

USNDP Fiscal Year 2000 Final Report



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I. Introduction

This report summarizes the work of the U.S. Nuclear Data Program (USNDP) for the period of October 1, 1999 through September 30, 2000. In September 1999, the participants of the program prepared and published a work plan for the fiscal year 2000. The plan was reviewed and approved by a panel convened by the DOE program manager on November 1, 1999. No significant changes in task definitions were made during the year.

This report consists of activity summaries for the major components of the U.S. Nuclear Data Program that were prepared by the chairs of the USNDP Working Groups and Task Forces. These summaries are followed by the work plan which is included here in its entirety with notes on the status of each commitment made by the program participants in the original plan. The final section of this report is an updated staff level assignment table that reflects the final distribution of effort among the tasks carried out during FY2000.

Total staff assigned to USNDP activities during the year was lower than anticipated by 1.27 FTE. This lower figure is largely due to later than expected arrival of newly hired staff at the National Nuclear Data Center (BNL). A new hire in support of reaction data activities did not arrive in FY2000 due to the fact that the H1-B visa quota had already been filled early in the fiscal year. Staff changes at the Isotope Project (LBNL) resulted in a significant decrease in staff assigned to dissemination activities (down .38 FTE) which was partially compensated by an increase in staff (up .22 FTE) working on nuclear structure data evaluations. At the Nuclear Data Project (ORNL), the task of supporting network nuclear structure evaluators by supplying old references only available at the Nuclear Data Project was terminated in June 2000.

This has been the first year during which the Nuclear Data Program has operated under a work plan developed by the program participants and reviewed externally. Overall, this method for determining program activities has been successful. In most cases, the work planned has been successfully carried out. The most significant failure to meet agreed goals was in the project to develop a common interface to the nuclear structure databases. This project was part of the dissemination effort involving BNL, LBNL, ORNL and San Jose State University. This activity needs to be carefully reviewed during the mid-year update to the FY2001 work plan in light of the reduced level of effort available. The late hire of a new staff member at BNL will have no long term significant effect, except to delay implementation of some reaction data evaluation plans and transfer of responsibility for reaction database maintenance.

As the following sections clearly illustrate, the nuclear data program is successfully carrying out important work in direct support of DOE missions. The work is a balance of continuing tasks of collecting, analyzing, and archiving nuclear physics information critical to basic nuclear research and to the development and improvement of nuclear technologies and electronic distribution of this information to users in a timely and convenient manner.

II. National Nuclear Data Center Operations and Coordination

The NNDC continues to serve as the core facility of the U.S. Nuclear Data Program (USNDP). While serving as the secretariat for the program, the NNDC has prepared the program work plan for fiscal year 2001. The NNDC Head continues as chair of the program Coordinating Committee, which consists of the Principal Investigators from each of the participating groups, and chaired the annual meeting of the program held at Lawrence Berkley National Laboratory in April 2000. NNDC continues to chair the Cross Section Evaluation Working Group, which produces the ENDF/B evaluated nuclear data library for applied nuclear technology use and hosted the annual meeting held at BNL in November 1999.

Staff members from the Idaho group, Los Alamos National Laboratory, and Lawrence Berkley National Laboratory chair the three working groups of the USNDP, which are responsible for coordinating the technical activities of the program. These three chairs organized the technical discussions held during the USNDP annual meeting.

The NNDC serves as the focal point for U.S. collaboration in international nuclear data activities. Staff from NNDC participated in the IAEA-sponsored Nuclear Reaction Data Center (NRDC) meeting in Obninsk, Russia in June 2000. The NRDC coordinates the compilation of nuclear reaction data and the dissemination of nuclear data worldwide. NNDC staff have served as consultants to the IAEA Nuclear Data Section and lectured at one of their training courses. A staff member from Los Alamos National Laboratory chaired an IAEA Coordinated Research Project on photonuclear data. An NNDC staff member chaired the annual meeting of the Nuclear Energy Agency's Working Party on Evaluation Cooperation in Japan in June 2000.

The NNDC operates a Compaq ALPHA 4100 computer which archives and serves the nuclear data produced by the U.S. Nuclear Data Program and the data obtained by other national and international collaborations. This facility operates 24 hours a day, 7 days a week, to provide electronic access to the data. During the past year, this service was available for 51 weeks out of the year. One week was lost due to the decision of BNL management to electronically disconnect BNL from the Internet as a result of hacker attacks.

The NNDC maintains seven nuclear physics databases for the USNDP. These databases have been updated continuously in FY2000 with new and revised information from efforts of the NNDC, the USNDP and international collaborators. Distributions of all or parts of these databases have been made to national and international collaborators as scheduled. Release 7 of the ENDF/B library was distributed on schedule. Retrievals from the network databases located at NNDC increased 41% as compared to the prior fiscal year.

A major research project to investigate commercially available database software was completed in July 2000. The objective of this study is to determine the next generation of software to be used for the nuclear databases. In September, the draft report was reviewed at a workshop held at BNL. The participants represented the NNDC international collaborators. A few issues need to be resolved before the final report is released.

III. Dissemination Summary

During the past year, there has been a continued effort to inform the research and applied communities of the wealth of nuclear data that is available, and to make this data accessible to these communities in a variety of user-friendly formats. This effort has involved giving talks at various scientific meetings about the work of the USNDP, publishing journal articles, books, and pamphlets, and the continued development of internet web sites for the dissemination of nuclear data. This effort has involved the work of many of the institutions that are members of the USNDP. The major highlights of these efforts are listed below:

- The usage of USNDP web sites has increased substantially over the past year in terms of both the number of users and the amount of data being downloaded.
- USNDP web pages have been added, updated, and improved.
- A collaborative project to develop a common web interface to the ENSDF, XUNDL, and NSR databases has been started.
- All 150 reports from the Argonne ANL/NDM Report Series (1973-Present) have been placed on the Internet at <http://www.td.anl.gov/reports/ANLNDMReports.html>.
- The 6th edition of the Nuclear Wallet Cards was published and electronic versions were placed on the web.
- LANL's medical physics work has been published in a book: "Nuclear Data for Fast Neutron and Proton Radiotherapy and for Radiation Protection," International Commission on Radiation Units, ICRU63 (2000).
- CSISRS/EXFOR Database registry system was implemented.
- Windows-95/98 version of PC-NuDat was released.
- Three contributed talks on USNDP activities were delivered at the APS/DNP meeting, Asilomar, CA, October 1999.
- One contributed talk on USNDP activities was delivered at the APS Spring meeting, Long Beach, CA, April 2000.

IV. Nuclear Structure and Decay Data Evaluation Summary

The main activity of the evaluators during the past year has involved the evaluation of the nuclear structure and decay data for mass chains and the entry of these results into the Evaluated Nuclear Structure Data File (ENSDF) with the subsequent publication in the Nuclear Data Sheets. In addition, evaluations have been carried out for priority nuclides using newly published data on superdeformed bands, and the data in new publications have been reviewed and entered into the XUNDL file. The ENSDF system has made use of data from horizontal evaluations, and its processing codes have been continuously upgraded.

Evaluations for ENSDF

The Center reports in the later sections indicate that these groups have submitted for inclusion in ENSDF evaluations for 18 mass chains and 11 nuclides for masses 20-265. The evaluators have also reviewed evaluations for 13 mass chains and 2 nuclides. In addition, the data on superdeformed bands have been submitted for three nuclides, which maintains the currency of these bands in ENSDF. The ENSDF data sets for the alpha-decay chain masses $A=267-293$ have been submitted. Below mass 20, the data for $A=1$ have been updated, the evaluations for $A=5-7$ have been distributed for review, those for $A=8-9$ are underway. TUNL has transcribed the data sets from the latest evaluation of $A=11-13$ by Selove to ENSDF.

Compilations for XUNDL

The XUNDL file includes data sets from the compilation of data from recent single papers. The McMaster group has submitted 180 data sets which are primarily, but not exclusively, for high-spin data. Of these data sets, 30 were originally coded in Grenoble, but were edited by the McMaster group. This brings the total data sets in XUNDL to 585. These evaluations are current with the published literature. These data have been entered into XUNDL by BNL.

Transfer of Evaluations for $A=21-44$ from the Utrecht Group

With the termination of the contributions from P. Endt and C. van der Leun of Utrecht University, three groups have, or will, contribute in this mass region. The group at Lawrence Berkeley National Laboratory (LBNL) has transferred the data for masses 21-39 from the most recent Endt publication to ENSDF. The Endt data for $A=40-42$ have been transferred by the McMaster group.

