



USNDP Work Plan for Fiscal Year 2013

Prepared by:

Michal Herman

National Nuclear Data Center

Brookhaven National Laboratory

March 2012

With contributions from:

Allan D. Carlson, NIST

Richard Firestone, LBNL

Toshihiko Kawano, LANL

John Kelley, TUNL

Filip G. Kondev, ANL

Balraj Singh, McMaster U.

Michael Smith, ORNL

Alejandro Sonzogni, BNL

Neil Summers, LLNL

www.nndc.bnl.gov/usndp

Table of Contents

Introduction

I. NNDC Facility Operation

II. Coordination

III Nuclear Physics Databases

IV. Information Dissemination

V. Nuclear Structure Physics

VI. Nuclear Reaction Physics

USNDP Staffing table FY2013

Introduction

The work plan described in this document has been developed to cover work to be done by the United States Nuclear Data Program (USNDP) during fiscal year 2013 that begins on October 1, 2012. Previously, **13 work plans** have been prepared for the data program covering fiscal years 2000 - 2012. This plan has been prepared in consultation with the members of the Coordinating Committee who represent the organizations participating in the program. Each Coordinating Committee member prepared a draft plan for his/her organization. Each contribution was integrated into a unified work plan. The draft plan was then circulated to the Coordinating Committee for comments and corrections before the final document was submitted to the Department of Energy.

As was done in previous years, the tasks proposed by the various organizations were reviewed internally according to the following criteria which were developed considering the mission and goals outlined in past review panel reports and oversight committee discussions, and in consultation with the DOE program manager.

1. A task should meet one of the three program priorities:
 - a) Maintenance & update of information in the USNDP nuclear physics databases
 - b) Improvement in dissemination of the information contained in those databases to the user community
 - c) Modernization of data evaluation software used by the program participants
2. A task should be useful to at least one major user community
3. A task should not duplicate effort within or outside the program

The plan is divided into six major components. Specific tasks have been assigned to one of these components. They are as follows:

- I. NNDC Facility Operation
- II. Coordination
- III. Nuclear Physics Databases
- IV. Information Dissemination
- V. Nuclear Structure Physics
- VI. Nuclear Reaction Physics

The following section details the proposed work plan for FY2013, defining tasks, organizational responsibilities, and planned activities. Incorporated in the NNDC plan is a group of subcontracted external scientists, including nuclear structure evaluators and compilers.

The present Workplan was prepared for the **2012 Appropriations** and **2013 Guidance** scenarios.

Table 1: Summary of the USNDP funding and metrics for FY2001- FY2012, the last two years are projections under the **2012 Appropriations** and **2013 Guidance** scenarios.

Fiscal Year	USNDP Funding	Year to Year 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%	4,035	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 Approp.	\$6,185K	-5.3%	4,733	419	3,270	25	67	50
2013 Guidance	\$5,559K	-10.1%	4,730	351	3,332	24	71	40

We expected that the 5% reduction in the **2012 Appropriations** budget will be offset by the stimulus funding (including remaining funds from the ANST 2009 call) and accumulated reserves so that the program might be maintained on an acceptable level in FY 2012. Further 10% reduction in FY2013 will be more difficult to mitigate and will have some negative effect in certain Labs (e.g., at ANL while BNL should still be able to function using its reserves). We expect to achieve:

- Compilation, dissemination activities will be fully supported.
- Evaluation effort will suffer moderate decline.
- Training and mentoring of new ENSDF evaluators will continue but might be reduced in FY2013.
- An effort will be devoted to the organization and hosting of the Nuclear Data Conference in 2013 (BNL).
- Development of nuclear reaction codes will continue (covariations, fission, prompt fission neutron spectra, angular distributions).
- International consensus for the new XML format will be sought with possible extension to integrate all nuclear data libraries.

- Dissemination of the nuclear data will continue approximately on the same level although radical modernization of services will not be possible.

ANL will discontinue the DDEP coordination activities and limit ENSDF mentoring activities – all this will lead to loss of benefits from collaborations and leverage that we gain by collaborating with other ND groups.

