USNDP Work Plan for Fiscal Year 2012

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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 2012 that begins on October 1, 2011. Previously, **12 work plans** have been prepared for the data program covering fiscal years 2000 - 2011. 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 the case in the work plan for FY2011, 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 FY2011, defining tasks, organizational responsibilities, and planned activities. It is envisioned that this document will serve as the basis for a performance review at the end of fiscal year 2010. 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 **2011 January AFP** and **2012 guidance** scenarios.

Table 1: Summary of the USNDP funding and metrics for FY2001- FY2012, the last two years are projections under the **2011 January AFP** and **2012 guidance** scenarios.

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%	4,035	400	3,294	26	61	56
2010	$6,549K	+4.5%	4,662	395	2,843	27	83	51
2011	$6,174K	−5.7%	4,680	398	3,023	24	77	55
2012	$6,492K	+5.2%	4,733	378	3,250	25	74	55

We expected that the budgets under the **2011 January AFP** and **2012 guidance** scenarios plus the stimulus funding will ensure a solid program for FY 2012. We expect to achieve:

- Compilation, evaluation and dissemination activities will be fully supported.
- Training and mentoring of new ENSDF evaluators will continue.
- A large amount of effort will be devoted to release the new VII.1 version of ENDF/B.
- Development of nuclear reaction codes will continue (covariances and fission).
- The new XENDL format will enter testing phase, ARRA funding being instrumental.
- Preparation work on ND2013 will continue.

Several important staff issues will be dominant in 2012:

ANL will possibly have to convert an ARRA funded post-doc in staff in 2012.

BNL has had some difficulties filling vacancies due to the scarcity of suitable candidates and the high cost of living in Long Island. With the retirement of a senior ENDF PI looming, this issue will become crucial. The NNDC has a large number of highly-skilled external collaborators, about 13. This initiative should be maintained and strengthened.

LBNL is expecting the retirement of two ENSDF evaluators by 2012. LBNL needs to hire a new evaluator with leadership skills to work with outgoing staff to rebuild the program if it is to continue.

ORNL needs to strengthen the funding for its junior staff as well as maintaining the support for their programming activities.

Additionally, BNL will be the main Web-dissemination center after LBNL shuts down its web activities in 2011.

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
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.
Provide computer support to NNDC staff and its visitors in their use of NNDC computing resources.

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 FY2012 work plan for USNDP in time for spring 2011 FWP submittals.
Organize and chair CSEWG Meeting at BNL in November 2011.
Organize and chair USNDP Meeting at BNL in November 2011.
Edit and publish summary reports and proceedings of the CSEWG and USNDP meetings.
Maintain CSEWG and USNDP websites

Continue working on the organization of ND2013

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

LBNL: 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
Organize and chair Nuclear Structure and Decay Data Working Group meeting at USNDP meeting in Santa Fe, November 2011. Work with the NNDC to improve the efficiency of nuclear stucture data evaluation and better integrate US efforts with other nuclear data activities.
Coordinate Capture Gamma-ray Library evaluations with LLNL for preparation of ENDF format datasets and improved RIPL files.
Coordinate surrogate reaction cross section measurements at the LBNL LiBeRACE facility.

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

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

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.
Communicate current efforts and future plans with researchers in nuclear astrophysics and 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
Coordinate DDEP international activities
Host several international visitors to ANL to collaborate on nuclear structure and nuclear astrophysics data evaluation projects.
Participate in IAEA-organized training workshops and meetings

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 2012.
Participate in NEA WPEC annual meeting in 2012.
Conduct and lecture at likely IAEA-sponsored workshop at Trieste in 2012.
Continue working on the organization of 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 2011 meeting
Participate in relevant IAEA CRP meetings (FENDL and prompt fission neutron spectrum data).
Participate and give a talk at the workshop on compound nucleus and related topics, CNR11, Sep 19-23, 2011, Prague
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.
Help organizing International Conference on Nuclear Reaction Mechanism, Varenna, Italy, 2012.

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 International k0 users committee and the IAEA.
Edit the IAEA/LBNL Evaluated Gamma-ray Activation File (EGAF). Develop a new Nuclear Data Sheet publication format for EGAF.
Evaluate RIPL nuclear structure data for isotopes produced by (n,g) on stable and selected radioactive targets]in collaboration with the IAEA.
Coordinate LBNL/Budapest/Munich/IAEA thermal neutron cross section measurement program with guided neutron beams.

McMaster: Continue participation in new evaluators training program.

