



Annual Report for FY2012

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I. Introduction

The USNDP Annual Report for FY2012 summarizes the work of the U.S. Nuclear Data Program (USNDP) for the period of October 1, 2011 through September 30, 2012 with respect to the work plan for FY2012 that was prepared in February 2010. The work plan and final report for the U.S. Nuclear Data Program are prepared for the DOE Office of Science, Office of Nuclear Physics. The support for the nuclear data activity from sources outside the nuclear data program is described in the staffing table and in Appendix A. This leverage amounts to about 30 FTE scientific, mostly at NNSA laboratories, to be compared with 19.3 FTE scientific (permanent + postdocs + contractors) at USNDP laboratories funded by the DOE Office of Science, Office of Nuclear Physics. Since it is often difficult to separate accomplishments funded by various sources, some of the work reported in the present report was accomplished with nuclear data program support leveraged by other funding.

Fiscal year 2012 was the 13th year in which the Nuclear Data Program has operated under a work plan developed by the program participants. The program continued to carry out important work in support of the DOE mission. The work balances the ongoing collecting, analyzing, and archiving of nuclear physics information critical to basic nuclear research and to the development and improvement of nuclear technologies with the electronic distribution of this information to users in a timely and easily accessible manner. The present section of the report consists of activity summaries for the major components of the U.S. Nuclear Data Program. This is followed by an updated staff level assignment table that reflects the final distribution of effort among the tasks carried out during FY2012. Then, we continue with the detailed status of work done in FY2012. Total staff assigned to USNDP activities during the year represented 23.8 FTE. In recent years there has been continuing loss of permanent scientific staff in the USNDP activities. This year, the permanent scientific FTE involved in the USNDP activities reached 15.0 - a slight increase from 14.8 in FY2011. This modest FTE variation indicates consolidation of the USNDP workforce after extensive changes in recent years (especially at BNL where more than half of the NNDC scientific staff has been with the Data Center about three years or less). Stabilization of the young structure evaluator at ORNL should be mentioned as a major budgetary achievement of the year.

Table 1 summarizes the USNDP metrics for the last ten fiscal years. Table 2 shows the breakdown of the metrics by laboratory for the reported fiscal year and comparison with the previous fiscal year. The tables are followed by a definition of each metric.

Table 1 shows that the FY2012 budget grew by 3.8%. The remaining ARRA funding continued to help to maintain a relatively solid program.

Table 1: Summary of the USNDP metrics in FY2001- FY2012, the definitions of the various terms follow the table.

Fiscal Year	USNDP Funding	Change	Compilations	Evaluations	Dissemination (in thousands)	Reports	Papers	Invited Talks
2001			7,139	334	667	21	25	22
2002	\$4,890K		6,159	300	799	23	40	22
2003	\$4,932K	+0.9%	4,975	260	966	27	40	23
2004	\$5,015K	+1.7%	6,241	276	1,212	35	36	43
2005	\$5,437K	+8.4%	6,623	422	1,642	74	59	42
2006	\$5,099K	-6.6%	4,936	318	1,863	47	60	48
2007	\$5,841K	+14.6%	5,355	366	2,239	40	56	51
2008	\$5,967K	+2.2%	5,104	385	2,996	48	72	68
2009	\$6,267K	+5.0%	4,047	400	3,294	26	61	56
2010	\$6,549K	+4.5%	4,662	395	2,843	27	83	51
2011	\$6,534K	-0.2%	4,662	479	3,252	29	96	67
2012	\$6,785K	+3.8%	5,221	209	3,013	22	90	48

In particular:

1. **Compilations.** Compilations efforts, including NSR, CSISRS and XUNDL databases, remain on the similar level.
2. **Evaluations.** Evaluations efforts, including ENSDF and ENDF databases, remain on the similar level.
3. **Dissemination.** This year there has been a slight decrease in the number of web retrievals. at BNL, the most popular product continues to be NuDat that contributes almost 60% of data retrievals.
4. **Reports.** The number of published reports has remained approximately constant over the last three years.
5. **Papers.** The number of articles published in the refereed journals reached a new high value this year.
6. **Invited Talks.** The number of invited talks decreased slightly compared to the last year but remains relatively constant.

These results must be considered satisfactory taking into account that the performance, essentially equivalent to the previous year, has been achieved in spite of the loss of more than two permanent scientific FTE. Increased workload resulted in the decrease of the number of published reports, which is the most immediate indicator (papers take longer to be published).

Table 2: USNDP metrics in FY2012, numbers for FY2011 are shown for comparison.

Laboratory	Compilations		Evaluations		Dissemination (in thousands)		Reports		Papers		Invited Talks	
	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
ANL	43	21	25	0	30	40	3	0	21	14	10	2
BNL ¹	2,911	3,385	150	107	2,771	2,624	6	6	26	26	10	10
LANL	-	-	108	20	300	255	2	2	9	20	18	10
LBNL	-	-	36	24	-	-	11	8	17	2	10	5
LLNL	-	-	10	0	8	8	0	0	1	1	0	0
ORNL	-	-	29	8	97	40	0	0	8	11	10	12
Universities ²	1,708	1,815	121	50	46	46	7	6	14	16	9	9
Total	4,662	5,221	479	209	3,252	3,013	29	22	96	90	67	48

¹: BNL compilations for FY2012 consist of 2535 NSR papers and 850 CSISRS reactions. BNL evaluations for FY2012 consist of 107 nuclides for ENSDF and 0 reactions for ENDF.

²: Universities compilations for FY2012 consist of 1,245 NSR papers (McMaster), 508 XUNDL datasets (McMaster) and 62 XUNDL datasets (TUNL). Universities evaluations for FY2012 consist of 50 ENSDF evaluations (McMaster).

Definitions

- *Compilations*: The sum of the new entries added to the USNDP bibliographic (NSR - papers) and experimental databases (CSISRS - reactions, XUNDL – structure data sets).
- *Evaluations*: The sum of new evaluations submitted or accepted for inclusion in the USNDP evaluated nuclear databases. Structure – number of evaluated nuclei (ENSDF), reactions – number of evaluated reactions/covariances (ENDF).
- *Dissemination*: The number of electronic data retrievals made from USNDP maintained web sites. Data retrieval is defined as a request for data from any of the databases that receives a result. Total pages, gifs, etc. accessed is not tallied.
- *Reports*: The number of technical documents (includes papers in conference proceedings) or papers other than journal publications and invited talks. No administrative documents such as meeting minutes are reported.
- *Papers*: The number of articles published in refereed journals.
- *Invited talks*: The number of presentations given at the explicit invitation of the organizers of a conference, symposium, workshop, training course, etc.

II. Network Coordination and Data Dissemination

The National Nuclear Data Center (NNDC) continues to serve as the core facility of the U.S. Nuclear Data Program (USNDP). It has the main responsibility for national and international coordination, database maintenance, and data dissemination. However, many of the other program participants are also involved in the coordination and dissemination activities.

National and International Coordination

The NNDC, while serving as the secretariat for the program, has prepared the work plan for FY2013 in cooperation with the members of the Coordinating Committee. The NNDC Head serves as a chair of the USNDP Coordinating Committee, which consists of the Principal Investigators from each of the participating groups, and chairs the annual meeting of the program held at the Brookhaven National Laboratory. LANL chairs the Nuclear Reaction Data Working Group, and LBNL the Nuclear Structure Working Group. ORNL chairs the Astrophysics Task Force and LLNL chairs the Homeland Security Task Force.

In February 2012, DOE Office of Nuclear Physics conducted its annual Budget Briefing. Michal Herman, Richard Firestone, Toshihiko Kawano, Allan Carlson, William Horak, John Kelley, Filip Kondev, Michael Smith, and Alejandro Sonzogni represented the USNDP and made the case for the FY2015 funding.

The NNDC serves as the focal point for U.S. collaboration in international nuclear data activities. This collaboration continued both in nuclear structure and decay data (Network of Nuclear Structure and Decay Data Evaluators, NSDD) and reaction data (NEA Working Party on International Nuclear Data Evaluation, WPEC, and Network of Nuclear Reaction Data Centers, NRDC).

The NNDC continues to chair the Cross Section Evaluation Working Group, which produces the ENDF/B evaluated nuclear data library for nuclear science and applied nuclear technology use. The 2011 CSEWG meeting was traditionally held at BNL. The major topic of the CSEWG meeting was to set up priorities and responsibilities for the future work leading to the next release of the ENDF/B library.

USNDP Databases

The NNDC operates five Dell servers running Linux operating system to support its compilation, evaluation, database maintenance, and information dissemination functions. These computers archive and serve the nuclear data produced by the U.S. Nuclear Data Program and the data obtained by other national and international collaborations. In addition, the NNDC maintains the collaboration GForge server that facilitates data and codes development and employs Subversion to keep track of changes.

The NNDC maintains seven nuclear physics databases for USNDP. These databases have been updated continuously in FY2012 with new and revised information from efforts of the NNDC, the USNDP and international collaborators. Distributions of all or parts of these databases have been made to national and international collaborators as scheduled.

Data Dissemination

In FY2012, retrievals from the USNDP databases as offered by the USNDP laboratories reached 3,013 million database retrievals - a 7% decline compared to the previous year.

Major Publications

The USNDP continues to publish the refereed journal Nuclear Data Sheets dedicated predominantly to nuclear structure and decay data (ENSDF evaluations) while the December issue is devoted to nuclear reaction data.

III. Nuclear Structure and Decay Data

The Working Group's priorities emphasize the evaluation of nuclear structure and decay data, either for entire mass chains or for individual nuclides, and the entry of these results into the Evaluated Nuclear Structure Data File (ENSDF). ENSDF is of particular importance because it provides the source information for various other databases and applications such as NuDat, Nuclear Wallet Cards and MIRD as well as contributing much valuable structure and decay data information needed for ENDF/B.VII. Most ENSDF evaluations will also appear as peer-reviewed publications in either Nuclear Data Sheets or Nuclear Physics A.

In addition, the USNDP leads the Decay Data Evaluation Project (DDEP) in collaboration with the Bureau International des Poids et Mesures (BIPM, France) and the Evaluated Gamma-ray Activation File (EGAF) effort in collaboration with the International Atomic Energy Agency (IAEA, Vienna). Nuclear structure and decay data provided by the USNDP are widely used in basic nuclear and astrophysics research and applications in fields including nuclear energy, nonproliferation, homeland security, nuclear medicine, geology, chemistry, and biology.

ENSDF: The Nuclear Structure and Decay Data Working Group's priorities emphasize the evaluation of nuclear structure and radioactive decay for entry of into the Evaluated Nuclear Structure Data File (ENSDF). ENSDF is of particular importance because it provides the source information for various other databases and applications including NuDat, Nuclear Wallet Cards, Medical Internal Radiation Dose (MIRD) file, Reaction Input Parameter Library (RIPL) and ENDF/B.VII. Nuclear structure and decay data provided by the USNDP are widely used in basic nuclear and astrophysics research and applications in fields including nuclear energy, nonproliferation, homeland security, nuclear medicine, geology, chemistry, and biology. ENSDF evaluations are peer-reviewed and published primarily in Nuclear Data Sheets and Nuclear Physics A. A total of 16 mass chain evaluations were published in 2012 in Nuclear Data Sheets

XUNDL: The XUNDL compilation is led by the McMaster group with the assistance of evaluators at TUNL, ANL, and BNL. Research published in all major nuclear science journals is continuously scanned into ENSDF format and provided on-line by the NNDC. The file includes 4965 datasets for 2138 nuclides compiled from about 3200 journal articles published from 1995-2012. In FY2012 592 datasets from 280 publications were added to XUNDL.

DDEP: The USNDP leads the Decay Data Evaluation Project (DDEP) in collaboration with the Bureau International des Poids et Mesures (BIPM, France). DDEP evaluations are published in Applied Radiation and Isotopes and available in ENSDF format. As of 2012 evaluations of decay data for 197 nuclides were available from the DDEP website.

EGAF: The Evaluated Gamma-ray Activation File (EGAF) effort is led by LBNL in collaboration with LLNL and the International Atomic Energy Agency (IAEA, Vienna). The EGAF collaboration is responsible for evaluating neutron capture γ -ray data, primarily measured with guided neutron beams at the Budapest and Garching FRM II reactors. In 2012 revised data for ^{12}C was entered into ENDF, new cross sections for $^{39,40,41}\text{K}(n,\gamma)$ were accepted for publication in Phys. Rev. C, and new (n,γ) measurements were made on the enriched isotopes $^{151,153}\text{Eu}$, $^{155,157}\text{Gd}$, and $^{180,182,183,184,186}\text{W}$ at the Budapest Reactor. A new evaluator for the Forschungszentrum Jülich GmbH has joined the EGAF collaboration.

Atomic Mass Data: The Atomic Mass Data Center (AMDC, CSNSM Orsay, France) published a new atomic mass evaluation in 2012. Atomic mass data are updated continuously and interim evaluations are provided to ENSDF evaluators. The AMDC also evaluates NUBASE, an up to date database of all known nuclides, isomers. The AMDC is moving its center of operations to Orsay to Lanzhou China in 2013.

Nuclear Science References: The NSR database and its content is managed by the NNDC in collaboration with evaluators at the IAEA, McMaster and Slovakia. NSR contains over 202,000 keyworded references and is the starting point for all USNDP evaluations.

Recent Progress: The reaction and structure data communities met jointly at the 2012 CSWEG/USNDP nuclear data meetings where the research activities of both the CSWEG and USNDP communities were shared. New cross section measurements coming from USNDP members were discussed. The LLNL effort to modernize the ENDF file structure using Extensible Markup Language XML has been extended, in collaboration with LBNL and BNL, to also modernize ENSDF file structure. Nuclear Data Sheets is rapidly moving towards fully electronic publication which will mitigate the concern for the ever increasing page size of mass chain publications. New proposals were brought forward by LBNL to streamline ENSDF evaluation by merging with XUNDL to replace supporting datasets, and using the DDEP and EGAF collaborations to reduce duplication of effort in ENSDF.

