United States Department of Energy

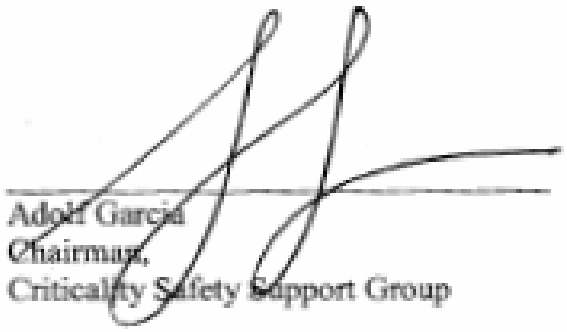
Nuclear Criticality Safety Program

Five-Year Plan

September 2005

Nuclear Criticality Safety Program Plan, September 2005.

Reviewed:



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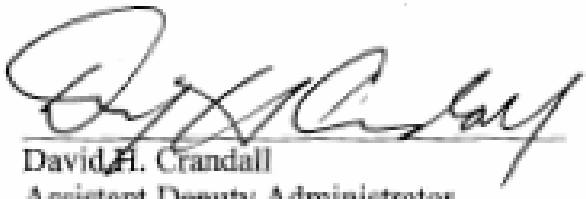

David H. Crandall
Assistant Deputy Administrator
For Research, Development, and Simulation
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TABLE OF CONTENTS

LIST OF ACRONYMS

AMPX	Nuclear cross-section processing computer code
ANL	Argonne National Laboratory
ANS	American Nuclear Society
ANSI	American National Standards Institute
ARH	Atlantic Richfield Hanford
AROBCAD	Applicable Ranges of Bounding Curves and Data
BNL	Brookhaven National Laboratory
CEF	Criticality Experiments Facility (Project)
CENTRM	Discrete Ordinates Transport Computer Code
COG [1]	Lawrence Livermore National Laboratory Monte Carlo Computer Code
CSCT	Criticality Safety Coordinating Team
CSEWG	Cross Section Evaluation Working Group
CSIRC	Criticality Safety Information Resource Center
CSSG	Criticality Safety Support Group
DAF	Device Assembly Facility
DICE	Database for the International Criticality Safety Benchmark Evaluation Project
DOE	United States Department of Energy
EM	Office of Environmental Management
ENDF	Evaluated Nuclear Data File
FFTF	Fast Flux Test Reactor
FY	Fiscal Year
GLLSM	Generalized Linear Least Squares Method
GNASH[2]	A statistical nuclear model computer code
HCTLTR	High Core Temperature Lattice Test Reactor
HEU	Highly Enriched Uranium
ICNC	International Conference on Nuclear Criticality
ICSBEP	International Criticality Safety Benchmark Evaluation Project
INL	Idaho National Laboratory
KENO[3]	Monte Carlo criticality computer code
LACEF	Los Alamos Critical Experiments Facility

LANL	Los Alamos National Laboratory
LEU	Low Enriched Uranium
LLNL	Lawrence Livermore National Laboratory
LWBR	Light Water Breeder Reactor
MCNP	Monte Carlo N Particle (N currently equals 3) Computer Code
MOX	Mixed Oxide Fuel
MURR	Missouri University Research Reactor
NA-11	Assistant Deputy Administrator for Research, Development and Simulation
NA-117	Office of Facilities Management and Environment, Safety and Health
NASA	National Aeronautics and Space Administration
NE	Office of Nuclear Energy, Science and Technology
NNSA	National Nuclear Security Administration
NCSET	Nuclear Criticality Safety Engineer Training
NCSP	Nuclear Criticality Safety Program
NERI	Nuclear Energy Research Initiative
NDAG	Nuclear Data Advisory Group
OECD-NEA	Organization for Economic Cooperation and Development - Nuclear Energy Agency
ORELA	Oak Ridge Electron Linear Accelerator
ORNL	Oak Ridge National Laboratory
PCTR	Physical Constants Test Reactor
PRTR	Plutonium Recycle Test Reactor
RSICC	Radiation Safety Information Computational Center
RW	Office of Civilian Radioactive Waste Management
SAMMY[4]	A nuclear model computer code
S/U	Sensitivity and Uncertainty
SCALE[5]	Standardized Computer Analyses for Licensing Evaluation
SRS	Savannah River Site
VIM	Vastly Improved Monte Carlo Computer Code
NRC	Nuclear Regulatory Commission
WINCO	Westinghouse Idaho Nuclear Company
ZPPR	Zero Power Physics Reactor

ZPR Zero Power Reactor

(1) COG was originally developed to solve deep penetration problems in support of underground nuclear testing. Variance reduction techniques are very important to these problems and hence the name COG was chosen as in "to cog the dice" or cheat by weighting.
(2) GNASH is a pre-equilibrium, statistical nuclear model code based on Hauser-Feshbach theory (and additional models) for the calculation of cross sections and emission spectra, primarily in the epithermal and fast neutron energy ranges.
(3) KENO is a family of Monte Carlo criticality codes whose name came from an observation of the KENO game in which small spheres, under air levitation, arbitrarily move about in a fixed geometry.
(4) SAMMY is a nuclear model code, which applies R-Matrix theory to measured data and produces resolved and un-resolved resonance parameters in Reich-Moore and other formalisms. The name SAMMY was a personal choice of the author.
(5) SCALE is a system of well-established codes and data for performing nuclear safety (criticality, shielding, burn up-radiation sources) and heat transfer analyses.

United States Department of Energy
Nuclear Criticality Safety Program Five-Year Plan

EXECUTIVE SUMMARY

The primary objective of the Department of Energy (DOE) Nuclear Criticality Safety Program (NCSP) is to maintain fundamental infrastructure that supports operational criticality safety programs. This infrastructure includes key calculative tools, differential and integral data measurement capability, training resources, and web based systems to enhance information preservation and dissemination. Another important function of the NCSP is to solicit feedback from the operational criticality safety community so that the infrastructure remains responsive to evolving needs. The objective of operational nuclear criticality safety is to ensure that fissile material is handled in such a way that it remains subcritical under both normal and credible abnormal conditions to protect workers, the public, and the environment. A robust operational criticality safety program requires knowledgeable people and technical resources. The NCSP maintains these two key elements so the DOE can continue to do work safely and efficiently with fissile materials.

The NCSP is funded by the Assistant Deputy Administrator for Research Development, and Simulation (NA-11), Defense Programs, National Nuclear Security Administration (NNSA)[1]. Dr. Jerry McKamy, from the Office of Facilities Management and Environment, Safety and Health (NA-117) is the NCSP Manager. He is supported by the Criticality Safety Support Group (CSSG) and the Nuclear Data Advisory Group (NDAG) regarding technical matters and by the Criticality Safety Coordinating Team (CSCT), consisting of Federal Criticality Safety Practitioners at the sites, and the End Users Group (DOE Contractor Criticality Safety Representatives) regarding DOE Field criticality safety issues.

The NCSP includes the following seven technical program elements:

> Applicable Ranges of Bounding Curves and Data: develop method(s) to interpolate and extrapolate from existing criticality safety data.
>
> Analytical Methods Development and Code Support: support and enhance numerical processing codes used in criticality safety analyses.
>
> International Criticality Safety Benchmark Evaluation Project: identify, evaluate and make available benchmarked data to support validation of criticality safety analyses.

[1] In addition to the funding provided by NA-11, the DOE Office of Science is committed to maintain the Oak Ridge Electron Linear Accelerator in an operational state to support nuclear cross section data acquisition. Also, the Office of Nuclear Energy's Idaho Office has agreed to support Mr. Adolf Garcia's activities associated with his chairmanship of the CSSG.

Nuclear Data: provide nuclear cross section data required for codes to accurately model fissionable systems encountered by operational criticality safety programs.

Integral Experiments: provide integral experimental data for the validation of the calculation methods used to support criticality safety analyses.

Information Preservation and Dissemination: collect, preserve and make readily available criticality safety information.

Training and Qualification: maintain and improve training resources and qualification standards for criticality safety practitioners.

Each of these areas is interdependent on the others and together form a complete criticality safety infrastructure. If any of these program elements is eliminated, the ability of the Department's criticality safety engineers to perform their work will be substantially diminished. In addition to the seven technical program elements, two important facilities are required for successful execution of the NCSP: the Criticality Experiments Facility (CEF) and the Oak Ridge Electron Linear Accelerator (ORELA). Figure ES-1 contains a flow chart that shows how the NCSP works and Figure ES-2 contains a NCSP organizational chart.

The infrastructure maintenance portion of the NCSP Budget is requirements based. Requirements for preservation of capability in each of the seven technical program elements are provided in this five-year plan along with budget, schedule, and a description of how each of the program elements contributes to the overall enhancement of operational criticality safety. A budget summary for the NCSP is contained in Table ES-1.

The NCSP is primarily a capability maintenance program aimed at preserving a unique skill set and associated infrastructural assets for the Nation. Skills and infrastructure are preserved and maintained by doing mission related work in each of the program elements. The results of this work significantly enhance criticality safety throughout the Department. In addition to maintaining the infrastructure or "base program", NCSP resources are routinely employed to identify and correct Departmental criticality safety program and implementation problems. Such program specific applications are coordinated by the NCSP Manager and costs are recovered wherever appropriate. The program specific application section of this plan contains detailed information about scheduled and proposed work. In addition, the expertise resident within the CSSG is used to assist sites on a periodic basis. Details about this activity are contained in the CSSG section of the Plan.

