



Department of Energy
National Nuclear Security Administration
Washington, DC 20585

NOV 21 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 fourth quarter of Fiscal Year FY 2001, which ended on September 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 has reviewed the NCSP in detail, validated program requirements, and updated the Five Year Program Plan accordingly. This Plan provides the basis for establishing an appropriate level of support for the NCSP. The Management Team is currently working with affected program offices to institutionalize funding support for the program. 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.

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

Enclosure

cc (w/encl):
M. Whitaker, S-3.1
J. Roberson, EM-1
R. Haeckel, NA-10
J. Gordon, NA-1
J. Decker, SC-1



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QUARTERLY STATUS OF THE IMPLEMENTATION PLAN
FOR
DEFENSE NUCLEAR FACILITIES SAFETY BOARD RECOMMENDATION 97-2
FOURTH 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. 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 quarter, the NCSPMT and CSSG updated the Five Year Program Plan, provided justification necessary for maintaining funding support, developed a draft Memorandum of Understanding between affected program offices to institutionalize funding support for the program, and worked 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 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

The following is a summary of experimental activities conducted at the Los Alamos Critical Experiments Facility (LACEF) during the fourth quarter, Fiscal Year (FY) 2001.

Experiments were conducted on three of the five LACEF assemblies during this quarter in support of the NCSP. In addition to performing these experiments, one 3-Day Course for uncleared individuals (July 10-12, 2001) and a second 3-Day Course for Q- and L-cleared individuals (July 24-26, 2001) were conducted.

Flattop: Flattop was inoperable for this entire quarter due to a malfunction of the control rod drive system. The redesigned control rod drive system arrived at Technical Area (TA)-18, and installation is scheduled to begin within the next few weeks. A restart notification will be delivered to the Department of Energy Los Alamos Area Office (DOE/LAAO) within the next few weeks to allow for restart 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 (3rd 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 testing of the actuator is completed, the remaining Zeus experiments with different configurations of oralloy and other interstitial materials will be conducted.

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 a 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 from DOE/LAAO, the system will be repaired and SHEBA will be restarted. It is anticipated that this activity will take approximately 9 months.

Godiva: The Godiva assembly remains operational. 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 approved a request to allow neutron measurements with instruments in the glory hole and a subsequent test plan for add-on irradiation experiments.

Planet: The Planet assembly remains operable. Eighteen operations were performed this quarter in support of NCSP activities, criticality safety courses, and operator training. Experimental activities with waste/tuft materials continue. Work also continued on documenting the results of these activities for the benchmark program. Two benchmarks were completed and submitted to the benchmark evaluation program. A new experimental configuration involving U(93) foils, polyethylene plates, and Gadolinium foils was initiated during this quarter and initial criticality was achieved in July 2001.

One of the more significant accomplishments of the fourth quarter FY 2001 was the completion and submittal of the TA-18 Basis for Interim Operation and the new Technical Safety Requirements. This is the final deliverable of a multi-year multi-million dollar safety analysis effort that completely redefines the Authorization Basis at TA-18. In addition, biennial crew member/crew chief recertification and certification of six new LACEF crew members were completed during the quarter.

Benchmarking

International Criticality Safety Benchmark Evaluation Program (ICSBEP) participants focused on the publication of the September 2001 Edition of the "International Handbook of Evaluated Criticality Safety Benchmark Experiments" during the fourth quarter of FY 2001. This major

ICSBEP milestone was completed during September, and distribution of the new version of the handbook in CD-ROM format began on September 21. The ICSBEP Internet Site (<http://icsbep.inel.gov/icsbep>) was also updated and the entire contents of the 2001 Edition of the handbook were made available on September 14, 2001. Included in the 2001 edition of the handbook are 23 newly approved evaluations, major revisions to three previously approved evaluations, and the first edition of the "ICSBEP Guide to the Expression of Uncertainties." The handbook now contains 307 evaluations that span over 22,000 pages and provides 2,462 critical configurations that may be used by criticality safety analysts for validation of their analytical methods. Half of the newly approved evaluations were contributed from outside the United States.

A relational database and a Java users' interface were also developed during FY 2001 to provide a more efficient characterization of the data contained in the Handbook. Development of the database, called **DICE** (**D**atabase for the **I**nternational Handbook of Evaluated **C**riticality Safety **B**enchmark **E**xperiments), was a joint Organization for Economic Cooperation and Development - Nuclear Energy Agency / ICSBEP effort. DICE is also included on the 2001 CD-ROM.