Other Activities:

- USNDP evaluators played an important role in organizing and participating in the 14th annual Nuclear Structure in 2012 Conference at Argonne National Laboratory. Interaction between the nuclear structure, astrophysics, and applied nuclear physics communities was beneficial, highlighting the need for better coordination of these efforts in the future. Initial discussions on forming an FRIB data working group were very positive.
- USNDP evaluators are leading an IAEA Coordinated Research Project on "Beta-delayed Neutron Emitters". A McMaster/NNDC collaboration evaluating the systematics of beta-delayed neutron emission and associated half-life data in the $A \leq 72$ mass region.
- USNDP evaluators played a pivotal role at the 20th IAEA Nuclear Structure and Decay Data (NSDD) Evaluators Meeting in Kuwait, January 27-31, 2013. The NSDD provides International leadership to the nuclear data community and is pivotal towards providing human resources for the ENSDF, XUNDL, EGAF, DDEP, Atomic Masses, NSR and other efforts.
- USNDP evaluators played a pivotal role as lecturers at the Nuclear Structure and Decay Data: Theory and Evaluation Workshop at the ICTP in Trieste, August 2012. This workshop brings ENSDF philosophy and analysis procedures to young scientists and potential new evaluators.

- The IAEA has developed Livechart, an advanced filter on nuclides, levels, bands, gammas and decay radiations from ENSDF. The USNDP is working with the IAEA to reformat ENSDF using XML formats to make Livechart even more useful and accessible to other data bases and software development.
- A new cooperative agreement has been entered between LBNL, LLNL, Forschungszentrum Julich GmbH Budapest Reactor Centre, and the FRM II Reactor near Munich to measure and evaluate actinide prompt gamma ray data for the EGAF evaluation effort. First measurements of (n, γ) cross sections on ^{237}Np , ^{241}Pu , and $^{241,243}\text{Am}$ have begun at FRM II.
- A new collaboration has been formed between Oslo University and LBNL for statistical gamma ray data from photonuclear, neutron, and charged particle reactions. These data are not compiled in any databases but are important for reaction calculations, astrophysics, and basic nuclear physics research.

IV. Nuclear Reaction Data

The nuclear reaction data effort focuses on evaluation of nuclear reaction data and the related measurement and compilation activities. The USNDP also makes important contributions to nuclear reaction model code development and improvement of reaction cross-section standards.

Reaction Data Highlights

The ENDF/B-VII.1 library was released in December 2011, as an essential update to the VII.0 version released in 2006. This is our latest recommended evaluated nuclear data file for use in nuclear science and technology applications, and incorporates advances made in the five years since the release of ENDF/B-VII.0. These advances focus on neutron cross sections, covariances, fission product yields and decay data, and represent work by the US Cross Section Evaluation Working Group (CSEWG) in nuclear data evaluation that utilizes developments in nuclear theory, modeling, simulation, and experiment. The extensive documentation was published in the December 2011 issue of Nuclear Data Sheets.

The BNL is developing nuclear data assimilation techniques which fold differential and integral experimental uncertainty and modeling uncertainties into covariance estimates. This work is still in progress but very encouraging results have been already obtained. Work continues on the COMMARA-3 version of the energy-group wise covariance library based on the point-wise covariances in ENDF/B-VII.1.

LANL upgraded the evaluation for ^{233}U , ^{238}Pu , ^{240}Pu , and ^{241}Am evaluations were completed. New evaluations of ^9Be capture cross section performed. The ^{16}O capture cross section was also upgraded. Both evaluations include the covariance data. New fission prompt fission neutron spectrum data for ^{235}U , ^{239}Pu , and ^{252}Cf were produced using the Monte Carlo technique recently developed at LANL.

During the 2011 Nuclear Data Week CSEWG held a session dedicated to the development of the Generalized Nuclear Data (GND) format as a proposed successor format for ENDF. The NNDC hosts the GND project on its GForge site. WPEC Subgroup 38 dedicated to the new XML format has been established. LLNL efforts have been focused on converting LLNL's ENDF nuclear reaction database to GND.

Model Code Highlights

EMPIRE-3.1 (Rivoli) was released in March 2012. The major changes are: (i) new input/output routines for the ENDF-6 format, (ii) prompt fission neutron spectrum calculation with the Los Alamos and Kornilov model including covariances, (iii) calculation of angular distributions for the compound elastic/inelastic scattering, and (iv) adjustment of compound cross sections when strongly coupled channels exist. Large scale test calculations were performed with the built-in model parameters to confirm the stability of the code system.

The TORUS collaboration (www.reactiontheory.org), which involves LLNL, MSU, TAMU, OU, and ORNL is dedicated to the theory of reactions on unstable isotopes. This collaboration addresses deficiencies in the current reaction theories, such as the distorted wave Born approximation, and neglect of higher order paths in the direct reactions. The goal is to develop (i) full three-body model calculation, (ii) Coulomb distorted Faddeev equation, and (iii) R-matrix method for the (d,p).

LANL has released the CoH3 and DeCE codes. CoH3 is the coupled-channels and Hauser-Feshbach code, which is employed for the nuclear data evaluation work at LANL. Besides the standard capabilities of similar Hauser-Feshbach codes, CoH3 runs in a Monte Carlo mode to calculate the correlated particle and gamma-ray emissions. DeCE is an ENDF-6 formatting utility code written in an object-oriented manner, which helps to produce the evaluated files for ENDF/B-VII.

Nuclear Standards Highlights

Improvements have been made to the nuclear data standards. The experimental database for the cross section standards evaluation has been updated with the results of recent experiments. Each experimental result is critically reviewed. The most recent results were n_TOF data on measurements of the $^{238}\text{U}(n,f)/^{235}\text{U}(n,f)$ cross section ratio. Experiments have been suggested that are now underway for the hydrogen, lithium, boron and fission standards. Our work has broadened its range of activities beyond that of the traditional activities related to the cross section standards by including work on extending the energy ranges of the standards and also 'reference data' that are not so widely used as the standards but can be very useful in the measurements of certain types of cross sections. This has led to several experiments that indicate the gold capture cross section in the 25 keV region, that is used for astrophysics applications, is better defined by the standards evaluation procedure than the cross section used by that community. Several candidates for gamma-ray production reference data have been investigated with a conclusion that neutron reactions on ^7Li and ^{nat}Ti appear to be the best candidates. Also included is an effort to improve the ^{252}Cf spontaneous fission neutron spectrum standard. This latter work also has an impact on an evaluation of the ^{235}U thermal fission neutron spectrum. Our efforts are complemented with an IAEA Data Development Project. An IAEA meeting involving researchers from Australia, Austria, Belgium, China, France, Germany, Japan, Russia and the United States is planned for July of 2013 at which the results of work leading to improved standards will be discussed.

Nuclear Astrophysics Highlights

The first results from the CARIBU decay studies were compiled in ENSDF format by ANL. Development of a dedicated decay data library of relevance to r-process nucleosynthesis modeling and other energy-related applications is continuing.

Maxwellian-averaged cross sections and Astrophysical reaction rates were published by BNL for ENDF/B-VII.1, JEFF-3.1.2, JENDL-4.0, ROSFOND-2010, CENDL-3.1 and EAF-2010 Evaluated Data Libraries.

Systematic behavior of average gamma-width and level density parameters were investigated at LANL.

ORNL published four papers (i) on levels in ^{19}Ne important in $^{18}\text{F}+p$ thermonuclear burning (ii) on assessment of inelastic / elastic proton branching ratio of resonance in ^{18}Ne crucial in $^{14}\text{O}+\alpha$ burning in novae (iii) assessment of upper limits on strong proton levels in ^{27}Si from direct $^{26}\text{Al}+p$ scattering experiment at ORNL. (iv) on levels in ^{131}Sn from measurement of $^{130}\text{Sn}(d,p)$ at ORNL HRIBF. In addition, assessment is in progress of levels in ^{27}Si , and analog levels in ^{27}Al , relevant for $^{26}\text{Al}+p$ thermonuclear destruction in stellar explosions.

V. Additional Accomplishments

ENDF/B-VII.1 release

The ENDF/B-VII.1 library is our latest recommended evaluated nuclear data file for use in nuclear science and technology applications, and incorporates advances made in the five years since the release of ENDF/B-VII.0. These advances focus on neutron cross sections, covariances, fission product yields and decay data, and represent work by the US Cross Section Evaluation Working Group (CSEWG) in nuclear data evaluation that utilizes developments in nuclear theory, modeling, simulation, and experiment. The principal advances in the new library are:

1. An increase in the breadth of neutron reaction cross section coverage, extending from 393 nuclides to 423 nuclides;
2. Covariance uncertainty data for 185 of the most important nuclides;
3. R-matrix analyses of neutron reactions on light nuclei, including isotopes of He, Li, and Be;
4. Resonance parameter analyses at lower energies and statistical high energy reactions for isotopes of F, Cl, K, Ti, V, Mn, Cr, Ni, Zr and W;
5. Modifications to thermal neutron reactions on fission products (isotopes of Mo, Tc, Rh, Ag, Cs, Nd, Sm, Eu) and neutron absorber materials (Cd, Gd);
6. Improved minor actinide evaluations for isotopes of U, Np, Pu, and Am, and adoption of JENDL-4.0 evaluations for isotopes of Cm, Bk, Cf, Es, Fm, and some other minor actinides;
7. Fission energy release evaluations;
8. Fission product yield advances for fission-spectrum neutrons and 14 MeV neutrons incident on ^{239}Pu ;
9. A new Decay Data sublibrary.

For nuclear criticality, the VII.1 library maintains the generally-good performance seen for VII.0, with improved performance coming from new structural material evaluations, especially for Ti, Mn, Cr, Zr and W. Actinide cross section updates are also assessed through comparisons of fission and capture reaction rate measurements in critical assemblies and fast reactors, and improvements are evident. Maxwellian-averaged capture cross sections at 30 keV are also provided for astrophysics applications.

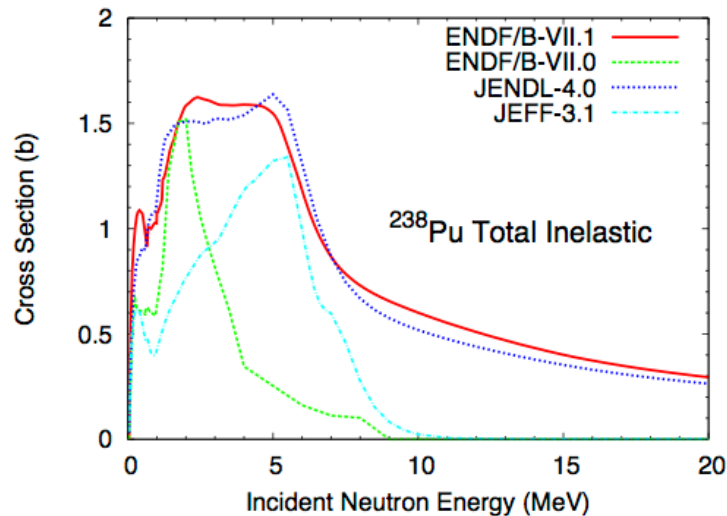


Fig. 1 Total inelastic cross section for $n+^{238}\text{Pu}$ - proper account for pre-equilibrium and direct mechanisms in the ENDF/B-VII.1 and JENDL-4.0 evaluations eliminates un-physical drop of cross sections observed in the remaining two evaluations.

Improving systematic predictions of beta-delayed neutron emission probabilities

The probability, P_n , for emitting a neutron following beta-decay is critical in many areas of nuclear science, from understanding nucleosynthesis during the r-process to control of reactor power levels and nuclear waste management. As it is not always easy to measure or calculate, indirect empirical approaches have been developed to estimate the P_n value from the decay Q_{β} value and the neutron separation energy, S_n . A new prescription incorporating also the half-life, $T_{1/2}$, which correlates the known data better and thus improves an estimation of P_n when only $T_{1/2}$, Q_{β} , and S_n are known. This new relation can be used to predict P_n values for cases where the half-life is known thus, can be useful in r-process network calculations and in modeling advanced fuel cycles. The work has been published in Physical Review C 86 (4), 041305, 2012.

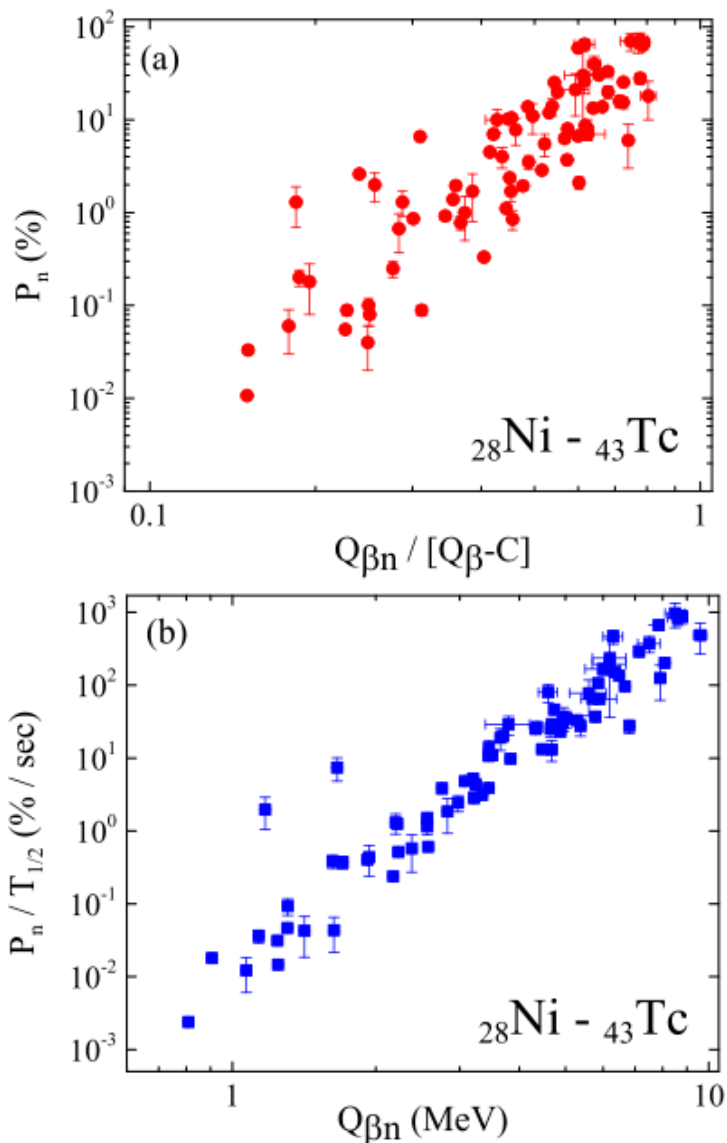


Fig. 2 The new systematics (Fig. 2b) provides a more accurate method for predicting P_n values compared to the previous formula (Fig. 2a). In addition, with the data lying on a more compact trajectory, it can be useful for identifying nuclei that deviate from the overall trend, as shown in Fig. 2b.

