DEFENSE NUCLEAR FACILITIES SAFETY BOARD

625 Indiana Avenue, NW, Suite 700, Washington, D.C. 20004
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March 23, 1993

The Honorable Hazel R. O'Leary
Secretary of Energy
Washington, DC 20585

Dear Madame Secretary:

On March 23, 1993, the Defense Nuclear Facilities Safety Board, in accordance with 42 U.S.C. § 2286a(5), unanimously approved Recommendation 93-2 which is enclosed for your consideration. Recommendation 93-2 deals with The Need for Critical Experiment Capability.

42 U.S.C. § 2286d(a) requires the Board, after receipt by you, to promptly make this recommendation available to the public in the Department of Energy's regional public reading rooms. The Board believes the recommendation contains no information which is classified or otherwise restricted. To the extent this recommendation does not include information restricted by DOE under the Atomic Energy Act of 1954, 42 U.S.C. §§ 2161-68, as amended, please arrange to have this recommendation promptly placed on file in your regional public reading rooms.

The Board will publish this recommendation in the Federal Register.

Sincerely,

John T. Conway
Chairman

Enclosure

RECOMMENDATION 93-2 TO THE SECRETARY OF ENERGY
pursuant to 42 U.S.C. § 2286a(5)
Atomic Energy Act of 1954, as amended.

Dated: March 23, 1993

The end of the international competition in manufacture of nuclear weapons, and the transition to large scale dismantling of nuclear weapons, have generated strong pressures to reduce the defense nuclear budget and to close down many defense nuclear facilities and operations. At the same time, the development of firm plans for a Complex 21 to serve future nuclear defense needs has slowed. These trends lead to a possibility that capabilities and functions necessary for current and future needs could be terminated along with those no longer required. One of these, important for the avoidance of certain types of accidents, is support of nuclear criticality control.

Because of the importance of avoiding criticality accidents, the Board carefully follows the state of criticality control at DOE's defense nuclear facilities. This interest has been evident as Board members and staff have reviewed practices at the Pantex Plant. The Board believes it is important to maintain a good base of information for criticality control, covering the physical situations that will be encountered in handling and storing fissionable material in the future, and to ensure retaining a community of individuals competent in practicing the control.

In the course of retrenchment of its activities in recent years, the Department of Energy and its predecessor agencies have terminated use of all but one of its general purpose facilities for conducting neutron chain-reacting critical experiments with fissionable material. The research at these facilities had served programmatic purposes of diverse DOE programs, as well as laying a general experimental basis for practices that ensure averting criticality accidents. The Board is informed that there is now a strong possibility that the last DOE facility capable of general purpose critical experiments will be shut down in the near future, due to lack of funding. This possibility arises because no single program of the Department has an overriding need for this remaining facility at the Los Alamos National Laboratory, and therefore no single program office is motivated to provide its financial support in this period of budget stringency. A certain complacency fed by some years of freedom from criticality accidents seems also to underlie this possibility.

The Board observes that the art and science of nuclear criticality control have three principal ingredients. The first is familiarity with factors that contribute to achieving nuclear criticality, and the physical behavior of systems at and near criticality. This familiarity is developed in individuals only through working with critical systems. It cannot be imparted solely through learning theory and using computer codes. The second is theoretical understanding of neutron multiplication processes in critical and subcritical systems, leading to predictability of the critical state of a system by methods that use theory benchmarked against good and well characterized critical experiments.

The third is thorough familiarity of nuclear criticality engineers with the first two factors, obtained through a sound program of training that indoctrinates them in the experimental and theoretical aspects.

The Board has reviewed the status of benchmarking the theoretical methods of criticality control against existing critical experiments and has found that there are notable failures of theoretical analysis to account for the results of a number of experiments. It is not known whether this discrepancy results from inadequate nuclear data used in the analysis or from inadequate care in conducting the experiments and recording their physical features. Both factors could contribute. In addition, it seems that on the average there may be a small non-conservative bias in overall predictions of the theory. In spite of these shortcomings, conservatism in methods used to develop the limits to be applied during handling and storage of fissionable material seems to have led to adequate safety in recent years. The Board believes that in the interest of continued safety it is important to clear up the existing discrepancies, which are obstacles to confident understanding of criticality control. To do so will require conduct of further neutron chain-reacting critical experiments targeted at the major sources of discrepancy between the theory and the experiments, as well as careful analysis of the experiments.

Finally, the Board believes that there is no guarantee that the physical circumstances of handling and storage of fissionable material in the future will always be found in the realm of benchmarked theory. This point is especially important under circumstances that will exist for a number of years to come, with increasing amounts of fissionable material to be stored in a variety of chemical and physical forms. This does not appear to be an appropriate time to eliminate an ability to ensure that such activities will be free of criticality hazard. For safety purposes it will be necessary to retain the capability to perform experiments under conditions not foreseen at this time. This capability once lost would be most difficult to reproduce, and it could be approximated only at great cost and after substantial time, deterring such development even if it were needed badly.

For all the above reasons, the Board believes that continuation of an experimental program of general purpose critical experiments is necessary for continued safety in handling and storing fissionable material. It is needed to improve the basis for the methodology. It is needed as part of the process of properly educating criticality control engineers. It is needed to ensure the capability of answering criticality questions with new and previously unresearched features.

Therefore the Board recommends that:

1. The Department of Energy should retain its program of general purpose critical experiments.

2. This program should normally be directed along lines satisfying the objectives of improving the information base underlying prediction of criticality, and serving in education of the community of criticality engineers.

3. The results and resources of the criticality program should be used in ongoing departmental programs where nuclear criticality would be an important concern.

John T. Conway, Chairman