The Secretary of Energy
Washington, DC 20585

December 12, 1997

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:

We are pleased to forward the Department's Implementation Plan for Defense Nuclear Facilities Safety Board's Recommendation 97-2, *Criticality Safety*. This Plan addresses the need for improved criticality safety practices and coherent programs to alleviate the potential adverse impacts on safety and productivity of Department of Energy operations. It builds upon the successful actions taken in response to Board Recommendation 93-2, *The Need for Critical Experiment Capability*, which is being implemented through the Nuclear Criticality Predictability Program. Because the Implementation Plan for Recommendation 97-2 incorporates ongoing Nuclear Criticality Predictability Program activities, I propose closure of Recommendation 93-2.

To continue successful implementation of Recommendation 93-2 and implement Recommendation 97-2 in an integrated fashion, the Department is taking steps to ensure stable funding for these important crosscutting safety activities now and in the outyears. We have established a responsible line manager and identified necessary funding for fiscal years 1998 and 1999.

The Implementation Plan was prepared by a cross-organizational response team reporting to the Assistant Secretary for Defense Programs in coordination with other affected Headquarters and Field offices. Dr. Robin Staffin, Deputy Assistant Secretary for Research and Development, Office of Defense Programs, will be the responsible manager for implementing this plan. He can be reached at (202) 586-7590.

Sincerely,

Federico Peña

Enclosure

Department of Energy
Implementation Plan

for

Defense Nuclear Facilities Safety Board
Recommendation 97-2

Criticality Safety

December 1, 1997

Executive Summary

On July 14, 1997, the Department of Energy (the Department) accepted Defense Nuclear Facilities Safety Board (the Board) Recommendation 97-2. The recommendation addresses the effectiveness of criticality safety programs at defense nuclear facilities. In developing this Implementation Plan, the Department builds on the actions taken for Board Recommendation 93-2, *The Need for Critical Experiment Capability*. The Implementation Plan for Board Recommendation 93-2 established programs to ensure the viability of the Department's critical experiments program. It resulted in the five-element Nuclear Criticality Predictability Program (NCPP) as described in the NCPP five-year plan of November 1996. The ongoing activities of the NCPP will be managed under the program established for Board Recommendation 97-2. Effective implementation of the 97-2 crosscutting criticality safety activities is important to the successful completion of other Departmental programs, such as those programs which address Board Recommendations 97-1, 94-1, 94-4, and 95-2. The Implementation Plan for Board Recommendation 97-2 will support the efficient integration and functioning of criticality safety programs across all Departmental operations involving fissile material.

The Department recognizes the need to integrate safety into its work. Initiatives are being implemented, as appropriate, to apply graded or tailored approaches to the work and any associated hazards. Where operations involve significant quantities of fissile material, accidental criticality is a hazard that must be analyzed and for which controls must be identified and implemented. The Department recognizes that the process of identifying and analyzing credible accident scenarios and implementing appropriate controls to prevent or mitigate an accidental criticality must involve an efficient process that does not use excessive resources and that allows the work to be accomplished in a timely manner. Therefore, this Implementation Plan identifies and will address the following central safety issue: the need for improved criticality safety practices and coherent programs to alleviate the potential adverse impacts on safety and productivity of Department of Energy operations.

The Department will take the following actions to address this issue:

1. Improve the technical knowledge of criticality safety personnel. This will be accomplished by updating and improving the training offered at DOE's critical experiments facility, improving site training and qualifications programs by identifying and incorporating best practices, and by identifying exceptional criticality safety curricula offered at institutions outside the Department;

2. Improve the availability and use of criticality safety information (i.e., experimental data, calculational studies, and evaluations) and guidance. Effective use of criticality safety Internet web pages will ensure widespread availability of information, and guidance will stress the appropriateness and application of simplified methods of criticality safety analysis; and

3. Verify that sites having fissile material operations have appropriately considered criticality safety in the work planning process through the implementation of the Integrated Safety Management System (ISMS), and that their criticality safety programs are organized as a staff function advising line management.

Table 1 summarizes the commitments in this plan, which are described further in Section 6.