ANL will also limit travel to conferences, workshops and collaborative meetings, which put ANL staff and post-doc in danger of not attending the ND2013 and the NSDD meeting that are scheduled during FY13.

BNL has successfully rebuilt scientific staff after a few turbulent years. Currently two-thirds of the BNL-NNDC scientific staff has about 2 years of experience at NNDC. After multiyear hiring effort, staff situation at the USNDP is good and it will be of critical importance to preserve this state after FY2013.

ORNL will be still looking to strengthen the funding for its junior staff as well as maintaining the support for their programming activities.

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 their 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
Ensure compliance with DOE cyber security requirements through regular network scanning and vulnerabilities remediation on NNDC servers and clients. Noncompliance could result in a total block of a machine from network access.
Provide computer support to NNDC staff and visitors in their use of NNDC computing resources. Also provide remote assistance to external NNDC collaborators in their use of BNL's Web-accessible scientific publications.
Upgrade and maintain NNDC's Linux cluster to handle CPU-intensive calculations due to data verification and data validation of new and revised nuclear data evaluations, and COMARRA-related covariance processing.
Upgrade and maintain NNDC's continuous integration server (CruiseControl) and provide technical support to its end-users.
Maintain NNDC's GForge server, the collaboration platform for the U.S. nuclear data community, and provide technical support to its end-users.
Conduct regular backup of mission-critical servers to minimize loss of data and staff productivity during system failures.

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 of the Cross Section Evaluation Working Group

ANL Planned Activities
Organize and chair the CSEWG Covariance Committee

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

BNL planned activities
Prepare FY2014 work plan for USNDP in time for spring 2013 FWP submittals.
Organize and chair CSEWG Meeting at BNL in November 2012.
Organize and chair USNDP Meeting at BNL in November 2012.
Edit and publish summary reports and proceedings of the CSEWG and USNDP meetings.
Maintain CSEWG and USNDP websites
Host ND2013.
Organize and chair the CSEWG Task Force on Nuclear Data Needs for Homeland Security.

LANL planned activities
Organize and chair CSEWG Evaluation Committee meeting at BNL, November 2012.
Organize and chair Nuclear Reaction Working Group meeting at USNDP meeting in November 2012.
Help organizing ND2013.

LBNL: Serve as a member of the USNDP Coordinating Committee.

LBNL planned activities
Coordinate the LLNL/LBNL ENDF Gamma-ray Library project to use EGAF data to improve capture gamma ray data in ENDF.

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
Summarize USNDP efforts in nuclear data for nuclear astrophysics at USNDP Meeting in November 2012.
Communicate current efforts and future plans with researchers in nuclear astrophysics data.
Represent USNDP nuclear astrophysics efforts at international collaboration meetings on nuclear astrophysics data.
Initiate collaborative research projects to raise the visibility of nuclear data projects directed at astrophysics applications.
Discuss future plans in nuclear astrophysics data with DOE, with USNDP/NNDC, and with other agencies.

B. International Coordination

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

ANL planned activities
Participate in the 2013 NSDD meeting
Participate in the DDEP collaboration meeting
Host several international visitors to ANL to collaborate on nuclear structure and nuclear astrophysics data evaluation projects.

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 of the IAEA's International Nuclear Data Committee (INDC), the lead US member and chair 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
Participate in the IAEA-sponsored NRDC meeting in FY2014.
Participate in NEA WPEC annual meeting in 2014.
Participate in the IAEA-sponsored NSDD meeting.
Lecture at the IAEA-sponsored workshops (including ICTP at Trieste) if such are organized.

Host ND2013.

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

Participate in NEA-WPEC 2014 meeting

Participate in relevant IAEA CRP meeting (prompt fission neutron spectrum data).
--

Make latest version of NJOY data processing code available to the international community.
--

Host a couple of international visitors to LANL to collaborate on the evaluation of reaction data.
--

Participate in the International Advisory Committee and the International Advisory Committee for ND2013, the International Conference on Nuclear Data for Science and Technology
--

Participate and give a talk at the workshop on compound nucleus and related topics, CNR13, 2013, Sao Paulo.