McMasters planned activities
Continue to participate in the matters related policies, ESNDF formats and procedures for the NSDD network.
Continue to participate in training/mentoring of new ENSDF evaluators through collaborative work.

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
Distribute database to collaborators.
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 collaborators twice a year.
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).

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 ≤ 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 V 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-VII.1 library.
Maintain and improve Sigma database and web interface for users without specialized knowledge of ENDF-6 format. (See also information dissemination, chapter IV).

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 six nuclear physics databases maintained by NNDC.

I. Database Systems Development

The multi-year effort to migrate the USNDP databases to a LINUX/MySQL environment was completed in FY2009. Several follow-up tasks will need to be performed.

BNL planned activities
Effort needed to maintain Linux/MySQL database system and improve 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 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
Improve ENSDF and NSR web interfaces.
Maintain web interfaces for ENDF and EXFOR databases.
Improve Sigma web interface by adding new and extended features following user's requests.
Maintain web interface 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 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.
Strictly follow all BNL and DOE cybersecurity rules and regulations during the Web application design, development and implementation.
Maintain GForge Web site.

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.
Extend the Nuclear and Atomic Data Viewer as per user requests.
Maintain and upgrade LLNL's Computational Nuclear Physics web pages.

LBNL planned activities
Due to many complaints that the loss of the WWW Table of Radioactive Isotopes will adversely affect many University, corporate, and governmental research efforts the Isotopes Project web site will continue to be maintained until FY2012.

ORNL Planned Activities
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.
First implementation of workflow tools to help international collaboration in evaluations for nuclear astrophysics

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 PDF and HTML documents for FAS reviews for the A = 3 - 20 series.
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.
Provide compiled and evaluated data on the decay of unstable ground states and on structure data from thermal neutron capture.

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 and for Nuclear Wallet Cards.

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 twelve issues of Nuclear Data Sheets for publication.
Prepare special issue of Nuclear Data Sheets on neutron reaction data.

McMaster Planned Activities	Status
Develop software for Nuclear Data Sheets publication	Ongoing effort.

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 three European journals prepared at the IAEA Nuclear Data Section.
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 all articles in Physical Review C journal during October 2011 to September 2012

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.
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 2012 for XUNDL and other compilation work.
Compile new mass measurements and submit data file to nuclearmasses.org webpage at ORNL

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 6 mass chains, or their equivanent nuclides, will be evaluated.
At least 6 mass chains, or their equivanent nuclides, will be reviewed.
Continue mentoring new ENSDF evaluators.

LBNL Planned Activities

| Evaluate the equivalent of at least 3 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 publish it in Nuclear Data Sheets. |
| Train new evaluators to replace retiring 2.0 FTE expected in FY2012. |

McMaster Planned Activities
3.0 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.
Collaborate with a new center/evaluator as part of mentoring process, as needed.

ORNL Planned Activities
Complete evaluation of structure information for one nucleus in A=241-249 region, or others assigned by NNDC.
Review one mass chain evaluation.

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.

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 develop the EGAF database. Update EGAF prompt gamma-ray cross sections from new measurements. Add activation data to the EGAF file. Include improved nuclear stucture data for the RIPL library in EGAF datasets. Develop a Nuclear Data Sheet publication format for EGAF data.
Collaborate with LLNL 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.

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.
Continue to evaluate A=14 & 15 nuclei.

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 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
Participate in research activities using the GRETINA spectrometer and in dissemination of produced data from those activities

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 fission-product nuclei to search for previously unobserved transitions in this nuclides.
Interact with mass chain evaluators on the nuclear structure of these nuclei.

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 and utilize nuclear analytical methods for the analysis of the Younger Dryas (13 kyr BP) and Beringian (35 kyr BP)impact events that led to mass extinctions and global climate and environmental change. Investigate the Paleolithic record of the global carbon and nitrogen cycles.
Analyze the radiocarbon and other cosmogenic isotope records for evidence of near Earth prehistoric supernovae and study the mechanisms for propagation of cosmic rays from the supernova remnants and the galactic supernova explosion rate.
Investigate the causes of apparent oscillations of radioactive decay half-lives with respect to Earth orbital position and possible connections to long-standing problems with the measurement of consistent, precise half-life values.
Perform DICEBOX statistical model calculations to determine total radiative cross sections and elucidate nuclear level spins and parities.