Table 1. Summary of Implementation Plan Commitments and Deliverables/Milestones

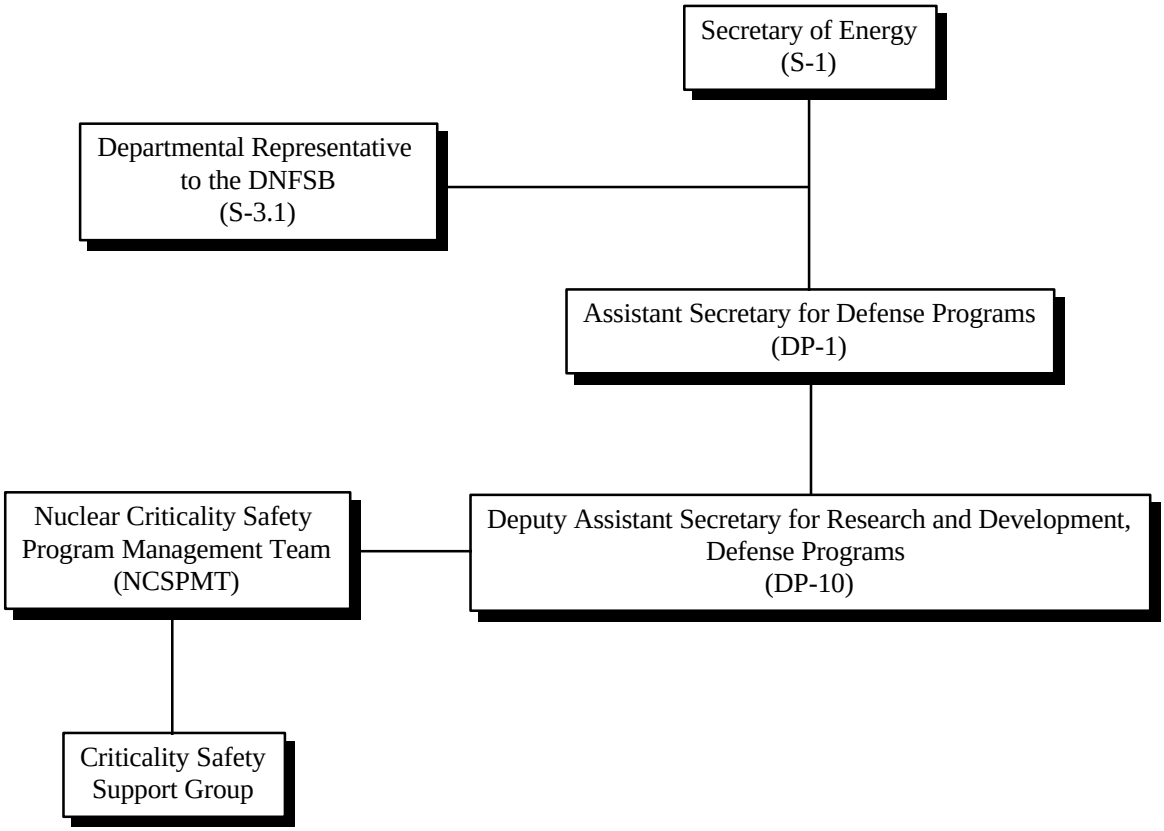
Commitment	Deliverable/Milestone	Due Date	Responsibility
6.1 Reexamine the experimental program in criticality research	1. Assessment report of criticality research program	March 1998	NCSPMT
6.2.1 Perform CSIRC pilot program	1. Identify an experiment to archive	November 1997	NCSPMT
	2. Archive logbook(s) and calculation(s) for that experiment	December 1997	NCSPMT
	3. Videotape the original experimenter	January 1998	NCSPMT
	4. Digitize data and calculations	February 1998	NCSPMT
	5. Publish data and calculations	April 1998	NCSPMT
6.2.2 Continue to implement the CSIRC program	1. Collocate logbooks (copies or originals) from all U.S. critical mass laboratories	December 1998	NCSPMT
	2. Screen existing logbooks with original author/experimenter	December 1998	NCSPMT
	3. CSIRC program plan	December 1998	NCSPMT
6.3 Continue and expand work on ORNL sensitivity methods development	1. Technical program plan	July 1998	NCSPMT
	2. Document initiation of priority tasks from the program plan in the quarterly report to the Board	January 1999	NCSPMT
6.4 Make available evaluations, calculational studies, and data by establishing searchable databases accessible through a DOE Internet web site	1. DOE criticality safety web site	March 1998	NCSPMT
	2. Y-12 evaluations on DOE web site	June 1998	NCSPMT
	3. Calculations compiled by the Parameter Study Work Group on DOE web site	September 1998	NCSPMT
	4. Nuclear Criticality Information System Database on DOE web site	March 1999	NCSPMT
6.5.1 Revise and reissue DOE-STD-3007-93	1. Revise DOE-STD-3007-93	September 1998	NCSPMT
6.5.2 Issue a guide for the review of criticality safety evaluations	1. Departmental guide for reviewing criticality safety evaluations	May 1999	NCSPMT
6.6.1 Expand training course at LACEF	1. Expanded LACEF training course	July 1998	NCSPMT

Commitment	Deliverable/Milestone	Due Date	Responsibility
6.6.2 Investigate existing additional curricula in criticality safety	1. Assessment of additional training needs and review of available supplementary curricula	June 1998	NCSPMT
	2. Initiate a program which addresses identified needs	December 1998	NCSPMT
6.6.3 Survey existing contractor site-specific qualification programs	1. Report on the review of site qualification programs	June 1998	NCSPMT
	2. Guidance for site-specific criticality safety training and qualification programs	September 1998	NCSPMT
	3. Guidance to procurement officials specifying qualification criteria for contractor criticality safety practitioners	September 1998	NCSPMT
	4. DOE Field will provide line management dates upon which contractors will have implemented guidance in Deliverable #2, above	March 1999	Field Office Managers
6.6.4 Federal staff directly performing criticality safety oversight will be qualified	1. Qualification program for Departmental criticality safety personnel	December 1998	NCSPMT
	2. DOE criticality safety personnel qualified	December 1999	NCSPMT
6.7 Each site will conduct surveys to assess line ownership of criticality safety	1. Individual sites issue report of findings	June 1998	Field Office Managers
6.8 The Department will form a group of criticality safety experts	1. Charter for Criticality Safety Support Group approved by the NCSPMT	January 1998	NCSPMT
6.9 Create NCSPMT charter and program plan	1. NCSPMT charter	January 1998	NCSPMT
	2. NCSPMT program plan	June 1998	NCSPMT

Figure 1 illustrates the organization of the Department's criticality safety function. The Assistant Secretary for Defense Programs (DP-1) will be responsible for leading the Department's criticality safety activities. The Departmental Representative to the Defense Nuclear Facilities Safety Board (S-3.1) will assist DP-1 in resolving funding issues, if necessary. The Responsible Manager will be the Deputy Assistant Secretary for Research and Development, Office of Defense Programs (DP-10), who will oversee the execution of this plan. A Nuclear Criticality Safety Program Management Team (NCSPMT) will be responsible for the execution of this Plan as well as ongoing activities from the Department's response to Board Recommendation 93-2. The NCSPMT will receive technical support from a Criticality Safety Support Group. Both the NCSPMT and the Criticality Safety

Support Group will be established under charters developed as part of this Implementation Plan.

Figure 1. Department of Energy Nuclear Criticality Safety Program Organization



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1. Background

On May 19, 1997, the Board issued Recommendation 97-2, addressing the need for improved criticality safety practices and programs to alleviate potential adverse impacts on safety and productivity of Department of Energy operations. This Plan describes the actions which will enhance criticality safety in the Department's operations and will effectively respond to the Board's specific recommendations listed below:

Subrecommendation 1: Restructure the program of experimental research in criticality established under the Implementation Plan for Recommendation 93-2 to emphasize determination of bounding values for criticality of systems most important in the current programs at DOE facilities.