Figure ES-1 How the Nuclear Criticality Safety Program Works

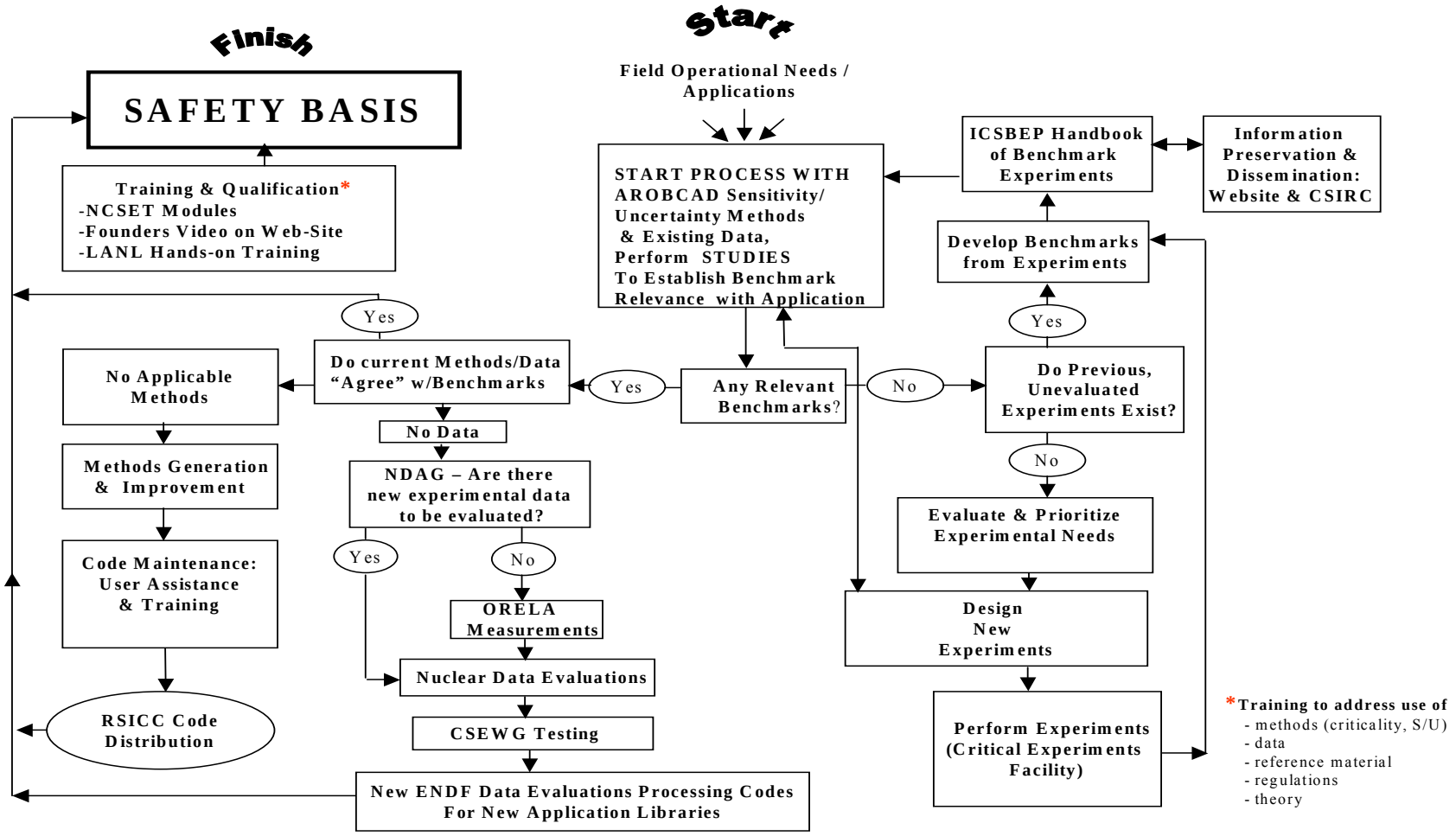

Figure ES-2: Nuclear Criticality Safety Program Organization

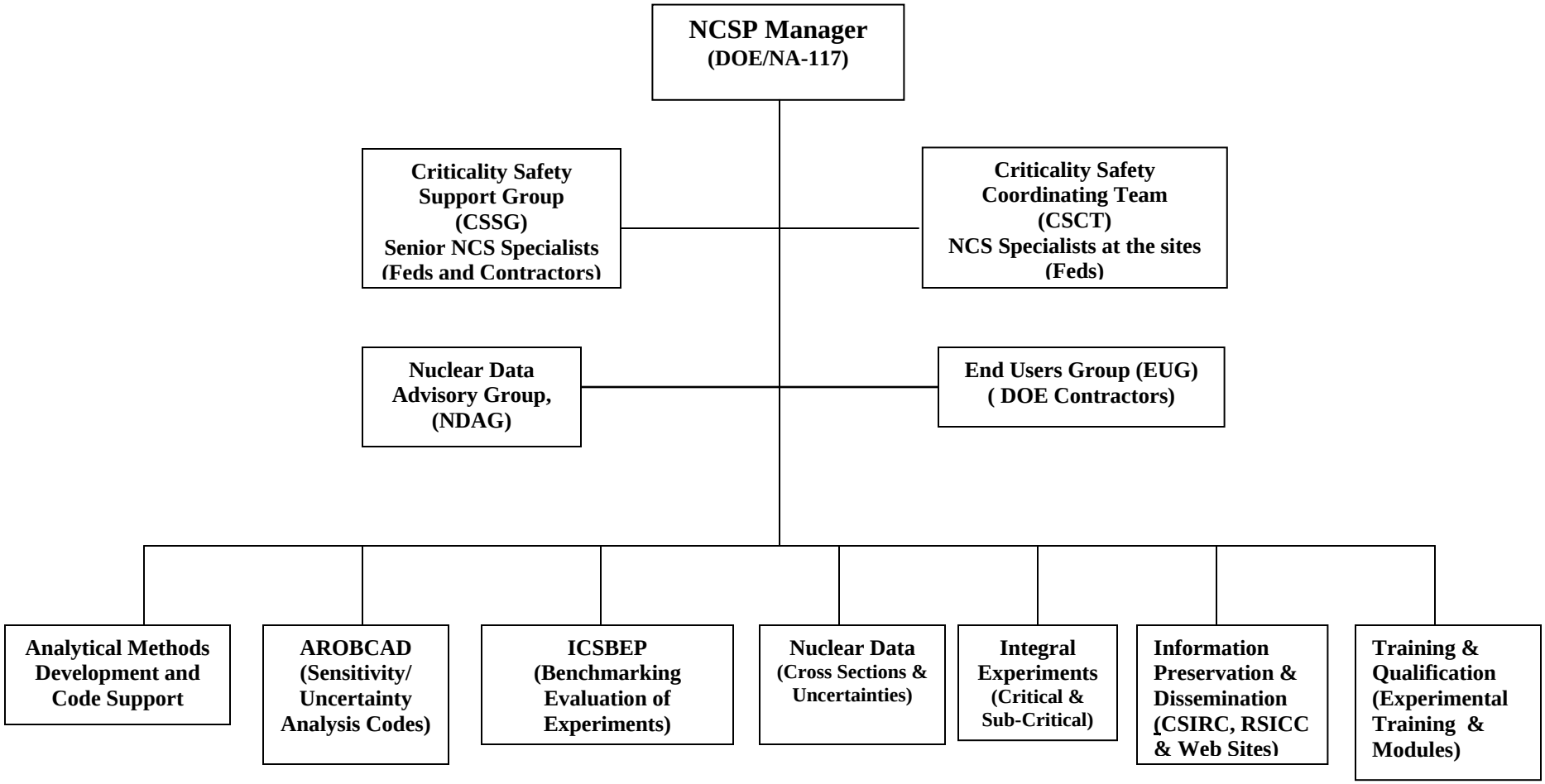

Table ES-1: Nuclear Criticality Safety Program Base Funding, Fiscal Years 2006 – 2010

	FY 2006 ($K)	FY 2007 ($K)	FY 2008 ($K)	FY 2009 ($K)	FY 2010 ($K)
Applicable Ranges of Bounding Curves and Data	505	550	550	400	0
Analytical Methods Development and Code Support	2,640	2,700	2,750	2,800	3,100
International Criticality Safety Benchmark Evaluation Project	1,900	1,900	1,900	1,900	1,900
Nuclear Data	3,572	3,220	3,135	3,090	3,160
Integral Experiments	650	1,000	1,100	1,200	1,300
Information Preservation and Dissemination	380	360	370	400	400
Training and Qualification	200	210	220	230	250
NCSP Support	260	260	275	380	390
TOTAL	10,107	10,200	10,300	10,400	10,500

United States Department of Energy
Nuclear Criticality Safety Program
Five-Year Plan

1. Nuclear Criticality Safety Program Purpose and Scope

The primary objective of the Department of Energy (DOE) Nuclear Criticality Safety Program (NCSP) is to maintain fundamental infrastructure that supports operational criticality safety programs. This infrastructure includes key calculative tools, differential and integral data measurement capability, training resources, and web based systems to enhance information preservation and dissemination. Another important function of the NCSP is to solicit feedback from the operational criticality safety community so that the infrastructure remains responsive to evolving needs. The objective of operational nuclear criticality safety is to ensure that fissile material is handled in such a way that it remains subcritical under both normal and credible abnormal conditions to protect workers, the public, and the environment. A robust operational criticality safety program requires knowledgeable people and technical resources. The NCSP maintains these two key elements so the DOE can continue to do work safely and efficiently with fissile materials.

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The infrastructure maintenance portion of the NCSP Budget is requirements based. Requirements for preservation of capability in each of the seven technical program elements are provided in this five year plan along with budget, schedule, and customers/Departmental missions supported by each of the program elements. A budget summary for the NCSP is contained in Table ES-1.

The NCSP is primarily a capability maintenance program aimed at preserving a unique skill set and associated infrastructural assets for the Nation. Skills and infrastructure are preserved and maintained by doing mission related work in each of the program elements. The results of this work significantly enhance criticality safety throughout the Department. In addition to maintaining the infrastructure or "base program", NCSP resources are routinely employed to identify and correct Departmental criticality safety program and implementation problems. Such program specific applications are coordinated by the NCSP Manager and costs are recovered wherever appropriate. The program specific application section of this plan contains detailed information about scheduled and proposed work. In addition, the expertise resident within the CSSG is used to assist sites on a periodic basis. Details about this activity are contained in the CSSG section of the Plan.

2. Applicable Ranges of Bounding Curves and Data (AROBCAD)

Program Element Description

The AROBCAD program element provides for the adaptation, extension, and use of software tools that enable sensitivity/uncertainty (S/U), optimization, and statistical methods to be applied in the study of nuclear criticality safety (NCS) technology issues and in NCS evaluations. AROBCAD will gradually transition the developed tools to the SCALE code system, which is maintained and enhanced under the "Analytic Methods Development and Code Support" program element, and provide training and guidance that can be used by the "Training and Qualification" program element to assure proper use of these tools by the NCS practitioner. The AROBCAD program element and tasks are directed at:

1) reducing safety risk by assuring a rigorous capability for selection of applicable benchmarks and determining computational biases and uncertainties for NCS evaluations;
2) reducing excess conservatisms through identification of experimental needs in both integral data (critical experiment benchmarks) and differential data (neutron cross section) measurements and evaluations;
3) improving efficiency and effectiveness of Integral Experiments by enabling improved design of critical experiments to meet identified needs; and
4) enhancing the "International Criticality Safety Benchmark Evaluation Project" program element capabilities for experiment evaluation.

Approved Sub Tasks (FY 2006)

Sub-Task 1 ($225k): Complete the development of compatible KENO V & VI adjoint solution. This task will extend the S/U capability within the TSUNAMI sequences of the SCALE code system to enable use with the KENO VI code. The extension will be completed by implementing a revised adjoint solution within KENO V that will be compatible with planned implementation of the technology within KENO VI. Such an approach has been assessed to simplify the input, reduce the user expertise required for accurate results, and reduce the required memory and computing time. Implementation of the S/U capabilities within KENO VI will significantly extend the geometries where the S/U capabilities can be applied. The deliverables will be a revised prototypic version of TSUNAMI-3D-K5 (KENO V), a new prototypic version of TSUNAMI-3D-K6 (KENO VI), and associated draft documentation.

Sub-Task 2 ($30k): Complete adaptation of CENTRM for processing implicit Evaluated Nuclear Data File (ENDF)/B VI and VII cross-section sensitivities. Resonance processing of ENDF/B-VI (and eventually –VII) multi-group cross sections is now performed in SCALE using CENTRM. Under this task, TSUNAMI sequences will be updated to incorporate a version of CENTRM that will enable calculation of the implicit sensitivity components arising from the sensitivity of the problem-dependent cross sections to the resonance processing model. This update will enable these implicit sensitivities to be included in TSUNAMI and TSURFER (for the Generalized Linear Least Squares Method (GLLSM) post-processing of S/U data) when ENDF/B-VI (and eventually –VII) cross sections are used in the analysis. The deliverable will be a prototypic version of TSUNAMI-3D and associated documentation.

Sub-Task 3 ($40k): Investigate, develop, and justify the process for organizing, formatting and distributing criticality benchmark sensitivity data files of existing and subsequent NCS benchmarks. The broad suite of sensitivity data files that have been and are being produced at Oak Ridge National Laboratory (ORNL) in support of numerous testing-, verification-, and application-related projects stemming from the AROBCAD development and use should be of significant value to NCS users seeking to expeditiously apply the S/U methodology. Distribution of the sensitivity files should also help support the identification of needs and measurement evaluation from the "Nuclear Data" and **"**Integral Experiments" program elements. The sensitivity files should also be of value in the training and qualification of users of the AROBCAD technology. However, the pedigree of the information applied in the individual sensitivity files varies and the process for formatting, organizing, and distributing the files is not clear. This task will provide a guide for preparation of a sensitivity data base that can distributed along with a proposal for implementation.

Sub-Task 4 ($90k): Develop graphical user interfaces for existing S/U codes. This task will provide a graphical user interface (GUI) that will simplify the exchange of data and presentation of analysis among the S/U codes for interpretation and implementation of the results. The GUI will assist in the training and qualification of users and enable users to readily obtain visual interpretation of sensitivity and uncertainty information as it applies to NCS evaluations, benchmark evaluations, nuclear data impacts and uncertainty assessments, and integral experiment needs and design. The deliverables will be SCALE code modules that can provide interactive 3D plotting of cross-section scattering matrices and covariance data; 2D plotting of energy-dependent cross-section data; generation of HTML-based sensitivity output for TSUNAMI; and an integrated graphical data analysis package combining capabilities from TSUNAMI post-processing codes (e.g., TSUNAMI-IP, TSURFER and USLSTATS) for determination of subcritical margins for safety evaluations.

Sub-Task 5 ($120k): AROBCAD Task Management. This task will plan, monitor, and report on the tasks; document the progression of the AROBCAD program in conference papers and peer-reviewed journals; assure coordination of the AROBCAD deliverables with other program elements (including the CSSG); and provide technical support to the user community. The deliverables will be quarterly reports, budget proposals, documents, peer reviewed papers, technical critiques, and technical consultation.

<u>Proposed Future Sub Tasks (FY-2007 and beyond)</u>

- Process ENDF/B-VI data through S/U methodologies to provide and distribute a more complete set of sensitivity files to the user community.
- Develop user guidance documentation and training modules for group-wise and continuous energy versions of TSUNAMI and TSURFER SCALE sequences.
- Develop guidance for subcritical margins applications.
- Develop S/U capabilities for Continuous Energy KENO to provide a more versatile and rigorous method to perform inter-comparisons with other computational methods.