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
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 120 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 LANL on upgraded evaluations for future release of the ENDF/B library.
Improve methodology for providing covariance data in the resonance region and in the fast neutron region to the next release of ENDF.
Release ENDF/B-VII.1 library

LANL Planned Activities
Upgrade the LANL ENDF evaluations for plutonium isotopes that perform well in criticality benchmarks, considering new LANSCE experimental data.
Provide upgraded ENDF evaluated data files for light and medium mass elements, including covariance data. Perform criticality benchmarks.
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.
Finalize new evaluations of delayed gamma-ray data, and produce a CINDER delayed gamma data library.
Provide new evaluations of the prompt fission neutron spectra for major actinides, based on the Monte Carlo technique, and perform criticality benchmarks.

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 GForge version of the ENDF-6 formats manual up-to-date with CSEWG endorsed format changes. Issue official release of the manual.

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
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.
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.
Continue the search for suitable (n,x γ) reactions as possible reference cross sections to complement or replace the ^{56}Fe(n,x γ = 847 keV) reaction, which has several experimental limitations.

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 documentation for the standards to be published as a journal publication.
Continue to recommend and encourage new measurements and perform examinations of the data from them for use in future evaluations of the standards.
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.
Work on an experiment 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 a measurement of the ^{6}Li(n,t) standard cross section at ~ 4 meV neutron energy using an improved fluence determination based on alpha-gamma coincidences with the ^{10}B(n,alpha) reaction. Study stability of ^{10}B deposits for ^{10}B(n,alpha)cross section measurements. If suitable targets can be made, cross section measurements will be initiated.

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.
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.

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 – 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. 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
Continue to improve reaction modeling in the EMPIRE code, maintain code's numerical integrity and enhance user friendly GUI.
Improve EMPIRE covariance capabilities for fast neutrons.
Extend resonance module allowing to generate covariances utilizing information from Atlas of Neutron Resonances to account for systematic uncertainties.
Maintain GForge site with the current version of the EMPIRE code.
Attempt parallelization of EMPIRE on the NNDC cluster.

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 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.
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.
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 nucleo-synthesis studies.
Study neutron elastic scattering angular distributions in the fast energy range, which have high sensitivities to the simulation for critical assemblies.
Study neutron inelastic scattering from actinides in the fast energy range, to which theoretical calculations are essential, in collaboration with CEA, France.
Perform prompt fission spectrum calculations with the Monte Carlo method to ^{235}U and ^{239}Pu, and compare available experimental information.

LLNL Activities
Event by event fission modeling
Reaction theory for surrogate reactions

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 activities at ANL using the Accelerator Mass Spectrometry technique, and in 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 near mass 90.

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.

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' γ) reactions.

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.

Measure neutron capture cross sections on ^{238}Pu for neutron energies less than 200 keV, contingent on obtaining the targets.

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

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) cross sections using guided neutron beam in collaboration with the Budapest Research Centre and at the Munich Reactor.
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.
Investigate nuclear level densities and gamma ray strengths at the Budapest and Munich Reactors and the LBNL LiBeRACE facilty. Develop improved statistical model calculations in collaboration with Charles University, Prague.

LLNL Planned Activities
Neutron induced reaction measurements on one or more isomer targets.
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)
Perform neutron capture measurements with DANCE array at LANSCE in collaboration with LANL. (funded from other sources)
Perform fission cross-section measurements with the lead slowing down spectrometer at LANSCE in collaboration with LANL. (funded from other sources)

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 nuclear data for known cosmo-chronometers in the rare-earth region - 176Lu, 180Ta and 186Re.
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.

BNL Planned Activities
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.

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.

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
Specific reactions planned for evaluation in FY12: 17F(p,gamma)18Ne and 55Co(p,gamma)56Ni

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 ORNL's Holifield Radioactive Ion Beam Facility.
Extract spectroscopic information (excitation energies, spectroscopic factors, spins, parities, ANCs) on nuclei near the N=82 closed shell – 131Sn, 135Te - from transfer reaction measurements on radioactive Sn and Te nuclei. This information is important for modeling the r-process in supernovae.