Subrecommendation 2: Organize the records of calculations and experiments conducted to ensure the criticality safety of DOE's past operations so as to provide guidance for criticality safety in similar situations in the future and avoid repetition of past problems.

Subrecommendation 3: Establish a program to interpolate and extrapolate such existing calculations and data as a function of physical circumstances that may be encountered in the future, so that useful guidance and bounding curves will result.

Subrecommendation 4: Collect and issue the experimental and theoretical data from the above in a publication as guidance for future activities.

Subrecommendation 5: Clarify in guidance that simple, bounding methods of analysis can be used in place of specific theoretical analysis in setting criticality limits for processes, and that limits derived in this manner are even preferable where they serve the purpose. The decreasing order of preference should be experimental data, theory benchmarked against experimental data, and nonbenchmarked criticality analysis with an adequate safety margin.

Subrecommendation 6: Develop and institute a short but intensive course of instruction in criticality and criticality safety at DOE's criticality experiments facility to serve as the foundation for a program of formal qualification of criticality engineers. This course should instill in students a familiarity with the factors contributing to criticality, the physical behavior of systems at and near criticality, and a theoretical understanding of neutron multiplication processes in critical and subcritical systems. A goal would be for reliance for criticality safety at any DOE facilities to rest in a group of individuals endowed with such experience.

Subrecommendation 7: Where not already done, assign criticality safety as a staff function assisting line management, with safety responsibility residing in line management.

Subrecommendation 8: Identify a core group of criticality experts experienced in the theoretical and experimental aspects of neutron chain reaction to advise on the above steps and assist in resolving future technical issues.

Subrecommendation 9: Organize funding of the criticality research and instruction program to improve its stability and to recognize the cross-cutting importance of this activity.

2. Underlying Causes

The Department recognizes the need for improved criticality safety practices and coherent programs to alleviate potential adverse impacts on safety and productivity of Department of Energy operations. The Department believes that the following items have contributed to the current situation which has resulted in Board Recommendation 97-2:

A. Criticality safety has not been systematically integrated into work planning and implementation. In some instances, this has resulted in inadequate process descriptions, procedures, and scope of applicable process upsets during the development of criticality safety evaluations and limits.

B. The criticality safety data, calculational studies, and evaluations that have been identified and made readily accessible to the practitioner are not sufficiently inclusive of all data, calculational studies, and evaluations that exist. Much of the available information still resides in logbooks and internal reports at individual sites. For most of these, there is no catalog, retrieval, or distribution system which can make them available to the criticality safety practitioner.

C. Adequate criticality safety data supporting some current missions do not exist. If this deficiency is not addressed, criticality safety personnel will have to impose additional conservative margins of subcriticality on the affected operations. In a few instances where this has happened in the past, this practice has resulted in inefficiencies in operations and has delayed completion of the supporting criticality safety evaluations.

D. Some criticality safety personnel have not had sufficient practice in the application of methods for determining margins of subcriticality alternative to those relying on detailed computer modeling to permit generalization and extrapolation from existing calculations or data. This results in over-reliance on complex computational methods which may in some cases be less efficient than using alternative analytical methods, where such methods can be shown to be applicable.

E. Criticality safety practitioners often lack the practical experience with fissile material operations necessary to identify or assist operating personnel in identifying the proper set of credible process upset conditions applicable to operations. Reliance instead is improperly placed on the review process for identification. The lack of experience with operations also detracts from the ability of the criticality safety practitioner to justify why a particular set of process upsets make up a necessary and sufficient set of scenarios. It is in the better interest of both safety and efficiency for such proper-set identification to occur earlier in the criticality safety evaluation process.

3. Baseline Assumptions

In the development of this Implementation Plan, the following assumptions are made:

A. Recommendation 97-2 builds upon the successful actions taken in response to Recommendation 93-2, The Need for Critical Experiment Capability, which established the Nuclear Criticality Predictability Program.
B. Funding for out-year tasks in this Plan will be provided.
C. Recommendation 97-2 is viewed as supplementing the scope of Recommendation 93-2 activities to

focus on remaining practical criticality safety issues.

4. Related Activities

The following ongoing or completed activities are relevant to the issues in this Plan:

A. The International Criticality Safety Benchmark Evaluation Project is promulgating benchmarked criticality data to the field (benchmarking program element of NCPP) including previously undocumented United States experiments as well as data from outside the United States.
B. Los Alamos National Laboratory has archived the Rocky Flats, Hanford, and Brookhaven critical mass laboratory logbooks.
C. Criticality safety related web pages are under development.
D. Y-12 has developed a relational database for criticality safety evaluations and document indexes that may be used as an example for information sharing (inactive data bases include LLNL, NCIS, Hanford, etc.).
E. Russian process criticality accident histories are being researched and documented and will be promulgated.
F. A Departmental Review Guide for criticality safety evaluations has been drafted and issued to the Oak Ridge Operations Office.
G. The Department developed the NCPP five-year plan of November 1996 in response to Board Recommendation 93-2, which consists of the following five elements:
    - Experiments;
    - Training;
    - Benchmarking;
    - Methods; and
    - Nuclear Data.
H. A Department Good Practices Guide for criticality safety is in draft form and is ready for review.
I. Nuclear data and criticality calculational methods continue to be published and issued to the Department's nuclear criticality safety practitioners by the Radiation Safety Information Computational Center (RSICC) as supported, in part, by the Department's objectives for 93-2.

5. Organization and Management

The Department recognizes the need to conduct a coherent nuclear criticality safety program which performs essential crosscutting activities such as improving the technical training and qualification of the criticality safety community and providing criticality safety information and guidance for the practitioner. These activities will enhance the safety of all operations involving fissile material while improving the efficiency of criticality safety programs. Since criticality safety issues affect a number of Departmental Program Offices, involvement of all affected Program Offices is essential to conduct a coherent and efficient criticality safety program.