- Update GUIs for existing S/U codes.
- Transition all completed S/U program sequences to the Analytical Methods Development and Code Maintenance program element by FY 2010 (reflected in budget table, below).

Budget

The prioritized listing in the "Approved NCSP FY06 Task Ranking with Associated Funding 5-11-01.doc" has been modified to accommodate work/budget changes in the SCALE/KENO Support and the AROBCAD Program Element. The *Automated Pitzer Solution Solver* (Sub-task priority 3, $50k – FY06) was moved from AROBCAD to the SCALE/KENO Growth subtask. Also added to the SCALE/KENO Growth subtask is the previously proposed, *Enhanced KENO features supporting continuous-energy capability* by deferring the *Guidance documentation for TSUNAMI and TSURFER methods* until the software and experience base is sufficient to provide the guidance.

Table 2-1: AROBCAD Budget, Fiscal Years 2006 – 2010 (All ORNL Tasks)

SUBTASK	FY 2006 ($K)	FY 2007 ($K)	FY 2008 ($K)	FY 2009 ($K)	FY 2010 ($K)
TOTAL	505	550	550	400	0

3. Analytical Methods Development and Code Support

Program Element Description

This program element provides for the development and maintenance of redundant, state-of-the-art analytical capability for the processing of nuclear data from the Evaluated Nuclear Data File (ENDF) and the radiation transport analysis needed to predict system k-effective values. An essential aspect of this capability is the human expertise required to develop the analytical software, provide software configuration control, and train and assist the user community throughout the DOE complex. The software is distributed through the Radiation Safety Information Computational Center (RSICC) at ORNL. The NCSP software (codes and processed data) supported by the this program element are key tools used in most nuclear criticality safety (NCS) evaluations and are routinely used by the International Criticality Safety Benchmark Experiment Project (ICSBEP) in evaluation of critical experiments. The work done under this NCSP work element to maintain the software and associated staff expertise contributes significantly to:

1) reducing safety risk and operational costs by providing rigorous and reliable software with associated technical information and training material needed to qualify users;
2) maintaining a National Asset technical capability;
3) providing the analytical capability to meet DOE compliance requirements and external regulatory commitments.

This program element supports work at Argonne National Laboratory (ANL), Los Alamos National Laboratory (LANL), Lawrence Livermore National Laboratory (LLNL), and ORNL and not only maintains and enhances codes important to operational criticality safety, but also maintains diverse expertise in an esoteric discipline that represents an essential national asset capability. The Analytical Methods Development and Code Support program element is closely tied to the Nuclear Data program element.

Approved Sub Tasks (FY 2006)

ANL:

Sub-Task 1 ($315k): VIM Maintenance and User Support. VIM is a general-purpose continuous-energy Monte Carlo transport code. As criticality safety specialists are forced to rely more heavily upon use of "rigorous" Monte Carlo methods for benchmarking and for performing criticality safety analyses, the VIM code provides independent verification of the MCNP code and its data libraries. The NCSP provides support for code maintenance and user-assistance and creation, verification, and validation of new nuclear data libraries for VIM. ANL also provides a secondary and independent verification of the MCNP libraries. The VIM code plays an essential role in producing benchmark descriptions of the ANL Zero Power Reactor (ZPR)/Zero Power Physics Reactor (ZPPR) critical assemblies for the ICSBEP Handbook.

Sub-Task 2 ($100k): Cross Section Processing Code Support. The suite of nuclear data processing codes for VIM creates data tables for VIM and for various multi-group codes. The development feature of most importance to criticality safety is continued work on implementing the functionality required to support new data representations approved by the Cross Section Evaluation Working Group (CSEWG) for ENDF data and the newly released ENDF/B-VII data libraries.

LANL:

Sub-Task 1 ($450k): MCNP Maintenance and User Support. MCNP is a general-purpose continuous-energy Monte Carlo transport code. Criticality safety specialists heavily use MCNP for benchmarking and for performing criticality safety analyses. The NCSP provides support for creation, verification, and validation of new nuclear data libraries for MCNP. In addition, supporting criticality safety users takes on many forms, including direct user consultation, assistance with code installation, e-mail discussions, etc. Also, several MCNP training courses are offered each year. Finally, several V&V test suites for criticality safety will be consolidated into one documented package of test problems for distribution to users with the code via RSICC. Criticality safety users have requested this feature.

Sub-Task 2 ($100k): NJOY Nuclear Data Processing Code. NJOY is the most widely used nuclear data processing system in the world. NJOY creates data tables for MCNP and for various multi-group codes. The development feature of most importance to criticality safety is continued work on implementing the functionality required to support new data representations approved by CSEWG for covariance data.

Sub-Task 3 ($100k): ENDF/B-VII Library for MCNP. This sub-task involves creation, verification, and validation of MCNP cross-section library based upon the latest version of ENDF, ENDF/B-VII, that is scheduled to be released late in calendar year 2005. This sub-task builds on the work of the Nuclear Data program element to provide improved evaluations to CSEWG for ENDF/B-VII. NJOY will be used to create the library, which is essential to allow MCNP users to take advantage of ENDF/B-VII.

LLNL:

Sub-Task 1 ($100k): COG/PREPRO Maintenance and User Support. Continued support for the COG/PREPRO codes is necessary to allow for utilization of the latest cross section data.

ORNL:

Sub-Task 1 ($625K): SCALE/KENO Maintenance and User Support. Under this sub-task, ongoing maintenance, training and user assistance associated with the modules within the criticality safety sequences of the SCALE code system is provided.

Sub-Task 2 ($100k): AMPX Cross Section Processing Methodology. The AMPX software processes data produced from the Nuclear Data work element into continuous energy formulations and system-independent multi-group data for use by SCALE. During FY 2006, work will continue in conjunction with library generation and testing to make AMPX more reliable.

Sub-Task 3 ($560k): Radiation Safety Information Computational Center. Under this sub-task, the RSICC infrastructure is supported to assure that software supporting NCS ($240K) and software supporting NA-10 non-NCS programmatic needs ($320K) are collected, packaged, and disseminated. User support in software installation, export control administration, and interface with code developers is also provided.

Sub-Task 4 ($50k): Automated Pitzer Solution Solver Data. The SCALE material information processor computes accurate nuclide compositions based on general solution specifications provided as input by the user. The current limitation to uranyl fluorides and uranyl nitrates will be expanded using data obtained from literature searches and chemistry experiments.

Sub-Task 5 ($70k): Generate KENO continuous energy (CE) cross-section library. Using an independent neutron kinematics treatment provided by AMPX, a library for the prototypic version of the CE-KENO code will be generated and tested.

Sub-Task 6 ($70k): Administration. This sub-task coordinates the planning, administration, and reporting of the activities performed under this program element and consults with the CSSG and DOE on all Analytical Methods issues.

Proposed Future Sub Tasks (FY-2007 and beyond)

Code maintenance and user support will continue at all four laboratories. At LANL, the creation of an ENDF/B-VII Library for MCNP will not be completed until FY 2007. In general, creating advanced data libraries as the latest nuclear data becomes available is highly desirable. At ORNL, the inclusion of CE-KENO (planned for release with SCALE 5.2 in early FY 2008) and the TSUNAMI software from the AROBCAD program element will require additional SCALE maintenance support in FY 2007 and beyond. An improved V&V database and update process is also proposed for FY 2007.

Maintenance of the rigor of these modern Monte Carlo codes cannot be performed on a "stagnant" system; that is, modest and continual code enhancements are a requirement for code maintenance. Therefore, several code enhancements should be pursued in the out-years. In particular, ANL would like to implement the improved source convergence capabilities already developed by NCSP support and demonstrated by the NEA Expert Group. Among the many additional MCNP features of interest to the nuclear criticality safety community are the following: a library of standard material; automated convergence testing; improved parallelization for eigenvalue problems; capabilities for a random geometry (e.g., pebbles), automated fission source point generation; eigenvalue convergence acceleration; depletion capabilities; ability to generate and use data libraries incorporating covariance information; updates to the MCNP criticality primer; enhanced visualization of fission source points; improved eigenvalue perturbation methodology; and enhanced code output to support user physics comprehension. Proposed code enhancement activities at ORNL for FY07 and beyond include development of an ENDF/B-VII library, inclusion of source convergence algorithms in all KENO versions, and extension of the Pitzer solution solver to include plutonium solutions.

Budget

Table 3-1: Analytical Methods Development and Code Maintenance Budget, Fiscal Years 2006–2010

SUBTASK	FY 2006 ($K)	FY 2007 ($K)	FY 2008 ($K)	FY 2009 ($K)	FY 2010 ($K)
TOTAL	2,640	2,700	2,750	2,800	3,100

4. International Criticality Safety Benchmark Evaluation Project

Program Element Description

The International Criticality Safety Benchmark Evaluation Project (ICSBEP) was initiated in 1992 by DOE's Defense Programs, now NNSA. The project is managed through the Idaho National Laboratory (INL), but involves nationally known criticality safety experts from nine DOE national laboratories or sites and 17 different countries. The ICSBEP is also an official activity of the Organization for Economic Cooperation and Development - Nuclear Energy Agency (OECD-NEA).

The purpose of ICSBEP is to (1) identify and evaluate a comprehensive set of criticality safety related experimental benchmark data; (2) verify the data, to the extent possible, by reviewing original and subsequently revised documentation, and by talking with the experimenters or individuals who are familiar with the experiments or the experimental facility; (3) evaluate the data and quantify overall uncertainties through various types of sensitivity analyses; (4) compile the data into a standardized format; (5) perform sample calculations using standard criticality safety codes and data; and (6) formally document the work into a single source of verified, extensively peer reviewed benchmark data.

The arguments that were originally made to justify the ICSBEP are even stronger today. Knowledgeable individuals upon whom the ICSBEP rely continue to age. The window of opportunity to evaluate valuable existing data at ANL, INL, Hanford, LANL, LLNL, and ORNL is closing. It is also essential that new or recently performed experiments at LANL and SNL be evaluated while materials and components are still available for examination and while the experiments are still fresh in the minds of the experimenters.

In terms of the NCSP prioritization criteria, the ICSBEP is considered as a capability maintenance activity that helps reduce operational costs and inefficiency and provides necessary tools to ensure compliance with American National Standards Institute (ANSI) American Nuclear Society (ANS) standards and Nuclear Regulatory Commission (NRC) license requirements.

Approved Sub Tasks (FY 2006)

The ICSBEP is divided into three subtasks, ICSBEP Infrastructure, Laboratory Participation, and International Experiments. Infrastructure includes project management, project administration, a significant fraction of the independent peer review and technical editing, graphic arts, project meeting organization, publication costs, travel for selected participants who are contributing evaluations, database (DICE) upgrades and maintenance, internet site upgrades and maintenance, minimal support for the Russian Federation and others, and participation in other NCSP activities. Laboratory Participation includes data evaluation; internal peer review; limited independent peer review; and ICSBEP meeting preparation, participation, and travel by participants at each of seven national laboratories or sites: Idaho National Laboratory (INL), LANL, LLNL, ORNL, ANL, Savannah River Site (SRS), and the Hanford Site. Sandia National Laboratory (SNL) and Bettis Laboratory (BL) also participate at their own expense. The International Experiments subtask includes the procurement and evaluation of new experiments at non U.S. facilities. Such experiments are supported through the NCSP only when U.S. facilities are unavailable to respond to specific DOE programmatic needs. When possible LANL experimenters are given the opportunity to either participate in or observe the experiments.

Proposed Future Sub Tasks (FY-2007 and beyond)

Specific evaluations that are planned for FY-2006 through FY-2010 are provided in Appendix C. The list of planned experiment evaluations given in these tables and in Appendix C is dynamic and is not all-inclusive. Every planned benchmark shown in Appendix C has been placed there

because of its importance to programs at one or more of the participating DOE Laboratories or sites.