USNDP Staffing table FY2012

	ANL		BNL			LANL		LBNL	LLNL	MCMMASTER		NIST			ORNL		TUNL			Sum
	PhD P	PhD T	PhD P	PhD T	T/A	PhD P	PhD T	PhD P	PhD P	PhD P	PhD T	PhD P	PhD T	GS	PhD P	PhD T	PhD P	PhD T	T/A	
I. NNDC Facility Operation			0.60		1.45															2.05
Management			0.60																	0.60
Secretarial/Administrative Support					0.90															0.90
Library					0.05															0.05
Computer Operations					0.50															0.50
II. Coordination	0.30		0.60			0.25		0.10	0.13						0.05					1.43
National Coordination			0.30			0.05		0.05	0.10						0.05					0.55
International Coordination	0.30		0.30			0.20		0.05	0.03											0.88
III. Nuclear Physics Databases			1.13		0.80															1.93
Nuclear Science References, NSR			0.20		0.70															0.90
Exper. Nucl. Structure Data, XUNDL																				
Eval. Nucl. Structure Data, ENSDF			0.25																	0.25
Numerical Nuclear Data, NuDat			0.20																	0.20
Reaction Data Bibliography, CINDA																				
Experimental Reaction Data, CSISRS			0.05																	0.05
Evaluated Nuclear Data File, ENDF			0.15																	0.15
Database Software Maintenance			0.20		0.10															0.30
Future Database System Develop.			0.09																	0.09
IV. Information Dissemination			1.18	0.15	1.25				0.24						0.75				0.60	4.17
Nuclear Data Sheets			0.25	0.15	0.85															1.25
Customer Services			0.20		0.30															0.50
Web Maintenance & Development			0.73		0.10				0.24						0.75				0.60	2.42
	ANL		BNL			LANL		LBNL	LLNL	MCMMASTER		NIST			ORNL		TUNL			Sum
	PhD P	PhD T	PhD P	PhD T	T/A	PhD P	PhD T	PhD P	PhD P	PhD P	PhD T	PhD P	PhD T	GS	PhD P	PhD T	PhD P	PhD T	T/A	
V. Nuclear Structure Physics	0.60		1.90	1.65		0.10		1.60		1.00	0.30				0.80	0.15	0.76	0.10	0.15	9.11
NSR Abstract Preparation			0.25	0.25						0.20										0.70
Compilation of Exper. Structure Data	0.10		0.05							0.25							0.10			0.50
Eval. of Masses & Nuclides for ENSDF	0.30		1.30	1.40				1.00		0.55	0.30				0.80	0.15	0.33		0.15	6.28
Ground & Metastable State Properties			0.10																	0.10
Radioactive Decay Data Evaluation	0.10																			0.10
Thermal Capture Gamma Data Eval.								0.50												0.50
Light Mass Eval. for Nucl. Physics A																	0.33	0.10		0.43
Nuclear Structure Data Measurement	0.10		0.10			0.10		0.10												0.40
ENSDF Evaluation Support Codes			0.10																	0.10
VI. Nuclear Reaction Physics	0.10		1.25	1.34	0.20	0.95	0.25	0.30	0.03	0.20	0.10	0.10			0.10					4.92
Experimental Data Compilation			0.25	0.70																0.95
ENDF Manuals and Documentation			0.01																	0.01
ENDF Evaluations			0.25	0.42		0.30			0.03											1.00
Nuclear Reaction Standards						0.10						0.10	0.10							0.30
Nuclear Model Development			0.01			0.10	0.05	0.10												0.26
Nucl. Reaction Data Measurements						0.30	0.20	0.20												0.70
Astrophysics Nuclear Data Needs	0.10		0.10			0.10				0.20					0.10					0.60
Covariances development			0.15	0.22		0.05														0.42
Reactor anti-neutrino and decay heat calculations			0.40																	0.40
Verification and Validation			0.09		0.20															0.29
DOE-SC Nucl. Data Funded Staff	1.00		6.66	3.14	3.70	1.30	0.25	2.00	0.40	1.00	0.50	0.10	0.10		1.70	0.15	0.76	0.10	0.75	23.61
Staff Supported by Other Funds		1.00	2.00	1.17		12.70	5.75	2.30	5.81			2.50		1.00	0.60					34.83
TOTAL STAFF	1.00	1.00	8.66	4.31	3.70	14.00	6.00	4.30	6.21	1.00	0.50	2.60	0.10	1.00	2.30	0.15	0.76	0.10	0.75	58.44

PhD P: PhD Permanent,
 PhD T: PhD Temporary,
 T/A: Technical and administrative,
 GS: Graduate student.

Detailed Status of the Work Plan Fiscal Year 2012 Report

I. NNDC Facility Operation

A. Management

This task includes planning, budgeting, personnel, interaction with BNL management, and interaction with funding authorities.

B. Library

NNDC maintains an archival collection of low- and intermediate-energy nuclear physics publications. This library supports the NNDC compilation activities and the U.S. nuclear reaction and nuclear structure data evaluation and international nuclear structure evaluation effort.

C. Computer Operation

The NNDC operates several servers running Red Hat Enterprise Linux in support of its compilation, evaluation, database maintenance, and information dissemination functions. In addition, each staff member has a PC that supports an interface to these Linux servers and supports administrative functions such as word processing and email. Furthermore, MS Windows servers provide centralized backup, printing and file serving for the PCs. This task includes software upgrades, hardware and software procurements, machine operations and internal user support for both the Linux and Windows platforms.

BNL planned activities	Status
Conduct regular scanning and remediation of vulnerabilities on NNDC servers and clients to ensure compliance with DOE cyber security requirements. Noncompliance could result in a total block of a machine from network access.	Performed quarterly scanning on NNDC computers and network devices and remediated security vulnerabilities found. Actively coordinated with BNL-ITD to ensure that NNDC's computing resources would pass the annual DOE cyber security audit.
Provide computer support to NNDC staff and its visitors in their use of NNDC computing resources.	Provided technical support to NNDC staff in their daily use of NNDC computing resources such as the GForge server, Linux cluster and servers, MySQL database servers, and Apache/Tomcat Web servers. Rendered technical assistance to visiting NSR and EXFOR compilers, ENDF evaluators, CSEWG-USNDP meeting participants and external collaborators.
Unplanned: Operate a continuous integration and deployment system to automate the building of codes and the deployment of results in various NNDC projects.	Operated CruiseControl and then later upgraded to Control Tier as platform for ADVANCE, NNDC's first continuous integration and deployment system. Every hour, this system checks for additions or modifications to the ENDF repository residing on GForge, runs all pertinent tests on the changed data files, and then posts all results on NNDC's Web site for viewing by the community. The platform was subsequently expanded to include projects like the ENDF-6 formats manual and the END/B-VII.1 Web interface.
Unplanned: Upgrade the GForge server to keep up with the community's growing collaboration requirements.	Replaced the aging GForge server with a more powerful Dell server and installed the latest version of GForge Advanced Server software on it. The response time and stability of the system significantly improved even with the increased demand over time.

II. Coordination

A. National Coordination

National coordination is required for activities under the US Nuclear Data Program as well as Cross Section Evaluation Working Group. This is mostly performed by the National Nuclear Data Center, with contributions from other laboratories (USNDP Working Groups and Task Forces as well as CSWEG Committees).

ANL: Chair the Covariance Committee the Cross Section Evaluation Working Group.

ANL Planned Activities	Status
Organize and chair the CSEWG Covariance Committee	Completed

BNL: Chair USNDP Coordinating Committee, chair Cross Section Evaluation Working Group, develop USNDP work plan, and maintain its USNDP website.

BNL planned activities	Status
Prepare FY2013 work plan for USNDP in time for spring 2012 FWP submittals.	The FY2013 work plan for USNDP has been prepared and published in March 2012.
Organize and chair CSEWG Meeting at BNL in November 2011.	The CSEWG meeting has been organized as a part of the Nuclear Data Week, November 14-18, 2011 .
Organize and chair USNDP Meeting at BNL in November 2011.	The USNDP meeting has been organized as a part of the Nuclear Data Week, November 14-18, 2011 .
Edit and publish summary reports and proceedings of the CSEWG and USNDP meetings.	Joint CSEWG/USNDP report has been published in January 2012.
Maintain CSEWG and USNDP websites	The CSEWG and USNDP websites were maintained.
Unplanned activity: Work on ND2013.	Two circulars were sent out, poster has been designed and sent out, registration system has been set up and 598 participants have registered by 10/16/2012, abstract collection system has been set up and over 580 abstracts were collected, all abstracts were reviewed and 576 were accepted, 436 invited and featured talks were selected and scheduled, 138 posters were accepted.
Aid LLNL to organize and chair the CSEWG Task Force on Nuclear Data Needs for Homeland Security.	Continuing.

LANL planned activities	Status
Organize and chair CSEWG Evaluation Committee meeting at BNL, November 2011.	Organized and chaired Evaluation Committee meeting at the November 2011 CSEWG meeting.
Organize and chair Nuclear Reaction Working Group meeting at USNDP meeting in November 2011, and help coordinate Homeland Security and Astrophysics Task Forces.	Organized and chaired Nuclear Reaction Working Group meeting at the November 2011 USNDP meeting, and help coordinate Homeland Security and Astrophysics Task Forces.

LLNL: Serve as a member of the USNDP Coordinating Committee and chair the USNDP Nuclear Structure and Decay Data Working Group in addition to overseeing, coordinating, and directing the work of members of the Isotopes Project. The latter effort includes working with LBNL management, with other members of the USNDP, and with the program officers of the DOE.

LBNL planned activities	Status
Organize and chair Nuclear Structure USNDP meeting at USNDP meeting at BNL, November 2012. Work with the NNDC to improve the efficiency of nuclear structure data evaluation and better integrate US efforts with other nuclear data activities.	Completed
Coordinate EGAF Capture Gamma-ray Library evaluations with LLNL for preparation of ENDF format datasets and improved RIPL files.	Participated in NNSA review of the program with positive results. Developed methodology for extending EGAF to higher neutron energies. Published K isotopes in PRC. Evaluation of Fe, Y, Eu, Gd, and W isotopes continuing.
Coordinate the West Coast collaboration to measure and evaluate neutron cross section measurements at the LBNL Cyclotron, UC Berkeley Department of Nuclear Engineering, and National Ignition Facility neutron facilities.	Prepared neutron generator site at UC Berkeley. Took management responsibility for installation of neutron generator. Served on NIF Ignition and NIF Science Advisory Committees.

LLNL: Chair the Task Force on Nuclear Data Needs for Homeland Security of the Cross Section Evaluation Working Group.

LLNL planned activities	Status
Organize and chair the CSEWG Task Force on Nuclear Data Needs for Homeland Security.	BNL acting as chair

ORNL: Chair the Astrophysics Task Force, and help facilitate and coordinate nuclear astrophysics data work at different labs to advance USNDP goals; provide leadership in planning future activities in nuclear data for nuclear astrophysics

ORNL planned activities	Status
Summarize USNDP efforts in nuclear data for nuclear astrophysics at USNDP Meeting.	Summarized USNDP astrophysics activities and gave presentation at USNDP meeting in Fall 2011
Communicate current efforts and future plans with researchers in nuclear astrophysics and nuclear astrophysics data.	Gave presentations on "Online Nuclear Astrophysics Resources" at the Low Energy Community Meeting [August 2012] and the Nuclear Astrophysics Town Meeting {October 2012}; led discussions on nuclear astrophysics data at both meetings
Represent USNDP nuclear astrophysics efforts at international collaboration meetings on nuclear astrophysics data.	Submitted tutorial lectures on USNDP astrophysics resources to the Nuclei in the Cosmos meeting in Australia in August 2012

Initiate collaborative research projects to raise the visibility of nuclear data projects directed at astrophysics applications.	Initiated a project between 2 US institutions and China, involving both nuclear reaction and structure theorists, that resulted in a PRC Rapid Com publication
Discuss future plans in nuclear astrophysics data with DOE, with USNDP/NNDC, and with other agencies.	Co-chaired the "Data and Codes" section of the Nuclear Astrophysics Town Meeting in October 2012, wrote the summary of this meeting, and will serve on writing panel for the White Paper from this meeting; also initiated discussions with DOE program officers regarding future activities in nuclear astrophysics data, and proposed numerous future activities at the Low Energy Community Meeting in August 2012

B. International Coordination

ANL: Represent the ANL in IAEA-sponsored Nuclear Structure and Decay Data Network (NSDD) and Decay Data Evaluation Project. Participate in IAEA-sponsored coordinated research programs (CRP) and training workshops.

ANL planned activities	Status
Coordinate DDEP international activities	Completed
Host several international visitors to ANL to collaborate on nuclear structure and nuclear astrophysics data evaluation projects.	Continuing
Principal organizer of the international conference "Nuclear Structure 2012"	The major nuclear structure conference in North America was organized by ANL. More than 200 participants (58 PhD students) attended the meeting, where 72 oral and 81 poster presentations were given. A report on the conference is submitted for publication to the Nuclear Physics News magazine.
Lecturer at the International Exotic Beams Summer School	Presented an invited lecture on Nuclear Data issues

BNL: Represent the United States in IAEA-sponsored Nuclear Reaction Data Center Network (NRDC) and Nuclear Structure and Decay Data Network (NSDD). The NNDC center head is the U.S. member and vice-chair of the IAEA's International Nuclear Data Committee (INDC), the lead US member of the NEA Working Party on International Evaluation Cooperation (WPEC) in his position as chair of CSEWG. Many of the NNDC staff participates in IAEA sponsored activities such as Workshops and Technical Meetings.