The group at McMaster University has taken the responsibility for the complete evaluations for the nuclides in the mass region $A=31$ through 44. Of these, the evaluations for $A=43-44$ have been completed. At the April meeting of the USNDP, the group at TUNL offered to add to their responsibility the data for the nuclides in the mass region $A=21$ through 30, if additional funding can be arranged.

Horizontal Evaluation Contributions

E0 transitions and the related nuclear structure were reviewed throughout the periodic table by John Wood. As part of this effort, he provided information to update ENSDF where the ENSDF data were not complete.

The Decay Data Evaluation Project, DDEP, which includes non-ENSDF evaluators from France, Germany, Russia, Spain, and the United Kingdom, has previously published reports with evaluations for 29 radionuclides. Evaluators from LBNL and Idaho provided ENSDF data sets to the NNDC, or the appropriate ENSDF evaluator, for these radionuclides. New evaluations have been completed for three (3) nuclides by LBNL.

Expansion of Nuclear Structure Reference File

The keyworded references included in the NSR file have been expanded by 3091.

Modification of Rules for JPI Assignments

At the international Network meeting in December 1998 at the International Atomic Energy Agency (IAEA) headquarters in Vienna, a subcommittee was established to consider and revise the rules that appear in the Nuclear Data Sheets concerning the assignment of JPI values and other related information. Since then this group has functioned within this Working Group to prepare these modifications. Except for some final wording, this work has been completed and will be reported at the next international Network meeting in December 2000, again at the IAEA headquarters in Vienna.

Improvement of Physics and Evaluation Tools

Currently discussions have been initiated concerning the calculations of the log ft values and average beta energies from the LOGFT code for 2nd and higher forbidden, nonunique transitions. This discussion has to do with the shape factor, or range of shape factors, that should be assumed for these transitions.

Persons at ORNL and McMaster have continued to develop computer methods for preparation of ENSDF data sets from the tables in published articles.

The atomic data within the RADLST code was updated by BNL, based on an evaluation of the atomic data by a DDEP evaluator.

Contact has been maintained with S. Raman, Oak Ridge National Laboratory, concerning a new program based on the work of Band and Trzhaskovskaya that has been written to calculate internal conversion coefficients, ICC's. When new ICC's are available, the ENSDF network and the DDEP will evaluate these results in order to determine whether it should make them its standard values, as well as to determine the uncertainties that should be assigned to these values.

Administrative and Other Items

Evaluators from LBNL and Idaho have provided support for the International Atomic Energy Agency through participation in its Coordinated Research Projects on prompt gamma activation analysis and decay data for detector calibration.

V. Nuclear Reaction Data Summary

Reaction Data Highlights

- ENDF/B-VI Release 7 was issued by BNL, making available numerous improved nuclear cross sections to the community. This release included LANL's new bismuth high-energy evaluation, which has application in high-energy neutron dosimetry and spallation target design.
- Nuclear reaction evaluation capabilities were re-established at BNL by installing a series of modern nuclear reaction codes on the NNDC computers. The work focused on implementing the code system EMPIRE that comprises optical model, Hauser-Feshbach with width fluctuation corrections as well as multi-step direct/compound physics, including utilities and graphical package.
- Performance of the above reaction code at BNL was tested by undertaking several partial evaluations, including fission products and reactions of astrophysical interest.
- New mercury isotope ENDF evaluations (14 in total, for incident neutrons and protons), important for ORNL Spallation Neutron Source (SNS) design, were completed through a LANL-JAERI collaboration.
- Latest version of the NJOY99 data processing code was released to the user community.
- Major parts of the ORELA total cross section measurements made prior to closing of ORELA program have been recovered by BNL and added to the experimental database.

Model Code Highlights

Nuclear reaction model codes play an important role in nuclear data ENDF evaluations, and in interpreting physics experiments. The U.S. Data Program is working to produce new state-of-the-art codes, based upon modern coding practices. These codes also incorporate some of the latest developments in nuclear reaction mechanism physics. This activity is also closely related to a Nuclear Energy Agency Working Party on Evaluation Cooperation (WPEC) project, which coordinates international research in this field. Below we highlight the progress in this field this year.

McGNASH development: The Los Alamos McGNASH fortran90 code has undergone major development this year (Chadwick). The module to calculate sequential Hauser-Feshbach decay, for an unlimited number of particle or gamma ray emissions, has been completed and tested. This required the development of modules to compute optical model transmission coefficients, nuclear level densities, nuclear masses, gamma-ray strength functions, and to make use of ENSDF nuclear level and decay information. Work on fission decay was initiated.

Preequilibrium spin distributions: Through a LANL-BNL collaboration (Chadwick and Oblozinsky), the Monte Carlo preequilibrium module used in McGNASH has been extended to include a model for preequilibrium spin distributions. This was a crucial requirement for coupling the preequilibrium and Hauser-Feshbach parts of the code (since the latter follows spins explicitly). Comparisons were made with the quantum Feshbach-Kerman-Koonin theory, as well as with other semiclassical preequilibrium models, to test and validate the approach. An accurate modeling of these processes is important for spin-dependent observables, namely isomer cross sections and cross sections for gamma-ray transitions following particle decay.

PRECO exciton model: A new version of TUNL's preequilibrium code, PRECO (Kalbach), has been completed and a first draft of extensive documentation completed. This code incorporates a vast amount of experience in the systematical properties of preequilibrium reactions, with special attention to shell and pairing effects, surface effects, collectivity, and isospin. This code will be incorporated as a module into our other statistical model codes.

Activation experiments. ANL has completed measurements at IRMM, Geel (Belgium) that will help test Hauser-Feshbach and preequilibrium theory development. A new formalism has been developed for use in assessing the sensitivity of specific nuclear model parameters to individual measured neutron activation cross sections, and statistical model calculations have begun that analyze these data.

Code intercomparisons: Livermore worked closely with Los Alamos (Dietrich and Chadwick) on the testing and validation of Hauser-Feshbach theory codes. After insuring that all input ingredients were identical between GNASH, McGNASH, and Livermore's version of the STAPRE code, they were able to obtain excellent agreement for model predictions of excitation functions and emission spectra. Similar interactions are underway with Koning and others under the auspices of the NEA WPEC project.

Collaborations with GEANIE experimentalists: GNASH was used to model $(n,xnyp .. \gamma)$ data measured at LANSCE's GEANIE gamma-ray detector by Livermore and Los Alamos experimentalists. This allowed data for Sn, Mo, Pt, U, Pu, to be interpreted in terms of various nuclear reaction mechanisms, and the results are being submitted to Phys. Rev. C for publication.

Nuclear Standards Highlights

Carlson (NIST) continued work under the auspices of the NEANSC Working Party on International Evaluation Cooperation (WPEC) Subgroup that promotes international cooperation on measurements and evaluations of the nuclear data standards. Additional experimental standards data obtained since the ENDF/B-VI standards evaluation were added to the database to be used for the standards evaluation. Evaluation of these experiments has revealed cases where corrections or changes in uncertainties should be made.

An important part of the activity associated with this program is suggesting, motivating and monitoring measurements for use in standards evaluations, largely through the WPEC. This

effort has led to new measurements which are now being made of the ^{10}B branching ratio at IRMM in the 100 keV to approximately 1 MeV neutron energy region.

Initial plans are to avoid a separate combination procedure as was done for the ENDF/B-VI evaluation. The process would be to run EDA (Hale, LANL) to convergence for both the $^6\text{Li}+n$ and $^{10}\text{B}+n$ systems. The output cross sections and their variance-covariance matrices from EDA will then be used as input to GMA; essentially the same procedure as was used for Axton's thermal constants evaluation in the ENDF/B-VI standards evaluation. The GMA output for the $^6\text{Li}+n$ and $^{10}\text{B}+n$ systems will have some scatter. That data will be fit with EDA to get the smoothed data which are required for an evaluation. Proper ways for doing the smoothing for the other data are under consideration.

Progress was made in setting up the IAEA Coordinated Research Program (CRP) which will study some of the standards problems and ultimately perform the evaluation. An important goal of a CRP on this topic would be to build wider confidence in the realism of the uncertainty assignments in the final results.