The Assistant Secretary for Defense Programs (DP-1) will be responsible for leading the Department's criticality safety activities. The Departmental Representative to the Defense Nuclear Facilities Safety Board (S-3.1) will assist DP-1 in resolving funding issues, if necessary. The Responsible Manager is the Deputy Assistant Secretary for Research and Development, Office of Defense Programs (DP-10), who will oversee the execution of this plan. A Nuclear Criticality Safety Program Management Team (NCSPMT) will be responsible for the

execution of this Plan as well as ongoing activities from the Department's response to Board Recommendation 93-2. This team will consist of representatives from the following offices: Defense Programs (DP); Environmental Management (EM); Environment, Safety and Health (EH); Energy Research (ER); Fissile Materials Disposition (MD); and Nuclear Energy, Science and Technology (NE). The NCSPMT, co-chaired by DP and EM, will advise and assist the Responsible Manager on technical and programmatic issues involving the implementation of crosscutting activities of the Department's criticality safety program. The NCSPMT will receive technical support from an Criticality Safety Support Group. This Criticality Safety Support Group will be a standing group of recognized criticality safety experts from Department of Energy and contractor communities, and will help resolve present and future technical criticality safety issues. Both the NCSPMT and the Criticality Safety Support Group will be established by charter designating initial members.

5.1 Change Control

Long-range plans require sufficient flexibility to address changes in commitments, actions, or completion dates that may be necessary because of additional information, improvements, or changes in the Department's baseline assumptions. The Department's practice is to (1) bring to the Board's attention any substantive changes, and their bases, to this Implementation Plan as soon as identified and prior to the passing of the milestone date, and (2) have the Secretary approve all revisions to the scope and schedule of plan commitments. Fundamental changes to the Plan's strategy, scope, or schedule will be provided to the Board through formal revision of the Implementation Plan. Other changes to the scope or schedule of the planned commitments will be formally submitted in appropriate correspondence approved by the Secretary, along with the basis for the changes and appropriate corrective actions.

5.2 Reporting

To ensure that the various Department implementing elements and the Board remain informed of the status of the plan implementation, the Department's policy is to provide periodic progress reports until the Implementation Plan commitments are completed. For this plan, the Department will provide quarterly reports to the Board. The first report will be due April 1998, with subsequent reports due every three months thereafter until closure of the recommendation.

6. Central Safety Issue

The central safety issue is the need for improved criticality safety practices and coherent programs to alleviate potential adverse impacts on safety and productivity of Department of Energy operations. The Department will address this central safety issue by assuring the viability of a coherent Departmental criticality safety program. With these improvements, important safety programs such as the stabilization of nuclear materials, deactivation of contaminated facilities, and providing for secure and safe storage of fissile materials can be accomplished in a safe, efficient, and timely manner. These improvements will address the nine Subrecommendations and will resolve the associated issues.

6.1 Issue 1

Issue Description:

The current critical experiments program does not emphasize the production of bounding experimental results

for support of current missions of the Department.

Board Subrecommendation 1:
Restructure the program of experimental research in criticality established under the Implementation Plan for Recommendation 93-2 to emphasize determination of bounding values for criticality of systems most important in the current programs at DOE facilities.

Resolution Approach:

In responding to Board Recommendation 93-2, the Department established a prioritization system for experiments that weighted them in categories, one of which was multi-purpose experiments, of which bounding experiments were assumed to be natural members. The experimental program established under the NCPP and its implementation will be reexamined to emphasize determination of bounding values for criticality of systems most important in the current programs at DOE facilities.

One example of an identified program which will produce useful bounding data involves integral critical benchmark experiments using W82 units. This program was identified in 1995, and the Department has initiated actions to facilitate performing the experiments. This program will provide unique data directly applicable to the storage of fissile units.

Another example is the planned Waste Matrices experiment which will be performed utilizing the ZEUS apparatus at LACEF. This critical experimental series will produce integral bounding data which will permit the Department to better characterize the nuclear properties of waste matrices.

It should be noted that, in some cases, nuclear cross section and integral critical experiment data necessary to produce bounding curves are not currently available, and both must be acquired. For example, nuclear cross section and integral experiment data for U-233 in the intermediate energy range, which are necessary to address specific EM criticality safety issues, must be acquired if reliable bounding curves are to be derived and utilized.

Commitment 6.1:

The Department will reexamine its experimental program in criticality research to emphasize the appropriate prioritization of experiments for obtaining data to produce bounding experimental results for support of its current missions.

Deliverable/Milestone	Due Date
Assessment report of the criticality research program	March 1998

6.2 Issue 2

Issue Description:

Some existing data and calculational studies which are relevant to current and future Departmental missions have not been organized and made available to criticality safety practitioners who would benefit from them.

Board Subrecommendation 2:
Organize the records of calculations and experiments conducted to ensure the criticality safety of DOE's

past operations so as to provide guidance for criticality safety in similar situations in the future and avoid repetition of past problems.

Resolution Approach:

The Department has already begun to consider this subrecommendation under the Criticality Safety Information Resource Center (CSIRC) program. The Department plans to preserve and index criticality experimental logbooks and related notebooks through digitization, videotape commentary, and archival preservation. The archive will be maintained at the Los Alamos National Laboratory. The CSIRC program will incorporate selected criticality calculational studies included previously in various data bases. The scope of available logbooks and experiments has already been identified to facilitate selection of data for further documentation. The Criticality Safety Support Group (defined below) will assist in the development of a comprehensive list of existing data and calculational studies and will concur in the final selection of material for more extensive documentation.

The most important goal of the CSIRC program will be preservation of logbooks and notebooks against loss, the lesson learned being the apparent loss of the Savannah River Laboratory experiment logbooks. Preference will be given to preservation of experiment logbooks and notebooks. Calculational notebooks, studies, and reports will also be preserved, but secondarily in accordance with the preference given experimental over calculational data in section 4.2.5 of ANS-8.1.

