

USNDP

U.S. Nuclear Data Program Work Plan for Fiscal Year 2002

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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 2002 that begins on October 1, 2001. Previously, two work plans have been prepared for the data program covering fiscal years 2000 and 2001. The Chair of the U.S. Nuclear Data Coordinating Committee has prepared this plan 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. The Coordinating Committee Chair prepared a unified work plan based on these submissions. The draft plan was then circulated to the Coordinating Committee for comments and corrections.

As was the case in the work plan for FY2001, 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 FY2002, 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 2002.

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.

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 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

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

BNL Deliverables:

Prepare FY2003 work plan for USNDP in time for spring 2002 FWP submittals.

Chair USNDP Meeting in April 2002.

Organize and chair CSEWG Meeting at BNL, November 2002.

Maintain USNDP WWW-site.

Idaho -- Chair U.S. Nuclear Data Program's Nuclear Structure Working Group, and help coordinate nuclear structure data work at different labs to advance USNDP goals.

Idaho Deliverables:

Organize and chair Nuclear Structure Working Group meeting at USNDP meeting in 2002.

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 goals, member of USNDP Steering Committee, 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 2002.

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 2002.

B. International Coordination

BNL -- Member of Nuclear Reaction Data Center Network, Member Nuclear Structure and Decay Data Network, Advisor to U.S. Member of the International Nuclear Data Committee,

member of NEA Working Party on Evaluation Cooperation, participation in IAEA sponsored activities such as Advisory Group Meetings and Coordinated Research Projects.

BNL Deliverables:

Participate in technical meeting of NRDC in Paris in 2002.

Participate in NEA Working Party on Evaluation Cooperation in 2002.

Provide a lecturer for the “mini” Structure Workshop in Vienna in 2002.

Idaho -- Chair USNDP Nuclear Structure Working Group and interact with international Nuclear Structure and Decay Data network on behalf of USNDP on technical matters. Chair the international Decay Data Evaluation Project.

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. LANL will host visits by foreign scientists with international reputations to benefit from the exchange of information and ideas.

LANL Deliverables:

Participate in NEA Working Party on Evaluation cooperation meeting in 2002.

Participate in IAEA-sponsored Trieste Workshop.

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

Host a couple of international visitors to collaborate on the evaluation of nuclear data.

Assist in the organization of the 2002 international nuclear data conference in Japan.

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. Entry preparation not included. Updates are done on a continuing basis.

BNL Deliverables:

Database distributed to collaborators six-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 monthly.

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:

20 CINDA exchange files from cooperating centers will be added to the database.

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 (18 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 Western Europe, 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:

Create a site from which new evaluations can be obtained before formal release of ENDF/B-VII.

H. Database Software Maintenance

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

I. Future Database Systems

In FY2001, the project to identify the path forward for migrating the NNDC databases to use modern relational database software was completed. Detailed plans for accomplishing this migration are being developed in FY2001 and the migration started. As part of this task, legacy support software must be migrated and dissemination software modernized. We intend to accomplish this migration without interrupting our present electronic data access. It is expected that the task will be completed in two to three years, depending on the level of support available.

BNL Deliverables:

- Complete migration of NSR database.

- Develop new ENSDF database and software.

- Complete test database for bibliographic, experimental and evaluated reaction data and supporting maintenance software.

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 WWW.

BNL Deliverables:

- No enhancements are planned for the remote login (TELNET) access software.
- Migrate web interfaces for NSR and ENSDF to new relational databases.
- Develop and test standard interfaces to the NNDC databases with emphasis on ENSDF and XUNDL, which can be used by all USNDP-produced user access programs such as MacNuclide and Isotope Explorer.

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.

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 WWW site.
- Add access to ENDF/B-VI, Release 8, when available.
- Continue coordination of T-16 site with other USNDP sites.

LBNL Deliverables:

- Complete website for compiled capture gamma data as part of IAEA Coordinated Research Program for Prompt Capture Gamma-Ray Analysis.
- Update Table of Radioactive Isotopes and add new utilities.
- Maintain currency of data on LBNL web site.

TUNL Deliverables:

Continue to provide most recent reviews for $A = 3$ through 20 in PDF format.
Provide Reference Update lists for $A = 14$ and 16 and start generating lists for $A = 17$ –20.

Keep existing Reference Update lists current.

Prepare “Energy Levels” publications from 1981, 1982, 1984, 1985, and 1986 in PDF format, and continue project with publishers of Nuclear Physics A to provide online versions of all prior publications in the Energy Levels of Light Nuclei for 1959 through 1991. Continue the development of PalmOS applications and databases and add them to the TUNL site.

Develop a web site for $A=21-30$.

D. 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), 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.

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:

Keyword abstracts for 3200 references will be prepared in FY2002.

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:

Compiled data sets (in ENSDF format) of current publications, primarily in high-spin physics.

Compile older high-spin publications needed for outdated 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. Examples used in the development of these procedures will be submitted to BNL as XUNDL data sets.