Some highlights of work underway on this project are:

- 50 new data sets not used in the last evaluation have been identified. Eleven (11) have been reviewed, 21 are being reviewed and 18 are awaiting final data.
- The CRP proposal appears to have been a success. The agenda for the Consultants' Meeting next February (which precedes the CRP) is being defined.
- The work on the hydrogen angular distribution at 10 MeV has been submitted for publication.
- A new measurement of the hydrogen (n,p) angular distribution at 15 MeV is being designed to help resolve discrepancies in this standard.

VI. Nuclear Astrophysics Data Summary

A number of efforts by U.S. Nuclear Data Program (USNDP) personnel either directly or indirectly help improve our understanding of stellar explosions, the interior of our sun, Red Giant stars, or other exciting astrophysical phenomena. This work includes evaluations of particular nuclear reactions and nuclear structure properties, development of nuclear models to calculate unmeasured properties, dissemination in formats requested by astrophysicists and in standard NNDC formats, and assistance in the design of next-generation experimental facilities. The work done by members of the Nuclear Astrophysics Data Task Force spans the activities done within the USNDP Nuclear Reaction, Nuclear Structure, and Dissemination Working Groups.

Nuclear Reaction Data

In a collaboration of ANL and Hiram College, a compilation of data for the $^{31}\text{P}(p,\gamma)$ reaction has been completed and written up as an ANL internal report available on the WWW. An evaluation of the resonance parameters for the $^{31}\text{P}(p,\gamma)$ and $^{31}\text{P}(p,\alpha)$ reactions is nearly completed, and an evaluation of the non-resonant components of these reaction cross sections is underway. A Hauser-Feshbach (HF) code has been acquired from RSICC to be used for calculation of astrophysical reaction rates in the continuum energy domain. A new formalism has been developed for dealing with large errors that are often encountered in nuclear astrophysics reaction rates, and a collaboration led by ORNL is utilizing this technique for simulations of nova explosions.

At LANL, work is underway to resolve the puzzle surrounding the $^{12}\text{C}(\alpha,\gamma)$ E1 and E2 capture at stellar energies using R-matrix methods. This reaction is crucial in helium burning in red giants, influencing the evolution and eventual fate of most massive stars; it is widely considered one of the most important reactions in nuclear astrophysics. They have found that the $^{12}\text{C}(\alpha,\gamma)$ cross section was not sensitive to the E1 capture parameters, and the E2 capture is now being included in the calculation. The n-p capture is also being investigated – a crucial reaction in Big-Bang nucleosynthesis. This analysis is near completion: currently, new TUNL experimental results for the M1 to E1 ratio are being folded into their capture rate. They are also initiating analysis to predict the $^7\text{Be}(p,\gamma)^8\text{B}$ cross section, very important for the solar neutrino problem, and collaborating with ORNL to understand a recent measurement of the (inverse of the) $^{14}\text{O}(\alpha,p)^{17}\text{F}$ reaction important for novae and X-ray bursts. They are also using HF methods to calculate photonuclear reactions (including silicon) important to nucleosynthesis studies, which will be completed next year. Finally, an improved fission model has been developed which may influence the termination of the r-process.

At ORNL, evaluations of the $^{18}\text{F}(p,\gamma)$ and $^{18}\text{F}(p,\alpha)$ reactions, important for understanding stellar explosions, and $^{17}\text{O}(p,\gamma)$ and $^{17}\text{O}(p,\alpha)$ reactions, important for understanding the evolution of Red Giant Stars, are in progress. The reactions on ^{18}F are incorporating the latest exciting new experimental results with an ^{18}F beam from ORNL's Holifield Radioactive Ion Beam Facility. The evaluations will be put into formats requested by astrophysicists and distributed over the WWW. Evaluated cross sections for the 19 reactions important for the solar neutrino problem are being converted into reaction rates, parameterized, and compared to analytical

approximations and to other rate evaluations. ORNL is also leading a novel effort to gauge the influence of nuclear reaction rate uncertainties (such as those determined from detailed cross section evaluations) on nucleosynthesis predictions in novae.

Nuclear reaction databases are crucial for astrophysics studies. The NNDC completed ENDF/B-VI Release 7 with numerous new evaluated cross sections. The NNDC also has updated the CSISRS database containing experimentally measured nuclear reaction data in low- and intermediate-energy regions. For example, the compilation of charged-particle reaction data by the European NACRE collaboration – incorporating 86 reactions crucially important for nuclear astrophysics – has been incorporated into the NNDC databases. The NNDC has also compiled data from 36 charged-particle reactions and 10 neutron reactions and put them into CSISRS. Some of these reactions are important for astrophysics. A significant effort is also underway to add legacy measurements of neutron-induced reactions (some important for astrophysics) at the Oak Ridge Electron Linear Accelerator (ORELA) to the NNDC databases.

Nuclear reaction model codes play an important role in nuclear data ENDF evaluations, and in interpreting experimental results. The USNDP is working to produce new state-of-the-art codes such as Hauser-Feshbach (HF) statistical model codes incorporating some of the latest developments in nuclear reaction mechanism physics. These codes are extremely useful in calculating cross sections of reactions of astrophysical importance that have not been measured in the laboratory, and for interpretation of the latest experimental measurements. Much of this work is proceeding at LANL and TUNL; LLNL is also working on developing a platform-independent HF code. Nuclear reaction evaluation capabilities were also re-established at NNDC by installing a series of modern nuclear reaction codes on their computers. These codes were used to partially evaluate a number of reactions, including some of astrophysical interest.

In related work, the design of future radioactive ion beam (RIB) facilities, such as the Rare Isotope Accelerator (RIA), requires high-quality nuclear reaction data both for RIB target and facility design. LANL has developed improved model code tools enabling, for example, far more accurate predictions of radionuclide production in RIB targets. They have worked with ORNL, ANL, and LBNL researchers on RIB facility design projects. They are also exploring ways in which material science research at LANL can be coupled to nuclear physics algorithms in MCNPX to improve modeling of the release of radionuclides from production targets.

Nuclear Structure Data

The updated ENSDF database was distributed in February 2000 by the NNDC, as was a new version of the Nuclear Wallet Cards in January 2000. TUNL and LANL collaborated on new $A=5$ and $A=6$ evaluations, and $A=7$ is being finalized. TUNL is also preparing $A=11-13$ evaluations. When finished, these will be added to their extremely valuable collection of online evaluations. LBNL is working on decay data sets for seven (7) nuclides of astrophysical interest.

Dissemination

LANL has added light charged-particle cross sections and reaction rates, some of which are important to astrophysics, to their T2 web site. TUNL has added PDF versions of documents of $A=3-20$ evaluations to their website, along with a new reference update list for $A=5-12$. LBNL has put the valuable evaluations for $A=21-39$ performed by the Utrecht group into ENSDF format and included them into the database. These evaluations are very important for nuclear astrophysics, especially for calculating the cross sections of charged-particle reactions on stable and proton-rich isotopes in this mass range.

USNDP Level of Effort for October 1999 through September 2000

	ANL	BNL	Idaho	LANL	LBNL	LLNL
		Sci/Pro	Support			
I. NNDC Facility Operation	0.00	1.40	1.35	0.00	0.00	0.00
Management		0.45				
Secretarial/Administrative Support			1.00			
Library			0.35			
Computer Operation		0.70				
NT Server Operation		0.25				
II. Coordination	0.00	0.55	0.00	0.30	0.30	0.00
National Coordination		0.35		0.05	0.1	0.3
International Coordination		0.20		0.05	0.2	
III. Nuclear Physics Databases	0.00	2.55	1.50	0.00	0.00	0.00
Nuclear Science References (NSR)		0.15	0.75			
Experimental Nuclear Structure Data (XUNDL)		0.10				
Evaluated Nuclear Structure Data (ENSDF)		0.30	0.60			
Numerical Nuclear Data (NuDat)		0.10				
Reaction Data Bibliography (CINDA)		0.15	0.05			
Experimental Reaction Data (CSISRS)		0.05	0.10			
Evaluated Nuclear Data File (ENDF)		0.20				
Database Software Maintenance		0.65				
Future Database Systems		0.85				
IV. Information Dissemination	0.00	1.55	0.50	0.10	0.62	0.00
Maintenance of Remote Access to USNDP Data	0.00	0.25				
Telnet Service		0.05				
WWW Service		0.20				
Customer Services		0.15	0.45			
Web Site Maintenance		0.15	0.05		0.10	0.40
Common ENSDF Web Interface	0.00	0.10			0.00	0.22
Interface to Isotope Explorer JAVA Applet		0.10				
MacNuclide Project						
Isotope Explorer Project						0.22
APS Link to NNDC Experimental databases		0.65				
Nuclear Reaction Data on a CD-ROM						
Nuclear Wallet Cards, 2000 edition		0.20				
Windows Version of PC-NuDat		0.05				

