USNDP

U.S. Nuclear Data Program
Work Plan for
Fiscal Year 2003

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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 during fiscal year 2003 that begins on October 1, 2002. Previously, three work plans have been prepared for the data program covering fiscal years 2000, 2001 and 2002. 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 or 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 FY2002, the tasks proposed by the different 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 meets one of the three program priorities:

    a) The maintenance and update of the USNDP nuclear physics databases;
    b) The improvement of dissemination of the information contained in those databases to the user community;
    c) The modernization of data evaluation software used by the program participants.

2. A task is useful to more than a single user community.

3. A task does 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:

- NNDC Facility Operation
- Coordination
- Nuclear Physics Databases
- Information Dissemination
- Nuclear Structure Physics
- Nuclear Reaction Physics

The following section details the proposed work plan for FY2003, defining tasks, organizational responsibilities, and deliverables. One must understand that a plan is just a plan. To be successful, the planning process must be flexible enough to be able to respond to

unforeseen circumstances. It is envisioned that this document will serve as the basis for a performance review at the end of fiscal year 2003.

An effort table follows the detailed work plan. The effort table provides a summary of the total effort devoted to the defined tasks and the distribution of this effort by organization. The effort table shows a reduction of 3.45 FTE scientific/professional and 1.0 FTE support compared to the FY2002 plan. The continuing activities of the USNDP show a reduction of 4.45 FTE scientific/professional staff. This dramatic decrease is in large part due to the program's flat-budget for FY2002. One FTE has been added by including the LANSCE activity in this new plan.

Finally, the detailed plan submissions by each organization are attached as appendices to allow for more detailed explanation of their plans.

Work Plan Tasks and Deliverables

I. NNDC Facility Operation

A. Management

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.

C. Computer Operation

The NNDC operates a Compaq Alpha 4100 server using the OpenVMS operating system to support our compilation, evaluation, database maintenance, and information dissemination functions. In addition to the primary production server, the NNDC operates WINDOWS-NT and LINUX servers in support of its database migration project. Task includes software upgrades, hardware and software procurements, machine operations and internal user support.

BNL Deliverables:

Keep downtime to less than 3%.

II. Coordination

A. National Coordination

ANL -- Lead Measurement and Basic Physics Committee of the Cross Section Evaluation Working Group and represent U.S. measurement interests in the NEA Working Party for Evaluation Cooperation.

ANL Deliverables:

Chair meeting of the Cross Section Evaluation Working Group.
Provide Measurement and Basic Physics Committee report for CSEWG.
Compile U.S. contributions to NEA High Priority Request List.

BNL -- Chair USNDP Coordinating Committee, Chair Cross Section Evaluation Working Group, USNDP specific tasks.

BNL Deliverables:

Prepare FY2004 work plan for USNDP in time for spring 2003 FWP submittals.
Organize and chair CSEWG Meeting at BNL in November 2002.
Organize and chair USNDP Meeting at McMaster University in April 2003.
Edit and publish summary reports of the CSEWG and USNDP meetings.
Maintain USNDP Web site.

LANL -- Chair U.S. Nuclear Data Program's Nuclear Reaction Working Group, and help coordinate nuclear reaction data work at different labs to advance USNDP, chair of Evaluation Committee of the Cross Section Evaluation Working Group.

LANL Deliverables:

Organize and chair CSEWG Evaluation Committee meeting at BNL, November 2002.
Organize and chair Nuclear Reaction Working Group meeting at USNDP meeting in 2003.

LBNL -- Chair U.S. Nuclear Data Program's Data Dissemination Working Group, and help coordinate data dissemination work at different labs to advance USNDP goals. Included here is also the Isotopes project management responsibilities of interacting with LBNL management and the DOE program manager.

LBNL Deliverables:

Organize and chair Data Dissemination Working Group meeting at USNDP meeting, April 2003.

B. International Coordination

BNL -- Member of Nuclear Reaction Data Center Network, Member Nuclear Structure and Decay Data Network, Vice-Chair and U.S. Member of the International Nuclear Data Committee, member of NEA Working Party on International Evaluation Cooperation, participation in IAEA sponsored activities such as Advisory Group Meetings and Coordinated Research Projects.

BNL Deliverables:

Participate in technical meeting of NRDC at Vienna in 2003.
Participate in NEA Working Party on International Evaluation Cooperation in 2003.
Provide a lecturer for the NSDD Workshop at Trieste in 2003.

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 chair NEA committees in fission spectra, and international model code development cooperation; and chair IAEA coordinated research programs on photonuclear reactions, and on reference input model parameters (RIPL). LANL will host visits by foreign scientists with international reputations to benefit from the exchange of information and ideas.

LANL Deliverables:

Continue organization of the major international nuclear data conference (ND2004), to be held in Santa Fe, September 2004.
Participate in NEA June 2003 meeting.
Participate in relevant IAEA meetings, including Trieste Lectures.
Make latest version of NJOY data processing code available to the international community.
Host international visitors to LANL to collaborate on the evaluation of reaction data.

McMaster – Host 2003 annual USNDP meeting and the biennial IAEA- sponsored international meeting of nuclear structure evaluators.

McMaster Deliverables:

Host USNDP and NSDD (IAEA) meetings in May 2003.

III. Nuclear Physics Databases

A. Nuclear Science References (NSR)

The NNDC is responsible for NSR, the bibliographic database for nuclear physics research. 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 Deliverables:
Database distributed to collaborators monthly.

B. Experimental Nuclear Structure Data File (XUNDL)

The NNDC is responsible for XUNDL, the database of unevaluated experimental nuclear structure data. Recent additions contain mostly "high-spin" data sets. NNDC responsibility is limited to maintaining database and access to it. Data set compilation coordinated through McMaster University. Updates are done as data sets are received.

C. Evaluated Nuclear Structure Data File (ENSDF)

The NNDC is responsible for the ENSDF database that contains evaluated experimental nuclear structure and decay data. The NNDC is responsible for maintaining the database and organizing the quality control (review) of evaluations submitted for inclusion. Task includes database updates and distribution to collaborators. Updates are done upon completion of reviews. Corrections implemented on a continuing basis.

BNL Deliverables:
Database distributed to collaborators twice in the year.

D. Numerical Nuclear Data File (NuDat)

The NNDC is responsible for NuDat, an all numeric database of nuclear data including level and γ-ray properties extracted from ENSDF, ground and metastable state properties (Wallet Cards), atomic and nuclear radiations derived from ENSDF and thermal neutron cross sections and resonance integrals. Database is also available in a PC version. The database is updated twice a year.

BNL Deliverables:
Database distributed to collaborators twice in the year.

E. Neutron Reaction Data Bibliography (CINDA)

The NNDC is responsible for the CINDA database that contains references to nuclear reaction data in the published and unpublished literature. Its contents are produced cooperatively by the four international neutron data centers with updates exchanged in an agreed computer

format. The data is organized by data measured, not by reference. The database serves as an index to the neutron data contained in the experimental database, CSISRS. The database is updated as transmissions from the data centers are received and checked.

BNL Deliverables:

Update CINDA database with CINDA transmissions from cooperating centers (12 expected).

F. Experimental Reaction Data File (CSISRS)

The NNDC is responsible for maintaining the CSISRS database. This database contains experimentally measured nuclear reaction data covering low- and intermediate-energy regions. Many groups worldwide compile and exchange experimental data in an agreed format, EXFOR. In support of the reaction data compilation effort, we maintain a database of validated coded information (thesaurus) called the EXFOR dictionary system. The effort described here includes the quality control, file update and data exchange activities. The database is updated, as transmissions from the compiling centers are received and checked. The compilation activity is given under Nuclear Reaction Physics.

BNL Deliverables:

Update CSISRS with EXFOR exchange tapes from cooperating centers (20 expected).

G. Evaluated Nuclear Data File (ENDF)

The NNDC is responsible for ENDF, a database of evaluated nuclear data required for many nuclear applications. The 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 are also included. The data are stored in the ENDF format developed at NNDC about 35 years ago. This format has been 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. There will be no more releases of ENDF/B-VI before ENDF/B-VII is ready.

BNL Deliverables:

Maintain CSEWG Web site; keep information current.
Make ENDF/B-VII evaluations available on the CSEWG Web site after reviews are completed.

H. Database Software Maintenance

Includes software bug fixes and enhancements for the six nuclear physics databases maintained by NNDC.

I. Future Database Systems

In the 1980's, the NNDC migrated most of its databases to run under the Digital Equipment Corporation (DEC) CODASYL database management system (DBMS) on the VMS operating system (this DBMS has since been bought by Oracle). Retrieval programs written in FORTRAN allowed dial-up, DECNET, and telnet-based online retrieval well before the advent of the World-Wide Web. In the 1990's, Web interfaces were developed using the very same DBMS system.

In recent years, relational database management systems (RDBMSs) using Structured Query Language (SQL) have become standard in business and academia. There are many ways in which the nuclear data program could benefit from an increased use of relational database technology. Because it is a widely used technology, a large variety of auxiliary tools and interfaces exist for the administration and dissemination of data. These tools include replication and synchronization capabilities that would improve the efficiency and reliability of data exchange between centers. Because commercial RDBMSs software is available on a wide variety of platforms, and in a wide variety of price ranges, their use provides an opportunity to explore new options for dissemination to end-users of the data. The use of common standards in data storage will allow data centers to choose the software that best meets their needs, without being tied to a particular vendor.

Migration to this new database format represents a generational shift in the way data are stored. This is a major project that requires substantial amount of effort stretched over a period of several years. Among the tasks that need to be undertaken for each database are:

- Database design: The design of relational schema should be compatible with the current system, and allow flexible and efficient access to the data.
- Data migration: Current data will be loaded into the Sybase RDBMS system. The software written to do this will also be used to add new data as it comes in. Until the migration project is complete, parallel instances of the data will be kept in both the old and new database formats.
- Code migration: To the extent that it is feasible, the legacy programs for database administration, written mostly in FORTRAN, will be modified to work with the new RDBMS.
- Code development: For many tasks, and in particular for Web-based data dissemination, new software will be developed. Because of its portability, the Java programming language is being used for new software development.

Over the last three years, the NNDC has worked to develop a path forward for migration of nuclear data to a relational format, evaluated several software options, and began the process

of migrating databases to a Sybase RDBMS on the Linux operating system. We started with NSR in FY2001, followed by ENSDF in FY2002. The three reaction databases (CINDA, CSISRS and ENDF) will be created in FY2002; they will undergo intensive testing and should be ready for use in FY2003. The project includes migration of legacy codes and modernization of dissemination software. We intend to accomplish migration without interrupting our present electronic data access. It is expected that this major project will be completed in about two years, depending on the level of support available.