C. Data Evaluation

The USNDP evaluates nuclide and mass chain nuclear structure and decay data for inclusion in the ENSDF database. ANL has added a skilled nuclear structure physicist to its staff in order to participate in the nuclear structure data evaluation activity. TUNL has expressed interest in taking responsibility for $A=21-30$. This would complement the agreement from Canada to assume responsibility for $A=31-44$ and thereby cover the region formerly evaluated by the Utrecht group.

ANL Deliverables:

This is a new activity. One mass chain will be evaluated.

BNL Deliverables:

Three and one-half equivalent mass chains will be evaluated.

At least four mass chains will be reviewed.

Hire a post doc for training as an evaluator.

Idaho Deliverables:

Complete evaluation of A=156.
Begin evaluation of A=155 and 159
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=40, 165 and 190 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:

Accepted temporary reassignment of masses 242 and 244 from Kurchatov.
Evaluation of A=244 will be completed.
Mass chains will be reviewed as requested.

TUNL Deliverables:

Evaluate mass 10 and distribute for comment.
Prepare publication for A = 8, 9 and 10 for submission to Nuclear Physics A.
Prepare ENSDF files for A = 8, 9 and 10.
Begin evaluation in the A=21-30 mass range.

D. Ground and Metastable State Properties

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

BNL Deliverables:

NNDC will include the 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.

LBNL Deliverables:

Decay data for two nuclides will be evaluated.
Coordinate international activity in this area.

Adopted and decay data sets from non-U.S. evaluators will be coded into ENSDF format.

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. The results of this evaluation will be placed into a database.

LBNL Deliverables:

This database will be completed.

G. 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 2nd-order non-unique forbidden β^\pm transitions.

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.

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.

Incident charged particle data have not been completely 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.

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 100 charged-particle and neutron reaction publications.

B. 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:

The ENDF summary documentation will be updated for release 8 of ENDF/B-VI and placed on the WWW.

C. 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:

Review and recommend the best available fission product neutron reaction evaluations for ENDF/B-VII.

LANL Deliverables:

Lead planning effort for ENDF/B-VII.

Submit improved neutron and photonuclear evaluations for $^{235,238}\text{U}$ and ^{239}Pu to be included in ENDF/B-VII.

LLNL Deliverables:

Prepare evaluations for Eu, Sm, Cr, and Ti isotopes.

Review evaluations submitted for inclusion in ENDF/B as requested.

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 Nuclear Energy Agency is the umbrella organization for completing the project to update these recommended data. The IAEA is planning to initiate a Coordinated Research Program in support of this activity.

LANL Deliverables:

Organize and participate in the effort to evaluate the light-element standard cross sections.

NIST Deliverables:

Coordinate the international standards activity.

Determine the methodology for producing the new standards evaluation.

Review existing experimental data and recommend new measurements as needed.

Collaborate with Ohio University and LANL in the measurement of hydrogen elastic angular distributions; continue 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 other measurements made with DOE low-energy physics funds (e.g., Grimes, Haight, Becker and others) will play a crucial role in the validation of the models in these computer codes.

ANL -- Work on a journal article that will report results from measurements performed during 1999-2001 will be completed. A detailed nuclear model parameter sensitivity study will be performed for calculations relevant to these and earlier data acquired from a collaborative program with IRMM, Geel, Belgium. This program also involves contributions from theoretical physicists in Romania and Hungary.

ANL Deliverables:

A journal article will be submitted.

Completed evaluations in ENDF format.

Experimentally validated nuclear model parameters submitted to IAEA Reference Input Parameter Library (RIPL).

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 with experimentalists at LANSCE (R.C. Haight, M. Devlin, J.A. Becker, S.M. Grimes) 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.

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 $n+^{196}\text{Pt}$ reactions producing far-from-stability products, and reactions in competition with fission of $^{235,238}\text{U}$.

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:

First version of program will be available for testing.

TUNL – The ongoing development of pre-compound nuclear reaction models involves the improvement and benchmarking of the computer code PRECO. New work will focus on extending its validity to higher incident energies for (N,xN) reactions. Issues to be considered are isospin conservation, energy dependences of both the collective state model, and the matrix elements for residual nn, np and pp interactions (energy dependence and relative size).

TUNL Deliverables:

- Submit a journal article describing benchmarking up to 100 MeV.
- Collect data from the literature for (N,xN) reactions up to 200 MeV.

F. 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 – The compilation of charged-particle data of the type (p, α) and (p, γ) for mass A = 30-50 nuclides will continue. The focus during this period will be on the stable isotopes of sulfur. Work will begin on the evaluation of data for these reactions. The objective is the preparation of evaluated data files that can be used for computation of astrophysical nuclear reaction rates.

ANL Deliverables:

Compilations of (p, α) data for ^{32}S and of (p, α) and (p, γ) data for the minor sulfur isotopes, $^{33,34,36}\text{S}$.

BNL – In support the nuclear data needs 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 α reactions below 20 MeV leading to production and destruction of ^{44}Ti .

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:

Predict fission-barriers for neutron-rich heavy nuclei for r-process nucleosynthesis using recent advances in Moller-Nix theory.

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

Continue evaluation of other processes important in Big-Bang nucleosynthesis.

