Department of Energy
National Nuclear Security Administration
Washington, DC 20585

AUG 23 2001

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 (IP) for Defense Nuclear Facilities Safety Board Recommendation 97-2, *Criticality Safety*, requires a quarterly status report. Enclosed is the Department of Energy's quarterly status report for the third quarter of Fiscal Year FY 2001, which ends on June 30, 2001.

The IP 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 (NCSP) is a primary concern. The NCSP Management Team is working with program sponsors to review the NCSP in detail, validate program requirements, achieve agreement on appropriate scope and level of necessary support, and establish a process that stabilizes funding support for the program. This process will also yield an updated Five-Year Plan for the NCSP. I remain committed to working closely with the contributing program offices to stabilize funding for the NCSP, as well as resolving the other issues raised in your July 20, 2001, letter to the Secretary prior to proposing closure of the Recommendation.

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Assistant Deputy Administrator
for Research, Development, and Simulation
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Enclosure

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QUARTERLY STATUS OF THE IMPLEMENTATION PLAN
FOR
DEFENSE NUCLEAR FACILITIES SAFETY BOARD RECOMMENDATION 97-2
THIRD QUARTER FISCAL YEAR 2001

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. Implementation of the NCSP is being accomplished according to the Five-Year NCSP Plan which was published in August 1999.

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 (IP). During the quarter, the NCSPMT and CSSG reviewed the NCSP, provided justification necessary for maintaining funding support, developed formal comments on the Departmental Guides for 10 CFR 830, *Nuclear Safety*, and finalized the response to DNFSB Technical Report # 29, *Criticality Safety at Department of Energy Defense Nuclear Facilities*, which was forwarded to the DNFSB in May 2001.

Regarding ongoing efforts to stabilize funding for the NCSP, the NCSPMT and CSSG had several meetings during the quarter to review NCSP requirements, determine a baseline budget for validated requirements, achieve agreement on an appropriate scope and level of necessary support, and establish a process that stabilizes funding support for the program. This process is targeted for completion by the end of September 2001 and will also yield an updated Five-Year Plan for the NCSP.

Because all 30 of the Recommendation 97-2 milestones are completed, this quarterly 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

Experiments were conducted on three of the five Los Alamos Critical Experiments Facility (LACEF) assemblies during this quarter. In addition to performing these experiments, four criticality safety courses were also provided (one 5-day basic course, one 5-day advanced course, and two 2-day courses). A status of activities by critical assembly is as follows:

Flattop: Flattop was inoperable for this entire quarter due to a malfunction of the control rod drive system. The newly redesigned control rod drive system has arrived at Technical Area

(TA)-18, and installation will begin soon. A restart notification will be delivered to the DOE/Los Alamos Area Office (LAAO) within the next few weeks, and restart should occur in approximately 6 months.

Comet/Zeus: Installation of the sinusoidal actuator was completed during this quarter, and testing has commenced. This actuator will eventually be used to measure the worth of the CERES samples (third on the list of priority critical experiments) on both the Comet and SHEBA critical assemblies. A total of 21 Comet operations were performed during this quarter. A benchmark write-up of the current Zeus configuration (3 cm graphite, oralloy plate, 3 cm graphite) was completed and submitted to the benchmark evaluation group. Once the test of the actuator has been completed, the remaining Zeus configurations (e.g., all oralloy and other interstitial materials) will be assembled.

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 gases and pass them through the catalytic recombiner, was not performing at full capacity. This resulted in the declaration of 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 has been submitted to DOE/LAAO. Once approval is received, the system will be repaired and SHEBA will be restarted. This is expected to take approximately 9 months.

Godiva: Ten Godiva operations were performed this quarter in support of criticality safety courses, operator training, neutron dosimetry measurements for ESH-4 and ESH-17, and benchmarking of nuclear instrumentation for the emergency response program. DOE/LAAO granted permission for neutron measurements with instruments in the glory hole and approved a test plan for add-on irradiation experiments.

Planet: Eighteen operations were performed this quarter in support of 97-2 experimental activities, criticality safety courses, and operator training. Experimental activities with waste/tuff materials continue. Work also continues on documenting the results of these activities for the benchmark program. Two benchmarks were completed and submitted to the benchmark evaluation group. These benchmarks were returned by the group to have some discrepancies resolved. The two benchmarks are currently being reworked and will be resubmitted to the evaluation group by the end of August. A new experimental configuration involving U(93) foils, polyethylene plates, and Gadolinium foils was initiated during this quarter. While initial criticality was achieved during the fourth quarter of FY 2001 (July 19, 2001), the vast majority of the preparatory work was performed during the third quarter.