Work continued throughout the quarter on new evaluations that are planned for publication in FY 2002. Two of these evaluations were completed and submitted for independent peer review.

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. The development of the criticality sequences for the new SCALE system version 5.0 was essentially completed, and documentation was finished. Further changes may be required to fix bugs, and to maintain compatibility with additional new parts of SCALE 5.0 as they are implemented into the system. However, the methods and software developments required to meet the SCALE 5.0 goals have been completed. Some effort was expended on preparing for the next Scale criticality course and "hands-on" workshop to be conducted at ORNL. A much more substantial effort will be required for the next course, as it will cover all of the new computational features in SCALE 5.0. Significant user technical assistance was rendered to the SCALE/KENO user community. As part of the RSICC subtask, during this quarter a total of 82 code packages were provided to DOE sites and contractors, 53 to Defense Programs work and 29 to Environmental Management work.

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. In addition, an Introductory MCNP class was taught at Los Alamos in August, and another Introductory MCNP class was taught in Germany in September. Work was performed on a criticality validation suite, which users can employ to show that their installed version of MCNP gives accurate answers for real benchmarks. A team of MCNP developers has been participating in the Expert Group on Source Convergence, under the auspices of the OECD/NEA Working Party on Nuclear Criticality Safety. A number of benchmark calculations which exhibit

convergence problems were recently completed using MCNP, paying particular attention to convergence reliability, statistical checks on results, and guidelines for convergence. The results of this study were issued in LANL Report LA-UR-01-5181, "MCNP Calculations for the OECD/NEA Source Convergence Benchmarks for Criticality Safety Analysis," September 2001, and have been shared with the international criticality safety community. Efforts being made to understand, quantify, and improve the convergence of criticality problems are continuing. In a related effort, a postdoctoral research associate has begun research into improved methods for estimating confidence intervals and for reducing inter-generation correlation for criticality calculations. This work is in the formative stage at present but may result in new capabilities for future versions of MCNP.

Argonne National Laboratory (ANL): Staff at ANL continued to maintain VIM software and to perform studies on fission source convergence. A paper on the theory and implementation of Monte Carlo fission source convergence methods and their susceptibility to excessive variance has been accepted for publication in Nuclear Science and Engineering and is in final revision. Statistical tests commonly used in Monte Carlo codes are being tested for their applicability to problems with challenging source convergence characteristics. The focus is on the "checkerboard" spent-fuel-storage source-convergence benchmark promulgated by the Nuclear Energy Agency Expert Group on Source Convergence. Initial results indicate that these tests will not perform reliably when the fission source has not converged. A report on these tests is being written for the criticality safety community. Point-by-point cross section library comparisons between the VIM and MCNP libraries are continuing, and improvements to the VIM cross section codes and their standard inputs have been made where appropriate.

Nuclear Data

Oak Ridge National Laboratory: The samples for the potassium transmission and capture measurements were acquired, and all environmental, safety, and health issues were addressed to perform measurements with these very reactive samples. Samples for the fluorine capture and transmission measurements were also acquired. Capture and transmission measurements with potassium and fluorine were initiated during this quarter. In addition to the measurement activities, several evaluations are currently in progress or are being updated. Issues to address the continuity between the resolved and unresolved resonance region are being addressed for the silicon evaluation. An initial evaluation for fluorine has been started to take into account the allowance for multiple entrance and exit channels and modification to the ENDF/B-VI format may be necessary. Analysis of the interferences between neutron channels is underway for the aluminum evaluation that may result in another modification to the ENDF/B-VI format. Concerns about the ^{238}U neutron capture cross section are also being reviewed to determine if new measurements and/or a new evaluation are necessary. Evaluations are nearing completion for ORELA chlorine capture and transmission measurements, older total cross section data, and ^{35}Cl (n,p) data. The inclusion of charged particle cross sections will require a new ENDF/B-VI format that is currently being developed. Various enhancements have been made to the SAMMY code including a user-defined resolution function, improvements in charged particle angular distributions and code structure, modifications in the data plotting, and addition of various debugging options.

The ^{233}U neutron cross-section paper has been published in Nuclear Science and Engineering number 139, in October 2001. Nine papers were submitted to the Nuclear Data conference in Japan.