Complete analysis to predict the ${}^7\text{Be}(p,\gamma){}^8\text{B}$ cross section, for the solar neutrino problem.

Continue to contribute to the TUNL Energy Levels of Light Nuclei (A=5-10) effort.

Study effects of electronic screening on Maxwellian rates under astrophysical conditions.

Provide data for light radioactive targets beginning with ${}^{17}\text{F}+p$

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:

Work will continue on the evaluation of reaction data for ${}^{33}\text{Cl}$, ${}^{25}\text{Al}$, and ${}^{26}\text{Si}$.

H. Reaction Data for RIA Target Design

Rare Isotope Accelerator facility design needs high-quality nuclear reaction data for target design, and facility design. LANL works with ORNL and ANL researchers 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 and improve nuclear reaction models for predicting (p,xn) reactions, as well as spallation and fission in intranuclear cascade model codes.

Complete and publish isospin-dependent global relativistic Schrödinger 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.

LBNL – Members of the Isotopes Project plan to increase their activities in the area of nuclear physics experiments addressing the nuclear data needs of nuclear astrophysics. We are planning to perform a series of (α,γ) cross section measurements on nuclides with $A>100$. We also are planning to measure the half-life of the long-lived fission product, $^{121}\text{Sn}^m$. Support for this activity comes from the nuclear physics program.

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

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USNDP Staffing Table for October 2001 through September 2002

	ANL	BNL Sci/Pro	BNL Support	Idaho	LANL	LBNL	LLNL
I. NNDC Facility Operation							
Management	0.00	1.20	1.35	0.00	0.00	0.00	0.00
Secretarial/Administrative Support		0.40					
Library			1.00				
Computer Operation		0.80	0.35				
II. Coordination							
National Coordination	0.00	0.55	0.00	0.05	0.30	0.30	0.00
International Coordination		0.35		0.05	0.1	0.3	
		0.20			0.2		
III. Nuclear Physics Databases							
Nuclear Science References (NSR)	0.00	3.60	1.50	0.00	0.00	0.00	0.00
Experimental Nuclear Structure Data (XUNDL)		0.15	0.75				
Evaluated Nuclear Structure Data (ENSDF)		0.05					
Numerical Nuclear Data (NuDat)		0.45	0.60				
Reaction Data Bibliography (CINDA)		0.05	0.05				
Experimental Reaction Data (CSIRS)		0.05	0.10				
Evaluated Nuclear Data File (ENDF)		0.20					
Database Software Maintenance		0.35					
Future Database Systems		2.25					
IV. Information Dissemination							
Maintenance of Remote Access to USNDP Data	0.00	0.80	0.50		0.10	0.40	
Telnet Service		0.40					
WWW Service		0.05					
Customer Services		0.35					
Web Site Maintenance		0.15	0.45				
APS Link to NNDC Experimental databases		0.15	0.05		0.10	0.40	
		0.10					

USNDP Staffing Table for October 2001 through September 2002

	McMaster	NIST	ORNL Sci/Pro	TUNL	Program Total	
					Sci/Pro	Support
I. NNDC Facility Operation						
Management	0.00	0.00	0.00	0.00	1.20	1.35
Secretarial/Administrative Support					0.40	0.00
Library					0.00	1.00
Computer Operation					0.00	0.35
					0.80	0.00
II. Coordination						
National Coordination	0.00	0.00	0.00	0.00	1.20	0.00
International Coordination					0.80	0.00
					0.40	0.00
III. Nuclear Physics Databases						
Nuclear Science References (NSR)	0.00	0.00	0.00	0.00	3.60	1.50
Experimental Nuclear Structure Data (XUNDL)					0.15	0.75
Evaluated Nuclear Structure Data (ENSDF)					0.05	0.00
Numerical Nuclear Data (NuDat)					0.45	0.60
Reaction Data Bibliography (CINDA)					0.05	0.00
Experimental Reaction Data (CSIRS)					0.05	0.05
Evaluated Nuclear Data File (ENDF)					0.05	0.10
Database Software Maintenance					0.20	0.00
Future Database Systems					0.35	0.00
					2.25	0.00
IV. Information Dissemination						
Maintenance of Remote Access to USNDP Data	0.00	0.00	0.00	1.65	2.95	0.50
Telnet Service					0.40	0.00
WWW Service					0.05	0.00
Customer Services					0.35	0.00
Web Site Maintenance				1.65	0.15	0.45
APS Link to NNDC Experimental databases					2.30	0.05
					0.10	0.00