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

LBNL planned activities

Coordinate the evaluation of a new k0/cross section database with the IUPAC k0 users committee.

Evaluate and maintain the IAEA/LBNL Evaluated Gamma-ray Activation File.
--

Contribute updated nuclear structure data to the IAEA RIPL data file.

Evaluate neutron activation decay data in collaboration with the DDEP

McMaster: Continue participation in new evaluators training program.

McMasters planned activities

Participate in the matters related policies, ENSDF formats and procedures for the NSDD network.

Continue to participate in training/mentoring of new ENSDF evaluators through collaborative work.

Participate in IAEA-NSDD 2013 meeting.
--

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

TUNL planned activities

Participate in the policy matters related to the NSDD network.
--

Participate in NSDD/IAEA meetings

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

Database distributed to collaborators monthly.
--

Provide international coordination of NSR compilations and activities.
--

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

Weekly update of the database using input received from McMasterUniversity.

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

Database distributed to NSDD network twice a year and to researchers when requested.

Process evaluations received from NSDD evaluators.

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

Update NuDat database as necessary, about 10 times a year.

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

Contribute to CINDA by compiling experimental cross-section data to the CSISRS database (120 compiled papers expected). Provide NSR data for CINDA updates.

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

Update CSISRS with EXFOR compilations from cooperating centers (~500 entries expected). The NNDC compilation work can be found under Nuclear Reaction Physics, chapter VI of the present document.

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 the GForge web interface.

BNL planned activities

Maintain Linux/MySQL database system.

Maintain GForge/Subversion system for tracking development of the ENDF/B library.

Maintain and improve Sigma database and web interface for users without specialized knowledge of ENDF-6 format. (See also information dissemination, chapter IV).

Perform data verification and data validation on new and revised evaluations submitted to the ENDF/B library. Present results in library pre-release meetings conducted by CSEWG.

H. Database Software Maintenance

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

BNL planned activities

Fix bugs and develop enhancements for the nuclear physics databases maintained by NNDC.

I. Database Systems Development

The USNDP databases have been migrated to a Linux/MySQL environment in FY 2009. Typical maintenance needs to be performed.

BNL planned activities

Maintain Linux/MySQL database system and continuously fine tune its performance.

Implement and maintain automatic replication of updates from the internal MySQL database server to the external.

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 quad-processor Dell servers running on the Linux operating system and using the Apache Tomcat and Sybase server software. This type of solution was made public in April 2004. Most of the databases were redeveloped to take advantage of the new hardware possibilities as well as new programming technologies, such as the use of the Java and Java scripts languages. In FY 2009 all the servers were replaced and the software was upgraded, migrating from Sybase to MySQL. The NNDC also maintains the Atomic Mass Data Center website. Other USNDP members (LANL, ORNL and TUNL) also offer nuclear physics information through their websites. These services require resources to maintain currency and improve performance.

ANL Planned Activities

Maintain and upgrade the ANL/NDM report series web site.

Maintain and upgrade Experimental Resources for Nuclear Data web site.

Maintain and upgrade ANL Nuclear Data Information web site.

BNL Planned Activities

Maintain and improve ENSDF/XUNDL web interface.

Maintain web interfaces for NSR, ENDF and EXFOR databases.

Improve Sigma web interface by adding new and enhanced features following user's requests.

Maintain web interfaces for double-beta decay, B(E2) and Maxwellian-averaged cross sections and reaction rates.

Maintain currency of the CSEWG, USNDP and the NNDC web sites, proactively respond to the users requests.

Improve reliability of 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.

Strictly follow all BNL and DOE cybersecurity rules and regulations during the Web application design, development and implementation. Patch immediately security vulnerabilities discovered during network scans.

Maintain GForge Web site.

If the proposed Generalized Nuclear Data (GND) format is approved by CSEWG, extend the Sigma web interface to use reaction data in the GND format.

