



Department of Energy
National Nuclear Security Administration
Washington, DC 20585



FEB 01 2005

The Honorable John T. Conway
Chairman
Defense Nuclear Facilities Safety Board
625 Indiana Avenue, N.W.
Suite 700
Washington, D.C. 20004

Dear Mr. Chairman:

In your August 7, 2003, letter closing Recommendation 97-2, *Criticality Safety*, you established an annual reporting requirement. Enclosed is the report for Calendar Year 2004.

Overall, actions taken in response to Recommendation 97-2 have substantially improved the Department's criticality safety infrastructure and operational programs. Stable funding has been demonstrated again this year and the Nuclear Criticality Safety Program (NCSP) organization continues to function effectively to maintain important capabilities while addressing the most pressing operational criticality safety needs. A total of seven critical experiments and seven training classes were conducted at the Los Alamos Critical Experiments Facility. The NCSP continues to be closely involved in the effort to accelerate relocation of the facility's mission to the Nevada Test Site while minimizing impacts to the program. Neutron cross-section measurements were performed at the Oak Ridge Electron Linear Accelerator and more measurements are planned for 2005. An experienced Federal criticality safety person was added at the National Nuclear Security Administration Service Center to provide additional support to Los Alamos, Sandia and Pantex and additional staffing needs identified at other sites are being filled. Members of the Criticality Safety Support Group made visits to several sites to conduct assessments and design reviews, and to follow up on corrective actions identified in earlier reviews. Through implementation of the NCSP, a viable process for assessing needs, maintaining infrastructure, providing technical assistance and enhancing operational criticality safety has been institutionalized.

If you have any questions, please contact me directly or have your staff contact Mike Thompson at 301-903-5648.

Sincerely,

David H. Crandall
Assistant Deputy Administrator
for Research, Development, and Simulation
Defense Programs

Enclosure



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SEPARATION

PAGE

**STATUS OF THE DEPARTMENT OF ENERGY
NUCLEAR CRITICALITY SAFETY PROGRAM
FOR CALENDAR YEAR 2004**

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1. Introduction

In a letter dated August 7, 2003, the Defense Nuclear Facilities Safety Board (DNFSB) closed Recommendation 97-2, *Criticality Safety*, and established an annual reporting requirement. The enclosure to the DNFSB letter requested that a status of the following items be provided annually:

- Updates to the Nuclear Criticality Safety Program (NCSP) Five-Year Plan including the status of individual projects in the program.
- NCSP Funding (actual and projected).
- Critical experiments status and Los Alamos National Laboratory (LANL) Technical Area (TA)-18 Relocation Program status.
- The status of contractor criticality safety engineer training and qualification programs.
- The status of Federal criticality safety engineer training and qualification programs.
- A summary of lessons learned from criticality safety program assessments.
- A summary of lessons learned from Criticality Safety Support Group (CSSG) reviews of proposed nuclear criticality safety controls for new facility designs.
- A summary of the results of trending and analysis of reportable and non-reportable criticality safety occurrences.
- The status of open issues identified in the previous annual report.

This annual report is structured to address each of these areas in the order in which they appear above.

In addition to the 9 items, cited above, in a letter dated April 5, 2004, the DNFSB cited three other opportunities for improvement based on their review of the 2003 NCSP Annual Report.

- The Board's letter of August 7, 2003, stressed the value of proactive rather than reactive initiatives as key elements in the enhancement of nuclear criticality safety throughout the Department of Energy (DOE) defense nuclear complex. The Board's position is that DOE's reviews of the effectiveness of actions taken to improve nuclear criticality safety must be much more comprehensive, especially with regard to collection of data at the field level by knowledgeable nuclear criticality safety professionals.
- The Board's letter noted that the 2003 NCSP Annual Report does not provide adequate information with regard to the staffing levels of both contractor and federal nuclear criticality safety personnel. While the report specifies the number of qualified/not-yet-qualified personnel in each case, it does not clearly show that this number has been

analyzed and determined to be adequate. For those cases in which a vacancy is found to exist, clear plans, as well as interim compensatory measures, must be provided.

- The Board's position is that DOE's efforts to conduct trending and analysis must be brought to a much more mature level. Likewise, the ability to develop and disseminate useful lessons learned must be improved.

These opportunities for improvement noted by the DNFSB are addressed in the various sections of the annual report.

2. Updates to the NCSP Five-Year Plan and a Status of individual projects in the program.

The NCSP Five-Year Plan contains details on the program structure, budget and scheduled activities. A copy of the latest version of the plan, dated October 2004, is attached.

A status of the individual program elements is as follows:

Applicable Ranges of Bounding Curves and Data (AROBCAD)

- Training materials for AROBCAD software were developed.
- Training in the use of TSUNAMI was provided to the CSSG at the March bi-annual meeting in Las Vegas, BWXT Idaho National Environmental Engineering Laboratory, Washington Safety Management Solutions at Savannah River, and Hanford Flour nuclear criticality safety organizations based upon Oak Ridge National Laboratory (ORNL) analyses of site-specific nuclear criticality safety problems. In addition, a TSUNAMI tutorial was presented at the Pittsburgh American Nuclear Society Meeting in June 2004.
- The generalized linear least squares method (GLLSM) code, TSURFER, was finished and is scheduled to be released late 2004 or early 2005 and associated training materials are currently being developed.
- The building of a "Sensitivity Data File" consisting of about 500 experiments (to date) for incorporation with a future revision to the Standardized Computer Analysis for Licensing Evaluation (SCALE) software is progressing.
- The AROBCAD software products (TSUNAMI-1D, TSUNAMI-3D, Javapeno, and SMORES) were released by ORNL Radiation Safety Information Computational Center (RSICC) as a part of the SCALE 5 release in the spring 2004.
- Code development/debugging has been progressing steadily due to recent TSUNAMI evaluations in support of the following work:

- Comprehensive Organization for Economic Cooperation – Nuclear Energy Agency (OECD-NEA) Mixed Oxide (MOX) fuel experimental needs analyses;
 - Modeling of Department of Energy (DOE) Office of Environmental Management (EM) Irradiated Fuel Storage Facility (IFSF) project at the Idaho National Laboratory (INL); and
 - The DOE Office of Nuclear Energy, Science and Technology (NE) space power reactor safety analyses.
- Code modifications continued for performing the adjoint solution in both KENO-V and KENO-VI.
 - The differentiation code, GRESS, has been transitioned to FORTRAN-90 for the differentiation of the CENTRM cross section processing code to be used with ENDF/B-VI and TSUNAMI. There has been success in demonstrating its capability on a limited number of nuclides in a single mixture.
 - Publications for review and distribution included:
 - A journal article, regarding the new SCALE 5 Pitzer solution-modeling capability for performing sensitivity analyses, has been submitted and reviewed for publication in Nuclear Technology;
 - A journal article, regarding Sensitivity-and-Uncertainty-Based Criticality Safety Validation Techniques, has been submitted and reviewed for publication in Nuclear Science and Engineering; and
 - A journal article, regarding Perturbation Theory Eigenvalue Sensitivity Analysis with Monte Carlo Techniques, has been submitted and reviewed for publication in Nuclear Science and Engineering.

Analytical Methods Development and Code Support

Criticality Safety Analyses: The NCSP continued to support the criticality safety community in providing independently-redundant, corroborative analytical methods for production analyses (SCALE/KENO and MCNP5) and critical experiment benchmarking analyses (VIM and MCNP5). This effort, performed by software specialists at ORNL, LANL and Argonne National Laboratory (ANL), involved quality assurance through software maintenance, training through the conduct of multi-day, hands-on workshops, and user assistance in the performance and evaluation of analyses for a wide variety of DOE applications.

New Methodology: RSICC packaged and distributed a major new version of SCALE (SCALE 5) and an enhanced version of MCNP5 (MCNP5 1.30). The new software includes additional

capabilities for performing transport analyses, as well as improved methods for problem-dependent data processing. Progress was made in the development of a WINDOWS PC version of VIM. New procedures were established for RSICC code distribution that simplify multiple code use at DOE sites with a single site-responsibility for meeting Export Control qualifications.

Cooperative Studies: The NCSP-sponsored analytical capabilities were utilized in the evaluations performed by the International Criticality Benchmark Evaluation Project (ICSBEP), as well as in other international studies coordinated through the OECD-NEA Working Party on Nuclear Criticality Safety (WPNCS). Notably, the fission source convergence studies, chaired by ANL, are being documented and NCSP-sponsored expertise performed a major role in the evaluation of critical experiments for the validation of MOX operations.

An in-depth survey was conducted on the capabilities and features of the three code systems presently sponsored by the NCSP, as well as those of the COG and PREPRO software developed at Lawrence Livermore National Laboratory (LLNL). On the basis of this survey, NCSP financial support will continue for upgrades to the LLNL nuclear data-processing methods and for an small internal LLNL effort to export advanced COG features to the other code communities.

International Criticality Safety Benchmark Evaluation Project

The annual ICSBEP Meeting was held in San Lorenzo del Escorial, Spain, during May of 2004. A total of 39 participants from United States, Russian Federation, United Kingdom, France, Japan, Spain, Brazil, and the Czech Republic attended the meeting. Thirty-three new evaluations and two evaluations that were revised to include additional configurations were discussed at the meeting along with several other evaluations that underwent less significant revision. Included, for the first time, were two evaluations of measured data that may be used to validate neutron transport through various labyrinth configurations and one evaluation of a Californium source, heavily shielded by iron. These data are useful for validation of calculations made to determine the need for and placement of criticality alarms. Twenty nine of the thirty three evaluations were eventually approved for publication. One evaluation was withdrawn, but should be resubmitted in 2005. None of the criticality alarm type benchmarks was finalized in time for publication; however, one of the labyrinth benchmarks was published as a draft and comments were requested from the criticality safety community. This evaluation includes benchmark specifications for six labyrinth type configurations with multiple measurement points for each.

The 2004 Edition of the "International Handbook of Evaluated Criticality Safety Benchmark Experiments" was published in September 2004. Included in this version of the handbook are 29 newly approved evaluations and a *draft* version of one of the three-criticality alarm placement benchmarks. The handbook now contains 379 approved evaluations that span over 30,000 pages and provide 3331 critical or accurately known subcritical configurations that may be used by criticality safety analysts for validation of their analytical methods and data or by nuclear data

evaluators to improve basic nuclear data. An improved version of the database, called DICE, is also included on the 2004 DVD. The ICSBEP Intranet Site (<http://icsbep.inel.gov/>) was updated to include the new 2004 data.

Use of the ICSBEP Handbook has broadened significantly. As evidenced in several papers presented at the International Conference on Nuclear Data for Science and Technology, ND-2004, and the annual meeting of the Cross Section Evaluation Working Group (CSEWG), ICSBEP Handbook data are being much more frequently used for testing and improvement of basic nuclear data.

Nuclear Data

Nuclear Data Advisory Group (NDAG): The NDAG, under the chairmanship of ANL, has continued its semi-annual meetings to establish areas where improvements in nuclear data measurements and evaluations are needed. With the maturity of the NCSP Nuclear Data Work Element allowing the extension of capabilities to other DOE programs, notably DOE/EM, an effort has been initiated to canvas all DOE programs utilizing nuclear data to determine where data needs are overlapping in applications.

Nuclear Data Measurements: The NCSP continued to support the operation of the Oak Ridge Electron Linear Accelerator (ORELA) facility at ORNL in the performance of neutron cross section measurements in the resonance or intermediate-energy range. Measurements were performed on ^{39}K and ^{41}K . Preparations were made for continued measurements on ^{55}Mn . However, a series of equipment failures and technical difficulties limited the ORELA output in this fiscal year.

Nuclear Data Evaluations: Resonance-energy evaluations with the SAMMY code at ORNL and high-energy ($> \sim 500$ keV) evaluations with the GNASH code at LANL were performed for a number of nuclides important to criticality safety evaluations. New evaluations for the fissile nuclides, as well as fuel packaging and storage materials, are being submitted to the National Nuclear Data Center at BNL for testing and release in the upcoming ENDF/B-VII data compilation. Preliminary testing by LANL has shown significant improvement in the analysis of fast and thermal uranium-fueled critical experiments.

Cooperative Studies – The NCSP-sponsored SAMMY software is being utilized in the international studies coordinated through the OECD/NEA Working Party on Evaluation and Cooperation (WPEC). WPEC activities include the development of cross section uncertainty files and covariance matrices. Work in these areas is being performed at ORNL, LANL and ANL. Additionally, NCSP-sponsored expertise is participating in the evaluation of nuclear data standards, an activity coordinated through the International Atomic Energy Agency (IAEA).

Nuclear Data Staff: An effort was initiated in FY03 to attract young technical staff into the NCSP sponsored nuclear data work areas at ORNL and LANL. Through the Nuclear Theory Task, a nuclear model expert was brought to ORNL to work on the methodology for analyzing direct neutron capture. Initially on a post-doctoral assignment, this expert is now a member of the ORNL Nuclear Data Group. Additionally, the Nuclear Data Group has added an expert in data-processing and an expert/trainee in data evaluation. A new technician has been added to the ORELA staff to replace an ORELA staff retiree. Also, the LANL T-16 Group has added an expert in data uncertainty evaluation, who has performed leadership roles in the WPEC international activities in this area.

Integral Experiments

During FY 2004, seven major experiments were completed, including: Neptunium/Highly Enriched Uranium (Np/HEU) reflected by Iron, Np/HEU reflected by Polyethylene and Gadallinium-alloy mixed with Highly Enriched Uranium. One new experimental activity was started (Component Benchmark Experiment). Two experimental activities are ongoing (Special Moderator and Source Jerk).

In terms of the training and proficiency, seven criticality safety classes were conducted in FY 2004: four 2-day classes, two 3-day classes and one 5-day class. This training averaged 12 students per class. LANL continued to train operators and maintain proficiency on the critical assemblies. The critical experiments facility had over forty five experimental days, which the NNSA considers acceptable given the increased workload associated with the relocation project and the LANL stand-down that began in July 2004.

Researchers at the critical experiments facility submitted four benchmark evaluations to the ICSBEP for publication. In addition, three papers were published in the Journal of Nuclear Material Management and Journal of Nuclear Science and Engineering.

Information Preservation and Dissemination

The Criticality Safety Information Resource Center (CSIRC) at LANL serves as the NCSP focal point for collecting and preserving documents directly related to critical experiments and criticality safety. During 2004, CSIRC completed several significant activities that included compilation of the Rocky Flats Environmental Technology Site (RFETS) Critical Mass Laboratory History, scheduled for publication in early calendar year 2005; completion of the RFETS Logbook index; publication of LA-14098, "Modern Fission Theory for Criticality"; and completion of LA-UR-04-6514, The Heritage and Usage of the Words Fissionable and Fissile in Criticality".

Other activities aimed at preservation and dissemination of criticality safety information were accomplished at Hanford. Improved criticality safety information retrieval and presentation

efforts included validation and reissue of ARH-600 as a computerized handbook and updating the Hanford topically screened parameter study database.

All pages in ARH-600 were scanned and the approximately 1600 curves available were digitized. The scanned pages were labeled, indexed, and incorporated in an electronic hypertext version (HTML index with linked PDF files). A successful demonstration of the electronic hypertext version was presented during the March CSSG meeting and at the summer American Nuclear Society meeting. The present electronic hypertext version is being installed on the NCSP web site at Livermore for general use. Supplemental information was generated utilizing MCNP4C such that 6000 curves are available to be included in the interactive, electronic reissue. An alpha version of the computer program, CritView, has been prepared to allow concept demonstration, and improved interactive information manipulation and retrieval for the final product.

The Hanford database was increased by 516 new entries. With this addition the total number of items is 4748. Current criticality safety literature was screened for potential additions. Significant contributions were obtained from the 2003 International Conference of Nuclear Criticality. Almost all new entries are provided with abstracts facilitating word searches in addition to topical compilations. Approximately 130 entries have the OSTI ID number included to facilitate full document retrieval. The database is available at the NCSP Livermore web site. Efforts to enhance search flexibilities have been successfully performed during 2004.

Regarding the NCSP Website, accomplishments for calendar year 2004 are as follows. A new NCSP web site design was released that included a new DOE logo and background pictures. Approximately 13,000 web pages of the NCSP web site were modified. Over 250 annual user information verification email letters were sent and 115 users registration information records were updated. LLNL Bibliography and Hanford NCTSP databases now contain over 12,000 bibliographic entries. During the last twelve months both of these databases have been accessed a total of 17380 times. Also, during calendar year 2004, the NCSET training modules have been downloaded over 2964 times. As for site visits, the average access rate is 29.66 hits/day. The website has received over 26,405 total visitors since its inception in 1998.

Training and Qualification

The training and qualification element of the NCSP made steady progress in 2004 Hands-on training at LANL continued as described in the Integral Experiments Section, above. Qualification activities continued as described in Section 5 and Section 6, below. As for training development, the second Nuclear Criticality Safety Engineer Training (NCSET) module on hand calculations was started, but then put on hold in favor of working a primer that parallels the first module and includes what was intended for the second module. This primer will be completed early next year and will serve as the basis for the second NCSET module. In addition, NCSP training development funds were provided to LANL to develop a non-destructive analysis (NDA) tutorial that was offered at the November American Nuclear Society winter meeting in

Washington, D.C. Approximately 50 people attended this tutorial that focused on NDA techniques and assumptions, potential inaccuracies associated with these techniques and their impacts on criticality safety evaluations. The NDA tutorial is also being converted to a NCSET module and will be added to the NCSP website in FY 2005.