Other Significant Accomplishments:

One of the more significant accomplishments of the last quarter was the completion of the TA-18 Basis for Interim Operation and the new Technical Safety Requirements. This is the final deliverable (to DOE/ LAAO) of a multi-year multi-million dollar safety analysis effort that

completely redefines the Authorization Basis at TA-18. In addition, the biennial crew member/crew chief recertification was completed, and six new LACEF crew members were certified.

Benchmarking

The 2001 International Criticality Safety Benchmarking Evaluation Project (ICSBEP) Working Group Meeting was held from June 11 through June 15, 2001. The meeting began with a tour of the critical facilities at Argonne National Laboratory -West on Monday, June 11, and culminated in a series of technical meetings, June 12 through June 15, 2001, in Jackson Hole, Wyoming. Representatives from the United States, United Kingdom, France, Japan, the Russian Federation, and Slovenia participated in this meeting. Twenty-five new evaluations were reviewed at the meeting along with three evaluations that underwent significant revision. Twenty-three of the twenty-five new evaluations were approved for publication. Twelve of the approved evaluations were contributed from outside the United States. Of the eleven evaluations contributed by United States participants, four were provided by Argonne National Laboratory, two were provided by the Oak Ridge National Laboratory, and five were contributed by the Idaho National Engineering and Environmental Laboratory or its subcontractors (three of the five were provided by Westinghouse Safety Management Solutions at the Savannah River Site). Additional configurations were added to previously published evaluations by the Lawrence Livermore National Laboratory and the Los Alamos National Laboratory.

Also reviewed at the meeting was a "Guide to the Expression of Uncertainties" and the Database for the International Criticality Safety Benchmark Evaluation Project (D.I.C.E.). The "Guide to the Expression of Uncertainties" was prepared by ICSBEP participants from France and was first presented to the ICSBEP in June of 2000. D.I.C.E. was developed jointly by the Organization for Economic Cooperation and Development - Nuclear Energy Agency (OECD - NEA) and the ICSBEP. The guide and D.I.C.E. will be published, for the first time, with the 2001 Edition of the Handbook.

A presentation entitled "Preview of the 2001 Edition of the International Handbook of Evaluated Criticality Safety Benchmark Experiments" was given at the American Nuclear Society (ANS) Meeting in Milwaukee, Wisconsin. A second presentation entitled "The Status of the International Criticality Safety Benchmark Evaluation Project" was given at The DOE Nuclear Criticality Safety Program Review that was held in conjunction with the ANS Meeting.

A series of previously undocumented ^{233}U solution experiments was documented and published by the experimenter, J. T. Thomas (retired) and C. M. Hopper (Staff at ORNL). The reference for this report is:

> J. T. Thomas and C. M. Hopper, "Critical Experiments With Aqueous Solutions of $^{233}UO_2(NO_3)_2$", ORNL/TM-2000/245, Oak Ridge National Laboratory, May 2001.

Nuclear Data

ORNL: With the restored funding for the data measurement subtask, effort resumed on the fabrication of sample holders and the design of samples for potassium and fluorine. Effort continued on various data reduction and evaluation tasks. A re-evaluation of fluorine utilizing existing data was initiated. Evaluations of the chlorine capture and transmission measurements and the silicon capture measurements were completed. Evaluations in progress include Cl-35 and Cl-37. An interesting development is the importance of the proton production by neutron capture reaction. It turns out to make a significant contribution to total neutron absorption, and it has not been included in previous evaluations for chlorine. The unresolved resonance parameters for U-235 are being evaluated with the TNG code. The SAMMY code has been enhanced to consider multiple scattering in its data evaluation. A summary of the status of the Nuclear Data subtasks was presented at the NCSP review in Milwaukee. A paper on silicon has been prepared for the upcoming nuclear criticality safety topical meeting. This paper demonstrates integration of nuclear data, critical experiments, analytical methods and the ICSBEP to produce improved capability for the evaluation of fissile systems containing silicon.

