National Nuclear Security Administration

Department of Energy
National Nuclear Security Administration
Washington, DC 20585

FEB 0 8 2006

The Honorable A. J. Eggenberger
Chairman
Defense Nuclear Facilities Safety Board
625 Indiana Avenue, N.W.
Suite 700
Washington, D.C. 20004

Dear Mr. Chairman:

In the August 7, 2003, letter closing Recommendation 97-2, *Criticality Safety*, the Defense Nuclear Facilities Safety Board established an annual reporting requirement. Enclosed is the report for Calendar Year 2005.

Overall, actions taken in response to Recommendation 97-2 have substantially improved the Department's criticality safety infrastructure and operational programs. Stable funding was provided in 2005 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. Progress was made in each of the seven technical program element areas and the foundation has been laid for a Departmental Criticality Safety Monitoring Program that will systematically review and monitor operational criticality safety programs. Expertise resident within the Criticality Safety Support Group is increasingly being applied to resolve Departmental criticality safety issues. Although the Criticality Experiments Facility project is progressing on schedule and within budget, the most significant challenge is to maintain critical experiments and hands-on training capability during the transition of these activities from Los Alamos National Laboratory to the Device Assembly Facility (DAF) in Nevada. The NCSP Manager initiated tasks to: 1) ensure participation of Los Alamos researchers in critical experiments in Russia and, 2) establish an interim hands-on training capability at Lawrence Livermore National Laboratory. These two tasks will help to minimize the impacts of the transition to the DAF.

If you have any questions, please contact me directly or have your staff contact Jerry McKamy at 301-903-3081.

Sincerely,

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

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06.0209

STATUS OF THE DEPARTMENT OF ENERGY NUCLEAR CRITICALITY SAFETY PROGRAM FOR CALENDAR YEAR 2005

1. Executive Summary

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. This report addresses the topics requested by the DNFSB albeit in a somewhat different format from previous years.

The past year was eventful for the Department of Energy (DOE) criticality safety programs and another year in which there were no criticality accidents or near-misses at any site. The Department successfully completed the TA-18 Early Move Project relative to removing all Security Category I & II nuclear materials from the Los Alamos Technical Area 18 site. Major advances were made in the refurbishment of the Oak Ridge Electron Linear Accelerator (ORELA) and it is expected to come back online early in 2006. Funding for the Nuclear Criticality Safety Program (NCSP) remained stable at about $10 million/year. A significant accomplishment was the complete re-write of the criticality safety section of DOE Order 420.1B, Facility Safety, that addresses the recommendations made in the 2000 report to the Secretary of Energy on criticality safety. The new DOE Order 420.1B substantially reflects the input from the Department's Criticality Safety Support Group (CSSG), places increased reliance upon the national consensus American National Standards Institute (ANSI) / American Nuclear Society (ANS)-8 series standards for criticality safety, and clarified the definition of double contingency. New nuclear data has been measured, new methods developed and promulgated, and a new DOE Criticality Safety Monitoring Program established.

However, amid all the progress, certain challenges and gaps remain in criticality safety programs that are now being addressed or will be in the near future. The Department continues to have federal criticality safety staffing shortages at several sites. One major DOE site, the Los Alamos National Laboratory (LANL) was found to have significant weaknesses in its criticality safety program. Due to the planned outage associated with the TA-18 Early Move of special nuclear material, the United States is now without a general purpose critical experiment capability that must be restored as soon as is practicable. The Department does not currently have the capability to provide hands-on criticality training, although several near-term measures are being considered to minimize the impacts while the critical experiments capability is transitioned to Nevada Test Site. Finally, challenges remain in standing up the DOE Criticality Safety Monitoring Program, processes for effectively tracking and trending criticality safety infractions/deficiencies at the headquarters level, and incorporating more activities into the funded NCSP that directly impact the floor level implementation of criticality safety.

The Department ensures continuous improvement in criticality safety with the ongoing advice and assistance of the criticality safety experts resident in the CSSG and the talented cadre of site office federal Criticality Safety Coordinating Team (CSCT) members working alongside the End-User Group who all support the NCSP Manager. The NCSP Manager is further supported

in the specialized area of nuclear data by the Nuclear Data Advisory Group (NDAG) who helps to identify fundamental nuclear data measurement and evaluation needs to improve the accuracy and precision of criticality safety calculations.

Overall, the NCSP established in response to DNFSB Recommendation 97-2 is serving the Department well. The Department looks forward to continuing its close collaboration with the DNFSB in ensuring that all fissile material operations continue to be performed safely and efficiently from a criticality safety perspective.

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 September 2005, can be downloaded from the NCSP website at: http://ncsc.llnl.gov/

A status of the individual program elements for calendar year 2005 is as follows:

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

Oak Ridge National Laboratory (ORNL):

- Presented eight technical papers were presented at the American Nuclear Society (ANS) 2005 Nuclear Criticality Safety Division (NCSD) Topical Meeting highlighting the value and/or applications of AROBCAD software.
- Upgraded AROBCAD capabilities have been upgraded to include the impact of the data uncertainties as applied in the advanced neutron physics models on the neutron cross sections generated with these models.
- Performed a generalized least squares analysis with the prototypic code TSURFER to predict the computational bias and uncertainty of a Jezebel-like critical experiment, without actual Jezebel experiment data, using only other Pu benchmark information.
- Participated in the Organization for Economic Cooperation and Development (OECD) Nuclear Energy Agency (NEA) Working Party on Nuclear Safety (WPNCS) Minimum Critical Values and Experimental Needs activities, including the evaluation of Russian mixed oxide (MOX) experiments for the validation of United States MOX fuel fabrication applications.
- Transmitted the completed SMORES control program software to the University of California - Berkeley to close of the "geometric optimization" option.