3. NCSP funding

NCSP funding has been stabilized and continues to receive appropriate financial support to execute program task elements focused on maintaining criticality safety capability. Table ES-1 of the NCSP Five-Year Plan (attached) contains the planned funding levels for Fiscal Year (FY) 2005 through 2009. This level of funding is adequate for maintaining capability in NCSP program task elements and addressing identified requirements. NNSA's FY 2005 appropriation includes \$10,125 million, and all funds have been distributed according to the Work Authorization Statement text contained in Appendix B of the NCSP Five-Year Plan. The FY 2006 funding (\$9,789 million) identified in Table ES-1 of the Five-Year Plan is in the President's FY 2006 budget request that will be submitted to Congress in February 2005. Defense Programs is committed to continue providing adequate support for the NCSP.

4. Critical experiments status and Los Alamos Technical Area 18 Relocation Program status

The critical experiments program at LANL made progress in 2004. As stated above, seven experiments were completed and four benchmark evaluations were submitted to the ICSBEP for publication during calendar year 2004. In 2005, plans include two experiments and publication of four benchmarks. More detailed information on the critical experiments program is contained in Section 6 and Appendix F of the NCSP Five-Year Plan.

Regarding the LANL Technical Area (TA)-18 Mission Relocation Program, on March 31, 2004, the National Nuclear Security Administration (NNSA) announced an initiative to accelerate special nuclear material (SNM) moves from TA-18 to the Device Assembly Facility (DAF) at the Nevada Test Site (NTS). The decision to reduce the TA-18 security posture below security category I/II levels by September 30, 2005 was driven by a requirement to either de-inventory TA-18 by that date or implement the new design basis threat (DBT). Implementing the new DBT at TA-18 was determined by NNSA to be cost prohibitive. Any SNM not moved to DAF by September 30, 2005, will be staged at another secure location until it can be shipped.

The Criticality Experiments Facility (CEF) Project, formerly the TA-18 Mission Relocation Project, includes facility design and modification activities necessary to relocate the capabilities from TA-18 to the DAF and other supporting facilities at the NTS. The DAF modifications will include locations to house four critical assemblies and SNM vaults to accommodate TA-18 programmatic SNM. The design will include all of the provisions necessary for safeguarding the SNM and securing programmatic work from unauthorized personnel while allowing for cost and operational efficiencies. The design will preclude interference with adjacent facilities, while

optimizing the use of shared capabilities for reducing construction costs. The CEF project, sponsored by Defense Programs, received Critical Decision 1, Approval of Alternative and Cost Range on June 14, 2004. As part of this approval, the Nevada Site Office was designated as the lead field entity with LANL as the lead project contractor. Funding for the CEF Project (current range is \$125M to \$148M) is provided through a Congressional Line Item construction account. The project is scheduled for completion in late 2009.

Following the decision to de-inventory TA-18 by September 30, 2005, the NCSP manager has refined the requirements for initiating interim operations at DAF. Interim operations are defined as those proposed activities required for mission continuity of TA-18 programs from FY2005 through FY2008. The scope of the interim activities is based on the NCSP's minimum requirements to meet its commitments to internal and external customers, maintain personnel expertise, and to assure national security as well as worker safety. In FY 2005, the NCSP plans to conduct a limited number of security category I/II critical assembly operations at TA-18 to complete two experiments and support four training courses using two critical assemblies. NNSA will terminate all security category I/II critical assembly operations by July 2005 and defuel the 4 critical assemblies (Planet, Flattop, Comet, and Godiva) slated for transfer to DAF. In parallel, the NCSP plans to establish the capability to conduct sub-critical measurements at DAF in 2005. Once the critical assemblies are transferred to DAF, the only critical assembly that will remain in operational standby at TA-18 is the Solution High-Energy Burst Assembly (SHEBA) in its security category III/IV configuration. This assembly will remain in operational standby at TA-18 until a similar capability is established in Nevada. Additionally, the NCSP will study the feasibility of accelerating the relocation of critical assemblies to the DAF. The NCSP will coordinate operations with the Nevada Site Office and the CEF Project to assure construction activities are not adversely impacted. Beginning in 2006, the NCSP plans to conduct up to four criticality experiments per year at the DAF until completion of the CEF project in late 2009.

High priority is being given to reduction of impacts to operations during transition from LANL to the NTS. The TA-18 Closure Plan, signed by Ambassador Brooks, November 3, 2004, directed LANL to provide a detailed staffing transition plan by March 31, 2005. Both the NCSP Program Sponsor (NA-11) and the NCSP Manager are committed to maximize availability of critical experiments and training capabilities throughout the relocation of these important Defense Program missions. Phased transition of critical assemblies and associated special nuclear materials, detailed operational readiness review planning, table-top DAF operations exercises, comprehensive staff planning, and planned installation of a state-of-the-art high-speed secure video/data-acquisition system at the DAF with a link to LANL are examples of steps being taken to reduce transition time and risk and enhance operational safety and efficiency.

5. Status of contractor criticality safety engineer training and qualification programs

Contractor criticality safety programs at many DOE facilities are supported by trained and qualified criticality safety engineers (per DOE-STD-1135) reporting to the criticality safety

manager and by criticality safety officers (CSOs) reporting to operations line management. Typically, CSOs receive specialized additional nuclear criticality safety (NCS) training and provide the day-to-day line management operational awareness, oversight, and implementation function for NCS working closely with the criticality safety engineers. Sites that have utilized CSOs (or their equivalent) for a time such as Hanford, Rocky Flats, and Y-12 have found them extremely beneficial in improving on-the-floor implementation of criticality safety practices. With this in mind, Tables 1 and 2 contain information on contractor criticality safety engineer (CSE) and CSO positions respectively.

DOE NCS staff members in the field supporting DOE line management assess their contractors' staffing levels and budget requests. Responsible Site Office Managers, in consultation with the NNSA Administrator, determine the adequacy of Site Office staffing levels. If they discover shortfalls, they appropriately advise DOE line management at the field/site office level and develop appropriate corrective actions.

TABLE 1 – CONTRACTOR PERMANENT CSE STAFFING AND QUALIFICATION

Site/Contractor	Number 1135 Qualified	Number in Training	Additional Needed	Open positions	Delta in CSE Needs from 2003	Comments/Plans/ Interim Comp Measures
ANL (Univ. of Chicago)	8	2	0	0	0	The ANL/INL realignment will cause these figures to change in the coming year in a way still being determined by site line management.
LLNL (Univ. of California)	9	0	0	0	-1	LLNL staffing levels are largely in response to program needs. One staff member retired this year; due to reduced weapons program needs, this position was not filled.
Hanford (Fluor Federal Svcs)	16	2	1	1	+2	D&D projects cause temporary surges that are met using qualified subcontractors.
INL (Bechtel BWXT Idaho)	8	0	0	0	0	Increases in the number of NCS resources may be needed due to the pending realignment of ANL/INL (see note above under ANL).
LANL (Univ. of California)	7	0	TBD	0	+1	Interim comp measure being used is negotiation with facility to stretch out work and apply NCS resources only to highest priority tasks. One senior NCS staff member retired and new NCS management is reviewing current staffing needs. Requisitions will be open (if applicable) upon approval of staffing plan.
SNL (Lockheed Martin)	3	2	0	0	+3	CSE duties are collateral at SNL; no one is a full-time CSE. Two qualified subcontractor CSEs support the three qualified SNL CSEs. The increase is due to more stringent requirements and the need to add flexibility. The SNL Technical Support Group grew by two nuclear engineers, one of which has qualified and the other is nearly qualified. Other staff members obtained their NCS qualification for professional development.
Pantex (BWXT Pantex)	2	1	0	0	+1	Additional resource in-training to support increased workload.
RFETS (Kaiser-Hill)	2	0	0	0	-1	Site CSE resource decreases to only 1 in January 2005. Site closure is April, 2005. Contingency plan in place to use subcontractor support if needed between January and April. Site successfully transitioned to removal of all CAAS and NCS program termination with no significant NCS incidents.
Y-12 (BWXT Y-12)	25	6	6	2	-2	Qualified subcontractors are used to meet resource shortfalls. A revised staffing plan was recently approved for six additional positions in FY05 for which the remaining 4 requisitions will be opened. Currently, overall staffing level is adequate to meet funding demands. This effort is to adjust mix of subcontractor and permanent staff.
East Tennessee Technology Park (ETTP) (BNFL)	4	0	0	0	-1	ETTP 3 Bldg. D&D Project scheduled to complete 12/31/04. No active fissile processes (excluding static storage) will exist after 12/31/04. After January, 2005 NCS resources will be provided on an as needed (i.e. on-call) basis only.
ETTP/Ports/Pad (BJC and its major subs)	22	2	1-2	1	-3	Resources down from last year due to completion of several generic D&D evaluations being done by subcontractor support. The K-25 Project has now achieved a staffing level that will be stable over the next year or two.
ORNL (UT-Batelle)	2	1	TBD	0	0	NCS Staffing needs are currently under review. 1135 qualified subcontractors used meet temporary surges in workload. ORNL project subcontracting reduces reliance on UT-Batelle NCS staff (e.g. 3019 and ISOTEK).
SR (WSMS)	19	1	0	0	-10	SRS has reduced direct support numbers because fewer nuclear criticality safety evaluations (NCSEs) are being done; daily support requirements are reduced due to deactivation/closure of some processes. For example, the Pu processing Canyon and its finishing facility are well on their way to a long-term surveillance and maintenance mode after reaching a defined deactivation state.

TABLE 2 – CONTRACTOR CSO STAFFING

Site/Contractor	Number Of CSOs	Additional CSOs Needed	Open positions	Comments/Plans/ Interim Comp Measures
ANL (Univ. of Chicago)	N/A	N/A	N/A	
LLNL (Univ. of California)	14	0	0	LLNL's CSOs are program managers who are responsible for implementation of NCS controls for their own program.
Hanford (Fluor Federal Services)	7	0	0	One of the seven CSOs is still in training. Hanford CSOs host an annual on-site workshop/meeting to share lessons learned. This past year the Chairman of the CSSG was an invited speaker and participant.
INEL (Bechtel BWXT Idaho)	17	0	0	
LANL (Univ. of California)	11	0	0	CSOs responsibilities are typically part time (25%) duties of specified operations/technical staff members.
SNL (Lockheed Martin)	1	0	0	The CSO is also qualified as a CSE.
Pantex (BWXT Pantex)				
RFETS (Kaiser-Hill)	2	0	0	A third CSO is currently supplemental. The need for CSOs will go away when the site closes in 2005.
Y-12 (BWXT Y-12)	4	0	0	
ETTP (BNFL)	N/A	N/A	N/A	
ETTP/Ports/Pad (BJC and its major subs)	2	6	6	Currently, two CSOs is adequate. However, it is projected that 8 will be needed when the D&D work is in full swing. The site is therefore ramping up over the next several months to meet future needs.
ORNL (UT-Batelle)	N/A	N/A	N/A	
SR (WSMS)	N/A	N/A	N/A	

6. Status of Federal criticality safety engineer training and qualification programs

The DOE has made steady progress in improving its criticality safety expertise in recent years. This has been accomplished by hiring additional, experienced criticality safety professionals and by ensuring that all DOE staff overseeing criticality safety are formally trained and qualified.

DOE has hired criticality safety staff with significant criticality safety experience as practitioners to improve its criticality safety expertise. Individuals with more than a decade of experience practicing criticality safety have been added to DOE's staff at the Office of Environment, Safety and Health (EH), NNSA, EM, the NNSA Service Center, Idaho, Richland, and Oak Ridge over the past several years. In some cases, the individuals have several decades of criticality safety experience and are recognized nationally as experts in the field. These individuals fill GS-14 or Excepted Service level positions, which is indicative of the DOE's commitment to hire and retain exceptionally qualified staff.

The DOE issued comprehensive training and qualification standards for DOE staff. The DOE staff expectations were developed initially as a new Technical Qualification Program (TQP). Each site/area office has a criticality safety specialist qualified according to the TQP requirements. In several instances, oral examination boards made up of experts from the CSSG were held as part of the qualification process. A May 26, 1999, letter to Chairman Conway described the TQP developed for Federal staff. A February 22, 2001, letter to Chairman Conway reported that at least one Federal employee at each site with a criticality safety program had been qualified to the DOE qualification standard. The requirement to train and qualify DOE criticality safety staff is institutionalized. The TQP was revised and reformatted into a new DOE technical standard in 2003. This revised and updated Criticality Safety Functional Area Qualification Standard (DOE-STD-1173-2003) was issued in December 2003. This standard did not change the technical substance of the qualification program but represented a fundamental format change. It did update some ancillary expectations that will be addressed by line management as appropriate under individual professional development plans at the site level. There is no need or intent to requalify individuals based upon issuing the TQP as a DOE technical standard. These qualified Federal nuclear criticality safety personnel comprise the voluntary membership of the DOE Criticality Safety Coordinating Team (CSCT) that is chartered by the NCSP Manager.

Table 3 contains information on the current status of qualified DOE NCS staff.

TABLE 3 – DOE NCS STAFFING AND QUALIFICATION

Site/Contractor	Number Qualified	Number in Training	Additional Needed	Open positions	Delta in CSE Needs from 2003	Comments/Plans/ Interim Comp Measures
HQ (EH/EM/OA/NNSA)	3	0	0-2 TBD	0	0-2 TBD	The 2004-1 IP calls for CTA(s) in NNSA and EH that may need additional NCS expertise and these needs are still being evaluated as the IP is finalized and organizations realigned to meet commitments. Currently NNSA (from EH), EM and OA have qualified NCS staff.
NNSA LSO	1	0	0	0	0	
NNSA AL SC	1	1	0	0	+1	A new excepted service NCS staff member has been added to the AL NNSA Service Center to provide the additional needed technical support to Los Alamos, Pantex, and Sandia. The individual is an experienced (>20 years) criticality safety professional who should qualify quickly and provide valuable assistance to the site offices.
NNSA YSO	1	0	0	0	0	YSO has one Federal full time equivalent (FTE), supported by 0.85 FTE senior support service contractors. YSO nuclear criticality safety program oversight staffing needs for FY 2006 are currently being evaluated. The NNSA YSO NCS staff member was recently re-qualified to 1173 and the YSO Technical Qualification Standard.
NNSA NSO	0	0	1	0	+1	With the transfer of the TA-18 mission to the DAF, NSO will need to add a qualified NCS staff member to provide line criticality safety oversight. In the interim, NNSA NA-117 has obtained the services of an experienced qualified NCS SME and that individual will be working closely with NSO management to ensure that rigorous NCS programs are in place on both the NNSA and contractor sides to support the TA-18 mission transition. The individual is a member of the CSSG.
SR	3	0	0	0	0	The latest staffing needs evaluation conducted by the line organizations indicates the need for approximately 2.5 FTE in the criticality safety area. One of the qualified individuals is currently supporting site work outside of the criticality safety arena. Should the two actively involved personnel need assistance, the third individual is available to support.
RL	1	0	0	0	0	The RL NCS staff member also is qualified as a System Safety Oversight Engineer for the Plutonium Finishing Plant (PFP) Vital Safety System – Criticality Alarm System
CH	1	0	0	0	0	
ORO	1	0	1	1	-1	One qualified ORO NCS staff member left the Department during the year. ORO has posted a position to backfill. In the interim, EM and EH HQ NCS staff are being called upon to provide support (e.g. EH NCS staff provided support in the development of the K25/K27 D&D DSA; EM NCS staff will provide support on Criticality Accident Alarms). Both of these individuals are members of the CSSG.
NE ID	2	0	0	0	0	
NNSA LASO	0	1	0	0	0	A LASO staff member with expertise in nuclear safety has begun formal qualification to 1173 and should complete the qualifications in 2005. LASO NCS needs are met with this addition and the additional support from the SC.

7. Lessons learned from criticality safety program assessments

The mandatory ANSI/ANS-8 standards for criticality safety require criticality safety audits and self-assessments. In particular, every fissile material operation must be reviewed frequently, at least annually. Generally, contractor self-assessments performed by either operations staff or the nuclear criticality safety staff occur monthly in some portion of any given plant. The requirement to review every fissile material operation is usually met by performing a systematic schedule of assessments over a small portion of the facility/site monthly, with the roll-up covering all areas in a year. Most site contractors utilize criticality safety committees in addition to line operations and nuclear criticality safety staff audits/assessments. The nuclear criticality safety committees often include external expertise to advise contractor management. Finally, it is a common practice for contractors to perform biennial or triennial comprehensive criticality safety program reviews by teams comprised of some mix of internal and external expertise. Standard practice at the sites is to capture findings from all these types of self-assessments in a site-specific corrective action-tracking database that contractor management uses as a tool to ensure that improvements occur.

It is important to differentiate self-assessment findings and observations from criticality safety deficiencies/infractions. The former are often programmatic or reflect deviations from expected policy or practice that do not involve specific criticality safety limits and controls. The latter explicitly arise from deviations from approved criticality safety limits, controls, and procedures as derived from criticality safety evaluations.

Site DOE criticality safety staff ensures that contractors have programs and procedures in place for performing the required self-assessments. This assurance is gained by conducting DOE line criticality safety assessments/reviews on an ongoing basis. These assessments examine program documentation, spot-checking self-assessment and corrective action-tracking reports, and frequently examining individual criticality safety evaluations and limits. DOE site criticality safety staff periodically tour fissile material facilities and operations, usually as a team with Facility Representatives. Site DOE criticality safety staff do not, in general, review every report of every audit/self-assessment performed by the contractor. DOE site line management holds its contractor management responsible for maintaining awareness of criticality safety issues and concerns based on feedback from all assessments and implementing corrective actions as needed.

If contractor self-assessments do identify criticality safety deficiencies/infractions, these are reported to contractor management and to the site DOE criticality safety staff. The site DOE criticality safety staff, collaborating with the CSCT, will then track and trend all criticality safety deficiencies/infractions.