BNL planned activities	Status
Participate in the IAEA-sponsored NRDC meeting in 2012.	M Herman and S. Hlavac (NNDC contracted compiler) attended the NRDC meeting in NEA Headquarters in Paris. Herman presented status of preparations to ND2013.
Participate in NEA WPEC annual meeting in 2012.	M. Herman led US delegation to the WPEC meeting held at NEA Headquarters in Paris. He presented release of the ENDF/B-VII.1 library and status of preparations to ND2013.
Conduct and lecture at likely IAEA-sponsored workshop at Trieste in 2012.	J. Tuli was one of the Directors of IAEA-sponsored workshop on nuclear structure evaluations held at ICTP. He helped with selection of candidates and lecturers, planning of agenda, and day to day running of the workshop. J. Tuli, together with T. Johnson, E. McCutchan, and A. Sonzogni delivered bulk of the lectures given at two-week workshop. All of them were involved in providing hands-on training by evaluating various nuclides in mass chain A=211.
Continue working on the organization of ND2013	Continuing (see National Coordination for details).
Participate in IAEA INDC meeting.	M. Herman participated in the INDC meeting held at IAEA Headquarters in Vienna and chaired working group on data dissemination.
Unplanned: Participate in the IAEA meeting "Further Development of the Multinationally-Maintained Experimental Nuclear Reaction Database (EXFOR)"	D. Brown participated in this meeting and functioned as the meeting rapporteur.

LANL: Participate in and chair international nuclear reaction data collaborations. This insures that the U.S. benefits from breakthroughs around the world, and plays a leadership role in new developments. LANL staff members participate in NEA/WPEC committees on covariance data and international model code development cooperation. LANL will host visits by foreign scientists with international reputations to benefit from the exchange of information and ideas.

LANL planned activities	Status
Participate in NEA-WPEC 2012 meeting	Two LANL participants participated in the WPEC meeting in Paris.
Participate in relevant IAEA CRP meetings (FENDL and prompt fission neutron spectrum data).	Three LANL participants participated in the IAEA meetings (FENDL and fission neutron spectrum).
Participate and give a talk at the workshop on compound nucleus and related topics, CNR11, Sep 19-23, 2011, Prague	Four LANL scientists gave talks at the CNR11 conference in Prague.

Make latest version of NJOY data processing code available to the international community.	Upgrades to NJOY were released to international NJOY nuclear data processing community.
Host a couple of international visitors to LANL to collaborate on the evaluation of reaction data.	Dr. Kunieda of JAEA, Japan visited LANL, worked on the light element cross section evaluation.
Help organizing International Conference on Nuclear Reaction Mechanism, Varenna, Italy, 2012.	Organized International Conference on Nuclear Reaction Mechanisms in Varenna, Italy.

LBNL: Participate in IAEA-sponsored training workshops, planning meetings and coordinated research programs on nuclear structure and decay data.

LBNL planned activities	Status
Coordinate the development of a website for the k0/cross section database with International k0 users committee and the IAEA.	Initial website started at IAEA
Coordinate EGAF and RIPL evaluation with the IAEA	Took responsibility for RIPL data for (n,g) reaction product nuclides.
Coordinate the development of a new continuum reaction/gamma-ray database with the IAEA and researchers at the Oslo Cyclotron Laboratory.	Scheduled IAEA consultants meeting for Fall 2013.
Coordinate LBNL/Budapest/FRM-II/Julich TransActinide Nuclear Data Evaluation and Measurement (TANDEM) collaboration to measure actinide neutron cross sections.	Approved measurements of Ge, Zr, and ²³⁸ U(depleted) isotopes. Measured gamma ray cross sections for ²³⁷ Np, ²⁴¹ Pu, ²⁴¹ Am in collaboration with Julich group.

McMaster: Continue participation in new evaluators training program.

McMasters planned activities	Status
Continue to participate in the matters related policies, ENSDF formats and procedures for the NSDD network.	Continuing
Continue to participate in training/mentoring of new ENSDF evaluators through collaborative work.	Participated in IAEA-ICTP ENSDF workshop at Trieste August 6-17, 2012: lectures, coordination of A=211 ENSDF evaluation.

TUNL: Represent TUNL at IAEA-sponsored at Nuclear Structure and Decay Data network (NSDD).

TUNL planned activities	Status
Participate in the policy matters related to the NSDD network.	Continuing
Participate in NSDD/IAEA meetings	Continuing

III. Nuclear Physics Databases

A. Nuclear Science References (NSR)

The NNDC is responsible for NSR, the bibliographic database for nuclear physics research. This task includes quality control, file update and maintenance, and file distribution to collaborators. Updates are done on a continuing basis. The preparation of NSR entries is given under Nuclear Structure Physics.

BNL planned activities	Status
Distribute database to collaborators.	Database was distributed 12 times a year to IAEA.
Provide international coordination of NSR compilations and activities.	NSR compilation activities were coordinated between NNDC, McMaster University and Institute of Physics (Bratislava). IAEA stopped contributing to NSR, so coordination with the IAEA ceased.
Database updates and maintenance.	Database content was updated 112 times, content was verified for consistency.

B. Experimental Nuclear Structure Data (XUNDL)

The NNDC is responsible for maintaining and providing access to the XUNDL database. This database contains compilations (in ENSDF format) of recently published or completed level-structure data for high-spin and low-spin physics. The compilation work is mainly carried out at McMaster University. The McMaster group also coordinates this work with that of other centers. The NNDC updates the database as new/revised data sets are received from McMaster.

BNL planned activities	Status
Weekly update of the database using input received from McMaster University.	Weekly update of the database using input received from McMasterUniversity
Distributed twice a year to the NSDD network.	Distributed twice a year to the NSDD network.

C. Evaluated Nuclear Structure Data File (ENSDF)

The NNDC is responsible for ENSDF, a database of evaluated experimental nuclear structure and decay data. The NNDC is responsible for format and content checking, preparation of manuscript, and quality control (review) of evaluations submitted for inclusion. The NNDC maintains the database, which includes database updates and distribution to collaborators. Corrections are implemented on a continuing basis.

BNL planned activities	Status
Database distributed to collaborators twice a year.	ENSDF as well as XUNDL are distributed to the NSDD network twice a year. Last distributions were on March 7, 2012 and October 23, 2012.
Process evaluations received from NSDD evaluators.	A total of 19 A-chains were received, processed and sent to referees. In addition 13 nuclides were revised and updated in ENSDF.

D. Numerical Nuclear Data File (NuDat)

The NNDC is responsible for NuDat, which consists of a database and a suite of codes that access it, allowing web users to search for level and γ -ray properties extracted from ENSDF, ground and meta-stable state properties (Wallet Cards), atomic and nuclear radiations derived from ENSDF, and thermal neutron cross sections and resonance integrals. Additionally, NuDat contains an interactive Chart of Nuclides and interactive level schemes.

BNL planned activities	Status
Update NuDat database as necessary, about 10 times a year.	NuDat was updated regularly, on average every two weeks.

E. Neutron Reaction Data Bibliography (CINDA)

The NNDC continues to contribute to the CINDA database that contains references to nuclear reaction data in the published and unpublished literature. Since 2004, CINDA also contains bibliography information on charged-particle and photonuclear reactions. The database serves as an index to the data contained in the experimental database, CSISRS. The database is maintained by the Nuclear Data Section, IAEA Vienna.

BNL planned activities	Status
Contribute to CINDA by compiling experimental cross-section data to the CSISRS database (120 compiled papers expected).	NNDC has been contributing indirectly to CINDA by compiling EXFOR entries. These entries are automatically converted into CINDA entries at the IAEA.

F. Experimental Reaction Data File (CSISRS)

The NNDC is responsible for maintaining the CSISRS database at BNL. This database contains experimental nuclear reaction data for incident energies below 1 GeV, including neutron-induced reactions and reactions with incident charged particles of mass $A \leq 12$. Many groups worldwide compile experimental data and send it to the central database in Vienna in the EXFOR format. Then, each is responsible to update its own database. The effort described here includes quality control, file update and data transfer activities. The NNDC database is updated, as compilations are exchanged and checked from the compiling centers. The compilation activity is given under Nuclear Reaction Physics.

BNL planned activities	Status
Update CSISRS with EXFOR compilations from cooperating centers (500 entries expected). The NNDC compilation work can be found under Nuclear Reaction Physics, chapter V of the present document.	11 incremental and 1 complete update were implemented in FY2012.

G. Evaluated Nuclear Data File (ENDF)

The NNDC is responsible for ENDF, a database of evaluated nuclear data required for many nuclear applications. The work is organized under the Cross Section Evaluation Working Group (CSEWG), coordinated by the NNDC. The ENDF file contains complete descriptions of nuclear reactions of neutrons with many nuclides and elements for energies up to 20 MeV and radiations from radioactive decay. A number of evaluations for energies up to 150 MeV and for incident charged particles and photons are also included. The data are stored in the ENDF format developed at NNDC about 35 years ago, and adopted as an international standard. In addition to the U.S. library, ENDF/B, the database contains evaluated data libraries from the European Union, Japan, Russia, and China. This activity includes the processing and quality control for the U.S. ENDF/B library, the distribution of this database in the United States and the exchange of libraries internationally. New evaluations for the next release of the library, ENDF/B-VII.1, are assembled, tested and made available to users through NNDC's Web servers and GForge collaboration server.

BNL planned activities	Status
Maintain Linux/MySQL database system.	Upgraded ENDF database system's capabilities and functionalities to meet end-user requirements.
Maintain GForge/Subversion system for tracking development of the ENDF/B-VII.1 library.	Replaced the GForge server hardware with a more powerful Dell server and installed the latest version of the GForge Advanced Server software. Since then, the system's reliability and response time significantly improved.

Maintain and improve Sigma database and web interface for users without specialized knowledge of ENDF-6 format. (See also information dissemination, chapter IV).	Sigma was updated periodically. The new ENDF/B-VII.1 library was added in December 2011.
Unplanned: Stand-up ADVANCE, the ENDF continuous integration system that continually checks for modification to the ENDF database then runs all available tests on the changed data files.	System is operational as of 10/2012.

H. Database Software Maintenance

This activity includes software bug fixes and enhancements for the six nuclear physics databases maintained by NNDC.

BNL planned activities	Status
Fix bugs and develop enhancements for the six nuclear physics databases maintained by NNDC.	The six nuclear data bases were maintained. The ADVANCE system has been developed for QA of the ENDF database and for bug tracking.

I. Database Systems Development

The multi-year effort to migrate the USNDP databases to a LINUX/MySQL environment was completed in FY2009. Afterwards, several follow-up tasks needed to be performed. A new web interface, complementary to the existing one, should be developed to facilitate the retrieval of experimental data in CSISRS by non-ENDF users, such as nuclear astrophysicists. This interface should focus on the relevant experimental data, such as a full reference to the publication, a comprehensive reaction description and the experimental data. The existing interface, giving access to the complete compilation (with more details than the reference, reaction and data) will be retained and will still be accessible to users who need it. Also, a new ENDF interface should be developed for users who do not possess specialized knowledge of ENDF-6 format.

BNL planned activities	Status
Effort needed to maintain Linux/MySQL database system and improve its performance.	Coordinated with BNL-ITD to identify and address performance bottlenecks due to increased retrieval from external users and the growing number of applications running on the servers.
Implement and maintain automatic replication of updates from the internal MySQL database server to the external.	Continuing

IV. Information Dissemination

The goal of the dissemination activities of the USNDP is to provide scientists and engineers with nuclear data from the USNDP-maintained nuclear databases in a variety of user-friendly formats and media.

A. Web Site Maintenance

The NNDC provides electronic access to the nuclear physics databases that it maintains on behalf of the USNDP as well as access to other nuclear physics information through its Web site. The NNDC Web services are powered by four Dell servers each with two 3.3-GHz, quad-core processors running on the Linux operating system and using the Apache, Tomcat and MySQL database server software. The migration from Sybase was completed in July 2009 and has proven to be secure, fast and to have minimum downtime. Overall, the migration significantly improved the reliability and cost-effectiveness of the NNDC Web services. The NNDC also maintains the Atomic Mass Data Center website. Other USNDP members also offer nuclear physics information through their websites. These services require resources to maintain currency and improve performance.

ANL Planned Activities	Status
Maintain and upgrade the ANL/NDM report series web site.	Continuing
Maintain and upgrade Experimental Resources for Nuclear Data web site.	Continuing
Maintain and upgrade ANL Nuclear Data Information web site.	Continuing

BNL Planned Activities	Status
Improve ENSDF and NSR web interfaces.	The ENSDF/XUNDL web application for search was completed and released. All code was checked into GForge for source control and a bug database was added and is being maintained. Closed 7 issues so far noted by users.
Maintain web interfaces for ENDF and EXFOR databases.	ENDF and EXFOR Web interfaces were upgraded in cooperation with the IAEA. Automated the generation and posting of updates to the ENDF/B-VII.1 Web interface using Control Tier, an open-source continuous build and deployment system.
Improve Sigma web interface by adding new and extended features following user's requests.	Continuing

Maintain web interface for double-beta decay, B(E2) and Maxwellian-averaged cross sections and reaction rates.	The Web interfaces were updated to reflect the current status of these projects.
Maintain currency of the CSEWG, USNDP and the NNDC web sites, proactively respond to the users requests.	Kept NNDC front page current with upcoming events. Maintaining agenda for CSEWG 2012 meeting. Added latest Empire web app. Updated Wallet Cards site. Fixed various broken link problems, cleaned up much of the HTML code and checked main page and several sub-projects into GForge. Added Google gmail account to create an event Calendar, used on the front page to maintain an up-to-date list of meetings and events and parsed calendar feed to display hyper-linked events on the main page.
Improve reliability of its web services by installing the latest version of Apache/Tomcat servers and mod-jk connector software for a new dual web server system. Maintain the NNDC Web Services readiness above the 99% level.	This was done and WebServices were maintained >= 99%. In accordance with the practice of some industrial leaders in software maintenance, a restart script was set to kick off at midnight for minimum disruption.
Strictly follow all BNL and DOE cybersecurity rules and regulations during the Web application design, development and implementation.	All NNDC-developed applications passed the annual DOE cyber security audit.
Maintain GForge Web site.	Improved significantly Web site response time and reliability by upgrading to a more powerful Dell server and installing on it the latest version of GForge Advance Server software at that time.
Unplanned: Develop and release a Wallet Cards mobile application for Android.	This was done and released and is available from the web site.

LANL Planned Activities	Status
Maintain LANL web site and provide actinide ENDF/B-VII data for criticality data testing, together with other LANL evaluations.	We maintain the T-2 web site to make the new actinide and light element evaluations available inside the LANL.