The first step in implementing CSIRC will be a demonstration of the complete process: a digitized version of a sample logbook (chosen to benefit from a videotape commentary), with videotape commentary by the experimenter to add important information not found in the logbook. The final CSIRC product will result by applying this demonstrated process to produce, in standardized, digitized format, indexed experiment logbooks and notebooks (that have first been screened for their usefulness), augmented by video commentaries where appropriate.

Commitment 6.2.1:

The Department will perform a CSIRC pilot program to provide a complete near-term deliverable consisting of archived logbook(s), videotaped interview, and digitized data and related calculations resulting in a publication available to the criticality safety community at large.

Deliverables/Milestones	Due Dates
1. Identify an experiment to archive	November 1997
2. Archive logbook(s) and calculation(s) for that experiment	December 1997
3. Videotape the original experimenter	January 1998
4. Digitize data and calculations	February 1998
5. Publish data and calculations so that the results are generally available	April 1998

Commitment 6.2.2:

The Department will continue to implement the CSIRC program by applying the demonstration process described in Commitment 6.2.1 to other experiment logbooks and notebooks. First, however, logbooks and notebooks whose authors are still available will be screened for usefulness. In parallel, all logbooks, or copies thereof, will be collocated at LANL. A CSIRC program plan will then be developed to screen remaining

collocated logbooks and produce indexed experiment logbooks and notebooks in standardized, digitized format. The program plan will include an evaluation of the cost vs. benefit of the program elements based on the experience gained in the pilot program.

Deliverables/Milestones	Due Dates
1. Collocate logbooks (originals or copies in the case of ORNL) from all U.S. critical mass laboratories, past or present, at LANL	December 1998
2. Screen existing logbooks with original author/experimenter	December 1998
3. CSIRC program plan	December 1998

6.3 Issue 3

Issue Description:

The Department has not provided enough technical guidance for computational methods used to interpolate and extrapolate limited experimental data which may be utilized to establish bounding values for safety applications.

Board Subrecommendation 3:
Establish a program to interpolate and extrapolate such existing calculations and data as a function of physical circumstances that may be encountered in the future, so that useful guidance and bounding curves will result.

Resolution Approach:

The Oak Ridge National Laboratory has been investigating, under an NRC program, the broad issues of areas of applicability, parameter sensitivity and uncertainties, and extrapolation and interpolation of data. This work is currently funded only by NRC as described below. The purpose is to develop sensitivity and uncertainty analyses for critical experiment data and methods to interpolate and extend the area of applicability of existing data.

The Department will develop a technical program plan, with milestones and identified funding, which expands the current work to include activities of interest to both the NRC and the Department. When implemented, the program will extend the range of applicability of neutronics codes and data that are now validated by limited benchmarks and identify needed differential and integral experiments to resolve issues where insufficient validations exist for safety analysis. The program will provide guidance on the use of computational methods for the development of useful bounding curves.

The program plan will include tasks to utilize improved nuclear data with criticality modeling codes, along with advanced sensitivity methods, to establish their applicability and performance in the analysis of fissile systems under current and/or projected areas of DOE responsibility. The coordinated tasks will be performed by ORNL, LANL, ANL, and other National Laboratories, as appropriate. In addition to the continuing work established with committed funding for the NCPP in response to Board Recommendation 93-2, these tasks will be chosen and will be coordinated to complement and supplement current work under NRC JCN W6479, "Development and Applicability of Criticality Safety Software for Licensing Review," dated May 27, 1997, and DOE FWP EMSP102, "Development of Nuclear Analysis Capabilities for DOE Waste Management Activities," dated April 11, 1997.

The preliminary scope of the work includes guidance for extending the area of applicability for existing data, sensitivity studies of various parameters important to previous experiments, and the investigation of long-standing criticality physics questions as well as fissile systems specific to emerging DOE applications. Some already identified areas for investigation are: (1) fission source convergence in Monte Carlo methods; (2) the physics of neutrons slowing down, intermediate energy kinematics; (3) neutron transport in loosely-coupled systems; (4) reactivity worth of moderating reflectors; and (5) reactivity worth of the actinides.

Commitment 6.3:

The Department will develop a technical program plan, with milestones and identified funding, which expands the current work to include activities of interest to both the NRC and the Department (e.g., extending areas of applicability, sensitivity and uncertainty studies, unresolved discrepancies, etc.). When implemented, this program will extend the range of applicability of neutronics codes to address identified and emerging Departmental missions and experimental needs and will provide guidance on the use of computational methods for the development of useful bounding curves.

Deliverables/Milestones	Due Dates
1. A program plan containing technical objectives and milestones	July 1998
2. Document initiation of priority tasks from the program plan in the quarterly report to the Board	January 1999

6.4 Issue 4

Issue Description:

The Department has not efficiently distributed the experimental and theoretical data obtained from past experiments and studies.

Board Subrecommendation 4:
Collect and issue the experimental and theoretical data from the above in a publication as guidance for future activities.

Resolution Approach:

Over the last twenty years, the Department has partially recognized and acted on aspects of this subrecommendation. The deliverables/milestones listed below represent past or ongoing Departmental actions which will be continued.

One major effort which has been underway for over five years is the International Criticality Safety Benchmark Evaluation Project (ICSBEP). This Department-funded program has led to stronger confidence in published benchmark descriptions and has eliminated much duplication of benchmarking and validation efforts at different DOE sites. The benchmark manuals produced by the ICSBEP are currently available on a web page. The ICSBEP, which was initiated in October 1992, was included as a program element of the NCPP in response to Board Recommendation 93-2.

Previously, LLNL published a bibliography (Nuclear Criticality Information System Database) of criticality experiments which, while valuable in itself, did not address the issue of unreported experiments. This

information is in an easily retrievable form and will be disseminated to the community via a web page. Web pages devoted to criticality safety currently exist at LLNL, INEEL, SRS, and LANL.