USNDP Staffing table FY2012

	ANL			BNL			LANL	LBNL	LLNL	MCMASTER		NIST			ORNL			TUNL			Sum
	PhD P	PhD T	GS	PhD P	PhD T	T/A	PhD P	PhD P	PhD P	PhD P	PhD T	PhD P	PhD T	GS	PhD P	PhD T	GS	PhD P	PhD T	T/A	Sum
I. NNDC Facility Operation	0.00	0.00	0.00	0.60	0.00	1.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.85
Management				0.60																	0.60
Secretarial Administrative Support						0.75															0.75
Library						0.10															0.10
Computer Operations						0.40															0.40
II. Coordination	0.10	0.00	0.00	0.20	0.00	0.00	0.40	0.25	0.21	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	1.21
National Coordination				0.15			0.10	0.15	0.21						0.05						0.66
International Coordination	0.10			0.05			0.30	0.10													0.55
III. Nuclear Physics Databases	0.00	0.00	0.00	1.30	0.20	1.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.55
Nuclear Science References, NSR				0.15		0.75															0.90
Exper. Nucl. Structure Data, XUNDL				0.05																	0.05
Eval. Nucl. Structure Data, ENSDF				0.20																	0.20
Numerical Nuclear Data, NuDat				0.30																	0.30
Reaction Data Bibliography, CINDA																					0.00
Experimental Reaction Data, CSISRS																					0.00
Evaluated Nuclear Data File, ENDF				0.15																	0.15
Database Software Maintenance				0.30		0.30															0.60
Future Database System Develop.				0.15	0.20																0.35
IV. Information Dissemination	0.00	0.00	0.00	0.70	0.00	1.20	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.70	0.00	0.00	0.00	0.00	0.60	3.30
Nuclear Data Sheets				0.25		0.90															1.15
Customer Services				0.15		0.30															0.45
Web Maintenance & Development				0.30			0.05	0.05							0.70					0.60	1.70

	ANL			BNL			LANL	LBNL	LLNL	MCMASTER		NIST			ORNL			TUNL			Sum
	PhD P	PhD T	GS	PhD P	PhD T	T/A	PhD P	PhD P	PhD P	PhD P	PhD T	PhD P	PhD T	GS	PhD P	PhD T	GS	PhD P	PhD T	T/A	Sum
V. Nuclear Structure Physics	0.85	0.00	0.00	2.40	1.60	0.00	0.10	1.50	0.00	0.60	0.80	0.00	0.00	0.00	0.20	0.15	0.00	0.86	0.48	0.15	9.69
NSR Abstract Preparation				0.10	0.20					0.10											0.40
Compilation of Exper. Structure Data	0.10									0.20								0.10			0.40
Eval. of Masses & Nuclides for ENSDF	0.50			2.05	1.40			0.80		0.30	0.80				0.20	0.15		0.33	0.19	0.15	6.87
Ground & Metastable State Properties				0.10																	0.10
Radioactive Decay Data Evaluation	0.15																				0.15
Thermal Capture Gamma Data Eval.								0.50													0.50
Light Mass Eval. for Nucl. Physics A							0.10											0.43	0.29		0.82
Nuclear Structure Data Measurement	0.10							0.20													0.30
ENSDF Evaluation Support Codes				0.15																	0.15

	ANL			BNL			LANL	LBNL	LLNL	MCMASTER		NIST			ORNL			TUNL			Sum
	PhD P	PhD T	GS	PhD P	PhD T	T/A	PhD P	PhD P	PhD P	PhD P	PhD T	PhD P	PhD T	GS	PhD P	PhD T	GS	PhD P	PhD T	T/A	Sum
VI. Nuclear Reaction Physics	0.05	0.00	0.00	1.25	0.85	0.20	1.05	0.20	0.19	0.00	0.20	0.10	0.10	0.00	0.15	0.00	0.00	0.00	0.00	0.00	4.34
Experimental Data Compilation					0.40																0.40
Neutron Data																					0.00
Charged Particle Data																					0.00
Photonuclear Data																					0.00
ENDF Manuals and Documentation				0.05	0.05																0.10
ENDF Evaluations				1.05	0.20	0.20	0.25		0.19												1.89
Nuclear Reaction Standards							0.10					0.10	0.10								0.30
Nuclear Model Development				0.05	0.20		0.40														0.65
Nucl. Reaction Data Measurements							0.10	0.20													0.30
Astrophysics Nuclear Data Needs	0.05			0.10			0.20				0.20				0.15						0.70
DOE-SC Nucl. Data Funded Staff	1.00	0.00	0.00	6.45	2.65	3.70	1.60	2.00	0.40	0.60	1.00	0.10	0.10	0.00	1.10	0.15	0.00	0.86	0.48	0.75	22.95
Staff Supported by Other Funds	0.00	2.00	0.50	2.68	0.70	0.00	12.00	1.30	5.00	0.40	0.00	2.50	0.00	1.00	0.60	0.00	1.00	0.00	0.00	0.00	29.68
TOTAL STAFF	1.00	2.00	0.50	9.13	3.35	3.70	13.60	3.30	5.40	1.00	1.00	2.60	0.10	1.00	1.70	0.15	1.00	0.86	0.48	0.75	52.63

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