Department of Energy
National Nuclear Security Administration
Washington, DC 20585

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APR 16 2002

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:

The Implementation Plan for Defense Nuclear Facilities Safety Board Recommendation 97-2, *Criticality Safety*, requires quarterly status reports. Enclosed is the Department of Energy's quarterly status report for the first and second quarters of Fiscal Year 2002.

The Implementation Plan contains 30 milestones, all of which have now been completed. Although all commitments have now been met, stability of funding for the Nuclear Criticality Safety Program has been an ongoing concern. The Department has made substantial progress in addressing this issue. The funding shortfall in Fiscal Year 2002 has been restored, but the funding process has clearly not been stable or reliable. Accordingly, Defense Programs has decided to fully fund and manage the Nuclear Criticality Safety Program for Fiscal Year 2003 and beyond. This is a significant departure from the shared funding approach that has been used with limited success over the past few years. I believe this new approach will provide better overall program management and a reasonable degree of funding stability. This program and its funding requirements will be defined in the Readiness and Technical Base and Facilities portion of the National Nuclear Security Administration's annual budget request.

Sincerely,

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

Enclosure

cc (w/encl):
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QUARTERLY STATUS OF THE IMPLEMENTATION PLAN FOR DEFENSE NUCLEAR FACILITIES SAFETY BOARD RECOMMENDATION 97-2 FIRST AND SECOND QUARTERS OF FISCAL YEAR 2002

The Department of Energy (DOE) began implementing Defense Nuclear Facilities Safety Board (DNFSB) Recommendation 97-2 in January 1998 by formally establishing the Nuclear Criticality Safety Program (NCSP). Each of the seven NCSP Tasks (Critical Experiments, Benchmarking, Analytical Methods, Nuclear Data, Training and Qualification, Information Preservation and Dissemination, and Applicable Ranges of Bounding Curves and Data) is dependent upon the others for a successful program. The NCSP is being conducted according to the Five-Year NCSP Plan which was updated in September 2001.

The Nuclear Criticality Safety Program Management Team (NCSPMT) and the Criticality Safety Support Group (CSSG) are performing their respective chartered functions in supporting the Responsible Manager's execution of the Implementation Plan. During the first and second quarters of Fiscal Year (FY) 2002, the NCSPMT and CSSG provided justification necessary for maintaining and institutionalizing funding support for the program, and continued to work with the Office of Environment, Safety and Health to resolve issues raised in CSSG comments on the Departmental Guides for 10 CFR 830, *Nuclear Safety*.

Because all 30 of the Recommendation 97-2 milestones are completed, this report will focus on the status of activities for each of the seven NCSP elements. Steady progress is being made in all seven of the NCSP task areas. Accomplishments and key issues in each of the program task areas which arose during the period are contained in the following sections of the report.

Critical Experiments

The following is a summary of experimental activities conducted at the Los Alamos Critical Experiments Facility (LACEF) during the first and second quarters, FY 2002.

Experiments were conducted on three of the five LACEF assemblies during this period in support of the NCSP. In addition to performing these experiments, three criticality safety courses were also provided.

Flattop: Flattop was inoperable for this entire period. The newly redesigned control rod drive system has been installed and appears to be functioning properly. An interlock that was identified as missing during an authorization basis cross walk performed in 2000 is being installed. Once the interlock is installed and a readiness assessment is completed, Flattop will be restarted. It should be noted that in addition to addressing the safety issues, post September 11 security issues have been raised and must also be addressed prior to restart. These security issues are also being addressed.

Comet/Zeus: This was a very aggressive and successful period for the Zeus series of experiments. Three complete restacks of the Zeus core were completed: 2 graphite/fuel/2 graphite, 1 graphite/fuel/1 graphite, and the all fuel (all oralloy) configurations. Each core configuration was thoroughly evaluated including performing Ross-α and neutron spectral measurements. Multiple series of replacement measurements were performed on the all oralloy configuration. Preparations are now under way for the next series of Zeus experiments which will include iron as the interstitial material. Experiment design calculations are being performed, and the raw materials for the experiment are being procured.