The DOE issued a formal technical standard, DOE-STD-1158-2002, *Self-Assessment Standard for DOE Contractor Criticality Safety Programs*, as an aid to establish consistent, high-quality self-assessments. This standard was written with the intent of the entire scope being covered at a

site approximately every three years. Properly implemented, such a systematic self-assessment program will maintain best practices consistent with the expectation of the mandatory standard ANSI/ANS-8.19.

Most DOE contractors have incorporated DOE-STD-1158-2002 in some fashion as part of their ongoing self-assessment program. Some use it as part of their criticality safety committee protocol, some use it as part of their monthly self-assessment programs, and others utilize it for their biennial/triennial reviews. Typically, when site DOE offices conduct assessments of their contractor's criticality safety programs, the lines of inquiry from this standard are utilized.

In addition to these ongoing systems of line management self-assessments at the DOE site and contractor management level, DOE developed its implementation plan in response to Board Recommendation 2004-1. The Department will enhance its oversight and assessment function overall and the NCSP and CSSG expect to support improvements in this area as appropriate in accordance with the structure established by the IP. Details are still being worked out as to how the expertise resident within the CSSG will be leveraged to support these new activities.

The CSSG has had an active year providing technical assistance to the Department's site office managers relative to criticality safety self-assessments. The CSSG performed one 'official' CSSG NCS assessment and supported, or led, numerous other activities and assessments leveraging their considerable NCS expertise throughout the Department. In all, Hanford, Rocky Flats, Y-12, Sandia National Laboratory, New Brunswick Laboratory, the East Tennessee Technology Park (K25/K27), and the Idaho National Laboratory all received assistance by the CSSG in some form during the year at the request of the respective DOE site offices who provided the funding for these activities in the majority of cases.

In January 2004, a CSSG member developed a lessons learned white paper dealing with leading indicators of criticality safety accidents. The white paper described the indicators that were observed at Rocky Flats in advance of the 1994 criticality accident near-miss and that accurately foreshadowed the occurrence. Generalized leading indicators were developed and shared with the CSSG and CSCT. The white paper was posted on the CSCT bulletin board and distributed via email. Discussions of the leading indicators by the CSCT with CSSG members led to the CSSG site review that was performed at Y-12 at the request of the NNSA Y-12 Site Office. This is one example of a proactive lessons learned initiative undertaken by the CSSG.

Also, in January 2004, a CSSG member led the NCS review of the Bechtel-Jacobs Company (BJC) NCS Program at the ETTP. This review was a comprehensive assessment of compliance to DOE-STD-1158 done for the Oak Ridge Operations Office (ORO) by a federal team comprised of three CSSG members and three CSCT members. The overall conclusion of the team was that the BJC NCS Program meets the expectations of ANSI/ANS-8.19. The team identified no Issues, six Observations, and three Noteworthy Practices. The program is still maturing, but the elements are in place and functioning. BJC management now has the program

and personnel to ensure that operations are conducted safely and efficiently from an NCS standpoint. BJC has made excellent progress in line management/supervisor involvement in criticality safety and should continue to make this an emphasis of the program. Operator awareness and knowledge of criticality safety has markedly improved as a result of the new nuclear criticality safety evaluation-specific training provided by the NCS staff. Finally, BJC management is developing a Nondestructive Assay (NDA) Program to support Decontamination and Decommissioning (D&D) of the K-25/K-27 buildings and should have an external technical review of this program performed prior to implementation, since it could not be reviewed at this time.

In April 2004, at the request of the NNSA YSO Manager and funded by the NNSA Service Center, members of the CSSG performed a site NCS review at Y-12. The review was stimulated by the promulgation of the leading indicator white paper developed by a CSSG member. The purpose of the review was to examine conduct of solution operations practices in Building 9212 as they impact criticality safety and make recommendations to YSO for improvement. The focus was on operations management and the implementation of the criticality safety program in the facility. This was a technical assistance activity for the YSO, not an 'oversight' compliance review and is another example of a proactive, not reactive, action to improve criticality safety. Therefore, the team was able to make unfettered observations and recommendations based on the experience and knowledge of the team members gained from over 80 years of collective criticality safety experience. The teams report was issued by the NCSP Manager (NA-11) and distributed to senior NNSA management. The three person CSSG team reviewed criticality safety evaluations, policies, and procedures, toured the Oxide Conversion Facility, C-1 and B-1 Wings of Building 9212, observed a pre-job briefing and small group seminar, and interviewed contractor (BWXT) management, staff and operators. The team held daily briefings with YSO and BWXT management and staff to communicate the team's observations in a timely manner. The CSSG's overall conclusion was that while implementation of criticality safety in solution operations in Building 9212 has a solid foundation, there are several areas needing additional attention from operations management. The history of process related criticality accidents shows that fissile solution operations are those most at risk. Operations management at Y-12 must make conscious, disciplined decisions to avoid becoming complacent and contented with the adequacy of the criticality safety program in the absence of high-visibility events. This should result in a continuous reduction in the risk of an accident by improving compliance with safety requirements and reducing reliance on administrative controls. Finally, the CSSG team leader and the NCSP Manager formally briefed the DNFSB on the results of the review in June, 2004.

The CSSG and NCSP Manager recognized the importance of NDA to the criticality safety of D&D projects like that at ETTP and the Hanford Plutonium Finishing Plant (note: a CSSG member led a review of the Hanford NDA program in 2003) and developed a NDA tutorial for criticality safety engineers. A CSSG member met with LANL NDA technical staff in May to outline the NDA needs of criticality safety staff and to develop an outline for the tutorial. The timing of the tutorial was set to provide support to EM sites with major D&D efforts. CSSG

members coordinated with the LANL, NCSP and the American Nuclear Society to present the tutorial at the November 2004 meeting of the ANS in Washington, D.C. In addition, all the materials presented at the NDA tutorial were made available on the LLNL NCSP website. The tutorial presented technical information about the theory, methods, equipment and pitfalls of NDA pertinent to criticality safety evaluations. The day-long tutorial was attended by about 50 people.

Also in May 2004, the Richland Operations Office invited a CSSG member to visit the Hanford site. The CSSG member was guest speaker at the annual Criticality Safety Representatives meeting held at PNNL facilities. Additionally, he provided technical assistance to the Spent Nuclear Fuels programs in the form of document reviews. He met with several members of the Fluor Hanford technical staff tasked with producing criticality safety analyses supporting operations on the Hanford site and also participated in discussions surrounding proposed changes to the Hanford criticality safety program and the Annual Criticality Safety Assessment.

In June 2004, two CSSG members participated in the final biennial NCS review at Rocky Flats. This was a joint activity between the contractor and the DOE Rocky Flats Office. The scope of this assessment was to evaluate the adequacy of the site's criticality safety program, with particular emphasis and concentration in the following areas:

- Adequacy of the current RFETS closure Criticality Safety Program with associated lessons learned;
- Adequacy of current criticality Safety Evaluations, particularly Incredibility Evaluations with associated lessons learned;
- Adequacy of compliance with criticality safety requirements and controls; and,
- Adequacy of site level criticality safety training with associated lessons learned.

RFETS' criticality safety program was determined to be adequately documented and implemented for supporting the safe and efficient closure of the site. The assessment identified two good practices, one opportunity for improvement, and one deficiency. The results of the review were disseminated to CSSG members.

In July 2004, a CSSG member visited the INL to become acquainted with current state of the criticality safety program. Prior to visiting the site he reviewed program descriptive documents, some criticality safety evaluations, and examples of Chapter 6 of facility Safety Analysis Reports. During the visit week, the CSSG member interviewed various Idaho Operations Office staff, Bechtel BWXT staff, and BNFL staff. He also toured the Advanced Mixed Waste Treatment facility, the Accelerated Retrieval Project, the Subsurface Disposal Area, the Transuranic Storage Area, and the Idaho Nuclear Technology and Engineering Center. Observations were reported to DOE ID Management in a trip report that contained a lengthy discussion about the integration of criticality safety into the Authorization Basis (AB) documentation. The report was discussed by CSSG members and contributed to the ongoing work by the CSSG to better integrate the NCS program with the AB.

In September 2004, the DOE Chicago (CH) Office utilized CSSG expertise to assist with reviews of the New Brunswick Laboratory's NCS program and AB documentation. The primary purpose was to help prepare for an upcoming assessment by the Office of Independent Assessment (OA). The CSSG member reviewed criticality safety evaluations, the Safety Analysis Report (SAR), and Unreviewed Safety Question (USQ) documentation and provided recommendations for improvement to CH. The primary need for improvement is in the area of updating the SAR based on USQs performed in the past year or so to reflect and protect the assumptions that a criticality accident is an incredible event at the NBL (which it is!). For example the material at risk (MAR) values listed in the current SAR do not reflect actual practice and do not by themselves reflect the MAR assumed by the crit-incredible USQ and supporting analysis. The OA team identified no new NCS related findings and because of the assistance provided by the CSSG member corrective action plans were already in place when OA arrived. The OA review did not uncover any additional deficiencies.

In October 2004, the Sandia Site Office (SSO) engaged a CSSG member to assist with a limited scope NCS self-assessment of Technical Area V at the Sandia National Laboratory (SNL). The two sections covered from DOE-STD-1158 dealt with MC&A and Criticality Analyses. There were three findings dealing with NCS training of operators, errors in the MC&A inventory in specific storage areas, and the need to perform a major revision to the criticality safety evaluation and DSA for the Auxiliary Hot Cell Facility (AHCF). The team identified specific improvements that should allow the AHCF to be categorized as a Category III Nuclear Facility from a NCS viewpoint at least. However, the as found condition of the analysis and controls did not support such a categorization.

Finally, plans were underway for the CSSG to perform a site review at Los Alamos when the operations stand-down occurred in the summer. The Los Alamos Site Office (LASO) was coordinating with the NCSP and CSSG to arrange for a comprehensive 1158 review of the LANL NCS program. Planning for this review will resume when the operating environment at LANL is able to support it.

The CSSG discusses lessons learned and results of all CSSG related reviews. Reports of reviews are shared among CSSG and CSCT members. In this way virtually all DOE sites are aware at some level of what the CSSG is learning about safety. The NDA tutorial is, itself, a lessons learned because the CSSG and the NCSP identified NDA as an area needing attention and proactively provided this training for the Department's NCS staff. The CSCT regularly shares lessons learned and good practices on its web based bulletin board.

Finally, the CSSG provided information on the Department's lessons learned from the Tokaimura criticality accident and the leading indicator precursors developed from the Rocky Flats white paper case study on forecasting the potential for a criticality accident to the NNSA Chief of Defense Nuclear Safety for inclusion in the December 2004 edition of the NNSA Technical

Bulletin. This is a new formalized lessons-learned vehicle established by NNSA to which the CSSG will continue to contribute as requested and as appropriate.

8. Lessons learned from CSSG reviews of criticality safety controls for new facility designs

The CSSG has been closely following the NNSA plans to relocate the TA-18 mission and critical experiments facility to the Device DAF in Nevada. In March, the CSSG convened in Las Vegas for the first of two NCSP reviews that occur each year. The CSSG received briefings on NNSA's plans for relocation, the impact on experiments and training, and toured the DAF while in Nevada. Later, in June, the CSSG issued formal recommendations to the NCSP manager to help in the planning for the project. The CSSG, working with the NCSP manager, helped initiate the plans for an early move of critical assemblies to the DAF so that experiments can resume at the DAF as soon as practicable. Also high on the CSSG recommendation list is the preservation of human capital and associated expertise during the transition period. The CSSG continues to monitor the progress of the TA-18 to DAF transition and provides feedback regularly to the NCSP manager. One member of the CSSG is currently on detail to NNSA with the specific task of helping the Nevada Site Office establish viable criticality safety programs in Nevada. In addition, this individual will draw upon the expertise resident in the CSSG to review proposed controls for the critical experiments facility in the DAF and assure that an appropriate set of controls are established.

Another ongoing project being supported by the CSSG is the Oak Ridge Building 3019 U233 processing facility being done by ISOTEK under contract to the DOE Office of Nuclear Energy, Science and Technology (NE). In June 2004, a CSSG member traveled to Oak Ridge to meet with DOE Oak Ridge Operations (ORO) and ISOTEK staff to review draft NCS programs and procedures and to review the preliminary design of the facility. The CSSG member provided recommendations for improvements including, most importantly, the need to use SCALE-5 with its TSUNAMI capabilities coupled with the recently re-measured U233 cross sections. At the time of the review, a 5% penalty in sub-critical margin was arbitrarily being assigned (probably appropriately) by the ISOTEK NCS staff due to the uncertainties in the code and cross section set they used. With the capabilities of TSUNAMI coupled with the best available cross-sections the uncertainty in the sub-critical margin can be more accurately determined. It may or may not be smaller than 5% but it will be better understood and quantified analytically based on the best available methods developed by the NCSP. The CSSG worked with the NCSP manager and ORNL staff (also CSSG members) to allocate \$60K of funding to perform TSUNAMI calculations on existing U233 benchmarks. CSSG members also subsequently met with ISOTEK staff to discuss their needs and how the NCSP/CSSG can support safe, efficient NCS evaluations supporting the facility and processing design. The work continues on with the CSSG reviewing the 60% design of the facility and plans to review the PDSA.

Lessons learned from CSSG reviews of these new facility designs and future reviews will

continue to be disseminated as described in the last paragraph of section 7, above.

9. Trending and analysis of reportable and non-reportable criticality safety occurrences

In late 2003, the CSCT worked to improve its ability to characterize deficiencies and infractions to better deduce lessons learned, share the information across sites more efficiently, and develop effective corrective actions. The CSCT undertook the development of a web-based database for tracking/trending reportable and non-reportable criticality safety deficiencies and infractions. The data that was used to populate this database is routinely collected by the contractors as part of their requirements to comply with ANSI/ANS-8.1 and 8.19. The CSCT did track/trend deficiencies/infractions monthly using this protocol beginning in January 2004, analyzed the occurrences, and uploaded the data monthly. The database is accessible only by CSCT members, in order to protect the integrity of the data. The information used by the CSCT for this purpose was input into the database in the format shown below.

CSCT Infraction Reporting/Tracking Format

Date:

Site:

Building/Facility and Contractor:

Reporting CSCT Member:

Discovered by (Contractor/DOE; Criticality Safety/Operations):

ORPS Reportable (Y/N):

Brief Description of Operation:

Brief Description of Infraction/Deficiency:

Infraction/Deficiency Category (List all that apply):

- Mass
- Volume
- Concentration
- Spacing/Interaction
- Labeling
- Unauthorized/Improper Transfer or Location
- Unauthorized/Improper Fissile Material Type/Form
- Improper/Inadequate Criticality Safety Posting
- Unauthorized/Improper Containers
- Unauthorized/Unanalyzed Operation
- Operation without Criticality Safety Posting/Limits
- Moderation/Flooding/Wetting
- Criticality Safety Alarm System Failure
- Limiting Condition for Operations Violation
- Technical Safety Requirement Violation

- Other (Describe)

Causal Factors (List all that apply):

- Less Than Adequate (LTA) Work Planning/Hazards Analysis
- LTA Pre-Job Walk-Down
- LTA Pre-Job Brief
- LTA Fissile Handling/Operational Procedures
- LTA Policies or Program Procedures
- LTA Training
- Failure to Follow Operational Procedures
- Failure to Follow Policies/Program Procedures
- Equipment Failure/Error
- Discovery of Pre-Existing Condition
- LTA Criticality Safety Evaluation
- Software Failure/Error
- Surveillance Failure
- LTA Assay of Material
- LTA Materials Control and Accountability
- Other (Describe)

From January through June the CSCT members, several of which are also CSSG members, reviewed this deficiency/event information monthly and discussed observations on the monthly teleconference calls. By June 2004, it became apparent that this data was not dramatically improving the ability to understand emerging criticality safety problems or potential problems at the sites and a small subcommittee of the CSCT performed a mid-year self-assessment of the program to provide feedback on improving the process.

Meanwhile, another data point had emerged. In April 2004, the CSSG completed its Y-12 review at which ALL the available information was reviewed pertaining to reportable and non-reportable criticality safety deficiencies/infractions for the past year at the Y-12 site. When all the Y-12 site's information was presented to the CSSG, patterns did emerge that provided insight into weaknesses in the Y-12 NCS program. These patterns could not be discerned from the CSCT tracking database alone. For example, some of the information available at the site could not be uploaded without classifying the database. Also, the volume of information would have been prohibitive and not easily cast into a searchable database. Particularly useful to the CSSG's NCS review were information on repeat infractions/deficiencies, recommended action plans for preventing recurrence, information on specific groups/supervisors that were involved, and information on funding requests, mechanisms, and line management organizational structure.

Based on the midyear review of the database and the results of the comprehensive onsite review at Y-12, the CSCT sub-committee recommended that while the CSCT database provided

information that was not completely useless, it was nevertheless, far less than optimal. It was just a collection of numbers that did not reveal any correlated patterns, even at a specific site level. Given the increasing security concerns and the lack of general utility the CSCT stopped entering information into the database in July 2004.

The recommended path forward is to incorporate a comprehensive review of all available information on reportable and non-reportable criticality safety deficiencies/infractions into site reviews performed by the CSSG. It is anticipated that the CSSG will perform technical assistance reviews of some sort at several sites per year. The exact number and protocol for accomplishing this is yet to be determined because the Department's Implementation Plan for Board Recommendation 2004-1 is not yet final, nor is it clear how the CSSG will involve itself in the activities being planned in the Implementation Plan. However, it is clear from the experience at Y-12 that a CSSG review of all available site information at one time looking back for a year or so can yield valuable insights and opportunities for improvement in a site's NCS program. In addition, the CSCT and CSSG will also consider looking into improvements and developments in the ORPS process for lessons learned relative to criticality safety. The CSCT and CSSG continue to monitor in real time the reportable events that are documented in ORPS. Finally, lessons learned from trending analysis as a result of CSSG reviews will continue to be disseminated as described in the last paragraph of section 7, above.