Overall, the AROBCAD task continues to make progress in developing AROBCAD technologies. The first generation of AROBCAD senstivity software is operational in SCALE version 5.0, the AROBCAD uncertainty software is being prepared for release in future versions of SCALE, work is proceeding on the completion of of the simultaneous forward and "pseudo-adjoint" method and on guidance for applying these methodologies in establishing subcritical

margins. A September 2010 completion date is projected for AROBCAD technology development activities.

2.b Analytical Methods Development and Code Support Accomplishments:

Argonne National Laboratory (ANL):

- Chaired the OECD/NEA Expert Group on Source Convergence.
- Completed Phase I final report of the OECD/NEA Expert Group on Source Convergence.
- Completed development and testing of PC Version of the VIM code.
- Completed and reported exhaustive comparisons of VIM and MCNP point libraries (including ENDF/B-III, -IV, -V, -VI and JEF-2.2 data).
- Processed all ENDF/B-VII beta0 and beta1 nuclear data files into VIM libraries and contributed to CSEWG validation effort for ENDF/B Version VII data.
- Implemented LAW=7 for ENDF/B File 6 data in VIM processing.
- Implemented File 7 thermal scattering data in THTAPE code for VIM libraries.
- Completed Phase 1 of VIM code conversion to Fortran 90.
- Developed, verified and documented new VIM input-to-MCNP input translator code (VIM2MCNP) for plate lattice critical experiments.
- Began upgrade and Fortran 90 conversion of BLDVIM code.
- Maintained user support, training, and consulting for VIM code, including update of VIM web site and on-line User's Guide.

Overall, ANL continues to make progress in maintaining and enhancing VIM. ANL continues to provide user support, training, and consulting for VIM; performs maintenance of VIM and VIM library processing codes; and maintains on-going inter-comparisons of VIM and MCNP libraries and results. One significant enhancement was the development of a VIM input-to-MCNP input translator code for plate lattice critical experiments.

Los Alamos National Laboratory (LANL):

- Released MCNP version 5.1.40 to the Oak Ridge Radiation Safety Information Computational Center (RSICC). This release included the following features for criticality safety analysts: fission neutron multiplicity, lethargy normalized plotting, logarithmic interpolation, stochastic geometry, and eigenvalue source entropy convergence diagnostics.
- Provided several 4-day training classes, including "Introduction to MCNP," "Criticality Calculations with MCNP," and "Advanced MCNP". A half-day criticality workshop was held at the 2005 ANS Mathematics and Computation Topical meeting.
- Added a stochastic geometry feature to MCNP5 for modeling random fuel locations for High Temperature Gas Cooled Reactors (HTGRs) was added to MCNP. Performed further research into automated detection techniques for source convergence of criticality.
- Issued LA-UR-04-8817, "Fundamentals of Monte Carlo Particle Transport." This report contains the lecture notes for a 20-hour course about Monte Carlo methods and computer codes. (350+ viewgraphs).

- Developed and updated five MCNP software process procedures: 1) Review Meeting Procedure; 2) Bug Fix Procedure; 3) New Feature Development Procedure; 4) Release Procedure; and 5) Risk Management Procedure.
- Developed and implemented, in coordination with the NCSP Manager and LANL, a structured checklist notification and alert system for notifying DOE elements and DOE contractors of code and data errors that could potentially impact criticality safety analyses discovered in the SCALE and MCNP code/cross-section packages.
- Converted the NJOY nuclear data processing code to Fortran 90 and work was begun on processing capabilities required to support covariance data. Early versions of ENDF/B-VII were processed into MCNP format for data testing.

MCNP continues to be a primary simulation tool for nuclear criticality safety analysts. In summary, calendar year 2005 saw meaningful MCNP developments that directly support the nuclear criticality safety community. As the reliance on MCNP for criticality safety applications continues to grow, it is expected that requests for additional development and support grow as well. In addition, NJOY continues to be the most widely used nuclear data processing code in the world.

ORNL:

- Developed a new version of the PUFF module for AMPX to process new ENDF/B covariance formats—support & interface with AROBCAD & Nuclear Data tasks.
- Continued development of SCALE version 5.1, including the continous-energy version of KENO and advanced AROBCAD software, testing with benchmark critical experiments and 238-group ENDF/B-VI libraries. A special session at the ANS Annual Meeting was conducted on the new features of the upcoming SCALE 5.1.
- Conducted week-long workshops on SCALE/KENO and MCNP at the laboratories and at user sites.
- Performed MCNP research on automated detection techniques for source convergence of criticality. New compiler optimization implemented into the MCNP version 5 was released through RSICC.
- Approved RSICC - site license for multiple users and posted on the web; user support was provided through the delivery of ~ 1200 code packages; also provided electronic responses to ~3000 user inquiries; published monthly newsletters to user community.
- Modernized the VIM source program and peformed extensive VIM/MCNP interlibrary comparisons on ICSBEP benchmarks.
- Prepared the Phase I final report of the OECD/NEA Expert Group on Fission Source Convergence studies.
- Participated in the development of a procedure for notifying NCSP management and the user community on software bugs.
- Participated in the November 2005 NCSP Enduser's workshop where present and future needs for code features and capabilities were identified and discussed.

Overall, the SCALE/KENO software are being maintained and enhanced. Training and user assistance are being provided. In response to user needs, new features and capabilities are being

developed. This includes capabilities for processing new releases of the ENDF/B neutron cross section data.