LANL Planned Activities

Maintain LANL web site and provide actinide ENDF/B-VII data for criticality data testing, together with other LANL evaluations.

LLNL Planned Activities

Maintain LLNL's Nuclear and Atomic Data Viewer.

ORNL Planned Activities

Continued development and maintenance of our online software suite to convert nuclear data to astrophysical reaction rates and plot, manipulate, and share results online; this activity is at risk of termination.

TUNL Planned Activities

Continue to improve the TUNL website and provide access to new information on A = 3 - 20 nuclei.

Continue to prepare new PDF and HTML documents of the most recent TUNL reviews.

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.

Continue to provide information for thermal neutron capture reactions on A=3-20 nuclei.

Continue to provide information for beta-decay reactions and ground-state particle-decay reactions relevant to A=3-20 nuclei.

Provide information of excitation functions for (p,X) and (alpha,X) reactions on A=3-20 nuclei. When possible we provide a link to the NNDC X4 cross section library.

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

Provide technical support to users as necessary.

Maintain Comments/Questions option for all reaction databases, for the NNDC web services, ENDF, EXFOR.

Modernize help systems for the Web based data retrieval.

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

Prepare eleven issues of Nuclear Data Sheets based on ENSDF evaluations for publication.

Prepare special issues of Nuclear Data Sheets with proceedings of the ND2013 conference.

Distribute Nuclear Wallet Cards as per requests from users.

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

Prepare entries for about 3,100 new references, and keyword abstracts for 2,000 of them.

Check and edit approximately 700 key-worded abstracts for two European journals prepared at Institute of Physics, Slovak Academy of Sciences.

Check and edit key-worded abstracts from other collaborators as applicable and necessary.

Provide training and knowledge sharing for external NSR collaborators.

McMaster Planned Activities

NSR keywording for Physical Review C journal

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

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.

BNL Planned Activities

Compile new B(E2) experimental data. Continue work on a B(E2) evaluation project (in collaboration with McMaster and Central Michigan Universities).

Compile new double-beta decay experimental data. Produce a new double-beta decay evaluation.

Maintain, update and distribute XUNDL.

McMaster Planned Activities

Compile data sets (in ENSDF format) for current experimental nuclear structure publication. Scan the webpages of prominent journals in nuclear physics for new papers.

Review compiled data sets submitted by other data centers prior to inclusion in the XUNDL database.

Communicate with the authors of the original papers for data-related problems and to request additional details of unpublished data.

Train a new undergraduate student in 2013 for XUNDL and other compilation work.

TUNL Planned Activities

Compile XUNDL data for A=2-20

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

Evaluate at least 1 mass chain from the ANL region of responsibility.

Review mass chain evaluations, as requested.

Collaborate with scientists from other NSDD network centers on data evaluation projects.

BNL Planned Activities

At least 4 mass chains, or their equivalent nuclides, will be evaluated.

At least 4 mass chains, or their equivalent nuclides, will be reviewed.

Continue mentoring new ENSDF evaluators.

LBNL Planned Activities

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.

Review mass-chain evaluations, as requested.

Work with the NNDC to include DDEP decay data and EGAF capture gamma-ray data in the ENSDF file and published in Nuclear Data Sheets.

Move Isotope Project activities to the UC Berkeley Department of Nuclear Engineering, hire an additional nuclear data evaluator, and begin a search for new senior evaluation personnel to replace retiring group members.

Collaborate with LLNL to develop a new XML format for the ENSDF file.

McMaster Planned Activities

2 equivalent mass chains and the data for new nuclides (as mentioned below) will be evaluated.

Mass chains will be reviewed as requested.

Update ENSDF for the identification of new nuclides and for the first publications on the findings of the excited states of nuclides.

Prepare final versions of the mass chains currently in the pipeline

ORNL Planned Activities

Complete evaluation of structure information for nuclei in the A=241-249 region: A = 243 and A=244 are anticipated.

TUNL Planned Activities

Prepare the ENSDF files corresponding to new publications in the "Energy Levels of Light Nuclei" series.