10. Open issues identified in the previous annual report

There were five open issues identified in last year's report. The status of each of these is presented in this section.

Issue 1: Optimizing the use of CSSG expertise to assist site office and contractor line management and developing a system for sharing lessons learned.

The Board's specific recommendation relative to what became the CSSG in its Recommendation 97-2 is listed below.

Board Subrecommendation 8:

Identify a core group of criticality experts experienced in the theoretical and experimental aspects of neutron chain reaction to advise on the above steps and assist in resolving future technical issues.

In the Department's Implementation Plan for Recommendation 97-2, DOE committed to form the CSSG with the following purpose.

The Department will form a group of experts that is composed of persons from its staff and the site contractors having collective knowledge in a broad spectrum of criticality

safety areas to advise the Departmental management team on programmatic issues and to help resolve present and future technical criticality safety issues.

The CSSG, in its technical support function to the NCSP Manager and the Department, fulfills its charter and the intent of the Department's commitment in the Implementation Plan to the Board's recommendation by providing expert technical advice on the NCSP program elements and assistance in resolving criticality safety related technical issues. In addition to providing technical advice regarding the NCSP program elements, the CSSG reviews described in detail in Section 7, above, clearly demonstrate that it is fulfilling the Department's original commitment to the Board. While the NCSP will continue to optimize the use of CSSG expertise to assist site office and contractor line management, the Department's recently approved implementation plan for Recommendation 2004-1 includes additional actions to develop a system for sharing lessons learned. The Department considers this issue closed.

Issue 2: Resolution of issues surrounding the relationship between criticality safety evaluations/controls and authorization basis documents;

and,

Issue 3: Resolution of issues regarding the way criticality safety is addressed in the DOE Implementation Guides for Title 10 of the Code of Federal Regulations, Part 830, *Nuclear Safety Management*.

Issues 2 and 3 are being addressed by developing a revision to DOE Order 420.1 and re-writing DOE-STD-3007. The CSSG has had major input to the complete revision of the criticality safety section of DOE O 420.1 and the draft now reflects the long-standing CSSG position that criticality safety be conducted according to the national consensus ANSI/ANS-8 Standards without substantial modification by the DOE. The Department recommended in the report of its assessment of the criticality safety program subsequent to the Tokai-mura accident that DOE-STD-3007 be converted from an optional format guide to a mandatory criticality safety evaluation standard. The revision to 3007 is now underway and will contain major new sections dealing with the linkage between criticality safety and the authorization basis. Drafts of this revision have been discussed by the CSSG, EH, and the Energy Facility Contractor Operations Group Safety Analysis Working Group at meetings during the past year. The new 3007 will have sections on selecting TSR level criticality controls and developing a 'bridging document' between criticality safety evaluations and the authorization basis. It will also provide guidance on how to address beyond design basis criticality accidents and dose calculations. The draft revision to DOE O 420.1 contains language that makes compliance to DOE-STD-3007 a requirement. The NCSP and CSSG will continue to work this issue through to completion along with other involved Departmental elements. It is expected that both revisions will be finalized and published in 2005.

Issue 4: The potential relocation of the Los Alamos Critical Experiments Facility activities conducted at LANL TA-18.

See Section 4, above, for a TA-18 relocation status. This issue will be carried forward as an open issue until the integral experiments and training programs are fully functional in Nevada.

Issue 5: Federal oversight of LANL, Sandia National Laboratories, and Pantex criticality safety programs.

Federal oversight of LANL, Sandia National Laboratories, and Pantex nuclear criticality safety (NCS) programs has been dramatically improved. The NNSA Service Center has hired a second criticality safety professional with more than 20 years of experience in the field. He will provide criticality safety support on an ongoing basis to these three sites. In addition, LASO has identified an experienced nuclear safety person who is in the process of becoming formally qualified in NCS. This individual has been working closely with the CSSG and the Office of Environment, Safety and Health in developing the major revision to DOE-STD-3007 and is an active member of the CSCT. Finally, NNSA has added a senior CSSG member to its staff that will be available to provide technical assistance to all NNSA sites, including the NSO and its ongoing activities to support the transition of TA-18 to the DAF. The Department considers this issue closed.

11 Open Issues

Several issues will be carried forward as open issues requiring further work. These are:

- The relocation of the Los Alamos Critical Experiments Facility activities conducted at LANL TA-18 to the DAF.
- Issuing revisions to DOE O 420.1 and DOE-STD-3007.

12 Conclusion

Overall, the NCSP has made significant progress in maintaining important criticality safety infrastructure and supporting operational programs. Funding has been stabilized and the NCSP is leveraging its assets to provide support for the most pressing operational criticality safety needs. Both the LACEF and the Oak Ridge Electron Linear Accelerator are recognized as important contributors to the NCSP and are being supported. Training and qualification programs are functioning. Pertinent criticality safety information is readily available on web sites supported by the NCSP, and feedback from the criticality safety community is being used to plan program work. The CSSG is actively providing technical support to the NCSP and technical assistance to the sites. Through implementation of the NCSP, a viable process for assessing needs and enhancing criticality safety has been institutionalized.

SEPARATION

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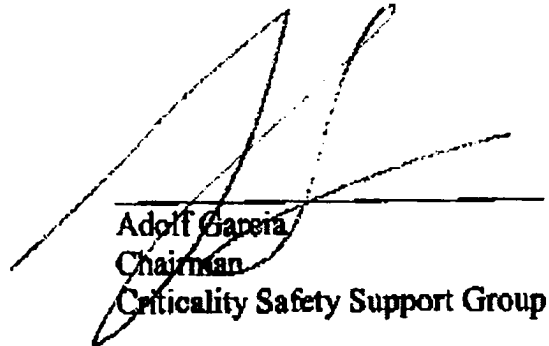
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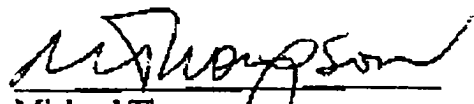
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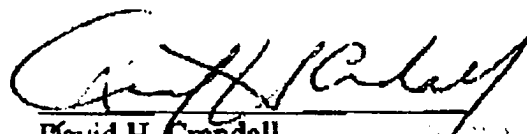
Adolf Garcia
Chairman
Criticality Safety Support Group

Recommend Approval:



Michael Thompson
Director
Office of Facilities Management
and Environment Safety and Health
Defense Programs
Manager, Nuclear Criticality Safety program

Approved:



David H. Crandall
Assistant Deputy Administrator
for Research, Development and Simulation
Defense Programs
Sponsor, Nuclear Criticality Safety Program

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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
EH	Office of Environment, Safety and Health
EM	Office of Environmental Management
ENDF	Evaluated Nuclear Data File
FFTF	Fast Flux Test Reactor
FTE	Full-Time Equivalent
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
INEEL	Idaho National Engineering and Environmental 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
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
PNNL	Pacific Northwest National Laboratory
PRTR	Plutonium Recycle Test Reactor
RL	Richland Operations Office
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

USNRC	United States Nuclear Regulatory Commission
WINCO	Westinghouse Idaho Nuclear Company
WSMS	Westinghouse Safety Management Solutions
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 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. Mr. Mike Thompson, 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) 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.

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

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.

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 Los Alamos Critical Experiments Facility (LACEF) 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.

Figure ES-1 How the Nuclear Criticality Safety Program Works

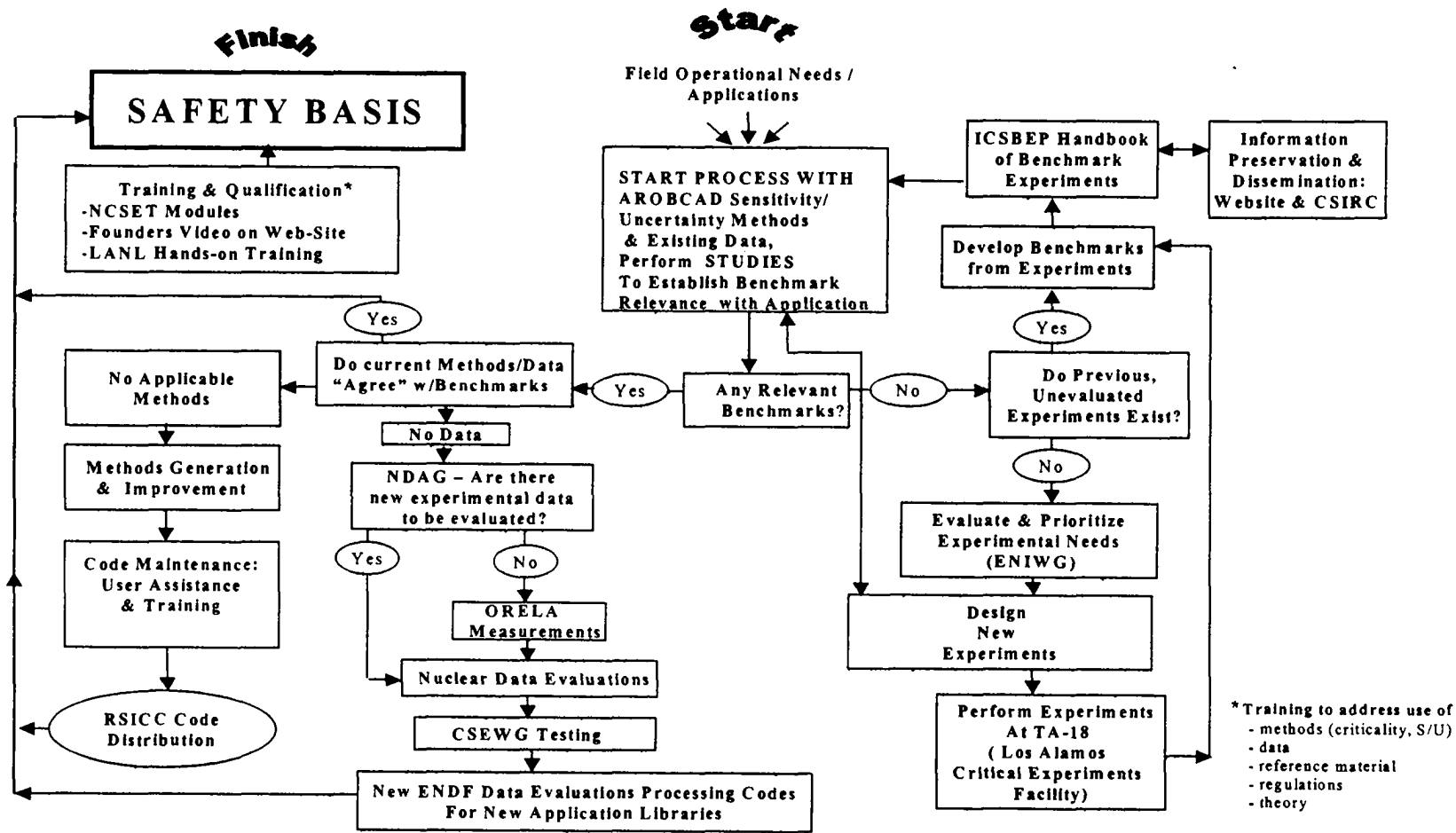
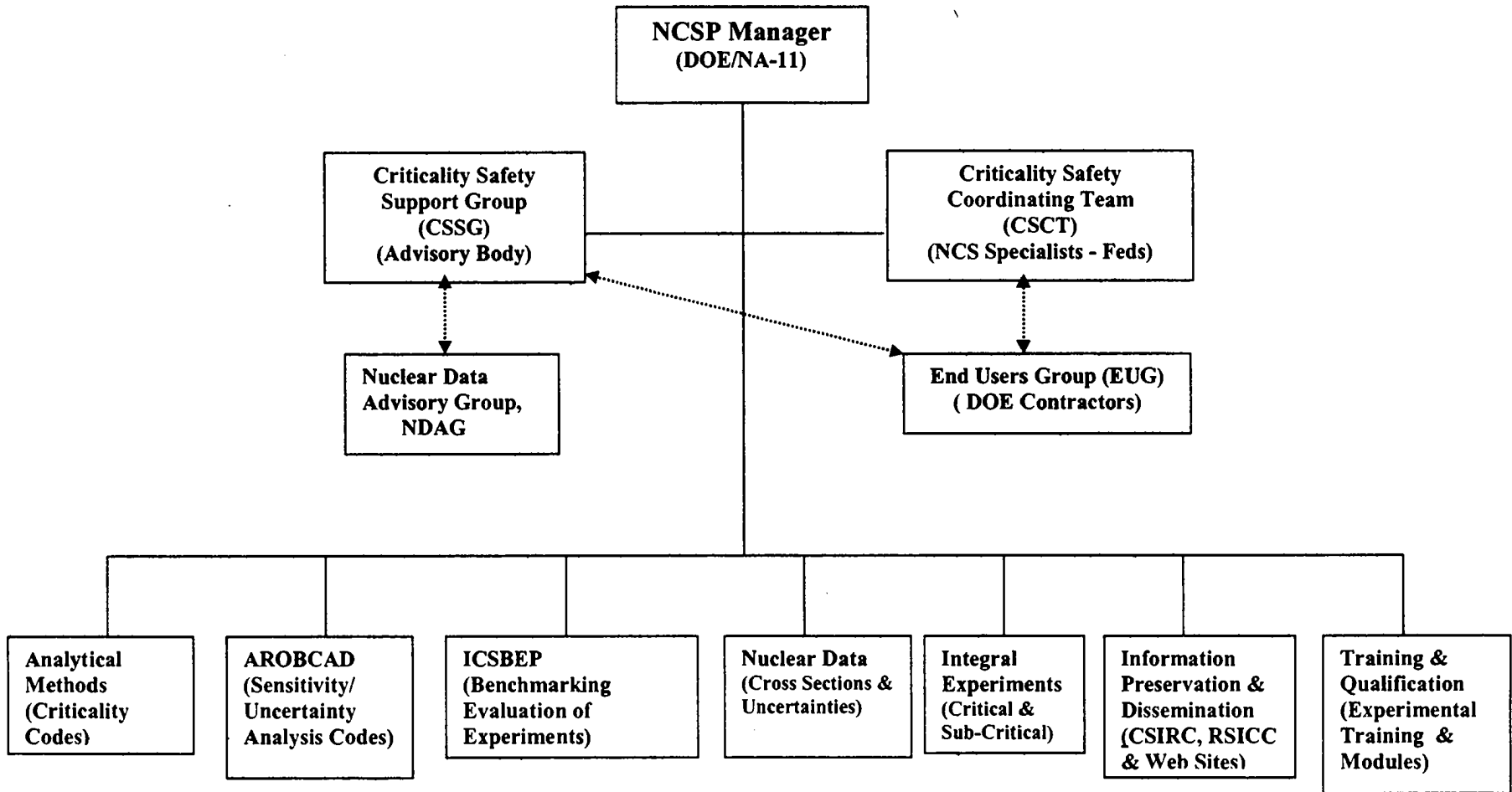


Figure 1-2: Nuclear Criticality Safety Program Organization



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.

Table ES-1: Nuclear Criticality Safety Program Base Funding, Fiscal Years 2005 – 2009

	FY 2005 (\$K)	FY 2006 (\$K)	FY 2007 (\$K)	FY 2008 (\$K)	FY 2009 (\$K)
Applicable Ranges of Bounding Curves and Data	800	800	400	300	300
Analytical Methods Development and Code Support	2,235	2,145	2,545	2,500	2,500
International Criticality Safety Benchmark Evaluation Project	1,900	1,800	1,800	1,800	1,900
Nuclear Data	3,045	2,754	2,700	2,917	3,000
Integral Experiments	1,451	1,580	1,782	1,782	1,886
Information Preservation and Dissemination	265	270	270	270	270
Training and Qualification	200	190	190	230	230
Criticality Safety Support Group	230	250	250	250	250
TOTAL	10,126	9,789	9,937	10,049	10,336

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 enhances criticality safety throughout the Department. In addition to maintaining the infrastructure or "base program", NCSP resources are routinely employed to solve Departmental 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.

**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 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. Mr. Mike Thompson, 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) 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 Maintenance: support and enhance numerical processing codes used in 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.

International Criticality Safety Benchmark Evaluation Project: identify, evaluate and make available benchmarked data to support validation of criticality safety analyses.

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 Los Alamos Critical Experiments Facility (LACEF) 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 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 enhances criticality safety throughout the Department. In addition to maintaining the infrastructure or "base program", NCSP resources are routinely employed to solve Departmental 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.

2. Applicable Ranges of Bounding Curves and Data

Program Element Description

The Applicable Ranges of Bounding Curves and Data (AROBCAD) Program Element involves adapting and extending the use of optimization, sensitivity/uncertainty (S/U), and statistical methods into useable software tools; applying these tools in studies of technology issues and/or DOE programmatic applications; and then providing training and guidance in the use of these tools. The overall objective is the establishment of safe and efficient margins of sub-criticality. Planned activities are being performed through five technical subtasks and one program administration subtask. These subtasks, including interim results, which lead to the completion of the two end products (AROBCAD software and guidance), are:

1. Implementation of optimization techniques for establishing bounding values;
2. Investigation of the means to resolve or incorporate anomaly and discrepancy effects into bounding values;
3. Implementation of the use of S/U and statistical methods for identifying experimental needs (i.e., critical or near critical and cross-sections);
4. Development and publication of guidance and provision of education/training for interpolating and extrapolating bounding values;
5. Development and publication of guidance and provision of education/training for establishing bounding margins of subcriticality, and
6. Planning, administration, and reporting.