Budget

Table 4-1: ICSBEP Budget, Fiscal Years 2006 – 2010

SUBTASK	FY 2006 ($K)	FY 2007 ($K)	FY 2008 ($K)	FY 2009 ($K)	FY 2010 ($K)
1. ICSBEP Infrastructure (INL)	848	850	866	881	896
2. National Laboratory Participation (All)	952	950	934	1,019	1,004
3. International Experiments (Russia)	100	100	100	TBD	TBD
TOTAL	1,900	1,900	1,900	1,900	1,900

5. Nuclear Data

Program Element Description

The Nuclear Data Program Element of the NCSP includes the measurement, evaluation and testing of neutron cross section data for nuclides of high importance to nuclear criticality safety analyses. New measurements are performed at ORNL using the Oak Ridge Electron Linear Accelerator (ORELA) Facility. Evaluation and data testing are performed under the auspices of the DOE-sponsored Cross Section Evaluation Working Group (CSEWG). The low and intermediate energy (eV, keV) evaluations are performed at ORNL with the SAMMY software. The high-energy evaluations (MeV) are performed primarily at LANL with the GNASH software. Nuclear modeling methods are being maintained and improved and the need for data uncertainty covariance files is being addressed.

The NCSP continues to improve coordination of nuclear data activities by fostering a strong collaborative effort among all of our national resources in this highly technical area. The objective is to solve the highest priority nuclear data problems relevant to criticality safety in a timely manner. This collaboration is accomplished through the Nuclear Data Advisory Group (NDAG). In addition, the NCSP continues to rely on the deputy director of the National Nuclear Data Center (BNL) for consultation regarding maintenance of nuclear reaction databases, covariance development, and CSEWG and international interactions.

Appendix D shows the sequence of activities necessary to obtain an update to the official U.S. Evaluated Nuclear Data File (ENDF). The planned priorities, as established by the NDAG for the Nuclear Data work element, are also shown in Appendix D.

This program element is essential for the NCSP, because it provides the nuclear cross section data required by the Analytic Methods and AROBCAD program elements. Additionally, current covariance data work efforts have revealed that integral experimental data can play an important role in the development of cross-section covariance data for specific applications. As a result, there is an increasing linkage between the ICSBEP program element and the Nuclear Data program element. Together these NCSP program elements are vital for criticality safety practitioners in the performance of NCS evaluations. As such, this NCSP work element supports the reduction of safety risk and operational costs evidenced by improved understanding and utilization of nuclear data, the maintenance of National Asset technical capability, and the analytical capability to meet DOE compliance requirements (standards, orders, etc.) and external regulatory commitments (DNFSB, NRC, etc.).

Approved Sub Tasks (FY 2006)

ANL:

Sub-Task 1 ($220k): Nuclear Data Support. ANL will continue to process and data test new evaluations related to the upcoming release of ENDF/B-VII. ANL will also focus on implementation of the stochastic approach outlined by D. L Smith to augment covariance data available in ENDF. Several ANL data experts will participate in twice-yearly NDAG meetings, and yearly CSEWG and WPEC meetings. These meetings are not only required for gathering priorities and communication with other experts, but also leverage NCSP resources through international collaboration and lead to the final data product (ENDF) for the criticality safety community. ANL will continue development of improved resonance theory, including implementation of the extended Reich Moore treatment and analytical treatment of the unresolved resonance region, which can be implemented in the other NCSP-supported codes. ANL will continue to harvest existing measured neutron data to support new evaluations. Three retirees who are internationally-recognized experts in the fields of data evaluation, covariance theory, and resonance modeling will continue make contributions (for minimal costs) and provide some training to next generation experts.

BNL:

Sub-Task 1 ($15k): Timely publication of nuclear data evaluations. BNL will ensure that nuclear data evaluations important to criticality safety are processed, reviewed, and included in the ENDF in a timely manner.

Sub-Task 2 ($10k): Technical support to the NCSP, CSSG and NDAG. BNL will participate in two NCSP and two NDAG meetings per year. BNL will also provide quarterly reports on the status of the ENDF/B library, highlighting matters of importance to the criticality safety community.

Sub-Task 3 ($30k): Covariance Data Development. BNL will develop the capability to calculate theoretical covariance data and begin production of these data based on NDAG prioritization. Included in this sub-task will be a joint project with ANL and LANL to incorporate a Monte

Carlo technique in the EMPIRE code to provide covariance data as a part of a nuclear model evaluation.

Sub-Task 4 ($45k): Gamma ray production data for fission product nuclei for use by MCNP. This sub-task will require reevaluation of fast neutron cross sections for fission product nuclei with EMPIRE to provide gamma ray production data consistent with cross section evaluations. These data are essential improving for material and radiation safety calculations that support analyses of criticality accident detector placement at DOE facilities.

LANL:

Sub-Task 1: ($280k) Nuclear Data Support. The NDAG recommend that neutron evaluations for criticality safety applications be improved. LANL will partner with ORNL to develop such improved evaluations. The FY 2006 focus will be on Be-9 and radiative capture for U-235. The NDAG has identified development of covariance data as a high priority. In FY 2006, LANL will focus on fission and capture covariance data for U-235, U-238, and Pu-239. Data testing has proven essential to make improvements in neutron evaluations. LANL will continue to focus on data testing using fast critical assemblies related to the upcoming release of ENDF/B-VII. Several LANL data experts will continue to participate in twice-yearly NDAG meetings, and yearly CSEWG and WPEC meetings. These meetings are required for gathering priorities and communication with other experts.

ORNL:

Sub-Task 1: ($1,132k): Data Evaluations and Uncertainty Covariances. This subtask engages expert staff to utilize information from differential measurements, integral measurements, and nuclear modeling codes to obtain improved data evaluations and uncertainty covariances for selected nuclides. In FY 2006, ORNL will focus on completing the evaluations for ^{39}K, ^{40}K, and ^{41}K. Additionally, efforts will focus on completing the covariance data files for ^{233}U, ^{235}U, and ^{238}U. In FY 2005, an initial resonance evaluation was completed for ^{232}Th, and FY 2006 efforts will focus on the generation of resonance parameter covariance data for ^{232}Th. Once the ^{55}Mn measurement is completed, a resonance evaluation for ^{55}Mn will be initiated. A ^{19}F inelastic cross-section measurement has been proposed for the GEANIE facility at LANSCE. If improved ^{19}F inelastic data become available, FY 2006 efforts will focus on making improvements to the ^{19}F resonance evaluation.

Sub-Task 2 ($330k): Nuclear Modeling. This subtask supports the ongoing maintenance and capability improvement of the SAMMY software. In FY 2006, efforts will focus on continued maintenance of the software package, user support, training courses, a major update to the SAMMY manual, and software development activities to support the covariance data evaluation work.

Sub-Task 3 ($330k): ORELA Measurements. This subtask supports expert staff engaged in planning and performance of differential measurements at the ORELA facility and general consultation on measurement techniques. (See Appendix D for planned measurements.)

Sub-Task 4 ($620k): ORELA Operations. This subtask provides funding that partially supports the operation and staff of the ORELA facility.

Sub-Task 5 ($490k): ORELA Refurbishment. This subtask initiates a three-year facility refurbishment plan for the ORELA. The goal of this plan is to address key infrastructure needs within the ORELA facility and return the facility to operational status. In FY 2006, a small $15K activity is planned to study the feasibility of using off-the-shelf equipment for some specific ORELA needs. The FY 2006 ORELA refurbishment plan activities call for repairs of the vacuum cooling system, revitalization of the electron gun program, and installing computer control of the ORELA data acquisition.

Sub-Task 6 ($70k): Nuclear Data Administration. This subtask supports the planning, administration, and reporting of the activities performed under the Nuclear Data program element and the coordination of the work element with the NDAG. Consultation on nuclear data issues will be provided to the CSSG as requested.

Proposed Future Sub Tasks (FY-2007 and beyond)

Support of the Nuclear Data work element at each of the four national laboratories is a planned ongoing activity with support for nuclear data evaluations and differential measurements focused on the priorities established by NDAG. Support for nuclear modeling and ORELA operations will continue to maintain the capability and expertise required for conducting data evaluations and measurements. The multi-year task to return ORELA to reliable operations will end in FY 2008 and additional funds may be requested in FY 2009 to assure continued reliability of the ORELA operations under an improved maintenance program. Based on results from the NERI sponsored work to improve thermal S(alpha, beta) scattering kernels with ORELA experimental data, a quality assessment of the existing versus improved data will be performed and reported to the Nuclear Data Advisory Group.

Budget

Table 5-1: Nuclear Data Budget, Fiscal Years 2006 – 2010

SUBTASK	FY 2006 ($K)	FY 2007 ($K)	FY 2008 ($K)	FY 2009 ($K)	FY 2010 ($K)
TOTAL	3,572	3,220	3,135	3,090	3,160

6. Integral Experiments

Program Element Description

The Integral Experiments program element of the NCSP maintains a fundamental capability for the DOE/NNSA to be able to perform critical mass measurements, and within the limits of is resources, to address specific site needs on a prioritized basis. This program element also supports maintaining a fundamental nuclear materials handling capability by providing support

for the hands-on nuclear criticality safety training programs. In addition, and beyond the scope of the NCSP, infrastructure maintained by the Integral Experiments program element also supports specific program requirements in the stockpile stewardship program, emergency response and counter terrorism program, the non-proliferation and arms control program, and the space nuclear power program.

Approved Sub Tasks (FY 2006)

Sub-Task 1 ($200k): Conduct sub-critical experiments at the Device Assembly Facility (DAF). This subtask is a continuation of collaborations with ORNL. It contributes to the safe operation of sub-critical configurations in the field. It provides means to benchmark and compare sub-critical calculations. It is also a capability maintenance activity by engaging the Criticality Experiments Facility (CEF) and ORNL personnel in the performance of experimental activities. The deliverable is a benchmark evaluation to be included in the International Handbook of Evaluated Criticality Safety Benchmark Experiments.

Sub-Task 2 ($150k): Develop and implement a plan for hands-on nuclear criticality safety training involving SHEBA and a hand-stack of uranium foils not to exceed a multiplication of 20. The deliverables are a resource loaded plan for conducting criticality safety hands-on training until the capability to do so is established elsewhere, conducting supporting safety basis revisions, and developing and implementing necessary procedures for conducting the training. The goal is to conduct 4 training courses at LANL during FY 2006.

Sub-Task 3 ($150k): Conceptual design for the new SHEBA. A new SHEBA will be designed and made operational prior to decommissioning the old SHEBA at TA-18. The preferred alternative for the new SHEBA is to locate it near the DAF, pending completion of the environmental analysis required in accordance with the National Environmental Policy Act. This new SHEBA will have greater flexibility in terms of geometry configuration and preserves the only solution critical assembly capability in the nation. The deliverable by the end of FY 2006 is a written report delineating the benefits and functions of the new geometry configurations along with a preliminary design.

Sub-Task 4 ($150k): Identify and plan for shipment of reflectors and miscellaneous materials to DAF. The LACEF capability is being transitioned to DAF under the CEF project. This project does not have the monetary resources to ship non-nuclear materials (reflectors, moderators and miscellaneous tools) that support critical experiments. This is a capability maintenance activity that preserves the large investment spent on these unique materials. The deliverable is moving the materials to DAF by the end of FY 2006.

Proposed Future Sub Tasks (FY-2007 and beyond)

The CEF Project has been initiated to relocate LACEF activities to the DAF at the Nevada Test Site and is sponsored by Defense Programs. It received an Approval of Alternative and Cost Range (Critical Decision 1) memorandum on June 14, 2004 and is scheduled for completion in late 2009. Funding for the CEF Project (current range is $125M to $148M) is provided through a Congressional Line Item construction account.

As the CEF project prepares the DAF to accommodate LACEF activities, interim operations will be conducted at LANL and the DAF to maintain the capability to conduct integral experiments and hands-on training. The number of experiments has been substantially reduced during the planned relocation of LACEF activities to the DAF. The reduction in number of planned experiments derives from applying some program resources to the mission relocation project and the unavailability of certain critical assemblies in the interim. The NCSP manager is working with the LACEF staff to maintain a limited integral experiments capability while TA-18 is transitioned to DAF. In addition, it is anticipated that TA-18 technical staff will participate in interim integral critical experiments in the Russian Federation funded under the ICSBEP task in this plan. This will enable the NCSP to maintain some continuity of integral experiment capability and will ensure that technical staff members maintain proficiency during the transition period. The NCSP is committed to make this transition as smooth as possible.

Transition of critical experiments and training capability from LANL to the DAF will proceed according to the following plan: In FY 2006, the NCSP plans to conduct one subcritical measurement at the DAF and support four training courses at LANL by doing a hand stack with the class foils to a multiplication of 20 and using SHEBA. SHEBA will remain operational at TA-18 throughout the transition to DAF. The NCSP will also pursue options to accelerate the operation of Planet in the DAF. If this plan is successful, the hiatus in critical assembly operations (with metal special nuclear material) will be substantially less than if no operations occur until 2010 when CEF is completed. Transition of integral experiments and hands-on training activities to the DAF will be completed by FY 2010.