USNDP Staffing Table for October 2001 through September 2002

	ANL	BNL Sci/Pro	Support	Idaho	LANL	LBNL	LLNL
V. Nuclear Structure Physics	0.50	3.20	0.00	0.45	0.00	2.90	0.00
NSR Abstract Preparation		0.55	0.00				
Compilation of Experimental Structure Data							
Evaluation of data for ENSDF	0.50	2.50		0.45		2.90	0.00
Masses and Nuclides	0.50	2.40		0.35		2.00	
Ground and Metastable State Properties		0.10					
Radioactive Decay Data Evaluation		0.00		0.10		0.40	
Thermal Capture Gamma Data Evaluation						0.50	
ENSDF Physics and Checking Codes		0.15					
VI. Nuclear Reaction Physics	0.50	1.15	0.25	0.00	1.10	0.00	0.40
Experimental Data Compilation	0.00	0.55	0.25	0.00	0.00	0.00	0.00
Neutron Data		0.05	0.25				
Charged Particle Data		0.45					
EXFOR Manuals		0.05					
Evaluation of Fission Product Nuclides		0.20					
ENDF Manuals and Documentation		0.05					
ENDF Evaluations					0.10		0.20
Nuclear Reaction Standards							
Nuclear Model Development	0.20				0.40		0.20
Evaluation of Data Needed for Astrophysics	0.30	0.35			0.40		
Reaction Data for RIA Target Design					0.20		
DOE/Science Nuclear Data Funded Staff	1.00	10.50	3.60	0.50	1.50	3.60	0.40
Staff Supported by Other Funding		0.50	0.40			1.40	
TOTAL STAFF	1.00	11.00	4.00	0.50	1.50	5.00	0.40

USNDP Staffing Table for October 2001 through September 2002

	McMaster	NIST	ORNL	TUNL	Program Total	
					Sci/Pro	Support
V. Nuclear Structure Physics						
NSR Abstract Preparation	0.50	0.00	0.70	2.15	10.40	0.00
Compilation of Experimental Structure Data	0.10		0.20		0.55	0.00
Evaluation of data for ENSDF	0.40		0.50	2.15	9.40	0.00
Masses and Nuclides	0.40		0.50	2.15	8.30	0.00
Ground and Metastable State Properties					0.10	0.00
Radioactive Decay Data Evaluation					0.50	0.00
Thermal Capture Gamma Data Evaluation					0.50	0.00
ENSDF Physics and Checking Codes					0.15	0.00
VI. Nuclear Reaction Physics						
Experimental Data Compilation	0.00	0.20	0.50	0.40	4.25	0.25
Neutron Data					0.55	0.25
Charged Particle Data					0.05	0.25
EXFOR Manuals					0.45	0.00
Evaluation of Fission Product Nuclides					0.05	0.00
ENDF Manuals and Documentation					0.20	0.00
ENDF Evaluations					0.05	0.00
Nuclear Reaction Standards		0.20			0.30	0.00
Nuclear Model Development				0.40	0.20	0.00
Evaluation of Data Needed for Astrophysics			0.50		1.20	0.00
Reaction Data for RIA Target Design					1.55	0.00
					0.20	0.00
DOE/Science Funded Staff	0.50	0.20	1.20	4.20	23.60	3.60
Staff Supported by Other Funding	0.50	0.80	0.00	0.00	3.20	0.40
TOTAL STAFF	1.00	1.00	1.20	4.20	26.80	4.00

Work Plan for FY2002

Argonne National Laboratory

The format of the present work plan is based on the similar document prepared in 2000 for FY2001. The structure and components of the Argonne contributions differ somewhat from those presented in last year's document. Only those items that pertain to the Argonne activities are shown in each section below:

Work Plan Tasks and Deliverables

V. Nuclear Structure Physics

C. Data Evaluation

ANL – Traditionally, the contributions from Argonne National Laboratory to the U.S. Nuclear Data Program have been made exclusively to Nuclear Reaction Physics (Category VI). However, in February 2001, a new scientist will join the ANL data program. During FY2002, this individual will be working at a 0.5 FTE level. This scientist is experienced in the field of nuclear structure and high-spin physics, having most recently been employed as a post doctoral associate in the ANL Physics Division and therein active in the experimental research program at ATLAS. Because of these circumstances, it is evident that Argonne is well positioned to assume responsibilities for contributing to the nuclear structure activities of the USNDP. Working in close cooperation with the U.S. and international nuclear structure evaluation network, Argonne will begin during FY2002 to contribute to the ENSDF evaluation effort. The choice of mass region and nuclides to address will be decided in the near future in consultation with the leadership of the ENSDF evaluation network.

Deliverables:

It is likely that Argonne will assume responsibility for the evaluation of one mass chain. This is the appropriate level of effort that can be applied to this activity given the anticipated funding level for FY2002.

VI. Nuclear Reaction Physics

F. Nuclear Model Development

ANL – The main effort during FY2002 will involve the preparation of a journal article that will represent a final report on experimental work carried out during 1999-2001. This work will be performed in collaboration with IRMM, Geel, Belgium. This activity is being carried out within the framework of a NEA Working Party on Evaluation

Cooperation project that aims to acquire a substantial amount of experimental cross section data for neutron activation reactions in the energy range 16-21 MeV and then use these data to extract nuclear model parameters. A sensitivity analysis approach will be invoked in this project so as to determine just where measurements can be used most effectively to define specific model parameters.

Deliverables:

A journal article.

Completed evaluations in ENDF format.

Experimentally validated nuclear model parameters submitted to IAEA Reference Input Parameter Library (RIPL).