Preservation of AROBCAD Capability

This work element requires support from two to three full time equivalent (FTE) personnel at Oak Ridge National Laboratory (ORNL) to perform the five technical subtasks. Methodology resources draw heavily from resident ORNL staff expertise in criticality safety analyses, as well as sensitivity/uncertainty and statistical theories. Additionally, the optimization methodology incorporates and extends work performed by the University of California, Berkeley. The AROBCAD development effort is focused on demonstrating the AROBCAD software tools, evaluating specialized and novel problems, designing differential and integral experiments, and completing the software transition to code maintenance and training (Nuclear Criticality Safety Engineer Training (NCSET) Module) by 2008. The level of effort drops significantly with subtask completion in FY 2007 and FY 2008.

Table 2-1: AROBCAD Budget, Fiscal Years 2005 – 2009 (\$k)

SUBTASK	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009
AROBCAD	800	800	400	300	300

AROBCAD is a Key Element of the NCSP

Along with the other NCSP technical work elements, in conjunction with staff training and qualification, the products of AROBCAD provide validated methods and qualified expertise for performing criticality safety analyses. This is a very exciting development effort because it will allow for extension of existing integral data into areas where little benchmark data exists and provide the criticality safety engineer with a method for quantifying the uncertainty of derived safety margins. In addition, AROBCAD will help illuminate discrepancies in integral and differential data so that scarce research dollars can be focused on the highest priority problems. This activity has the potential to significantly enhance operational safety and efficiency.

AROBCAD Contributions to Operational Criticality Safety

The customers for these activities are all DOE fissionable material operations requiring criticality safety analyses. Generally, these include all operations with more than 700 grams of fissile material, with the exception of those operations in which the aggregation of this material into a critical mass can be shown to be impossible. Additionally, under certain circumstances, criticality safety analyses are required for operations involving fissionable but not fissile material, e. g. Pu-238. DOE fissionable material operations are performed by the various elements of the National Nuclear Security Agency, as well the Offices of Environmental Management (EM), Civilian Radioactive Waste (RW), and Nuclear Energy, Science and Technology (NE).

A good example of the utilization of AROBCAD technology to directly enhance operational criticality safety is the sensitivity/uncertainty studies that are being performed for EM operations at SRS, INEEL, and RL to demonstrate capabilities for improvements in determining safe margins of subcriticality, as well as increased efficiencies in EM operations. More information on this work is contained in Section 10, below. Other potential program specific applications include the NE effort to design and evaluate new reactors and associated fuel-cycle concepts in the Generation-IV Reactor Program, as well as the cooperative effort between DOE and NASA to develop the technical bases for nuclear criticality safety in the application of fission technology in space missions.

National Nuclear Security Agency programs which will ultimately benefit from the utilization of AROBCAD technologies include: 1) the evaluation of data uncertainties in the design of integral experiments that support operational criticality safety, and 2) quantification of data uncertainties in U-238/ weapons-grade MOX disposition so these operations can be conducted efficiently.

3. Analytical Methods Development and Code Support

Program Element Description:

This program element provides for the maintenance of redundant, state-of-the-art analytical capability. An essential aspect of this capability is the human expertise required to develop the analytical software, provide software configuration control and assist the user community throughout the DOE complex. In addition to the operational software, stability in this area has served to provide a fertile environment for the cultivation of valuable human capital in this relative arcane discipline. The NCSP has become the mainstay in advancing and maintaining DOE contractor staff expertise in this technical area.

The NCSP methods (codes and processed data) have been utilized in a redundant, corroborative manner, along with the technology provided by the other NCSP program elements, to perform two primary functions:

1. Establish Critical Experiment Benchmarks (MCNP and VIM software along with the ICSBEP, Nuclear Data, and Critical Experiments).
2. Perform Criticality Safety Analyses (SCALE/KENO, MCNP, and software along with established ICSBEP Benchmarks, Validated Nuclear Data, and Critical Experiments and with future utilization of AROBCAD Sensitivity/Uncertainty Methods). These analyses are the primary bases for evaluating criticality safety hazards, and then defining and qualifying criticality safety controls, two activities that enable Integrated Safety Management.

Currently, the work under the Analytical Methods Development and Code Support program element includes seven ongoing subtasks:

Capability maintenance, training and user assistance, and code enhancements are performed on the SCALE/KENO software by ORNL (Lead-Lester Petrie).

Capability maintenance, training and user assistance and code enhancements are performed on the MCNP code and related software by Los Alamos National Laboratory (LANL), with associated management support (Lead-Bob Little).

Capability maintenance, training and user assistance and code enhancements are performed on the VIM code and related software by Argonne National Laboratory (ANL), with associated management support (Lead-Roger Blomquist).

The CSSG is reviewing the features and capabilities of the Monte Carlo criticality codes (KENO, MCNP, VIM) relative to the uniqueness of the LLNL COG code. If the CSSG finds a basis for increasing support for COG, funding in FY05 and beyond for COG maintenance will be adjusted accordingly. (Potential Lead-Dave Heinrichs).

Cross Section Processing Methodology will continue to be supported. (ORNL-Maurice Greene, LANL-Bob MacFarlane, and ANL-Dick McKnight).

The Radiation Safety Information Computational Center (RSICC, Lead-Hamilton Hunter) at ORNL performs the functions of collecting, packaging, and disseminating the software (codes and data libraries).

As Contractor Project Manager, Mike Westfall, assisted by Bob Little, Dick McKnight, and Hamilton Hunter, perform the functions of planning, administration and reporting for this NCSP program element.

Preservation of Analytical Methods Development and Code Support Capability

This program element requires between 0.5 and 2 full time equivalent employees at each of the laboratories to perform the seven ongoing subtasks and maintain capability. In the time frame of FY 2004 through FY 2006, the following major code enhancements are scheduled:

- ORNL: Additional continuous-energy kinematics in the CENTRM Discrete-Ordinates Transport Code, Continuous Energy Monte Carlo- validation and implementation into the SCALE System, Three Dimensional Discrete Ordinates with Variable Irregular Mesh, Time and Frequency-Dependent Transport Capabilities.
- LANL: Implementation of automatic fission source generation and geometry testing, ICSBEP spectral parameters, and advanced graphics into MCNP; generation of new MCNP cross section libraries based on new (ENDF/B – VI & VII) data, and demonstration of these new capabilities on advanced super computers.
- ANL: Develop a graphical user interface for VIM and energy and temperature interpolation of the data and perform upgraded data processing of VIM libraries.
- LLNL: Depending on the evaluation and recommendation of the CSSG, demonstrate the Computer-Aided Design (CAD) capability for automated building of Monte Carlo geometry models, and assist the other code communities in incorporating this capability into their codes.

Analytical Methods Development and Code Maintenance Budget

The following activities, listed in priority order, could be accomplished if additional funding is secured in FY 2005:

1. The new 238 group ENDF/B-VI cross section library is nearing completion. The next step in preparation of the library for release is the compilation of a test set of Benchmark critical experiments typical of the materials appearing in current DOE nuclear criticality safety applications. This compilation is estimated to require one-person month (\$30k). Then the validation study would be performed and documented. Estimated effort is two person months (\$60k).
2. The Pitzer Method has been applied to upgrade the determination of components of uranium solutions in correlations applied in SCALE system material specifications. The analytical chemistry group at ORNL can supplement this capability with additional data for applying this method for plutonium nitric acid solutions and uranium fluoride solutions. The estimated cost is \$50k.
3. At LANL, a prototypic capability has been established for the specification of materials as elements and/or as mixtures of elements for input into MCNP analyses. This capability can be tested and put into a production status for approximately \$40k.

Table 3-1: Analytical Methods Development and Code Maintenance Budget, Fiscal Years 2005 – 2009

SUBTASK	FY 2005 (\$K)	FY 2006 (\$K)	FY 2007 (\$K)	FY 2008 (\$K)	FY 2009 (\$K)
1. SCALE/KENO Support	595	625	700	670	670
2. MCNP Support	480	415	500	505	505
3. VIM Support	400	375	500	480	480
4. COG Support	160	110	160	160	160
5. Cross Section Processing Code Support	300	300	300	300	300
6. RSICC Support	240	240	285	285	285
7. Administration	60	80	100	100	100
TOTAL	2,235	2,145	2,545	2,500	2,500

Analytical Methods Development and Code Support is a Key Element of the NCSP

This program element is an essential part of the criticality safety infrastructure because the maintenance, user assistance, improvements, and continued support for these codes enables calculations by criticality safety professionals that are necessary to conduct criticality safety analyses that assure the safety of workers and the public.

Analytical Methods Development and Code Support Contributions to Operational Criticality Safety

All DOE fissionable material operations requiring criticality safety analyses benefit from the products of this program element. Generally, these include all DOE fissionable material operations, which are performed by the various elements of the National Nuclear Security Agency (NNSA), as well the offices of Environmental Management (EM), Civilian Radioactive Waste Management (RW), and Nuclear Energy, Science and Technology (NE).

Currently, NCSP technology (Analytical Methods, Nuclear Data, ICSBEP Benchmarks, AROBCAD Sensitivity/Uncertainty Methods, and Critical experiments) are being applied to EM program specific applications at SRS, INEEL, and RL to demonstrate capabilities for improvements in determining safe margins of subcriticality, as well as increased efficiencies in EM operations. The three studies are being performed collaboratively with analytical specialists at the three sites.

Other potential program specific applications include the DOE NE effort to design and evaluate new reactors and associated fuel-cycle concepts in the Generation-IV Reactor Program, as well as the cooperative effort between DOE and NASA to develop the technical bases for nuclear criticality safety in the application of fission technology in space missions.

The Office of Civilian Radioactive Waste Management is benefiting from the qualification of burn-up credit in the design of fissionable waste transportation and storage equipment. Qualification of burn-up credit depends upon validated analytical capabilities for criticality safety evaluations involving the higher actinides, as well as the fission products.

4. International Criticality Safety Benchmark Evaluation Project

Program Element Description:

The primary focus of the International Criticality Safety Benchmark Evaluation Project (ICSBEP) is to: consolidate and preserve the information base that already exists in the United States, identify areas where more data are needed, draw upon the resources of the international criticality safety community to help fill identified needs, and identify discrepancies between calculations and experiments. This program represents a tremendous capability. It preserves a valuable national asset and provides the United States with access to the global database of experimental benchmarks to validate calculative methods that simulate the neutronic behavior of fissile systems.

Preservation of ICSBEP Capability:

The ICSBEP is a national, as well as an international effort that requires participation from several different DOE Laboratories and Facilities. Base capability is maintained by

involving criticality safety experts from the Idaho National Engineering and Environmental Laboratory (INEEL), LANL, LLNL, ANL, ORNL, Savannah River Site Hanford, and Sandia National Laboratories as well as representatives from 16 other countries. The project is managed through the INEEL and requires about 1 FTE for evaluation work at each of the above named sites. Independent reviews, participation by the Russian Federation, spectra data calculations, partial database support, project administration, graphic arts, and publication are also provided primarily by the INEEL and / or INEEL subcontractors.

ICSBEP Budget

Over the next 5 years, for the funding depicted below, the ICSBEP will continue to evaluate and compile (1) Critical Benchmark Data, (2) Criticality-Alarm/Shielding Benchmark Data, (3) Subcritical Benchmark Data, and (4) Relevant Fundamental Physics Measurements. Specific evaluations that are planned for the next 5 years by United States participants are provided in Appendix D. The content and priority of the planned evaluations may change frequently with the changing needs of the criticality safety community. Special requests will also be made of foreign participants and the United States will be expected to respond to special requests from foreign participants.

Table 4-1: ICSBEP Budget, Fiscal Years 2005 – 2009

SUBTASK	FY 2005 (\$K)	FY 2006 (\$K)	FY 2007 (\$K)	FY 2008 (\$K)	FY 2009 (\$K)
1. INEEL	779	829	843	859	876
2. Other Participants	1,121	971	957	941	1,024
TOTAL	1,900	1,800	1,800	1,800	1,900

The ICSBEP is a Key Part of the NCSP

The objectives of the ICSBEP are to systematically consolidate and preserve the benchmark information base that already exists in the United States and expand it by drawing upon the resources of the international criticality safety community. By meeting these objectives, a large portion of the tedious and redundant research and processing of critical experiment data is eliminated. The necessary step in criticality safety analyses of validating computer codes with benchmark critical data is greatly streamlined, and valuable criticality safety experimental data are preserved. The work of the ICSBEP highlights gaps in data, retrieves lost data, and helps to identify limiting assumptions in cross section processing and neutronics codes and deficiencies in nuclear data.

Coordination / integration with other NCSP program elements is accomplished by including NCSP Program element Leaders (or their designate) from the Analytical Methods Development and Code Maintenance, AROBCAD, Integral Experiments, and

Nuclear Data Program Elements as well as criticality safety practitioners at various DOE facilities as members of the ICSBEP Working Group. Coordination / Integration also takes place through the Nuclear Data Advisory Group. Electronic coordination resources include the NCSP Web Site, maintained by LLNL and the ICSBEP Web Site (<http://icsbep.inel.gov/icsbep>). Both sites are linked to one another.

ICSBEP Contributions to Operational Criticality Safety

The ICSBEP has one major product: the annual publication of the "International Handbook of Evaluated Criticality Safety Benchmark Experiments". This Handbook has been published annually (typically in September) since the first publication in 1995. Approximately 20 to 25 new evaluations representing 200 to 300 configurations are completed each year. The ICSBEP also collaborates with the Organization for Economic Cooperation and Development - Nuclear Energy Agency (OECD-NEA) in the production, improvement, and maintenance of a database and user interface, DICE, which enables users to more easily identify data that fills their validation needs. DICE is also updated and published annually with the Handbook. Approximately 500 copies of the Handbook are distributed annually.

The ICSBEP Handbook is used extensively by criticality safety practitioners for evaluation of essentially all DOE operations involving fissile material. The data contained in the Handbook have eliminated a large portion of the tedious, redundant research and processing of critical experiment data, and streamlined computer codes validation efforts. Cost savings in terms of time saved during required validation efforts for fissile material operations has been estimated to exceed a million dollars annually. Savings as a result of international participation and contribution of data are of the order of several tens of millions.

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 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. Cross section processing methods are being maintained and improved and the need for data uncertainty covariance files has been recognized.

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 timelier manner. This is being 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 the CSEWG process for review, testing and publication on net differential nuclear data. Progress has been made in addressing the NDAG three-fold mission of identifying data needs, involving the other NCSP work elements in addressing these needs, and shepherding each of the nuclear data tasks to completion.

The Nuclear Data Program Element includes three subtasks:

ORNL - data measurement, evaluation, testing, evaluation method development, covariance development, and CSEWG and international interactions. As Contractor Project Manager, Mike Westfall (ORNL), assisted by Luiz Leal (ORNL), Bob little (LANL) and Dick McKnight (ANL), perform the functions of planning, administration and reporting for this NCSP Program Element.

LANL - evaluation, testing, evaluation method development, covariance development, and CSEWG and international interactions.

ANL - testing, covariance development, and CSEWG and international interactions.

Preservation of Nuclear Data Capability

For the FY 2004 budget, the Nuclear Data staff included eight FTEs. The six ORNL positions include two experimentalists, one nuclear model code specialist and three evaluators. One FTE at LANL and one FTE at ANL are required for subtasks 2 and 3 and NDAG activities. The ORELA Material/Equipment budget includes experimental costs (\$80k-electricity, \$100k-target samples & special equipment) and \$620 thousand to the ORNL Physics Division for ORELA administration and operation (the DOE Office of Science adds \$250k to this fund).

In FY 2004 through FY 2006, there is a one to two FTE base program increase to bring in and mentor young technologists in anticipation of NCSP staff retirements. Two post doc positions have been established at ORNL to mentor nuclear modeling and data evaluation roles. A new NCSP work element was initiated in FY 2004 to develop a stronger basis for neutron fission/capture theory. This will be a multi-Lab effort with ties into the academic community. A graduate-study-level intern position has been developed in the area of data measurements with ORELA. In FY 2004, an effort was initiated to establish understudy positions for the operator/engineer/technician positions on the ORELA staff. At LANL, a staff addition was made involving the lead Japanese specialist in developing covariance files. Substantial progress has been made in re-evaluating the high-energy reaction types (inelastic, elastic, fission, etc) in the uranium isotopes. At ANL, two retirees who are internationally-recognized experts in the fields of resonance modeling and data evaluation are contributing substantial continuing effort. Dick McKnight is performing the NDAG Chairperson role.

Nuclear Data Budget

The following activities, listed in priority order, could be accomplished if additional funding is secured in FY 2005:

1. The Nuclear Data work at ORNL currently includes the generation of cross section uncertainty data, by rough estimation, for the nuclides in the ENDF/B-VI compilation. Restoration of the \$125k FY05 funding will support the generation of covariance files for use in sensitivity analyses. This effort will be performed by a junior nuclear data specialist utilizing the PUFF software. The estimated effort is four person months (\$125k).
2. Restoration of the \$30k FY 2005 Nuclear data funding at LANL would support additional effort in the generation of high-energy neutron cross section uncertainty data to be utilized in the development of covariance files.