LLNL Planned Activities	Status
Maintain LLNL's Nuclear and Atomic Data Viewer.	Maintained.
Extend the Nuclear and Atomic Data Viewer as per user requests.	No upgrades performed in FY12.
Maintain and upgrade LLNL's Computational Nuclear Physics web pages.	Web pages maintained. Plans for upgrade to web site exist but have lacked sufficient resources to implement plan.

LBNL planned activities	Status
Update the on-line Table of Isotopes website in collaboration with the Kai Vetter group at UC Berkeley.	Continuing effort

ORNL Planned Activities	Status
Continued development and maintenance of our online software suite to convert nuclear data to astrophysical reaction rates and plot, manipulate, combine, and share results online; this activity is at risk of termination.	Overhauled handling of lists of nuclides that are the interface between nuclear data sets and astrophysical simulation input due to incorporation of new and revised reaction rate libraries in our system; imported the JINA REACLIB v2 thermonuclear reaction rate library into our system, and set this library as the default in our system
First implementation of workflow tools to help international collaboration in evaluations for nuclear astrophysics	software system was updated with minor changes and prepared for implementation, now awaiting progress on organizational efforts [establishment of editorial board]

TUNL Planned Activities	Status
Continue to improve the TUNL website and provide access to new information on A = 3 - 20 nuclei.	Continuing
Continue to prepare new PDF and HTML documents of the most recent TUNL reviews.	Continuing
Continue to provide PDF and HTML documents for FAS reviews for the A = 3 - 20 series with the most current NNDC reference keys and with the direct hyperlink of reference with TUNL keys.	We have completed FAS reviews from year 1987 to 1991.
Continue to provide Energy Level Diagrams (in GIF, PDF and EPS/PS formats) to accompany the PDF and HTML documents for the most recent TUNL reviews and preliminary reports, and for the earlier FAS reviews.	Continuing
Provide compiled and evaluated data on the decay of unstable ground states and on structure data from thermal neutron capture.	Continuing

Provide compiled data related to the level parameters for A = 3 - 20 nuclei populated in proton- and alpha-particle-induced reactions.	Continuing
Provide online access of TUNL dissertations collection.	More than half of TUNL dissertations have been collected.

B. Customer Services

This task accounts for the non-electronic services which the USNDP renders to customers. At the scientific staff level, this means direct assistance to users needing advice from nuclear data experts or advice on solving complex queries via electronic access to the database. The NNDC staff allocation at the support level is for maintaining a "help desk" and for administrative/clerical support of its customer services.

BNL Planned Activities	Status
Provide technical support to users as necessary.	NNDC staff responded to numerous user's e-mail inquiries including technical that regard retrieval of the data as well as more fundamental ones regarding differences between evaluations, the way data are coded in the libraries and possible deficiencies in the evaluations.
Maintain Comments/Questions for all reaction databases, for the NNDC web services, ENDF, EXFOR and for Nuclear Wallet Cards.	Comments/Questions for all USNDP reaction databases were made available to the users on the Web pages respective to each database.

C. Publications

The USNDP provides some paper publications as well as electronic access to the nuclear physics databases that it maintains. This includes the Nuclear Data Sheets published by Elsevier and various versions of the Nuclear Wallet Cards.

BNL Planned Activities	Status
Prepare twelve issues of Nuclear Data Sheets for publication.	During FY12 12 issues of Nuclear Data Sheets were published. Except for the 12/2011 issue all others were devoted to ENSDF evaluations. Total number of 16 mass chains were published.
Prepare special issue of Nuclear Data Sheets on neutron reaction data.	The special issue dedicated to the release of the ENDF/B-VII.1 library was prepared and printed in December 2011 simultaneously with the release of the library.

McMaster Planned Activities	Status
Develop software for Nuclear Data Sheets publication	A working copy of JAVA-NDS code delivered to NNDC October 2011. Also on request, sent a copy to Dr. Marco Verpelli at NDS, IAEA for use in plotting of decay schemes and possibly XUNDL datasets.

V. Nuclear Structure Physics

A. NSR Abstract Preparation

The literature search and preparation of KEYWORD abstracts for publications included in NSR require scientific expertise. BNL continues to have the overall responsibility for this database. The IAEA is expected to provide more than 20% of the keywords. Similar contributions from other external collaborators are expected. These will be checked and edited by BNL as necessary before being added to the database.

BNL Planned Activities	Status
Prepare entries for about 3,100 new references, and keyword abstracts for 2,000 of them.	The total count: 3,804 new articles, including 2,315 keyworded articles. Directly at NNDC: 1,367 new articles, 502 modified articles and 798 keyworded. Large number of modified articles due to changes Z=114 and 116 to FI and Lv, respectively. 311 keyworded abstracts were modified to accomplish this task.
Check and edit approximately 700 key-worded abstracts for three European journals prepared at the IAEA Nuclear Data Section.	These activity was transferred to Institute of Physics (Bratislava). IAEA is no longer NSR contributor.
Check and edit key-worded abstracts from other collaborators as applicable and necessary.	---- 114 new and 27 keyworded articles were checked from the IAEA. ---- 1,168 new and 762 keyworded articles were checked from Bratislava. ---- 1,155 new and 728 keyworded articles (11 months keywording) were checked from McMaster University.
Provide training and knowledge sharing for external NSR collaborators.	Provided training and help on NSR dictionaries to Institute of Physics (Bratislava).

McMaster Planned Activities	Status
NSR keywording for all articles in Physical Review C journal during October 2011 to September 2012	NSR keywording supplied for 13 issues of PRC (August 2011 to August 2012): total of 1250 articles were consulted: keyword abstract written for 820 articles.

B. Compilation of Experimental Structure Data

This activity involves compilation of recently published or completed experimental nuclear structure data for inclusion in XUNDL. The compilation is done by McMaster, while the NNDC is maintaining the database. In FY09, ANL plans to start contributing to compilation effort.

ANL Planned Activities	Status
Compile and review datasets for recently published experimental nuclear structure data for inclusion in the XUNDL database. Interact with the authors for requesting additional experimental data or for further clarification of the published results.	21 XUNDL compilations were completed. Trained two undergraduate students from DePaul University for XUNDL compilation work

BNL Planned Activities	Status
Compile new B(E2) experimental data. Continue work on a B(E2) evaluation project (in collaboration with McMaster and Central Michigan Universities).	Compiled 16 nuclides. Worked with McMaster and Central Michigan Universities on B(E2) evaluation project.
Compile new double-beta decay experimental data.	Compiled 10 nuclides and 20 decay modes. Started to work with V. Tretyak (KINR, Ukraine) on double-beta decay compilation and evaluation.
Maintain, update and distribute XUNDL.	

McMaster Planned Activities	Status
Compile data sets (in ENSDF format) for current experimental nuclear structure publication. Scan the webpages of prominent journals in nuclear physics for new papers.	466 datasets compiled by McMaster group + 42 together with D. Kulp (NNDC contract). Many journals scanned on daily basis for new papers.
Review compiled data sets submitted by other data centers prior to inclusion in the XUNDL database.	84 datasets received from TUNL and ANL reviewed and edited, if needed.
Communicate with the authors of the original papers for data-related problems and to request additional details of unpublished data.	Many communications in FY-12 for additional data and clarification of published data. One submission to XUNDL in support of a published paper in PRC. Four datasets prepared from this work.
Train a new undergraduate student in 2012 for XUNDL and other compilation work.	A new student Ervin Thiagalingam at McMaster trained for XUNDL and NSR keywording.
Compile new mass measurements and submit data file to nuclearmasses.org webpage at ORNL	19 papers published from Nov 2011 to Oct 2012 compiled with 195 values for new masses and Q values. Compiled file has been submitted to nuclearmasses.org webpage maintained by M. Smith at ORNL.

TUNL Planned Activities	Status
Compile XUNDL data for A=2-20	We have compiled 63 XUNDL data sets for the FY2012.

C. Data Evaluation for ENSDF

The USNDP evaluates nuclear structure and decay data for inclusion in the ENSDF database. This effort includes the critical analysis of all available experimental nuclear structure and radioactive decay data for a nuclide or a group of related nuclei to deduce recommended values from the measured data and prepare a file in ENSDF format that is the basis for publications in "Nuclear Data Sheets" and is used to update the contents of the USNDP nuclear structure and decay database, ENSDF. The US effort is supplemented by foreign contributions prepared under the auspices of the IAEA-sponsored international Nuclear Structure and Decay Data network.

ANL Planned Activities	Status
Evaluate at least 1 mass chain from the ANL region of responsibility.	Following comments from the reviewer, the evaluation of A=110 mass chain was completed and published in Nuclear Data Sheets. Work is continuing on A=112, 174, 177, 188 and 209 mass chains
Review mass chain evaluations, as requested.	Review of A=146 is near completion
Collaborate with scientists from other NSDD network centers on data evaluation projects.	Collaborated with scientists from Australia, Bulgaria, China, Finland, India and US on ENSDF data evaluations.

BNL Planned Activities	Status
At least 6 mass chains, or their equivalent nuclides, will be evaluated.	Total number of 107 nuclides were evaluated. This includes nine mass chains evaluated. These mass chains are: A=68,88 (McCutchan); 87 (Johnson/Kulp); 141 (Nica); 156 (Reich); 230,251,253,255 (Browne/Tuli); as well as a contribution to A=211 evaluated in Trieste.
At least 6 mass chains, or their equivalent nuclides, will be reviewed.	Seven mass chains were reviewed: McCutchan (3), Tuli (2), Browne (1), Reich (1)
Continue mentoring new ENSDF evaluators.	T. Johnson, E. McCutchan, A. Sonzogni, J. Tuli each mentored groups of 4 to 6 trainees in ENSDF evaluation at Trieste, August 2012, workshop.

LBNL Planned Activities	Status
Evaluate the equivalent of at least 2 mass chains, including a minimum of one from the A=21-30 region. Emphasis will be placed on evaluating data of current interest to the nuclear structure and nuclear application communities.	Published A=23,92,143*,192,230* in Nuclear Data Sheets. *in collaboration with NNDC
Review mass-chain evaluations, as requested.	Reviewed 2 mass chains
Work with the NNDC to include DDEP decay data and EGAF capture gamma-ray data in the ENSDF file and publish it in Nuclear Data Sheets.	Continuing
Train new evaluators to replace retiring 2.0 FTE expected by FY2014.	Hired ARRA supported staff scientist as permanent LBNL employee.

McMaster Planned Activities	Status
3.0 equivalent mass chains and the data for new nuclides as mentioned below) will be evaluated.	A=42 and 164 full A-chain updates were submitted. 5 nuclides for A=211 which was coordinated by B. Singh at IAEA-ICTP-TRIESTE workshop in August 2012. Total number of nuclides: 33
Mass chains will be reviewed as requested.	A=114 was reviewed. Also edited several datasets for this mass chain as part of the review process
Update ENSDF for the identification of new nuclides and for the first publications on the findings of the excited states of nuclides.	15 nuclides were updated in this category.
Collaborate with a new center/evaluator as part of mentoring process, as needed.	Mentoring process is continuing with P.K. Joshi at TIFR in India, and A. Negret in Bucharest

ORNL Planned Activities	Status
Complete evaluation of structure information for one nucleus in A=241-249 region, or others assigned by NNDC.	Evaluated A=247 nuclei
Review one mass chain evaluation.	Reviewed two A-chains: A=68 and A=69 evaluations. Current status is A=69 (12 nuclides) and 152 (17 nuclides) was submitted, A=69 is with evaluator after referee report (Post review), A=152 with evaluator after referee report (Post review), A=247 was submitted and is with NNDC (Pre-review)

TUNL Planned Activities	Status
Prepare the ENSDF files corresponding to new publications in the "Energy Levels of Light Nuclei" series.	We submitted the updated ENSDF with the most recent review of "Energy Levels of Light Nuclei A = 11" on January, 2012 (5 nuclides). Seven beta-decay (delayed neutron) data sets have been updated.

D. Ground and Metastable State Properties

The NNDC maintains a database of nuclide properties for the Nuclear Wallet Cards.

BNL Planned Activities	Status
Update database as new information becomes available.	Nuclear Wallet Cards file was replaced by the October 2011 version, the 8th edition, of Nuclear Wallet Cards booklet. The file was further updated as the ENSDF updates.

E. Radioactive Decay Data Evaluation

Decay data for nuclides of importance for metrology are evaluated in an international collaboration. When complete, these evaluations will be entered into the ENSDF format, included into the ENSDF database and made available to ENSDF evaluators. In the United States, E. Browne (LBNL) coordinates this project at no cost to the US Nuclear Data Program.

ANL Planned Activities	Status
Evaluate at least one radionuclide for the DDEP collaboration.	None were completed.
Review of selected nuclides for the DDEP collaboration.	Reviewed 22 decay data evaluations

McMaster Planned Activities	Status
Evaluate or review decay datasets for one or two radionuclides, as needed.	Participated in DDEP meeting Oct 8-10, 2012: Three presentations: XUNDL, B-N evaluation; Averaging procedures

F. Neutron-Induced γ -Ray Data Evaluation

The EGAF (Evaluated Gamma-ray Activation File) database, disseminated by the IAEA and maintained by LBNL, currently provides discrete-line prompt γ -ray information from thermal (n, γ) reactions in a format tailored to suit the needs of the neutron activation analysis community. However, it

requires ongoing maintenance and development to make it more useful to the applied communities it serves. Statistical-model calculations can generate quasi-continuum photon cascade data to complement these experimental discrete-line data. Together, the experimental and calculated data could constitute a valuable resource required for updating the ENDF database. Additionally, delayed photon data need to be added to EGAF. The k0-value database currently used by the neutron activation analysis community needs to be assessed and compared with the corresponding decay information in ENSDF, and the resulting evaluated k0 values then need to be integrated into EGAF and, ultimately, made available to ENSDF evaluators.

LBNL Planned Activities	Status
Continue to maintain and develop the EGAF database. Update EGAF prompt gamma-ray cross sections from new measurements. Add activation data to the EGAF file. Include improved nuclear structure data for the RIPL library in EGAF datasets. Develop a Nuclear Data Sheet publication format for EGAF data.	Published 39,40,41K evaluation in PRC. Prepared manuscripts for Eu, Gd data. Continuing evaluation of Fe, Cu, Y, and actinide data.
Collaborate with Charles University (Prague) to perform statistical-model calculations of quasi-continuum γ -ray cascade information and generate ENDF-format capture γ -ray datasets for use with MCNP and other transport-code calculations.	Continuing

LLNL Planned Activities	Status
Evaluation of EGAF data in collaboration with LBNL	
Thermal-n capture gamma rays	NNDC website provides thermal-n capture gamma rays in tabular as well as interactive form, organised by target nuclides as well as by g-ray energy. These data are based on ENSDF and J. Tuli updated it to current ENSDF.