BNL Deliverables:

Migrate NSR database administrative functions to the new system. Once this is accomplished, the RDBMS version will replace the current version of NSR on the Web.

Develop ENSDF relational database and supporting software, and make Web-based access publicly available.

Migrate legacy FORTRAN codes associated with NSR and ENSDF.

Complete code migration and code development for evaluated reaction data (ENDF together with CSISRS and CINDA). Once this is accomplished, the RDBMS version will replace the current versions on the Web.

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. Maintenance of Remote Access to USNDP Databases

The NNDC provides electronic access to the nuclear physics databases that it maintains. This access is supported in two forms, remote login (TELNET) and *via* the Web.

BNL Deliverables:

Migrate Web interfaces for NSR and ENSDF to new relational databases.
Maintain and upgrade current Web interfaces to NNDC nuclear physics databases while migration to relational databases is in progress.

B. Customer Services

This task accounts for the non-electronic services which the USNDP renders to customers. At the scientific staff level, we mean direct assistance to users needing advice of 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.

C. Web Site Maintenance

USNDP members who offer information through a web site require resources to maintain currency and improve performance. All sites will coordinate their effort and implement a "USNDP approved site" program with an appropriate identifier.

ANL Deliverables:

Maintain electronic access to the ANL Nuclear Data Measurements ANL/NDM report series web site.
Maintain and upgrade Experimental Resources for Nuclear Data Web site.
Maintain ANL Nuclear Data information Web site.

BNL Deliverables:

Effort required keeping the USNDP and the NNDC site current.

LANL Deliverables:

Include access to new reaction and structure data evaluations, supported by DOE/Nuclear Physics, via the T-16 Web site.
Continue coordination of T-16 site with other USNDP sites.

LBNL Deliverables:

Home pages for nuclear astrophysics, structure and decay systematics, superdeformation, atomic masses, and other topics will be updated and maintained as needed.

ORNL Deliverables:

Maintain, update, and improve the Web FTP site providing the RadWare interface to ENSDF and XUNDL information.

Migrate the server to a faster computer to improve cgi inquiry performance.

TUNL Deliverables:

Add PDF documents of the most recent TUNL reviews (A = 8, 9, 10 to be completed).

Add new PDF documents for earlier Fay Ajzenberg-Selove evaluations based on A = 13 - 15 (76AJ04), A = 16 - 17 (77AJ02), A = 18 - 20 (78AJ03), and A = 5 - 10 (79AJ01).

Continue to provide General Tables to accompany the most recent TUNL reviews of the A = 3 - 20 series; General Tables for A = 8, 9, 10 to be completed to correspond to the review published in *Nuclear Physics A*.

Provide HTML documents with expanded information for individual nuclides found within the TUNL and Fay Ajzenberg-Selove evaluations. HTML documents to be completed for TUNL's A = 8, 9, 10 review, as well as A = 11 - 12 (80AJ01), A = 13 - 15 (81AJ01), A = 16 - 17 (82AJ01), and A = 18 - 20 (83AJ01).

Provide Update Lists for A = 17 and 18 experimental and theoretical level information. Begin work on A = 19 - 20 in order to complete the set of Update Lists on the TUNL website for A = 5 - 20. Continue to revise and add new references to all existing Update Lists on a continuing basis.

Continue to provide scanned versions of earlier Energy Level Diagrams to accompany the PDF and HTML documents for those nuclides.

Continue to add PalmOS applications and databases (begun in 2001) that are of interest to the Nuclear Physics community to the new Palm Pilot page available on the TUNL website

D. <u>APS Link to NNDC Experimental Data Bases</u>

Presently NNDC provides a link from our bibliographic databases to paper abstracts for journals which support this access. For those with subscriptions, the user can then access the complete paper. In cooperation with APS (Ridge), we will provide the ability to go from the Phys. Rev. C abstract/article to the NNDC database (CSISRS or XUNDL) where data mentioned in the publication will be archived.

BNL Deliverables:

System will be in operation for extensive testing.

V. Nuclear Structure Physics

A. NSR Abstract Preparation

The literature search and preparation of KEYWORD abstracts for publications included in NSR require scientific expertise. NNDC staff creates most of the entries with some help from Russia and Japan.

BNL Deliverables:

Prepare entries for 4200 new references with keyword abstracts for 3200.

B. Compilation of Experimental Structure Data

Compilation of currently published or completed experimental nuclear structure data (primarily high-spin) for inclusion in XUNDL.

McMaster Deliverables:

Compile data sets (in ENSDF format) of current publications, primarily in high-spin physics. Selected low-spin publications will also be compiled.
Compile high-spin publications for outdated (older than about 7 years) ENSDF evaluations on a time available basis.
Review compiled data sets submitted by other data centers prior to inclusion in the XUNDL database.

ORNL Deliverables:

Improve software for converting tabular/graphic published level-scheme data in journals and unpublished data supplied by researchers to Radware database into ENSDF format.
Finish debugging code that was recently ported from Fortran to C.

C. Data Evaluation

The USNDP evaluates nuclide and mass chain nuclear structure and decay data for inclusion in the ENSDF database. TUNL has expressed interest in taking responsibility for A=21-30 but funding has not yet been obtained. This would complement the agreement of Canada to assume responsibility for A=31-44 and thereby cover the region formerly evaluated by the Utrecht group. LBNL intends to hire a post doc who will spend 50% of his or her time working on evaluation and 50% on reaction experiments for astrophysics.

ANL Deliverables:

One equivalent mass chain will be evaluated.
One mass chain will be reviewed.

BNL Deliverables:

Three and one-half equivalent mass chains will be evaluated.
At least four mass chains will be reviewed.

Idaho Deliverables:

Complete evaluation of A=159.
Continue evaluation of A=155.
Two mass chains will be reviewed.

LBNL Deliverables:

Four equivalent mass chains will be evaluated.
Mass chains will be reviewed as requested.

McMaster Deliverables:

1.5 equivalent mass chains (including some in the A=31-44 region) will be evaluated. Evaluations for A=39, 80 and 194 are planned.
Mass chains will be reviewed as requested.
Update super-deformed data in ENSDF. All nuclides will be covered that do not require a complete reevaluation.

ORNL Deliverables:

Evaluate A=247 nuclei
Begin to evaluate A=243 nuclei which are connected to A=247 and 239 nuclei via alpha decays

TUNL Deliverables:

Publish *"Energy Levels of Light Nuclei, A* = 8 - 10*"* in *Nuclear Physics A.*
Evaluate and distribute for comment *A* = 11 preliminary version.
Evaluate and distribute for comment *A* = 12 preliminary version.
Submit ENSDF files for *A* = 8 - 10 to correspond with the *Nuclear Physics A* publication.

D. Ground and Metastable State Properties

This is the evaluation of data for the Nuclear Wallet Cards.

BNL Deliverables:

NNDC will include data revisions in the NuDat databases.

E. Radioactive Decay Data Evaluation

Decay data for nuclides of importance for metrology are evaluated in an international collaboration. When complete, these evaluations are entered into the ENSDF format and merged into the ENSDF database. In the United States, LBNL coordinates this project.

ANL Deliverables:

Decay data for ^{177}Lu and ^{177m}Lu will be evaluated.

LBNL Deliverables:

Coordinate and plan activities of this international collaboration
Submit decay datasets for two radionuclides.
Review evaluations of ~5 radionuclides.

Idaho Deliverables:

Decay data for 5 nuclides will be evaluated.

F. Thermal Capture Gamma Data Evaluation

This work is being performed by LBNL as part of an IAEA Coordinated Research Project entitled "Prompt Gamma Activation Analysis." The specific task assigned to LBNL is to evaluate thermal and cold (n,γ) data sets for stable nuclei. A database will be prepared and LBNL will coordinate the CRP evaluation and research efforts.

LBNL Deliverables:

Complete CRP work.
Prepare evaluated data from this CRP in ENSDF format for integration into the ENSDF.

G. Nuclear Structure Data Measurement

LANL/LANSCE maintains a small program to measure nuclear decay information.

LANL Deliverables:

Examine the prompt gamma-ray emission data on ^{181}Ta and ^{197}Au to search for previously unobserved transitions.
Interact with mass chain evaluators on the nuclear structure of these nuclei.

H. ENSDF Physics and Checking Codes

The NNDC maintains ENSDF checking and physics programs on behalf of the national and international evaluator networks. Only maintenance and upgrades for format changes are planned.

BNL Deliverables:

Upgrade RadList and LOGFT to properly treat higher-order (>=3) unique forbidden $\beta^{\pm}$ transitions and to use the Schoenfield electron-capture probabilities.
Begin to implement the "Evaluator's Corner" that will allow ENSDF evaluators remote interactive Web access to ENSDF physics and checking codes.

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 only.

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.

NNDC is responsible for maintaining the manuals describing the EXFOR format and the methods for compiling different kinds of data.

BNL Deliverables:

Compile data from 150 charged-particle and neutron reaction 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, and LLNL will provide neutron, proton and photonuclear reaction data evaluations for ENDF/B-VII.

BNL Deliverables:

Lead international effort (WPEC Subgroup 21) to review the bulk of fission products.

Recommend the best available fission product neutron reaction evaluations for ENDF/B-VII.

LANL Deliverables:

Work with BNL to coordinate upgraded evaluations for new version of ENDF: ENDF/B-VII.

Submit new improved evaluations that will be eventually available in ENDF/B-VII (uranium and plutonium isotopes including improved fission and prompt and delayed neutron information; various nuclides with improved capture cross sections important in astrophysics and neutron dosimetry, and new high-energy (LA150) evaluations as they become available).

Provide ENDF evaluated data files for charged-particle reactions having A<=10.

LLNL Deliverables:

A ^{11}B evaluation will be submitted to NNDC for inclusion in ENDF/B. This submission will require data formatting, testing, and documentation.
Community activities such as refereeing other evaluations and contributing to CSEWG will be performed.

C. ENDF Manuals and Documentation

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

BNL Deliverables:

Complete ENDF-7 formats manual and make it available on Web.

D. Nuclear Reaction Standards

Nearly all nuclear reaction data measurements are made relative to some reaction standard such as the hydrogen elastic cross section. Maintaining accurate current values for the standard cross sections is the objective of this task. The task can be accomplished only through international cooperation. The OECD Nuclear Energy Agency is the umbrella organization for completing the project to update these recommended data. The IAEA has initiated a Coordinated Research Project CRP in support of this activity.

LANL Deliverables:

Participate in international effort to reevaluate the light-element standard cross sections.
Participate in test problems designed to investigate the nature of output covariances from R-matrix analyses of systems containing the light-element standard cross sections.