As part of a different activity, a Parameter Study Work Group, which was previously funded by DOE, produced a compilation of criticality evaluations over a period of approximately ten years. This information is nearly in publishable form and exists in a relational database which can be formatted for general use.

The Nuclear Criticality Safety Department at Y-12 has produced a searchable database catalog of all unclassified evaluations performed there. This information will be made available on the DOE web site.

The Department will make available the evaluations, calculational studies, and data cited above by establishing a DOE criticality safety Internet web site with searchable databases of criticality safety information and hyperlinks to other sites with related information.

Commitment 6.4:

The Department will make available evaluations, calculational studies and data by establishing a DOE criticality safety Internet web site with searchable databases of criticality safety information and hyperlinks to other sites with related information.

Deliverables/Milestones	Due Dates
1. DOE criticality safety web site for data, calculational studies, and evaluations	March 1998
2. Y-12 evaluations on DOE web site	June 1998
3. Calculations compiled by the Parameter Study Work Group on DOE web site	September 1998
4. Nuclear Criticality Information System Database on the DOE web site	March 1999

6.5 Issue 5

Issue Description:

Some criticality safety personnel have not had sufficient practice in the application of methods for determining margins of subcriticality alternative to those relying on detailed computer modeling to permit generalization and extrapolation from existing calculations or data. This results in over-reliance on Monte Carlo methods, which may in some cases be less efficient than using alternative analytical methods, where such methods can be shown to be applicable. This deficiency has been exacerbated by the lack of clear guidance and examples in the use of simple, bounding methods of analysis in place of detailed computational analysis, where possible, in setting criticality limits for processes.

Board Subrecommendation 5:
Clarify in guidance that simple, bounding methods of analysis can be used in place of specific theoretical analysis in setting criticality limits for processes, and that limits derived in this manner are even preferable where they serve the purpose. The decreasing order of preference should be experimental data, theory benchmarked against experimental data, and nonbenchmarked criticality analysis with an adequate safety margin.

Resolution Approach:

The Department will clarify in guidance that simple, bounding methods of analysis can sometimes be used in place of detailed computational analysis in setting criticality limits for processes. Furthermore, the guidance will indicate that simple, bounding methods are even preferable where they serve the purpose of documenting that the process in question will remain subcritical under all normal and credible abnormal conditions.

The decreasing order of preference for establishing subcritical limits (as specified in ANSI/ANS-8.1) should be experimental data, computational methods benchmarked against experimental data, and computational methods which extend the area of applicability of experimental data with an adequate additional margin of subcriticality. Except for instances relying upon broadly peer reviewed evaluations of "critical," "subcritical," and "safe" values determined from applicable data measurements such as in Nuclear Criticality Control of Special Actinide Elements (ANSI/ANS-8.15-1981; R1987), the use of completely nonbenchmarked, non-validated computational methods is inconsistent with ANSI/ANS-8.1 and is unacceptable to the Department. Without some form of validation or logical theoretical basis, there is no way to determine an adequate margin of subcriticality or margin of safety.

Commitment 6.5.1:

The Department will revise and reissue DOE-STD-3007-93 to include specific annotated examples of criticality safety evaluations which rely upon comparative analysis to existing data and calculations to emphasize the acceptability of this approach. The annotations will explain the logic used in preparing the evaluation with emphasis on the following general types of topics as they apply: 1) hand calculations, 2) development and use of models, 3) reactivity uncertainty, 4) validation, 5) establishing safety margins, 6) establishing margins of subcriticality, and 7) use of bounding data.

Deliverable/Milestone	Due Date
Revise DOE-STD-3007-93	September 1998

Commitment 6.5.2:

Issue a Departmental guide for the review of criticality safety evaluations. This guide will emphasize the acceptability of using bounding values and simplified analytical methods where applicable. The guide will stress the importance of practical, efficient criticality safety analysis, practices, and controls to the reviewer.

Deliverable/Milestone	Due Date
A Departmental Guide for reviewing criticality safety evaluations	May 1999

6.6 Issue 6

Issue Description:

The typical criticality safety staff consists largely of individuals who have no first-hand experience in critical experiment facilities and consists of some individuals who have been trained on the job in analytical aspects of criticality control but without a theoretical understanding. While experience in critical experiment facilities is not necessary to perform proper criticality safety evaluations, such experience is desirable and should be obtained when practical. Some on-the-job training is necessary and desirable from the standpoint of familiarity with site

operations. However, such training does not uniformly ensure that criticality safety personnel have had sufficient practice in the application of methods for determining margins of subcriticality alternative to those relying on detailed computer modeling to permit generalization and extrapolation from existing calculations or data. This results in over-reliance on Monte Carlo methods, which may in some cases be less efficient than using alternative analytical methods, where such methods can be shown to be applicable. This deficiency has been exacerbated by the lack of clear guidance and examples in the use of simple, bounding methods of analysis in place of detailed computational analysis, where possible, in setting criticality limits for processes.

The Department recognizes that being grounded in neutron physics is a necessary, although not a sufficient, prerequisite for the application of academic knowledge to criticality safety. Since most criticality safety engineers have nuclear engineering or physics degrees, lack of adequate knowledge of neutron physics is not a general concern. Criticality safety practitioners often lack the practical experience with fissile material operations to identify the proper set of credible process upset conditions applicable to operations, relying instead on the review process for such proper-set identification. In such situations, senior criticality safety and/or operations personnel review the draft evaluation to ensure that no credible upset scenarios have been missed. The lack of experience with operations also detracts from the ability of the criticality safety practitioner to justify why a particular set of process upsets makes up a necessary and sufficient set of scenarios. It is in the better interest of both safety and efficiency for such proper-set identification to occur earlier in the criticality safety evaluation process.

To develop and maintain competency, there is further need to assure that criticality safety practitioners thoroughly understand site-specific operations and possess related analysis skills, such as the ability to reliably determine process upset conditions.