G. Evaluation of Light Nuclei for Nuclear Physics A.

TUNL evaluates additional data not included in ENSDF for publication in Nuclear Physics A and on its web site.

TUNL Planned Activities	Status
Continue to evaluate A=12 & 13 nuclei.	"Energy Levels of Light Nuclei A = 11" was published in April, 2012. We continue to evaluate the A=12 & 13 Nuclides.

H. Nuclear Structure Data Measurement

ANL - ANL will devote a relatively small effort (0.1 FTE) to participate through collaborative agreements in nuclear physics research activities related to nuclear data needs. The emphasis will be on data measurements aimed at providing answers to specific questions that arise from recent nuclear data evaluations and at improving the quality of existing databases in specific areas, such as (but not limited to) decay data of minor actinides and neutron-rich fission products. Maintain important collaborative connections with RIA and GRETINA research communities, because of their vital importance to the nuclear science in US.

ANL Planned Activities	Status
Participate in nuclear physics research activities at ANL with main emphasis on decay studies of neutron-rich fission products of relevance to reactor decay heat and astrophysics applications (Co-PI of a DOE/ONP ARRA funded project), spectroscopy of heavy actinide nuclei and nuclei far from the line of stability	Continuing.
Participate in research activities using the GRETINA spectrometer and in dissemination of produced data from those activities	Continuing.

LANL: LANL/LANSCE continues to maintain a small program to measure nuclear decay data information.

LANL Planned Activities	Status
Examine prompt gamma-ray emission data and gamma-gamma coincidence data from neutron reactions on fission-product nuclei to search for previously unobserved transitions in these nuclides.	$^{86}\text{Kr}(n,\gamma)$ measured with GEANIE at LANSCE. Data are nearly complete. A couple of new levels and their decay modes have been identified.
Interact with mass chain evaluators on the nuclear structure of these nuclei.	No requests from evaluators.

LBNL – to promote a closer working relationship with the nuclear structure community, LBNL will devote a small effort (~0.1 FTE) to participation in local nuclear structure experimental work.

LBNL Planned Activities	Status
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Perform DICEBOX statistical model calculations to determine total radiative cross sections and elucidate nuclear level spins and parities.	Continuing with each isotope evaluation
Measure gamma ray cross sections at the Garching FRM-II and Budapest Reactors and produce improved (n,g) decay schemes and total radiative capture cross sections.	Measured ²³⁷ Np, ²⁴¹ Pu, ²⁴¹ Am(n,g). Approved proposal to measure all Ge and Zr isotopes.
Investigate primary gamma ray photon strength functions and the contribution of the M1+E2 mixing ratio to nuclear statistical model calculations.	Continuing
Measure neutron cross sections at the UC Berkeley neutron generator laboratory and at the LBNL 88" cyclotron.	Completed first demonstration experiments with LLNL
Measure nuclear cross sections in the plasma at the LLNL National Ignition Facility.	Continuing
Analyze the cosmogenic isotope records to discover prehistoric near Earth supernovae and study the evolution of cosmic ray production for supernova remnants.	Completed paper ready for submission
Investigate the origin of nuclear reactions induced by meteorite impacts.	Field trip to Whitehorse Canada yielded new evidence of meteorites embedded in fossils. Determined that YD impact and other events produced nuclear reactions.
Continue the investigation of the Younger Dryas impact event that caused the extinction of mammoths and megafauna, 1300 years of global cooling, and massive fires 12,900 years ago. Prompt/delayed Neutron Activation Analysis tools, developed by LBNL, will be used to analyze geological samples to investigate the remarkable similarity between the impact layer and Lunar Procellarum KREEP Terrane.	Published two papers about the YD Impact in the Proceedings of the National Academy.

I. ENSDF Physics and Checking Codes

The NNDC maintains ENSDF checking and physics programs on behalf of the national and international evaluator networks

BNL Planned Activities	Status
Maintain and upgrade ENSDF checking and physics programs for format changes as required.	Disseminated new BrIcc code. Added new features to FMTCHK to be released. Modified PANDORA to include some additional physics consistency.

VI. Nuclear Reaction Physics

A. Experimental Data Compilation

The NNDC, as part of a larger international cooperation, has responsibility for compiling experimental nuclear reaction data that have been produced in the U.S. and Canada. Incident neutron reactions have been well covered historically. NNDC thus concentrates on new measurements, but continues compilations of earlier publications that have not been included in the CSISRS database. Since incident charged particle data have not been completely compiled in the past, NNDC is compiling new charged-particle measurements. In addition, because of emerging needs such as astrophysics, the NNDC is compiling older data. Hence, there is a larger staff commitment to compiling this type of data.

BNL Planned Activities	Status
Compile experimental data for neutron, charged particle, and photon induced reactions from 120 publications.	The total count: 121 new and 392 modified articles including the Atlas of Neutron Resonances compilation (1433 EXFOR subentries). 30 new, 2 Atlas entries and 5 modified were processed at the NNDC, 86 by a contractor in Bratislava and 3 new and 387 modified by another contractor in Sarov.

B. ENDF Evaluations

Evaluated nuclear reaction data, for applications and for basic science needs, are stored in the ENDF database, which is maintained by BNL. As chair of the CSEWG evaluation committee, LANL staff works with BNL to insure quality control, particularly for new evaluations. New evaluations funded primarily from other sources are prepared for archival in the ENDF library. BNL, LANL, LLNL and ORNL provided neutron, proton and photonuclear reaction data evaluations for ENDF/B-VII released in FY2007. LLNL develops a computer code that translates LLNL evaluations in the internal ENDL format into ENDF-6 formatted data so that LLNL evaluations can flow back into the nuclear data community.

BNL Planned Activities	Status
Respond to user needs for evaluated nuclear reaction data.	Such requests typically are collected and passed on to the CSEWG or USNDP community. Long term requests are typically handled in the Nuclear Data Week reporting sessions e.g. during the Nuclear Astrophysics Task Force report or the Homeland Security Task Force

	report or using the Nuclear Data High Priority Request List maintained by the OECD-NEA.
Collect and address users feedback related to the ENDF library.	The NNDC typically receive 1-2 such questions/feedback per month. Each item can take 0.5 days to handle as we decide whether the issue is a data problem or a problem on the user's end (e.g with data processing). Data issues and data format issues are logged in the appropriate GForge tracker. Issues with processing codes are referred to the appropriate responsible individuals.
Work with CSEWG on upgraded evaluations for future release of the ENDF/B library.	This is an ongoing task, facilitated by the ADVANCE continuous integration system which ensures all evaluations that are submitted to ENDF are checked. When evaluations fail these tests, they are logged in a GForge tracker. The NNDC and others in the CSEWG collaboration work to fix the issues on an ongoing basis.
Improve methodology for providing covariance data in the resonance region and in the fast neutron region to the next release of ENDF.	The NNDC is developing nuclear data assimilation techniques which fold differential and integral experimental uncertainty and modeling uncertainties into covariance estimates. This work is in progress but shows promise. In addition, the NNDC implemented the kernel approximation for assigning covariance in the resolved resonance region.
Release ENDF/B-VII.1 library	Released 12/2011.
In collaboration with LLNL, coordinate the development of the Generalized Nuclear Data (GND) format as a proposed successor format for ENDF.	CSEWG held a dedicated session for these efforts during the 2011 Nuclear Data Week and the NNDC hosts the GND project on its GForge site. In the 2012 Nuclear Data Week, there will be followup talks on this effort and the NNDC is part of the newly established NEA WPEC-38 to further develop the format and tools under international auspices.

LANL Planned Activities	Status
Upgrade the LANL ENDF evaluations for plutonium isotopes that perform well in criticality benchmarks, considering new LANSCE experimental data.	The evaluation of ²³³ U upgraded. ²³⁸ Pu, ²⁴⁰ Pu, and ²⁴¹ Am evaluations finalized.
Provide upgraded ENDF evaluated data files for light and medium mass elements, including covariance data. Perform criticality benchmarks.	New evaluations of ⁹ Be capture cross section performed. The 16O capture cross section was also upgraded. Both evaluations include the covariance data.
Provide new evaluations for helium production cross-sections on structural materials at high energies based on an improved pre-equilibrium model, considering LANSCE experimental data.	Alpha-particle production cross sections on structural materials were re-evaluated based on the LANSCE experimental data. An improved Iwamoto-Harada model for a cluster emission in the pre-equilibrium process was developed.
Finalize new evaluations of delayed gamma-ray data, and produce a CINDER delayed gamma data library.	New delayed gamma-ray data evaluation finalized, and the results sent to BNL for ENDF compilation.
Provide new evaluations of the prompt fission neutron spectra for major actinides, based on the Monte Carlo technique, and perform criticality benchmarks.	New fission prompt fission neutron spectrum data for ²³⁵ U, ²³⁹ Pu, and ²⁵² Cf produced based on the Monte Carlo technique. Criticality benchmark tests not started yet.

LLNL Planned Activities	Status
Perform new evaluations as per LLNL customer requests and submit these and other LLNL generated evaluations into ENDF.	No new evaluations in FY12. Efforts have been focused on converting LLNL's ENDL nuclear reaction database to Generalized Nuclear Data (GND).
In collaboration with BNL, coordinate the development of the Generalized Nuclear Data (GND) format as a proposed successor format for ENDF.	Held workshop on GND at Nov CSEWG meeting. Proposed new WPEC subgroup to foster international collaboration towards a modern nuclear data infrastructure. Subgroup 38 was approved. Released GND and fudge infrastructure code, and made available to CSEWG (and international) community.

C. ENDF Manuals and Documentation

The NNDC is responsible for maintaining the format and procedures manual for the ENDF system. We also produce the documentation supporting the contents of the ENDF/B library.

BNL Planned Activities	Status
Maintain GForge version of the ENDF-6 formats manual up-to-date with CSEWG endorsed format changes. Issue official release of the manual.	Incorporated CSEWG-approved format changes into the manual. Issued official release in December 2011.
Unplanned: Automate the generation and posting of the latest unofficial version of the ENDF-6 formats manual.	Used Control Tier to automatically generate and post the latest unofficial version of the manual each time updates are done to the manual's GForge-based repository. This version is primarily for the benefit of the

D. Nuclear Reaction Standards

Nearly all neutron cross section measurements are made relative to a neutron cross section standard such as the hydrogen elastic cross section. Maintaining accurate current values for the standard cross sections is the primary objective of this task that can be most efficiently accomplished through international cooperation. A new international evaluation of the neutron cross-section standards, which was initiated by the CSEWG, was recently completed. It is important to improve the standards database and procedures for evaluations in preparation for new evaluations of the standards. To assist in this, an IAEA data development project "maintenance of the neutron cross section standards" was initiated to ensure that we are prepared for the next evaluations of the neutron cross section standards. Historically the standards evaluation activity has included data other than the cross section standards, i.e. the thermal constants and the ^{252}Cf spontaneous fission neutron spectrum. Recently the scope has been broadened, largely through the data development project, to include an investigation of possible inelastic scattering cross section reference standards; considering adding additional standards energy ranges for the Au(n, γ) cross section; and proposing updates for the evaluations of the ^{252}Cf spontaneous fission neutron spectrum and the ^{235}U thermal neutron-induced fission neutron spectrum.

LANL Planned Activities	Status
Participate in the international effort to reevaluate the light-element standard cross sections with LANL leadership for H, Li and B, and investigate the nature of output covariance data from R-matrix analyses of systems containing the light-element standard cross sections.	$^6\text{Li}(n,\alpha)^3\text{H}$ data produced and entered into EXFOR. Analysis in terms of R-Matrix in progress in T-2.
Incorporate the cross section standards into the new ENDF evaluations, and perform validation tests with integral measurements.	No evaluations in relevance with the standards this year.
Continue experiment on H(n,n) angular distribution for improving the standard at several neutron energies for forward neutron scattering angles in the center-of-mass. This measurement follows the H(n,p) measurements that improved the data base at backward angles. We collaborate with researchers at Ohio University and NIST.	Discuss regularly with Ohio University and NIST. Conference calls every 2 or 3 weeks. New neutron sources are being studied for calibrating efficiency of neutron detectors.
Continue the search for suitable (n,x γ) reactions as possible reference cross sections to complement or replace the $^{56}\text{Fe}(n,x \gamma = 847 \text{ keV})$ reaction, which has several experimental limitations.	Measurements at GEANIE for $^7\text{Li}(n,n'\gamma)$, Ti(n,x γ), Cr(n,x γ), Fe(n,x γ). Those without iron have the advantage that they are not common structural materials and therefore do not suffer from unwanted background reactions. This project is ongoing.

