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Department of Energy
National Nuclear Security Administration
Washington, DC 20585

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UNF SAFETY BOARD

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 third quarter 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. With the Secretary's decision for Defense Program to fully fund and manage the Nuclear Criticality Safety Program (NCSP) for Fiscal Year 2003 and beyond, stability of funding should be achieved.

The NCSP continues to sustain progress in all of the program task areas. In addition, significant progress was made in baselining the NCSP and drafting a new Five Year Plan. Your staff has actively participated in this process, and I welcome continued participation as we finalize the Plan.

Finally, I want to inform you about our completion of the following commitment that was made in a Secretarial letter to you of May 6, 2002:

Regarding contractor criticality safety qualification plans, Field Offices are required by Department of Energy Order 420.1, *Facility Safety*, to review and approve these plans. We have asked our Field elements to provide their assessment of contractor qualification plans, including the bases upon which they made these assessments, and will inform you about the results after we review their submissions. We expect to complete this action by June 2002.

Dr. Jerry McKamy was asked to review the contractor qualification plans and Field Office assessments, as required in this commitment. Overall, contractor implementation of qualification programs has gone quite well. However, Dr. McKamy's review revealed some



areas for improvement that are being actively addressed by the Field Offices. More details on the review are contained in the Training and Qualification section of the enclosure to this letter.

Sincerely,

A handwritten signature in black ink, appearing to read "D. H. Crandall", written in a cursive style.

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

Enclosure

cc (w/encl):

M. Whitaker, S-3.1

E. Beckner, NA-10

L. Brooks, NA-1

QUARTERLY STATUS OF THE IMPLEMENTATION PLAN
FOR
DEFENSE NUCLEAR FACILITIES SAFETY BOARD RECOMMENDATION 97-2
THIRD QUARTER 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 (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 will be finalized in early August 2002.

The Criticality Safety Support Group (CSSG) is performing its chartered functions in supporting the NCSP Manager's development of the New Five Year Plan. During the third quarter of Fiscal Year (FY) 2002, the CSSG played a central role in reviewing NCSP Task Manager input and developing a baseline for the NCSP that maintains capability and addresses the Department's most pressing criticality safety needs. This new baseline along with program specific application work are reflected in the new Five Year Plan.

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.

Integral Experiments

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

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

Flattop: After two and one half years of down time, Flattop was returned to operable status on June 19, 2002. Flattop's return to service occurred after a complete replacement of the control rod drive system, resolution of several Technical Safety Requirement issues, and resolution of multiple security issues. Currently, training and requalification of all of previous Flattop operators are occurring. Flattop will be used for all upcoming criticality safety courses and will continue to be the LACEF "workhorse" with respect to operator training.

Comet/Zeus: This was another very aggressive and successful quarter for the Zeus series of experiments. Preparations continue 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. SHEBA should be approved for operation following DOE Site Office approval of the new Basis for Interim Operation which is expected to occur within the next few months.

Godiva IV: Multiple Godiva operations were performed this quarter in support of criticality safety courses, operator training, and integral cross section measurements for benchmarking neutron transport computer codes at Los Alamos.

Planet: The Planet assembly was returned to operable status on May 28, 2002, after a complete replacement of its control system. The existing control system (designed and implemented in the 1980's) failed in January 2002, and a new, modern Allen-Bradley control system was designed to replace it. The vast majority of previously qualified Planet operators have been requalified on the new system, and NCSP priority experiments and criticality safety demonstrations for our criticality safety courses have resumed.

Benchmarking

Throughout the third quarter of FY 2002, activities of the International Criticality Safety Benchmark Evaluation Project (ICSBEP) were primarily focused on preparations for the annual Working Group Meeting. The meeting was held in London, United Kingdom, June 17 through June 20. Representatives from the United States, United Kingdom, France, Japan, Russian Federation, and Spain participated in this meeting. Representatives from the International Atomic Energy Agency (IAEA) and the Organization of Economic Cooperation and Development (OECD) Nuclear Energy Agency (NEA) also participated. A total of 24 new evaluations and one evaluation that was revised to include one additional configuration were reviewed at this meeting. All but one of these evaluations was approved for publication in the 2002 Edition of the "International Handbook of Evaluated Criticality Safety Benchmark Experiments." Revisions to two additional evaluations (no new configurations) and the ICSBEP Guide to the Expression of Uncertainties were also reviewed and approved for publication. Publication of all of these documents is subject to satisfactory resolution of all action items identified by the project participants. A summary of this meeting, including action items, was written and distributed to ICSBEP participants. The reference for this summary is INEEL CCN 33956.