G. Evaluation of Data Needed for Astrophysics

ANL – The emphasis during FY2002 will be on compiling all available data on the $^{32}\text{S}(p, \alpha)$ and for the (p,γ) and the (p,α) reactions for the minor sulfur isotopes, $^{33,34,36}\text{S}$. The motivation for this work is the preparation of evaluated cross sections for these reactions so that astrophysical reaction rates can be calculated.

Deliverables:

Data compilations will be prepared and submitted to NNDC.

Documentation of this work will appear in an ANL report.

USNDP Level of Effort for October 2000 through September 2001

V. Nuclear Structure Physics – 0.5 FTE (total effort for this category)

Evaluation of Data for ENSDF - 0.50 FTE

VI. Nuclear Reaction Physics – 0.5 FTE (total effort for this category)

Nuclear Model Development - 0.20 FTE

Evaluation of Data Needed for Astrophysics - 0.30 FTE

APPENDIX

Argonne National Laboratory

Program Administration

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Program Technical Overview

The Nuclear Data Program at Argonne National Laboratory during FY2002 will amount to 1 FTE, in line with previous year funding, and will consist of three components:

1. Evaluation of nuclear structure data for ENSDF (0.5 FTE).
2. Compilation and evaluation of charged-particle reaction data for astrophysics (0.3 FTE).
3. Nuclear reaction measurements aimed at improving quality of nuclear modeling (0.2 FTE).

Item No. 1 represents a new initiative at Argonne that has been introduced as a consequence of addition to staff of a scientist who is skilled in nuclear structure physics. The remaining two items in this list represent a continuation of work in preceding years.

Evaluation of Nuclear Structure Data

For many decades the A-chain project has represented an international activity aimed at compiling and making readily available to the basic and applied research communities various information on the structure and radioactive decay of nuclei. Unfortunately, work in this area has been on the decline due to aging personnel, deaths, and limited funding. The situation is now critical since work has stopped in several countries (e.g., Holland and Germany). In the U.S. the activity is heavily dependent upon scientists past retirement age who pursue this work out of love and recognition of its

necessity. This cannot last forever, so young scientists must be recruited to continue the effort and, possibly, expand it into new domains (e.g., nuclei far from the line of stability). Argonne has been successful in recruiting just such an individual. This is the principal motivation for suggesting that Argonne join the ENSDF network and begin contributing to the evaluation of mass chains and other specialized databases of interest to various user communities.

Evaluation of Nuclear Data for Astrophysics

For the last three years Argonne has been 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. This work is progressing rather slowly as various analytical tools have to be implemented to insure that reliable evaluations can be produced. The work is carried out in collaboration with Hiram College, Hiram, Ohio. Three Argonne reports dealing with the compilation activity have been produced and compiled data have been sent to NNDC. The evaluation of the (p,α) and (p,γ) reactions for ^{31}P is now in progress.

Nuclear Data for Nuclear Modeling

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 that calculated results will be sufficiently a priori 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, and Japan to generate such a database. Experiments are performed in Belgium at little or no cost to the U.S. Argonne participants in these experiments and in the analysis of data. The work is coordinated under the auspices of the Nuclear Energy Agency WPEC organization.

15 January 2001

Idaho Evaluators

Work for U. S. Nuclear Data Program

Responsibilities and Activities for FY2002

R. G. Helmer and C. W. Reich

	FTE
Evaluation responsibilities: masses 87, 153-163	
FY2002 evaluations: complete A=156 and initiate A=155 and 159	0.31
Coordinate Working Group of Nuclear Structure and Decay Data	
Facilitate technical communications within Working Group	0.02
Plan and chair Working Group session at the US NDP meeting in 2002	0.05
Review evaluations from other groups	
Review two mass chain evaluations when requested	0.04
Decay Data Evaluation Project	
Evaluate data for the decay of five radionuclides	0.08
TOTAL	0.50

LANL Group T-16 FY2002 Work Plan for US Nuclear Data Program (USNDP)

(01/22/01)

	Description	Effort (FTEs)
1	USNDP Reaction Working Group Organization	0.1
2	Nuclear Physics ENDF Database	0.1
3	Astrophysics Reaction Data	0.4
4	Reaction data for RIA Target Design	0.2
5	Model code development, and reaction theory studies at LANSCE and GEANIE	0.4
6	WWW Dissemination of nuclear data	0.1
7	International nuclear data cooperation	0.2
8	Publications	
		Total=1.5

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 2001
- Organize and chair Reaction Working Group meeting at USNDP meeting, April 2002.

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 inclusion in ENDF/B-VI.

Deliverables:

- Organize/Participate in international effort to reevaluate the light-element standard cross sections
- Work with BNL to define scope of new version of ENDF: ENDF/B-VII
- Submit new improved evaluations that will be eventually available in ENDF/B-VII ($^{235,238}\text{U}$, ^{239}Pu , various nuclides with improved thermal capture cross sections, new high-energy and photonuclear evaluations, as they become available)

3. Astrophysics Reaction Data (0.4 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:

- Predict fission-barriers for neutron-rich heavy nuclei, for r-process nucleosynthesis taking advantage of recent advances in Moller-Nix theory
- Extend n-p capture analysis to higher energies and provide evaluated data
- Continue analyses of other processes important in Big-Bang nucleosynthesis
- Complete analysis to predict the $^7\text{Be}(p,\gamma)^8\text{B}$ cross section, for the solar neutrino problem
- Continue to contribute to the TUNL Energy Levels of Light Nuclei project
- Provide electronic screening factors for Maxwellian rates under astrophysical

conditions

Provide data for light radioactive targets, beginning with $^{17}\text{F}+\text{p}$.

