DEFENSE NUCLEAR FACILITIES SAFETY BOARD

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January 14, 2000

The Honorable Bill Richardson
Secretary of Energy
1000 Independence Avenue, SW
Washington, DC 20585-1000

Dear Secretary Richardson:

On May 26, 1994, the Defense Nuclear Facilities Safety Board (Board) submitted to the Secretary of Energy Recommendation 94-1, dealing with the need to stabilize and safely store large amounts of fissionable and other nuclear material that for safety reasons should not be permitted to remain unremediated. The Board was especially concerned about specific liquids and solids in spent fuel storage pools, reactor basins, reprocessing canyons, processing lines and various defense facilities remaining in the manufacturing pipeline when pit production was terminated in 1988. On August 31, 1994, Secretary O'Leary agreed with and accepted the recommendation. On February 28, 1995, Secretary O'Leary forwarded to the Board the Department of Energy's (DOE) plan for implementation of the Board's recommendation on this issue. Subsequently, on December 28, 1998, you forwarded to the Board a revision to Secretary O'Leary's original Implementation Plan for Recommendation 94-1.

During the past year, the Board and its staff have been closely following and noting further slippage in the time table for meeting the dates set forth in the Implementation Plan. While a great deal has been accomplished in meeting the safety objective set forth in Recommendation 94-1 particularly with regard to those materials that constituted the most imminent hazards, the Board is concerned that severe problems continue to exist and delay the implementation of Recommendation 94-1. After careful consideration, the Board has concluded that the progress being made in certain of the stabilization activities addressed by Recommendation 94–1 does not reflect the urgency that the circumstances merit and that was central to the Board's recommendation.

The Board will continue to follow and urge DOE to implement Recommendation 94-1. In addition, the Board, on January 14, 2000, unanimously approved Recommendation 2000-1 which is enclosed for your consideration.

42 U.S.C. § 2286d(a) requires that after your receipt of this recommendation, the Board promptly make it available to the public in DOE's regional public reading rooms. The Board believes the recommendation contains no information that 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 it promptly placed on file in your regional public reading rooms.

The Board will also publish this recommendation in the *Federal Register*.

Sincerely,

John T. Conway
Chairman

Enclosure

c: Mr. Mark B. Whitaker, Jr.

DEFENSE NUCLEAR FACILITIES SAFETY BOARD
RECOMMENDATION 2000-1 TO THE SECRETARY OF ENERGY
pursuant to 42 U.S.C. § 2286a(a)(5)
Atomic Energy Act of 1954, as amended

Dated: January 14, 2000

Background

It is now almost six years since the Defense Nuclear Facilities Safety Board (Board) transmitted to the Secretary of Energy its Recommendation 94-1 entitled, "Improved Schedule for Remediation in Defense Nuclear Facilities Complex." That Recommendation pointed to the existence of large quantities of unstable fissionable material and other radioactive material that had been left in the production pipeline following termination of nuclear weapons production. These materials required prompt conversion to more stable forms, to prevent deterioration leading to inevitable spread of radioactive contamination. Further, some of the material was in such a state that serious safety problems could be expected in a very short period of time if remediation did not take place.

The Recommendation identified safety problems posed by plutonium both as metal and in chemical compounds, and plutonium-bearing materials such as residues and spent nuclear fuel. Most of this material was and still is at three sites: Savannah River, Hanford, and Rocky Flats Environmental Technology Site (RFETS). A substantial amount of spent nuclear fuel also existed at the Idaho National Engineering and Environmental Laboratory. In the Implementation Plan responding to the Recommendation, the Department of Energy (DOE) justifiably saw fit to add to the sources of concern the enriched uranium solution stored at the Savannah River Site, accumulated from processing of spent nuclear fuel, and the highly radioactive uranium–233 in the decommissioned Molten Salt Reactor Experiment (MSRE) at the Oak Ridge National Laboratory. The highly enriched uranium solution, amounting to many thousands of gallons of liquid, is stored outside the H-Canyon in large tanks where over a period of time precipitation resulting from freezing, chemical changes, or evaporation of liquid could produce sediments posing a threat of accidental criticality. The MSRE has been shut down for many decades, and deterioration, the onset of which had already been detected, could in time release its radioactive material into the environment.