2.c International Criticality Safety Benchmark Evaluation Project (ICSBEP) Accomplishments:

Idahao National Laboratory (INL):

- Conducted the annual ICSBEP Meeting in New York City, May 16 – May 20, 2005. Representatives from 11 of the 17 participating countries attended, including the United States, Russia (IPPE, VNIITF, RRC KI), France (IRSN and CEA), Japan, Czech Republic, Slovenia, Poland, Brazil, Israel, Canada and India as well as a representative from the OECD NEA. A total of 44 individuals attended the meeting. First-time participants included a representative from Sandia National Laboratory (SNL) who contributed an evaluation of recent fission-product experiments that were performed at SNL under a Nuclear Energy Research Institute grant.
- Formally invited the Bhabha Atomic Research Centre (BARC), Mumbai, India; Atomic Energy of Canada Limited (AECL), Chalk River, Canada; and CNEA Centro Atomic Bariloche, Bariloche, Argentina to participate on the ICSBEP and special training meetings were held at each of their facilities. All invitees indicated their intention to contribute data from their respective facilities. India successfully contributed U-233 data from their KAMINI experiments to the ICSBEP Meeting in New York City.
- Published the September 2005 Edition of the "International Handbook of Evaluated Criticality Safety Benchmark Experiments." Included in this edition are 36 newly approved evaluations. The Handbook now contains 416 evaluations that span nearly 35,000 pages and provide benchmark specifications for 3549 critical or subcritical configurations plus 13 criticality alarm placement / shielding configurations. First-time contributors include Sandia National Laboratory, India, Poland, and the Czech Republic.

The ICSBEP is progressing well. Currently, there are 39 new evaluations in progress, including contributions from seven DOE National Laboratories or Sites. Calendar year 2006 International contributions should include several MOX benchmarks from Russia, France and Slovenia, titanium reflected/moderated benchmarks from Russia, criticality alarm type benchmarks from Russia, U-233 benchmarks from India and several other low or highly enriched uranium benchmarks from Russia, Brazil, Japan, and Slovenia. The next ICSBEP Working Group Meeting will be hosted by Brazil, May 15 – 19, 2006, in Rio de Janeiro.

2.d Nuclear Data Accomplishments:

ANL:

- Chaired the NCSP Nuclear Data Advisory Group (NDAG).
- Participated in the Cross Section Evaluation Working Group (CSEWG); chaired the CSEWG Data Validation Committee; and participated as a member of the CSEWG Executive Committee.

- Participated in the OECD/NEA Working Party on International Evaluation Cooperation (WPEC) and in WPEC Subgroup C – High Priority Nuclear Data Request List.
- Developed and tested analytical methods for improved probability density functions in the unresolved resonance region.
- Participated in developing and testing of improved methods for evaluating covariance data, including methods to produce covariance matrices for nuclear cross-sections derived from nuclear model calculations.
- Processed all ENDF/B-VII beta0 and beta1 nuclear data files into VIM libraries and contributed to the CSEWG validation effort for ENDF/B Version VII data.
- Implemented (in collaboration with Brookhaven National Laboratory) the EMPIRE code at ANL for nuclear data evaluations.
- Evaluated and published nuclear data measurements for tantalum and ^{197}Au.

ANL continues to support the NCSP nuclear data task through development of improved evaluation and processing methodologies (primarily for treatment of the resolved and unresolved resonance region and production of nuclear data covariance data). In CY2005 ANL, contributed to the processing, testing and validation of new nuclear data evaluations; assessed priority nuclear data needs for the criticality safety community; and performed leadership roles in the national and international nuclear data community.

Brookhaven National Laboratory (BNL):

- Assembled, checked and distributed a new evaluated nuclear data library, ENDF/B-VII, for extensive testing (beta1 in March 2005, beta2 in October 2005).
- Prepared new fission product evaluations for ENDF/B-VII, including 219 materials. These evaluations are either completely new or taken from other evaluated libraries, representing a massive improvement of existing ENDF/B-VI evaluations.
- Re-evaluated a set of 8 isotopes of gadolinium (Gd) (152-158, and 160), both in the resonance and fast neutron regions. Resonance data were provided to ORNL to assist them in producing updated covariance data for criticality safety. Sensitivity matrices were also produced to assist LANL in producing covariance data in the fast region.

BNL continues to provide a key linking function to the NCSP nuclear data efforts at the other three national laboratories. It is expected that in calendar year 2006 a BNL-LANL-ORNL collaboration on low fidelity covariance development will provide reasonable covariance data for use with the AROBCAD sensitivity/uncertainty software. In addition, some of the high fidelity covariance data that was developed during calendar year 2005 will be included in final release of the ENDF/B-VII library.

LANL:

- Developed U-235 fission covariance data for ENDF/B-VII, based on the International Atomic Energy Agency evaluation.
- Provided a code to ORNL that can produce ad-hoc covariance data above the resonance region for application to U-233.

- Generated new Be-9 elastic and total cross sections based on an R-matrix analysis; the resultant updated evaluation was tested for ENDF/B-VII and found to reduce a previous reflector bias problem.
- Modified Pb-208 inelastic scattering cross sections for ENDF/B-VII in support of a request from LLNL.
- Completed new Gd cross-section evaluations in collaboration with BNL. This includes covariance data in ENDF-6 format.
- Submitted all LANL modified evaluations to BNL for consideration in ENDF/B-VII.
- Conducted extensive data testing of evaluations intended for the initial release of ENDF/B-VII using benchmarks from ICSBEP, the MCNP criticality validation suite, and others. LANL worked on the evaluation of the 5th ZEUS experiment for the ICSBEP.

LANL continues to make progress on nuclear-data evaluations in the high-energy range (often in collaboration with ORNL work at lower energies), evaluation of covariance data, data testing, and participation in organizations such as NDAG and CSEWG. Recent successes from LANL have been most visible in actinide evaluations and data testing. Several long-standing problems have been resolved. The recent NCSP emphasis on covariance data is well matched to LANL strengths and capabilities. LANL also led the evaluation sub-committee of CSEWG and contributed substantially to the major new release of ENDF/B-VII, planned for summer 2006.