LANL: Effort focused on maintenance and enhancement of the NJOY cross section processing system and the generation and testing of new libraries for the MCNP transport code. Additionally, testing continued on the new U-238 evaluation that makes some significant enhancements to the existing ENDF/B-VI evaluation. Some of the notable changes/ improvements are: 1) new elastic and inelastic scattering information based on coupled-channel optical model ECIS calculations, width-fluctuation compound nucleus reactions, and direct reaction calculations; 2) new channel cross sections for reactions such as (n, n'), (n, 2n), and (n, 3n); 3) new fission cross section based on Lisowski's more recent LANSCE measurements; and 4) new direct + compound elastic calculation which results in a new average scattering angle, mu-bar. With these modifications, agreement in the calculation of the FLATTOP critical assembly is improved. LANL has completed a new O-16 evaluation that includes significant improvements. It is being tested against a number of benchmarks, and it is performing well. A report on the status of NJOY was presented to the NJOY User's Group meeting sponsored by the NEA and held in May in Aix-en-Provence, France. The topic of Software Quality Assurance remains very important at Los Alamos, and new draft procedures have been circulating for evaluation and comment. The new web-based "issue tracker" is giving NJOY users around the world access to the latest issues and their resolutions.

ANL: Benchmarking activity is continuing. Data testing for new LANL evaluations of U-238 and O-16 was conducted, and the Cross Section Evaluation Working Group data community was appraised about performance of the new U-238 data. Some progress has been made on the comparisons of Monte Carlo (VIM and MCNP) point libraries, identifying deficiencies in the processed files.

Analytical Methods

Oak Ridge National Laboratory (ORNL): Staff at ORNL continued to maintain KENO software and assist the nuclear criticality safety community in the use of this software. In April, a SCALE/KENO-VI workshop was conducted at ORNL for ten participants from government, industry, and academia. The NCSP provides for base funding in KENO user assistance, as well as the preparation of training materials. During this quarter, substantial coding was performed to assure the compatibility of the new SCALE multi-cell option with the various SCALE search options. The new SCALE multi-cell option provides for the simultaneous treatment of multiple fuel cell types in problem-dependent cross section processing. A new version of CENTRM, which features greatly improved memory management, has been implemented into the prototypic SCALE Version 5.0. Presentations were made at the Milwaukee ANS meeting on a CENTRM application, as well as on the status of the NCSP Analytical Methods subtasks. Significant assistance was rendered to the SCALE/KENO user community.

Los Alamos National Laboratory (LANL): Staff at LANL continued to maintain MCNP software and assist the nuclear criticality safety community in the use of this software. In addition, an Advanced MCNP class was taught at LANL in April, and an Introductory MCNP class was taught at LANL in May. Work continued on updates to the MCNP manual, including the addition of a 12-page index in the "pdf" version of the manual on the LANL web site. Also, benchmark specifications have been developed for several Rossi alpha sub-critical measurements. Among features of interest to the criticality safety community that are being worked on for the future are automatic source point generation for eigenvalue problems and improved source definition capability for repeated structure geometries. These features tie in with the solution of fission source convergence studies being performed on an international basis. A new version of MCNP has been shown to perform very efficiently in the parallel mode.

Argonne National Laboratory (ANL): Staff at ANL continued to maintain the VIM code and to perform the studies on fission source convergence. American Standard Code Information Exchange versions of the VIM libraries were sent to the Radiation Safety Information Computational Center to accommodate non-Sun installations. Staff at ANL completed a total of 354 calculations for the four OECD - NEA Source Convergence Benchmark sets and submitted the results to the appropriate analysts in the Expert Group on Source Convergence in Criticality-Safety Analyses. A subset of the results, including the ANL results, were reviewed at an informal meeting of the Expert Group at the ANS Annual Meeting at Milwaukee. A permanent update of the cross section processing codes was completed along with the necessary quality assurance, and the revised codes were placed in production. In addition to the modifications for processing ENDF/B-VI and JEF-2.2, the codes' readability, maintainability, bounds checking, and internal documentation were improved. The latest U-235 evaluation has been accommodated by further code modifications that will be included in the next production code update.

Training and Qualification

This program element includes three subelements: (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 quarter. One basic 5-Day Course (April 23-27) and an advanced 5-Day Course (June 4-8) were conducted.