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

The RIA R&D committee has recently endorsed official LANL collaboration. High-quality nuclear reaction data is required for the target design, and facility design of a Rare Isotope Accelerator. 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 and improve nuclear reaction models for predicting (p,xn) reactions, as well as spallation and fission in intranuclear cascade models and codes.

- Complete and publish isospin-dependent global relativistic Schrodinger optical model

5. Model code development, and reaction theory studies at LANSCE and GEANIE (0.4 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, McGNASH, 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, preequilibrium 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 $n+^{196}\text{Pt}$ reactions producing far-from-stability products, and reactions in competition with fission ($^{235,238}\text{U}$).

6. WWW Dissemination of nuclear data (0.1 FTE)

Continue to develop our T-16 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-16 WWW site

- Continue coordination of T-16 WWW site with other USNDP sites

- Include WWW access to ENDF/B-VI Release 8, when available

7. International nuclear data cooperation (0.2 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 programs on photonuclear reactions, and on reference input model parameters. 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:

- Participate in NEA June 2002 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
- Help organize international nuclear data conference, Japan, October 2001

8. 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 FY2002 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, participation in two international collaborations will grow. 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 coding of special non-US evaluations for inclusion in ENSDF and in the review of other data evaluations submitted to NNDC. The anticipated level of effort for the above activities is 2.6 FTE from LBNL employees plus 0.7 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: 2.00 FTE (which includes 0.3 FTE from visitors)

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

Three-year IAEA CRP for Prompt Gamma Activation Analysis:
This program covers the evaluation of isotopic and elemental (thermal/cold n,γ) data to develop an adopted capture γ ray database. A database will be completed and we will coordinate the CRP evaluation and research efforts.

Effort: 0.9 FTE (which includes 0.4 FTE from visitors)

- **Leadership of Decay Data Evaluation Project (DDEP): Nuclear and Atomic Radiations:**

Coordinate and plan activities of this international collaboration

Submit decay datasets for two radionuclides.

Code Decay and Adopted data sets for non-US evaluations of radionuclides as needed for inclusion in the ENSDF database.

Effort: 0.4 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 0.4 FTE LBNL staff in collaboration with Lund University and EVITech.

- **WWW Table of Radioactive Isotopes**

Databases will be updated and additional utilities will be added in collaboration with Lund University.

Effort: 0.1 FTE

- **Capture Gamma-Ray Data**

Completion of a website for the IAEA Coordinated Research Program (CRP) for Prompt Capture Gamma-Ray Activation Analysis.

Effort: 0.1 FTE

- **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: 0.2 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 $A > 100$. We also are planning to measure the half-life of the long-lived fission product, $^{121}\text{Sn}^m$.

Effort: 1.00 FTE

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 FY2002

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 FY02 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 neutron and charged-particle reactions on Eu, Sm, Cr, and Ti
- Data compilation and evaluation interest in charged-particle fusion reactions on light nuclei

Modular nuclear reaction codes

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++.

Deliverable: First version of software will be made available to the nuclear physics community through ftp download. This release will require some testing, documentation, and an internal (LLNL) software review and release procedure. Community feedback will be considered and acted upon.

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 and proton cross section evaluations of the Eu, Sm, Cr, and Ti stable isotopes will have been completed by early FY02 for stockpile stewardship. This work includes the (n,n'), (n,2n), (n, γ), (p,n), and (p,2n) channels on all of these isotopes. Recent data and model calculations (STAPRE and ALICE) are being incorporated into the evaluation.

LLNL will also participate in community activities including refereeing other evaluators and contributing to the Cross Section Evaluation Working Group (CSEWG).

Deliverable: The Eu, Sm, Cr, and Ti evaluations 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

Charged-particle fusion reactions on light nuclei

LLNL has identified improvements to this area of nuclear reaction data as an important priority. In addition, this nuclear data is important to the nuclear astrophysics community. LLNL intends to grow the effort in this area and is considering several productive avenues for light nuclei ($A < 28$):

- Making LLNL's Evaluated Charged Particle Library (ECPL) and the Caughlin/Fowler evaluations available in ENDF/B format
- Reviewing the literature and providing more recent evaluations in ENDF/B format
- Incorporate new techniques in nuclear structure calculations of light nuclei with R-matrix methods to improve reaction models and light-nuclei reaction data

LLNL has gotten positive feedback from members of the nuclear astrophysics community for these ideas.

There is no deliverable or effort level for this area, but it is currently under exploration. Increased funding from the US Nuclear Data Program would be put to good use in this area.