SHEBA: SHEBA remains inoperable as a result of failure of the cover gas system. It was discovered that the cover gas system, which is designed to sweep out the radiolytic gasses and pass them through the catalytic recombiner, was not performing at full capacity. This resulted in an Unusual Occurrence and termination of SHEBA operations. Repair of the cover gas system continues. A Potentially Inadequate Safety Analysis positive Unreviewed Safety Question Determination (USQD) was submitted to DOE. Once approval is received, the system will be repaired and the assembly will be restarted. It is anticipated that restart will occur in approximately 4 months.

Godiva: The Godiva assembly remains operational. Fourteen Godiva operations were performed this period in support of criticality safety courses, operator training, and neutron dosimetry/shielding measurements for the Technical Area (TA)-18 Mission Relocation Study.

Planet: The Planet assembly was operable for the first part of the period. Operations were performed in support of 97-2 experimental activities and operator training. Experimental activities included a Magnesium Oxide experiment, two Gadolinium experiments, and various tests of the new 2 x 2 core configuration. A significant amount of work also continues to be put forth documenting the results of these activities for the International Criticality Safety Benchmark Evaluation Project. The new Critical Assembly Storage Area 1 cable run was also completed during the first quarter of FY 2002. The Planet control system failed in January of 2002. A new, modern Allen-Bradley control system is being designed to replace the old system. Thus far, the requirements document, design document, test plan, software Quality Assurance plan, and the USQD for replacement have all been completed. It is anticipated that the new system will be installed within the next 4 weeks, and Planet will be operational within the next eight weeks.

Other Significant Events

The events of September 11, 2001, continue to have a significant impact on programmatic activities at TA-18. Security enhancements continue to impact programmatic activities. The LACEF staff will continue to work with DOE and Los Alamos security staffs to find ways to satisfy enhanced security requirements while minimizing impacts to programmatic activities.

Benchmarking

The International Criticality Safety Benchmark Evaluation Project (ICSBEP) was invited to hold the next Working Group Meeting in the United Kingdom (UK). The invitation came from UK Minister of Transport, John Spellar, to the U.S. Secretary of Energy, Spencer Abraham. The meeting will be held Monday, June 17 through Friday, June 21, 2002, in London, United Kingdom. Friday, June 21 will be devoted to a tour of some of the experimental facilities at Aldermaston. Essentially all arrangements for this meeting were completed during the second quarter of FY 2002.

ICSBEP participants focused on new evaluations during the first two quarters of FY 2002. There are currently 40 evaluations in progress of which 26 are expected to be ready for review by the ICSBEP Working Group at the next meeting. Evaluations planned for the FY 2002 publication include three evaluations from Argonne National Laboratory, five evaluations from the Los Alamos National Laboratory (LANL), one evaluation from the Oak Ridge National Laboratory, one evaluation from the Oak Ridge Y-12 Plant (an unfunded contribution), three evaluations from Westinghouse Safety Management Solutions, three evaluations from the Idaho National Engineering and Environmental Laboratory (INEEL), nine evaluations from outside the United States, and one joint INEEL /Russian evaluation. In addition, two previously published evaluations are being revised to include additional configurations, one from the Lawrence Livermore National Laboratory and one from LANL. All participating United States National Laboratories are assisting with independent reviews as well as several different countries (United Kingdom, Spain, Israel, Russian Federation, France, Korea, and Japan).

Eleven requests for specific experiment evaluations have been received from the criticality safety community. Four of the evaluations that are in progress for FY 2002 are in response to these requests and will be complete for publication in 2002. ICSBEP participants from France are seeking information on two of the other requests, and the remaining requested experiment evaluations will be completed as soon as possible. The ICSBEP will continue to try to fill such requests from within its allocated resources, however, additional funding provided by the requestor would assure high priority for the request.