D. Ground and Metastable State Properties

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

BNL Planned Activities

Update database as new information becomes available.

E. Radioactive Decay Data Evaluation

Decay data for nuclides of importance for metrology, medicine, energy and non-energy applications are evaluated within the Decay Data Evaluation Project (DDEP) international collaboration. When completed, these evaluations are coded in ENSDF format and made available to the NSDD evaluators for inclusion into the ENSDF database.

ANL Planned Activities

Evaluate at least one radionuclide for the DDEP collaboration.

Review of selected nuclides for the DDEP collaboration, as requested.

McMaster Planned Activities

Evaluate or review decay datasets for one or two radionuclides, as needed.

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

Continue to maintain and update the EGAF database in collaboration with the IAEA and LLNL.

Collaborate with LLNL to perform statistical-model calculations of quasi-continuum gamma-ray cascade information and generate ENDF-format capture gamma-ray datasets for use with MCNP and other transport-code calculations.

Provide improved nuclear structure data for the RIPL library from the EGAF evaluations.

LLNL Planned Activities

Evaluation of EGAF data in collaboration with LBNL

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

Finalize publications in the A=12 and 13 region.

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 FRIB and GRETINA research communities, because of their vital importance to the nuclear science in US.

ANL Planned Activities

Participate in nuclear physics research activities at ANL and other major nuclear physics facilities with main emphasis on decay studies of neutron-rich fission products, spectroscopy of heavy actinide nuclei and nuclei far from stability line.

Complete analyses of 179Tl and 180Tl decay data and publish the results.

BNL: Scientific staff from BNL plans to participate in experiments in Argonne's new CARIBU facility.

BNL Planned Activities

Participate in beta-decay measurements at Argonne's CARIBU facility with an emphasis on beta-delayed neutron emitters

Complete analyses of 152Eu and 154Eu decay data and publish results

Perform precision measurements of electromagnetic transition strengths in light nuclei as a guide for improved formulations of ab-initio theories

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

LANL Planned Activities

Examine prompt gamma-ray emission data and gamma-gamma coincidence data from neutron reactions on nickel isotopes to search for previously unobserved transitions in these nuclides.

Interact with mass chain evaluators on the nuclear structure of these nuclei.

Search for isomers following neutron-induced reactions at GEANIE and DANCE.

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

Develop a high intensity D+D,D+T neutron generator facility in collaboration with the UC Berkeley Department of Nuclear Engineering, LLNL, and the Berkeley Geochronology Department. Perform neutron cross section and capture gamma ray measurements with 0-14 MeV neutrons.

Continue capture gamma-ray cross section measurements with neutron beams at the Budapest and Garching FRM II Reactors.

Perform DICEBOX statistical model calculations to determine total radiative cross sections and nuclear level spins and parities.

Publish new research on the Younger Dryas impact event, discovered by the LBNL Isotopes Project, that caused 1300 years of global cooling and the extinction of the Mammoths and megafauna.

Publish the discovery of 22 supernovae that exploded <250 pc from Earth during the past 300 kyr. This analysis based on the radiocarbon record is the first complete observation of cosmic rays emitted from an SNR.

I. ENSDF Physics and Checking Codes

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

ANL Planned Activities

Port and test the main ENSDF analysis codes to Mac X OS in collaboration with other NSDD centers.

BNL Planned Activities

Maintain and upgrade ENSDF checking and physics programs for format changes as required.

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

Compile experimental data for neutron, charged particle, and photon induced reactions from about 110 publications.

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. LLNL is also developing a new XML based format for ENDF data.

BNL Planned Activities

Respond to user needs for evaluated nuclear reaction data.

Collect and address users feedback related to the ENDF library.

Work with members of CSEWG to upgrade evaluations for future release of the ENDF/B library (version VII.2).

Improve methodology for providing covariance data in the resonance region and in the fast neutron region to the next release of ENDF.

If the proposed Generalized Nuclear Data (GND) format is approved by CSEWG, begin releasing ENDF libraries in the GND format.