January 17, 2001

2002 WORK PLAN FOR DATA EVALUATION (MCMASTER UNIVERSITY)

FUNDING:

DOE supported staff: 0.5 FTE for data evaluation.
(Present funding runs to June 2001. Application for renewal
of grant has been submitted to DOE.)

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

MCMASTER'S WORK PLAN DURING OCT 2001-SEP 2002:

Nuclear Structure Physics:

Data Evaluation for inclusion in ENSDF database:
(About 0.4 FTE to ENSDF work)

1. Evaluate 1.5 equivalent mass chains (including A=31-44 region)
for submission to ENSDF/NDS. Planned A-chains during
2001-2002 are: A=40, 165 and 190.
2. Update ENSDF for data on superdeformed structures from current
publications. This would include all nuclides, except where
a complete nuclide update would be required.
3. Review equivalent of one mass chain evaluation prepared at
other data centers.

Compilation of Experimental Structure Data for inclusion in
XUNDL database: (About 0.1 FTE to XUNDL work)

1. Compile data sets (in ENSDF format) from current publications,
primarily in high-spin physics. If time permits, compile high-spin
publications for those A-chains which are outdated in ENSDF.
2. Review, check and edit compiled data sets submitted by other
data centers prior to inclusion in XUNDL database.

National Institute of Standards and Technology

Nuclear Data Verification and Standardization Program

2002 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. Coordinate, as chairperson, 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. Participate in the coordination required for the first IAEA Coordinated Research Program (CRP) meeting which follows the Consultants' Meeting in FY 2001 on the Improvement of the Standard Cross Sections. The initial focus of the CRP is a study of the magnitude of the uncertainties obtained from standards evaluation processes. Investigate with the CRP the procedures for doing a comprehensive standards evaluation. Test some of the programs which could be used for this effort. Continue examining the experimental database and preparing it for use in the evaluation process. Involvement in the standards evaluation program now includes Austria, China, France, Germany, Japan and the USA. This activity is done under the auspices of the U.S. CSEWG, the NEANSC, and the IAEA. (0.15 FTE)

Suggest, motivate and monitor measurements for use in standards evaluations, largely through the NEANSC's WPEC. Continue the NIST-Ohio University-LANL collaboration on measurements of the hydrogen angular distribution at 15 MeV neutron energy. Publish the results of the measurements of the collaboration at 10 MeV neutron energy. Investigate methods to improve the $^{10}\text{B}(n,\alpha)$ standard. Coordinate CSEWG standards activities. Participate in CSEWG meetings. Participate in USNDP Coordinating Committee meetings. Perform duties as a member of the International Technical Program Committee of the ND2001 conference (held in FY2002). Maintain the National Repository for Fissionable Isotope Mass Standards. Perform duties as a member of the Symposium Committee and Program Committee for the ISRD'2002 meeting. 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. (0.04 FTE)

DISSEMINATION ACTIVITIES: Give an invited talk at the ND2001 conference in October of 2001 on the evaluation of the neutron cross section standards. Make presentations at other meetings on the NIST standards activities. (0.01 FTE)

OTHER: NIST provides 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 FY2001, the project to identify the path forward for migrating the NNDC databases to use modern relational database software was completed. Plans for accomplishing this migration were developed in FY2001 and the migration started. As part of this task, legacy support software must be migrated and dissemination software modernized. We intend to accomplish this migration without interrupting our present electronic data access. It is expected that the task will be completed in two to three 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 2nd-order

non-unique forbidden β^\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.

Work Plan for the ORNL Nuclear Data Project for FY2002

Scientific support: 1.18 FTE

The Nuclear Data Project's program for nuclear structure evaluation, reaction data evaluation for nuclear astrophysics, and experimental nuclear structure data compilation meets the present needs and interests of the nuclear research community. Our work plan for FY2002 which is in accordance with the guidelines set by the International Nuclear Data Network and the USNDP advisors, is outlined below.

I. Nuclear Structure Evaluation (0.5 FTE)

We plan to continue our study on the systematic behavior of nuclear states and other nuclear properties in the heavy-mass region which provides needed systematics of evaluated data to use for searches for superheavy elements, a field of high current interest in the community. This survey should serve as the basis for expectations of the properties of nuclei in this region, and should help the exploration of new mass regions. Such studies will also be valuable for experiments using in the development of neutron-rich radioactive beams and in plans to study new nuclei with the use of radioactive beams, as well as stable beams. To be most useful, this systematic study requires the information given to be complete and up-to-date. The evaluations of the nuclei in the $A \geq 248$ region have been recently completed, bringing the structure information for the heaviest elements region up-to-date which is one of the high priorities set by USNDP.

The structure information in ENSDF for nuclei with mass numbers 242 and 244 which are assigned by the Network as the responsibility of the Center for Nuclear Structure and Reaction Data of Kurchatov Institute in Moscow, have not been updated since 1985 and 1986, respectively. There are new important experimental data published for these nuclei, and the Center for Nuclear Structure and Reaction Data of Kurchatov Institute has agreed to transfer their responsibility for those nuclei to the Nuclear Data Project on a temporary basis. Evaluation of $A=242$ nuclei will be completed in FY2001. We plan to evaluate the available data for nuclei with mass number 244 in FY2002.