The ICSBEP and the Organization for Economic Cooperation and Development - Nuclear Energy Agency (OECD-NEA) initiated two new collaborative efforts during the first half of FY 2002, and a third was initiated between the ICSBEP and the International Science and Technology Center (ISTC):

1. An effort is being made to get three students from France to help accelerate the efforts of ICSBEP. This work will be jointly funded by the French Institute, the OECD-NEA, and the ICSBEP. Two of the students will be assigned to work for six months at the Argonne National Laboratory. The third student will work at an institute in France. It is expected that each student will produce at least one evaluation.

2. An effort is being made to enhance the information provided in the ICSBEP Database, DICE. This database has greatly improved the user's ability to identify and characterize the information contained in the ICSBEP Handbook.

3. An effort is being made to generate sensitivity coefficients and correlation matrices for all of the experiments published in the 2001 Edition of the ICSBEP Handbook. This work is being carried out under ISTC Project 815 and is funded jointly by the United States Department of State and the ICSBEP.

Three presentations on the work of the ICSBEP were given during the first quarter of FY 2002. First, an invited paper entitled, "The Activities of the International Criticality Safety Benchmark Evaluation Project" was presented at the "International Conference on Nuclear Data for Science and Technology," ND2001. Copies of the "International Handbook of Evaluated Criticality Safety Benchmark Experiments" were distributed to interested conference participants at the OECD-NEA display booth. Second, a presentation focused on the ICSBEP efforts planned for FY 2002 was given at the November NCSP meeting (held in conjunction with the American Nuclear Society (ANS) winter meeting). Finally, an annual report on the status of the ICSBEP was given to the OECD-NEA Nuclear Science Committee's Working Party on Nuclear Criticality Safety.

Analytical Methods

Oak Ridge National Laboratory (ORNL)

The Staff at ORNL continue to maintain the SCALE/KENO software and assist the nuclear criticality safety community in the use of this software. Assistance included a "hands-on" SCALE/KENO workshop, conducted at ORNL in October, which featured the new computational capabilities of SCALE Version 5.0; a demonstration of these capabilities at the ANS Winter Meeting in November; and travel by one of the KENO code specialists to Rio de Janeiro, Brazil, to conduct a three-day workshop in December. In terms of code development, a new computational scheme was implemented into both KENO-V.a and KENO-VI for selecting the new neutron energy group and scattering angle subsequent to a collision. The result is that execution time efficiency has been enhanced; in some cases with the 238-group cross section library, reductions of up to 20 percent in running time have been obtained. Several new geometry types are being developed for KENO-VI. One is a hexagonal close-pack array of spherical rubble particles that will enhance the modeling capability for many problems involving disposition of fissionable material in spent-fuel. The draft of a new validation report comparing KENO-V.a and KENO-VI is under review. ORNL performed the OECD-NEA Source Convergence Benchmarks and participated in each of the OECD-NEA Work Group meetings in Paris. ORNL gave an overview of the status of the NCSP at the OECD-NEA Nuclear Criticality Safety Working Party Plenary Meeting.

Los Alamos National Laboratory (LANL)

The staff at LANL continue to maintain MCNP software and assist the nuclear criticality safety community in the use of this software. Regarding code development, the MCNP team has been working on converting MCNP from F77 to F90 to improve its potential for long-term support. An important part of that work has been to modularize the criticality sections of the code to allow for better testing, maintenance, and clarity. This modularization will allow the direct study of efficiency issues. It will also ease the future development of new features by confining change to a limited subset of the code. One new feature that is being researched is the capability to calculate second (and higher) eigenvalues for k-effective. Methods have been shown to allow direct calculation of the second or third eigenvalues and eigenfunctions (neutron flux distribution) without necessarily knowing the lower ones. If proven practical in real-world configurations, this feature will allow better analysis of source convergence (how many cycles to skip) and provide more accurate confidence intervals on the calculated first eigenvalue. Finally, a senior MCNP code specialist attended the OECD-NEA Working Party on Nuclear Criticality Safety in December. The LANL contributions were focused on the Expert Group on Source Convergence. LANL presented results for the four Monte Carlo criticality benchmarks (spent fuel storage pool, axially varying depleted fuel rod, loosely coupled fissile regions separated by water, and an array of widely-separated spheres). These were very difficult problems to calculate because the fissile regions were decoupled, or loosely-coupled, there was very slow convergence, and in some cases there were localized hot spots. In addition to presenting MCNP results (which were generally adopted as reference values for all of the other codes), some work to investigate correlation in k-effective calculations was described. Ongoing research is looking into improved methods for computing/correcting confidence intervals.