NIST Deliverables:

Coordinate the international standards activity (NEA Working Party on Evaluation Cooperation Subgroup 7) and chair the IAEA CRP on the Improvement of the Standard Cross Sections.
Examine the methodology for performing a comprehensive standards evaluation.
Recommend new measurements to support the standards effort.
Review discrepant experimental data with the highest impact.
Collaborate with Ohio University and LANL in the measurement of hydrogen elastic angular distributions; complete the 15 MeV measurements.

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 LANL code development work will be coordinated with the proposed LLNL work. The collaboration will include intercomparison of results, validation of model with experimental data and development of new physics modules. The TUNL pre-compound code will be incorporated into the LANL code. Measurements made by ANL and LANL along with other measurements made with DOE low-energy physics funds (e.g., Grimes, Becker and others) will play a crucial role in the validation of the models in these computer codes.

ANL – Analysis of neutron activation cross section data measured at IRMM, Geel, Belgium, will continue. Final results will be archived in the EXFOR system and special evaluations will be prepared for inclusion in ENDF/A, where possible.

ANL Deliverables:

The experimental data will be submitted in EXFOR format to the NNDC.
Completed evaluations for some of these reactions will be performed and the results submitted to the NNDC for inclusion in ENDF/A.
A study of nuclear model parameter sensitivities will be continued under the auspices of the Nuclear Energy Agency Working Party for Evaluation Cooperation (WPEC) in collaboration with scientists in Belgium, Hungary, and Romania.

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 develop a new version of this code to provide a state-of-the-art capability to predict reaction cross sections. This task also involves a close collaboration between the T16 and the LANSCE program to interpret new measurements using the GEANIE γ-ray detector, as well as (n,charged-particle) data, resulting in advances in our understanding of nuclear reaction mechanisms, as well as improvements in our modeling codes. In addition, we will continue to modernize the EDA R-matrix code used for light nucleus data evaluation.

Neutron-induced reactions provide insights into nuclear level densities. With the continuous-in-energy neutron source at LANSCE/WNR, we investigate the effect of nuclear level densities in three ways by measuring: (1) particle emission spectra (both light charged particles and neutrons); (2) excitation functions of cross sections as a function of incident neutron energy; (3) prompt gamma rays that indicate the angular momentum distribution of states populated in compound nuclear reactions.

LANL Deliverables:

Continue development of McGNASH, our improved version of the GNASH Hauser-Feshbach code, using Fortran90 and modern coding practices, with numerous improved physics packages, particularly: level densities, preequilibrium reactions, transmission coefficients, and γ-ray strength functions. Include a Monte-Carlo option. (Note that this is highly leveraged with support from DOE/DP). Collaborate with LLNL and with the NEA WPEC on code validation.

Calculate and interpret γ-ray reactions measured with GEANIE at LANSCE, including n+^{89}Y and n+^{193}Ir reactions producing far-from-stability products, and reactions in competition with fission of ^{235,238}U.

Calculate prompt fission neutron spectrum matrix for the n + 238-U system with the Los Alamos model, and collaborate with LANSCE experimentalists on new measurements for this system.

Focus on the interpretation of nuclear reactions on (and producing) unstable nuclides and isomers, a current thrust of interest in the international nuclear physics community.

Complete analysis of LANSCE data for neutron interactions with ^{56}Fe and ^{58,60}Ni including both charged-particle emission and prompt gamma-ray production with the goal of testing nuclear level density theories and providing cross sections.

Complete analysis of ^{59}Co(n,xγ) data to complement our previous (n,xα) studies.

Obtain information on nuclear level densities near A=90 through (n,n'γ) reactions.

Analyze data to investigate the effect of pre-equilibrium reactions on both (n,charged particle) and (n,xγ) reactions.

Complete analysis of gamma-ray production from ^{181}Ta and ^{197}Au.

Work with S. Grimes and colleagues on neutron-induced charged particle emission cross sections, in particular for sulfur and calcium.

LLNL --We are developing a suite of reaction modeling codes that will be suitable for investigating processes involving reactions on unstable targets, such as encountered in astrophysics, radioactive ion beam physics, and other applications. A new Hauser-Feshbach code using object-oriented programming techniques is being developed. These techniques eliminate the need for fixed dimensions within the program and will facilitate incorporation of special features, such as isospin conservation and nonstandard forms for level densities. The code is being written in ANSI/ISO standard C++.

LLNL Deliverables:

Second version of software will be made available to the nuclear physics community through ftp download. This release will incorporate fission as a reaction channel.

TUNL – Development of preequilibrium nuclear reaction models. Work will include improvement and benchmarking of the computer code PRECO, extending code validity to higher incident energies for nucleon induced reactions (emphasis on effective matrix element systematics) and/or improvements to the code functionality as requested by users (increasing stand-alone capabilities and simplifying interfacing with Hauser-Feshbach codes). Specific work to be undertaken will be guided by ongoing user input.

TUNL Deliverables:

Updated version of PRECO, possibly with updated formal release.
Submit a journal article describing benchmarking up to 100 MeV.
Collect data from the literature for (N,xN) reactions up to 200 MeV.

F. Nuclear Reaction Data Measurements

LANL -- The nuclear data for fission products are important for a number of applications. This task is related to the evaluation activity described in Section VI.B.

LANL Deliverables:

Complete the experiment and analysis of prompt gamma-ray emission following interactions of fast neutrons with 99Tc.
Measure prompt gamma rays from neutron interaction with at least one other fission product with the goal of deducing partial reaction cross sections.
Consult with evaluators on neutron interactions with fission products.

LBNL -- Members of the Isotopes Project may spend a portion of their time working on experiments in the area of low energy nuclear physics. In the coming year, we plan to increase our activities in the area of experiments related to needs of nuclear data, particularly in the area of nuclear astrophysics.

LBNL Deliverables:

Measure (α,γ) cross section on nuclides with A>100.

G. Evaluation of Data Needed for Astrophysics

The objective of this activity is to support the nuclear data needs of the increasingly sophisticated nuclear astrophysics universe modeling. The Astrophysics Task Force of the USNDP, presently chaired by Michael Smith (ORNL) plans, initiates and implements cooperative nuclear data evaluation activities which involve the nuclear data and the nuclear astrophysics communities.

ANL – Information on sulfur (p,γ) and (p,α) reactions will be compiled and made available to the NNDC. A report on this activity will be issued in the ANL/NDM series.

ANL Deliverables:

Data will be compiled and documented for all stable sulfur (p,α) reactions.
Data will be compiled and documented for the $^{33,34,36}S(p,\gamma)$ reactions.

BNL – In support of the increasingly sophisticated nuclear data needs for astrophysics, NNDC has initiated a project to compile and evaluate alpha-induced nuclear reaction cross sections for astrophysics. The work will focus on nuclei $8 < Z < 32$ and alpha particles with the incident energy below 20 MeV. These reactions, important in the helium burning stage of stars, novae, and supernovae events, include (α,α), (α,n), (α,p) and (α,γ) reaction channels. Of particular interest are reactions leading to production and destruction of ^{44}Ti. Based upon thorough compilation of data including reactions and structural information, critical analysis of the data will be done, and related cross sections and reaction rates will be evaluated.

BNL Deliverables:

Complete evaluation of reactions ^{40}Ca(α,γ) and ^{40}Ca(α,p) below 20 MeV.
Create Web site containing these evaluations along with updated decay and structure data.

LANL -- Participate in 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 Dissemination Working Group.

LANL Deliverables:

Develop folded Yukawa macroscopic-microscopic code to include axial-asymmetry shape-degree of freedom, for fission barriers important in "termination of r-process", and calculate shape-isomer properties.
Use beta-decay code with new first-forbidden capability to calculate and compile half-lives and beta-delayed neutron emission probabilities important in nucleosynthesis.
Extend N-N analysis to higher energies and provide evaluated n-p data.
Perform analyses of other processes important to Big Bang Nucleosynthesis, and provide S-factors and reaction rates.
Continue to contribute to the TUNL Energy Levels of Light Nuclei project.
Continue analyses of reactions involving radioactive light isotopes, including ^{17}F+p, and possibly other reactions being measured at ORNL.

ORNL -- Evaluate capture reactions on radioactive proton-rich nuclei which are important for element synthesis and energy generation in stellar explosions. Evaluate capture reactions important for understanding Red Giant Stars. Evaluate reactions important for nuclear burning in the interior of the sun.

ORNL Deliverables:

Complete evaluations of proton capture on ^{18}F and ^{17}O.
Continue analysis of solar thermonuclear reaction rate evaluations.
Continue assessments of capture reactions on proton-rich radioactive nuclei.

H. Reaction Data for RIA Target Design

Rare Isotope Accelerator facility design needs high-quality nuclear reaction data for target design, and facility design. The RIA R&D committee has recently endorsed official LANL collaboration in order to provide key reaction cross-sections using theory calculations and measurements to evaluate the data.

LANL Deliverables:

Work closely with RIA community to determine nuclear data needs for RIA target design.

Develop spallation and fission models in intranuclear cascade models and codes (CEM).

Benchmark & validate new LANL isospin-dependent global relativistic Schrodinger optical model

Activities Funded from Sources Outside the Nuclear Data Program

The information here is not complete. The information is not required but is included here to show some examples of related external funding for those organizations that are mostly funded by the U.S. Nuclear Data program.

BNL -- Produce computer-generated photoready copy for the Nuclear Data Sheets with support from Academic Press.

McMaster – Receives 0.5 FTE support from the Canadian research agency to evaluate A-chains/nuclides for ENSDF and to train/supervise summer students for compilation of experiments nuclear data for XUNDL.

NIST -- The Department of Commerce through NIST supports the standards activity.

