Department of Energy
National Nuclear Security Administration
Washington, DC 20585

MAY 30 2003

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 second quarter of Fiscal Year 2003.

The Implementation Plan contains 30 milestones, all of which have now been completed. Although all commitments have been met, stability of funding for the Nuclear Criticality Safety Program (NCSP) has been an ongoing concern. With the Secretary's decision for Defense Programs to fully fund and manage the NCSP for Fiscal Year 2003 and beyond, stability of funding should be achieved. In Fiscal Year 2003, Defense Programs provided the level of funding for the NCSP specified in the Five Year Plan. The Fiscal Year 2004 budget request provides sufficient funding to meet NCSP requirements as well. Defense Programs is committed to provide sufficient funding in the out years to institutionalize the NCSP.

The NCSP continues to sustain progress in all of the program task areas as reflected in the body of the enclosed report. 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

cc (w/encl):
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QUARTERLY STATUS OF THE IMPLEMENTATION PLAN FOR DEFENSE NUCLEAR FACILITIES SAFETY BOARD RECOMMENDATION 97-2 SECOND QUARTER OF FISCAL YEAR 2003

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 (Integral Experiments, Benchmarking, Analytical Methods Development and Code Maintenance, 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 new Five-Year NCSP Plan which was finalized in September 2002.

The Criticality Safety Support Group (CSSG) is performing its chartered functions in support of the NCSP Manager's implementation of the NCSP according to the new Five Year Plan. During the second quarter of Fiscal Year (FY) 2003, the CSSG participated in several teleconferences regarding issues of interest to the criticality safety community and assisted the NCSP Manager in preparations for the annual technical program review, conducted during the first week of April 2003.

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. Although the lengthy continuing resolution has delayed some activities, many of the program areas have made substantial progress. 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.

Integral Experiments

The following is a summary of experimental activities conducted at the Los Alamos Critical Experiments Facility (LACEF) during the second quarter of FY 2003.

The highlight of this quarter was the return of SHEBA to operable status, thus giving LACEF five out of five operable assemblies. Experiments were conducted on all five critical assemblies during this quarter in support of the NCSP. In addition to performing these experiments, four criticality safety courses were also provided (three NCSP courses and one internal Los Alamos course).

Flattop: Multiple operations were performed during this quarter in support of criticality safety courses and general operator training. Flattop is the ideal critical assembly for these tasks because of its simplicity, reproducibility, safety, and general ease of operation. Students and trainees are permitted to operate Flattop under the direct supervision of two LACEF operators. This significantly enhances the content of the criticality safety courses because it gives the student an additional opportunity to gain some hands-on experience with multiplying systems.

Comet/Zeus: The second and third intermediate energy spectrum experiments using iron (Fe) as the interstitial material were completed during this quarter. Fifty mill sheets of polyethylene were used to slightly soften the neutron energy spectrum for these two configurations. The Zeus iron core will be evaluated and published as part of the International Criticality Safety Benchmark Evaluation Project (ICSBEP) during the remainder of this fiscal year.

SHEBA: The highlight of this quarter was the return of SHEBA to operable status, which happened on January 30, 2003. This was followed by SHEBA achieving critical for the first time in over two years on February 3, 2003. The remainder of the quarter was dedicated to performing Technical Safety Requirement surveillances and requalifying SHEBA crew members. SHEBA will be available for the upcoming advanced criticality safety class in May of 2003. In addition, modifications necessary to prepare SHEBA for burst mode operations continue.

Godiva IV: Multiple Godiva operations were performed this quarter in support of benchmarking neutron transport computer codes here at Los Alamos, irradiating samples for the weapons programs, qualifying new Criticality Accident Alarm Systems and general operator training. A new system for measuring burst yield was installed and tested during this quarter. This new system uses a modern digital oscilloscope and our existing photodiode and photocathode instruments and replaces two entire CAMAC crates and a data acquisition computer.

Planet: The Planet critical assembly also continues to be in high demand supporting various NCSP experimental programs. Experiments completed during this quarter include: (1) continuing the series of ^{237}Np critical mass experiments, (2) performing Rossi-α measurements on the Np core, (3) iron waste matrix critical mass experiment, (4) neutron leakage spectrum measurements on the ^{237}Np core, and (5) a critical mass experiment using a 4.5 kg sphere of alpha-phase plutonium reflected by HEU. The ^{237}Np experiment, the iron and aluminum waste matrix experiments, and the Hastelloy critical mass experiment will all be evaluated and published as part of the ICSBEP during the remainder of this fiscal year.