Selected ICSBEP Working Group Members participated in a NCSP Nuclear Data Advisory Group Meeting in Chicago, Illinois, and a workshop on the FY 2003 Five-Year Plan in Las Vegas, Nevada. A draft Five-Year Plan for the Benchmarking Task was written and submitted to DOE NCSP Management.

Discussions on current collaborations between the ICSBEP and the OECD were held at the OECD NEA offices in Paris, France. Discussions on improvements to the ICSBEP Database, DICE, focused on the Russian efforts to provide independent verification of previous data entry, the format of the 299 group spectra data, and the format for inclusion of the newly obtained sensitivity data and correlation matrices for the data in the "International Handbook of Evaluated Criticality Safety Benchmark Experiments." Discussions were also held on an opportunity to produce a special edition of the technical journal, "Nuclear Science and Engineering" that is focused on the ICSBEP. A letter announcing this opportunity was drafted, cosigned by the ICSBEP and the OECD, and was distributed to ICSBEP participants. Titles and abstracts of potential papers were submitted by ICSBEP participants in June.

Three students began working on the ICSBEP and will continue their efforts throughout the summer.

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. Assistance included the following: a "hands-on" SCALE/KENO workshop was conducted at ORNL in April, which featured the new computational capabilities of SCALE Version 5.0; a SCALE Training Course on KENO-VI and ORIGEN-ARP was conducted in Mexico City, Mexico, for ten IAEA representatives from five Latin American nations; and a SCALE KENO V.a and ORIGEN-ARP Training Course was conducted at Florida Power & Light (FP&L) office in Juno Beach, Florida, for eight engineers from FP&L's core reload design group.

Calvin Hopper and Bryan Broadhead conducted a training course on the Slide Rule for Nuclear Criticality Accident Response. Eleven persons from the United States and one from Japan attended the two-day course held at ORNL. The hand-held slide rule, developed by Hopper and Broadhead, is a tool included in the Nuclear Regulatory Commission emergency response manual. The course teaches attendees how to use the slide rule to quickly estimate fission yields from an accident; estimate dose to accident victims; and estimate current, future, and time-integrated neutron and gamma dose at various distances from the accident.

In terms of code development, a number of modifications and updates were performed on the KENO V.a, KENO VI, XSDRNPM and NITAWL modules. Also, a new validation report comparing KENO-V.a and KENO-VI was completed.

At the request of the DOE Office of Environmental Management, Calvin Hopper and Sedat Goluoglu performed extensive criticality safety analyses of three types of fissionable material containers designed for shipping transuranic fissionable material from the DOE production sites to the Carlsbad Waste Isolation Pilot Plant. Their study, part of a larger scoping evaluation by

the NCSP, showed the potential for savings by reducing the number of containers by factors up to five and reducing the number of shipments by factors up to twenty-four. Sedat Goluoglu and Calvin Hopper were awarded Certificates of Appreciation by Dr. Crandall, Assistant Deputy Administrator for Research, Development, and Simulation, National Nuclear Security Administration, for their role in the performance of this study, which demonstrated the opportunity for significant increases in fissile mass limits, with corresponding benefit to the transuranic waste disposition program.

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. Version 5 of MCNP is nearing completion. This version has been entirely upgraded to follow modern software practices and standards and was converted to Fortran-90. Its release to the Radiation Safety Information and Computational Center is targeted for November 2002. The MCNP team revised the lecture notes and example problems for the MCNP Criticality Applications course and taught the class in the Knoxville area in early May. Work has continued on investigating methods for improving the computed confidence intervals. It is well known that Monte Carlo under estimates confidence intervals if cycle-to-cycle correlation is present. Significant progress has been made in this area, and a paper on the use of auto-regressive fitting was presented at the American Nuclear Society meeting in June 2002. Finally, very promising work is in progress to use the "entropy" of the source distribution to determine whether a Monte Carlo eigenvalue calculation is stationary, i.e., has fully converged. A paper on this subject will be presented at the American Nuclear Society Winter meeting in November 2002.