Argonne National Laboratory (ANL)

The Staff at ANL continued to maintain VIM software and to perform studies on fission source convergence. Four statistical tests commonly used in Monte Carlo codes were tested for their applicability to problems with challenging source convergence characteristics. The tests evaluated are a "drift-in-mean" test, an uncertainty magnitude test, a normality test, and a figure-of-merit drift test. The test problem used is the "checkerboard" spent-fuel-storage source-convergence benchmark promulgated by the NEA Expert Group on Source Convergence. It was shown that, when applied to eigenvalue, these tests do not perform reliably when the fission source has not converged. The same is true for fission rate distributions, unless serial correlation is accounted for in the estimation of uncertainties. It was also confirmed that the Shapiro-Wilk normality test does not detect a steadily drifting sequence as non-normal. These results and the source convergence benchmark results were presented to the NEA Expert Group Meeting in December by the senior VIM code specialist, who also chairs the Group. A presentation on the VIM fission source algorithm was also made. Additional improvements have been made to the VIM cross section codes as a result of point-by-point inter-library comparisons with an MCNP library. In particular, Doppler-broadening has been made more precise, and the treatment of the background cross section in the resolved range has been improved.

Nuclear Data

ORNL

Potassium transmission and capture measurements were performed during this period. Transmission measurements were performed with two metallic potassium samples while capture measurements were performed with K_2CO_3 natural sample and with a ^{41}KCl sample. The chlorine evaluation has been extended to 1.2 MeV, and the distribution of level spacings and widths are being compared with statistical predictions. Difficulties in fitting all types of data for the ^{35}Cl 398-eV resonance have been resolved. The SAMMY multiple scattering corrections to capture cross sections were found to agree with Monte Carlo calculations. For the ^{235}U unresolved resonance range, the SAMMY fit of total, fission, and capture cross section has been completed in the energy range 2 keV to 30 keV in 15 partial energy ranges in order to obtain local values of the average parameters for self shielding factor calculations in the unresolved energy range, taking into account the new cross section evaluation. Preliminary values were obtained and translated into the ENDF/B-VI format. The possibility of obtaining the average parameters in ENDF/B-VI format directly in the SAMMY output is under study. The experimental total cross section of ^{238}U (from Harvey et al) was checked in the energy range 2 keV to 100 keV, and preliminary values of the self-shielding correction were obtained. It has been proven that this data could be used for the improvement of the ^{238}U evaluation by extending the resolved energy range up to about 30 keV and by allowing the determination of accurate values of the average parameters up to 100 keV. Enhancements have also been made to the SAMMY program: the code structure has been modified, the code has been tested on various platforms, and work has been initiated on implementing a crystal lattice Doppler broadening scheme. An interim version of SAMMY has been released to the Radiation Safety Information Computational Center (RSICC).

The ORNL staff made nine presentations at the International Nuclear Data conference in Japan in October. Also, papers were presented at the WPEC/Sub Group 20 meeting, the IAEA/CRP Light-Element Standards meeting, the SAMMY users' meeting, the Cross Section Evaluation Working Group (CSEWG) meeting at the Brookhaven National Laboratory, the Reno ANS meeting, and at the NCSP review as part of the ANS meeting. Additionally, three journal articles were published.