Integrate processing and validation codes into the ENDF continuous integration system so that evaluators can have instant quality feedback on their submitted evaluations.

Improve calculations of decay heat and anti-neutrino spectra following the fission of actinides nuclides.

LANL Planned Activities

Upgrade the LANL ENDF evaluations for actinides that perform well in criticality benchmarks, considering new LANSCE experimental data.

Provide upgraded ENDF evaluated data files for light elements, including covariance data.

Provide new evaluations of prompt fission neutron spectrum for major actinides based on improved modeling at LANL.

Provide new evaluations for major actinides when the target is in its excited state.

LLNL Planned Activities

Perform new evaluations as per LLNL customer requests and submit these and other LLNL generated evaluations into ENDF.

C. ENDF Manuals and Documentation

The NNDC is responsible for maintaining the format and procedures manual for the ENDF system, which recently has been updated and migrated to LaTeX. We also produce the documentation supporting the contents of the ENDF/B library.

BNL Planned Activities

Maintain ENDF-6 formats manual up-to-date with CSEWG endorsed format changes. This format is used for the ENDF/B-VII library. Updates are now being managed using a Subversion repository on NNDC's GForge server.

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 $\text{Au}(n,\gamma)$ 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

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.

Incorporate the cross section standards into the new ENDF evaluations, and perform validation tests with integral measurements.

Complete report on the measured cross sections for the standards reaction $^6\text{Li}(n,\alpha)$ in the MeV region together with an R-matrix analysis of these and literature data. The measured data have already been given to the NNDC.

Continue experiments on $\text{H}(n,n)$ angular distribution for improving the standard at several neutron energies for forward neutron scattering angles in the center-of-mass. This measurement follows the $\text{H}(n,p)$ measurements that improved the data base at backward angles. We collaborate with researchers at Ohio University and NIST.

Continue measurements and analysis of data taken at GEANIE to identify and quantify neutron-induced gamma-ray production cross sections that could be used as reference cross sections against which other measurements could be normalized.

NIST Planned Activities

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.

Prepare a paper for the ND2013 conference on the standards.

Work on the Program Committee for the 15th International Symposium on Reactor Dosimetry to be held in 2014.

Continue work on an experiment using neutron detection (instead of proton detection) to measure the $\text{H}(n,n)$ angular distribution in collaboration with Ohio University and LANL. Investigate uncertainties possible with the use of a time projection chamber for hydrogen angular distribution measurements.

Continue work based on ^{252}Cf nu-bar leading to an improved calibration of NBS-I, the U.S. national primary standard neutron source and determination of our bath efficiency.

Complete the analysis of 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. Continue work to finalize the design for the ^3H target for the $n\text{-}^3\text{H}$ coherent scattering length measurement including safety review, detailed design, prototype fabrication, and element testing. This work complements work on

the $^3\text{He}(n,p)$ standard cross section
Continue 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.
Continue to recommend and encourage new measurements and perform examinations of the data from them for use in future evaluations of the standards.
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.
Work on the Program Committee for the ND2013 conference. Contribute to a session on 75 years with nuclear fission

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 - focuses on development of the nuclear reaction code EMPIRE including improving nuclear reaction modeling, further extensions of its capabilities, stability improvements and overall modernization of the code. The work on validation of the code is actively pursued, in particular in relation to emerging needs such as homeland security applications and advanced reactor development. Close collaboration with LANL continues 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 and in the resonance region.

BNL Planned Activities
Release new version of the code EMPIRE with above-mentioned improvements.
Maintain GForge site with the current version of the EMPIRE code.
Advance integration of the particular features need for the data assimilation.
Expand testing framework to improve the EMPIRE development cycle.

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 due to the decrease in operating experimental facilities throughout the world. The LANL GNASH code has proved to be an important tool, and we will continue development of a new version of this code, McGNASH, to provide a state-of-the-art capability to predict reaction cross sections. This also involves a close collaboration with experimentalists at LANSCE to interpret new measurements using the GEANIE and DANCE gamma-ray detectors, and FIGARO detectors for neutron emission as well as (n,charged-particle) data. These data will result in advances in our understanding of nuclear reaction mechanisms, and improvements in our modeling codes. Also, largely under DOE/DP support, we will continue modernization of our R-matrix EDA code (used for light nucleus calculations and data evaluations) and explore implementation of exact particle-exchange formalism.