Argonne National Laboratory (ANL)

Staff at ANL continued to maintain VIM software and to develop improved methods of cross section processing and quality assurance. Software is under development that will allow a complete check of a newly produced library (requiring 100 megabytes of data) in less than a day, which is also the time it takes to produce one VIM library. This new software should provide increased confidence in the libraries. It performs automated detailed point-by-point comparison of VIM fission, capture, elastic scattering, and total cross sections with a reference library (currently, an MCNP library) and highlights significant differences. The system used to perform these checks, when applied to a developmental VIM library, has pinpointed processing errors for a number of nuclides mainly due to changes in ENDF data conventions. (It should be noted that existing production libraries contain none of the important errors found.) Even though the format changes between ENDF versions are modest, the evaluators' exploitation of the formats tends to change, so that the processing codes commonly need upgrading to accommodate new data. As a result of the current testing, the processing codes are being upgraded and will be thoroughly tested.

After a few modifications, VIM has been successfully ported to a MacIntosh computer. A similar version will eventually be released as a PC version for the criticality safety community.

Two papers of interest to the criticality safety community were presented at American Nuclear Society-sponsored meetings. The first was "Status of the VIM Monte Carlo Neutron/Photon Transport Code," by R. N. Blomquist, *Proceedings of the 12th Biennial RPSD Topical Meeting (ANS)*, Santa Fe, NM, April 14-18, 2002 (CD-ROM). The second was "VIM Calculations of ICSBEP Pu Benchmarks for ANSI/ANS-8.1", by J. W. Thomas and R. N. Blomquist, *ANS Transactions* 86, pp53-55, June 2002. A journal article describing ANL analysis and findings from work on fission source convergence algorithms was published as "Alternative Implementations of the Monte Carlo Power Method," by R. N. Blomquist and E. M. Gelbard, *Nucl. Sci. Eng.* 141, pp 85-100 (2002).

Nuclear Data

ORNL

A new electron gun was installed in the ORELA during this quarter. However, after much testing the new gun failed after being installed in the gun tank. The exact cause for the failure of the new gun has yet to be determined and another gun is to be installed later this month. The accelerator cannot operate without the electron gun; therefore, much effort has also been devoted to repairing and replacing the electron gun. The measurements with the enriched potassium sample will continue when ORELA becomes operational again.

The Fluorine evaluation is nearing completion, and a modified version of NJOY has been created to process the Reich-Moore parameters including inelastic channels. Several code-dependent libraries have been generated for preliminary versions of our ^{233}U , silicon, and chlorine data and have been made available to the criticality safety community for data testing. A method to retroactively produce new covariance data by treating existing resonance data has been included in SAMMY. Covariance data, in the resonance region, has been generated for $^{152,154,155,157,158,160}\text{Gd}$. The generation of covariance data for the unresolved region is still under development. Modifications to the ^{238}U nuclear data are also under investigation and will contribute to the international effort to address deficiencies in this data; resonance parameters have been generated in the energy region from 10 to 20 keV. A reevaluation of the resonance parameters for ^{241}Pu from thermal to 20 eV has been completed and will be published in a joint report with the CEA. Reports have been prepared to describe the silicon evaluations and the aluminum evaluation. These reports will be published later this year.

Enhancements have also been made to the SAMMY program: a crystal lattice Doppler broadening scheme has been implemented and has undergone preliminary testing. The SAMDIS routine has been modified to more accurately represent the statistical distribution of resonances. An interim version of SAMMY, correcting some of the earlier release's difficulties related to portability, has been released via RSICC. Subsequently, an optional, more accurate (but more

time-consuming) Coulomb function has been implemented in the code. In the unresolved resonance region (URR), the capability has been provided to use different resonance parameters in different energy regions. URR results can now be reported in ENDF format. In both the resolved resonance region (RRR) and the URR, covariance matrices can now be reported in a concise format which will be proposed this fall for inclusion in ENDF. In the RRR, a “true Reich Moore” format for ENDF has been developed and is being tested; this format will eliminate the limitations that current ENDF formats artificially impose on analyses, and instead will permit the analyst to utilize the correct physics for the nuclide under study.