Regarding SHEBA, the preferred alternative is to relocate SHEBA to a location near the DAF. Design of the new SHEBA will begin in FY 2006 and pending the outcome of an environmental assessment, construction of the new SHEBA could begin as early as FY 2007. This activity is being accomplished outside the CEF Project. Once the new SHEBA is operational, the old SHEBA at LANL will be decommissioned.

Budget

Table 6-1: Integral Experiments Budget, Fiscal Years 2006 – 2010 (All LANL Tasks)

SUBTASK	FY 2006 ($K)	FY 2007 ($K)	FY 2008 ($K)	FY 2009 ($K)	FY 2010 ($K)
TOTAL[(1)]	650	1,000	1,100	1,200	1,300

(1) In addition to NCSP program funding, facility operations funding totaling ~ $1 Million is provided annually through another NNSA Readiness in Technical Base and Facilities account to support the integral experiments ant hands-on training activities at TA-18.

7. Information Preservation and Dissemination

Program Element Description

The Information Preservation and Dissemination Program Element of the NCSP was established to preserve primary documentation supporting criticality safety and to make this information available for the benefit of the technical community. There are two major sub elements within this program element:

1. The Criticality Safety Information Resource Center (CSIRC). CSIRC is tasked with collecting and preserving documents directly related to critical experiments and criticality safety The collection effort includes both human (video taping) interviews and documentation assets. The information is distributed in various manners, DVDs, paper copies, via CSIRC website download. CSIRC was created to reduce information loss as the complex and human resources age as well as to provide a centralized location for information storage and exchange in the complex.

2. The NCSP World Wide Web Internet site (http://ncsc.llnl.gov:8080/). This website is the central focal point for access to criticality safety information collected under the NCSP, and the gateway to a comprehensive set of hyperlinks to others sites containing criticality safety information resources. The NCSP web site serves as an efficient means for the DOE NCSP to disseminate information electronically to the entire criticality safety community. Extensive use is made of the hyper links to other DOE web sites to point a user to the original data source to ensure accuracy and access to the most up-to-date information.

Approved Sub Tasks (FY 2006)

CSIRC (LANL; $74k):

Sub-Task 1: Review (with cross section experts) the efficacy and value of producing and testing new fission cross sections and develop a path forward.
Sub-Task 2: Maintenance the CSIRC Website.
Sub-Task 3: Upgrade CSIRC website server.

CSIRC (ORNL; $50k):

Sub-Task 1: Videotape ORELA Pioneers to document/capture experience in maintaining and operating the facility.

CSIRC (Hanford; $90k):

Sub-Task 1: Continue the revision of Atlantic Richfield Hanford (ARH)-600.
Sub-Task 2: Maintain and enhance the Hanford Database.

Website (LLNL; $166k):

Sub-Task 1: Operation and Maintenance of the NCSP Website. This subtask will install monthly Operating System patches, upgrade web server software, perform daily and monthly backup, monitor daily hackers attempts, and perform monthly risk assessment required by NNSA cyber security policy.
Sub-Task 2: Information Coordination and Dissemination: this subtask will coordinate via email and/or telephone NCSP information from CSSG and End Users and CSCT, convert various types of documents into PDF files or web pages, and solve accessing and printing problems.
Sub-Task 3: Improve user interface and contents at the NCSP Website. This subtask will continue to incorporate CSSG and End Users requests and feedbacks, change current navigation menu buttons to the LHS menu with new logos, enhance LLNL bibliographic database and Hanford NCTSP database (searching by Value Index, Document date, OSTI document number, and Category), update and release new version of the web site users registration information, and continue to improve CEF web pages with facility specific information and training modules.
Sub-Task 4: NCSP Website hardware and software upgrade. This subtask will buy new hardware and software to replace the current five years old Sun Ultra10, 300 megahertz workstation with a Dell Power Edge Linux Server, move and convert current applications and web site contents to new web server.

<u>Proposed Future Sub Tasks (FY-2007 and beyond)</u>

CSIRC:
Sub-Task 1: Review and index ORNL logbooks (LANL).
Sub-Task 2: Review and index ZPPR logbooks (LANL).
Sub-Task 3: CSIRC Website redesign and software upgrades (LANL).
Sub-Task 4: Website maintenance (LANL).
Sub-Task 5: Fission XS Calculations (LANL).
Sub-Task 6: Historical photograph presentation and narration (LANL).
Sub-Task 7: Revise LA-10860-MS (LANL).
Sub-Task 8: Continue to update the Hanford Database (Hanford).
Sub-Task 9: Continue to enhance ARH-600 (Hanford).
Sub-Task 10: Produce ORNL Heritage DVDs (ORNL).

Website (LLNL):
Sub-Task 1: Continue the following: website operations and maintenance; information coordination and dissemination; and improving user interface.
Sub-Task 2: Multimedia web base training. This subtask will develop first example of a training module with multi-media streaming video feature, utilizing LLNL's HS3104 training module as a starting point and adding the multi-media video to support multimedia web base training. If successful, additional training modules will be developed using state-of-the-art multimedia technology.

Budget

Table 7-1: Information Preservation and Dissemination Budget, Fiscal Years 2006 – 2010

SUBTASK	FY 2006 ($K)	FY 2007 ($K)	FY 2008 ($K)	FY 2009 ($K)	FY 2010 ($K)
1. NCSP website operations and maintenance (LLNL)	166	142	150	175	166
2. CSIRC Sub-Tasks 1-5 (LANL)	74	98	130	135	144
3. CSIRC Sub-Task 1 (ORNL)	50	30	0	0	0
4. CSIRC Sub-Tasks 1-2 (Hanford)	90	90	90	90	90
TOTAL	380	360	370	400	400

8. Training and Qualification

Program Element Description

The Training and Qualification program element has two subtasks:

1. Continue to offer hands-on training courses at LANL as needed by DOE; and
2. Identify training needs and develop new resources in areas where no suitable materials exist.

The goal of this program element is to maintain the technical capabilities of criticality safety professionals and provide for the training and qualification of people entering the criticality safety discipline from related scientific fields.

Approved Sub Tasks (FY 2006)

Hands-On Training:

Sub-Task 1 ($150k): Hands-On Training. LANL will provide instructors for up to four 3-Day courses using CAT-III/IV materials at TA-18.

Training Development:

Sub-Task 2 ($25k): Develop a Nuclear Criticality Safety Engineer Training (NCSET) module for criticality accident dose calculations, including an interactive training tool based on the criticality accident slide rule. The user community has asked for a module on criticality accidents. This task would include development of such a module that associates types of criticality accidents

with estimated fission yields and dose rates. Depending on copyright conditions, the criticality accident slide rule developed by ORNL for the NRC may be incorporated into the module.

Sub-Task 2 ($25k): Develop a proposal to design and implement a criticality assembly an accident training simulator. Simulators have been used in the past as part of a complete criticality safety training program. With the potential lack of hands-on training for some interval during the critical assembly relocation, the need for a simulator has once again been raised. Working with CSSG members who are familiar with previous simulators, a conceptual design for a state-of-the-art simulator will be developed and plans for implementing the design will be developed along with cost estimates.

Proposed Future Sub Tasks (FY-2007 and beyond)

Hands-On Training:

Sub-Task 1: Redesign courses to conduct them at the Device Assembly Facility.
Sub-Task 2: Redesign and upgrade course materials (notebooks).
Sub-Task 3. Conduct four 3-Day courses per year at TA-18 and/or the DAF.
Sub-Task 4: Conduct one 5-Day Basic Course per year at TA-18 and the DAF.
Sub-Task 5: Conduct one 5-Day Practical methods course per year at TA-18 and the DAF.

Training Development:

As an integral part of maintaining capability through training of criticality safety specialists, training modules will continue to be developed at the rate of approximately two per year.

Budget

Table 8-1: Training and Qualification Budget, Fiscal Years 2006 – 2010

SUBTASK	FY 2006 ($K)	FY 2007 ($K)	FY 2008 ($K)	FY 2009 ($K)	FY 2010 ($K)
1. Hands-on Training (LANL)(1)	150	155	160	165	180
2. Training Development (ANL)	50	55	60	65	70
TOTAL	200	210	220	230	250

(1) The funding for these courses is shared between the Critical Experiments Facility and the Nuclear Criticality Safety Group in a 60/40 percentage split, respectively.

9. NCSP Support

CSSG Activities

The Criticality Safety Support Group (CSSG) is comprised of recognized criticality safety experts from DOE offices and contractor organizations (see Appendix A for CSSG members). The primary function of the CSSG is to provide operational and technical expertise to the Department of Energy through the Nuclear Criticality Safety Program (NCSP) manager, who has the responsibility for the implementation and execution of the program and the disposition of the advice of the CSSG. The CSSG also provides the NCSP manager with technical reviews of orders, standards, rules and guides issued by DOE related to criticality safety. In its support role, the CSSG responds to requests from the NCSP manager for information, technical reviews, and evaluations of criticality safety issues throughout the complex. The CSSG charter has recently been revised and a membership policy implemented to provide a strategy for assuring continuity of the criticality safety infrastructure. The CSSG began providing technical assistance to site offices during FY 2004. These site visits are expected to continue in accordance with the new policy for base lining and subsequent monitoring of operational criticality safety programs. The CSSG continues to provide important input for the annual report to the Defense Nuclear Facilities Safety Board on NCSP activities and effectiveness. The NCSP budget provides support for CSSG members and some travel associated with site visits.

CSCT Activities

The Criticality Safety Coordinating Team (CSCT) is the group of federal staff providing line oversight for criticality safety at the field level. The CSCT ensures that the contractors implement DOE criticality safety orders and standards. They also have a pivotal role to play in understanding the technical infrastructure needs at the site level that the NCSP provides. The primary function of the CSCT is to ensure uniformity of criticality safety programs and compliance throughout all the sites. They form the cadre of federal criticality safety subject matter experts and will also assist the site office managers and headquarters with monitoring criticality safety programs through site assist visits.

Approved Sub Tasks (FY-2006):

1. The CSCT will meet together in conjunction with either an ANS meeting or one of the biennial meetings of the CSSG to promote coordination of activities and to advise the NCSP manager on implementation of criticality safety infrastructure at the site level. This task supports improved safety, operational efficiency, and helps ensure regulatory compliance.

2. A subset of qualified CSCT members will perform site visits to assist the DOE field office managers, the NCSP, and the Chief of Nuclear Safety organizations monitor criticality safety programs. Teams of two CSCT members will perform assessments throughout the year on a schedule TBD.

Proposed Future Subtasks (FY-2007 and beyond):

1. One annual CSCT meeting.
2. Annual site visits to monitor criticality safety programs TBD.

End Users Activities

The End Users Group is a group of contractor nuclear criticality safety personnel formed to advise the NCSP manager on infrastructure needs of criticality safety practitioners and to provide feedback on the products of the NCSP. The End-Users participation in the NCSP improves efficiency of operations and enhances safety by ensuring the deliverables are useful and implementable. The LLNL Criticality Safety Section has agreed to provide a Chairman for the End Users in FY 2006 according to the following plan.

Approved Sub Tasks (FY-2006):

1. John Pearson who is currently the LLNL Superblock criticality safety task force leader has agreed to serve as the FY 2006 End Users Group Chairman. The End Users Group Chairman will transform the current NCSP meetings that are held in conjunction with the biannual American Nuclear Society (ANS) Meetings into End Users Group workshops that will provide meaningful feedback to the NCSP.
2. The End Users Group Chairman will organize conference calls to be held at least 4 times a year. In consulting with the End Users Group, the Chairman will set the agenda beforehand and distribute the telephone conference call results to all interesting parties.
3. The End Users Group Chairman will organize and chair the two NCSP End Users Group workshops (the two Friday meetings after the ANS conferences). To ensure orderly preparation of the workshops and provide meaningful dialogues and input, the Chairman will perform the following coordination tasks starting with the 2005 November ANS meeting.
    a. Reconstitute the End Users Group Roster to include key active participants from each site for the End Users Group.
    b. Coordinate with the End Users Group starting in August 2005, and prior to the Knoxville Criticality Safety Topical Meeting in September 2005, to formulate the first draft of the main End Users Group need areas for the purposes of forming working groups to handle them.
    c. Use the Knoxville Criticality Safety Topical Meeting to gather additional input from the End Users Group key stakeholders to finalize the working groups and appoint the Chairmen for these groups.
    d. Working with the NCSP Manager, CSSG Chair, and the End Users Group working group Chairmen, formulate the November NCSP End Users Workshop agenda, break-out working group sessions, discussions, and presentations.
4. The End Users Chairman will attend CSSG meetings (no more than two if held away from the ANS annual meetings).
5. If necessary, the End Users Group Chairman will convene an End Users Group conference.