USNDP Level of Effort for October 1999 through September 2000

	McMaster	NIST	ORNL		SJSU	TUNL	Program Total	
			Sci/Pro	Support			Sci/Pro	Support
I. NNDC Facility Operation	0.00	0.00	0.00	0.00	0.00	0.00	1.40	1.35
Management							0.45	0.00
Secretarial/Administrative Support							0.00	1.00
Library							0.00	0.35
Computer Operation							0.70	0.00
NT Server Operation							0.25	0.00
II. Coordination	0.00	0.00	0.00	0.00	0.00	0.00	1.25	0.00
National Coordination							0.80	0.00
International Coordination							0.45	0.00
III. Nuclear Physics Databases	0.00	0.00	0.00	0.00	0.00	0.00	2.55	1.50
Nuclear Science References (NSR)							0.15	0.75
Experimental Nuclear Structure Data (XUNDL)							0.10	0.00
Evaluated Nuclear Structure Data (ENSDF)							0.30	0.60
Numerical Nuclear Data (NuDat)							0.10	0.00
Reaction Data Bibliography (CINDA)							0.15	0.05
Experimental Reaction Data (CSISRS)							0.05	0.10
Evaluated Nuclear Data File (ENDF)							0.20	0.00
Database Software Maintenance							0.65	0.00
Future Database Systems							0.85	0.00
IV. Information Dissemination	0.00	0.00	0.10	0.00	1.20	1.40	4.97	0.50
Maintenance of Remote Access to USNDP Data							0.25	0.00
Telnet Service							0.05	0.00
WWW Service							0.20	0.00
Customer Services							0.15	0.45
Web Site Maintenance			0.10			1.40	2.15	0.05
Common ENSDF Web Interface					1.20		1.52	0.00
Interface to Isotope Explorer JAVA Applet							0.10	0.00
MacNuclide Project					1.20		1.20	0.00
Isotope Explorer Project							0.22	0.00
APS Link to NNDC Experimental databases							0.65	0.00
Nuclear Reaction Data on a CD-ROM							0.00	0.00
Nuclear Wallet Cards, 2000 edition							0.20	0.00
Windows Version of PC-NuDat							0.05	0.00

USNDP Level of Effort for October 1999 through September 2000

	ANL		BNL		Idaho	LANL	LBNL	LLNL
	Sci/Pro	Support	Sci/Pro	Support				
V. Nuclear Structure Physics	0.00	0.00	2.50	0.00	0.30	0.00	2.52	0.00
NSR Abstract Preparation			0.50	0.00				
Compilation of Experimental Structure Data								
Evaluation of data for ENSDF			1.80		0.30		2.52	
Mass Chains and Nuclides			1.70		0.25		1.77	
Ground and Metastable State Properties			0.10					
Radioactive Decay Data Evaluation					0.05		0.25	
Thermal Capture Gamma Data Evaluation							0.30	
Entering Endt Data into ENSDF							0.20	
ENSDF Physics and Checking Codes			0.20					
VI. Nuclear Reaction Physics	1.10	0.85	0.25	0.25	0.00	1.10	0.00	0.40
Experimental Data Compilation		0.40	0.25					
Neutron Data		0.10	0.25					
Charged Particle Data		0.25						
EXFOR Manuals		0.05						
Compilation of RHIC and TJNAF Data		0.05						
ENDF Manuals and Documentation		0.05						
ENDF Evaluations						0.10		
Nuclear Reaction Standards								
Nuclear Model Development	0.40					0.40		0.40
Evaluation of Data Needed for Astrophysics	0.70	0.35				0.40		
Reaction Data for RIB Target Design						0.20		
DOE/Science Nuclear Data Funded Staff	1.10	9.40	3.60	0.40	0.40	1.50	3.44	0.40
Staff Supported by Other Funding		0.35	0.40				1.00	
TOTAL STAFF	1.10	9.75	4.00	0.40	0.40	1.50	4.44	0.40

USNDP Level of Effort for October 1999 through September 2000

	McMaster	NIST	ORNL		SJSU	TUNL	Program Total	
			Sci/Pro	Support			Sci/Pro	Support
V. Nuclear Structure Physics								
NSR Abstract Preparation	0.50	0.00	0.60	0.19	0.00	1.15	7.57	0.19
Compilation of Experimental Structure Data	0.05		0.10				0.50	0.00
Evaluation of data for ENSDF	0.45		0.50	0.19	0.00	1.15	6.72	0.19
Mass Chains and Nuclides	0.45		0.50	0.19		1.15	5.82	0.19
Ground and Metastable State Properties							0.10	0.00
Radioactive Decay Data Evaluation							0.30	0.00
Thermal Capture Gamma Data Evaluation							0.30	0.00
Entering Endt Data into ENSDF							0.20	0.00
ENSDF Physics and Checking Codes							0.20	0.00
VI. Nuclear Reaction Physics								
Experimental Data Compilation	0.00	0.20	0.40	0.00	0.00	0.40	4.45	0.25
Neutron Data							0.40	0.25
Charged Particle Data							0.10	0.25
EXFOR Manuals							0.25	0.00
Compilation of RHIC and TJNAF Data							0.05	0.00
ENDF Manuals and Documentation							0.05	0.00
ENDF Evaluations							0.10	0.00
Nuclear Reaction Standards		0.20					0.20	0.00
Nuclear Model Development						0.40	1.60	0.00
Evaluation of Data Needed for Astrophysics			0.40				1.85	0.00
Reaction Data for RIB Target Design							0.20	0.00
DOE/Science Funded Staff	0.50	0.20	1.10	0.19	1.20	2.95	22.19	3.79
Staff Supported by Other Funding	0.50	0.80	0.00	0.00	0.00	0.00	2.65	0.40
TOTAL STAFF	1.00	1.00	1.10	0.19	1.20	2.95	24.84	4.19

Detailed Status of Work Plan

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 computer to support our compilation, evaluation, database maintenance and information dissemination functions. Task includes software upgrades, hardware and software procurements, machine operations and internal user support.

BNL Deliverables:

Upgrade to version 7.2 of VMS and install related required software upgrades.
Keep downtime to less than 3%.

Status:

- Upgrade to version 7.2 of VMS completed.
- Lost one (1) week external access due hacker attacks on BNL with subsequent disconnect of BNL from the Internet.

D. NT Server Operation

The NNDC operates a DELL Work Station running WINDOWS-NT and WINCENTER software as a multi-user PC software server with output to staff X-window terminals. Task includes software upgrades and internal user support.

Status:

- WINCENTER concept abandoned due to multi-user implementation conflicts for critical software. WINCENTER has been converted to a LINUX server to be used as a test platform for NNDC software migration project.
- All staff now have a PC with an X-terminal emulator. Considerable extra effort was required for the migration due to problems with purchased hardware and some incompatibilities of installed software.

II. Coordination

A. National Coordination

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

BNL Deliverables:

- Prepare FY2000 work plan for USNDP and present to DOE review.
- Prepare FY2001 work plan for USNDP in time for FY2001 FWP submittals.
- Participate in USNDP Steering Committee Meeting.
- Chair USNDP Meeting at LBNL in April 2000.
- Organize and chair CSEWG Meeting at BNL, November 1999.
- Maintain USNDP WWW-site.

Status:

- FY2000 work plan for USNDP completed and presented to DOE review on Nov 1. FY2001 work plan for USNDP distributed April 1, 2000.
- No Steering Committee meetings were held in FY2000
- Charles Dunford organized and chaired CSEWG Meeting at BNL, November 1999.
- Charles Dunford chaired the USNDP meeting at LBNL in April 2000.
- Organized and maintained USNDP2000 Meeting Web site.
- USNDP WWW-site has been updated as contributions were received.

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, LBNL, April 2000.

Status:

- Nuclear Structure Working Group session organized and chaired.

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 USNDP Steering Committee. Chair Evaluation Committee of the Cross Section Evaluation Working Group.

LANL Deliverables:

Prepare FY2000 Reaction Working Group Work Plan, with BNL, for review by DOE.