II. Nuclear Reaction Evaluations for Astrophysics (0.48 FTE)

We plan to continue our evaluations of nuclear reactions of vital importance for studies in nuclear astrophysics. These reactions address some of the most fundamental questions in nature: what are the origins of the elements that make up our bodies and our world? How did the solar system, the sun, the stars, and the galaxy form, and how do they evolve? Progress in many such fundamental problems in nuclear astrophysics can be significantly aided by improvements in nuclear data. Our evaluation work in FY2002 will focus primarily on reactions important for understanding the nuclear burning in the interior of our sun, as well as capture reactions on radioactive isotopes on the proton-rich side of stability such as ^{25}Al and ^{33}Cl , reactions that are important for understanding the element

synthesis and energy generation in stellar explosions.

These reactions will be studied over a variety of energy ranges as required for applications in astrophysics. All cross sections that are evaluated will be provided in an ENDF-style format. All reaction rates determined will be disseminated on the WWW. Since many reactions are dominated by resonances, all recommended resonance parameters will be provided in ENDF-style formats.

III. Database and Web Interface Development; Experimental Nuclear Structure Data Compilation (XUNDF) (0.2 FTE)

We will continue to participate in the NNDC Common Web Interface working group. This initiative aims to improve the consistency of the data dissemination web interface at different NNDC sites, to provide more modern, efficient and consistent user access to the nuclear data.

Some further development of the software for semi-automatic extraction and conversion of tabular level-scheme data contained in PDF manuscripts into ENSDF-format data sets, will be done to extend its applicability, and to make it more robust and easier to use. During the course of this development, ENSDF-format data sets will be created from published papers for testing purposes, and for the XUNDL database.

The compilation and electronic dissemination of most recent data on reaction gammas will be done continuously throughout FY2002 as data become available. Upkeep of the RadWare database will be continued.

Other types of data that could be automatically or semi-automatically converted to XUNDL data sets will be investigated; these may include user-contributed level schemes in various formats.

TRIANGLE UNIVERSITIES NUCLEAR LABORATORY NUCLEAR DATA PROGRAM

Work Plan for FY 2002

NUCLEAR DATA EVALUATION PROJECT

A = 3 – 20

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

NUCLEAR STRUCTURE

FTE 1.4

- EVALUATIONS:

Evaluate $A = 10$ and distribute a preliminary version for comment.

Prepare "*Energy Levels of Light Nuclei, A = 8 - 10*" for submission to *Nuclear Physics A*.

- ENSDF:

Prepare 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 update and revise PDF documents based on the most recent review (TUNL or Fay Ajzenberg-Selove) for $A = 3 - 20$.

Provide new PDF documents for earlier Fay Ajzenberg-Selove evaluations based on $A = 16 - 17$ (86AJ04), $A = 5 - 10$ (84AJ01), $A = 11 - 12$ (85AJ01), $A = 13 - 15$ (81AJ01), and $A = 16 - 17$ (82AJ01) evaluations in conjunction with the collaboration begun in year 2000 with *Nuclear Physics A* to provide online versions of all of Fay Ajzenberg-Selove's "*Energy Levels of Light Nuclei*" publications.

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.

Provide Update Lists for $A = 14$ and 16 experimental and theoretical level information. Begin work on $A = 17 - 20$ 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 develop and 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.

NUCLEAR DATA EVALUATION PROJECT on $A = 21 - 30$

(Contingent upon approval for research and support staff)

G.E. Mitchell

NUCLEAR STRUCTURE

FTE 0.75 (estimate based on preliminary proposal)

- EVALUATIONS:

Evaluate $A = 30$ and prepare an ENSDF file for submission to Brookhaven.

DISSEMINATION

FTE 0.25 (estimate based on preliminary proposal)

Develop a website for the $A = 21 - 30$ project:

Develop an interface to distribute relevant information for $A = 21 - 30$ nuclides.

PROGRAM ON PREEQUILIBRIUM PHENOMENOLOGY

Constance Kalbach Walker

PROGRAM (Nuclear Reactions) 0.4 FTE (Senior Research Scientist).

Develop Models / Code PRECO / Global Input for Preequilibrium Rxns.

Achieve a predictive tool for continuum reactions at 14 to 200 MeV.

Use alone or in Hauser-Feshbach codes (e.g. GNASH).

RECENT ACCOMPLISHMENTS

Journal article in *Physics Review C* on surface and collective effects.

PRECO-2000 users manual reviewed by potential users prior to formal release.

FY 2002 PLANS

Continue testing/revising exciton model against (N,xN) data up to 100 MeV.
Isospin conservation.
Energy dependence of residual matrix elements.
Energy dependence of collective state model.

Time permitting; gather literature data for (N,xN) reactions up to 200 MeV.
Perform lab-cm conversions and angle integrations as needed.

FY 2002 DELIVERABLES

Journal article describing benchmarking up to 100 MeV, if work completed. (The extent of necessary changes to the model is unknown.)