LANL Planned Activities
Develop a code to calculate the prompt neutron and gamma spectra from fission fragments, using the Monte Carlo technique for the Hauser-Feshbach statistical decay, and apply this to prompt fission neutron spectrum evaluation.
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.
Study ^{238}U and ^{239}Pu neutron elastic and inelastic scattering at low-excitation energies where the evaluated nuclear data libraries are discrepant.
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
Study excitation energy sharing between two fragments at fission, which is important for calculating prompt fission neutron spectrum.

LLNL Activities
Event by event fission modeling with FREYA
Reaction theory for surrogate reactions
Coupled-channels optical potentials
R-Matrix for light ion evaluations

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 (Co-PI of a DOE/ONP ARRA funded project) on Measurement of Actinide Neutronic Transmutation Rates with Accelerator mass spectroscopy (MANTRA) in collaboration with INL. The main aim is to obtain valuable integral information about practically all high-mass actinide neutron cross sections that are of importance to advanced nuclear fuel cycles and to USNDP.

ANL Planned Activities

Coordinate research activities between INL and ANL and participate in nuclear data measurements, equipment development, cross section modeling and sensitivity studies.

LANL Planned Activities

Analyze neutron inelastic scattering made with the GEANIE and FIGARO arrays. Correlate new data from GEANIE with data from FIGARO on targets of ^{56}Fe and ^{58}Ni . New measurements at GEANIE will include ^{60}Ni .

Continue to improve the techniques to measure the fission-neutron spectrum for fission induced by neutrons of 0.4 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 and CEA 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 FY13, we will complete measurements on the portion of the fission neutron spectrum below 1 MeV for ^{235}U or ^{239}Pu .

Complete analysis of data on $^{173}\text{Lu}(n,\gamma)$ at DANCE for studying level densities on ^{174}Lu through the capture resonances on radioactive ^{173}Lu nucleus.

Complete data analysis for gamma-ray output from neutron-induced fission of ^{235}U and ^{242}Pu and spontaneous fission of ^{252}Cf . Collaborators include scientists from LLNL.

Measure neutron capture cross sections ^{239}Pu and ^{241}Pu for neutron energies less than 200 keV, contingent on obtaining the targets. Measure ^{239}Pu capture-to-fission ratio.

Measure the neutron capture cross-section at DANCE for at least one radioactive isotope of importance to nuclear astrophysics.

Develop the Time-Projection Chamber for accurate fission cross section measurements.

Analyze data for the $^{237}\text{U}(n,f)$ cross section taken at the LANSCE Lead Slowing-Down Spectrometer.

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

Measure thermal (n, γ) gamma ray and total radiative cross sections using guided neutron beam in collaboration with the Budapest Research Centre and the Garching FRM II reactor.

Lead series of surrogate-reaction benchmarking measurements at the LBNL 88" cyclotron.

LLNL Planned Activities

Perform neutron capture measurements with DANCE array and fission cross section measurements with the lead slowing down spectrometer at LANSCE in collaboration with LANL. (funded from other sources)

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)

β -delayed neutron emission measurements for fission fragments

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

ANL will continue working in the area of data needs for nuclear astrophysics. The main emphasis will be on improving the data for cosmochronometers in the rare-earth region - ^{176}Lu , ^{180}Ta and ^{186}Re .

Compile and evaluate nuclear structure and decay data for neutron-rich fission fragments, produced at the CARIBU facility (ANL), that are of relevance to r-process modeling.

BNL Planned Activities

Produce Maxwellian-average neutron capture cross sections and astrophysical reaction rates for entire s-process path.

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

Improve neutron capture models to provide neutron capture rates off-stability to s and r-process hydro-dynamics simulations.