LANL

An NJOY development completed during this quarter is the capability to produce delayed neutron data for MCNP. Testing was performed on the most important isotopes, including static k-effective calculations for several fast critical assemblies. These results were compared with results done with the ENDF66 library, and the results were within statistics. The delayed neutron effect on the fission spectrum turned out to be small for the faster assemblies like GODIVA, but the softer BIGTEN assembly showed a 0.2 percent decrease in k-effective. These results were reported at the CSEWG meeting in November. The delayed neutron capability for NJOY/ACER

is ready for production use. It has been included in the latest NJOY 99.63 release, and user feedback on any problems will be utilized.

LANL staff presented a talk at the ANS Criticality Safety meeting in Reno, November 2001, where summaries were made of progress in the following areas: MCNP Library Support with ENDF66 (to be available from RSICC in the spring); new ENDF evaluations for O-16, Cl-35, and Cl-37 now available in ENDF/B-VI Release 8; and improvements needed for fast criticals for Pu-235, Pu-238, and Pu-239 (where data testing is providing insights into changes needed in fission, elastic, and inelastic cross sections). There is a suggestion that the fission cross sections need to be increased in the 1-4 MeV region. LANL T-16 staff attended the CSEWG meeting in Brookhaven, November 2001, and chaired the evaluation committee meeting where many of these issues were discussed in detail.

Work has begun on n+U-233 reactions for criticality safety, to augment the ORNL resonance region work with upgraded GNASH analyses at higher neutron energies. Experimental data is being compiled for the analysis, and a relatively recent JENDL evaluation has been obtained for making comparisons.

ANL

In conjunction with the library verification effort (on the point libraries of MCNP and VIM), a series of benchmark calculations were performed using both continuous energy Monte Carlo and deterministic methods. These results were presented at the November 2001 CSEWG meeting. The CSEWG Data Validation Committee meeting included a number of presentations of high interest to the Criticality Safety community. ANL staff has summarized this work in the minutes for the CSEWG meeting. The inter-comparison of the VIM and MCNP point cross section libraries has included all 97 nuclides with ENDF/B-VI data at 300K common to the two libraries. ANL staff presented results of this verification and validation activity at the 2001 Topical Meeting on "Practical Implementation of Nuclear Criticality Safety" and at the NCSP Program Review in Reno, Nevada. Work has begun to implement an analytical Doppler broadening of the potential scattering into the ETOE-2 and UNIDOP codes with the goal of improving the rigor of the VIM cross section library.

Training and Qualification

This program element includes three sub-elements: (1) hands-on criticality safety training at LANL; (2) training development; and, (3) criticality safety qualification program activities.

Hands-on criticality safety training continued at LANL during the first half of FY 2002. One 5-Day Advanced Course (January 14-18, 2002) and two 3-Day Courses (February 5-7, 2002, and March 12-14, 2002) were conducted.

Regarding training development, a draft Nuclear Criticality Safety Engineer Training (NCSET) module on the criticality safety of plutonium separations has been completed. Final editing and formatting are in progress, and the module (or modules) should be in place on the NCSP web site early in the next quarter. This module includes a review of the fundamentals of plutonium and uranium separation via the PUREX process, then discusses the criticality safety concerns and potential problems at each stage of the process.

The second of two NCSET modules on hand calculations has been started with the criticality safety group at LANL. This module will deal with the more advanced methods that were introduced in the first hand calculation methods module.

A module on the development, selection and use of cross sections sets in criticality safety has been outlined and will be started at ANL during the next quarter. This module will explain the process used to acquire raw nuclear cross section data, evaluate the data, and test the data prior to formally releasing the it as part of the standard cross section sets used by criticality safety analysts. Selection of the proper cross section set for specific codes and criticality safety calculations will be included in the module.

Sites continued to develop and improve training and qualification of criticality safety engineers. In response to a DNFSB letter dated July 20, 2001, the Department committed to review DOE Field assessment of contractor qualification plans, including the bases upon which these assessments were made. Dr. Jerry McKamy will review all site plans and provide input to a Departmental response to the DNFSB on the adequacy of these plans. This action is scheduled to be completed by June 2002.

