STATUS of
LANL Group T-16 FY2001 Work Plan for US Nuclear Data Program (USNDP)

(Status comments are given in bold, April 2001)

This is an informal document to be used in our nuclear reaction data working group.

	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.
Done. Chaired the US Cross Section Evaluation Working Group (CSEWG), chaired the US Nuclear Data Program Reaction Working Group

We also chair international committees in the nuclear data field: (a) IAEA project on photonuclear data; (b) IAEA project on model input parameters; (c) NEA project on fission neutron spectra; (d) NEA project on nuclear model codes.

Deliverables:

Participate in USNDP Steering Committee meetings - **No meetings have been called this FY**

Organize and chair CSEWG Evaluation Committee meeting at BNL, Nov 2000 – **Done. We organized the evaluation CSEWG session, provided an agenda, and documented the conclusion in the minutes. The main outcome of this meeting was a decision to move towards issuing a new version of ENDF/B reaction cross-section library, ENDF/B-VII. This will include a new set of standards, and will include numerous enhancements to the cross section evaluations, including high-energy data to 150 MeV, photonuclear evaluations, new actinide evaluations such as ^{238}U, etc.**

Organize and chair Reaction Working Group meeting at USNDP meeting, April 2001**. This is being done at present.**

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 insure quality control, particularly for new evaluations. We will also submit new evaluations listed below (funded primarily from other sources) for archival in ENDF/B-VI.

Deliverables:

Work with BNL to issue Release VIII of ENDF/B-VI. **Done.**

Submit suite of new photonuclear ENDF evaluations to CSEWG – this will be the first

time that photonuclear data are available in the ENDF/B Library **The photonuclear evaluations have been completed and have been issued by the IAEA. We will submit them to CSEWG by the end of the FY, after we have received feedback on their performance by IAEA testers. The IAEA nuclear data section, including Trkov, as well as LANL X-div scientists (White and Little) are providing some valuable testing of these data.**

Submit new p+Li evaluations for ENDF, important for design of quasimonoenergetic neutron sources for reaction cross-section measurements **Our fist version of this library has been completed. However, before submitting to BNL we are collaborating with Nils Olsson's group in Uppsala who are collaborating with us on making some enhancements to this library, through a more accurate representation of (p,n_0) and (p,n_1) neutron-producing reactions at higher energies and forward angles. We expect to be able to send this updated evaluation to BNL by the end of the FY.**

Complete and submit new n+16O evaluation up to 150 MeV, including major improvements in the 6-30 MeV region through use of LANSCE/WNR γ-ray data.

This evaluation is now complete, and represents a major improvement on the previous evaluation that was available in ENDF. This new evaluation represents a dramatic improvement in accuracy, due to use of new γ-ray data from LANSCE/WNR. We will probably include some elastic scattering evaluated data from Cecil Lubitz into the evaluation, and then submit it to CSEWG for Release 8 of ENDF/B-VI.

We also completed 42 new evaluations for ENDF/B-VI in which the neutron capture cross sections are improved, and submitted the evaluations to BNL.

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:

Provide evaluated cross sections, S-factors, and Maxwellian rates for n-p capture; continue analysis of other processes important in Big-Bang nucleosynthesis

Done. New evaluated cross sections (S-factors) and Maxwellian rates were obtained for n+p capture, as well as other processes important for Big-Bang nucleosynthesis, using R-matrix methods.

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

This work progresses well. I will provide details at BNL (Hale is on travel at present)

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

Done. The A=5-7 preprints of the "Energy Levels of Light Nuclei" series (a collaboration between TUNL and LANL) were finalized, incorporating information from our R-matrix scattering theory analyses.

Study effects of electronic screening on Maxwellian rates under astrophysical conditions, using a fully quantum-mechanical description

Done. The applicability of the Salpeter screening treatment for reaction rates was studied in detail, and found to be valid for a large class of screening potentials.

Continue a project initiated in FY00 to use Hauser-Feshbach methods to calculate photonuclear data important in nucleosynthesis

Done. Our nuclear theory code development is described below. This has enabled us to produce evaluations for reactions such as γ+28Si, important in nucleosynthesis network calculations.

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

A Rare Isotope Accelerator (RIA) facility design needs high-quality nuclear reaction data for target design, and facility design. We have worked with ORNL and ANL researchers to provide key reaction cross

sections, using theory calculations and measurements to evaluate the data, and will continue to address their needs in the future.