NIST Planned Activities	Status
Continue work on the IAEA data development project on maintenance of the neutron cross section standards. Prepare for the next IAEA Consultants' Meeting on this project and provide results on the updating of the standards database and its impact on the standards.	Work continues on the IAEA data development project on maintenance of the neutron cross section standards. We are preparing for the next IAEA Consultants' Meeting on this project. The date has not been established for that meeting. The objective is to provide results on the updating of the standards database and its impact on the standards. Also a considerable effort is now underway on extending the range of the gold standard. There is also work on establishing a reference cross section for experiments such as inelastic scattering.
Prepare documentation for the standards to be published as a journal publication.	A comprehensive publication has recently been published in Metrologia on the evaluation of the neutron cross section standards. It was in a special edition of Metrologia that was devoted to neutron metrology. We wrote the section on neutron cross section standards-their history, how they are measured, evaluated and used. This combined with the Nuclear Data Sheets publication provides adequate information to a wide audience on the evaluation of the standards.
Continue to recommend and encourage new measurements and perform examinations of the data from them for use in future evaluations of the standards.	We continue to recommend and encourage new measurements and perform examinations of the data from them for use in future evaluations of the standards. New work is underway on measurements initiated from our encouragement of hydrogen scattering, the boron standard, the lithium standard, gold capture, and ^{238}U capture. Tabulated data is expected soon related to the $^{238}\text{U}(n,f)/^{235}\text{U}(n,f)$ ratio measurement.
Complete the experiment using neutron detection to measure the H(n,n) angular distribution at 14.9 MeV. Start work on a similar experiment at 10 MeV. This work is done in collaboration with Ohio University, LANL and the U. of Guelma.	Diagnostic measurements on an experiment using neutron detection to measure the H(n,n) angular distribution at 14.9 MeV have been completed. The focus of this effort now is accurate determinations of the neutron fluence before continuing more work at 14.9 and at 10 MeV. At lower energies the standard spectra from ^{252}Cf will be used. For neutron energies above 9 MeV, a technique using reactions where the projectile and target are identical is being used. Because they are identical, the angular distribution must be symmetrical in the CMS. Thus, for a bombarding energy such that the backward portion of the angular distribution falls in the energy range below 9 MeV where the efficiencies are well known, we can reduce these data to obtain cross sections for the

	group in the backward hemisphere. Reflecting these data gives us the cross sections in the forward hemisphere which are the same. The center-of mass cross section can then be converted to lab cross sections. Analysis of the measured counts at the appropriate angles can then give us the efficiency for the 14 MeV neutron energy range. This work is done in collaboration with Ohio University, LANL and the U. of Guelma.
Work on an experiment based on ^{252}Cf nu-bar leading to an improved calibration of NBS-1, the U.S. national primary standard neutron source and determination of our bath efficiency.	Work continues on an experiment based on the accurately known ^{252}Cf nu-bar that can lead to an improved calibration of NBS-1, the U.S. national primary standard neutron source and determination of our bath efficiency. A new ^{252}Cf source has been ordered since the sample we have now has reduced intensity.
Complete a measurement of the $^6\text{Li}(n,t)$ standard cross section at ~ 4 meV neutron energy using an improved fluence determination based on alpha-gamma coincidences with the $^{10}\text{B}(n,\alpha)$ reaction. Study stability of ^{10}B deposits for $^{10}\text{B}(n,\alpha)$ cross section measurements. If suitable targets can be made, cross section measurements will be initiated.	The measurements of the $^6\text{Li}(n,t)$ standard cross section at ~ 4 meV neutron energy has been completed. The work used an improved fluence determination based on alpha-gamma coincidences with the $^{10}\text{B}(n,\alpha)$ reaction. Though the measurements are completed, in order to get the uncertainty to about 0.3%, further work is underway in the characterization of the ^6Li sample. Some work has been done to understand the stability of ^{10}B deposits for $^{10}\text{B}(n,\alpha)$ cross section measurements. At this point it is not clear if suitable targets can be made for high accuracy $^{10}\text{B}(n,\alpha)$ cross section measurements.
Complete the documentation of changes to EXFOR files based on the corrections obtained from the files of Poenitz and new information obtained from the CRP investigations.	Work continues on the documentation of changes to EXFOR files based on the corrections obtained from the files of Poenitz and new information obtained from the CRP investigations. This effort is being done at a low rate due to more important work.
Continue to acquire and monitor samples in the National Repository for Fissionable Isotope Mass Standards. Also make these samples available for loan in physics experiments.	We continue to monitor samples in the National Repository for Fissionable Isotope Mass Standards. We have not obtained samples recently but we are available for storing samples for use in nuclear data experiments. We also make these samples available for loan in experiments.

E. Nuclear Model Development

This task covers activities such as development and validation of nuclear reaction models used for prediction of nuclear reaction cross sections. The two major codes are GNASH (LANL) and EMPIRE (BNL). Measurements made by ANL and LANL along with other measurements made with DOE low-energy physics funds will play a crucial role in the validation of the models in these computer codes. BNL and LANL will also participate in the IAEA Coordinated Research Project RIPL-3 to improve accuracy and reliability of input parameters used in nuclear reaction calculations

BNL - We are active in nuclear reaction model development focusing on the BNL code EMPIRE. The work in this fiscal year will concentrate on further extensions and improvements of its capabilities, including a new version of the level densities with appropriate parameterization. The work on validation of the code will be actively pursued, in particular in relation to emerging requirements of homeland security applications. Close collaboration with LANL will continue focusing on validation of the fission models in EMPIRE and GNASH. Major effort is dedicated to the development of capabilities for estimating covariance data for fast-neutron reaction cross sections. In response to the needs from many user groups (such as Gen-IV reactors, criticality safety, Advanced Fuel Cycle Initiative), BNL will collaborate with LANL and ANL on a methodology for nuclear data covariances. To this end, a covariance module in EMPIRE for fast neutron energies should be extended and tested.

BNL Planned Activities	Status
Continue to improve reaction modeling in the EMPIRE code, maintain code's numerical integrity and enhance user friendly GUI.	The EMPIRE code has been upgraded with over one thousand modifications. In particular, level densities were modified by including the low-K approximation version of the EGSM, and the fission channel has been improved and better parametrized. The set of test cases and benchmarks were prepared for QA. These changes resulted in the 3.1 (Rivoli) release. The Web site was updated to accommodate the new version. Calculations of PFNS spectra were implemented, and anisotropic angular distributions for elastic and inelastic compound nucleus cross sections were coded using ECIS results.
Improve EMPIRE covariance capabilities for fast neutrons.	EMPIRE covariance capabilities were extended to include PFNS and nu-bars, which can be used to model actinides. The ability to calculate covariances for mu-bars through the variation of optical model parameters was also added.
Extend resonance module allowing to generate covariances utilizing information from Atlas of Neutron Resonances to account for systematic uncertainties.	The resonance module is functional and able to generate covariances from the information contained in the electronic version of the Atlas of Neutron Resonances. The KERCEN code has been included in the EMPIRE system as an independent module.
Maintain GForge site with the current version of the EMPIRE code.	EMPIRE development was carried out on the GForge server using it's Subversion, tracker and mailing list capabilities which provide an ideal platform for the effective collaboration of the international team of

	developers.
Attempt parallelization of EMPIRE on the NNDC cluster.	Parallel calculation of sensitivities on the NNDC cluster has been enhanced to include more fission channel parameters. This parallelization is realized through splitting incident energy calculations into separate jobs. Intrinsic code parallelization is still pending.

LANL - Nuclear reaction theory calculations have played a crucial role in the evaluation of nuclear data, and will continue to play an important part in future evaluations. The LANL GNASH code has proved to be an important tool, and we will continue development of advanced model codes to provide a state-of-the-art capability to predict reaction cross sections and to explore nuclear reaction physics in detail. This also involves a close collaboration with experimentalists at LANSCE to interpret new measurements using the GEANIE, DANCE, and CHI-NU detectors. These data will result in advances in our understanding of nuclear reaction mechanisms, and improvements in our modeling codes.

LANL Planned Activities	Status
Develop a microscopic description of fission process in the fast energy range, which includes Class-I and Class-II coupling. Apply this method to major actinides, such as ^{239}Pu , to validate this new fission theory.	Development of fission theory continuing. A peer-review paper to be submitted.
Continue development of a code to calculate the delayed gamma spectrum from fission products, using the Monte Carlo technique for the Hauser-Feshbach statistical decay, and extend the code to handle multiple neutron emissions.	Continuing. The Monte Carlo Hauser-Feshbach code includes multiple neutron emissions, and beta-delayed gamma energy spectra produced. The code has been applied to create a new delayed gamma database.
Apply a coupled-channels Hauser-Feshbach method to neutron capture process for deformed targets to study gamma-ray cascading, in support of DANCE and GEANIE measurements, and s-process nucleosynthesis studies.	The coupled-channels Hauser-Feshbach method applied to neutron capture process for deformed nuclei, such as neon. A Phys. Rev. C paper accepted for publication.
Study neutron elastic scattering angular distributions in the fast energy range, which have high sensitivities to the simulation for critical assemblies.	Neutron elastic scattering cross sections calculated based on the statistical S-matrix, and width fluctuation effect studied.
Study neutron inelastic scattering from actinides in the fast energy range, to which theoretical calculations are essential, in collaboration with CEA, France.	Study on the inelastic scattering from major actinides continues. Discussed at the workshop on elastic/inelastic scattering in Boston.
Perform prompt fission spectrum calculations with the Monte Carlo method to ^{235}U and ^{239}Pu , and compare available experimental information.	Prompt fission neutron spectrum with the Monte Carlo method calculated for ^{235}U and ^{239}Pu , and compared with experimental data available. Two invited talks given at international conferences, and a Phys. Rev. C paper published.

LLNL Activities	Status
Event by event fission modeling (funded from other sources)	We have improved photon emission in FREYA, including rotational energy of the fragments and emission of yrast photons. We have submitted a paper to Physical Review C. In addition, we are working with Chris Hagmann and Jerome Verbeke to incorporate FREYA into the MCNP transport code as a part of the LLNL fission library.
Reaction theory for surrogate reactions (funded from other sources)	Surrogate observables, which have been measured recently at LBNL and Texas A&M, cannot be directly connected to the desired $88\text{Y}(n,2n)$ cross section, but require theoretical corrections that account for the spin-parity differences in the surrogate and desired reactions. Predictions of spin-parity distributions for surrogate ($3\text{He},3\text{He}'$) reactions in the Y/Zr region were carried out, using both (Q)RPA structure models. Subsequently, using these spin-parity distributions to predict surrogate observables and to constrain Hauser-Feshbach parameters that describe the decay of the 89Y isotope. A preliminary $88\text{Y}(n,2n)$ cross section can be obtained this way and completion of this work is expected in FY13. Progress towards evaluation of $241,242\text{mAm}(n,f)$ cross sections: Modeling of the HF cross sections was carried out and a preliminary (n,f) result was obtained. The experimental surrogate data will become available and a new set of cross sections will be provided in FY13.

F. Nuclear Reaction Data Measurements

The measurement of nuclear data is essential to provide data, which either cannot be calculated or cannot be calculated with sufficient accuracy for user applications. This activity is also essential to support and verify nuclear model development and application.

ANL: ANL has recently initiated a new program in collaboration with INL (Measurement of Actinide Neutronic Transmutation Rates with Accelerator mass spectroscopy - MANTRA), supported through ARRA funding from ONP/DOE, aimed at obtaining valuable integral information about practically all high mass actinides neutron cross sections that are of importance to advanced nuclear fuel cycles and to USNDP.

ANL Planned Activities	Status
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Coordinate research activities between INL and ANL, and participate in nuclear data activities at ANL using the Accelerator Mass Spectrometry technique, and in cross section modeling and sensitivity studies	Continuing.
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LANL Planned Activities	Status
Analyze neutron inelastic scattering made with the GEANIE and FIGARO arrays. Correlate new data from GEANIE with data from FIGARO on targets near mass 90.	Analysis still to be done. Data have been taken.
Continue to improve the techniques to measure the fission-neutron spectrum for fission induced by neutrons of 0.5 to 200 MeV on ^{235}U and ^{239}Pu . The shape of the major part of the emission spectrum between 0.1 and 10 MeV will be determined in this experiment, performed in collaboration with LLNL researchers, and will be compared with the Los Alamos model prediction. The modeling includes the Monte Carlo prompt neutron emission technique and the microscopic quantum mechanical pre-equilibrium calculations. In FY12, we will complete measurements on the portion of the fission neutron spectrum below 1 MeV for ^{235}U and begin similar measurements on ^{239}Pu .	Lots of activity on these measurements. Several publications on detector development. A new building and flight path have been completed and are now being used for measurements of background, detector characterizations, time resolution, multifoil parallel-plate avalanche counter characterization, and development of data acquisition with waveform digitizers. Strong and positive interactions with T-2.
Complete the measurement and analysis of prompt neutron emission following interactions of fast neutrons with heavy nuclei such as thallium. These measurements are gated on gamma rays from $(n,n'\gamma)$ reactions.	Measurement completed, analysis yet to be done.
Complete data analysis for gamma-ray output from neutron-induced fission of ^{235}U for neutron energies from 1 to 100 MeV. Collaborators include scientists from LLNL.	Measurement and analysis completed; manuscript nearly ready for submission.
Measure neutron capture cross sections on ^{238}Pu for neutron energies less than 200 keV, contingent on obtaining the targets.	Data taken. Analysis in progress at LLNL.
Measure the neutron capture cross-section at DANCE for at least one radioactive isotope of importance to nuclear astrophysics.	$^{173}\text{Lu}(n,\gamma)$ cross section data taken. Analysis in progress in collaboration with CEA Bruyeres-le-Chatel.

LBNL: – LBNL has recently initiated a new program to use surrogate reactions to deduce reaction cross sections which are of importance to Advanced Fuel Cycle (AFC) programmatic needs (a national priority). This is collaboration between the nuclear structure and nuclear reaction groups at LBNL and outside groups at LLNL and the University of Richmond that is currently funded from outside of the DOE Data Program. The LBNL group is leading a series of benchmarking experiments to test the applicability and accuracy of these new techniques for deducing cross sections of importance to AFC and the s-process. It is anticipated that this activity will provide nuclear reaction data measurements of importance to the Data Program. LBNL is collaborating with the Budapest Reactor Centre in the measurement, using isotopically-enriched targets, of selected thermal (n,γ) cross section data to supplement earlier elemental target measurements from which important information was either lacking (e.g., data from low-abundance isotopes) or discrepant.

LBNL planned activities	Status
Measure thermal (n,γ) cross sections using guided neutron beams in collaboration with the Budapest Research Centre and at the Munich Reactor.	Continuing
Lead LBNL 88" Cyclotron experiments at the LiBeRACE facility with an emphasis on topical issues and data needs such as AFC-related measurements or nuclear structure experiments on nuclei far from stability.	Project cancelled due to loss of LiBeRACE facility by LBNL.
Investigate nuclear level densities and gamma ray strengths at the Budapest and Munich Reactors and the LBNL 88" cyclotron, and the UC Berkeley neutron generator laboratory. Develop improved statistical model calculations in collaboration with Charles University, Prague.	Continued with sabbatical in Oslo with the cyclotron group there. Developed new methods for measuring photon strengths. Published low energy enhancement in ^{96}Mo photon strength in Phys. Rev. Lett.