Table 5-1: Nuclear Data Budget, Fiscal Years 2005 – 2009

SUBTASK	FY 2005 (\$K)	FY 2006 (\$K)	FY 2007 (\$K)	FY 2008 (\$K)	FY 2009 (\$K)
1. ORNL	2,575	2,354	2,300	2,400	2,430
2. LANL	250	200	200	300	330
3. ANL	220	200	200	217	240
TOTAL	3,045	2,754	2,700	2,917	3,000

Nuclear Data are a Key Part of the NCSP

This program element is absolutely essential for the NCSP because it provides the nuclear cross section data that are necessary input for the modeling codes used by all criticality safety practitioners in performing criticality safety analyses.

Nuclear Data Contribution to Operational Criticality Safety

All DOE fissionable material operations requiring criticality safety analyses benefit from the products of this program element. Generally, these include all DOE fissionable material operations, which are performed by the various elements of the NNSA, as well the offices of EM, RW, and NE. In addition to the performance of criticality safety evaluations for all DOE fissionable material operations, the Nuclear Data work element provides improved nuclear data for a variety of DOE program specific applications as delineated in Section 10, below.

For RW, NCSP technical capabilities are being applied in developing better nuclear data to characterize the reactivity worth of spent fuel from DOE reactors. Under the burn-up

credit concept, greater operational efficiencies are obtained by relaxing the fresh-fuel assumption and taking credit for the reduced reactivity worth of the spent fuel. However, to provide the technical basis for the reduced reactivity, better nuclear data evaluations are required for the higher actinides (Np, Am, Cm, etc.) and the major, long-lived fission products. NCSP technology will be applied in new data measurements and evaluations.

Other potential program specific applications include the DOE NE effort to design and evaluate the new reactor and associated fuel-cycle concepts in the Generation-IV Reactor Program. Nuclear data needs for these advanced reactor designs are being compiled.

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 measurements, and within the limits of its 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 at the Los Alamos Critical Experiments Facility (LACEF). 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 propulsion program.

Preservation of Integral Experiments Capability

Personnel, equipment, facilities, and nuclear materials are the key elements required to maintain this capability. LACEF currently employs approximately eight full time staff (a few of which are supported with facility funding) with an additional five to ten staff providing part time support. The NCSP program provides funding for approximately five full-time personnel, which is considered the bare minimum to maintain the current level of capability. LACEF is the last operational general-purpose critical experiments facility in the United States.

The philosophy of the NCSP is to maintain capability by doing meaningful work. For an experiment to meet the definition of meaningful work, it either needs to be listed in LA-UR-99-2083, or meet an emergent need. (LA-UR-99-2083 contains the results of the 1998 review of LA-12683, *Forecast of Criticality Experiments and Experimental Programs Needed to Support Nuclear Operations In The United States of America: 1994 - 1999*, originally published in July, 1994). Although, the principal goal of the Integral Experiments program element is to maintain capability, there are specific deliverables associated with each proposed experiment. Appendix D lists the associated ICSBEP evaluation deliverables that LANL is committing to provide. Some of these evaluations depend on experiments that may be postponed due to the relocation of LACEF activities.

The Critical Experiments Facility (CEF) Project has been initiated to relocate LACEF activities to the Device Assembly Facility (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. Appendix F lists the integral experiments that are planned for fiscal years 2005 through 2009. 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. The NCSP is committed to make this transition as smooth as possible.

Transition of critical experiments and training capability from LACEF to the DAF will proceed according to the following plan: In FY2005, the NCSP plans to conduct critical experiments listed in Appendix F and support four training courses using Planet and SHEBA at LANL. NNSA will terminate all critical assembly operations at LACEF (except SHEBA) in the Summer of FY 2005 and ship Planet and Comet to DAF. SHEBA will remain operational at TA-18 throughout the transition to DAF. In parallel, the capability to do sub-critical measurements at DAF will be established in FY 2005. The NCSP will initiate safety basis activities in FY 2005 to operate Planet and Comet in a DAF building that is not involved in the CEF construction. It is anticipated that these assemblies will be operational at DAF no later than July 2006. If this plan is successful, critical assembly operations (with metal special nuclear material) will experience only about a one-year hiatus. The NCSP will fund the installation and operation of the Planet and Comet critical assemblies for interim operations at DAF out of program funds and will coordinate operations with the CEF Project to assure construction activities are not adversely impacted. From FY 2006 through FY 2009, the NCSP will conduct the critical and subcritical experiments listed in Appendix F at the DAF and will conduct four hands-on training courses per year. Each of these training courses will be conducted using facilities at LANL and DAF. 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 2005 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.

In addition to the planned integral experiments, a collaborative effort between LANL and ORNL to perform subcritical measurements continues. These subcritical measurements

will be performed at the DAF and will be evaluated and submitted to the ICSBEP. Together with existing critical measurements, these subcritical measurements will help solidify the methodology for making and evaluating these types of measurements and will provide excellent data to the criticality safety community.

Table 6-1: Integral Experiments Budget, Fiscal Years 2005 – 2009

SUBTASK	FY 2005 (\$K)	FY 2006 (\$K)	FY 2007 (\$K)	FY 2008 (\$K)	FY 2009 (\$K)
Integral Experiments	1,451	1,580	1,782	1,782	1,886

Integral Experiments are a Key Part of the NCSP

The Integral Experiments Program Element of the NCSP interfaces at some level with all of the NCSP program elements, but its primary contact is with the hands-on training and ICSBEP activities. The Nuclear Data Advisory Group works with the Experimental Needs Identification Working Group, which is part of the Integral Experiments program element, to establish the basic list of experimental needs and place some priority on the experiments to be performed.

Integral Experiments Contribution to Operational Criticality Safety

Unquestionably, the greatest contribution to operational criticality safety provided by the integral experiments element is hands-on training for both fissionable material handlers and criticality safety professionals. Between 50 to 80 people attend this training on an annual basis.

In addition to training, the primary contribution of this program element to operational criticality safety is the ability to establish or estimate the calculative bias in computer codes when performing criticality safety evaluations. This is essential to effectively implement an appropriate level of conservatism in the operational criticality safety controls and is one of the key requirements of American National Standards Institute (ANSI) / American Nuclear Society (ANS) Standard 8.1.

By maintaining an operating integral experiments program, DOE is also in a position to respond quickly to site-specific questions as criticality safety branches into non-traditional areas such as long-term geological waste storage and remediation of legacy materials. A credible integral experiments program, including the publication of scientific results and benchmarks, is essential to maintain expertise and the capability to properly address operational nuclear criticality safety issues associated with the conduct of current DOE programs.

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), which is tasked with collecting and preserving documents directly related to critical experiments and criticality safety as well as generating new documents such as the revised criticality accident report and the Heritage video series; and
2. The NCSP World Wide Web Internet site, which is the central focal point for access to criticality safety information collected under the NCSP sub element, and the gateway to a comprehensive set of hyperlinks to others sites containing criticality safety information resources.

Preservation of Information Preservation and Dissemination Capability

The pace of some of CSIRC work has significant urgency. As the pioneers and original experimenters dwindle in numbers and the memories of those remaining fade, irrecoverable losses occur. Thus, the allocation of funds to support the review of logbooks by original experimenters, where practical, and the videotaping of pioneers narrating the historical evolution of what have become accepted practices and in many cases regulatory norms will be given priority. This activity requires approximately one half of a FTE per year and is centered at LANL. Specific ongoing activities include videotaping of pioneers and original experimenters and editing/distributing the resultant videotapes, indexing scanned logbooks and papers to allow for electronic searches, updating various criticality safety information data bases and website interfaces maintained by the NCSP.

An important part of information preservation and dissemination is updating, correcting, and maintaining criticality safety handbooks. Atlantic Richfield Hanford (ARH)-600, an extensively used criticality safety handbook requires revision, correction, and reissue as an electronic handbook. Detailed activities under this task include identification of sections that need close review, correction of any inconsistencies, recalculation of graphic presentation with validated analysis codes, and presentation of information in electronic form for improved retrieval and presentation. Activities in FY 2004 included structuring the task, selection of validation tools, creation of the electronic version framework and processing the most urgently needed test cases. Additional needed revision of ARH-600 will continue during the out-years at a level commensurate with available funds.

The NCSP web site serves as the principal means for the DOE Nuclear Criticality Safety Program to disseminate information electronically to the entire criticality safety community. The main goal of the web site is to provide a forum for the timely distribution of information concerning the NCSP and other information of general interest to the criticality safety community. Extensive use is made of hyper links to other DOE web sites to point the user at the original data source to ensure accuracy and access to the most up-to-date information. This website is the result of the efforts contributed by many members of the criticality safety community and is maintained for the NCSP by the Lawrence Livermore National Laboratory (LLNL).

The NCSP web site has the following features:

1. Links to all major nuclear criticality safety web sites;
2. Training modules and key reference materials to assist the criticality safety practitioners;
3. Contact information to locate criticality safety practitioners at other sites;
4. Information on computational methods with links to computer code centers;
5. Two compendia of the criticality safety literature references with search engines;
6. An information posting service and interactive question and answer forum available to the criticality safety community; and
7. The latest NCSP 5-Year Plan

The NCSP web site utilizes a dedicated Sun Ultra 10 workstation with 10 Mb/s connection speed to the Internet. The web site is equipped with security software to protect against unauthorized intrusions. The server is physically located in a room with double locked doors for access control. Computer science professionals maintain the software in accordance with DOE requirements and LLNL policy.

From time to time, new development work is planned to enhance the web site. Specific improvements are formulated in response to input from the user community and implemented under the direction of the CSSG and the NCSP management team. For the coming fiscal years, the following activities are planned:

1. Continue to enhance the web site cascade menu style to facilitate website navigation;
2. Continue to enhance the navigational buttons using pop-up description boxes to reduce website clutter and improve clarity;
3. Setup Internet Mail Lists (i.e. Majordomo service) for NCSP management to send out NCS related announcements by email;
4. Create and maintain NCSP CSCT Infraction/Reporting database and trending analysis capabilities;
5. Procure new web server hardware and software to replace existing older hardware to prevent catastrophic failure;
6. Create online training with multi-media streaming capabilities;
7. Provide dedicated search capability of the relevant DOE regulations; and Standards related to NCS.

The NCSP web site is currently maintained at a modest level of effort that corresponds to only about one-third of a full time equivalent individual.

Table 7-1: Information Preservation and Dissemination Budget, Fiscal Years 2005 – 2009

SUBTASK	FY 2005 (\$K)	FY 2006 (\$K)	FY 2007 (\$K)	FY 2008 (\$K)	FY 2009 (\$K)
1. CSIRC	50	50	50	50	50
2. Hanford Data Base and ARH 600	85	90	90	90	90
3. Web Site	130	130	130	130	130
TOTAL	265	270	270	270	270

Information Preservation and Dissemination Activities are a Key Part of the NCSP

Mining the stockpile of experimental data before it is lost is extremely important. Recreation of many of these experiments in the current regulatory environment would be cost prohibitive. The CSIRC activities have already preserved data that has been documented as part of the ICSBEP and there is no reason to think that this will not continue. At a cost of ~\$300K and up for a single critical experiment, it makes sense to strive to make use of all existing data.

It is important to the DOE that criticality safety information and data are distributed to the criticality safety community audience as rapidly as possible. The development of the NCSP web site was in response to that need. With user-friendly tools to access and search the internet, a central web site to coordinate information at numerous DOE criticality safety sites offers great advantage in the dissemination of criticality safety information to a wide audience. The NCSP web site is designed not to duplicate the information held at other sites, but only to present the web site users with a structured set of links to those sites. This avoids duplication and maintenance of superceded versions of documents, and leads the users, whenever possible, to the original source of the information. By maintaining close communication with the CSSG and End-users, the NCSP web site manager is able to post NCS-related items in a timely manner. The web site also provides a set of resources beneficial to criticality safety engineers who are both experienced practitioners as well as newcomers to this field. A user of the web site can obtain various technical references through the LLNL and/or the Hanford bibliographical databases; gain access to the computer code centers; obtain basic criticality safety training through various training modules; and, ask questions and obtain technical assistance through the message board available at the web site.

Information preservation and Dissemination Contribution to Operational Criticality Safety

The CSIRC program is very important to operational criticality safety because its activities preserve logbooks, literature, and other information that form a criticality safety body of knowledge that has been accumulating for over 50 years. This body of knowledge is routinely accessed by criticality safety engineers to support development of their safety bases for fissionable material operations and to enrich the criticality safety culture.

It is important for the operational criticality safety community to have a centralized web site where criticality safety engineers can access and obtain information relevant to criticality safety and to have a forum to ask any question and obtain expert assistance. It is also very important for criticality safety practitioners to be able to access the information related to current status of the DOE NCSP in a timely manner. Listed below are some of the statistics of web site usage, which clearly demonstrate the importance of this web site to operational criticality safety programs.

1. More than two hundred and forty five registered users.
2. Average access rate is 22 hits/day.
3. The NCSP web site has 7,965 bibliographic entries in the Livermore database and 4,331 entries in the Hanford database.
4. The NCSP web site contains eleven training modules which have been downloaded over 2,022 times in the last nine months.
5. Over 22,456 total visitors have accessed the NCSP web site since its inception in 1998.

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.

Preserving Training and Qualification Capability

As experienced criticality safety practitioners leave the field, there are fewer opportunities for entry-level staff to participate in long-term mentor programs to gain first-hand knowledge of practical criticality safety. Also, the number of experimental

facilities where criticality safety experts can gain first-hand knowledge about the behavior of systems at or near the critical state has been drastically reduced. Both hands-on and classroom training are essential to maintaining the level of expertise needed to function as a criticality safety engineer. The Training and Qualification program element of the NCSP addresses these requirements by:

- 1) providing hands-on training courses where students actively participate in approach-to-critical experiments and see first-hand the effects of material interactions on the reactivity of various configurations;
- 2) identifying training resources, promoting the development of new training materials to supplement existing curricula and working with other organizations to quickly respond to training needs as new programs apply criticality safety to areas requiring new information.

The funding for hands-on training at Los Alamos represents a subsidy for a base level of courses consisting of 3 Three-Day Courses, 1 Five-Day Basic Course, and 1 Five-Day Advanced Course. Partial cost recovery is achieved through collection of tuition from each student (\$600 for a three-day course and \$1000 for a five-day course). Although needs are currently projected to be relatively flat, additional courses can be added in the out-years to accommodate additional needs should they arise. The NCSP management is working with the LACEF and LANL criticality safety staffs to maintain hands-on training while TA-18 is transitioned to DAF. Course content and material will require modification to accommodate limited availability of special nuclear materials, however, it is envisioned that fundamental demonstrations and training activities can still be accomplished. The NCSP is committed to make this transition as smooth as possible.

In the area of training development, Nuclear Criticality Safety Engineer Training (NCSET) modules will continue to be developed at a rate of one to two modules per year based on needs expressed by the criticality safety community. For example, in FY 2005, based on input from the criticality safety community, the NCSP is funding the development of a tutorial on Non Destructive Analysis for criticality safety engineers. This tutorial will be presented at the ANS Winter Meeting in Washington, D.C. and also placed on the NCSP web site as an NCSET module.

Table 8-1: Training and Qualification Budget, Fiscal Years 2005 – 2009

SUBTASK	FY 2005 (\$K)	FY 2006 (\$K)	FY 2007 (\$K)	FY 2008 (\$K)	FY 2009 (\$K)
1. Hands-on Training at LANL	150	140	140	180	180
2. Training Development	50	50	50	50	50
TOTAL	200	190	190	230	230

Training and Qualification Activities are a Key Part of the NCSP

The benefits to the DOE from having comprehensive criticality safety programs with well-trained staff members are significant. One benefit is an immediate increase in the efficiency of operations involving fissile materials. When doing evaluations to support the handling, storage and transportation of fissile materials, a well-trained staff will know the proper analysis techniques to use for a given situation. Above all, the proper training will instill the correct philosophy of criticality safety that will allow the practitioner to know what factors are important to criticality safety and how to develop the proper controls without being overly conservative to the point of restricting operations with no added safety benefits.

Contribution to Operational Criticality Safety

Proper training in all aspects of criticality safety is essential to safe operations. Through the hands-on training and the NCSET modules, criticality safety professionals learn that a thorough understanding of both the basic principles of criticality safety and the specific details of operations is necessary, and that interfacing with facility management, as well as the operators is fundamental to safe operations. This training is beneficial to all persons who either manage criticality safety programs or whose job functions include criticality safety responsibilities.

9. Criticality Safety Support Group 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 Nuclear Criticality Safety Program Manager, who has the responsibility for the implementation and execution of the coherent, efficient criticality safety program that is responsive to the criticality safety needs of DOE missions. The CSSG is also tasked to provide 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 also responds to requests from the NCSP Manager for information, technical reviews, and

evaluations of criticality safety issues throughout the complex. Another important activity that the CSSG is pursuing is a strategy for assuring criticality safety infrastructural critical skill needs are being met. In FY 2004, the CSSG identified three young individuals who are being mentored and brought into the CSSG. Their names are contained in Appendix A with the CSSG roster. Also in FY 2004, the CSSG began providing technical assistance to site offices. These technical assistance visits are expected to continue at a rate of about two per year. Finally, the CSSG continues to provide important input for the annual report to the Defense Nuclear Facilities Safety Board on NCSP activities and effectiveness.

10. Program Specific Applications

Integral Experiments

The Threat Response Operations Office uses Godiva for benchmarking and code development with an investment of \$225K in FY05. The weapons program at LANL uses Godiva about 10 times per year and pay as they go. This involves measuring emissions and developing radiochemistry techniques. This will probably continue in FY05 for a total of about \$50K. The weapons program also plans to fund some experiments on Flat Top, amounting to perhaps \$10K in FY05. NASA is interested in benchmark experiments for their proposed space reactor to power the Jupiter Icy Moons Orbiter. If this is supported, it could provide as much as \$300K in FY05. The United States Nuclear Regulatory Commission has expressed interest in conducting critical experiments with the MOX fuel rods. However, to date, no firm commitment exists.