Participate in USNDP Steering Committee meetings.

Organize and chair CSEWG Evaluation Committee meeting at BNL, November 1999.

Organize and chair Nuclear Reaction Working Group meeting at USNDP meeting at LBNL, April 2000.

Status:

- Prepared FY2000 Reaction Working Group Work Plan, with BNL and participated in plan review meeting.
- Organized and chaired CSEWG Evaluation Committee meeting at BNL, November 1999.
- Nuclear Reaction Working Group session organized.

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. LBNL staff members serve as an advisor to USNDP Steering Committee. 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 at LBNL, April 2000.

Status:

- Organized three contributed talks on USNDP activities at APS/DNP meeting, Asilomar, CA, October 1999.
- Organized one contributed talk on USNDP activities at APS Spring meeting, Long Beach, CA, April 2000.
- Data Dissemination Working Group session organized.
- Served as local organizer and host for USNDP meeting at LBNL, April 2000.

B. International Coordination

BNL -- Member of Nuclear Reaction Data Center Network (NRDC), Member Nuclear Structure and Decay Data Network (NSDD), Advisor to U.S. Member of the International Nuclear Data Committee (INDC), incoming Chair of NEA Working Party on Evaluation Cooperation (NEA WPEC), participation in IAEA sponsored activities.

BNL Deliverables:

Participate in meeting of NRDC in Obninsk, Russia, June 2000.

Chair NEA Working Party on Evaluation Cooperation in Tokai, Japan in June 2000.

Lecture at IAEA training course on Online Nuclear Data Services, December 1999.

One consultancy to IAEA Nuclear Data Section, December 1999.

Status:

- Tom Burrows lectured at IAEA training course on Online Nuclear Data Services.
- Tom Burrows completed a consultancy at the IAEA Nuclear Data Section in December 1999.
- Vicki McLane and Pavel Oblozinsky attended the NRDC meeting in Obninsk, Russia.
- Charles Dunford chaired WPEC meeting at JAERI, Japan and participated in the International Advisory Committee meeting for the 2001 International Nuclear Data Conference.
- Pavel Oblozinsky served as advisor to the U.S. member of the INDC at a meeting in Vienna in June 2000.

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.

Status:

- Initiated discussion of U.S. contributions to items for the agenda for the December 2000 meeting of the International Nuclear Structure and Decay Data Evaluators Network.
- Chaired the international Decay Data Evaluation Project, DDEP, including: organizing a Project meeting in May in Braunschweig, Germany.

LANL -- Participate in, and chair, international nuclear reaction data collaborations. This ensures that the U.S. benefits from breakthroughs around the world, and plays a leadership role in new developments. LANL staff members chair WPEC (NEA) committees in fission spectra, and international model code development cooperation; and chair IAEA coordinated research projects 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 evaluation meeting in Japan in May 2000.

Chair IAEA photonuclear data CRP in Japan, October 1999; complete IAEA "TECDOC" report.

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.

Status:

- Had to cancel NEA and INDC participation because of Los Alamos Cerro Grande fire.
- IAEA photonuclear data CRP completed. IAEA “TECDOC” report has been submitted for publication.
- Latest version of NJOY data processing code, NJOY99 has been released.
- Several international collaborators in the evaluation of nuclear data have come to LANL.

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 monthly.

Status:

- Twelve NSR database distributions have been made.

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.

Status:

- The database presently contains 562 data sets contributed by McMaster.

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.

Status:

- Database distributed in February and August 2000.

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.

Status:

- Database distributed in February and August 2000.

E. 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:

CINDA exchange files from cooperating centers will be added to the database on a regular basis.

Status:

- Four CINDA exchange file sent by BNL and eight received from cooperating centers. All have been included in the CINDA database.

A project CINDA2001 has been initiated to modernize the database and expand it to cover charged particle and photonuclear data references presently stored elsewhere.

BNL Deliverables:

Database design will be completed.

Database update codes will be completed and tested.

Database retrieval codes will be completed in FY2001.

Status:

- Database contents have been specified and agreed by Nuclear Reaction Data Center network (NRDC).
- A relational database schema has been designed. It is currently being reviewed by the NRDC.

Explanation:

The migration to CINDA2001 will be an integral part of the modernization of the NNDC nuclear databases. It will be closely linked to the experimental and evaluated databases, CSISRS and ENDF. The user interface to these three databases will be integrated. The NRDC will share in the software migration activity.

F. Experimental Reaction Data File (CSISRS)

The NNDC is responsible for maintaining the CSISRS database. This database contains experimentally measured nuclear reaction data covering the low- and intermediate-energy regions. Experimental data is compiled by many groups worldwide and exchanged 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.

Status:

- Twenty-two EXFOR exchange tapes have been sent by NNDC. Fifteen tapes were received from cooperating centers. All tapes were added to the EXFOR database.

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. Some evaluations cover energies up to 150 MeV. A limited number of evaluations 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.

BNL Deliverables:

Release 7 of the ENDF/B-VI evaluated data library will be issued.

Status:

- Release 7 of the ENDF/B-VI evaluated data library was distributed.

H. Database Software Maintenance

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

I. Future Database Systems

The NNDC is assessing new database software and computer platforms in order to determine the future directions that our database and computer activities should take. Effort includes the operation of "experimental" computing systems and development of prototype databases for various available database software packages. The effort is co-funded by Clark University.

BNL Deliverables:

Final report and recommendations are due July 1, 2000.

Status:

- Draft final report completed and distributed to co-sponsor of project (Brenner, Clark U.) and to international nuclear dissemination centers for review.
- Database software selection has been narrowed to SyBase and Caché.
- Workshop, co-sponsored by NEA, was held in September to review the report and discuss international collaboration to implement final recommendations.

Explanation:

Final report and recommendations of the database software investigation will be issued in December 2000. The proceedings of the workshop including contributions, conclusions and recommendations will be issued in November.

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.
- Add HTML and GIF output from MIRD interface on WWW.
- Improved tabular output from ENSDF and XUNDL databases on WWW.

Status:

- HTML and GIF output added to MIRD interface on WWW. Links to MIRD data for parent and daughter nuclides and related data in CSISRS, ENSDF, NSR and NuDat databases added.
- Prototype implementation of improved WWW tabular output from ENSDF and XUNDL being tested.

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:

None promised.

Status:

- Placed all 150 reports from the Argonne ANL/NDM Report Series (1973-Present) on the Internet in PDF format. Available at:

<http://www.td.anl.gov/reports/ANLNDMReports.html>

- Established a new Internet site, within framework of the USNDP that is identified as "Experimental Resources for Nuclear Data Studies in the United States." Available at:

<http://www.td.anl.gov/nres/>

BNL Deliverables:

Effort required to keep the USNDP and the NNDC site current.

Status:

- Site updated monthly.

LANL Deliverables:

Include access to new reaction and structure data evaluations, supported by DOE/Nuclear Physics, via the T-2 WWW site.

Add access to ENDF/B-VI, Release 6.

Complete development of "readable" output from ENDF formatted information.

Improve color data plotting capability.

Status:

- New light charged-particle cross sections and reaction rates, and high energy evaluations up to 150 MeV are now on the T2 web-site.
- Access to ENDF/B-VI, Release 6 has been implemented.
- Improved "readable" output from ENDF formatted information now available.
- Improve color data plotting capability completed.

LBNL Deliverables:

Continue development of WWW Table of Radioactive Isotopes.

Add bremsstrahlung database.

Add electron database.

Add genetic Feedings database.

Complete JAVA spectrum server.

Develop website for compiled capture gamma data as part of IAEA CRP.

Update Table of Superdeformed Bands and Fission Isomers with revised information prepared by McMaster.

Status:

- Added electron database, installed JAVA applets for serving to the WWW Table of Radioactive Isotopes. Other WWW Table of Radioactive Isotopes activities are under continuing development.
- Capture gamma website undergoing beta testing.
- Table of Superdeformed Bands waiting for updated information from McMaster.

ORNL Deliverables:

Investigate possibility of providing high quality graphical output of nuclear structure for web interfaces in conjunction with LBNL, BNL and SJSU.

Status:

- Software for creating RadWare-style graphical layouts of level schemes from ENSDF data sets has been rewritten in the C programming language. This was previously done in FORTRAN, using a specially-modified version of the program FCONV. Rewriting the code has greatly reduced the complexity and size of the source, and should significantly enhance the interfacing of these functions with web servers. It will also aid in the requirements for keeping up-to-date with modifications in the RadWare code base, which is all in C.
- Using these new codes, enhancements to the automatic graphical layout algorithms are being explored.