Benchmarking

As a result of the lengthy continuing resolution in the United States, only $700,000 of a planned $1,675,000 FY-2003 funding has been allocated to the ICSBEP. Consequently, the contribution to the next ICSBEP publication from United States (U.S.) participants will be significantly less than originally projected, but still comparable to the U.S. contribution in FY-2002.

Fifteen new evaluations from the U.S. are scheduled for review at the next ICSBEP meeting that will be held in New Orleans in May 2003. Only seven evaluations are being contributed by non-U.S. participants. This is down considerably from previous years, partly because Russia, who is largely funded by the ICSBEP, was not able to contribute this year because of funding problems in the U.S.

ICSBEP participants completed 24 of 25 papers for a special issue of Nuclear Science and Engineering (NS&E) that will be devoted to the project. These papers will be published in the 2003 September and October issues of NS&E.

Scientists from the Institute de Pesquisas Energeticas e Nucleares (IPEN) in Sao Paulo, Brazil accepted an invitation to participate in the ICSBEP and contribute data from their IPEN/MB-01 Research Reactor. A presentation on the ICSBEP, including instructions on how to contribute data to the ICSBEP was given to 12 members of the staff at IPEN in Sao Paulo. The IPEN/MB-01 Research Reactor is a light-water moderated lattice of low-enriched (4.35% ^{235}U) uranium dioxide fuel pins with a 1.50 cm pitch. There are 301 fuel pins in the lattice. There are two safety rods and two control rods. Criticality is typically achieved by changing the position of the control rods.

Analytical Methods Development and Code Maintenance

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. The ORNL staff provided direct on-going assistance to code users in the performance of their analyses. Also, ORNL staff prepared for a SCALE/KENO-V.a workshop, that was conducted at the ORNL Transportation Technology Center in April.

Work is progressing on the verification and validation reports for KENO-VI and CENTRM. Input models of critical experiments are being developed and executed as time permits. This is an on-going effort with the goal of having final reports finished by the end of FY 2003.

All the SCALE5 criticality safety codes are being modified and corrected as inconsistencies are identified. These tasks are performed with documented procedures under the SCALE software configuration control system. Several additional features have been added to KENO V.a and KENO-VI: a new method of calculating standard deviations using covariance data; a matrix data upgrade; and the ability to dynamically allocate geometry data. The original storage technique utilizing the variably-segregated D array (1970's technology) has been removed from KENO-V.a. The SCALE5 documentation is also being updated to reflect the code's additional capabilities on an on-going basis. Work is also in progress to prepare for the distribution of the SCALE5 code package.

RSICC continues to support the criticality safety community with the packaging and distribution of the MCNP, SCALE, VIM and SAMMY software.

Los Alamos National Laboratory (LANL)

The staff in Group X-5 (Diagnostics Applications) continue to support the MCNP Monte Carlo code and assist the nuclear criticality safety community in the use of this software.

MCNP5 Verification: MCNP verification suites for criticality and radiation shielding were run on additional computer systems, including the ASCI HP/Compaq Q system at LANL and a Linux cluster. Answers were correct and in most cases identical to those on the SGI Origin2000 and Windows PCs.

MCNP5 Manual: The manual for MCNP5 was completed and reviewed by the LANL Security division. To comply with DOE guidance on code manuals, the 1000-page manual was split into 3 volumes. Volume I (Overview & Theory) will be issued as an unlimited release document. Volumes II & III (Users Guide, Developers Guide) will be released as "limited distribution" documents available only to code users and developers, respectively.

Advanced Monte Carlo Methods: Work is progressing on incorporating several new features into MCNP5, including: (1) improved tests for the stationarity of the source distribution (based on the concept of relative Shannon entropy), (2) estimation of the problem dominance ratio (based on autoregressive fitting of the cycle-to-cycle source distribution), and (3) improved perturbation theory which accounts for changes in the source distribution shape.

Communications with Criticality Safety Community: Lectures concerning the new MCNP5 and other Monte Carlo research were presented to the Nuclear Engineering department at the University of Tennessee and to staff members at ORNL. Also, an MCNP class was given in London to 24 people from OECD countries.