Luiz Leal, Maurice Greene, Davis Reed, Tim Valentine and Mike Westfall participated in the Nuclear Data Advisory Group (NDAG) meeting at Argonne National Laboratory in May. The NDAG is being organized to enhance the coordination of the nuclear data activities with DOE needs.

LANL

At Los Alamos, the work on a new neutron (n) + ^{233}U evaluation has progressed. A new optical model potential for $n+^{233}\text{U}$ which allows the reliable modeling and evaluation of the important reaction (absorption), scattering, and total cross sections has been obtained. Progress has also been made in modeling $n+^{233}\text{U}$ fission reactions using the fission-barrier penetration model within the GNASH Hauser-Feshbach code. These steps will allow the completion of a newly improved ^{233}U evaluation.

Three staff members from LANL (Mark Chadwick, Bob MacFarlane and Bob Little) attended the May 2002 NDAG meeting in Argonne. Mark Chadwick was asked to chair the NDAG Working Group on Data Evaluation. This meeting allowed the nuclear data community to better understand the needs, both short term and longer term, of the criticality safety community. Work has progressed since then on organizing the Evaluation Working Group to respond to criticality safety needs, including: (a) providing NJOY doppler-broadened Gd data for better understanding the criticality of plutonium stored systems that include Gd absorbers (at Savannah River); (b) assessing the nuclear data accuracy for Gd, including needed upgrades; (c) long-term needs for better ^{233}U data; (d) improved Mn data needed for waste storage configurations at Idaho; (e) evidence for needed improvements in ^{238}U data; and (f) longer term improvements needed for ^{237}Np data for burnup credit studies.

Mark Chadwick also attended the Nuclear Energy Agency's Working Party on Evaluation Cooperation in May, which provides a forum for evaluators in the US, Japan, Europe, and Russia to collaborate and discuss nuclear data advances in their respective national databases. Criticality safety issues, both nuclear data evaluation and experiments, were discussed at the meeting.

ANL

On May 7-8, 2002, ANL hosted the first working meeting of the NDAG which included broad representation of the nuclear data community (ANL, BNL, LANL, ORNL), the user community (LLNL, WSMS), other NCSP program elements, and DOE. An initial structure for NDAG was created, including generation of six working groups (Data Needs, Measurements, Evaluation, Integral Experiments, Benchmarks, and Validation). The NDAG will focus on priority needs of the Criticality Safety community and coordination of the NCSP resources and program elements. Minutes of this meeting, including detailed action items, were prepared and distributed by the NDAG Chair (Dick McKnight, ANL) and the NCSP Nuclear Data Element Task Manager (Mike Westfall, ORNL).

Some validation calculations were performed in conjunction with the inter-comparison effort for the VIM and MCNP libraries (see ANL section of Analytical Methods Development and Code Maintenance, above). Work continued 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 third quarter of FY 2002. A 5-Day Basic Course and a 5-Day Advanced Course were conducted. A 3-Day Course scheduled in May was postponed until July due to low registration.

Regarding training development, the Nuclear Criticality Safety Engineer Training (NCSET) module on the criticality safety of plutonium separations has been completed. Savannah River reviewers would not release the report for unlimited distribution because of potentially sensitive material. Even though the contents are not applied technology or Unclassified Controlled Nuclear Information, this restriction is causing a delay in adding the module to the NCSP web site. The module is now being edited into a form that will allow it to be released with no restrictions, subject to Savannah River approval.

Work on the second of two NCSET modules on hand calculations continues under the direction of the criticality safety group at LANL with the help of Joe Thomas. This module will deal with the more advanced methods that were introduced in the first hand calculation methods module. It is expected that this module will be finished during the next quarter.

The module on the development, selection, and use of cross sections sets in criticality safety has been started at ANL. 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 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. This module should be completed and in place on the NCSP web site in the next quarter.

Regarding qualification activities, Dr. Jerry McKamy was asked to review the Field Office assessments of contractor qualification plans. This review fulfilled a commitment from a May 6, 2002, letter from Secretary Abraham to the Board. The results of his review are as follows:

With a few exceptions (Rocky Flats, Sandia, and Los Alamos), DOE Field Offices have approved all the contractor training and qualification plans. The DOE Rocky Flats Field Office is actively working with its contractor to negotiate final changes to the program so approval can be granted. Although the qualification programs at Sandia and Los Alamos meet the intent of the DOE Standard in practice, these programs have not been adequately documented or approved at this time. The DOE Albuquerque Operations Office is working hard to rectify this situation, and resolution is expected in the near future.