TUNL Deliverables:

Add PDF versions of most recent review publications for $A = 4, 11, 12, 14,$ and 15 .
Add reference updates lists for $A = 10$ through 15 .

Status:

- Preprint versions of the $A = 5, 6,$ and 7 reviews are posted in PDF format.
- "*Energy Levels of Light Nuclei: $A=5-7$* " to be submitted to Nucl. Physics A.
- "*Energy Levels of Light Nuclei*" series is also being provided in HTML format with dynamic links to journal articles via the NSR.
- PDF versions of documents of evaluations for $A=3-20$ now available on TUNL site.
- Reference update list for $A=5-12$ now completed.

Common ENSDF Web Interface

During FY2000, BNL, LBNL, ORNL, and SJSU will begin the development of the common web interface to the ENSDF, XUNDL and NSR databases. Three previously separate relevant tasks have been combined under this new project. These tasks are items D, E and F below. A plan outlining responsibilities and commitments for each of the four organizations will be completed before the end of 1999. Some of the following tasks may be redefined and

resources reallocated as a result of the implementation of this new activity. The Work Plan for FY2000 will contain the details agreed in the upcoming planning exercise.

D. Interface to Isotope Explorer Java Applet

NNDC will extract information from ENSDF or XUNDL databases and serve this information in the format required by the IE Java Applet served from LBNL.

BNL Deliverable:

Applet interface completed and implemented.

Status:

- Prototype ENSDF interface designed using samples downloaded from LBNL.
- NSR interface completed.

Explanation:

ENSDF interface still in prototype phase because required format and syntax specifications were not received from LBNL.

NSR interface not implemented because of critical comments from LBNL.

E. MacNuclide Project

MacNuclide is a PC-based nuclear data visualization tool being developed at San Jose State University (SJSU). Current developments emphasize Java technology and the creation of applets to be run over the WWW.

SJSU Deliverables:

Test and release of a platform independent Java-based version of MacNuclide.

Develop a database applet from MacNuclide database software.

Develop a chart applet interface using MacNuclide software.

Status:

- Completed platform compatibility tests for Java-based version of MacNuclide.
- Investigated use of stand-alone version of MacNuclide database engine.
- Installed interactivity in nuclide chart applet.
- Studied use of chart applet on other web pages.
- Testing RMI technology in MacNuclide database engine.

F. Isotope Explorer Project

The Isotopes Project has developed a PC-based software for displaying data from ENSDF and references from NSR. A WWW-based version of this software is also available.

LBL Deliverables:

Isotope Explorer 2 -- Port from Borland to MFC compiler.

Isotope Explorer 3 -- Add table-sorting capability.
Provide a chart module as now exists in IE2.
Begin development of common web interface to
ENSDF and XUNDL databases.

Isotope Explorer Reference Server -- Add links to additional journals.
Add new reference search criteria.

Status:

- **Isotope Explorer 2** -- modules for displaying level schemes and nuclear charts have been ported from Borland to the MFC compiler and are undergoing beta testing
- **Isotope Explorer 3** -- Table-sorting and chart modules have been developed.
- **Isotope Explorer Reference Server** -- not yet done.

Explanation:

- Delivery delayed because of decrease in manpower available.

G. 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 develop the ability to then go from the Phys. Rev. abstract/article to the NNDC database where data mentioned in the publication will be archived.

BNL Deliverable:

Prototype system in operation.

Status:

- APS – NNDC link completed and tested.
- Database access still under construction.
- Client side of the associated authors' submittal form completed and tested; server side still needs to be done.

H. Nuclear Reaction Data on a CD-ROM

The IAEA's Nuclear Data Section is planning to provide experimental and evaluated nuclear reaction cross sections from the CSISRS and ENDF databases on a CD-ROM with the necessary programs to retrieve and display the data. NNDC will participate in this project. The data display software was developed at the Ukrainian Nuclear Data Center in Slavutych.

BNL Deliverables:

Provide experimental data retrieval and formatting software necessary for input to the display program.
Test finished product.

Status:

- IAEA adopted a solution that did not require NNDC assistance.

I. Nuclear Wallet Cards

The last edition of the Nuclear Wallet Cards was published in 1995. The initial printing has been exhausted. NNDC plans to issue an updated edition in this fiscal year.

BNL Deliverables:

Publish of sixth edition of the Wallet Cards in Spring 2000.
Place an electronic version on the NNDC WWW site.

Status:

- Sixth edition of the Wallet Cards has been published; the electronic version put on NNDC web site.

J. Windows Version of PC-NuDat

The present version of the NNDC PC-based NuDat database operates under MS-DOS only.

BNL Deliverables:

A Windows-95/98 version of PC-NuDat will be released.

Status:

- Windows-95/98 version of PC-NuDat has been released.

V. Nuclear Structure Physics

A. NSR Abstract Preparation

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

BNL Deliverables:

NNDC -- Keyword abstracts for 3600 references will be prepared in FY2000.

Status:

- 3091 references keyworded in FY2000.

Explanation:

Contributions from Russia and Japan have been received but not yet included in the database. These are secondary references (conferences, reports) with some local language journals.

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.

Status:

- About 150 data sets (in ENSDF format) from current publications were prepared at McMaster and submitted to BNL for inclusion in XUNDL database. Another 30 data sets were initially prepared at Grenoble, but were thoroughly checked and edited at McMaster prior to inclusion in XUNDL.

ORNL Deliverables:

Improved 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.

Status:

- Software is developed for semi-automatic extraction of tabular level-scheme data in PDF manuscripts into ENSDF-format data sets. Documentation is written and is available at <http://radware.phy.ornl.gov/t2e.html>.

C. Data Evaluation

The USNDP evaluates nuclide and mass chain nuclear structure and decay data for inclusion in the ENSDF database.

BNL Deliverables:

- Three and one-half equivalent mass chains will be evaluated.
- Four equivalent mass chains will be reviewed.
- Two physicists will be trained in evaluation

Status:

- 2.0 mass chains have been submitted for review.
- Seven mass chains and two nuclides have been reviewed.
- One physicist has been trained for ENSDF evaluation work.

Explanation:

The two remaining evaluations committed by NNDC were submitted in October 2000.

Idaho Deliverables:

- Evaluate one mass chain and one nuclide.
- 1-2 equivalent mass chains will be reviewed.

Status:

- Evaluation of mass A=161 is complete and published.
- Evaluation of priority nuclide ^{156}Er completed.

LBNL Deliverables:

- Eight equivalent mass chains and seven nuclides will be evaluated.
- Three equivalent mass chains will be reviewed.

Status:

- Evaluations for A = 83, 92, 169, 215, 219, 223, 227, and 231 mass chains added to or submitted for inclusion in ENSDF.
- Evaluations for ^{81}Zr , ^{166}W , ^{179}Ta , ^{183}Hg , ^{187}Pb , ^{191}Bi , and ^{191}Po nuclides added to or submitted for inclusion in ENSDF.
- Evaluation of A = 265 – 293 alpha decay chains included in ENSDF.
- Three mass chains were reviewed.

McMaster Deliverables:

1.5 equivalent mass chains (including some in the A=40-44 region) will be evaluated.
One equivalent mass chain will be reviewed.
Super-deformed data in ENSDF will be updated.

Status:

- Evaluation of four full-length mass chains (A=164, 130, 43, 42) and ^{65}Zn as nuclide update was completed and submitted to BNL for inclusion in ENSDF. These are currently at review stage.
- Old evaluation of A=1 was updated with the addition of extensive bibliography for data on neutron and proton.
- For A=40, 41 and 42, Endt's 1998 update (Nucl. Phys. A633, 1 (1998)) was coded and included in ENSDF.
- Two mass chains (A=148 and 92) were reviewed.
- Data on superdeformed bands are continuously being updated as these appear in the literature, e.g. data for ^{65}Zn , ^{130}Ce , and ^{164}Lu were revised in ENSDF.

Explanation:

Since the last complete update (in September 1999) of SD bands in ENSDF, only selected SD band data published from September 1999 to September 2000 were updated in ENSDF. The updating of the SD band data now seems to require additional effort, since some of the newer papers report interconnection of these bands to the normal deformed structures. Inclusion of such data amounts to almost complete nuclide update as e.g., in 36AR, 59Cu, 136Nd, etc.