ORNL:

- Tested new covariance evaluations (U-233, Th-232, Gd isotopes) by processing them with the new PUFF module developed under Analytical Methods Task.
- Measurements on F-19 inelastic scattering were completed at LANCE (ORNL-LANL) and Mn-55 resonance total & capture were completed at Gelina (ORNL-EURATOM).
- The ORELA workshop presentations reaffirmed unique US capabilities of ORELA for neutron resonance measurements. An ORELA Refurbisment Program was developed and implemented in FY06; progress was made in identifying problems with the ORELA vacuum system and the fabrication of new electron guns.
- Substantial upgrades were made to the SAMMY nuclear modeling code for determining resonance-parameter covariance data, final-state reactions and resolution functions for major accelerator facilities.
- Provided SAMMY user support, including an annual international workshop and assistance to a broad user community, including DOE Office of Science Programs.
- Completed evaluations of Cl-35 and Cl-37, and began preliminary covariance data testing.
- Completed data testing of the new U-235 and U-238 evaluations, that demonstrated improved performance for high-energy systems (LANL evaluations) and thermal & intermediate energy systems (ORNL evaluations)

The ORNL continues to contribute to the multi-laboratory effort to assess user needs relative to the quality of experimental and evaluated data. These assessments include effective interfaces across the DOE data community as well as with international data evaluation efforts sponsored by the OECD Nuclear Science Committee and the International Atomic Energy Agency's Thorium

Coordinated Research Project. The NCSP Enduser's workshop in November 2005 included discussion of nuclear criticality safety data needs and recommendations that will be factored into NCSP planning.

2.e Integral Experiments Accomplishments:

LANL:

- Continued efforts to resuming critical assembly operations at TA-18.
- Developed a Staffing Strategy to ensure that personnel needs are addressed during and after transition of critical assembly operations to the Device Assembly Facility in Nevada.
- Initiated the pre-conceptual design for a replacement SHEBA critical assembly.
- Published three benchmark evaluations in the ICSBEP handbook.

Although no integral experiments were conducted during calendar year 2005, a strategy was developed for maintaining the human capital and providing TA-18 personnel with the opportunity to maintain skills associated with hands-on work on neutron multiplying systems during calendar year 2006. This strategy includes providing the opportunity for LANL experimenters to participate in critical experiments in Russia during 2006. Other options within the United States, such as low multiplication hand stacking operations at LLNL or the DAF, and sub critical measurements at the DAF, are also being considered. Finally, it is expected that a small project to relocate SHEBA to [location?] will be initiated during the Spring of 2006 with a view toward commencing operations of a new SHEBA in the early FY 2009 time frame.

2.f Information Preservation and Dissemination:

Criticality Safety Information Research Center (CSIRC) at LANL:

- Purchased a new dedicated server and the website design and content will undergo revision during 2006.
- Produced one thousand DVDs containing LA-10860, LA-10860 Reference Set, LA-12808, LA-12808 Reference Set, and LA-13638, "A Review of Criticality Accidents." Distribution was made upon request.
- Published the Rocky Flats Critical Mass History document. A limited run (20 Copies) of the 500+ page document was printed. An electronic, compressed, copy can be downloaded from the CSIRC website at http://www.csirc.net/.
- Completed the Bob Rothe review and indexing of the Rocky Flats logbooks. This resulted in the publication of "A Researcher's Guide Book to Information From the Rocky Flats Critical Mass Laboratory Now Housed at the LANL Archives in LANL Collection Number A-1996-051." An electronic version of this has been posted on the CSIRC website.

The CSRIC activity continues to acquire, preserve, and make available important criticality safety information. One important activity that will be completed in calendar year 2006 is the documentation on videotape of operational and maintenance aspect of ORELA.

LLNL NCSP Website:

- Implemented a new website design based on input from the Website Working Group to make the web page more functional and user friendly.
- Improved the NCSP bibliographical databases – expanded the Hanford database to 4853 entries and the LLNL database to 7965 entries with searchable options.
- Created a new Criticality Experiments Facility (CEF) web page for monthly progress reports and summaries.
- Released the COG computer code to RSICC that included versions for various platforms including PC/Windows, Intel/Linux, and Sun/Unix machines.
- Performed S(α,β) data testing in support of ENDF/B-VII and participated in Cross Section Processing activities for neutron transport computations.
- Vital Website Statistics to date:
  - Over 31,223 total visitors since the inception of the web site.
  - 3738 downloads of the training modules in last 9 months.
  - More than 250 registered users.
  - Averaged 28 hits per day.
  - Fended off over 1000 hackers' attempts per day.
  - Over 12,000 combined bibliographical entries in the web site data bases.
  - Contains 12 downloadable training modules.

This web site continues to be one of the cornerstones of the NCSP and provides easy access to timely information and technical data important to the criticality safety community. Monthly quality assurance is performed to update the information and facilitate dissemination of the data to the users community. The web site also provides high-level links to other web sites to facilitate communication among various criticality safety practitioners.

Hanford Data Base:

- Screened and categorized all the common 2005 references such as the ones in ANS publications, in the 2005 Topical meeting, and in International Conference on Nuclear Criticality 2004.
- Screened additional past references from foreign journals and site-specific documentation.
- Modified the database to permit processing strings of search elements.
- Posted several updates of the database on the LLNL NCSP website.
- Presented a paper on the Hanford Database at the 2005 Topical Meeting on Criticality Safety.

As of January of 2006 the task is progressing on schedule. Current references are screened as they become available. Screening the ICSBEP database for parameter studies was initiated. Reviews of foreign journals and site specific documentation is continuing. Acquisition of hardware that permits improved searching capabilities is in progress.

