cheng, TSI Research, Inc.)
- Recent Improvements to the Database for the Evaluation of the Neutron Cross Section Standards Including Recent Work at NIST (A.D. Carlson, NIST)
- Neutrons for Science SPIRAL-2 GANIL, Caen, France (D.L. Smith, ANL)
- Nuclear Data for Helium Production in Fusion (D.L. Smith, ANL)
- Covariances for Evaluated Cross Sections Derived from Nuclear Models (D.L. Smith, ANL)

ENDF/B-VII Evaluations and Validation

- Conversion of ENDF/B-VI (C. Dunford, BNL)
- Status of the ENDF/B-VII Library (M. Herman, BNL)
- Update on LANL Uranium Evaluations (M.B. Chadwick, LANL)
- Overview of the U238 Evaluation in the Resolved Resonance Range (H. Derrien, ORNL)
- Summary Report of WPEC Subgroup 22 –Nuclear Data for Improved LEU-LWR Reactivity Prediction (Y. Chao, Westinghouse)
- Testing Newest U-235, 238 (R.E. MacFarlane, LANL)

- Analysis of Critical Experiments Using ENDF/B-VI.3 and Pre-B-VII Data (H.C. Huria, BNFL/Westinghouse)
- Questions on 235-U Capture in 10-100keV Range (T. Kawano, LANL)
- ^{235}U Data Set Testing with (mostly) ICSBEP Benchmarks (Skip Kahler, Bechtel Bettis)
- Status of 241-Am Evaluation (T. Kawano, LANL)
- ^{242m,g}Am, ^{243}Am Evaluation (P. Talou, LANL)
- Resonance Evaluation for ^{233}U (L.C. Leal, ORNL)
- Recent Fast Data Testing Results from Los Alamos (R.E. MacFarlane, LANL)
- New T-16 Actinide (U, Pu, Am, Np isotope) Cross Section Library: ENDF6++ (Hale, LANL)
- ENDF/B-VI and Preliminary ENDF/B-VII Results for the MCNP Criticality Validation Suite (R.D. Mosteller, LANL)
- ENDF/B-VII: Fission Product Evaluations (P. Oblozinsky, BNL)
- Light Nuclei Reaction Update (P. Page, LANL)
- A=8 Reactions, Charged Particle Reactions (mainly) (P. Page, LANL)
- Validation of the Pre-ENDF/B-VII Libraries with ANL Codes (D. Naberezhnev, ANL)
- LLNL Contributions to ENDF-B-VII (D. Brown, LLNL)
- Fixes to LANL $^{232, 237, 239}$U(n, γ), (n, f) and (n, 2n) Cross Section Evaluations (D.A. Brown, LLNL)
- Status of ENDF/B Decay Data (W.B. Wilson, LANL)
- ENDF/B-VII Decay Data (A. Sonzogni, BNL)
- Status of ENDF/B Delayed Neutron Data (W.B. Wilson, LANL)
- Status of ENDF/B FP Yield Data (W.B. Wilson, LANL)
- Thermal Neutron Scattering Data (R.E. MacFarlane, LANL)
- Testing of Delayed Neutrons (R. Schaefer, ANL)
- Covariances (T. Kawano, LANL)
- What Should We Do With Elemental Evaluations (M. Herman, BNL)
- Paper on ENDF/B-VII (P. Oblozinsky, BNL)

<u>CSEWG Concluding Session</u>

- CSEWG 2004: Summary and Conclusions (P. Oblozinsky, BNL)

B. USNDP Meeting, November 3-5, 2004

Nuclear Structure Working Group

- NSR Status (D.F. Winchell, BNL)
- XUNDL Status Report (B. Singh, McMaster, D.F. Winchell and T.W. Burrows, BNL)
- ENSDF Status 10/2004 (J.K. Tuli, BNL)
- Status of the ENSDF Analysis & Utility (T.W. Burrows)
- Brlcc Program Package (T. Kibédi, ANU, Australia)
- NuDat 2.0 (A. Sonzogni, BNL)
- The Table of Nuclear Moments (N. Stone, Oxford, UK)
- Report on Minisymposium at October '04 DNP Meeting (D. Winchell, BNL)
- Evaluator Training (J.K. Tuli, BNL)
- ENSDF Editor (A. Sonzogni, BNL)
- Mass Chain Reassignments (J.K. Tuli, BNL)
- Inconsistent Treatment in ENSDF of Multipolarity and Jπ from (HI, xnγ) (C. Baglin)
- Use of Unpublished References (J.K. Tuli, BNL)
- Brlcc Program Package Addendum (T.W. Burrows, BNL)

Nuclear Data for Homeland Security

- Nuclear Wallet Cards for Homeland Security (J.K. Tuli, BNL)
- Neutron Cross-Section Evaluations for $^{70, 72, 73, 74, 76}$Ge (M. Herman, BNL)
- Neutron Activation Data for Neutron Interrogation Applications (D.L. Smith, ANL)
- $p + {}^{13}C \rightarrow \gamma$ Source Reaction for Interrogation & Photonuclear Work (P. Page, LANL)
- Neutron Capture Spectra and Other Nuclear Data Plans (D. McNabb, LLNL)
- Attribution Work on Americium (LA-UR-03-4354) (T. Kawano, LANL)
- Nuclear Data for Gamma Ray Telescope Simulations (B. Phlips, NRL)

Reaction Modeling & Astrophysics

- TUNL Program on Pre-equilibrium Phenomenology (C.K. Walker, TUNL)
- Empire-2.19 (Lodi) Advanced Tool for Nuclear Reaction Data Evaluation (M. Herman, BNL)
- The McGNASH Nuclear Reaction Code (P. Talou, LANL)
- TALYS, Monte Carlo and Covariances (A. Koning, NRG Petten, the Netherlands)
- Capture Cross Sections with DANCE for s-Process (T. Kawano, LANL)
- Computational Infrastructure for Nuclear Astrophysics (M. Smith, ORNL)

Dissemination

- New NNDC Web Service (B. Pritychenko, BNL)

Task Forces Reports

- Astrophysics Task Force (M. Smith, ORNL)

Laboratory Reports

- NNDC Report to USNDP Meeting 2004 (P. Oblozinsky, BNL)
- Nuclear Data Program at ANL (F.G. Kondev, ANL)
- B(E2) Data From ENSDF Using GTNDSE (W.D. Kulp, Georgia Institute of Technology)
- Nuclear Structure and Decay Data Evaluations and Related Activities of the Idaho Group (C. Reich, Idaho)
- LANL nuclear data activities (T. Kawano, LANL)
- Isotopes Project (C.M. Baglin, LBNL)
- National Institute of Standards and Technology Nuclear Data Verification and Standardization Program – Progress Report (Carlson, NIST)
- Nuclear Data Project at McMaster University (Cameron for Singh, McMaster Univ.)
- Recent Activities & New Initiatives in the ORNL Nuclear Data Program (M. Smith, ORNL)
- TUNL Contributions in the US Nuclear Data Program (J.H. Kelley, TUNL)

USNDP Concluding Session

- Proposal for High Energy Nuclear Database (D. Brown, LLNL and R. Vogt, LBNL)
- Mentoring in Nuclear Information Technology (MINIT) Initiative (M. Smith, ORNL)
- U.S. Nuclear Data Program Budget Briefing, Feb. 2004 (P. Oblozinsky, BNL)

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