Proposed Future Subtasks (FY-2007 and beyond):

Same as above with different site providing the Chairman (potentially).

Budget

Table 9-1: NCSP Support Activities, Fiscal Years 2006 – 2010

SUBTASK	FY 2006 ($K)	FY 2007 ($K)	FY 2008 ($K)	FY 2009 ($K)	FY 2010 ($K)
1. CSSG Activities	235	235	245	350	355
2. End Users Activities	25	25	30	30	35
TOTAL	260	260	275	380	390

10. Program Specific Applications

This section describes those activities aligned with the tasks and infrastructure capabilities maintained by the NCSP but that are not officially part of the NCSP Five Year Plan. This information is provided for information and completeness as the tasks described below are contingent upon funding and management decisions outside the purview of the NCSP Manager. As such, the tasks and deliverables mentioned in this section are not NCSP commitments.

ICSBEP

Program specific applications are typically merged with the annual ICSBEP Working Group Meeting or publication schedule. When necessary, extra effort is made to advance program specific applications through the independent review process and make the unofficial information available to the customer prior to formal publication. This information is subject to revision after the international review and approval process is completed. The following activities have been proposed and will be accomplished if the additional funding, delineated below, is provided:

1. ICSBEP participation of scientists from up to 5 weapons related institutes in the Russian Federation has been proposed to NNSA's office of Nuclear Non-Proliferation at a cost of $300K per year. Scientists from the Russian Federation joined the ICSBEP in 1994 and are the second largest contributor; however the level of their participation has declined significantly since 1997 because of lack of funding. Inclusion of these scientists in the ICSBEP naturally supports the DOE Office of Nuclear Nonproliferation mission in that it provides meaningful safety related work for former weapons scientists from Russia and Kazakhstan. In addition, DOE receives high quality criticality safety related data and the expertise developed in the Russian Federation. This is an ongoing proposal with the hope of obtaining funding beginning in FY-2006.

2. Sandia National Laboratory plans to perform and evaluate an experimental series involving water-moderated square-pitched U(6.93)O2 fuel rod lattices during 2006 to 2007, contingent upon the availability of funding from the Office of Nuclear Energy. The cost of the experiments is estimated to be nearly $3M of which approximately $50K to 60K would be used for the ICSBEP evaluation.

3. Plans have also been initiated to perform additional burn-up credit type experiments at Sandia National Laboratory in the 2007 to 2008 time frame. These experiments are intended to be follow-on to the Nuclear Energy Research Initiative (NERI, DOE Office of Nuclear Energy, Science and Technology (NE)-20) sponsored burn-up credit experiments that were evaluated and approved by the ICSBEP in FY-2005. The cost of the program is several million dollars and is subject to availability of funding from the Office of Civilian Radioactive Waste Management.

AROBCAD

1. The DOE office of Civilian Radioactive Waste (RW) is extending the AROBCAD computational capabilities into burn-up credit for radioactive waste applications. Although this is independent of the AROBCAD work, the sensitivity/uncertainty methods are indirectly benefiting from this work.

2. Proposals are under development to extend AROBCAD studies and training for other DOE-Office of Environmental Management (EM) sites (e.g., WIPP). Funding would be ~$75k if EM decides to pursue this.

3. An additional activity that utilizes the AROBCAD technology is the evaluation and qualification of Mixed Oxide Fuel (MOX) critical experiments performed for NA-263, the Office of International Technology. ($125K)

Analytical Methods Development and Code Maintenance

Modest levels of supplemental funding have assisted in expediting the completion of nuclear criticality safety related software. The following tasks with their associated deliverables were funded by EM-22 in FY05. The FY05 EM-22 budget for the Analytical Methods, Nuclear Data and AROBCAD sensitivity/uncertainty studies is $600k. A similar funding level will be proposed to the EM Change Control Board in FY06.

1. Cross Section Processing: Completion of the production version of AMPX (FY06) and preparation of the AMPX/ Evaluated Nuclear Data File, ENDF/B-VI Reference Library (FY06): The 238 group library will be released in December 2005. AMPX release to RSICC is anticipated in FY 2006. A subtask involves modifying the PUFF covariance-file software for consistency with current formats on cross-section uncertainties. ($200k).
2. Completion of the GLSSM code: FY06 work will include the completion of testing and the preparation of a user's guide. ($100k)

3. Besides the NCSP, enhancement and maintenance of the entire SCALE code system continues with collaborative funding from the NRC and other DOE offices (EM and RW). A year-end report on these activities is provided to all SCALE sponsors, including the NCSP, at the end of each FY.

Nuclear Data

1. An additional $150K from EM-22 has been provided to fund the development of covariance files for nuclides of high importance in EM fissionable material operations. This effort is being made on an incremental basis with recommendations made by the NDAG after reviewing results of special studies on EM applications. The initial effort addresses the isotopes of gadolinium. Additional covariance files are being developed for those nuclides that were recently measured and evaluated under this program: oxygen, chlorine, silicon, aluminum, and fluorine.

2. The Office of Radioactive Waste Management is sponsoring a program at ORNL to evaluate and improve nuclear data for the key fission products being considered for utilizing burn-up credit in the qualification of spent fuel shipping containers for the Yucca Mountain Project. This effort has become a significant sponsorship area for both data measurements and evaluation.

3. Under another NERI project sponsored by NE-20, thermal neutron scattering kernels in the S(alpha, beta) formulation are being developed experimentally and analytically. This effort, being led by North Carolina State University, involves the generation of scattering law data for graphite, Be, BeO, ZrH, ThH, polyethylene, and light water. Experimental measurements at several temperatures will be performed with ORELA.

Appendix A

Points of Contact for the Seven Technical NCSP Elements and CSSG Members

NCSP Program Element Points of Contact

AROBCAD

Contractor Program Element Manager:

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ICSBEP

DOE-ID Program Monitor:

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Nuclear Data

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Contractor Project Manager:

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Training and Qualification

Contractor Task Managers:

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CSSG Members

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Emeritus Members		
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Appendix B

Work Authorization Statements for Nuclear Criticality Safety Program Funding for Execution Year (FY 2006) Provided to NA-11 Budget Office in September 2005.

Tasks: Nuclear Data, Analytical Methods Development and Code Maintenance, Applicable Ranges of Bounding Curves and Data, and Criticality Safety Support Group
Oak Ridge National Laboratory (ORNL): $5,027K

Funds are provided to ORNL to conduct criticality safety related nuclear data acquisition, evaluation, testing, and publication; to maintain criticality safety codes, including associated cross section processing codes; to continue criticality safety related code distribution and user support through RSICC; and to conduct the Applicable Ranges of Bounding Curves and Data Program, in accordance with the schedule and milestones set forth in the NCSP (NCSP) Five-Year Plan, dated September 2005, or as directed by the NCSP Manager. Funds are also provided to ORNL for Criticality Safety Support Group (CSSG) technical support to the NCSP Manager regarding planning and execution of the NCSP. With approval of the NCSP Manager, the CSSG may also provide technical assistance to other DOE and DOE Contractor organizations. Quarterly reports on the status of all tasks shall be provided to the NCSP Manager no later than the last day of the month following the end of the quarter.

ORNL POC: Mike Westfall (865-574-5267) and Calvin Hopper (865-576-8617)
DOE POC: Jerry McKamy, NNSA (301-903-8031)

Task: International Criticality Safety Benchmark Evaluation Project
Idaho National Laboratory (INL): $1,800K

Funds are provided to the INL to conduct the International Criticality Safety Benchmark Evaluation Project (ICSBEP) as delineated in the Nuclear Criticality Safety Program (NCSP) Five-Year Plan, dated September 2005, or as directed by the NCSP Manager. Quarterly reports on the status of all tasks shall be provided to the NCSP Manager no later than the last day of the month following the end of the quarter.

INL POC: Blair Briggs (208-526-7628)
DOE-ID POC: Adolf Garcia (208-526-4420)
DOE POC: Jerry McKamy, NNSA (301-903-8031)

Task: Integral Experiments, Hands-On Training, Criticality Safety Information Resource Center, Analytical Methods Development and Code Maintenance, Nuclear Data Support, and Criticality Safety Support Group
Los Alamos National Laboratory (LANL): $1,904K

Conduct nuclear criticality integral experiments, hands-on criticality safety training, Criticality Safety Information Resource Center activities, MCNP support, and Nuclear Data support as delineated in the Nuclear Criticality Safety Program (NCSP) Five-Year Plan, dated September 2005, or as directed by the NCSP Manager. Re-validate experiment priorities based on input from the criticality safety community and publish an updated Nuclear Criticality Experiments Priority list by July 2006. Funds are also provided to LANL for CSSG technical support to the NCSP Manager regarding planning and execution of the NCSP. With approval of the NCSP Manager, the CSSG may also provide technical assistance to other DOE and DOE Contractor organizations. Quarterly reports on the status of all tasks shall be provided to the NCSP Manager no later than the last day of the month following the end of the quarter.

LANL POC: David Loaiza (505-667-4936), Shean Monahan (505-665-7567), and Robert Little (505-665-3487)
DOE POC: Jerry McKamy, NNSA (301-903-8031)

Task: Analytical Methods Development and Code Maintenance, Nuclear Data Support, Training Development, and Criticality Safety Support Group
Argonne National Laboratory (ANL): $ 710K

Funds are provided to ANL to continue supporting VIM and associated cross section processing codes, and Nuclear Data support, including Chairing the Nuclear Data Advisory Group, as delineated in the Nuclear Criticality Safety Program (NCSP) Five-Year Plan, dated September 2005, or as directed by the NCSP Manager. Funds are also provided to continue development of Nuclear Criticality Safety Engineer Training materials and for Criticality Safety Support Group (CSSG) technical support to the NCSP Manager regarding planning and execution of the NCSP. With approval of the NCSP Manager, the CSSG may also provide technical assistance to other DOE and DOE Contractor organizations. Quarterly reports on the status of all tasks shall be provided to the NCSP Manager no later than the last day of the month following the end of the quarter.

ANL POC: Richard McKnight (630-252-6088) and Jim Morman (630-252-6076)
DOE POC: Jerry McKamy, NNSA (301-903-8031)

Task: Nuclear Criticality Safety Web Site, COG Maintenance, and End Users Group Support
Lawrence Livermore National Laboratory (LLNL): $316K

Funds are provided to LLNL to maintain the DOE Nuclear Criticality Safety Web Site, to maintain cross section processing codes, and for End Users Group Support as delineated in the Nuclear Criticality Safety Program (NCSP) Five-Year Plan, dated September 2005, or as directed by the NCSP Manager. Quarterly reports on the status of all tasks shall be provided to the NCSP Manager no later than the last day of the month following the end of the quarter.

LLNL POC: Song Huang (925-422-6516)
DOE POC: Jerry McKamy, NNSA (301-903-8031)

Task: Validation and Reissue of ARH-600, Updating of the Hanford Data Base, and Criticality Safety Support Group (CSSG) support
Fluor Hanford: $115K

Funds are provided to Fluor Hanford for the continued revision of ARH-600, updating of the Hanford Data Base, and CSSG technical support to the Nuclear Criticality Safety Program (NCSP) Manager regarding planning and execution of the NCSP. With approval of the NCSP Manager, the CSSG may also provide technical assistance to other DOE and DOE Contractor organizations. Quarterly reports on the status of all tasks shall be provided to the NCSP Manager no later than the last day of the month following the end of the quarter.

Fluor Hanford POC: David Erickson (509-376-4146)
DOE POC: Jerry McKamy, NNSA (301-903-8031)

Task: Nuclear Data
Brookhaven National Laboratory (BNL): $100K

Funds are provided to BNL to continue Nuclear Data support as delineated in the Nuclear Criticality Safety Program (NCSP) Five-Year Plan, dated September 2005, or as directed by the NCSP Manager. Support will include shepherding new data evaluations through the Cross Section Evaluation Working Group process and subsequent publication of these data in the United States Evaluated Nuclear Data File. Quarterly reports on the status of all tasks shall be provided to the NCSP Manager no later than the last day of the month following the end of the quarter.