> *Board Subrecommendation 6:*
> *Develop and institute a short but intensive course of instruction in criticality and criticality safety at DOE's criticality experiments facility to serve as the foundation for a program of formal qualification of criticality engineers. This course should instill in students a familiarity with the factors contributing to criticality, the physical behavior of systems at and near criticality, and a theoretical understanding of neutron multiplication processes in critical and subcritical systems. A goal would be for reliance for criticality safety at any DOE facilities to rest in a group of individuals endowed with such experience.*

Resolution Approach:

The Department will continue to use the Los Alamos Critical Experiments Facility (LACEF) to the maximum extent practical to address training needs. The Department will also survey existing educational curricula to determine if they can be used to supplement the training at LACEF. In addition, the Department will review existing site-specific training and qualification programs and issue guidance that identifies essential elements of an adequate qualification program.

Commitment 6.6.1:

The Department will upgrade and expand the current five-day training course at LACEF to ten days by offering additional experiments, and increasing the emphasis on solving practical, operational criticality safety problems, including the practical application of simplified analytical methods and bounding values. Participants will be sensitized to proper methods of identifying and analyzing process upsets and producing documented criticality safety evaluations. Attendees at this course will be limited to criticality safety practitioners, in part due to the rigorous emphasis on practical analytical methods which require thorough familiarity with neutron physics. The

threefold emphasis of this new course will be: 1) expanded experience with critical systems, 2) application of simplified analytical methods, and 3) emphasis on identifying the proper set of process upset conditions for realistic applications.

Deliverable/Milestone	Due Date
Expanded LACEF Training Course	July 1998

Commitment 6.6.2:

The Department will assess criticality safety training needs with a broader perspective on applications such as contingency and safety analysis which consider methods of identifying process upsets, developing effective controls, and implementing controls through procedures and postings. This assessment will also include a complete criticality safety practitioner job task analysis. Existing curricula in criticality safety (e.g., Los Alamos courses, University courses, Site Specific Criticality Safety Curricula, etc.) will be surveyed to determine if identified needs can be met though utilization of existing training or if development of new training is required. Based on its findings, the Department will initiate a program which addresses the identified needs for additional criticality safety training.

Deliverables/Milestones	Due Dates
1. Assessment of additional training needs and review of available supplementary curricula	June 1998
2. Initiate a program which addresses identified needs	December 1998

Commitment 6.6.3:

The NCSPMT will survey existing contractor site-specific qualification programs and develop a report that documents the variety of requirements currently in place. The purpose of this survey is to identify common elements and those elements judged essential to an adequate training program to facilitate development of Departmental guidance. In the longer term, the Department will issue guidance concerning development of site-specific criticality safety training and qualification programs. Sites will then be responsible for considering this guidance in developing criticality safety training and qualification programs.

Deliverables/Milestones	Due Dates
1. Report on the Review on Site Qualification Programs	June 1998
2. Guidance for development of site-specific nuclear criticality safety training and qualification programs	September 1998
3. Guidance to procurement officials specifying qualification criteria for contractor criticality safety practitioners	September 1998
4. DOE field will provide to line management dates upon which contractors will have implemented guidance in Deliverable/Milestone #2, above	March 1999

Commitment 6.6.4:

The Department will ensure that federal technical staff directly performing criticality safety oversight be qualified commensurate with that identified for contractor personnel.

Deliverables/Milestones	Due Dates
1. Qualification program for Departmental criticality safety personnel	December 1998
2. DOE criticality safety personnel qualified	December 1999

6.7 Issue 7

Issue Description:

Not all Departmental contractor criticality safety programs are functioning in such a way to assure that criticality safety is a staff function assisting line management, with safety responsibility residing in line management. Operations and line management have not, in all cases, provided thorough process descriptions, procedures, scope of applicable process upsets and operator-oriented language for use in criticality safety postings during the development of criticality safety evaluations and limits. This has resulted in re-work of some criticality safety evaluations, performing more calculations than is sometimes necessary, and impractical criticality safety postings. This inefficient integration of criticality safety into line management has exacerbated the central safety issue.

Board Subrecommendation 7:
Where not already done, assign criticality safety as a staff function assisting line management, with safety responsibility residing in line management.

Resolution Approach:

ANSI/ANS-8.1 and 8.19 require that line management assume responsibility for its criticality safety program. These Standards, invoked by Department of Energy Order 420.1, Section 4.3, when properly implemented, affirm both line ownership of safety responsibility and the independence of criticality safety as a staff (not line) function. Each site will assess the degree of proper implementation of line ownership of criticality safety consistent with the Integrated Safety Management System expectation of continuous feedback and improvement.

The Department has adopted, through the efforts for Board Recommendation 95-2, contract reforms and requirements to achieve Integrated Safety Management Systems, which include requirements for integrated work planning, integrated hazard assessment, integrated hazard control development, integrated confirmation of work readiness and work performance with appropriate feedback. Moreover, the Department of Energy Acquisition Regulations clause requires line management responsibility for safety, the establishment of clear roles and responsibilities, and that contractors ensure personnel possess experience, knowledge, skill, and abilities to discharge duties. Departmental actions relative to 97-2 will be consistent with the recently enacted Department of Energy Acquisition Regulations described above.

Commitment 6.7:

Field managers at sites with significant quantities of fissile material will conduct a survey of their respective sites to determine if line management is functioning properly with respect to ownership of criticality safety, using criteria consistent with the Integrated Safety Management principles.

Deliverable/Milestone	Due Date
Individual sites issue reports of survey findings	June 1998

6.8 Issue 8

Issue Description:

The Department lacks a standing expert technical support function to offer guidance to management for managing and overseeing a coherent criticality safety program.