ARH-600

- Installed an electronic hypertext version of ARH-600 on the LLNL NCSP website. An updated version, with additional features, has been prepared and will be installed in 2006.
- Performed extensive calculations using SCALE/KENO and MCNP.
- Completed a revision to the CritView application to allow displaying of enrichment data among other features. Work is continuing on the CritView application to incorporate additional primary features and currently implemented test version feature upgrades.
- Entered additional data into the master database for CritView.
- Continued programming for a more automated CritView database.
- Presented a poster session at the 2005 Criticality Safety Topical Meeting that generated a lot of interest and resulted in a best paper award.
- Users of ARH-600 volunteered to provide additional data for the new computerized version of ARH-600.

As of January of 2006 the task is progressing on schedule. The new computerized ARH-600 should be available for testing FY 2007 and a final verified version with descriptive materials is scheduled to be in service by FY 2009.

2.g Training and Qualification Accomplishments:

Hands-On Training

- Transferred a set of the class notes to a portable document file for electronic publication. In addition, a copy of the notes was put through an optical character recognition process and converted to Microsoft WORD format.
- Conducted a compressed version of the 3-day class at LANL on June 28th and 29th. The class had six participants, three DOE interns and three LANL personnel. The class was restricted to lectures and a tour of PF-4 only. No experiments were conducted. The class was well received and was valuable in determining appropriate content and material presentation order for possible future lecture only classes.

Classes are on hold pending establishment of suitable operations/experimental location. Events at LANL made it problematic to re-establish a hands-on training capability there in CY06 as originally planned in the 2005 Five Year Plan. This was due to the LASO pause, the LANL contract changeover, increasing costs associated with TA-18 operations, and the resource constraints on the LANL criticality safety group following the LANL criticality safety assessment. The NCSP Manager is working with LLNL to establish a hands-on criticality safety training course utilizing pre-existing uranium parts specifically designed for criticality safety training. The priority will be to establish the level of training needed for training and qualifying criticality safety engineers to DOE-STD-1135-99. Funding has been provided to LLNL and a LLNL management team assigned to establish this course. The CSSG will be actively involved

in development of the syllabus and curriculum for the course. The goal is to begin offering this training in the summer of 2006 at LLNL. It is anticipated that this interim hands-on training will be utilized to fill the void during the years until CEF becomes operational.

The NCSP Manager tasked ORNL with providing an initial proposal to redesign a comprehensive training program beginning in FY07 that will utilize the expertise resident at ORNL and the University of Tennessee facilities that are available long-term at ORNL and Y-12, LANL and the CEF at DAF when it becomes operational. This proposal will be considered by the NCSP Manager and the CSSG at the March 2006 NCSP Review Meeting in Las Vegas.

Training Development

- Completed a draft Nuclear Criticality Safety Engineer Training (NCSET) module on "Cross Section Development, Selection and Use" and it is still undergoing technical review and refinement.
- Posted a PowerPoint presentation from the "Non-Destructive Analysis Applications to Nuclear Criticality Safety" workshop on the NCSP web site. Conversion of this material to NCSET module HTML format is approximately one-third complete.
- Compiled information for a NCSET module entitled "Hand Calculation Methods Part 2" and the authors have been selected. An outline and plan for the module was developed and work on NCSET module will commence in 2006.
- Solicited ideas for a Criticality Safety and Accident Simulator in a break-out group at the end-users workshop following the November ANS meeting. A proposal was developed for a proof-of-principle virtual simulator and submitted for consideration in FY 2007 budget.

3. NCSP funding

NCSP funding has been stabilized and the program continues to receive adequate financial support from Defense Programs to execute program task elements focused on maintaining criticality safety capability. Table ES-1 of the NCSP Five-Year Plan (included below) contains the planned funding levels for FY 2006 through FY 2010. This level of funding is adequate for maintaining capability in NCSP program task elements and addressing identified requirements. Defense Programs is committed to continue providing adequate support for the NCSP.

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

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

The Criticality Experiments Facility (CEF) Project was initiated in 2004 to relocate the Los Alamos Critical Experiments Facility activities to the Device Assembly Facility (DAF) at the Nevada Test Site. The project received an Approval of the Performance Baseline (Critical Decision 2) on December 2, 2005 and is scheduled for completion in late calendar year 2009. The approved baseline of $145,202,926 for the CEF Project is provided through a Congressional Line Item construction account. According to the Critical Decision 2 memorandum, the high level scope of the project includes:

1. Modifications of part of the unoccupied portion of the Device Assembly Facility to:
    a. accommodate the installation of four critical assembly machines that will be transferred from LANL TA-18 to the DAF (Planet, Comet, Flattop and Godiva);

b. provide office space and a 60 seat conference room;
c. provide two vault rooms for storage of nuclear materials; and,
d. provide two control rooms.

2. Disassembly and decontamination of the four critical assembly machines; transporting and re-assembling them at the DAF; and
3. Modifying the entry guard station to accommodate additional personnel during construction (This activity has already been completed).

Thus far, the CEF project is proceeding on schedule and within budget. The 60% final design review was conducted in December 2005 and the 90% final design review is scheduled for March 2006. Construction on the DAF is scheduled to begin in the Fall of 2006.

5. Summary of Criticality Safety Support Group (CSSG) Activities and Reviews

The CSSG performed several specific reviews and activities during 2005 at the direction of the NCSP Manager as well as other tasks taken on individually or collectively by CSSG members. The formal activities included holding four major meetings, providing deliverables for four formal taskings, and supporting a major site review at the Los Alamos National Laboratory. Other CSSG activities undertaken at the request of other DOE entities involved CSSG members performing site assistance reviews usually to a specified scope and to produce a particular deliverable.