ICSBEP

Program specific application is typically merged with the annual ICSBEP Working Group Meeting or publication schedule. When necessary, extra effort is made to advance program specific application 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. A collaborative effort between LANL and LLNL has been proposed to evaluate the LLNL pulsed sphere experiments. This work is also funded by NNSA. The first evaluation is scheduled for completion by FY 2005 and others will be completed over the next several years. Re-evaluation of these measurements will provide data that are needed for code and neutron cross section validation.
2. 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 (NN) 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.

3. Sandia National Laboratory, working under Nuclear Energy Research Initiative Project 99-0200, "Experimental Investigation of Burnup Credit for Safe Transport, Storage, and Disposal of Spent Nuclear Fuel", was able to complete an experiment with water-moderated U(4.31)O₂ fuel rod lattices containing the fission product rhodium. Evaluation of this experiment could not be completed in time for the 2004 ICSBEP Meeting; however, the ICSBEP is prepared to work through the independent review as soon as the completed evaluation is submitted. A second experiment involving water-moderated square-pitched U(6.93)O₂ fuel rod lattices is planned for 2005 contingent upon NE funding.

4. Continued analysis of existing data on Light Water Breeder Reactor (LWBR) Cores with ²³³U and thorium has been proposed by INEEL. This work is important because there are significant amounts of thorium in the ²³³U fuels stored at the INEEL; however, there are very little ²³³U and thorium data available. Completion of this work is contingent upon EM funding.

AROBCAD

DOE customers are benefiting from NCSP capabilities by providing additional funding. The following tasks, with their associated deliverables, have been funded by the Office of Environmental Management (EM-5):

1. Delivery of a prototypical SCALE sequence with uncertainty analysis capability using the Generalized Linear Least Squares Method (GLLSM): Completed in June 2004 (\$150K).
2. Training on AROBCAD tools has been performed for the SRS staff, for the INEEL and the Hanford criticality safety operational groups it is scheduled to be completed by October 2004 (\$125K).
3. Three SRS, INEEL and Hanford AROBCAD studies (guidance, practical training examples, and sample cases) have been interactively defined & developed during FY 2003 and FY 2004; \$50K/study x 3 studies = \$150K.

In addition to the support from EM, a National Aeronautics and Space Administration (NASA) effort to utilize the AROBCAD tools in evaluating methods and nuclear data for establishing the criticality safety aspects of space nuclear power reactor concepts was performed in FY 2003 at a funding level of \$225K. The follow-on work in FY 2004 involved the qualification of these tools, including the design of pertinent critical experiments, now being performed at TA-18. This work is a cooperative effort between NASA and DOE NE-50.

An additional activity that is utilizing the AROBCAD technology to evaluate and qualify MOX critical experiments is being performed for NA-263, the Office of International Technology. Consideration is being given to funding a series of MOX experiments at the IPPE, Obninsk critical experiments facility to support NCS evaluations for the design of plutonium disposition facilities in the US and in Russia.

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-5 beginning in June, 2003, with additional funding of \$300K in January, 2004

1. Release of SCALE 5.0: Public release in June, 2004 (\$300K).
2. Completion of the production version of AMPX and preparation of the AMPX/Evaluated Nuclear Data File, ENDF/B-VI Reference Library: The 238 group library will be released in FY 2004. AMPX release is anticipated in FY 2005. A subtask involves modifying the PUFF covariance-file software for consistency with current formats on cross-section uncertainties. (\$150K).

Nuclear Data

An additional \$300K from EM-5 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.

In FY 2004, the Office of Radioactive Waste Management initiated 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 promises to be a significant sponsorship area for both data measurements and evaluation.

Appendix A

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

NCSP Program Element Points of Contact

AROBCAD

Contractor Project Manager: Calvin Hopper
Oak Ridge National Laboratory
P.O. Box 2008
Oak Ridge, TN 37831-6370
Telephone: 865-576-8617
Facsimile: 865-576-3513
E-Mail: hoppercm@ornl.gov

Analytical Methods Development and Code Maintenance

Contractor Project Manager: R. Michael Westfall
Oak Ridge National Laboratory
P.O. Box 2008
Oak Ridge, TN 37831-6370
Telephone: 865-574-5267
Facsimile: 865-574-3527
E-Mail: rwe@ornl.gov

ICSBEP

DOE-ID Program Monitor: Adolf Garcia
United States Department of Energy
Idaho Operations Office
Idaho Falls, ID 83401-1226
Telephone: 208-526-4420
Facsimile: 208-526-7245
E-Mail: garciaas@id.doe.gov

Contractor Project Manager: J. Blair Briggs
Idaho National Engineering & Environmental Laboratory
2525 N. Fremont
P. O. Box 1625
Idaho Falls, ID 83415-3860
Telephone: 208-526-7628
Facsimile: 208-526-2930
E-Mail: bbb@inel.gov

Nuclear Data

Contractor Project Manager: R. Michael Westfall
Oak Ridge National Laboratory
P.O. Box 2008
Oak Ridge, TN 37831-6370
Telephone: 865-574-5267
Facsimile: 865-574-3527
E-Mail: rwe@ornl.gov

Integral Experiments

Contractor Project Manager: David Loaiza
Los Alamos National Laboratory
P.O. Box 1663, MS J562
Los Alamos, New Mexico 87545
Telephone: 505-667-4936
Facsimile: 505-665-1758
E-Mail: dloaiza@lanl.gov

Information Preservation and Dissemination

Contractor Project Managers: CSIRC
Shean Monahan
Los Alamos National Laboratory
P.O. Box 1663, MS F691
Los Alamos, NM 87545
Telephone: 505-665-7567
Facsimile: 505-665-4970
E-Mail: spm@lanl.gov

Web Site
Song Huang
Lawrence Livermore National Laboratory
Mail Stop L-128
7000 East Ave.
Livermore, CA
94550-9234
Telephone: 925-422-6516
Facsimile: 925-423-8204
E-Mail: huang3@llnl.gov

Training and Qualification

Contractor Project Managers: Hands-On Training
Shean Monahan
Los Alamos National Laboratory
P.O. Box 1663, MS F691
Los Alamos, NM 87545
Telephone: 505-667-7628
Facsimile: 505-665-4970
E-Mail: spm@lanl.gov

Training Development
Jim Morman
Argonne National Laboratory
9700 S. Cass Ave.
Argonne, IL 60439
Telephone: 630-252-6076
Facsimile: 630-252-4500
E-Mail: jamorman@anl.gov

Federal Qualification Program Manager Jerry McKamy
U.S. Department of Energy
EH-24
1000 Independence Ave., SW
Washington, DC 20585
Telephone: 301-903-8031
Facsimile: 301-903-4120
E-Mail: jerry.mckamy@eh.doe.gov

CSSG Members

<u>NAME</u>	<u>PHONE</u>	<u>E-MAIL ADDRESS</u>
Adolf S. Garcia	208-526-4420	garciaas@id.doe.gov
Richard E. Anderson	505-667-6912	randerson@nis6.lanl.gov
Calvin M. Hopper	423-576-8617	hoppercm@ornl.gov
Jerry McKamy	301-903-8031	jerry.mckamy@eh.doe.gov
Thomas P. McLaughlin	505-667-7628	tpm@lanl.gov
James A. Morman	630-252-6076	jamorman@anl.gov

Thomas A. Reilly	803-208-0801	thomas.reilly@srs.gov
Robert M. Westfall	423-574-5267	rwe@ornl.gov
Robert E. Wilson	303-966-9681	robert.wilson@rf.doe.gov
Hans Toffer	509-376-5230	hans_toffer@rl.gov
Ivon Fergus	301-903-6364	ivon.Fergus@oa.doe.gov

New CSSG Candidates

Fitz Trumble	803-502-9615	fitz.trumble@wsms.com
David Erickson	509-376-4146	david.erickson@fluor.com
Dave Heinrichs	925-424-5679	heinrichs1@llnl.gov
Shean Monahan	505-665-7567	spm@lanl.gov

Appendix B

Work Authorization Statements for Nuclear Criticality Safety Program Funding for Execution Year (FY 2005) Provided to NA-11 Budget Office in September 2004.

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): \$4,420K

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 (AROBCAD) Program, in accordance with the schedule and milestones set forth in the Nuclear Criticality Safety Program Five-Year Plan, dated October 2004, or as directed by the Nuclear Criticality Safety Program Manager. Funds are also provided to ORNL for 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 Nuclear Criticality Safety Program Manager at the end of each fiscal calendar quarter.

ORNL POC: Mike Westfall (865-574-5267) and Calvin Hopper (865-576-8617)
DOE POC: Mike Thompson, NNSA (301-903-5648)

Task: International Criticality Safety Benchmark Evaluation Project

Idaho National Engineering and Environmental Laboratory (INEEL): \$1,900K

Funds are provided to the INEEL to conduct the International Criticality Safety Benchmark Evaluation Project (ICSBEP) as delineated in the Nuclear Criticality Safety Program Five-Year Plan, dated October 2004, or as directed by the Nuclear Criticality Safety Program Manager. Quarterly reports on the status of all tasks shall be provided to the Nuclear Criticality Safety Program Manager at the end of each fiscal calendar quarter.

INEEL POC: Blair Briggs (208-526-7628)
DOE-ID POC: Adolf Garcia (208-526-4420)
DOE POC: Mike Thompson, NNSA (301-903-5648)

Task: Integral Experiments, Hands-On Training, Criticality Safety Information Resource Center, Analytical Methods Development and Code Maintenance, Nuclear Data Support, and Non-Destructive Analysis Training Development
Los Alamos National Laboratory (LANL): \$2,521K

Conduct nuclear criticality integral experiments, hands-on criticality safety training, Criticality Safety Information Resource Center activities, MCNP support, Nuclear Data support and non-destructive analysis training development as delineated in the Nuclear Criticality Safety Program Five-Year Plan, dated October 2004, or as directed by the Nuclear Criticality Safety Program Manager. Re-validate experiment priorities based on input from the criticality safety community and publish an updated Nuclear Criticality Experiments Priority list by July 2005. Quarterly reports on the status of all tasks shall be provided to the Nuclear Criticality Safety Program Manager at the end of each fiscal calendar quarter.

LANL POC: David Loaiza (505-667-4936), Shean Monahan (505-665-7567), Robert Little (505-665-3487), and Doug Reilly (505-664-0103)
DOE POC: Mike Thompson, NNSA (301-903-5648)

Task: Analytical Methods Development and Code Maintenance, Nuclear Data Support, Training Development, and Criticality Safety Support Group
Argonne National Laboratory (ANL): \$755K

Funds are provided to ANL to continue VIM support, including associated cross section processing codes, and Nuclear Data support as delineated in the Nuclear Criticality Safety Program (NCSP) Five-Year Plan, dated October 2004, or as directed by the Nuclear Criticality Safety Program 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 Nuclear Criticality Safety Program Manager at the end of each fiscal calendar quarter.

ANL POC: Richard McKnight (630-252-6088) and Jim Morman (630-252-6076)
DOE POC: Mike Thompson, NNSA (301-903-5648)

Task: Nuclear Criticality Safety Web Site and COG Maintenance

Lawrence Livermore National Laboratory (LLNL): \$290K

Funds are provided to LLNL to maintain the DOE Nuclear Criticality Safety Web Site and to maintain COG, including associated cross section processing codes as delineated in the Nuclear Criticality Safety Program Five-Year Plan, dated October 2004, or as directed by the Nuclear Criticality Safety Program Manager. Quarterly reports on the status of all tasks shall be provided to the Nuclear Criticality Safety Program Manager at the end of each fiscal calendar quarter.

LLNL POC: Song Huang (925-422-6516)

DOE POC: Mike Thompson, NNSA (301-903-5648)

Task: Criticality Safety Support Group

Westinghouse Safety Management Solutions (WSMS): \$25K

Funds are provided to WSMS for Criticality Safety Support Group (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.

WSMS POC: Tom Reilly (803-952-3562)

DOE POC: Mike Thompson, NNSA (301-903-5648)

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 validation and reissue 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 Nuclear Criticality Safety Program Manager at the end of each fiscal calendar quarter.

Fluor Hanford POC: Hans Toffer (509-376-5230)

DOE POC: Mike Thompson, NNSA (301-903-5648)

Task: Criticality Safety Support Group
Brookhaven National Laboratory (BNL): \$100K

Funds are provided to BNL for technical consultation to the Criticality Safety Support Group regarding all aspects of nuclear data relevant to criticality safety. 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 Nuclear Criticality Safety Program Manager at the end of each fiscal calendar quarter.

BNL POC: Charles Dunford (631-344-2804)
DOE POC: Mike Thompson, NNSA (301-903-5648)

Appendix C

Summary of Cost Recovery Activities

This section remains a work in progress. Aside from tuition charged for students who attend the hands-on training at Los Alamos, and funded program specific applications as described in Section 10, above, there is general agreement among CSSG and NCSP Task Managers that few additional cost recovery opportunities exist. However, some areas are still being evaluated. For example, the CSSG is developing policy for setting reasonable rates for time they spend reviewing and rendering opinions on issues of interest to DOE Field customers.

For the record, Los Alamos hands-on training tuition collection (at a rate of \$200/day/student) should bring in anywhere from \$42k to \$57k in FY 2005 depending on enrollment.

Appendix D

International Criticality Safety Benchmark Evaluation Project Planned Benchmarks

ICSBEP FIVE-YEAR PLAN	
ARGONNE NATIONAL LABORATORY	
IDENTIFIER	DRAFT TITLE
<i>FY-2005</i>	
HEU-COMP-FAST-005	ZPPR-20 Phase C: Space Reactor Mockup with Water Immersion Simulation
HEU-COMP-FAST-006	ZPPR-20 Phase E: Space Reactor Mockup with Earth Burial Simulation
HEU-COMP-FAST-007	ZPPR-20 Phase C: Space Reactor Mockup Reference Core
HEU-COMP-FAST-004	ZPR-3 Assembly 14: A Clean HEU (93% ²³⁵ U) Carbide Core Reflected by Depleted Uranium
IEU-MET-FAST-011	ZPR6-1 All Aluminum - 14% Enriched
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
MIX-COMP-FAST-002	ZPR-9 Assembly 29: Normal and Flooded Configurations of Mixed (Pu/U)-fueled GCFR Assembly
<i>FY-2006</i>	
PU-COMP-FAST-003	ZPR-9 Assembly 31: The Plutonium Carbide Benchmark Assembly Reflected by Depleted Uranium
IEU-COMP-FAST-003	ZPR-6 Assembly 5: A Large, Clean, Cylindrical Uranium Carbide Benchmark Assembly Reflected by Depleted Uranium
IEU-COMP-FAST-004	ZPR-3 Assembly 12: A Large, Clean, Cylindrical Uranium (21% ²³⁵ U) Carbide Benchmark Assembly Reflected by Depleted Uranium
<i>FY-2007</i>	
PU-COMP-FAST-004	ZPR-3 Assembly 48: A Clean Cylindrical Pu Carbide Core, 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
IEU-COMP-FAST-006	ZPR-3 Assembly 25: A Large, Clean, Cylindrical Uranium (9% ²³⁵ U) Carbide Benchmark Assembly Reflected by Depleted Uranium
<i>FY-2008</i>	
	To Be Determined
<i>FY-2009</i>	

	To Be Determined
<i>FY-2010</i>	
	To Be Determined

ICSBEP FIVE-YEAR PLAN	
FLOUR HANFORD / PNNL	
<i>IDENTIFIER</i>	<i>DRAFT TITLE</i>
<i>FY-2005</i>	
SUB-LEU-MET-THERM-001	Subcritical Spent Fuel for LEU Metal Tubular Fuel
SUB-MIX-COMP-THERM-001	Subcritical Waste Drums Measurements
<i>FY-2006</i>	
LEU-COMP-THERM-072	Max k_{∞} for UO_3 in Water for 1.0 w/o ^{235}U Enrichment
LEU-COMP-THERM-073	Max k_{∞} for UNH for 2.1 w/o ^{235}U Enrichment
<i>FY-2007</i>	
HEU-MET-THERM-023	Uranium, Chromium, Water Mixtures - Measurements Needed
HEU-MET-THERM-024	Uranium, Cerium, Water Mixtures - Measurements Needed
<i>FY-2008</i>	
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
<i>FY-2009</i>	
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
<i>FY-2010</i>	
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
LEU-MET-THERM-013	Graphite Moderated, Air-Cooled 305 Test Pile
LEU-MET-THERM-014	PCTR U-Th Supercells in Graphite Moderator
LEU-MET-THERM-011	HCTLTR Experiments
LEU-MET-THERM-012	PCTR Experiments with Graphite and LEU
LEU-MET-THERM-010	PCTR Experiments - Graphite Mod. 2.1 w/o Enriched LEU with Li Targets
LEU-COMP-THERM-074	Max k_{∞} for UF_4 Paraffin for 2.0 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	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 ENGINEERING AND ENVIRONMENTAL LABORATORY	
IDENTIFIER	DRAFT TITLE
<i>FY-2005</i>	
HEU-SOL-THERM-050	Unreflected Aluminum Cylindrical Vessels Containing Concentrated UO ₂ F ₂ Solutions
HEU-MET-THERM-022	Advance Test Reactor – Water Moderated High Enriched Uranium Metal Serpentine Core of Plate-Type Fuel Assemblies Reflected by Beryllium
MIX-SOL-THERM-008	U + Pu Nitrate Solution in a Raschig-ring-filled Tank
<i>FY-2006</i>	
HEU-COMP-THERM-019	Critical Experiments with BORAX-V Superheater Fuel Assemblies
IEU-COMP-THERM-006	Critical Experiments with BORAX-V Boiling and Superheater Fuel Assemblies
MIX-SOL-THERM-009	Nitrate Solutions of Depleted Uranium and Plutonium (6% ²⁴⁰ Pu) in a Water Reflected Cylindrical Tank Filled with Borated-Glass Raschig Rings
U233-COMP-THERM-002	LWBR ²³³ UO ₂ -ThO ₂ Detailed Cell Experiments -- Work For Others
U233-COMP-THERM-003	LWBR ²³³ UO ₂ -ThO ₂ BMU Experiments -- Work For Others
<i>FY-2007</i>	
PU-MET-FAST-042	Plutonium Hemishells in Oil - Part II
PU-MET-FAST-043	Plutonium Hemishells in Oil - Part III
MIX-MISC-THERM-005	UO ₂ + PuO ₂ Fuel Pins in U + Pu Nitrate Solution Containing Boron and Gadolinium
<i>FY-2008</i>	
HEU-SOL-THERM-026	Aqueous Solutions of ²³⁵ U Poisoned With Raschig Rings
IEU-COMP-THERM-007	Power Burst Facility – Water Moderated 18.5% Enriched Uranium Ternary Oxide Fuel Pin Lattice
	Others To Be Determined
<i>FY-2009</i>	
LEU-COMP-THERM-071	Loss of Fluid Test Reactor – Water Moderated Array of 4% Enriched Uranium PWR Fuel Assemblies
	Others To Be Determined
<i>FY-2010</i>	
	To Be Determined