Two projects were initiated this quarter under the training development subtask. Funds were transferred to ORNL to co-sponsor conversion of the criticality accident slide rule report into a PC-based program. Funds were also transferred to the Westinghouse Savannah River Company for the development of one or more Nuclear Criticality Safety Engineer Training modules on the chemistry and criticality safety of uranium and plutonium separations. The modules are due to be completed next quarter.

The Department continued to interact with its contractors regarding development and implementation of training and qualification programs for contractor criticality safety staff. The Oak Ridge Operations Office and criticality safety staff from the Office of Environment, Safety and Health held discussions with the Bechtel Jacobs Company regarding their training and qualification program. Several modifications to the program resulted from these discussions that will bring the program in line with the intent of DOE-STD-1135-99. Also, discussions were held with the DOE Y-12 Area Office regarding the potential of criticality safety staff from the Office of Environment, Safety and Health performing a review of the implementation of the training and qualification program at Y-12.

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. A videotaping session of Oak Ridge pioneers, patterned after the Los Alamos sessions in September of 2000, was conducted at Oak Ridge. Scanning of all known Oak Ridge logbooks was also completed. Scanning of logbooks and related historical documents continues at the Lawrence Livermore National Laboratory. Requests for hard copies and CDs of the documents LA-10860, LA-12808, LA-13638, and their reference sets are being filled. Bob Rothe continued to refine his History of the Rocky Flats Critical Mass Laboratory document, with publication planned later this year. A first videotape of the heritage series was edited and released during this quarter. This was a 45-minute tape showing Hugh C. Paxton, the leader of the Critical Experiments Group at LANL from 1950 to 1975, discussing aspects of the programs during these years as well as commenting on regulatory changes and impacts. The major Los Alamos Heritage Video sessions that were

conducted over a 3-day period in September of 2000 are being prepared for reproduction and distribution. Regular videotapes, DVD, and CDs will be available in the near future.

The NCSP web site at LLNL is being maintained and improved. This web site provides technical information and the latest information of interest to the criticality safety community. It also serves as a pointer to other web sites which are important to the NCSP. For the second quarter of FY 2001, the NCSP web site highlights included the following. Several frame-based versions of the new website design were developed and released for review. Nuclear Criticality Safety Engineer Training Module 8, "Hand Calculation Method – Part I," the University of New Mexico newsletter, and the "CSSG Review of draft Guides to 10 CFR 830" and links to the PDF version of the Guides were added to the web page. The new website design was presented at the NCSP workshop during the ANS annual meeting at Milwaukee, WI. NCSP web site usage statistics were generated, and discussions with Hanford about updating the Hanford Database were initiated.

Applicable Ranges of Bounding Curves and Data

During the third quarter of Fiscal Year 2001, three of the five technical program tasks were actively addressed. Emphasis was placed on moving software into production status, prior to the further development of guidance on its use and/or the performance of sensitivity/uncertainty studies.

Under subcontract extension, the University of California, Berkeley, continued to modify the SWANS code for performing geometric optimization.

Further work, at a reduced level, was conducted on the development of the SEN1 and SEN3 computational sequences for producing sensitivity coefficients for criticality safety models within the SCALE code system. The implementation of methods to compute the sensitivity of k-eff to the group cross section resonance processing with BONAMI and NITAWL-II was completed. Further testing of these new techniques was performed with both SEN1 and SEN3.

A demonstration of the use of the AROBCAD methodology in the establishment of safe margins of subcriticality was performed and documented as a paper for the upcoming topical meeting on nuclear criticality safety. The demonstration involved a comparison of the new methodology with the results of a previous safety evaluation of a shipping container utilizing currently acceptable techniques. This effort was performed to gain experience in preparing guidance for the use of the AROBCAD methodology.

The implementation of the SEN3 methods for SCALE5 has recently been enhanced to provide the user with more flexibility in the generation of flux moments for complex systems. The SEN1 and SEN3 control modules have also been updated to allow the use of the CENTRM point

transport code for resonance processing and to allow the definition of multiple unit cells in a model. Verification cases are being compiled to ensure accurate calculation of sensitivity coefficients for a variety of systems.

N1 is undergoing transition to SCALE5. SEN3 has been optimized to reduce memory requirements to better address problems involving large energy group structures or complex geometries. Application of SEN3 in the evaluation of the complex geometry in ICSBEP-233-SOL-THERM-006 indicated a need for enhanced memory management.