Continue working on beta-delayed fission rates in the astrophysical stellar environment, based on the macroscopic-microscopic nuclear mass model.

Study on nuclear reaction rate database currently used in the r-process calculations, and provide updated reaction rates if needed.

s

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

ORNL Planned Activities

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 radioactive ion beam facilities around the world.

Extract spectroscopic information (excitation energies, spectroscopic factors, spins, parities, ANC's) on nuclei near the N=82 closed shell – ^{127}Sn , ^{129}Sn , ^{131}Sn , ^{133}Sn , ^{135}Te - from transfer reaction measurements on radioactive Sn and Te nuclei. This information is important for modeling the r-process in supernovae.



USNDP Staffing table FY2013

	ANL		BNL			LANL		LBLN	LLN	McMaster		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		1.25															1.85
Management			0.60																	0.60
Secretarial/Administrative Support					0.85															0.85
Library					0.10															0.10
Computer Operations					0.30															0.30
II. Coordination			0.40			0.25		0.25								0.05				0.95
National Coordination			0.20			0.05		0.15								0.05				0.45
International Coordination			0.20			0.20		0.10												0.50
III. Nuclear Physics Databases			1.45	0.10	0.95															2.50
Nuclear Science References, NSR			0.15		0.75															0.90
Exper. Nucl. Structure Data, XUNDL			0.05																	0.05
Eval. Nucl. Structure Data, ENSDF			0.60																	0.60
Numerical Nuclear Data, NuDat			0.30																	0.30
Reaction Data Bibliography, CINDA																				
Experimental Reaction Data, CSISRS																				
Evaluated Nuclear Data File, ENDF			0.10																	0.10
Database Software Maintenance			0.10		0.20															0.30
Future Database System Develop.			0.15	0.10																0.25
IV. Information Dissemination			0.60	0.20	1.30			0.05								0.70			0.60	3.45
Nuclear Data Sheets			0.25	0.20	0.90															1.35
Customer Services			0.15		0.30															0.45
Web Maintenance & Development			0.20		0.10			0.05								0.70			0.60	1.65
	ANL		BNL			LANL		LBLN	LLN	McMaster		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	0.85		2.30	1.95		0.10		1.70		0.50	0.40				0.20	0.15	0.76	0.10	0.15	9.16
NSR Abstract Preparation			0.10	0.35						0.10										0.55
Compilation of Exper. Structure Data	0.15			0.20						0.20							0.10			0.65
Eval. of Masses & Nuclides for ENSDF	0.50		1.65	1.40				1.00		0.20	0.40				0.20	0.15	0.33		0.15	5.98
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		0.20			0.10		0.20												0.60
ENSDF Evaluation Support Codes			0.25																	0.25
	ANL		BNL			LANL		LBLN	LLN	McMaster		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	
VI. Nuclear Reaction Physics	0.05		1.25	2.35	0.30	0.95	0.35	0.20	0.37			0.10	0.10		0.15					6.17
Experimental Data Compilation			0.20	0.50																0.70
ENDF Manuals and Documentation			0.20																	0.20
ENDF Evaluations			0.95	1.45	0.30	0.30			0.37											3.37
Nuclear Reaction Standards						0.10						0.10	0.10							0.30
Nuclear Model Development			0.20			0.15	0.05													0.40
Nucl. Reaction Data Measurements						0.30	0.30	0.20												0.80
Astrophysics Nuclear Data Needs	0.05		0.10			0.10									0.15					0.40
DOE-SC Nucl. Data Funded Staff	0.90		6.60	4.60	3.80	1.30	0.35	2.20	0.37	0.50	0.40	0.10	0.10		1.10	0.15	0.76	0.10	0.75	24.08
Staff Supported by Other Funds	0.10	1.00	2.00	0.80		9.70	1.65	1.30	7.20	0.40		2.50		1.00	0.60					28.25
TOTAL STAFF	1.00	1.00	8.60	5.40	3.80	11.00	2.00	3.50	7.57	0.90	0.40	2.60	0.10	1.00	1.70	0.15	0.76	0.10	0.75	52.33

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