USNDP Staffing Table for October 2002 through Septemper 2003

	ANL	BNL		Idaho	LANL	LBNL	LLNL
		Sci/Pro	Support				
I. NNDC Facility Operation	**0.00**	**1.20**	**1.25**	**0.00**	**0.00**	**0.00**	**0.00**
Management		0.40					
Secretarial/Administrative Support			1.00				
Library			0.25				
Computer Operation		0.80					
II. Coordination	**0.05**	**0.50**	**0.00**	**0.00**	**0.50**	**0.30**	**0.00**
National Coordination	0.05	0.30			0.2	0.3	
International Coordination		0.20			0.3		
III. Nuclear Physics Databases	**0.00**	**3.25**	**1.05**	**0.00**	**0.00**	**0.00**	**0.00**
Nuclear Science References (NSR)		0.15	0.75				
Experimental Nuclear Structure Data (XUNDL)		0.05					
Evaluated Nuclear Structure Data (ENSDF)		0.45	0.30				
Numerical Nuclear Data (NuDat)		0.05					
Reaction Data Bibliography (CINDA)		0.05					
Experimental Reaction Data (CSISRS)		0.05					
Evaluated Nuclear Data File (ENDF)							
Database Software Maintenance		0.35					
Future Database Systems		2.10					
IV. Information Dissemination	**0.05**	**0.80**	**0.50**	**0.00**	**0.10**	**0.35**	**0.00**
Maintenance of Remote Access to USNDP Data		0.40					
Telnet Service		*0.05*					
WWW Service		*0.35*					
Customer Services		0.15	0.45				
Web Site Maintenance	0.05	0.15	0.05		0.10	0.35	
APS Link to NNDC Experimental databases		0.10					

USNDP Staffing Table for October 2002 through Septemper 2003

	McMaster	NIST	ORNL	TUNL		Program Total	
			Sci/Pro			Sci/Pro	Support
I. NNDC Facility Operation	**0.00**	**0.00**	**0.00**	**0.00**		**1.20**	**1.25**
Management						0.40	0.00
Secretarial/Administrative Support						0.00	1.00
Library						0.00	0.25
Computer Operation						0.80	0.00
II. Coordination	**0.05**	**0.00**	**0.00**	**0.00**		**1.40**	**0.00**
National Coordination	0.05					0.90	0.00
International Coordination						0.50	0.00
III. Nuclear Physics Databases	**0.00**	**0.00**	**0.00**	**0.00**		**3.25**	**1.05**
Nuclear Science References (NSR)						0.15	0.75
Experimental Nuclear Structure Data (XUNDL)						0.05	0.00
Evaluated Nuclear Structure Data (ENSDF)						0.45	0.30
Numerical Nuclear Data (NuDat)						0.05	0.00
Reaction Data Bibliography (CINDA)						0.05	0.00
Experimental Reaction Data (CSISRS)						0.05	0.00
Evaluated Nuclear Data File (ENDF)						0.00	0.00
Database Software Maintenance						0.35	0.00
Future Database Systems						2.10	0.00
IV. Information Dissemination	**0.00**	**0.00**	**0.05**	**1.40**		**2.75**	**0.50**
Maintenance of Remote Access to USNDP Data						0.40	0.00
Telnet Service						*0.05*	*0.00*
WWW Service						*0.35*	*0.00*
Customer Services						0.15	0.45
Web Site Maintenance			0.05	1.40		2.10	0.05
APS Link to NNDC Experimental databases						0.10	0.00

USNDP Staffing Table for October 2002 through Septemper 2003

	ANL	BNL		Idaho	LANL	LBNL	LLNL
		Sci/Pro	Support				
V. Nuclear Structure Physics	**0.75**	**2.20**	**0.00**	**0.50**	**0.10**	**2.60**	**0.00**
NSR Abstract Preparation		0.55					
Compilation of Experimental Structure Data							
Evaluation of data for ENSDF	0.75	1.50		0.50		2.60	
Masses and Nuclides	*0.70*	*1.40*		*0.40*		*1.75*	
Ground and Metastable State Properties		*0.10*					
Radioactive Decay Data Evaluation	*0.05*			*0.10*		*0.30*	
Thermal Capture Gamma Data Evaluation						*0.55*	
Nuclear Structure Data Measurement					0.10		
ENSDF Physics and Checking Codes		0.15					
VI. Nuclear Reaction Physics	**0.25**	**0.75**	**0.00**	**0.00**	**1.60**	**0.80**	**0.40**
Experimental Data Compilation	0.00	0.30					
Neutron Data		*0.05*					
Charged Particle Data		*0.20*					
EXFOR Manuals		*0.05*					
Evaluation of Fission Product Nuclides		0.25					
ENDF Manuals and Documentation							
ENDF Evaluations					0.10		0.20
Nuclear Reaction Standards							
Nuclear Model Development	0.10				0.65		0.20
Nuclear Reaction Data Measurements					0.35	0.80	
Astrophysics Nuclear Data Needs	0.15	0.20			0.30		
Reaction Data for RIA Target Design					0.20		
DOE/Science Nuclear Data Funded Staff	**1.10**	**8.70**	**2.80**	**0.50**	**2.30**	**4.05**	**0.40**
Staff Supported by Other Funding		**0.05**	**0.20**				

USNDP Staffing Table for October 2002 through Septemper 2003

	McMaster	NIST	ORNL	TUNL		Program Total	
						Sci/Pro	Support
V. Nuclear Structure Physics	**0.45**	**0.00**	**0.55**	**1.40**		**8.55**	**0.00**
NSR Abstract Preparation						0.55	0.00
Compilation of Experimental Structure Data	0.10		0.05			0.15	0.00
Evaluation of data for ENSDF	0.35		0.50	1.40		7.60	0.00
Masses and Nuclides	*0.35*		*0.50*	*1.40*		*6.50*	*0.00*
Ground and Metastable State Properties						*0.10*	*0.00*
Radioactive Decay Data Evaluation						*0.45*	*0.00*
Thermal Capture Gamma Data Evaluation						*0.55*	*0.00*
Nuclear Structure Data Measurement							
ENSDF Physics and Checking Codes						0.15	0.00
VI. Nuclear Reaction Physics	**0.00**	**0.20**	**0.45**	**0.40**		**4.85**	**0.00**
Experimental Data Compilation						0.30	0.00
Neutron Data						*0.05*	*0.00*
Charged Particle Data						*0.20*	*0.00*
EXFOR Manuals						*0.05*	*0.00*
Evaluation of Fission Product Nuclides						0.25	0.00
ENDF Manuals and Documentation						0.00	0.00
ENDF Evaluations						0.30	0.00
Nuclear Reaction Standards		0.20				0.20	0.00
Nuclear Model Development				0.40		1.35	0.00
Nuclear Reaction Data Measurements							
Astrophysics Nuclear Data Needs			0.45			1.10	0.00
Reaction Data for RIA Target Design						0.20	0.00
DOE/Science Funded Staff	**0.50**	**0.20**	**1.05**	**3.20**		**22.00**	**2.80**
Staff Supported by Other Funding	**0.50**	**0.80**	**0.00**	**0.00**		**1.35**	**0.20**

Work Plan for FY2003

Argonne National Laboratory

The format of the present work plan is based on the similar documents prepared for FY2001 and FY2002. Only those items that pertain to the Argonne activities are shown in each section below:

Work Plan Tasks and Deliverables

II. Coordination

A. National Coordination

ANL – Lead Measurement and Basic Physics Committee of the Cross Section Evaluation Working Group and represent U.S. measurement interests in the NEA Working Party for Evaluation Cooperation.

ANL Deliverables:
Chair meeting of the Cross Section Evaluation Working Group.
Provide Measurement and Basic Physics Committee report for CSEWG.
Compile U.S. contributions to NEA High Priority Request List.

IV. Information Dissemination

C. Web Site Maintenance

ANL – Provide scientists and engineers with electronic access to the ANL Nuclear Data Measurements (ANL/NDM) report series, Experimental Resources for Nuclear Data, and ANL Nuclear Data information Web sites.

ANL Deliverables:
Maintain ANL/NDM report series web site.
Maintain and upgrade Experimental Resources for Nuclear Data Web site.
Maintain ANL Nuclear Data information Web site.

V. Nuclear Structure Physics

C. Data Evaluation

ANL – Evaluation of nuclide and mass chain nuclear structure and decay data for

inclusion in the ENSDF database.

ANL Deliverables:

One equivalent mass chain will be evaluated.
One mass chain will be reviewed.

E. Radioactive Decay Data Evaluation

ANL – Evaluation of radioactive decay data for nuclides that are important for various applications and metrology.

ANL Deliverables:

Decay data for ^{177}Lu and ^{177m}Lu will be evaluated.

VI. Nuclear Reaction Physics

E. Nuclear Model Development

ANL – Analysis of neutron activation cross section data measured at IRMM, Geel Belgium, will continue. Final results will be archived in the EXFOR system and special evaluations will be prepared for inclusion in ENDF/A, where possible.

ANL Deliverables:

The experimental data will be submitted in EXFOR format to the NNDC.
Completed evaluations for some of these reactions will be performed and the results submitted to the NNDC for inclusion in ENDF/A.
A study of nuclear model parameter sensitivities will be continued under the auspices of the Nuclear Energy Agency Working Party for Evaluation Cooperation (WPEC) in collaboration with scientists in Belgium, Hungary, and Romania.

F. Evaluation of Data Needed for Astrophysics

ANL – Information on sulfur (p,γ) and (p,α) reactions will be compiled and made available to the NNDC. A report on this activity will be issued in the ANL/NDM series.

ANL Deliverables:

Data will be compiled and documented for all stable sulfur (p,α) reactions.
Data will be compiled and documented for the ^{33,34,36}S(p,γ) reactions.

APPENDIX

Argonne National Laboratory

Program Administration

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Program Technical Overview

The Nuclear Data Program at Argonne National Laboratory during FY2003 will amount to 1.1 FTE and will consist of five components:

1. National Coordination activities (0.05 FTE)

ANL will lead the Measurements and Basic Physics Committee of the Cross Section Evaluation Working Group and represent U.S. measurement interests in the NEA Working Party for Evaluation and Cooperation.

2. Information Dissemination activities (0.05 FTE)

ANL will continue to develop, update, and maintain the ANL Nuclear Data Measurement Report Series and ANL Nuclear Data Information Web sites. Special attention will be paid to the Experimental Resources for Nuclear Data Web site. It will be significantly upgraded in coordination with the USNDP Dissemination Working Group.

3. Evaluation of Nuclear Structure and Decay Data (0.75 FTE)

ANL will continue to contribute to the International Nuclear Structure and Decay Data Network activities by compiling and evaluating data for selected mass chains and individual nuclides. ANL has a desire to take responsibility for A=175-185 on a permanent basis, given the significant expertise and continuous scientific interest of the evaluator in this mass region. A review of selected evaluations submitted by members of NSDD network for publication will also be performed, as requested by the editor of the journal *Nuclear Data Sheets*. It is planned to submit one decay dataset to the Chairman of the Decay Data Evaluation Project. A special (horizontal) evaluation of properties of nuclear isomeric states that are of interest to the nuclear structure and applied physics

communities will be performed in collaboration with scientists from the ANL Physics Division, Australian National University, Australia, and University of Surrey, U.K. When completed, the data will be included in ENSDF and the corresponding results published on the USNDP Web resources in coordination with the USNDP Dissemination Working Group. A journal article is also anticipated upon completion of the project. It is planned to continue activities in the area of experimental nuclear physics related to the need of nuclear data, particularly in the areas of nuclear structure, decay, and RIA issues. The experimental activities will be carried out at the ANL Physics Division, as well as at other national low-energy nuclear physics facilities at little or no cost to the Argonne nuclear data participant. The results of this work will be documented in refereed journal articles and laboratory reports. These will be also made available to the members of the NSDD network for inclusion in ENSDF. It is planned to present a lecture at the IAEA sponsored workshop on nuclear structure and decay data evaluation at ICTP, Trieste, and to attend the 2003 Advisory Group Meeting on Co-ordination of the International Network of Nuclear Structure and Decay Data Evaluators at McMaster University, Hamilton, Ontario, Canada.