LLNL Planned Activities	Status
Perform surrogate (n,n') , $(n,2n)$, (n,γ) and (n,f) measurements on several nuclei with programmatic and/or astrophysical importance. (funded from other sources)	Cross section measurements of $\text{Am}240(n,f)$, $\text{Am}241(n,f)$, $\text{Am}242(n,f)$ have been completed. Evaluations are underway and expect to be complete by December 2012. Cross section measurement of $\text{Y}88(n,2n)$ is complete and final evaluation is underway. Expect evaluation to be complete December 2012. Data for $\text{Y}87(n,g)$ has been taken and data analysis and reduction is underway. Expect an evaluation September 2013. Final analysis being completed on $\text{Np}239(n,f)$ cross section. Results to be submitted December 2012 to peer reviewed journal. $\text{U}237$ nuclear structure 10 new gamma rays have been discovered in $\text{U}237$, two new states. $\text{U}235$ nuclear structure 6 + 2 tentative new gamma rays have been discovered and one new state in $\text{U}235$. Data taken and analysis underway for $\text{Pu}236(n,f)$ and $\text{Pu}237(n,f)$ cross sections limited energy range 0 to 6

	MeV. Data taken and analysis underway for U232(n,f) and U233(n,f) cross sections limited energy range 0 to 6 MeV. Data taken on Yb isotopes to validate (p,d) reaction channel in preparation for Lu measurements in FY13. Data taken on Mo95(d,p) to benchmark surrogate technique in spherical region for (n,g) reactions.
Perform neutron capture measurements with DANCE array at LANSCE in collaboration with LANL. (funded from other sources)	We have fielded two measurements on 238Pu using the DANCE array to determine the fission contribution as the background to the (n,gamma) cross section. We have published two articles on the fission prompt gamma emission. Another on the systematics of Fission prompt gamma emission has been submitted for publication.

G. Evaluation of Data Needed for Astrophysics

The objective of this activity is to support the nuclear data needs of the increasingly sophisticated simulations of astrophysical phenomena. The Astrophysics Task Force of the USNDP, presently chaired by ORNL, serves to improve communication and coordination of nuclear data evaluation activities relevant for studies in astrophysics.

ANL Planned Activities	Status
ANL will continue working in the area of data needs for nuclear astrophysics. The main emphasis will be on improving the nuclear data for known cosmo-chronometers in the rare-earth region - 176Lu, 180Ta and 186Re.	Continuing.
Compile and evaluate nuclear structure and decay data for neutron-rich nuclei in the fission fragments region, produced at the CARIBU facility (ANL), that are of relevance to modeling of the r-process nucleosynthesis.	The first results from the CARIBU decay studies were compiled in ENSDF format. Development of a dedicated decay data library of relevance to r-process nucleosynthesis modeling and other energy-related applications is continuing.
Contribute to the development of the Atomic Mass Evaluation and NUBASE libraries.	Work on the new AME2012 and NUBASE2012 evaluations is essentially completed in a collaboration with scientists from CSNSM-Orsay, IMP-Lanzhou and IPN-Orsay. Those evaluations will be published in the December issue of the journal Chinese Physics C.

BNL Planned Activities	Status
Produce uncertainties for Maxwellian averages of neutron capture cross sections in the energy region of interest for nuclear astrophysics. Extend cross section and reaction rates value calculations for entire range of s-process nucleosynthesis.	Maxwellian-averaged cross sections and Astrophysical reaction rates were produced for ENDF/B-VII.1, JEFF-3.1.2, JENDL-4.0, ROSFOND-2010, CENDL-3.1 and EAF-2010 Evaluated Data Libraries. These results including uncertainties calculations have been accepted for publication in December 2012 issue of Nuclear Data Sheets.

LANL: Participate in the USNDP effort to develop high-quality data for astrophysics calculations of nucleosynthesis. Make new calculated and evaluated results available to the wider astrophysics research community via the USNDP Astrophysics Task Force.

LANL Planned Activities	Status
Improve neutron capture models to provide neutron capture rates off-stability to s and r-process hydro-dynamics simulations.	A global test of neutron capture rate calculation performed against evaluated Maxwellian averaged cross sections. Systematic behavior of average gamma-width and level density parameters investigated.
Continue working on beta-delayed fission rates in the astrophysical stellar environment, based on the macroscopic-microscopic nuclear mass model.	Beta-delayed fission modeling continues, but in a slow pace.

McMaster: The evaluation of nuclear astrophysics data is expected to complement the on-going experimental program of measurements of radiative capture cross sections and particle-transfer experiments using radioactive ion beam facilities at TRIUMF, NSCL, RIKEN and ANL.

McMaster Planned Activities	Status
Specific reactions planned for evaluation in FY12: 17F(p,gamma)18Ne and 55Co(p,gamma)56Ni	Both reactions were evaluated and calculated reaction rates sent to ORNL for placement in nucastrodata.org webpage at ORNL.

ORNL: Evaluate capture reactions on radioactive proton-rich nuclei which are important for element synthesis and energy generation in stellar explosions.

ORNL Planned Activities	Status
Continue assessments of capture reactions on p-rich unstable nuclides that are important for novae and X-ray bursts. The nuclei to be studied are those planned for measurements at ORNL's Holifield Radioactive Ion Beam Facility.	Assessment in progress of levels in 27Si, and analog levels in 27Al, relevant for 26Al + p thermonuclear destruction in stellar explosions -- this work uses input from two recent measurements of 26Al(d,p) with a radioactive 26Al beam at ORNL's HRIBF. Published PRC paper on levels in 19Ne important in 18F+p thermonuclear burning from ORNL measurement of 18F(d,n).

	Published assessment of upper limits on strong proton levels in ^{27}Si from direct $^{26}\text{Al}+p$ scattering experiment at ORNL.
	Published assessment of inelastic / elastic proton branching ratio of resonance in ^{18}Ne crucial in $^{14}\text{O} + \alpha$ burning in novae.
Extract spectroscopic information (excitation energies, spectroscopic factors, spins, parities, ANCs) on nuclei near the N=82 closed shell – ^{131}Sn , ^{135}Te - from transfer reaction measurements on radioactive Sn and Te nuclei. This information is important for modeling the r-process in supernovae.	Completed analysis and published information on levels in ^{131}Sn from measurement of $^{130}\text{Sn}(d,p)$ at ORNL HRIBF in Phys. Rev. Lett; initiated project to interpret similarities of recent ^{131}Sn and ^{133}Sn level structure with nuclear structure model -- work published in Phys. Rev. C. Rapid Com; calculated resonant levels in ^{131}Sn and ^{133}Sn and compared density of levels to those required by statistical model treatments

H. Covariances Development

Quantification of uncertainties and their correlations, mathematically represented as covariance matrices, became recently a focal point of the ENDF evaluation effort world-wide. A strong motivation for this revival is the role of covariances in guiding adjustment of the evaluations to the integral experiments to improve reliability and performance of the new libraries. Work in this field includes improvement of the methodology as well as development of actual covariance data. Major covariance activities are carried out at BNL, LANL and ORNL (the latter in the resonance region).

BNL Unplanned Activities	Status
Work on COMMARA-3 library of covariances.	This library will refer to the central values in ENDF/B-VII.1 instead of VII.0 in case of COMMARA-2. The beta0 version of the new library has been prepared and initial tests have been performed.

I. Reactor Anti-neutrino and Decay Heat Calculations

Following a request from users, the NNDC has started a program to calculate anti-neutrino spectra using the fission yields and decay data sublibrary from the ENDF-6 formatted libraries.

BNL Unplanned Activities	Status
Setup methods and databases to calculate anti-neutrino spectra for major actinides.	The NNDC has calculated anti-neutrino spectra following the neutron-induced fission of $^{235,238}\text{U}$, $^{239,241}\text{Pu}$ and ^{252}Cf .

J. Verification and Validation

Quality Assurance (QA) of a nuclear data library requires that all files are checked for integral consistency and conformance with the adopted format. This part of the QA is called verification and is one of the fundamental functions of the National Nuclear Data Center. Furthermore, checking performance of the library against the integral experiments, known as validation, is an important step ensuring usefulness of the library for the end-users. The most extensive validation is performed by LANL and other CSEWG contributors funded with non-DOE-SC sources. The USNDP supports the ultimate validation effort carried out at BNL.

BNL Unplanned Activities	Status
Establish automatic, real time verification and validation of the new/modified ENDF evaluations submitted to the NNDC GForge server.	A preliminary version of the ADVANCE system has been developed and installed on a temporary server. Currently the system covers verification part only.

Appendix A

Nuclear Data Activities Funded from Sources outside the Nuclear Data Program (Report FY2012)

ANL

Additional support for the nuclear data work at Argonne comes from three ARRA projects funded by the Office of Nuclear Physics, DOE-SC (ONP/SC) and one LDRD project funded by ANL:

1. ARRA funded project through ONP/SC entitled "Nuclear Data Program Initiative" provided partial support for a post-doc. This project will be completed at the end of FY2013.
2. ARRA funded project through ONP/SC entitled "Measurement and Evaluation of Actinide Neutron Cross Sections Relevant to Advanced Fuel Cycles via Accelerator Mass Spectroscopy" provided partial support for a post-doc. This project will be completed at the end of FY2013.
3. ARRA funded project through ONP/SC entitled "Beta-decay Studies of Neutron-rich Fission Products for Advanced Fuel Cycle Applications" provided partial support for a post-doc. This project will be completed at the end of FY2013.
4. ANL LDRD project entitled "Development of a Close-Packed LaBr₃(Ce) Detector Array for Nuclear Physics Applications" provided partial support for a post-doc. This project will be completed at the end of FY2013.

BNL

Additional support for the nuclear data work at the National Nuclear Data Center comes from the following sources:

1. Elsevier supports the production of computer-generated photo-ready copy of manuscripts for the Nuclear Data Sheets.
2. The US Nuclear Criticality Safety Program (NCSP), funded by DOE NNSA, supports the NNDC services in maintaining NCSP data submitted to ENDF/B-VII library as well as data development work on estimates/evaluations of neutron cross section covariances for criticality safety applications.
3. The AFCI Data Adjustment project, funded by DOE-NE, supports the NNDC work on development of neutron cross section covariances for fast advanced burner reactors.
4. Two ANST grants from DOE support development of neutron cross section covariances for selected materials to be included in ENDF/B-VII.1.

LANL

Most of the nuclear data work is supported from funds other than the nuclear data program. The effort is in support of the ENDF-related work of nuclear model development, nuclear reaction evaluation and ENDF processing.

1. Advanced Simulation and Computing (ASC program). This work supports the development of more accurate ENDF cross section databases for actinide fission fuels, light-nucleus thermonuclear fuels, and for reactions on important materials used for diagnostics (radiochemical reactions). Nuclear model code development, for both statistical and preequilibrium models, and for light R-matrix codes, is supported by this program, as is the development of the NJOY data processing code for providing data usable by Monte Carlo and deterministic transport codes in applications. The funding also supports physics research developments in nuclear reaction and structure theory (with a recent emphasis on nuclei and isomers away from stability), and fission theory. Data testing using integral benchmarks such as fast critical assemblies is used to validate the ENDF data.
2. Advanced Fuel Cycle (AFC). This supports the development of improved nuclear data important for transmutation in the fast neutron energy region. Recent focuses have been improved ENDF data on actinides, including prompt fission neutron spectrum data and covariances. This program also supports experimental nuclear reaction measurements at LANSCE.
3. Nuclear criticality safety. This funding supports improved nuclear data important in criticality safety studies, such as uranium isotopes, as well as data on chlorine, aluminum, etc. Data testing using critical assemblies and NJOY processing code development is also funded by the program.
4. LANL LDRD. There are 2 LANL LDRD projects that support nuclear reaction data measurements and nuclear astrophysics r-process network calculation.
5. Nuclear Weapons supports LANSCE measurements of fission output (neutrons and gamma rays), neutron capture on actinides and radchem isotopes, and neutron reactions relevant to radchem.
6. Two ARRA stimulus funds support development of neutron cross section covariances and nuclear reaction modelling for actinides.

LBNL

1. ARRA research stimulus funds received this year funded 1.0 FTE for ENSDF mass chain evaluation and capture gamma-ray library evaluations in collaboration with LLNL.
2. FOA 09-13 Applications in Nuclear Science and Technology funding has been received from the DOE Office of Science to support 1 FTE staff scientist and 1 FTE postdoc in the analysis of capture gamma-ray data and particle/gamma-ray coincidence data using LBNL STARS/LiBeRACE at the 88" cyclotron.
3. A 5x10¹¹ n/s D+D neutron generator has been constructed using NSF funds and is being installed on the Berkeley campus. Additional funding has been requested from the Office of Science for cross section measurements.
4. A high intensity 8-33 MeV neutron beam facility has been constructed in collaboration with the LLNL NIF facility at the LBNL 88" cyclotron. Funding for this effort is supplied by LLNL and the LBNL low energy research program.
5. The Isotopes Project continues to mentor the LLNL nuclear data library effort, funded by NA-22.

LLNL

NNSA Defense Programs, the Department of Homeland Security, and branches of the Office of Science outside the USNDP support most of the nuclear efforts at LLNL. Funding from USNDP is used to coordinate these efforts and process data for use by the larger community. Much of the Livermore experimental work is made possible by beam time and collaborations at TUNL, TRIUMF, LBNL and LANSCE. Sponsorship for different nuclear efforts includes:

1. NNSA/ASC funds data evaluation, validation and verification efforts, development of theory supporting the surrogate measurement campaign for unstable actinides, and optical potentials. Also funds part of the nuclear data formats and the processing of nuclear data.
2. NNSA/DP/SC funds experimental campaigns for unstable actinides, including development of the Time Projection Chamber at LLNL for new ^{239}Pu fission cross section measurements.
3. NNSA/NA-22 funds the event by event fission modeling and the capture-gamma-ray evaluations.
4. OS/ARRA funds in part the generalized nuclear data efforts in tandem with ASC/IC.

McMaster

No additional funding in FY-12

NIST

A variety of sources support nuclear data activities:

1. The Nuclear Data Verification and Standardization program has funding through the Commerce Department (NIST). This provides about half of the total support for the program.
2. NIST provides 1 FTE for standard cross section work using ~ 4 meV neutrons and also for interferometry work, which has yielded coherent scattering lengths (which provide scattering data) needed for neutron cross-section evaluations.
3. NSF provided 1 FTE for a graduate student to work on the interferometry experiments cited above.
4. NIST provided 1 FTE (75% experimental, 25% evaluation) for nuclear structure and decay data work. Much of this work also has applications in radioactivity standards and radiopharmaceutical studies.

ORNL

The nuclear data work is partly funded by the DOE-SC Low Energy Nuclear Physics program.

TUNL

The nuclear data work is partly funded by the DOE-SC Low Energy Nuclear Physics program through a TUNL/NCSU grant.