BNL POC: Pavel Oblozinsky (631-344-2814)
DOE POC: Jerry McKamy, NNSA (301-903-8031)

Appendix C

International Criticality Safety Benchmark Evaluation Project Planned Benchmarks

ICSBEP FIVE-YEAR PLAN ARGONNE NATIONAL LABORATORY	
IDENTIFIER	***DRAFT TITLE***
FY-2006	
HEU-COMP-FAST-004	ZPR-3 Assembly 14: A Clean HEU (93% ^{235}U) Carbide Core Reflected by Depleted Uranium
HEU-MET-MIXED-012	ZPPR-20: Phase D Critical Configurations
IEU-MET-FAST-011	ZPR6-1 All Aluminum - 14% Enriched
Other Measurements (Possibly)	Selected measurements from HEU-MET-INTER-001 – PSR control worth measurements, matrix Interface gap worth, worth of removing the depleted-uranium room-return shield, worth measurements of fuel column at core edge and core center drawers, kinetics parameters: ßeff, ß/l and ßi/ß. ßeff was repeated after removing the room return, shield at the end of the program, neutron spectrum measurements near core center and in the radial reflector, reaction rates in a central cavity, reaction rates in the unit cell, reaction-rate axial and radial distributions.
FY-2007	
IEU-COMP-FAST-004	ZPR-3 Assembly 12: A Large, Clean, Cylindrical Uranium (21% ^{235}U)Carbide Benchmark Assembly Reflected by Depleted Uranium
IEU-MET-FAST-015	ZPR-3 Assembly 6F: A Clean Cylindrical Core with a ^{235}U-to-^{238}U Ratio of 1, Reflected by Depleted Uranium
FY-2008	
PU-COMP-FAST-004	ZPR-3 Assembly 48: A Clean Cylindrical Pu Carbide Core, Reflected by Depleted Uranium
MIX-COMP-FAST-002	ZPR-9 Assembly 29: Normal and Flooded Configurations of Mixed (Pu/U)-fueled GCFR Assembly
FY-2009	
PU-COMP-FAST-003	ZPR-9 Assembly 31: The Plutonium Carbide Benchmark Assembly Reflected by Depleted Uranium
IEU-COMP-FAST-005	ZPR-3 Assembly 11: A Large, Clean, Cylindrical Uranium (12% ^{235}U) Carbide Benchmark Assembly Reflected by Depleted Uranium
FY-2010 and Beyond	
IEU-COMP-FAST-003	ZPR-6 Assembly 5: A Large, Clean, Cylindrical Uranium Carbide Benchmark Assembly Reflected by Depleted Uranium
IEU-COMP-FAST-006	ZPR-3 Assembly 25:A Large, Clean, Cylindrical Uranium (9% ^{235}U) Carbide Benchmark Assembly Reflected by Depleted Uranium
Others	To Be Determined

ICSBEP FIVE-YEAR PLAN FLOUR HANFORD / PACIFIC NORTHWEST NATIONAL LABORATORY	
IDENTIFIER	***DRAFT TITLE***
FY-2006	
SUB-LEU-MET-THERM-001	Spent Fuel Subcritical Measurements for LEU Metal Tubular Fuel
FY-2007	
SUB-MIX-COMP-THERM-001	Subcritical Waste Drums Measurements
FY-2008	
LEU-COMP-THERM-072	Max k_∞ for UO_3 in Water for 1.0 ^{w}/o ^{235}U Enrichment
FY-2009	
LEU-COMP-THERM-073	Max k_∞ for UNH for 2.1 ^{w}/o ^{235}U Enrichment
FY-2010 and Beyond	
PU-COMP-THERM-003	PCTR Graphite Moderated Pu-Al Fuel Rods
PU-MET-THERM-005	PRTR Plutonium Rods in Water
PU-MET-THERM-006	PRTR Pu Rods in Water and PuO_2 / MgO
HEU-COMP-THERM-020	Uranium Carbide Experiments
HEU-MET-THERM-023	Uranium, Chromium, Water Mixtures - Measurements Needed
HEU-MET-THERM-024	Uranium, Cerium, Water Mixtures - Measurements Needed
LEU-COMP-THERM-074	Max k_∞ for UF_4 Paraffin for 2.0 ^{w}/o ^{235}U Enrichment
LEU-MET-THERM-010	PCTR Experiments - Graphite Mod. 2.1 w/o Enriched LEU with Li Targets
LEU-MET-THERM-011	HCTLTR Experiments
LEU-MET-THERM-012	PCTR Experiments with Graphite and LEU
LEU-MET-THERM-013	Graphite Moderated, Air-Cooled 305 Test Pile
LEU-MET-THERM-014	PCTR U-Th Supercells in Graphite Moderator
SUB-LEU-MET-THERM-002	Subcritical 2.1 ^{w}/o Enriched Uranium Rods in Water Intermixed with Cd
SUB-LEU-MET-THERM-003	Subcritical LEU Metal Rods in Water for 3.0 w/o ^{235}U Enrichment
SUB-LEU-MET-THERM-004	Subcritical LEU Metal Tubes in Water with 1.25 ^{w}/o ^{235}U Enrichment
SUB-LEU-MET-THERM-005	Subcritical LEU Metal Tubes in Water with 0.95 w/o ^{235}U Enrichment
SUB-LEU-MET-THERM-006	Subcritical LEU Metal Tube-Rod in Water
SUB-LEU-MET-THERM-007	Subcritical 1.44 w/o Enriched LEU Tubes in Water
MIX-COMP-FAST-004	Fast Flux Test Reactor (FFTF) Fuel Approach to Critical in Liquid Na Critical
MIX-COMP-FAST-005	FFTF Core Demonstration Experiment
MIX-COMP-THERM-017	FFTF Fuel Criticals in Water

ICSBEP FIVE-YEAR PLAN IDAHO NATIONAL LABORATORY	
IDENTIFIER	***DRAFT TITLE***
FY-2006	
HEU-MET-FAST-076	Uranium Metal Annuli and Cylinders with thick Polyethylene Reflectors and/or Internal Polyethylene Moderator
U233-COMP-THERM-002	LWBR $^{233}UO_2$-ThO_2 Detailed Cell Experiments -- Work For Others
Fundamental Physics Benchmark	NIST Water Spheres
FY-2007	
HEU-COMP-THERM-019	Critical Experiments with BORAX-V Superheater Fuel Assemblies
U233-COMP-THERM-003	LWBR $^{233}UO_2$-ThO_2 BMU Experiments -- Work For Others
FY-2008	
PU-MET-FAST-042	Plutonium Hemishells in Oil - Part II
IEU-COMP-THERM-006	Critical Experiments with BORAX-V Boiling and Superheater Fuel Assemblies
FY-2009	
PU-MET-FAST-043	Plutonium Hemishells in Oil - Part III
HEU-SOL-THERM-026	Aqueous Solutions of ^{235}U Poisoned With Raschig Rings
FY-2010 and Beyond	
IEU-COMP-THERM-007	Power Burst Facility – Water Moderated 18.5% Enriched Uranium Ternary Oxide Fuel Pin Lattice
LEU-COMP-THERM-071	Loss of Fluid Test Reactor – Water Moderated Array of 4% Enriched Uranium PWR Fuel Assemblies
Others	To Be Determined

ICSBEP FIVE-YEAR PLAN LOS ALAMOS NATIONAL LABORATORY	
IDENTIFIER	***DRAFT TITLE***
FY-2006	
HEU-MET-INTER-010	ZEUS (HEU) Intermediate Energy Spectrum with Iron
HEU-MET-INTER-016	NASA Related Programs Part II – Nb – 1Zr / Graphite
HEU-MET-FAST-059	NASA Related Programs Part III – Ta-2.5W/Graphite
HEU-MET-FAST-074	Critical Mass of Oralloy Shells
FY-2007	
PU-MET-FAST-046	NASA Related Programs Part IV – Re/Graphite
HEU-MET-INTER-011	SM1, Special Moderator HEU/Graphite
SPEC-MET-FAST-009	NP001/NP002 Neptunium/HEU Critical (natural uranium reflected)
FY-2008	
HEU-MET-THERM-015	P007/P008, Planet Waste Matrix HEU-Fe (2x2 array) 15-mil thick iron plates

SPEC-MET-FAST-010	NP003, Neptunium/HEU/Be Reflected
SUB-SPEC-MET-FAST-001	SUB2, Bare and HEU Reflected ^{237}Np Spheres
FY-2009	
PU-MET-INTER-003	SM4/SM6, Pu Reflected with Graphite and Beryllium
PU-MET-THERM-002	P022, Pu / Si / Poly (2x2)
HEU-MET-THERM-017	P012, Waste Matrices HEU / Ca / Poly
HEU-MET-THERM-019	PO13, Waste Matrices HEU / Zr / Poly (1x1)
FY-2010 and Beyond	
PU-MET-INTER-004	SM5, Pu Reflected with D_2O
PU-MET-FAST-038	BRP Ball Experiments Pu/Be
PU-MET-THERM-003	P023, Pu / Al / Poly
PU-MET-THERM-004	P024 / P025, Pu / MnO / Poly (1x1 and 2x2)
HEU-MET-INTER-013	Z013/Z014, ZEUS (HEU) Intermediate Energy Spectrum with SiO_2
HEU-MET-INTER-014	SM3, HEU Reflected by Beryllium
HEU-MET-THERM-020	P016, HEU / Concrete / Poly (2x2)
HEU-MET-THERM-021	P017/P018, HEU / Al_2O_3 / Poly (1x1 and 2x2)
MIX-MET-FAST-014	P019, Pu(δ) /HEU
SPEC-MET-FAST-012	NP006, Neptunium Reflected with Tungsten
SPEC-MET-FAST-013	NP005, Neptunium/HEU Reflected with Beryllium
	Others May Include the Following Existing Experiments
SPEC-MET-FAST-005	Replacement Measurements Performed with Am-241
SPEC-MET-FAST-006	Replacement Measurements Performed with Am-243
Others	To Be Determined

ICSBEP FIVE-YEAR PLAN
LAWRENCE LIVERMORE NATIONAL LABORATORY

IDENTIFIER	***DRAFT TITLE***
FY-2006	
PU-SOL-THERM-019 (Joint French/LLNL)	Proserpine Experiments: Aqueous Plutonium Solutions Reflected by Beryllium Oxide and Graphite
HEU-MET-INTER-012	SNOOPY Experiments -- Graphite Moderated HEU Foils – Part I (C/U = 297 and 600)
HEU-MET-FAST-077	Nimbus Part III *Requires help with declassification of original materials.
HEU-SOL-THERM-046 (Joint IRSN/LLNL)	Proserpine Experiments: Part II. Aqueous Uranium Solutions Reflected by Beryllium Oxide and Graphite
FY-2007	
HEU-MET-THERM-028	SPADE Experiments -- BeO Moderated Oy with Materials such as Iridium, Rhenium, Hafnium, Silver, Tantalum, Hastalloy, Indium, Cadmium, Tungsten, Niobium, Gold, or Aluminum in a Central Slot (~250 Configurations) – Part I
HEU-MET-MIXED-013	SNOOPY Experiments -- Graphite Moderated HEU Foils – Part II (C/U = 1200)
HEU-MET-THERM-030	SNOOPY Experiments -- Graphite Moderated HEU Foils – Part III(C/U = 2340)
HEU-MET-THERM-029	SPADE Experiments Special Materials – Part II

TBD	Nimbus: Part III. *Requires help with declassification of original materials.
FY-2008	
Neutron-Time-of-Flight	LLNL Pulsed Spheres: Part I. Plutonium (Luisa Hansen)
FY-2009	
HEU-MET-FAST-056	Graphite – Oy – D2O System (C/U: 500 – 35000)
Neutron-Time-of-Flight	LLNL Pulsed Spheres: Part II. Beryllium
FY-2010 and Beyond	
Neutron-Time-of-Flight	LLNL Pulsed Spheres: Part III. TBD
Neutron Transmission	LLNL (Bramblett & Czirr) ^{235}U and ^{239}Pu Plate Transmission Measurements
Others	To Be Determined

ICSBEP FIVE-YEAR PLAN OAK RIDGE NATIONAL LABORATORY	
IDENTIFIER	***DRAFT TITLE***
FY-2006	
SUB-HEU-MET-THERM-001	Research Reactor Fuel Assemblies (MURR fuel)
IEU-COMP-THERM-008	Cronin UF4-CF2 from 12.5 to 37.5% ^{235}U (ORNL-2968)
LEU-MET-THERM-007	U(4.89) Metal Rods in Water or Uranyl Fluoride Solution
FY-2007	
IEU-MET-THERM-001	Cronin U(37.5) Metal Experiments, Recently Unclassified
LEU-COMP-THERM-067	Cronin Sterotex U(4.89) Blocks, H/U from 0 to 37, ORNL-2986
LEU-MET-THERM-008	Libby Johnson U(4.89) Metal Rods, Various Interstitial Absorbers
FY-2008	
HEU-MET-FAST-047	GROTESQUE: A U(93.2) Metal Assembly [Table 5, CAS23]
HEU-SOL-THERM-048	HEU Uranyl Fluoride Solution (82 g U/l) in Slab Arrays (ORNL/CF-56-7-148)
LEU-SOL-THERM-026	U(4.89)O2F2 Solution in Cylinders, Spheres, and Boxes, H/X from 524 to 1009 (ORNL-2968)
FY-2009	
SUB-HEU-SOL-THERM-002	WINCO Slab Tanks with HEU Uranyl Nitrate Solution
LEU-MET-THERM-009	Libby Johnson U(3.85) Annular Metal Billets (7.62 cm OD)
U233-MET-INTER-001	Critical Measurements on the ^{233}U ZPPR Plates in the LANL ZEUS Assembly
FY-2010 and Beyond	
MIX-COMP-INTER-004	Cooperative Analysis of ^{238}U MOX Experiment with LANL
	Critical assemblies pertinent to reactor design & fuel cycle materials processing associated with the Generation-IV reactor concepts for nuclear energy generation, the advanced high temperature reactor concepts for hydrogen production and the space applications of nuclear energy. In this historical period, critical experiments pertinent to these applications were performed in Oak Ridge and elsewhere.