Argonne National Laboratory (ANL)

VIM support was minimal because under the continuing resolution no funding was provided to ANL. ANL maintains an active interest in the NCSP Analytical Methods Task, and will continue several development activities when funding is restored next quarter: 1) Universal Graphical User Interface (input & output) for VIM and eventually all NCSP Monte Carlo codes, 2) the modification of automated graphics capability developed at LLNL for the COG software, 3) advanced statistical tests to identify and mitigate source convergence behavior, and, 4) implementation of the ICSBEP spectral indices edits.

Nuclear Data

ORNL

The potassium transmission and capture measurements have not been completed because the ORELA electron guns are still under repair. The accelerator cannot operate without the electron guns; therefore, much effort has been devoted to their repair and replacement. With the projected NCSP budget

stability, the lead experimentalist has returned from Karlsruhe, Germany. Resumption of the potassium measurements is anticipated in the early summer. These are to be followed by measurements on Mn-55.

Emphasis in the data evaluation effort was placed on the generation and utilization of data uncertainty covariance matrices. In the resolved resonance region, the SAMMY software has been modified to generate covariance data based on the Reich – Moore resonance formalism. In the unresolved resonance region, the covariance data is based on the Breit – Wigner Single – Level formalism. As a demonstration of the entire process of covariance generation and application under various approximations, data was generated for U-235, Al-27 and the seven gadolinium isotopes. The PUFF software was utilized in coupling the data into a cross section library and the SEN3 software was utilized with this library in the analysis of a hypothetical benchmark configuration.

LANL

The following nuclear data related work has been accomplished at LANL during the quarter:

1. The U-233 high energy evaluation was merged with the ORNL resonance region evaluation. The resulting U-233 evaluation performs extremely well in critical assembly data testing (a significant improvement over the earlier evaluation). The results are documented in a lab report, LA-UR,03-1617 (Young, Chadwick, MacFarlane, Talou).

2. The U-238 evaluations have been updated with a new elastic scattering angular distribution in the fast region. This, together with other uranium isotope evaluations, has been tested in a suite of fast critical assemblies and the performance is excellent. In particular, the FLAT TOP biases are removed and the k-eff values are very close to one. (The spectral indices, though, suggest a neutron spectrum that is slightly too soft). The new evaluation also appears to improve thermal critical assembly calculations, showing slightly higher reactivity (as the experiments require).

3. Inter-comparisons of Gd isotope capture cross sections were made, showing different evaluations and different measurements. This is part of the Nuclear Data Advisory Group (NDAG) efforts to assess Gd uncertainty data that was presented at the NDAG meeting in April.

ANL

Although the continuing resolution significantly delayed nuclear data related work at ANL, some activities continued at a low level. Two retirees have continued to work part time on a professional basis: Dick Huang on the unified resonance formalism and Al Smith on ENDF/B evaluations.

Dick McKnight, in his role as NDAG chairperson, has continued to coordinate the activities of the group. Preparations were made for the NDAG meeting in April. ANL also continued to participate in

the CSWEG (US) and WPEC (International -- OECD) cross section evaluation efforts.

ANL also continued work on a proposed new effort involving coordination of covariance data development with other interested DOE programs (GEN-IV and Space reactors) and prioritization of the establishment of DOE programmatic data needs.

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 second quarter of FY 2003. There were two offerings of the 3-day class with a total of 22 attendees and one offering of the introductory 5-day class with 13 attendees.

Regarding Training Development, a draft of the completed Nuclear Criticality Safety Engineer Training (NCSET) module on the preparation of nuclear criticality safety evaluations (NCSEs) was distributed to the CSSG members for review and comment. This module has been prepared in two formats. The first version is written in HTML code, allowing the user to interactively move between the text of the training module and a sample NCSE used to illustrate each training point. The second is a standard PDF file that can be printed for internal training class use. Comments will be incorporated and it is expected that the module will be released next quarter. In addition, discussions were held with the Russians about several possible joint efforts, one of which was the design and manufacture of a criticality accident simulator, possibly along the lines of what the Rocky Flats plant designed, built, and used quite effectively during the late 1980's. There is general agreement about the utility of such a simulator and its development will be guided by the CSSG with input from all interested parties.

There is no new information on qualification activities to report at this time.