ORNL Deliverables:

A = 250, 254, 258 and 262 will be evaluated.

Status:

- Evaluation for A = 254, 258 and 262 have been completed and submitted for inclusion in ENSDF.
- Evaluations for A>266 were reviewed.

Explanation:

Evaluations of A = 250 nuclei are almost complete: final conclusions from two decay experiments and one reaction data are to be completed by two experimental groups soon. It is felt that inclusion of these data would be valuable enough to postpone the submission of A = 250 evaluation by about two-three months.

TUNL Deliverables:

Publish evaluations for A = 5, 6, and 7 and submit results for inclusion in ENSDF.
Evaluate masses 8 and 9. (This goal was revised in the Mid-Year Addendum).
Prepare ENSDF files for A = 8 through 13.

Status:

- Distributed preprint version of A= 5, 6, and 7 for review.
- Review of A = 8 and 9 nuclei in progress.
- Submitted A = 11-13 ENSDF files.
- ENSDF file for A = 14 should be completed by the end of the year.

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 and ENSDF databases.

Status:

- Data revisions for the new edition of the Wallet Cards have been included in the NuDat database.

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 U.S.

LBNL Deliverables:

Decay data sets for 7 nuclides of astrophysical interest will be evaluated.
Adopted and decay data sets for 4 nuclides will be coded into ENSDF format.
Host a training session for new evaluators organized jointly with INEEL.

Status:

- ENSDF decay data sets for ^{223}Ra , ^{227}Ac , and ^{227}Th completed; 4 other decay sets are approximately 25% complete.
- Adopted and decay data sets for ^{68}Ga , ^{68}Ge , ^{125}I , and ^{141}Ce coded into ENSDF format.
- Training session successfully completed.

Idaho Deliverables:

Decay data sets for 5 nuclides will be evaluated.

Status:

- Evaluation of five nuclides has been completed.
- Converted the results of 20 evaluations into ENSDF data sets.
- Assisted in the training of three new evaluators from Spain and the United Kingdom.

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 is to evaluate thermal and cold (n, γ) data sets for stable nuclei.

LBNL Deliverables:

Thermal neutron capture gamma data sets for $Z < 22$ will be submitted for inclusion in ENSDF.

Status:

- Evaluations in progress.

Explanation:

- Delivery delayed due to IAEA Coordinated Research project decision to deliver all data sets at a single date in Spring 2002.

G. Entering Endt Data into ENSDF

Evaluations performed by the Utrecht group for $A = 21$ through $A = 44$ are published in Nuclear Physics but not coded in the ENSDF format. LBNL is entering reaction data sets from the 1998 update for $A = 21$ through $A = 39$ into the ENSDF format.

LBNL Deliverables:

Data sets for masses 21 through 39 will be submitted for inclusion in ENSDF.

Status:

- Data sets for masses 21 through 39 have been submitted for inclusion in ENSDF.

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.

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 120 charged-particle reaction publications.
- Compile data from 30 neutron reaction publications.

Status:

- Data from 180 charged-particle reaction publications have been compiled.
- Data from 37 neutron reaction publications have been compiled.

B. Compilation of RHIC and TJNAF Data

For several years, the NNDC has maintained a small pilot project to investigate the compilation of high-energy data measured on the BNL AGS. With the start up of the RHIC facility coming in FY2000, it is timely to determine whether there is enough support in the RHIC community to begin a long-term compilation activity and to determine what physical quantities measured experimentally need to be archived.

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:

- The ENDF format manual will be updated and an electronic version placed on the WWW.
- The ENDF summary documentation will be updated and an electronic version placed on the WWW.
- A manual section on polarization data will be completed.

Status:

- The ENDF format manual has been updated. The conversion to WORD in preparation for posting on the Web is 50% complete.
- Work has begun on updating the ENDF summary documentation.
- Polarization section of EXFOR Manual completed.

Explanation:

New staff member to assist in the reaction data activities did not arrive until October 2000. These items were deferred as lower priority.

D. 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 ensure quality control, particularly for new evaluations. New evaluations funded primarily from other sources are prepared for archival in the ENDF library.

LANL Deliverables:

Work with BNL to issue Release 7 of ENDF/B-VI.

Submit new Hg evaluations for ENDF, important for ORNL Spallation Neutron Source design.

Submit additional evaluations up to 150 MeV (e.g. bismuth) for ENDF.

Submit new Si evaluation, guided by recent LANSCE measurements, to ENDF, important for single-event-upset calculations in microelectronics.

Status:

- Assisted BNL in preparing Release 7 of ENDF/B-VI.
- New Hg evaluations completed. Awaiting complete file-1 documentation for the <20 MeV cross section region from JAERI before formally submitting these 14 files for ENDF/B. These files are available for testing the evaluations.
- Bismuth evaluation included in ENDF/B-VI, release 7.
- New Si evaluation submitted for inclusion in ENDF/B-VI, release 8.

E. 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 proposing to initiate a Coordinated Research Project (CRP) in support of this activity.

NIST -- 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. Publish an article on the hydrogen angular distribution measurements at 10 MeV neutron energy.

Status:

- 50 new data sets not used in the last evaluation have been identified. Eleven (11) have been reviewed, 21 are being reviewed and 18 are awaiting final data.
- A new measurement of the hydrogen (n,p) angular distribution at 15 MeV is being designed to help resolve discrepancies in this standard.
- The work on the hydrogen angular distribution at 10 MeV has been submitted for publication.
- The IAEA had initiated the CRP. The agenda for a Consultants' Meeting next February (which will precede the CRP) is being defined.

F. 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 inter-comparison of results, validation of model with experimental data and development of new physics modules. The TUNL pre-equilibrium 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 -- Perform neutron activation measurements in the energy range from 16 to 21 MeV to provide an extensive database for use in validating pre-equilibrium nucleus modeling. This work is done in collaboration with IRRM, Geel, Belgium, at no cost to DOE other than salary and travel.

ANL Deliverables:

Submit for publication an article on the nuclear model analysis of data previously acquired and published in this activity.

Status:

- Experimental measurements at IRMM, Geel, completed and data sent to NNDC.
- Compiled all experimental and evaluated data from the literature for comparison with data obtained from neutron activation reactions measured recently at IRMM, Geel.
- Developed a new formalism for the determination of nuclear model-parameter sensitivities relevant to experimental neutron reaction data.

- Completed a nuclear model analysis of data for structural materials reactions.
- Prepared draft of journal paper to document model-parameter sensitivities formalism.
- Organized a new round of measurements to be conducted at IRMM, Geel, in January-February 2001. IRMM will pay for a portion of PI's travel costs and all expenses related to the actual conduct of the experiment.
- Organized an international collaboration to perform measurements related to nuclear model development. Participation will include PI plus scientists from Belgium, Romania, Hungary, and Bulgaria. Project has been approved by Nuclear Energy Agency WPEC.

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, 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.

LANL Deliverables:

Produce first working version 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, this is highly leveraged with support from DOE/DP).

Calculate and interpret γ -ray reactions measured with GEANIE at LANSCE, including n+¹¹²Sn reactions producing far-from-stability products, and reactions in competition with fission.

Study level densities, a crucial input in nuclear model calculations, using (n,z) measurements by Haight at LANSCE, and publish work on isospin and level densities in n+Si reactions.

Status:

- First working version of McGNASH is being tested. We have made significant progress and have completed the multistage-Hauser-Feshbach module and successfully tested it through code inter-comparisons with GNASH and with Livermore's version of the STAPRE code (with Dietrich). We have also tested it in comparisons with Koning's TALYS code under the auspices of the NEA/WPEC models subgroup. We have also completed and distributed our new Monte Carlo pre-equilibrium model. A model for calculating pre-equilibrium spin distributions was also developed and implemented in collaboration with Oblozinsky, BNL.

- Calculations to interpret γ -ray production from $n+^{112}\text{Sn}$ reactions measured with GEANIE at LANSCE have been completed.
- Paper on sensitivity of silicon reactions to level density and isospin effects has been published.

LLNL -- Develop a regional optical model potential for the actinides. Develop a platform independent Hauser-Feshbach calculation code.

LLNL Deliverables:

Complete analysis of actinide optical model parameters and publish results.
Complete programming of Hauser-Feshbach code and begin testing.