Los Alamos National Laboratory: The new LANL oxygen evaluation has been completed and released in ENDF/B-VI as release 8, which was recently issued by the Brookhaven National Laboratory National Nuclear Data Center to the data user community. This evaluation was based on a new R-matrix analysis by Hale, as well as improvements at higher energies by Young (based in part on new data from LANSCE/WNR). However, below 3.4 MeV, this evaluation used results from KAPL's R-matrix analysis. The new file performed significantly better than the previous ENDF file in a range of criticality benchmarks: 21 ORNL and Rocky Flats benchmark solution criticals (the reactivity trend in the previous ENDF file that was of concern is now small); Broomstick; and age benchmarks.

The LANL ^{37}Cl and ^{35}Cl evaluations, done by Phil Young for criticality safety, have been completed and released in ENDF/B-VI release 8. These evaluations included significant improvements in the description of neutron capture, neutron inelastic and elastic scattering, with detailed representations of discrete and continuum gamma-ray production.

New developments and improvements are being made to the NJOY data processing system. A new version, NJOY2001, dated September 30, 2001, was frozen and released for evaluation and testing. This version is functionally equivalent to the updated version of NJOY99, although it uses the Fortran-90 style. This new NJOY2001 is documented in a comprehensive report.

Small changes were made to the new LANL ^{238}U evaluation in order to better simulate the FLATTOP critical assembly (the existing ENDF evaluation over predicts K-eff because of a reflector bias). The recent LANL focus has been on the magnitude and energy dependence of inelastic neutron scattering, both to discrete levels and to the continuum. The changes being made are based upon both calculated and measured inelastic scattering cross sections, and on critical assembly information.

Argonne National Laboratory: Benchmarking activities continue, including inter-comparison (i.e., verification) of VIM and MCNP point cross section libraries and organization of (and participation in) the data validation efforts within the Cross Section Evaluation Working Group and WPEC nuclear data communities. Effort on processing method development has focused on extending the rigor of representing nuclear cross sections in the unresolved resonance range. Good progress has been made, with the goal of improving the methodology currently used in VIM and MCNP.

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 quarter. One 3-Day Course for uncleared individuals (July 10-12, 2001) and a second 3-Day Course for Q- and L-cleared individuals (July 24-26, 2001) were conducted.

Two ongoing projects within the training development subtask continued this quarter. Development of an interactive PC-based version of the criticality accident slide rule at ORNL was completed. Completion of the Nuclear Criticality Safety Engineer Training modules on the chemistry and criticality safety of uranium and plutonium separations has been delayed because of other higher priority commitments on the part of the individuals performing the work. The contract for this work has been extended until the end of calendar year 2001, and the modules are expected to be completed prior to then.

Sites continued to develop and improve training and qualification of criticality safety engineers. All sites reviewed their criticality safety improvement plans with regards to improving criticality safety engineer time in operating areas. Several other sites, (e.g. LANL, ORNL, Pantex), made progress toward implementing DOE-STD-1135-99 for criticality safety engineer training and qualification by formally incorporating DOE O 420.1 Chg 3 into their contracts.

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 (LLNL). 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 calendar 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, DVDs, and CDs will be available in the near future.

Improvements continue to be made to the NCSP web site, which is maintained at LLNL. This web site provides technical information and serves as a pointer to other web sites, which are important to the NCSP. During the fourth quarter of FY 2001, improvements to the web site included: (1) added ten more users to web site registration database; (2) deployed the new frame base NCSP web site to improve users friendliness in browsing the web pages; (3) installed new

operating system cluster patches as required by DOE cyber security policy; and (4) posted the third quarter NCSP quarterly report on the web page.

Applicable Ranges of Bounding Curves and Data

During the fourth quarter of Fiscal Year 2001, three 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.

Under subcontract extension, the University of California, Berkeley, continued to modify the SWANS code for performing geometric optimization. Also, the SWANS material optimization features are still being tested.

Work was completed on the development of the SEN1 and SEN3 computational sequences for producing sensitivity coefficients for criticality safety models within the SCALE code system. User manuals for these features, as well as the new methods to compute the sensitivity of K-eff to the group cross section resonance processing with BONAMI and NITAWL-II, will be initiated shortly. Further testing of these new techniques is being performed with both SEN1 and SEN3 on a complex, real-life application.

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. Additionally, the demonstration will be included in the NCSP Workshop at the November American Nuclear Society 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 5.0.