Information Preservation and Dissemination

This program element currently contains two sub-elements: (1) the Criticality Safety Information Resource Center (CSIRC); and (2) NCSP web page development.

Regarding the CSIRC Program, the following progress has been made. Retrieval and digitization of the records from the ANL critical facilities are ongoing. As noted by other laboratories, the scanning is complicated by auxiliary pages attached to the log book pages, the numerous sizes and formats of materials, and the hand annotations made on many documents by the experimenters.

A scanner and CD writer were purchased to be used for potentially contaminated records. A former ZPPR technician was hired to scan these records, while some of the uncontaminated loading records and log books are being scanned by a commercial subcontractor. To date, the records from the first nine and last nine ZPR-9 assemblies (1964-1966, 1975-1981) have been scanned. Approximately 20 percent of the uncontaminated records from the ZPPR facility have been scanned. These records occupy 25 compact disks and indicate the volume of the records still to be processed. Scanning has not yet been started on the records from the ZPR-3 and ZPR-6 facilities.

The NCSP web site at the Lawrence Livermore National Laboratory (LLNL) is being maintained and improved by LLNL under technical direction of the NCSP management. This web page provides technical information for the criticality safety community and serves as a hyperlink to other web sites which are important to the NCSP. During the first half of FY 2002, site improvements included:

(1) Updating web server and search engine applications;
(2) Installing new communication software per DOE cyber security requirements;
(3) Presentation of new web page features to the NCSP Workshop at the 2001 ANS winter meeting;
(4) Publication of the NCSP Workshop presentation viewgraphs on the web page for distribution;
(5) Updating the LLNL criticality safety literature bibliography data base;
(6) Updating over 7,960 entries of LLNL criticality safety literature bibliographic database. The nuclear criticality bibliographic database included in the NCSP web site has been substantially expanded and improved. The present database now includes nearly 8,000 records (an increase from about 4,600 in the previous edition). The papers and reports describe work reported as early as 1943 through the year 2001 that have contributed to a safety record unmatched by any other industry. The database now includes most criticality papers published by the American Nuclear Society (ANS Transactions, Nuclear Science & Engineering, Nuclear Technology, and ANS topical meetings), most papers presented at the ICNC conferences, plus many other papers presented in journals, company reports, and conferences such as those sponsored by the United Nations); and
(7) Updating both LLNL and Hanford search engine indexes.

Applicable Ranges of Bounding Curves and Data

During the first half of Fiscal Year 2002, four of the five technical program tasks were actively addressed. Emphasis continued on moving software into production status prior to the further development of guidance on its use and/or the performance of sensitivity/uncertainty studies.

Studies were performed to establish minimum values of the fissile actinides in common material and geometric forms. These were contributed to the OECD-NEA Working Group on Minimum Critical Mass Meeting in Paris.

The SWIF module of the SWANS software for performing material optimization has been incorporated into the SMORES analytical sequence in SCALE Version 5.0. A draft users guide for SMORES is in preparation. Geometric optimization methodology is under development at the University of California, Berkeley.

User manuals for SEN1 and SEN3, as well as the new methods to compute the sensitivity of k-effective to the group cross section resonance processing with BONAMI and NITAWL-II, are in preparation. Further testing of these new techniques with both SEN1 and SEN3 on a complex, real-life application continues.

A paper on the use of the AROBCAD methodology in the establishment of safe margins of subcriticality was presented at the November topical meeting on nuclear criticality safety. Additionally, a demonstration of this methodology was included in the NCSP Workshop conducted in conjunction with the Reno ANS meeting.

The revised SEN1 and SEN3 control modules, including the use of the CENTRM point transport code for resonance processing and the definition of multiple unit cells in a model, are ready for implementation into SCALE 5.0. Revisions include the improvement of memory management in both sequences. Also, a revised version of the CANDE module is ready for SCALE Version 5.0. Guidance on the use of CANDE and SAMS is in preparation.