4. Nuclear Model Development (0.10 FTE)

It is widely acknowledged that nuclear modeling will continue to play an expanding role in the development of nuclear data for various applications. It is simply not possible to measure all the physical quantities needed. Physics and cost limitations prevent that from happening. However, nuclear models are just that – models. It is impossible to incorporate fundamental physics into the codes to a degree sufficient to insure a priori that calculated results will be sufficiently reliable to meet the needs. Therefore, it is necessary to use parameters and to validate the calculations by comparisons with data wherever possible. It has been observed that calculations of nuclear reaction cross sections in the energy range 15-20 MeV are strongly dependent on nuclear model parameters, especially nuclear level densities. Consequently, a strong database of experimental reaction cross-section data in this energy range can be extremely valuable for model validation. Argonne has joined with scientists in Europe, especially at IRMM, Geel, Belgium to generate such a database. Experiments are performed in Belgium at little or no cost to the U.S. Argonne participates in these experiments and in the analysis of data. The work is coordinated under the auspices of the Nuclear Energy Agency WPEC organization. Experimental results from this activity are compiled in the EXFOR system once they become available. Special evaluations of cross sections for inclusion in ENDF/A are undertaken, where possible.

5. Evaluation of Data Needed for Astrophysics (0.15 FTE)

Argonne is involved in compiling and evaluating charged particle reaction data in the mass range A=30-50 with the intent that these results be used for the determination of astrophysical reaction rates. In particular, these reactions are important for analysis of explosive nucleosynthesis in nova and supernova environments.

23 January 2002

Idaho Evaluators

Work for U. S. Nuclear Data Program

Responsibilities and Activities for FY2003

R. G. Helmer and C. W. Reich

	FTE
Evaluation responsibilities: masses 87, 153-163	
FY2003 evaluations: complete A=159 and continue work on 155	0.35
Review evaluations from other groups	
Review two mass chain evaluations when requested	0.05
Decay Data Evaluation Project	
Evaluate data for the decay of five radionuclides	0.10
TOTAL	0.50

LANL Group T-16 FY2003 Work Plan for US Nuclear Data Program (USNDP)

(02/04/02)

	Description	Effort (FTEs)
1	USNDP Reaction Working Group Organization	0.1
2	Nuclear Physics ENDF Database	0.1
3	Astrophysics Reaction Data	0.3
4	Reaction data for RIA Target Design	0.2
5	Model code development, and reaction theory studies at LANSCE and GEANIE	0.3
6	WWW Dissemination of nuclear data	0.1
7	International nuclear data cooperation	0.1
8	Publications	
		Total=1.2

1. USNDP Reaction Working Group Organization (0.1 FTE)

Chair US Nuclear Data Program's Reaction Working Group, and help coordinate reaction data work at different labs to advance USNDP goals. Member of USNDP Steering Committee. Chair of Evaluation Committee of the Cross Section Evaluation Working Group.

Deliverables:

Organize and chair CSEWG Evaluation Committee meeting at BNL, Nov 2002
Organize and chair Reaction Working Group meeting at USNDP meeting, April 2003.

2. Nuclear Physics ENDF Database (0.1 FTE)

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, work with BNL to ensure quality control, particularly for new evaluations. We will also submit new evaluations listed below (funded primarily from other sources) for archival in ENDF/B. We will coordinate the evaluation effort to upgrade reaction cross section evaluations for ENDF/B-VII, a major new release anticipated in 2004-5.

Deliverables:

Organize/Participate in international effort to reevaluate the light-element standard cross sections.
Participate in test problems designed to investigate the nature of output covariances from R-matrix analyses of systems containing the light-element standard cross sections.
Work with BNL to coordinate upgraded evaluations for new version of ENDF: ENDF/B-VII
Submit new improved evaluations that will be eventually available in ENDF/B-VII (uranium and plutonium isotopes including improved fission and prompt and delayed neutron information; various nuclides with improved capture cross sections important in astrophysics and neutron dosimetry, and new high-energy (LA150) evaluations as they become available)
Provide ENDF evaluated data files for charged-particle reactions having A<=10.

3. Astrophysics Reaction Data (0.3 FTE)

Participate in 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 Dissemination Working Group.

Deliverables:

Develop folded Yukawa macroscopic-microscopic code to include axial-asymmetry shape-degree of freedom, for fission barriers important in "termination of r-process", and calculate shape-isomer properties.

Use beta-decay code with new first-forbidden capability to calculate and compile half-lives and beta-delayed neutron emission probabilities important in nucleosynthesis.

Extend N-N analysis to higher energies and provide evaluated n-p data.

Perform analyses of other processes important to BBN, and provide
S-factors and reaction rates.

Continue to contribute to the TUNL Energy Levels of Light Nuclei project.

Continue analyses of reactions involving radioactive light isotopes, including 17F+p, and possibly other reactions being measured at ORNL.

4. Reaction Data for RIA target design (0.2 FTE)

The RIA R&D committee has recently endorsed official LANL collaboration. A Rare Isotope Accelerator facility design needs high-quality nuclear reaction data for target design, and facility design. We have worked with ORNL and ANL researchers to provide key reaction cross sections, using theory calculations and measurements to evaluate the data, and will continue to address their needs in the future.
Deliverables:

Work closely with Nuclear Physics RIA community to determine nuclear data needs for RIA target design, and support these needs.

Develop spallation and fission models in intranuclear cascade models and codes (CEM).

Benchmark & validate new LANL isospin-dependent global relativistic Schrodinger optical model

5. Model code development, and reaction theory studies at LANSCE and GEANIE (0.3 FTE)

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, McGANSH, to provide a state-of-the-art capability to predict reaction cross sections. This also involves a close collaboration with experimentalist at LANSCE (R.C. Haight, M. Devlin, J.A. Becker, S.M. Grimes) to interpret new measurements using the GEANIE gamma-ray detector, as well as (n,charged-particle) data, resulting in advances in our understanding of nuclear reaction mechanisms, as well as 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.

Deliverables:

Continue development *of McGNASH*, our improved version of the *GNASH* Hauser- Feshbach code, using Fortran90 and modern coding practices, with numerous improved physics packages, particularly: level densities, preequilbrium reactions, transmission coefficients, and gamma-ray strength functions. Include a Monte-Carlo option. (Note, this is highly-leveraged with support from DOE/DP). Collaborate with LLNL, and with NEA working party group, on benchmark validation tests. Calculate and interpret gamma-ray reactions measured with GEANIE at LANSCE, including n+^{89}Y, n+^{193}Ir reactions producing unstable products and isomers, and reactions in competition with fission (particularly ^{238}U).

Calculate prompt fission neutron spectrum matrix for the n + 238-U system with the Los Alamos model, and collaborate with LANSCE experimentalists on new measurements for this system.

Focus on the interpretation of nuclear reactions on (and producing) unstable nuclides and isomers, a current thrust of interest in the international nuclear physics community.

6. WWW Dissemination of nuclear data (0.1 FTE)

Continue to develop our T-2 Online Nuclear Information Service, for convenient and wide access to our nuclear modeling research, data evaluations, and publications. Develop this WWW site in coordination with the USNDP Dissemination working Group.

Deliverables:

Include access to new reaction and structure data evaluations, supported by DOE/ Nuclear Physics, via the T-2 WWW site
Continue coordination of T-2 WWW site with other USNDP sites

7. International nuclear data cooperation (0.1 FTE)

Participate in, and chair, international nuclear reaction data collaborations. This ensures that the US benefits from breakthroughs around the world, and plays a leadership role in new developments. We chair NEA committees in fission spectra, and international model code development cooperation; and chair IAEA coordinated research program on reference input model parameters (RIPL). Host a couple of high-quality foreign scientist to visit LANL to undertake USNDP work, to benefit from collaborative exchanges of information and ideas.

Deliverables:

Continue organization of the major international nuclear data conference (ND2004), to be held in Santa Fe, September 2004.
Participate in NEA June 2003 meeting
Participate in relevant IAEA meetings, including Trieste Lectures
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

8. Publications

We will document our work in refereed journal articles and laboratory reports.

LANL Group LANSCE-3 FY2003 Work Plan for US Nuclear Data Program (USNDP)

(02/13/02)

	Description	Effort (FTEs)
1	USNDP Reaction Working Group Organization	0.2
2	Experiments relevant to nuclear level densities	0.3
3	Experiments relating to nuclear structure	0.1
4	Experiments relevant to nuclear data for fission products	0.3
5	International nuclear data cooperation	0.1
6	Publications	
		Total=1.0

9. USNDP Reaction Working Group Organization (0.2FTE)

Participate in US Nuclear Data Program's Reaction Working Group and Cross Section Evaluation Working Group.

Deliverables:

Participate in USNDP Reaction Working Group and CSWEG meetings
Prepare for hosting International Conference on Nuclear Data for Science and Technology in 2004 in Santa Fe

10. Experiments relevant to nuclear reaction cross sections and nuclear level densities (0.3 FTE)

Neutron-induced reactions provide insights into nuclear level densities. With the continuous-in-energy neutron source at LANSCE/WNR, we investigate the effect of nuclear level densities in three ways by measuring: (1) particle emission spectra (both light charged particles and neutrons); (2) excitation functions of cross sections as a function of incident neutron energy; (3) prompt gamma rays that indicate the angular momentum distribution of states populated in compound nuclear reactions.

Deliverables:

Complete analysis of LANSCE data for neutron interactions with ^{56}Fe and ^{58,60}Ni including both charged-particle emission and prompt gamma-ray production with the goal of testing nuclear level density theories and providing cross sections
Complete analysis of ^{59}Co(n,xgamma) data to complement our previous (n,xalpha) studies.
Obtain information on nuclear level densities near A=90 through (n,n'gamma) reactions.
Analyze data to investigate the effect of pre-equilibrium reactions both on (n,charged particle) and (n,xgamma) reactions.
Complete analysis of gamma-ray production from ^{181}Ta and ^{197}Au.
Work with S. Grimes and colleagues on neutron-induced charged particle emission cross sections, in particular for sulfur and calcium.