ICSBEP FIVE-YEAR PLAN	
LOS ALAMOS NATIONAL LABORATORY	
IDENTIFIER	DRAFT TITLE
<i>FY-2005</i>	
HEU-MET-INTER-010	Z007/Z008 ZEUS (HEU) Intermediate Energy Spectrum with Aluminum (Al)
HEU-MET-INTER-011	SM1, Special Moderator HEU/Graphite
HEU-MET-THERM-015	P007/P008, Planet Waste Matrix HEU-Fe (2x2 array) 15-mil thick iron plates
MIX-MET-FAST-013	P011, Bare Pu(α) / HEU
SPEC-MET-FAST-011	NP004, Neptunium/HEU Reflected with Poly
SUB-SPEC-MET-FAST-001	SUB2, Bare and HEU Reflected ²³⁷ Np Spheres
<i>FY-2006</i>	
PU-MET-FAST-038	BRP Ball Experiments Pu/Be
HEU-MET-INTER-009	ZEUS (HEU) Intermediate Energy Spectrum with Ni-Cr-Mo-Gd Alloy
HEU-MET-INTER-012	SM2 Special Moderator HEU/D ₂ O
HEU-MET-THERM-019	PO13, Waste Matrices HEU / Zr / Poly (1x1)
SPEC-MET-FAST-010	NP003, Neptunium/HEU/Be Reflected
<i>FY-2007</i>	
PU-MET-INTER-003	SM4/SM6, Pu Reflected with Graphite and Beryllium
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 ₂ O ₃ / Poly (1x1 and 2x2)
SPEC-MET-FAST-009	NP001/NP002 Neptunium/HEU Critical (natural uranium reflected)
<i>FY-2008</i>	
PU-MET-INTER-004	SM5, Pu Reflected with D ₂ O
PU-MET-THERM-002	P022, Pu / Si / Poly (2x2)
PU-MET-THERM-003	P023, Pu / Al / Poly
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
<i>FY-2009</i>	
PU-MET-THERM-004	P024 / P025, Pu / MnO / Poly (1x1 and 2x2)
	<i>Others May Include the Following Existing Experiments</i>
SPEC-MET-FAST-005	Replacement Measurements Performed with Am-241
SPEC-MET-FAST-006	Replacement Measurements Performed with Am-243
<i>FY-2010</i>	
	To Be Determined

ICSBEP FIVE-YEAR PLAN	
LAWRENCE LIVERMORE NATIONAL LABORATORY	
IDENTIFIER	DRAFT TITLE
<i>FY-2005</i>	
PU-SOL-THERM-019 (Joint IRSN/LLNL)	Proserpine Experiments: Part I. Aqueous Plutonium Solutions Reflected by Beryllium Oxide and Graphite
HEU-MET-FAST-059 Rev 1	SPADE Experiments: Part II. BeO Moderated Oy with Interstitial Materials
HEU-SOL-THERM-046 (Joint IRSN/LLNL)	Proserpine Experiments: Part II. Aqueous Uranium Solutions Reflected by Beryllium Oxide and Graphite
Neutron-Time-of-Flight	LLNL Pulsed Spheres: Part I. Plutonium (Luisa Hansen)
<i>FY-2006</i>	
IEU-COMP-MIXED-001	U(30.14)O ₂ & Paraffin Wax: H/X=8. 16.3, 39.5, & 81.6 (35 Configurations)
IEU-MET-FAST-016	U(37.5) -- 0.125 Al Metal Parallelepipeds (13 Configurations)
IEU-SOL-THERM-002	British Spheres: U(30.45)O ₂ F ₂ Aqueous Solutions Systems
Neutron-Time-of-Flight	LLNL Pulsed Spheres: Part II. Beryllium.
<i>FY-2007</i>	
IEU-SOL-THERM-003	British 8", 12" and 16" Cylinders: U(30.45)O ₂ F ₂ Aqueous Solutions Systems
TBD	Nimbus: Part II. *Requires help with declassification of original materials.
Neutron-Time-of-Flight	LLNL Pulsed Spheres: Part III. TBD
<i>FY-2008</i>	
HEU-MET-FAST-056	Graphite – Oy – D ₂ O System (C/U: 500 – 35000)
Neutron Transmission	LLNL (Bramblett & Czirr) ²³⁵ U and ²³⁹ Pu Plate Transmission Measurements
<i>FY-2009</i>	
	To Be Determined
<i>FY-2010</i>	
	To Be Determined

ICSBEP FIVE-YEAR PLAN

OAK RIDGE NATIONAL LABORATORY

<i>IDENTIFIER</i>	<i>DRAFT TITLE</i>
<i>FY-2005</i>	
PU-SOL-THERM-018	Cooperative Analysis of Pu-Gd Solution With WSMS, EM Work For Others
LEU-COMP-THERM-068	Plexiglas, Concrete, and Steel-reflected U(4.46)3O8 with H/U=1.25
LEU-COMP-THERM-069	Plexiglas and Concrete-Reflected U(4.46)3O8 with H/U=2.05
LEU-MET-THERM-007	Libby Johnson U(4.89) Metal Rods in Water or Uranyl Fluoride Solution
U233-COMP-THERM-004	Bettis U233-Th Lattice Physics Experiments, Judd Hardy, et.al.
U233-SOL-THERM-016	Bare and Water-Reflected Solutions of ²³³ UO ₂ (NO ₃) ₂ in Cylinders-Parkey
<i>FY-2006</i>	
IEU-MET-THERM-001	Cronin U(37.5) Metal Experiments, Recently Unclassified
IEU-SOL-THERM-006	Cronin UF ₄ -CF ₂ from 0.2 to 37.5% U-235 (ORNL-2968)
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
<i>FY-2007</i>	
SUB-HEU-MET-THERM-001	Research Reactor Fuel Assemblies (MURR fuel)
SUB-HEU-SOL-THERM-002	WINCO Slab Tanks with HEU Uranyl Nitrate Solution
U233-MET-INTER-001	Critical Measurements on the ²³³ U ZPPR Plates in the LANL ZEUS Assembly
MIX-COMP-INTER-004	Cooperative Analysis of ²³⁸ U MOX Experiment with LANL
<i>FY-2008</i>	
HEU-SOL-THERM-048	HEU Uranyl Fluoride Solution (82 g U/l) in Slab Arrays (ORNL/CF-56-7-148)
LEU-MET-THERM-009	Libby Johnson U(3.85) Annular Metal Billets (7.62 cm OD)
<i>FY-2009</i>	
<i>FY-2010</i>	
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	
RPI	
IDENTIFIER	DRAFT TITLE
<i>FY-2005</i>	
LEU-COMP-THERM-078	Water-reflected 4.82% Enriched Uranium Dioxide Fuel Pins
<i>FY-2006</i>	
<i>FY-2007</i>	
<i>FY-2008</i>	
<i>FY-2009</i>	

ICSBEP FIVE-YEAR PLAN	
SANDIA NATIONAL LABORATORIES	
IDENTIFIER	DRAFT TITLE
<i>FY-2005</i>	
LEU-COMP-THERM-079	Water-Moderated U(4.31)O ₂ Fuel Rod Lattices Containing the Fission Product Rhodium
LEU-COMP-THERM-080	Water-Moderated Square-Pitched U(6.93)O ₂ Fuel Rod Lattices
<i>FY-2006</i>	
<i>FY-2007</i>	
<i>FY-2008</i>	
<i>FY-2009</i>	

ICSBEP FIVE-YEAR PLAN	
SAVANNAH RIVER (WASHINGTON SAFETY MANAGEMENT SOLUTIONS, LLC)	
IDENTIFIER	DRAFT TITLE
<i>FY-2005</i>	
PU-MET-FAST-044	Pu Metal Sphere with Different Metal+Polyethylene Reflectors (Table IIIA2 of LA-30067-MS)
HEU-COMP-INTER-007	HEU/Be Space Reactor
MIX-COMP-FAST-003	Reflected Polystyrene Moderated, Mixed Oxide Cubes
MIX-COMP-THERM-015	Reflected Polystyrene Moderated, Mixed Oxide Cubes with Fixed Poisons (SS, Borated SS, dep-U, Boral, Cd, Pb)
<i>FY-2006</i>	
SUB-HEU-MET-THERM-002	Subcritical (Exponential) SRS Fuel Assemblies (Mk XVIB and Mk XIIA)[UCNI]
SUB-LEU-MET-THERM-008	Subcritical (Exponential) SRS Fuel Assemblies (Mk V and Mk 15) 0.95 to 1.1% Enriched
<i>FY-2007</i>	
SUB-PU-MET-THERM-001	Arrays of Pu-Al alloy rods in H2O [UCNI]
	Others TBD
<i>FY-2008</i>	
	To Be Determined
<i>FY-2009</i>	
	To Be Determined

Appendix E

Nuclear Data Schedule

Organization Key: A=ANL, B=BNL, L=LANL, N=NDAG, O=ORNL

Isotope Key: U5=U-235, U3=U233, O6=O-16, Al=Al-27, Si8=Si-28, Si9=Si-29, Si0=Si-30, Cl5=Cl-35, Cl7=Cl-37, F9= F-19, K9=K-39, K1=K-41, Gd5=Gd-155, Gd7=Gd-157, H=H, N4=N-14, Be9=Be-9, U8=U-238, Mn5=Mn-55, Pu9=Pu-239, Pu0=Pu-240, Pu1=Pu-241, Nd=Nd-143, Rh=Rh-103, Sm9=Sm-149, Pu2=Pu-242, Re5=Re-185, Re7=Re-187, Fe, Ni, Cr, Cu, Ce, Ca, Sm1=Sm-151, Cs=Cs-133, Xe1=Xe-131

Activity	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009
NDAG Review , (Data Needs and Status)	Fe, Ni, Cr, Cu, Ce, Ca, Hf, Zr, Th, Nb, Er, Am, Np, N4, Be9,	Cs, Eu, Ag, Sm1,Sm9,Nd, Rh, Ru, Tc, Ti, Mo, Xe1,	He, P, S, V,Hg	TBD	TBD
Measurement	Mn5(O), Re5, Re7, Nb	Rh, Cs, Nd, Xe1, Sm1, Sm9	TBD	TBD	TBD
Evaluation	K9, K1, Mn5, Re5, Re7, Nb, (O,L,A), ?	Rh, Cs, Nd, Xe1, Sm1, Sm9	TBD	TBD	TBD
Covariance Generation (New Evaluation & Retroactive)	F9(O,L), K9, K1(O,L,A), B, C, N4, Li6, Li7, Na, Mg, Ga, Pb, Re5, Re7, Nb	Fe, Ni, Cr, Cu, Ce, Ca, Hf, Er, Th, Rh, Cs, Nd, Xe1, Sm1, Sm9 ,(O, L, A)	Am, Np, Mn5, (O, L, A)	TBD	TBD
Beta Test Libraries (RSICC)	Pu9, Pu0, Pu1, Pu2, Gd5,Gd6, Gd7,Gd8, U8, Zr (O,N)	F9, K9, K1, Re5, Re7, Nb, N4,(O, N), Hf, Er, Th, Cu, Ce, Ca, Mn5,	Rh, Cs, Nd, Xe1, Sm1, Sm9	TBD	TBD
CSEWG Testing	Cl5(B), Cl7(B), U8, Zr	F9, K9, K1, Pu9,Pu0,Pu1,Pu2, Gd5,Gd6,Gd7,Gd 8,N4,Be9, Fe, Ni, Cr, Mn5(B)	Re5,Re7,N b, Cu, Ce, Ca, (B)	TBD	TBD
ENDF/B Release	Si8, Si9 Si0, Cl5, Cl7, U8, Zr,(B)	F9, K9, K1, Mn5,Gd5, Gd6,Gd7,Gd8, Ni, Fe, Cr (B)	N4, Be9, Pu9,Pu0, Pu1,Pu2, (B)	Cu, Ce, Ca, (B),	TBD

Isotopes subject to changes in programmatic needs. TBD = To Be Determined

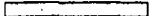



Appendix F

Planned Integral Experiments

Integral Experiments Planned for FY 2005 through FY 2009

FY 2005 (\$k) 1600	FY 2006 ^{a1} (\$k) 1800	FY 2007 ^{a2} (\$k) 1900	FY 2008 ^{a3} (\$k) 2000	FY 2009 ^{a4} (\$k) 2000
NASA Experiment Nb/HEU	Np007 HEU BARE (Planet)	NP006 Np-HEU/NU (Planet)	P029 HEU Reflected Poly (Planet)	SM5 Pu(3) D ₂ C Reflected (Comet)
NASA Experiment Re/HEU	SM1 HEU/Graphite (Comet)	P028 HEU Reflected W (Comet)	P030 HEU Reflected Steel (Comet)	
		Z008 Comet Zeus Al ² /HEU/Al ²	SM2 HEU/D ₂ O (Comet)	
		SUB3 Np-HEU Reflected W	SUB5 HEU Poly	SUB5 HEU NU Reflected
	SUB2 Np-HEU Reflected by Cu	SUB4 Pu Reflected Poly	SUB6 HEU Bare	SUB6 Np-HEU Reflected Be
SHEBA UO ₂ F ₂ Ops for NCSC	SHEBA UO ₂ F ₂ Burst Mode	SHEBA UO ₂ (NO ₃) ₂	SHEBA UO ₂ (NO ₃) ₂	SHEBA UO ₂ (NO ₃) ₂

^a Experiments to be performed at DAF.

-  Completed
 -  Initiated ongoing
 -  Experiments that will require material not currently available at LANL.
 -  Additional capital funding will be required.
- Superscript numbers ^{1,2,3} indicate first, second, and third configurations respectively. Actual configurations are unknown at this time.

Appendix G

Foreign Travel Requests

Applicable Ranges of Bounding Curves and Data

The AROBCAD Program Element will require one attendee at the annual OECD/NEA Nuclear Criticality Safety Working Group on Bounding Critical Systems meeting on an annual basis. Additionally, 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 ICNC conducted in FY 2008, requiring attendance of two to three individuals. The AROBCAD Contractor 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 and will assure the inclusion of the United States expertise in the development of these important 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, Criticality Excursions Analysis, and Experimental Needs Working Groups. Additionally, between four and six technical presentations (improved neutronics software, improved cross-section processing software, methods validation) from this work element would be made at the ICNC conducted in FY 2008, requiring attendance of four to six individuals.

International Criticality Safety Benchmark Evaluation Project

The ICSBEP is an international program involving 16 different countries and the OECD NEA. As such, annual project Working Group meetings are 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. ICSBEP Meetings to be held outside the United States during the next five years will occur in 2006, 2008, and 2010. In addition, the ICSBEP Element should support one attendee at the OECD/NEA Working Party on Nuclear Criticality Safety meeting on an annual basis where a report on ICSBEP activities is made. Additionally, between four and six technical presentations from this work element should be made at the ICNC 2007 in St. Petersburg, Russia.

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. For example, China was invited to participate in 2004 and a meeting was held in Beijing. Other current nonparticipating countries that may contribute data in the future include Germany, Canada, Poland, Czech Republic, Australia, South Africa, Argentina, and Italy.

Nuclear Data

The Nuclear Data Program Element will require three attendees at the annual OECD/NEA Working Party on Evaluation and Cooperation meetings on an annual basis. This is the major activity involving international cooperation on the development and evaluation of nuclear data. Also, there is a need for two to three nuclear data presentations at the International Conferences on Nuclear Criticality in FY 2008, requiring attendance of two to three individuals. The international forum for presentations on nuclear data is the annual series of PHYSOR reactor physics meetings. This Program Element supports participation at PHYSOR by two nuclear data specialists on an annual basis. Again, these are three laboratory activities.

Integral Experiments

The Integral Experiments Program Element will require about 5 foreign trips per year for the next five years. Annual requirements include 2 persons to the ICNC in FY 2008; 2 persons every other year to the ICSBEP meeting; 1 person per year to a technical conference on integral experiments; and 1 person per year to participate in International Standards Development activities.

Information Preservation and Dissemination

The Web Site portion of this Program Element projects 1 person traveling to the 8th ICNC in FY 2008.

Training and Qualification

No projected foreign travel.