The four meetings of the CSSG included the two meetings held in conjunction with the June and November meetings of the American Nuclear Society. The other two meetings are annual meetings called by the NCSP Manager to provide CSSG expertise in the development and execution of the NCSP tasks that are described in the Five Year Plan. The CSSG provided review and validation of the prioritization of the FY 2006 NCSP Task Proposals at the March meeting in Nevada. The CSSG provided the NCSP Manager with input regarding final execution plans for the funded FY 2006 Tasks at the September meeting held in Oak Ridge just ahead of the Nuclear Criticality Safety Division Topical Meeting.

The NCSP Manager issued four formal taskings to the CSSG in 2005. These entailed: 1) providing a recommendation on the tracking and trending of criticality safety infractions and deficiencies; 2) reviewing the most recent working draft of the revision to DOE-STD-3007 (version 3d); 3) review of the Hanford Demonstration Bulk Vitrification System (DBVS) Supplemental Treatment Criticality Safety Basis; and 4) providing a recommendation on criticality accident alarm system (CAAS) installation at the Device Assembly Facility. The input from the first tasking was folded into the DOE Monitoring Program for criticality safety programs discussed further below. Tasking 3 was initiated at the request of the DOE Richland Site Office. The CSSG recommendation on the placement of CAAS at the DAF supporting the CEF project was very helpful to LLNL in formulating their position on CAAS requirements.

CSSG members participated in several site assistance visits at the request of various Departmental Elements throughout the year. These include criticality safety reviews at the

Portsmouth Gaseous Diffusion Plant (GDP), Waste Isolation Pilot Plant (WIPP), Hanford PFP, and Idaho. Utilization of the CSSG in this manner has proven to be very beneficial and will undoubtedly increase as the word spreads on the quality of CSSG support.

6. NCSP Feedback and Improvement Initiatives

For several years the NCSP has hosted a full day working session at the end of the two major American Nuclear Society (ANS) meetings to foster feedback and dialog between the criticality safety community, the CSSG, and the NCSP manager. At the November 2005 Winter Meeting of the ANS the structure of this activity was substantially altered to enhance the dialog between the user community and the NCSP service providers. It was restructured under the leadership of the End-User Group Chair working with the NCSP Manager to be a NCSP focus group with specific topics. The purpose was to solicit 'customer' feedback on the specific 'product lines' of the NCSP and to identify new initiatives for consideration for inclusion in the NCSP. Some of these directly address the DNFSB comment in its letter to the Department responding to the last annual report that the criticality safety community should increase emphasis on improving the nexus where technology and criticality controls meet on the operating floor. For example, there are End-User focus groups chartered specifically to look at material/inventory control improvements, tracking/trending of infractions, reducing infractions during material movement, and improving criticality safety training. The report of the results from this first ever NCSP focus group can be downloaded from the NCSP website at: http://ncsc.llnl.gov/.

7. Establishment of the Headquarters Criticality Safety Monitoring Program

The Department worked to develop an overarching, comprehensive DOE Criticality Safety Monitoring Program (CSMP) for criticality safety programs at all sites. The NCSP Manager leads this program in close coordination and cooperation with the two Chiefs of Nuclear Safety and other Departmental Elements (e.g. EM and the CSCT). The DNFSB requested a briefing on the Department's plans for this activity and was subsequently briefed on October 11, 2005. The briefing materials provided to the DNFSB can be downloaded from the NCSP website at: http://ncsc.llnl.gov/. A summary discussion of activities conducted in 2005 under the auspices of the DOE CSMP is also included below.

The DOE CSMP is multifaceted and comprehensive. The purpose is to leverage and apply the Department's criticality expertise resident in the CSSG and the CSCT throughout the complex. The strategy is to perform baseline, focused reviews of priority sites using small CSSG/CSCT teams, augment the planned Chief of Nuclear Safety reviews with CSSG/CSCT expertise, conduct annual CSSG reviews of all criticality safety infractions/deficiencies at the priority sites and promulgate applicable lessons learned, and continuously monitor the state of criticality safety programs at all sites via CSCT monthly meetings/calls using criticality safety performance metrics as one set of tools for accomplishing this monitoring.

7.a Monitoring Activities in 2005

The DOE CSMP performed some initial activities in 2005. The Livermore and Nevada Site Offices and the LANL criticality safety program were reviewed under the auspices and protocols of the program. The Chiefs of Defense Nuclear Safety, augmented by the CSCT member from the DOE Livermore Site Office performed a review of the Nevada Site Office and found an inadequate site office criticality safety oversight/assessment function (similarly for most safety oversight programs) and the absence of a qualified criticality safety subject matter expert. The review of the LANL criticality safety program was requested by both LANL Management and the Los Alamos Site Office and was more comprehensive than just a baseline review. Therefore, a large team performed a comprehensive review of the entire program to ensure compliance with ANSI/ANS-8.19. The LANL Nuclear Criticality Safety Review report can be downloaded from the NCSP website at: http://ncsc.llnl.gov/. An excerpt from the Executive Summary follows.