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 original Heritage Video Series, taped at Los Alamos in September of 2000 and distributed as VHS tapes worldwide, has been reformatted to DVD and will be distributed during the next quarter to an even wider audience. The Russian language version of the report, "A Review of Criticality Accidents", LA-13638, was finished and reproduced. Two hundred copies were sent to Russia for distribution and a few were retained within the US for possible future distribution to visiting dignitaries. No progress was made on scanning the potentially contaminated ANL Zero Power Reactor materials since the retired technician who was doing the scanning has not yet

resumed his part-time work at ANL this year. Fifty CDs of data have been cleared for release by the ANL publications department. File indices for forty four of these disks have been completed. Once the remaining disk indices are completed, they will be sent to Los Alamos for inclusion in the archives.

The NCSP web site at the Lawrence Livermore National Laboratory is being maintained and improved under technical direction of the NCSP manager. This web page provides technical information for the criticality safety community and serves as a hyperlink to other web sites that are important to the NCSP. During the second quarter of FY 2003, web site improvements included:

(1) Created and sent out 247 email letters to NCSP registrar users to verify their name and email address;
(2) Updated the CSSG list;
(3) Added announcement and link for DOE standard STD-1158-2002 "Self-Assessment Standard for DOE contractor Criticality Safety Programs";
(4) Converted Microsoft PowerPoint viewgraphs from November 2002 Washington, DC, NCSP meeting to .pdf format and posted them on NCSP web site;
(5) Patched NCSP web server's sendmail vulnerability that is required by DOE NNSA cyber security policy;
(6) Added pop-up description box for NCSP web site menu buttons; and
(7) continued work on new design for NCSP web site as suggested by NCSP user feedbacks.

Applicable Ranges of Bounding Curves and Data

During the second quarter of Fiscal Year 2003, 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.

Follow on support of the work on advanced geometric optimization methodology software that is under development at the University of California, Berkeley has been delayed further until resolution of budget issues in FY2003.

Development of sensitivity and uncertainty analysis tools for SCALE5 continued. The distinctive name, TSUNAMI (Tools for Sensitivity and Uncertainty Analysis Methodology Implementation), has been assigned this suite of software within SCALE. The sensitivity analysis sequences have been renamed TSUNAMI-1D and TSUNAMI-3D from SEN1 and SEN3, respectively. The code formerly known as CANDE is now named TSUNAMI-IP.

An option has been added to TSUNAMI-IP to produce code output in HTML format. This allows the user to browse the output in a convenient and intuitive manner. Options are available to customize colors for automated highlighting of important data, which will aid analysts in quickly interpreting results. Several additional output edits have been added to TSUNAMI-IP to assist in the development of the g value.

An option is under development and testing in KENO V.a to produce refined neutron flux tallies in a simply defined cubic mesh that automatically subdivides the user-defined geometry input for TSUNAMI-3D. In its finished form, this new tally will greatly simplify the process of obtaining adequate resolution on the flux solution to obtain accurate sensitivity coefficients from TSUNAMI-3D.

Improvements have also been realized in the Javapeno plotting package, with the addition of user options and improvements in the responsiveness of the plotting package.

The integral parameter g has been used to address the issues with validation of gadolinium in the gadolinium-plutonium glass log project that was presented by the Savannah River Site. The integral index g value along with the sensitivity of the system to gadolinium have been used to assess the validation of gadolinium. Since there are no covariance data available for gadolinium in the existing SCALE cross section libraries, an analytical method that was developed during the first quarter of 2003 has been successfully applied to determine the penalty associated with the lack of applicable benchmarks and the lack of covariance data. A technical ORNL report has been written to describe and demonstrate the new g parameter and the analytical method.

The special moderators issue has been investigated for iron and graphite experiments that were planned to be performed at LANL. Since the experiments utilize highly-enriched uranium plates, they have harder spectra than the systems that fall under special moderators, i.e., very dilute systems with much softer spectra. Due to delays in funding, analysis of these experiments with the AROBCAD methodology could not be performed before the experiments were designed or completed. For future experiments, the goal is to use AROBCAD to assist in the design of integral experiments to assure that each experiment measures perameters it was intended to measure.

A report has been drafted that provides the results of calculations that have been performed to re-evaluate the common homogeneous minimum critical values (e.g., mass, volume, radius of spheres and cylinders, slab thickness, and concentration). These systems include UO_2-H_2O, UNH, PuO_2-H_2O, and PuNH systems with varying enrichments and full water reflection. This task has been performed for the Expert Group on Minimum Critical Values, OECD/NEA Nuclear Science Committee Working Party on Nuclear Criticality Safety.