> *Board Subrecommendation 8:*
> *Identify a core group of criticality experts experienced in the theoretical and experimental aspects of neutron chain reaction to advise on the above steps and assist in resolving future technical issues.*

Resolution Approach:

The Department will form a group of criticality safety experts that is composed of persons from its staff and contractors having collective knowledge in a broad spectrum of criticality safety areas to advise the NCSPMT on programmatic issues and to help resolve present and future technical criticality safety issues. The Criticality Safety Support Group will consist of a core set of members plus ad-hoc members when needed to provide inputs on specific issues. The Group will provide important operational perspectives on Departmental missions such as fissile materials stabilization and storage, facilities decommissioning, and waste disposal which can be factored into experiments, training, organizational structures, methods, and nuclear data requirements for performing criticality safety analyses in support of these activities. Also, as directed by the NCSPMT, the Criticality Safety Support Group will review applicable Departmental Orders and Standards periodically to assure criticality safety is appropriately addressed in these documents.

Commitment 6.8:

The Department will form a group of experts that is composed of persons from its staff and the site contractors having collective knowledge in a broad spectrum of criticality safety areas to advise the Departmental management team on programmatic issues and to help resolve present and future technical criticality safety issues. The Criticality Safety Support Group members will be identified in an appendix to the Group's charter.

Deliverable/Milestone	Due Date
Charter for the Criticality Safety Support Group approved by NCSPMT	January 1998

6.9 Issue 9

Issue Description:

The Department has not developed an organizational structure supported by appropriate funding to assure the viability of a coherent Departmental criticality safety program.

> *Board Subrecommendation 9:*
> *Organize funding of the criticality research and instruction program to improve its stability and to recognize the cross-cutting importance of this activity.*

Resolution Approach:

As discussed in Section 5, Organization and Management, the Department will establish the organizational structure to conduct a Department criticality safety program. The Department will create the Nuclear Criticality Safety Program Management Team (NCSPMT) that will manage allocated funds to implement this plan and to continue ongoing activities in response to Recommendation 93-2. It will also ensure that crosscutting activities of the program are effectively implemented and will advise and assist the Responsible Manager on programmatic and technical issues concerning the program. The NCSPMT will be composed of representatives from the following offices that benefit from an effective criticality safety program: Defense Programs (DP); Environmental Management (EM); Environment, Safety and Health (EH); Energy Research (ER); Fissile Materials Disposition (MD); and Nuclear Energy, Science and Technology (NE). The NCSPMT, co-chaired by DP and EM, will develop and execute a program plan to guide the Department's crosscutting criticality safety activities.

The funds required to implement the Department's criticality safety program include existing funded requirements developed in response to Recommendation 93-2, and additional unfunded requirements established in response to Recommendation 97-2.

For FY 1998 and FY 1999, DP, EM, and EH will be responsible for fully funding their elements of the Nuclear Criticality Predictability Program (NCPP), established in response to Recommendation 93-2. ER will be responsible for maintaining the Oak Ridge Electron Linear Accelerator. The Chief Financial Officer (CFO), in consultation with the Departmental Representative to the Defense Nuclear Facilities Safety Board and the NCSPMT, will be responsible for obtaining the funding required for commitments under this implementation plan.

For formulation of the FY 2000 budget and beyond, DP proposes to establish a line item for criticality safety programs. The CFO will adjust the DP FY 2000 and outyear funding targets to include the full funding level for nuclear criticality safety. Funding targets will be moved from the appropriate program offices to the DP line item.

Commitment 6.9:

The Department will establish the organizational structure and provide stable funding necessary to conduct a viable criticality safety program. The NCSPMT will be chartered to manage the program and develop a program plan for assuring the continued viability of a coherent Departmental criticality safety program. The Chief Financial Officer will obtain the funding for commitments in this plan as required.

Deliverable/Milestone	Due Date
1. NCSPMT charter	January 1998
2. NCSPMT program plan	June 1998

ATTACHMENT A: Glossary

Bounding values, as it relates to criticality, are those enveloping dependent values (masses, volumes, concentrations, densities, temperatures, flow rates, vessel dimensions, etc.) that describe specific systems given assumed limits of independent parametric variation.

Data, as it relates to criticality, refers to values obtained directly from experimental measurements of critical or near critical systems. For nuclear cross section data within the context of the Recommendation 93-2 Nuclear Criticality Predictability Program, "data" additionally refers to values obtained from: 1) the experimental measurements of nuclear cross section data, 2) the generation of the corresponding Evaluated Nuclear Data Files (ENDF/B), and 3) the analytical processing methods needed for the calculational codes to utilize those files.

Evaluations, as it relates to criticality, refers to the complete set of documentation demonstrating the subcriticality of an analyzed process or system for all normal and credible abnormal conditions. Evaluations may contain data and calculations.

ATTACHMENT B: List of Acronyms

ANL	Argonne National Laboratory
ANS	American Nuclear Society
ANSI	American National Standards Institute
CFO	Chief Financial Officer
CSIRC	Criticality Safety Information Resource Center
DNFSB	Defense Nuclear Facilities Safety Board
DOE	Department of Energy
DP	Office of Defense Programs
EH	Office of Environment, Safety and Health
EM	Office of Environmental Management
ENDF/B	Evaluated Nuclear Data File
ER	Office of Energy Research
FWP	Field Work Proposal
ICSBEP	International Criticality Safety Benchmark Evaluation Project
ISMS	Integrated Safety Management System
INEEL	Idaho National Engineering and Environmental Laboratory
JCN	Job Control Number
LACEF	Los Alamos Critical Experiments Facility
LANL	Los Alamos National Laboratory
LLNL	Lawrence Livermore National Laboratory
MD	Office of Fissile Material Disposition
NE	Office of Nuclear Energy, Science, and Technology
NCIS	Nuclear Criticality Information System
NCPP	Nuclear Criticality Predictability Program
NCSPMT	Nuclear Criticality Safety Program Management Team
NRC	Nuclear Regulatory Commission
ORNL	Oak Ridge National Laboratory
RSICC	Radiation Safety Information Computational Center
SRS	Savannah River Site
Y-12	Uranium Fabrication and Processing Facility in Oak Ridge, Tennessee