11. Experiments relating to nuclear structure (0.1 FTE)

Deliverables:

Examine the prompt gamma-ray emission data on ^{181}Ta and ^{197}Au to search for previously unobserved transitions.

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

12. Experiments relevant to nuclear data for fission products (0.3 FTE)

Deliverables:

Complete the experiment and analysis of prompt gamma-ray emission following interactions of fast neutrons with 99Tc.

Measure prompt gamma rays from neutron interaction with at least one other fission product with the goal of deducing partial reaction cross sections.

Interact with evaluators on neutron interactions with fission products.

13. International nuclear data cooperation (0.1 FTE)

Deliverables:

Host visitors to LANSCE to collaborate on experiments, make intercomparisons of data obtained at LANSCE and the various foreign laboratories.

Participate in IAEA activities as appropriate.

Prepare for hosting International Conference on Nuclear Data for Science and Technology in 2004 in Santa Fe

14. Publications

We will document our work in refereed journal articles and laboratory reports.

ISOTOPES PROJECT NUCLEAR STRUCTURE AND DECAY EVALUATION

The Isotopes Project's plans for FY2003 include a mix of individual nuclide and entire mass chain evaluations chosen from those for which LBNL has been assigned responsibility. The former are particularly effective in enabling the prompt inclusion in ENSDF of major new data for nuclides on which current research activities are centered. The latter, however, provide a comprehensive view of the nuclear systematics of isobars. In addition, Isotopes Project personnel will continue to play a leadership role in two international collaborations. These are concerned with evaluation of radioactive decay data (with emphasis on decays having specific astrophysical interest), and a systematic evaluation of nuclear structure aspects of (thermal/cold n,γ) data. Each was undertaken in response to current research community needs. Also, Isotopes Project personnel will continue to participate in the review of other data evaluations submitted to NNDC. The anticipated level of effort for the above activities is 2.28 FTE from LBNL employees (including 0.5 FTE from the post-doc we plan to hire in FY'03) plus 0.3 FTE from visiting evaluators.

- **Mass Chain and Nuclide Evaluation:**
  4 mass chain equivalents chosen from LBNL responsibility areas

- **Mass Chain Reviews:**
  Provide reviews of mass chains as needed.

Effort for above items: 1.75 FTE (which includes 0.3 FTE from visitors)

- **Leadership of (thermal/cold n,γ) Horizontal Evaluation:**

This three-year IAEA CRP for Prompt Gamma Activation Analysis covers the evaluation of isotopic and elemental (thermal/cold n,γ) data to develop an adopted capture γ ray database; a database will be prepared and LBNL will coordinate the CRP evaluation and research efforts.

- Complete CRP work.
- Prepare evaluated data from this CRP in ENSDF format for integration into the ENSDF file in a manner to be determined by the USNDP.

Effort: 0.55 FTE

- **Leadership of Decay Data Evaluation Project (DDEP): Nuclear and Atomic Radiations:**
  - Coordinate and plan activities of this international collaboration
  - Review evaluations of ~5 radionuclides.
  - Submit decay datasets for two radionuclides.

Effort: 0.28 FTE

ISOTOPES PROJECT ELECTRONIC DISSEMINATION

We are planning to continue nuclear data dissemination efforts with a view to providing scientists and engineers throughout the world with user-friendly means to access the wide variety of evaluated and compiled nuclear data. This work will be done with 0.35 FTE LBNL staff (including 0.1 FTE from post-doc yet to be hired) in collaboration with EVITech**.**

- **WWW Home Pages**
  Home pages for nuclear astrophysics, structure and decay systematics, superdeformation, atomic masses, and other topics will be updated and maintained as needed.

Effort: 0.35 FTE

EXPERIMENTAL ACTIVITIES

Members of the Isotopes Project have always been encouraged to spend a portion of their time working on experiments in the area of low energy nuclear physics. In the coming year, we plan to increase our activities in the area of experiments related to needs of nuclear data, particularly in the area of nuclear astrophysics. We intend to hire a post doc who will spend 50% of his or her time working on experiments. We are planning to perform a series of (α,γ) cross section measurements on nuclides with $A>100$.

Effort: 0.8 FTE (includes 0.5 FTE from post-doc yet to be hired)

ISOTOPES PROJECT MANAGEMENT

The group leader of the Isotopes Project works 30% of his time on USNDP activities. He is the leader of the USNDP Working Group on Data Dissemination, and serves as an ex-officio member of the USNDP Steering Committee. He oversees, coordinates, and directs the work of members of the Isotopes Project. This effort includes working with LBNL management, with other members of the USNDP, and with the program officers of the DOE.

Effort: 0.3 FTE

Lawrence Livermore National Laboratory

Work Plan for FY2003

LLNL provides nuclear reaction data and models to US Department of Energy nuclear physics communities through the Evaluated Nuclear Data File/B (ENDF/B) which is distributed by the National Nuclear Data Center (NNDC) at Brookhaven National Laboratory. This nuclear reaction data and modeling activity leverages LLNL's active effort to provide nuclear data for stockpile stewardship, in order to serve other US DOE nuclear physics communities.

This FY03 work plan builds on LLNL efforts in:

- Developing a suite of modular nuclear reaction codes for modern code developers
- Reaction modeling and data evaluation for reactions on ^{11}B

Modular nuclear reaction codes

We continue to develop a suite of reaction modeling codes that will be suitable for investigating processes involving reactions on unstable targets, such as encountered in astrophysics, radioactive ion beam physics, and other applications. A new Hauser-Feshbach code using object-oriented programming techniques is being developed. These techniques eliminate the need for fixed dimensions within the program and will facilitate incorporation of special features, such as isospin conservation and nonstandard forms for level densities. The code is being written in ANSI/ISO standard C++.

Deliverable: Second version of software will be made available to the nuclear physics community through ftp download. This release will incorporate fission as a reaction channel.

Effort: 0.2 FTE

Data evaluations

LLNL strives to be an active member of the ENDF/B community providing high-quality nuclear data for applications. Neutron cross section measurements and DWBA calculations on ^{11}B will ongoing in FY03 for stockpile stewardship. This data and calculations will be incorporated into a new evaluation. LLNL will also participate in community activities including refereeing other evaluators and contributing to the Cross Section Evaluation Working Group (CSEWG).

Deliverable: The ^{11}B evaluation will be submitted to NNDC for inclusion in ENDF/B. This submission will require data formatting, testing, and documentation. Community activities such as refereeing other evaluations and contributing to CSEWG will be performed.

Effort: 0.2 FTE

2003FY (Oct 1, 2002 to Sept 30, 2003) WORK PLAN FOR DATA EVALUATION (MCMASTER UNIVERSITY)

(Submitted by B. Singh, January 28, 2002)

Coordination (National / International):

McMaster Deliverables:

Organize USNDP and NSDD (IAEA) meetings in May 2003.
(0.05 FTE).

Nuclear Structure Physics:

Compilation of Experimental Structure Data:

Compilation of currently published or completed experimental nuclear structure data for inclusion in the XUNDL database.
(0.10 FTE)

McMaster Deliverables:

Compile data sets (in ENSDF format) of current publications, primarily in high-spin physics. Selected low-spin publications will also be compiled.

Compile high-spin publications for outdated (older than about 7 years) ENSDF evaluations on a time available basis.

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

Data Evaluation for ENSDF database:
(0.35 FTE)

McMaster Deliverables:

Evaluate 1.5 equivalent mass chains (including some in the A=31-44 region). Evaluations are planned for A=39, 80 and 149.

Update ENSDF for new data on super-deformed structures. All nuclides will be covered that do not require an extensive re-evaluation of other data.

Review mass chain evaluations as requested by NNDC.

FUNDING:

DOE supported staff: 0.5 FTE for data evaluation.

Other funding: 0.5 FTE for data evaluation (Canadian research agency).

National Institute of Standards and Technology

Nuclear Data Verification and Standardization Program
2003 Work Plan
(total of 0.2 FTE of support from the DOE)

STRUCTURE ACTIVITIES: NONE

REACTION ACTIVITIES: Perform the duties which will lead to an international evaluation of the neutron cross section standards. Chair the activities of the IAEA Coordinated Research Program (CRP) on the Improvement of the Standard Cross Sections. Continue working with the CRP on code comparisons for both R-matrix and least-squares codes which will lead to a better understanding of the cross section uncertainties. Investigate with the CRP the procedures for doing a comprehensive standards evaluation. Examine inconsistent (discrepant) data in the experimental database; focusing maximum attention on those experiments having the greatest weight. Continue preparing the data from experiments for use in the evaluation process. Act as Coordinator of the activities of the NEANSC's Working Party on International Evaluation Cooperation (WPEC) Subgroup which promotes international cooperation on measurements and evaluations of the nuclear data standards. This Subgroup has been most helpful in providing experimental work to improve the database for the standards evaluation. This standards evaluation activity is done under the auspices of the U.S. CSEWG, the NEANSC, and the IAEA, and includes participants from Austria, Belgium, China, France, Germany, Japan, Korea, Russia and the USA.

Suggest, motivate and monitor measurements for use in standards evaluations, largely through the NEANSC's WPEC. Such measurements will continue to be encouraged however the ones to be included in the international evaluation of the standards must be completed during this year. The measurements of the hydrogen standard which are to be included in this evaluation must be completed early in 2003 whereas the other standards can be completed by the middle of the year. Complete the NIST-Ohio University-LANL collaborative measurements of the hydrogen angular distribution at 15 MeV neutron energy. In order to effectively motivate and monitor standards experiments, which are needed for the standards evaluation, NIST has become an active participant in a number of experiments including measurements of the angular distribution of neutrons scattering from hydrogen which is one of the most important standards. When the hydrogen evaluation has been completed at LANL by Hale, begin the renormalization of all measurements in the database which are relative to the H(n,n) standard. Efforts will be made to produce an interim partial set of neutron cross-section standards for use in the ENDF/B-VII library. Continue the investigation of methods to improve the ^{10}B(n,$\forall$) standard. Coordinate CSEWG standards activities. Participate in CSEWG meetings. Participate in USNDP Coordinating Committee meetings. Maintain the National Repository for Fissionable Isotope Mass Standards. Perform duties as a member of the Program Committee for the International Symposium on Reactor Dosimetry (ISRD11).

DISSEMINATION ACTIVITIES: Make presentations at informal meetings on standards activities.

OTHER: NIST and the Contractor Carlson provide approximately a 0.8 FTE of support for these standards activities. Also, independent of the verification and standards program, there is approximately a one FTE NIST effort in nuclear structure and decay studies which receives no funding from DOE.