Dr. McKamy also reviewed the following contractor qualification programs: Savannah River, Rocky Flats, BNFL Oak Ridge, Bechtel-Jacobs Oak Ridge, Hanford contractors (Fluor, Bechtel, PNNL), BWXT Idaho, Argonne National Laboratory, Lawrence Livermore National Laboratory, BWXT Y-12, and Pantex. The review showed that all the programs comply with the intent of the standard on training and qualifications, DOE-STD-1135-99, with varying degrees of specificity. Some are written at a high level and others are very specific and detailed. All, for example, include the Advanced 5-Day Criticality Safety Course at Los Alamos in their programs and encourage staff to attend the course. All contain facility familiarization requirements albeit with variable rigor tailored to the specific site and facility. Other attributes evident were the basic technical knowledge requirements, and most included specific job tasks/work assignments and qualification levels to perform those tasks. Some particularly outstanding examples of training and qualification programs that clearly meet or exceed the expectations of DOE-STD-1135 include those developed by BWXT Y-12, LLNL, Bechtel Jacobs at Oak Ridge, and WSMS at Savannah River. Because of the variability of specificity and approaches found by the independent review, the NCSP plans to sponsor a best-practices/lessons learned session at its scheduled program review session held in conjunction with the Winter American Nuclear Society Meeting in November 2002 in Washington, D.C. The purpose will be to spotlight the best programs of the Department and encourage all sites to incorporate those best practices where practical.

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. The Heritage video series conducted at Los Alamos in September of 2000 has been edited and reproduced. A summary

document describing the series and the participants was also produced. The series consists of 15 tapes with approximately 12 hours of content. Distribution is currently being made. Similar editing and reproduction of the Oak Ridge Heritage video series are expected to be completed in FY 2003.

Scanning of the ANL log books continues. One component of the scanning effort is a contract with Cover to Cover to scan all ZPPR records that are standard size format. Approximately 25 percent of those records were scanned during this quarter, despite the breakdown of their scanner for an extended period. The other component progressed until the end of April when the retired technician who was doing the scanning left for about six months. In this quarter, he scanned all records for Assemblies 6, 6A, and 28 of ZPR-9, and Assemblies 5, 6, 6A, 7, 9 and 10 of ZPR-6. CSIRC monies were transferred from Los Alamos to Hanford during the quarter to update the Hanford Database. This database can be found on the NCSP web site and is an important source of information for the criticality safety community.

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 third quarter of FY 2002, web site improvements included:

- (1) Updating the main web page and DOE Order & Standard web page to include links to DOE standard "DOE-STD-1135-99;"
- (2) Participating in the formulation of the new baseline for the NCSP Five Year Plan;
- (3) Converting NCSP end users viewgraphs to PDF and creating web pages for NCSP web site posting;
- (4) Moving "CSSG Review of Draft Guides to 10 CFR 830," Dr. Kouts' viewgraph, and October 2000 NCSP workshop's viewgraphs to the web page archive; and
- (5) Installing Security software "OpenSSH v3.4p1" as mandated by DOE cyber security policy.

Applicable Ranges of Bounding Curves and Data

During the third quarter 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.

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 has been completed. A bug in the operation of the CENTRM module in the SMORES sequence was fixed. Advanced geometric optimization methodology is operational as prototypic software 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 involving the design features of a MOX fuel fabrication facility were performed. Results from this study were presented at the first Nuclear Data Advisory Group meeting at Argonne in May, as well as at the NCSP Workshop held in conjunction with the June American Nuclear Society Annual Meeting. Plans are being developed to apply AROBCAD methodology in the analysis of DOE/EM applications requiring near-term results. Also, the first public presentation on SMORES was given at the June American Nuclear Society Annual 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 being implemented into SCALE 5.0. Revisions include the improvement of memory management in both sequences. Also, further revisions were made on the CANDE module in preparation for implementation into SCALE Version 5.0. Guidance on the use of CANDE and SAMS is in preparation.