Deliverables:

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

Done. We are collaborating closely with Nolen (ANL) and Beene (ORNL) on nuclear data needed for RIA ISOL target design. Our interactions have led to our inclusion on the US RIA R&D team. Our focus this year is on improving intranuclear cascade models for predicting radionuclide production in an ISOL target – and providing a module to calculate these processes in the MCNPX simulation code used in RIA design.

Develop nuclear reaction model code tools for improved predictions of RIA cross sections (see 5 below), including isospin dependence in optical models for nuclei with large isospin, and improvements in fission theory for predicting neutron-rich nuclides.

We have made significant progress on our phenomenological isospin-dependent global optical model for neutrons and protons. This should be completed this FY. We also adapted our fully microscopic optical model, obtained from folding a nucleon-nucleon interaction with realistic structure information, for use in studying neutron projectiles. We established the power of microscopic formalism in predicting integral observables, as needed for various applications. (Phys. Rev. Lett. in press). We also continued development of our global (in projectile energy and isospin, and target Z,A) relativistic Schrodinger optical potential to a GeV. These optical model approaches are important in RIA applications where large target isospins are produced.

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

As mentioned above, we are collaborating in the national RIA design effort on the improvement and use of Los Alamos simulation codes for RIA ISOL target design.

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, McGANSH, to provide a state-of-the-art capability to predict reaction cross sections. This also involves a close collaboration with experimentalist at LANSCE (R.C. Haight, 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.

Deliverables:

Continue development *of McGNASH*, our improved version of the *GNASH* Hauser-Feshbach code, using Fortran90 and modern coding practices, with numerous improved physics packages, particularly: level densities, preequilbrium reactions, transmission coefficients, and γ-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.

Continued development of new nuclear reaction theory code, McGNASH that uses advanced physics packages and coding practices to provide an update of our GNASH Hauser-Feshbach and pre-equilibrium code. Collaborated with BNL and LLNL researchers, as well as Nuclear Energy Agency nuclear models group, to validate code developments through intercomparisons. We successfully established agreement with McGNASH, GNASH, and STAPRE, for Hauser-Feshbach calculations, but obtained differences with the IDA code (suggesting an error in IDA). This work was done with Dietrich during a 1-week visit to LANL. We have recently made some important developments in the implementation

of width-fluctuation physics in McGNASH, in collaboration with Stephane Hilaire of CEA-France.

Developed (with P. Oblozinsky, BNL) a theory for angular momentum transfer in our Monte Carlo preequilibrium model, which is useful for predicting spin-sensitive observables (such as γ-rays and isomer production). This will be submitted for publication.

Calculate and interpret γ-ray reactions measured with GEANIE at LANSCE, including $n+^{92}Mo$ reactions producing far-from-stability products, and reactions in competition with fission.

Study level densities, a crucial input in nuclear model calculations, using Ca(n,z) measurements by Haight and Grimes at LANSCE.

We continued a collaboration with S. Grimes and R. Haight to study information on nuclear level densities and isospin conservation from reactions $^{40}Ca(n,z)$ measured at LANSCE; completed and published in the *Physical Review* calculations compared with LANSCE Mo(n,x γγ) data, including a study of nuclear reaction mechanisms far from stability. See Phys. Rev. C 6205, 4608 (2000), in collaboration with LLNL researchers.

6. WWW Dissemination of nuclear data (0.1 FTE)

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

Deliverables:

Include access to new reaction and structure data evaluations, supported by DOE/ Nuclear Physics, via the T-2 WWW site **Done. We have also made significant changes to our WWW interface to reflect the nature of our new nuclear physics group, T-16**

Continue coordination of T-2 WWW site with other USNDP sites **In progress.**

Include WWW access to ENDF/B-VI Release 7, when available **In progress.**

Continue development of "interpreted ENDF" printout of reaction data. **Improvements have been made so that reaction ENDF data can be understood easily by non-specialists.**

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 2001 meeting **LANL is hosting this meeting in Santa Fe.**

Participate in relevant IAEA meetings, including Trieste Lectures **W e are presenting invited IAEA lectures at ICTP, Trieste, this September – an important contribution to physics education.**

Make latest version of NJOY data processing code available to the international community **The latest NJOY code has been released to the international community. MacFarlane has been invited to give a presentation on this to the NJOY users group in Cadarache, France, in May.**

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

We have hosted a number of outstanding scientists for short collaborative visits (typically a few days up to a couple of weeks), including Stephane Hilaire (CEA), Ettore Gadioli (Milan), Stephane Goriely (Brussels), Arjan Koning (Peten)..

8. Publications

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