BROOKHAVEN NATIONAL LABORATORY
National Nuclear Data Center
Work Plan for FY2002

The NNDC is responsible for data compilation, evaluation and information services for neutron, charged particle and photonuclear reactions, radioactivity, and nuclear structure physics. The NNDC maintains bibliographic, experimental, and evaluated data files for these areas of physics and provides data services to basic and applied scientists in the United States and Canada. The NNDC is the focal point for data exchange with other countries and international organizations. In particular, the Center is responsible for the development, maintenance, and distribution of the Nuclear Science References (NSR) database, the Evaluated Nuclear Data File/B (ENDF/B), and the Evaluated Nuclear Structure Data File (ENSDF).

The NNDC assists applied and basic research scientists by coordinating inter-laboratory groups of experts to provide recommended values for nuclear data. The NNDC coordinates the Cross Section Evaluation Working Group (CSEWG) consisting of representatives from over 20 U.S. laboratories, which meet annually to develop an internationally recognized database for nuclear energy applications. The NNDC also coordinates the U.S. Nuclear Data Network which provides data support for basic research. The NNDC provides support services for the U.S. Nuclear Data Network, consisting of low energy nuclear physics evaluation centers. These coordinated efforts integrate and support the United States data compilation and evaluation efforts to achieve maximum utilization of manpower.

I. NNDC Facility Operation

The National Nuclear Data Center operates a facility dedicated to the collection, analysis and dissemination of nuclear data. The Center staff consists of 8 scientific, 3 professional and 4 supporting staff members. The operation of this facility requires a Center Head to perform the tasks of planning, budgeting, personnel management, and interaction with BNL management and with funding authorities.

The NNDC operates a library in order to fulfill its mission to maintain an archival collection of low and intermediate energy nuclear physics publications. This library supports the NNDC compilation activities and the U.S. nuclear data evaluation and international nuclear structure evaluation work.

The NNDC operates several computers to support its compilation, evaluation, and database maintenance and information dissemination missions. In addition to the primary production server, a Compaq Alpha 4100 server using OpenVMS, the NNDC operates WINDOWS-NT and LINUX servers in support of its database migration project. NNDC computer management tasks include software upgrades, hardware and software procurements, machine operations and internal user support.

Staff: **1.2 Scientific/Professional and 1.35 Support**

II. Coordination

The NNDC serves as the focal point of the US nuclear data program and the point of contact for international cooperation in nuclear data. In this role, the NNDC serves as the secretariat for the US nuclear data program (USNDP) and the Cross Section Evaluating Working Group (CSEWG). An NNDC staff member chairs the Coordinating Committee of the USNDP and CSEWG.

The USNDP Coordinating Committee establishes the technical policy for the US data program. The Coordinating Committee chair is responsible for organizing the annual meetings of the program participants, for preparing the annual work plan for the data program, and for maintaining the official USNDP web site. In its secretariat role, the NNDC assembles and publishes the minutes of the annual meetings of the program participants and maintains the official program web site. An NNDC staff member participates in meetings of the USNDP Steering Committee. The NNDC performs similar functions for CSEWG, which organizes the production of the ENDF/B evaluated data file.

International collaborations provide an important mechanism for augmenting the nuclear data information made available to US researchers from non-US sources. As the international focal point for the US nuclear data program, the NNDC represents the US program in two IAEA-sponsored networks, the Nuclear Reaction Data Center Network and the Nuclear Structure and Decay Data Network. The NNDC represents the US CSEWG on the Nuclear Energy Agency (NEA) Working Party on Evaluation Cooperation and currently holds the chair of that organization. In addition, the NNDC contributes to IAEA sponsored training courses, participates in staff exchanges with the IAEA Nuclear Data Section, and participates in other IAEA-sponsored activities such as Advisory Group Meetings and Coordinated Research Projects.

Staff FTE: 0.55 Scientific/Professional

III. Nuclear Physics Databases

The NNDC maintains seven nuclear physics databases on behalf of the US nuclear data program. These are the

- Nuclear Science References (NSR) database containing keyword abstracts of publications in nuclear physics;
- Experimental Unevaluated Nuclear Data List (XUNDL) database containing experimentally measured nuclear structure and radioactivity data;
- Evaluated Nuclear Structure Data File (ENSDF) database containing evaluated nuclear structure and radioactivity data;
- Nuclear Data (NuDat) database containing searchable numeric nuclear data;

- Computerized Index to Neutron Data (CINDA) database containing bibliographic information from publications on nuclear reaction data indexed by reaction;
- Cross Section Information Storage and Retrieval System (CSISRS) database contains experimentally measured nuclear reaction data;
- Evaluated Nuclear Data File (ENDF) contains evaluated nuclear data required for large-scale calculations needed in the nuclear design of research, energy and non-energy applications.

The contents of these databases are generated largely through national and international collaborations. The NNDC contributes to the contents of these databases as described below. Data for inclusion in each database are prepared in internationally accepted computer formats. This data is exchanged among cooperating partners worldwide.

NNDC responsibilities include both the development and maintenance of the software for update of and retrieval from each database, and quality control and distribution of the contents of each database to collaborators on a regular basis.

NSR --- The NNDC maintains the master copy of the NSR database. It is responsible for quality control and for updating the database with information generated by NNDC and by international collaborators.

XUNDL --- The NNDC maintains the master copy of the XUNDL database. Input data is supplied solely by collaborators. Regular updates are sent to LBNL and ORNL.

ENSDF --- The NNDC maintains the master copy of the ENSDF database. The NNDC is responsible for maintaining the database and organizing the quality control (review) of evaluations submitted for inclusion. Many ENSDF evaluations are published in the **Nuclear Data Sheets**. The cost of preparing the manuscripts from the ENSDF database is borne by the publishers, Academic Press.

NuDat --- This data base contains numeric nuclear data in searchable form from ENSDF, from the Nuclear Wallet Cards, radiations derived from ENSDF using the RADLIST computer code and thermal neutron cross sections and resonance parameters. The database is updated as new information is received.

CINDA --- The NNDC maintains its own copy of the CINDA database. Additional copies are maintained at the Nuclear Energy Agency Data Bank, the International Atomic Energy Agency and the Russian Nuclear Data Center. These organizations exchange updates prepared by them in accord with well-defined responsibilities.

CSISRS --- The NNDC role in this database is identical to that for CINDA. Database copies exist at the three other centers mentioned under CINDA. Approximately 10 non-US centers compile data that we receive and enter into our database.

ENDF --- The NNDC maintains the master database for the US evaluated nuclear data file. New releases of this library are prepared and distributed annually. The database also contains the four evaluated data libraries prepared in Western Europe, Japan, Russia and China.

In the 1980's, the NNDC migrated most of its databases to run under the Digital Equipment Corporation (DEC) CODASYL database management system (DBMS) on the VMS operating system (this DBMS has since been bought by Oracle). Retrieval programs written in FORTRAN allowed dial-up, DECNET, and telnet-based online retrieval well before the advent of the World-Wide Web. In the 1990's, Web interfaces were developed using the very same DBMS system.

In recent years, relational database management systems (RDBMSs) using Structured Query Language (SQL) have become standard in business and academia. There are many ways in which the nuclear data program could benefit from an increased use of relational database technology. Because it is a widely used technology, a large variety of auxiliary tools and interfaces exist for the administration and dissemination of data. These tools include replication and synchronization capabilities that would improve the efficiency and reliability of data exchange between centers. Because commercial RDBMSs software is available on a wide variety of platforms, and in a wide variety of price ranges, their use provides an opportunity to explore new options for dissemination to end-users of the data. The use of common standards in data storage will allow data centers to choose the software that best meets their needs, without being tied to a particular vendor.

Migration to this new database format represents a generational shift in the way data are stored. This is a major project that requires substantial amount of effort stretched over a period of several years. Among the tasks that need to be undertaken for each database are:

- Database design: The design of relational schema should be compatible with the current system, and allow flexible and efficient access to the data.
- Data migration: Current data will be loaded into the Sybase RDBMS system. The software written to do this will also be used to add new data as it comes in. Until the migration project is complete, parallel instances of the data will be kept in both the old and new database formats.
- Code migration: To the extent that it is feasible, the legacy programs for database administration, written mostly in FORTRAN, will be modified to work with the new RDBMS.
- Code development: For many tasks, and in particular for Web-based data dissemination, new software will be developed. Because of its portability, the Java programming language is being used for new software development.

Over the last three years, the NNDC has worked to develop a path forward for migration of nuclear data to a relational format, evaluated several software options, and began the process of migrating databases to a Sybase RDBMS on the Linux operating system. We started with NSR in FY2001, followed by ENSDF in FY2002. The three reaction databases (CINDA, CSISRS and ENDF) will be created in FY2002; they will undergo intensive testing and should be ready for use in FY2003. The project includes migration of legacy codes and modernization

of dissemination software. We intend to accomplish migration without interrupting our present electronic data access. It is expected that this major project will be completed in about two years, depending on the level of support available.

Staff: 3.6 Scientific/Professional and 1.5 Support

IV. Information Dissemination

A mission of NNDC is to provide scientists and engineers with nuclear data from the USNDP nuclear databases that it maintains in a variety of user-friendly formats and media. This mission is accomplished by providing electronic access to the nuclear physics databases and by answering mail, email and telephone queries. Electronic access to the databases is supported in two forms, by remote login (TELNET) and *via* the WWW. Access to other data, documentation, computer program packages, and publications is also available through the WWW, TELNET and anonymous FTP. In the calendar year 2000, more than 220,000 electronic data retrievals were made from the NNDC computer facility with approximately eighty-five percent coming from the WWW service.

In FY2002, the NNDC does not plan to make any significant enhancements to the remote login (TELNET) access software. We plan to begin implementation and testing of WWW interfaces to the new relational versions of the nuclear data bases described in Section III.

While users retrieve most data disseminated from NNDC electronically, our scientific staff is available to give advice on solving complex queries *via* electronic access to the database. Our support staff is used to offer a "help desk" for NNDC customers, for administrative/clerical support of our customer services and for producing a Newsletter.

Common ENSDF Web Interface

During FY2000, BNL, LBNL, ORNL, and SJSU jointly began to develop a common web interface to the ENSDF, XUNDL and NSR databases. LBNL and SJSU no longer participate in this project. In FY2002, the NNDC will develop and test the necessary interfaces to the NNDC databases with emphasis on ENSDF and XUNDL.

APS Link to NNDC Experimental Data Bases

Presently NNDC provides a link from our bibliographic databases to paper abstracts for journals which support this access. For those with subscriptions, the user can then access the complete paper. In cooperation with APS (Ridge, NY), we are developing the capability to go from the Phys. Rev. C abstract/article to the NNDC CSISRS and XUNDL databases where data mentioned in the publication will be archived. We expect to have the system fully operational in FY2002 and begin to expand this capability to additional journals.