ICSBEP FIVE-YEAR PLAN SANDIA NATIONAL LABORATORIES	
IDENTIFIER	***DRAFT TITLE***
FY-2006	
FY-2007	
LEU-COMP-THERM-080	Water-Moderated Square-Pitched U(6.93)O_2 Fuel Rod Lattices
FY-2008	
FY-2009	
FY-2010 and Beyond	

ICSBEP FIVE-YEAR PLAN SAVANNAH RIVER (WASHINGTON SAFETY MANAGEMENT SOLUTIONS, LLC)	
IDENTIFIER	***DRAFT TITLE***
FY-2006	
PU-MET-FAST-044	Pu Metal Sphere with Different Metal+Polyethylene Reflectors (Table IIIA2 of LA-30067-MS)
PU-SOL-THERM-018	Cylinders Containing Plutonium Nitrate Solutions (PNL-9, PNL-10, PNL-11)
SUB-LEU-MET-THERM-008	Subcritical (Exponential) SRS Fuel Assemblies (Mk V and Mk 15) 0.95 to 1.1% Enriched
U233-COMP-THERM-004	Bettis U233-Th Lattice Physics Experiments, Judd Hardy, et.al.
TBD	$U0_2$-$Th0_2$ Systems in Water (B&W experiments) (BAW-1191)
FY-2007	
SUB-PU-MET-THERM-001	Arrays of Pu-Al Alloy Rods in H2O [UCNI]
SUB-HEU-MET-THERM-002	Subcritical (Exponential) SRS Fuel Assemblies (Mk XVIB and Mk XIIA)[UCNI]
HEU-COMP-INTER-007	HEU Space Reactors
FY-2008	
FY-2009	
FY-2010 and Beyond	
Others	To Be Determined

Appendix D

Nuclear Data Schedule

Activity	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010
NDAG Review, Priority Needs / Additional Needs	Re, Thermal data (BeO, HF, D_2O, etc.)/ Th, Ni, F, Ce, K, Cu, Ca, V, Ti, Fe, (^{240}Pu/^{239}Pu), ^{237}Np, Pb	***TBD***	***TBD***	***TBD***	***TBD***
Differential Measurements (ORNL)	K, ^{55}Mn,	^{235}U (inelastic), Be	^{237}Np, Ti	V, Li	Re, Pb
Integral Measurements (LANL)	Nb, Re, Mo	***TBD***	***TBD***	***TBD***	***TBD***
Evaluation	ORNL: ^{39}K, ^{40}K, ^{41}K, ^{55}Mn, ^{238}U (unresolved) ^{19}F (inelastic); LANL: ^{9}Be, Pb	ORNL: Nb, Re, Mo LANL: K, Mn, Np (correlated fission spectra)	LANL: ^{235}U (inelastic), ^{237}Np (capture & fission)	***TBD***	***TBD***
Covariance Generation (New evaluations and retroactive covariance generation)	ENDF/B-VII Covariances, ORNL: ^{233}U, ^{235}U, ^{238}U LANL: ^{235}U, ^{238}U, ^{239}Pu	ORNL: ^{39}K, ^{40}K, ^{41}K, ^{55}Mn, ^{232}Th LANL: ^{232}Th, ^{233}U	***TBD***	***TBD***	***TBD***
CSEWG Testing	Mature ENDF/B-VII evaluations, including covariance data	Mature ENDF/B-VII evaluations, including covariance data	***TBD***	***TBD***	***TBD***
ENDF/B Release	^{28}Si, ^{29}Si, ^{30}Si, ^{35}Cl, ^{37}Cl, ^{239}Pu, ^{235}U, ^{238}U, other U isotopes, ^{155}Gd, ^{156}Gd, ^{157}Gd, ^{158}Gd	***TBD***	***TBD***	***TBD***	***TBD***

TBD = To Be Determined

Potential Materials by Application for NDAG Review and/or Utilization of NCSP Nuclear Data Infrastructure-Supported Resources

DOE/EM & NNSA Criticality Safety Materials	
NDAG Review, Priority Needs Additional Materials: DOE & EM McKamy Report (Quality Assessment)	Pb, ^{9}Be, Np, Fe, Cr, Mn, ^{233}U, H, O, C, N, Al, Si, Zr, Gd, Th, Ni, F, Cl, Cu, Ce, Ca, K, FP's, higher actinides

Space Reactor Design Materials	
NDAG Review, Priority Materials (JIMO Design) Additional Materials - Various Concepts (Quality Assessment)	^{185}Re, ^{187}Re, ^{93}Nb, ^{9}Be, ^{6}Li, ^{7}Li, ^{14}N, ^{235}U, ^{238}U, O, C, Zr, Fe, Ni, Cr, Mn, Mo, Na, K, Hf, Ta, W, ^{239}Pu, ^{233}U, Th, higher actinides

DOE/RW Yucca Mountain Materials	
NDAG Review, (Quality Assessment) Priority Nuclides / Additional Fission Products / Additional Nuclides	^{149}Sm, ^{143}Nd, ^{103}Rh, ^{151}Sm, ^{133}Cs, ^{155}Gd, ^{155}Eu / ^{152}Sm, ^{99}Tc, ^{145}Nd, ^{147}Sm, / Ni, Fe, Cr, ^{55}Mn , ^{235}U, ^{238}U, ^{239}Pu, higher actinides, tuff, concrete

Space Reactor Shielding Materials	
NDAG Review, (Quality Assessment) Priority Materials (SP-100 Design) / Additional Materials - Various Concepts	^{185}Re, ^{187}Re, ^{93}Nb, ^{9}Be, ^{6}Li, ^{7}Li, ^{14}N, ^{1}H , / O, C, Zr, Fe, Ni, Cr, Mn, Mo, Na, K, Re, Hf, Ta, W

AFCI, GEN-IV, NGNP Materials	
NDAG Review, (Quality Assessment) Priority Materials (Palmiotti & Salvatores) / Additional Materials - Various Concepts – Workshop Minutes (Ti), Forsberg's MSFR (Rb)	^{232}Th, ^{233}U, ^{234}U, ^{235}U, ^{236}U, ^{238}U, ^{237}Np, ^{238}Pu, ^{239}Pu, , ^{240}Pu, ^{241}Pu, ^{242}Pu, , ^{241}Am, ^{242m}Am, ^{243}Am, ^{242}Cm, ^{243}Cm, ^{244}Cm, ^{245}Cm, Pb, Bi, ^{56}Fe, ^{57}Fe , ^{58}Ni, ^{52}Cr, Zr, ^{15}N, Si, C, O, Na, ^{10}B ^{1}H , / Ti (5 isotopes), ^{85}Rb, ^{87}Rb

Appendix E

FY-2006 Foreign Travel Requests

Applicable Ranges of Bounding Curves and Data

The AROBCAD Program Element will require

- one attendee at the annual meeting of the OECD/NEA Nuclear Criticality Safety Working Groups on Burnup Credit Criticality Safety, Experimental Needs in Criticality Safety, and Minimum Critical Values on an annual basis
- one attendee at the annual meeting of the OECD/NEA International Criticality Safety Benchmark Experiments Project review meeting
- between two and three technical presentations from this work element (S/U software tools, S/U studies, guidance on safe margins) will be made at the International Conference on Nuclear Criticality (ICNC) conducted in FY 2008, requiring attendance of two to three individuals
- the AROBCAD Program Manager serves as the Convener of ISO TC-85, SC-5, WG-8, and as such requires one foreign trip per year. This is the writing group for the development of international standards for nuclear criticality safety and the NCSP supports his participation and leadership of the annual WG-8 meetings. The work program for these standards includes a number of nuclear criticality safety topics in which the NCSP supplies subject matter experts (fission yield estimates, Mixed Oxide Fuel (MOX) Processing, Criticality Accident Alarm System qualification, etc.). WG-8 meetings will require one foreign trip per year for one to two United States subject matter experts to assure the integration of the US S/U technology and influence on international standards.

Analytical Methods Development and Code Maintenance

The Analytical Methods Development and Code Maintenance Program Element will require four attendees at the annual OECD/NEA Nuclear Criticality Safety Working Group meetings. From the three Labs, this includes two United States Representatives to the Nuclear Criticality Safety Working Party and membership on the Fission-Source Convergence and Criticality Excursions Analysis Work Groups. Additionally, presentations on nuclear criticality safety technology are made at the annual series of PHYSOR meetings on reactor physics.

International Criticality Safety Benchmark Evaluation Project

The ICSBEP is an international program involving 17 different countries and the OECD NEA. As such, annual project Working Group meetings are generally held outside the United States every other year. Approximately 15 - 20 participants from the United States (including Working Group Members, evaluators, independent reviewers, and administrative support) are required to travel to these meetings. One individual, the project administrator, is also expected to travel to the host country several months in advance to meet with the local hosts and finalize the meeting arrangements. The FY-2006 ICSBEP Meeting will be held in Rio De Janeiro, Brazil.

The chairman of the ICSBEP is expected to attend the annual OECD/NEA Working Party on Nuclear Criticality Safety (WPNCS) Meeting on an annual basis where a report on ICSBEP activities is made. This meeting is typically held at NEA headquarters in Paris, France. Currently, the chairman of the ICSBEP also serves as chairman of the WPNCS and, as such, is expected to attend the annual NEA Nuclear Science Committee (NSC) Meeting to report on the activities of the WPNCS. NSC Meetings are also held at NEA headquarters in Paris, France.

Periodically, data are identified in nonparticipating countries and these countries are invited to contribute their data. In some cases, an information/training meeting in the new participating country is deemed appropriate. Such an information gathering/training meeting will be held in Bariloche, Argentina in FY-2006 where researchers have expressed an interest in contributing criticality data for 20% enriched U_3Si_8/Al alloy fuels.

Nuclear Data

The Nuclear Data Program Element will require three attendees at the annual OECD/ NEA Working Party on Evaluation and Cooperation meetings (WPEC). This is the major activity involving international cooperation on the development and evaluation of nuclear data. The international forum for presentations on nuclear data is the biennial series of PHYSOR reactor physics meetings. This program element supports participation at PHYSOR by two nuclear data specialists in FY-2006, FY08 and FY10. The IAEA funds direct costs for two of the NCSP data specialists to participate in the IAEA Coordinated Research Project (IAEA-CRP) on an annual basis, as well as for the SAMMY presentations at the biennial Workshop on Nuclear Reaction Data and Reactor Physics. The IAEA trips may require NCSP foreign travel approval.

Integral Experiments

The integral experiments program element will require have at least 3 foreign trips next year: ICSBEP meeting in Brazil, the Nuclear Pacific Basin Conference in Australia, and the PHYSOR 2006 in Canada. Three people will attend the ICSBEP meeting, two will attend to the Nuclear Pacific Basin Conference and three will attend PHYSOR 2006.

Information Preservation and Dissemination

No projected foreign travel.

Training and Qualification

No projected foreign travel.