> *LANL has an expert-based system that is highly dependent upon the knowledge, experience and diligence of staff that function largely without benefit of complete documentation or formal processes. Based on interviews, the Team believes LANL Management understands that this informal operating and criticality safety basis posture is unacceptable because criticality safety cannot be objectively demonstrated or maintained solely by the processes that are now in place. Neither LANL line management nor the National Nuclear Security Administration currently has a complete, rigorous, and demonstrable basis for concluding that the risk of a criticality accident is adequately controlled. In many cases the team found it hard to comment on documents or programs because they do not exist. There are instances where one or more of the following deficiencies were noted: criticality safety evaluations could not be found; the analysis of some credible process upsets are not addressed in criticality safety evaluations; not all criticality safety controls are identified in some evaluations and operating procedures; configuration management control is absent for passive and active engineered controls; as-built drawings for process equipment do not exist; and, key safety and operations personnel were found not to be knowledgeable of potential credible process upsets or important safety controls for certain systems.* ***The team generated three Safety Recommendations that should be implemented as soon as possible, but no later than three months, from the issuance of this report in order to constitute the foundation for a formal criticality safety basis for ongoing operations.***
>
> *This report documents fourteen (14) Findings, three (3) Safety Recommendations, sixteen (16) Recommendations, thirteen (13) Opportunities for Improvement, and two (2) Noteworthy Practices. The actions identified in this report are essential to provide an objective basis for criticality safety risk acceptance at LANL.*

In addition to standing up this initiative, major efforts went into developing DOE Order 420.1B with the complete revision to the criticality safety section, Section 4.3. The Order was re-written and issued in December 2005. This completes one of the longstanding recommendations from the 2000 Report to the Secretary of Energy on Criticality Safety and substantially implements the CSSG vision for the criticality section of the Order. Major improvements are the substantial

reliance on the ANSI/ANS-8 Series of criticality safety standards without modification, removal of extraneous and confusing language, and restoration of the definition of double contingency to that originally meant in ANSI/ANS-8.1.

Significant time was also invested in a complete revision to the Department's criticality safety evaluation standard, DOE-STD-3007. The thrust of this revision is to successfully merge criticality safety practices into the documented safety analysis and safety basis process seamlessly. The NCSP Manager has comments in hand from the CSCT, CSSG, and End-User Group on this version of the draft and it is anticipated that once these comments are addressed and one more review is made by the 3007 writing team and the CSSG that the standard will go into RevCom for final review and approval. This should occur in CY 2006.

7.a(1) Contractor Criticality Safety Staffing, Training and Qualification

The DNFSB requires that the NCSP report on contractor criticality safety staffing, training and qualification status annually as part of this report. The NCSP Manager issued a data call to the End-User Group, which provided the information in Tables 1 and 2.

In addition to the data call, criticality safety staffing levels at LANL were reviewed independently as part of the kickoff program review of the CSMP. The Review Team (Team) found that the LANL nuclear criticality safety group is significantly understaffed. The Team recommended that approximately five to eight additional criticality safety engineers are needed at LANL. In addition, the Team recommended changes in the LANL criticality safety officer program to reflect best practices implemented at Y-12 and Hanford.

The areas of contractor criticality safety staffing, training, and qualification will continue to be part of the criticality safety reviews conducted under the CSMP and in the oversight reviews by the CDNS. Information to be provided in future criticality safety annual reports will come from these reviews. Over time as the CSMP matures, this will provide more insight into the adequacy of contractor staffing levels as demonstrated by the LANL review.

TABLE 1 – CONTRACTOR PERMANENT CSE STAFFING AND QUALIFICATION

Site/Contractor	Number 1135 Qualified	Number in Training	Additional Needed	Open positions	Number of CSE Staff Needing LANL Class	Comments/Plans/ Interim Comp Measures
Idaho Closure Project (ICP)	6	0	0	0	0	After ANL/INL realignment. Includes 3 permanent CSE staff plus 3 subcontractor staff, all qualified.
LLNL (Univ. of California)	9	1	1	1		LLNL staffing levels are largely in response to program needs. One staff member hired this year is in training. One staff member needed for increasing NTS support.
Hanford (Fluor)	16	2	2	2	1	D&D projects cause temporary surges that are met using qualified subcontractors.
Hanford (CH2M Hill)	0	0	0	0	0	Fluor provides CSE support.
INL (Battelle Energy Alliance, BEA)	8	0	0	0		After ANL/INL realignment.
LANL (Univ. of California)	8	0	see text 7.a(1)	see text 7.a(1)		see text 7.a(1)
SNL (Lockheed Martin)	5	0	0	0	0	CSE duties are collateral at SNL; no one is a full-time CSE. Two qualified subcontractor CSEs support the three qualified SNL CSEs.
Pantex (BWXT Pantex)	2	0	0	0		
RFETS (Kaiser-Hill)	N/A	N/A	N/A	N/A		Site closed.
Y-12 (BWXT Y-12)	28	3	6	6	3	Qualified subcontractors are used to meet resource shortfalls. Staffing plan approved for six additional positions. 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)	N/A	N/A	N/A	N/A		ETTP 3 Bldg. D&D Project complete and no fissile operations exist.
ETTP/Ports/Pad (BJC and its major subs)	19	0	0	0		16 CSEs at ETTP, 3 CSEs at Paducah. 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	0	0	1	The 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)	16	2	3	3	4	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.
Oak Ridge (WSMS)	9	1	1	1	1	

TABLE 2 – CONTRACTOR CSO STAFFING

Site/Contractor	Number Of CSOs	Additional CSOs Needed	Open positions	Comments/Plans/ Interim Comp Measures
Idaho Closure Project (ICP)	N/A	N/A	N/A	
LLNL (Univ. of California)	14	0	0	LLNL's CSOs are program supervisors who are responsible for implementation of NCS controls for their own program.
Hanford (Fluor)	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.
Hanford (CH2M Hill)	2	0	0	
INL (Battelle Energy Alliance)	16	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)	N/A	N/A	N/A	
RFETS (Kaiser-Hill)	0	0	0	Site closed in 2005.
Y-12 (BWXT Y-12)	4	0	0	
ETTP (BNFL)	N/A	N/A	N/A	Site closed.
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	
Oak Ridge (WSMS)	N/A	N/A	N/A	

7.a(2) Federal Criticality Safety Staffing, Training and Qualification

Under the Department's Implementation Plan for 2004-1, a DOE Sponsor and two alternates for criticality safety were identified to be actively involved in training and qualification of DOE criticality safety staff. The Deputy Secretary formally promulgated his expectations for involvement of these individuals in training and qualification processes in his memorandum of December 6, 2005, "Involvement of Highly-Qualified and Experienced Personnel in the Qualification of Others in the Department of Energy." The DOE Sponsor for Criticality Safety has implemented this process for one individual at the NNSA Service Center in Albuquerque whereby the candidate provided written statements/answers for all the DOE-STD-1135-99 competencies that were reviewed as part of the individual's qualification process.