Staff: 0.8 Scientific/Professional and 0.5 Support

V. Nuclear Structure Physics

The NNDC contributes to the contents of the nuclear structure and radioactive decay databases.

Nuclear Science References

The NNDC staff performs a literature search to identify publications that are appropriate for inclusion in the NSR database. NNDC maintains a WWW site with links to all of the journals covered that are available electronically. Keyword abstracts are prepared for references that are found to be appropriate. Approximately 4000 new entries are added to NSR per year. While most of the entries are created by the NNDC staff, some NSR entries for Russian and Japanese reports and conferences are prepared in Russia and Japan, respectively.

Nuclear Structure and Decay Data Evaluation

Members of the NNDC staff evaluate nuclear structure and decay data for the ENSDF database. The NNDC evaluators produce about three and one-half mass chain evaluations or their equivalent per year. Data to be selected for evaluation are chosen on the basis of priorities set by the USNDP/ENSDF file manager. In addition, NNDC reviews at least four mass chains or their equivalent as part of the ENSDF quality control activity. The NNDC plans to hire a Post Doc to be trained as an ENSDF evaluator.

Data for the ground and metastable state properties of all known nuclei are evaluated for inclusion in the NuDat database and for the Nuclear Wallet Cards that are published about every five years. The last published edition of the booklet was made in 2000.

ENSDF Physics and Checking Codes

The NNDC maintains ENSDF checking and physics programs on behalf of the national and international evaluator networks. For most of the programs, only maintenance and upgrades for format changes are planned. We plan upgrade RadList and LOGFT to properly treat 2^{nd}-order non-unique forbidden $\beta^{\pm}$ transitions. We will also begin to implement the "Evaluator's Corner" that will allow ENSDF evaluators remote interactive access to the latest versions of the ENSDF physics and checking codes via the World Wide Web.

Staff: 3.2 Scientific/Professional

VI. Nuclear Reaction Physics

Experimental Data Compilation

The NNDC as part of a larger international cooperation has responsibility for compiling experimental nuclear reaction data that has been produced in the U.S. and Canada. Experimental nuclear reaction data is compiled in an internationally agreed format called EXFOR. Approximately 11 nuclear data centers throughout the world participate in this compilation activity. Responsibilities are clearly defined and duplication avoided. Compilation results are exchanged on a regular basis.

The NNDC compiles all available new data for incident neutrons and charged particles. Coverage of incident neutron reaction data is essentially complete since 1936. However, charged particle data have been only selectively compiled in the past. NNDC is compiling new charged-particle measurements. However, because of emerging needs such as astrophysics, the NNDC is attempting to compile older data, hence, there is a larger staff commitment to compiling this type of data. In FY2002, NNDC expects to compile 100 sets of experimental nuclear reaction data.

NNDC is responsible for maintaining the manuals describing the EXFOR format and the methods for compiling different kinds of data.

ENDF Manuals and Documentation

The ENDF format for storing evaluated nuclear data which can be used as input for large scale application calculations was developed at Brookhaven National Laboratory about 35 years ago. It has become the international standard for storage and exchange of such data. The NNDC is responsible for maintaining the format and procedures manual for the ENDF system. We also produce the documentation supporting the contents of the ENDF/B library. The official format manual is posted on the NNDC www site.

Evaluation of Nuclear Data Needed for Astrophysics

The objective of this work is to support the nuclear data needs of the increasingly sophisticated nuclear astrophysics universe modeling. NNDC initiated a project to compile and evaluate alpha-induced nuclear reaction cross sections for astrophysics. The work will focus on nuclei $8 < Z < 32$ and alpha particles with the incident energy below 20 MeV. These reactions, important in the helium burning stage of stars, novae, and supernovae events, include (α,α), (α,n), (α,p) and (α,γ) reaction channels. Of particular interest are reactions leading to production and destruction of ^{44}Ti. Based upon thorough compilation of data including reactions and structural information, critical analysis of the data will be done and related cross sections and reaction rates will be evaluated.

Update of Fission Products Nuclear Data Evaluations for ENDF/B-VII

CSEWG has decided to prepare a new version of the Evaluated Nuclear Reaction Data File, ENDF/B-VII. The file should be released in about 2004. The majority of current fission product reaction data evaluations in the ENDF/B-VI is about 25 years old, and there is a clear need for substantial update and improvement. An international project will be initiated, under the Nuclear Energy Agency Working Party on Evaluation Cooperation, to assess the current status of all available fission product nuclide evaluations and to select best evaluations for ENDF/B-VII. The project should be completed in about 2 years.

Staff: 1.15 Scientific/Professional and 0.25 Support

VII. Funding sources outside the Nuclear Data program

The NNDC receives a subsidy from Academic Press to prepare computer-generated photoready copy for the "Nuclear Data Sheets".

The NNDC expects to receive funding through the new International Nuclear Energy Research Initiative (INERI) for a joint project to evaluate nuclear data for thorium fueled nuclear reactors. The work will be undertaken jointly with the Korea Atomic Energy Research Institute.

Oak Ridge National Laboratory Nuclear Data Project
FY03 Work Plan

IV. Information Dissemination

C. Web Site Maintenance

ORNL Deliverables:

- Maintain, update, and improve the WWW/FTP site providing the RadWare interface to ENSDF and XUNDL information.

- Migrate the server to a faster computer to improve cgi inquiry performance.

V. Nuclear Structure Physics

B. Compilation of Experimental Structure Data

ORNL Deliverables:

- Improve software for converting tabular/graphic published level-scheme data in journals and unpublished data supplied by researchers to Radware database into ENSDF format.

- Finish debugging code that was recently ported from fortran to C.

C. Data Evaluation

ORNL -- Continue study of the systematic behavior of nuclear states and other nuclear properties in the heavy-mass region to determine systematics of evaluated data to use for searches for superheavy elements and the development and utilization of neutron-rich radioactive beams.

ORNL Deliverables:

- Evaluate A=247 nuclei

- Begin to evaluate A=243 nuclei which are connected to A=247 and 239 nuclei via alpha decays

VI. Nuclear Reaction Physics

G. Evaluation of Data Needed for Astrophysics

ORNL - Evaluate capture reactions on radioactive proton-rich nuclei important for element synthesis and energy generation in stellar explosions. Evaluate capture reactions important for understanding Red Giant Stars. Evaluate reactions important for nuclear burning in the interior of the sun.

ORNL Deliverables:

- Complete evaluations of proton capture on 18F

- Complete evaluations of proton capture on 17O

- Continue analysis of solar thermonuclear reaction rate evaluations

- Continue assessments of capture reactions on proton-rich radioactive nuclei

EFFORT (in FTE)

IV. Information Dissemination - 0.05

C. Web Site Maintenance - 0.05

V. Nuclear Structure Physics - 0.55

B. Compilation of Experimental Structure Data - 0.05

C. Data Evaluation for ENSDF - 0.50

VI. Nuclear Reaction Physics - 0.45

G. Evaluation of Data Needed for Astrophysics - 0.45

TOTAL: 1.05 FTE

0.05 Dissemination
0.55 Nuc Structure
0.45 Astro

1.05 Total

TRIANGLE UNIVERSITIES NUCLEAR LABORATORY
NUCLEAR DATA PROGRAM

Work Plan for FY 2003
Oct. 2002-Oct. 2003

NUCLEAR DATA EVALUATION PROJECT

A = 3 – 20

J. L. Godwin, X. Hu, J.H. Kelley, J.E. Purcell, G. Sheu, D.R. Tilley, H.R. Weller

NUCLEAR STRUCTURE FTE 1.4

- EVALUATIONS:

Publish *"Energy Levels of Light Nuclei, A* = 8 - 10*"* in *Nuclear Physics A.*
Evaluate and distribute for comment *A* = 11 preliminary version.
Evaluate and distribute for comment *A* = 12 preliminary version.

- ENSDF:

Submit ENSDF files for *A* = 8 - 10 to correspond with the *Nuclear Physics A* publication.

DISSEMINATION FTE 1.4

- TUNL Nuclear Data Evaluation Project Website:

Continue to prepare new PDF documents of the most recent TUNL reviews (*A* = 8, 9, 10 to be completed), and older FAS reviews for the *A* = 3 - 20 series; provide new PDF documents for earlier Fay Ajzenberg-Selove evaluations based on *A* = 13 - 15 (76AJ04), *A* = 16 - 17 (77AJ02), *A* = 18 - 20 (78AJ03), and *A* = 5 - 10 (79AJ01).

Continue to provide General Tables to accompany the most recent TUNL reviews of the *A* = 3 - 20 series; General Tables for *A* = 8, 9, 10 to be completed to correspond to the review published in *Nuclear Physics A.*

Continue to provide HTML documents for individual nuclides found within the TUNL and Fay Ajzenberg-Selove evaluations. The HTML expands upon what is available via the PDF documents by providing HTML documents for each

individual nuclide, and dynamic links for discussions, references, tables, figures and reactions; HTML documents to be completed for TUNL's A = 8, 9, 10 review, as well as FAS A = 11 - 12 (80AJ01), A = 13 - 15 (81AJ01), A = 16 - 17 (82AJ01), and A = 18 - 20 (83AJ01).

Provide Update Lists for A = 17 and 18 experimental and theoretical level information. Begin work on A = 19 - 20 in order to complete the set of Update Lists on the TUNL website for A = 5 - 20. Continue to revise and add new references to all existing Update Lists on a continuing basis.

Continue to provide scanned versions of earlier Energy Level Diagrams to accompany the PDF and HTML documents for those nuclides.

Continue to add PalmOS applications and databases (begun in 2001) that are of interest to the Nuclear Physics community to the new Palm Pilot page available on the TUNL website.

PROGRAM ON PREEQUILIBRIUM PHENOMENOLOGY

Constance Kalbach Walker

NUCLEAR REACTIONS FTE 0.4

- Nuclear Model Development

Development of preequilibrium nuclear reaction models. Work will include improvement and benchmarking of the computer code PRECO, extending code validity to higher incident energies for nucleon induced reactions (emphasis on effective matrix element systematics) and/or improvements to the code functionality as requested by users (increasing stand-alone capabilities and simplifying interfacing with Hauser-Feshbach codes). Specific work to be undertaken will be guided by ongoing user input.

Deliverables:

Updated version of PRECO, possibly with updated formal release.
Possible journal article describing benchmarking up to 100 MeV.
Collect data from the literature for (N,xN) reactions up to 200 MeV.