Status:

- The development of a regional coupled-channel optical model potential has been completed.
- A set of requirements for the planned object-oriented reaction code was completed. Coding was begun by implementing containers to hold mass-table data.

Explanation:

The planned coding of a first test case was delayed approximately four months by the need to carry out an evaluation of the $^{239}\text{Pu}(n,2n)$ reaction. In connection with this work, we began an inter-comparison of the Stapsre-H and GNASH codes on the $(n,2n)$ reaction in collaboration with Mark Chadwick (LANL). This inter-comparison will provide suitable test cases for validating the new codes being developed at LLNL and LANL.

TUNL -- Development of pre-equilibrium nuclear reaction models. Improvement and benchmarking of the computer code PRECO. Extend code validity to higher energies for (N,N) reactions.

TUNL Deliverables:

Complete journal article on surface and collective effects.
A new release of PRECO code with a detailed user manual.

Status:

- Added excitation of giant resonance states with systematics for energy, width and deformation parameters.
- Compared calculated spectra against full database of over 150 spectra.
- Prepared Users Manual for code PRECO-2000, including a full description of the physics, the code structure, and the recommended set of global input.
- Journal article on surface and collective effects in pre-equilibrium reactions (PRC 62, 044608, October 2000)
- Users Manual for PRECO-2000 -- in final editing.

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 -- Compile information on $^{31}\text{P}(p,\gamma)$ reaction. Evaluate resonance parameters for $^{31}\text{P}(p,\gamma)$ and $^{31}\text{P}(p,\alpha)$ reactions and determine their uncertainties. Search by indirect means for low-lying resonances for these reactions. Investigate direct reaction component and calculate Hauser-Feshbach contributions for proton energies above 2 MeV. Prepare an evaluation for these two reactions. This work is being done in collaboration with Hiram College.

ANL Deliverables:

An ANL report documenting the compiled experimental data.

File of evaluated data for these two reactions in ENDF format with appropriate documentation.

Status:

- Compilation of data for $^{31}\text{P}(p,\gamma)$ reaction completed.
- Report ANL/NDM-140 documenting compilation of data for the $^{31}\text{P}(p,\gamma)$ reaction has been completed. Available at:
<http://www.td.anl.gov/reports/ANLNDMReports.html>.
- Evaluation of resonance parameters for $^{31}\text{P}(p,\gamma)$ and $^{31}\text{P}(p,\alpha)$ reactions is nearly complete.
- Acquired Hauser-Feshbach code to be used for calculation of continuum charged-particle cross sections. Code is being debugged and will be implemented on a PC platform at Hiram College.
- Evaluation of non-resonant components of the cross sections for $^{31}\text{P}(p,\gamma)$ and $^{31}\text{P}(p,\alpha)$ reactions is in progress.
- One conference paper on probability distributions for astrophysics was completed.
- Developed a new formalism for dealing with large errors encountered in generating reaction-rate information for nuclear astrophysics.
- Prepared draft of journal paper to document new error formalism.
- An outline of the journal paper, which will report on evaluations for the $^{31}\text{P}(p,\gamma)$ and $^{31}\text{P}(p,\alpha)$ reactions has been prepared. Written material for some sections of this paper has already been generated.

Explanation:

The difficulty of getting set up to calculate the Hauser-Feshbach component and deduce the direct reaction component was under-estimated. These are relatively minor contributors but they are needed in the evaluation for completeness. Data for

the major contributor to the reaction strengths, the discrete resonance components, were collected on schedule. In addition, the fact that large errors in nuclear data used for determining astrophysical reaction rates have to be handled in an entirely new way was not foreseen earlier. Together, these factors put the project behind schedule. A H-F code has been obtained and is currently being de-bugged by our collaborator at Hiram College and estimates for the direct reaction component will be obtained from work by the Notre Dame group. A considerable amount of time has been spent during FY2000 on examining the error issue and a new approach has been developed in collaboration with ORNL. Two conference contributions were made during FY2000 and a journal paper is in preparation.

BNL -- The incoming deputy head of the NNDC is an expert in evaluating nuclear reaction data with emphasis on incident energies above 10 MeV. The NNDC will build on this expertise to re-establish this evaluation capability at the NNDC. A new postdoc position will be established to initiate expanded support of nuclear astrophysics. One half of this effort will be devoted to evaluation of nuclear data for astrophysics. The new staff member will be trained in data evaluation. The selection of data to be evaluated will be made in consultation with the Nuclear Astrophysics Steering Committee.

Status:

- A series of selected nuclear reaction codes that represent the basic tools for performing nuclear reaction data evaluation have been installed and tested on the NNDC computer.
- Initial testing of the evaluation codes has been made on two reactions important for nuclear astrophysics, $^{44}\text{Ti}(\alpha,p)$ (α -rich freeze out in supernovae) and $^{192}\text{Os}(n,\gamma)$ (s-process in nucleosynthesis).
- New staff member did not arrive until the beginning of FY2001.

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:

Resolve puzzle surrounding the $^{12}\text{C}(\alpha,\gamma)$ E1 and E2 capture at stellar energies to determine impact of this crucial reaction on helium burning in red giants, using R-matrix methods.

Analyze n-p capture, as well as other processes important in Big-Bang nucleosynthesis.

Initiate 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.

Use Hauser-Feshbach methods to calculate photonuclear data important in nucleosynthesis.

Compute fission barriers using microscopic-macroscopic model for r-process termination.

Status:

- The $^{12}\text{C}(\alpha,\gamma)$ cross section was found not to be sensitive to the E1 capture parameters. E2 capture is now being included in the calculation.
- N-p capture analysis is near completion. Weller's new M1 to E1 ratio measurements are being considered in our analysis.
- Work has started on the analysis of the $^7\text{Be}(p,\gamma)^8\text{B}$ cross section.
- Collaboration with the TUNL Energy Levels of Light Nuclei effort on A=5 and 6 has been completed. Work on A=7 will be finished soon.
- Evaluation of 12 photonuclear reactions (including silicon) important to nucleosynthesis has been completed. These new ENDF evaluations will be submitted to CSEWG next year.
- Improved fission model has been developed. Paper accepted for Phys.Rev. C.

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:

An evaluated data file in ENDF format for $^{18}\text{F}(p,\alpha)$ and (p,γ) reactions.

An evaluated data file in ENDF format for $^{17}\text{O}(p,\alpha)$ and (p,γ) reactions.

Status:

- Evaluations of resonance parameters for $^{18}\text{F}(p,\alpha)$ and (p,γ) reactions nearly complete.
- Completion of these evaluations has been shifted to the first half of FY01 to incorporate the latest exciting new experimental results with an ^{18}F beam from ORNL's Holifield Radioactive Ion Beam Facility.
- Evaluations of resonance parameters for $^{17}\text{O}(p,\alpha)$ and (p,γ) reactions nearly complete.
- Completion of these evaluations has been shifted to the first half of FY01 to incorporate results from a measurement at TUNL of $^{17}\text{O}(p,\gamma)$. Also, the recent interest in these reactions for nova explosions (and not just Red Giant Stars) has suggested we extend our evaluations to a larger energy range than previously considered.
- Cross sections and reaction rates will be completed in the first half of FY01.

H. Reaction Data for RIB Target Design

Radioactive Ion Beam 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:

Study theoretical and phenomenological methods for predicting production cross sections of neutron-rich products of fission reactions for a future database of fission products in n+U RIB production experiments.

Develop nuclear reaction model code tools for improved predictions of RIB cross sections including isospin dependence in optical models for nuclei with large isospin, and improvements in fission theory for predicting neutron-rich nuclides.

Guide/support RIB researchers at ORNL, ANL, and LBNL, in the use of the Los Alamos CINDER/LAHET code for predictions of radioactive products in RIB facilities.

Status:

- Little progress on prediction of neutron rich fission product production due to lack of resources.
- Significantly improved nuclear reaction model code tools for improved predictions of RIB cross have been developed.
- We have worked closely with the RIA community, especially Jerry Nolen (ANL), on ways in which nuclear model simulation codes and nuclear data can impact RIA ISOL target design. Specifically, recent improvements at Los Alamos in intra-nuclear cascade and pre-equilibrium physics are helping produce far more accurate predictions of radionuclide production in RIA targets. A truly useful simulation tool for guiding RIA design also needs to include the physics of diffusion and effusion of radioactive species out of the targets. We are exploring ways in which material science research at LANL can be coupled to nuclear physics algorithms in MCNPX to provide such a tool.