Two independent reviews of DOE criticality safety programs revealed significant deficiencies in two site offices. The Chief of Defense Nuclear Safety staff, augmented by the Livermore Site Office (LSO) CSCT member as part of the CSMP process, conducted the biennial review of the Nevada Site Office (NSO). They found that NSO did not have a qualified criticality safety staff member and that their oversight program for criticality safety was inadequate. The second site office with the same situation was the Los Alamos Site Office (LASO) that was reviewed as part of the Operational Readiness Review for the startup of the LANL TA-55 Secure Safe Transport storage facility. Subsequently, both the NSO and LASO announced criticality safety vacancies on their staff. Until their new positions are filled, both offices are relying upon technical support from the NNSA Service Center and from NNSA Headquarters.

NNSA Headquarters performed an assessment of the LSO criticality safety program as part of the LSO self-assessment program. The review found that the LSO oversight program meets all expectations (e.g. those issued at the 1999 Criticality Safety Self-Improvement Workshop and subsequently by the Deputy Secretary as part of the DOE criticality safety self-improvement initiative.). The LSO criticality safety staff member is fully qualified to DOE-STD-1173-2002 and recently earned a M.S. in Nuclear Engineering with a criticality safety emphasis.

The NNSA Y-12 Site Office (YSO) partially addressed their longstanding staffing shortfall by hiring a full-time subcontractor to augment the fully qualified DOE staff member. The YSO now has two full time equivalent (FTE) staff members providing criticality safety oversight at Y-12. YSO is approximately 0.5 FTE understaffed at this point.

Staffing and qualification levels remained status-quo from 2004 at the Office of Environmental Management (EM) Headquarters (1), the Office of Nuclear Energy-Idaho (NE-ID) (1), the Chicago Site Office (1), the Richland Site Office (1), and the Oak Ridge Site Office (2). Richland provides criticality safety oversight support to the Office of River Protection. Likewise, the Oak Ridge Site Office provides criticality safety oversight support to the Lexington Office of EM that oversees Paducah and Portsmouth.

Finally, two qualified DOE staff members at the Savannah River Operations Office (SR) left criticality safety during 2005, leaving only one qualified staff member providing criticality safety oversight. One FTE is likely not adequate for a large site like Savannah River. The DOE

Headquarters criticality safety review at Savannah River planned for the first quarter of CY 2006 will assess the state of the SR criticality safety oversight program and DOE staffing levels.

7.b Schedule of Planned Site Reviews

The CSMP calls for baseline reviews of priority sites. The tentative schedule for performing these baseline reviews is listed below.

- Savannah River/SR: 1st Qtr CY 2006
- Idaho National Laboratory (INL) (not a 'priority site' but requested by NE-ID): 2nd Qtr CY 2006
- YSO only (by site request): 2nd Qtr CY 2006
- Hanford/RL: 3rd Qtr CY 2006
- Sandia National Laboratories / Sandia Site Office: 3rd Qtr CY 2006
- Bechtel Jacobs Corporation / Oak Ridge Site Office (ETTP): 4th Qtr CY 2006
- Y-12 (contractor only): 1st Qtr CY 2007
- Portsmouth GDP/Lexington-ORO: 2nd Qtr CY 2007
- Hanford / Office of River Protection: 3rd Qtr CY 2007

Execution of this schedule as proposed is highly dependent upon the availability of CSSG and CSCT members, securing adequate funding sources from various DOE elements, and emergent events that may place priorities elsewhere (e.g. for-cause reviews). The first three in the queue have defined paths forward. Dr. Bob Wilson of EM Headquarters is the Team Leader for the Savannah River/SR review and expects his three-person team to spend two weeks at the site in the late February and early March time frame. The INL review and the YSO review rely substantially on DOE CSSG expertise and so will be relatively simpler to accomplish.

7.c Remaining Steps for Full Implementation and Challenges for 2006

Listed below in no particular order are various challenges, self-identified weaknesses, and steps needed to fully implement the CSMP, to improve the NCSP and criticality safety that the NCSP Manager will emphasize CY 2006.

- Formalization of the DOE CSMP to get formal concurrence from DOE Elements (Line Management, Chief of Defense Nuclear Safety, ESE Chief of Nuclear Safety, and the two Central Technical Authorities)
- Work with OECM/NA-50 to formally require CSSG reviews in the design process under the DOE Order 413.3 framework. The NCSP Manager and CSSG will support the Chiefs of Nuclear Safety relative to incorporating CSSG criticality safety reviews as part of the analyses to support critical decisions for relevant projects.
- Funding challenges relative to executing non-NNSA baseline site reviews.
- Maintaining Critical Experimenter Qualification and Proficiency
- Establishing Hands-On Criticality Safety Training Courses
- Following Up on End-User Focus Group Recommendations

- Implementing the CSCT monitoring activity of the program
- Keeping CEF on course
- Long term planning for hands-on criticality safety training
- U.S. (LANL) participation in Russian critical experiments
- Development and implementation of criticality safety performance metrics
- Development of a DOE Standard for DOE Site Office Criticality Safety Oversight Programs
- Completion of DOE-STD-3007 major revision
- Tracking and trending of crit infractions/deficiencies; annual CSSG reviews
- Improved methods for promulgating lessons learned