Materials Stabilized Since the Recommendation

In the years since the Recommendation, progress has been made at defense nuclear facilities in remediating the most hazardous material. Most sites have repackaged plutonium metal and oxides that had been left in containers in contact with plastic that could become a source of hydrogen gas. Deteriorating spent nuclear fuel elements stored in the 603 Basin at the Idaho National Engineering and Environmental Laboratory have been moved to the 666 Basin where control of water purity is much better. Substantial amounts of spent nuclear fuel elements and nuclear targets stored in basins at the Savannah River Site have been chemically processed and plutonium and other radioactive material so extracted have been stored. Most of the

plutonium in solution at the Savannah River Site has been converted to metal and along with other plutonium metal at the Site has been packaged in seal-welded containers with inert atmospheres by means of the bagless transfer system. Almost all of the plutonium-bearing solutions in facilities at the RFETS have been chemically treated to remove the plutonium, which has then been stored as more stable oxide. Numerous drums containing radioactive residues, mostly at the RFETS, have been vented to prevent buildup of pressure by gas liberated through chemical reactions and by effects of radioactive decay. Though non-technical problems continue to plague actions to store nuclear waste in the Waste Isolation Pilot Plant (WIPP) facility in New Mexico, some storage at that site has taken place, and presumably momentum will build toward highly important shipment of more material to that disposal site. In these ways, most of the very immediate concerns prompting the Recommendation have been eased.

Furthermore, after a long period when it seemed that little was being accomplished, progress has been made toward cleanup of the important K-East and K-West fuel storage basins at the Hanford Site. Remediation of many of the cleanup problems at the RFETS has taken on momentum after a long initial period when little was accomplished. Some of the most notable advances have been made by arrangements to ship plutonium-bearing material to the Savannah River Site and to WIPP.

Approximately 300,000 liters of plutonium solution in the F-Canyon at the Savannah River Site have now been converted to metal in the FB-Line. This material is stored in approximately 80 welded stainless steel cans that will serve as the inner containers to meet DOE-STD-3013. Plutonium solutions resulting from stabilization of Mark-31 spent nuclear fuel have also been converted to metal, and along with the preexisting metal items in the FB-Line, are also stored in similar DOE-STD-3013 inner containers.

Problems Remaining

Severe problems continue to impede other remedial measures that had been promised in the original Implementation Plan issued by the Secretary of Energy in response to Recommendation 94-1, and in Revision 1 to that Plan as issued on December 28, 1998. For a variety of reasons, many of them stated below, most of the remaining milestones in the Implementation Plans will not be met. Among the remaining problems are the following:

- Approximately 34,000 liters of plutonium-bearing solution remain in the H-Canyon at the Savannah River Site. Originally this material was to have been stabilized by March 2000 in the HB-Line Phase 2 facility; however, preparing that facility for operation was not funded in FY 1999. The revised Implementation Plan deferred stabilization until June 2002. The contractor has provided an unofficial revised estimate of completion by December 2002, but that date is alleged to be at risk because the resources (mainly technical personnel) are not available to support development of procedures and Authorization Basis documents. There is at present no high confidence startup schedule.

- In the F-Area at the Savannah River Site are approximately 800 kilograms of plutonium oxide. This oxide was to have been fired at high temperature in accordance with DOE-STD-3013 and packaged in 3013-compliant containers by May 2002. So far there has been no appreciable action toward these objectives. The stated reason has been deferral of a decision to build the Actinide Packaging and Storage Facility (APSF), though as the Board noted in an earlier letter to the Assistant Secretary for Environmental Management, a decision not to build the facility appears already to have been made. This activity is at present not funded, nor is any funding planned for a facility which could be used in stabilizing and storing this material. Though Implementation Plans had originally set target dates for accomplishment of the actions, no dates based on revised plans have been established.

- In the F-Area at the Savannah River Site are also about 400 kilograms of plutonium in the form of miscellaneous residues. Several paths for processing the residues have been proposed, depending on their characteristics, but all the plutonium should end up as metal or oxide fired at high temperature according to DOE-STD-3013. Originally all were to occur by May 2002. Other than startup of the FB-Line for characterizing the material, there has been no appreciable action so far toward the final objectives. As for the oxides referred to above, stabilization and packaging of this material were to be accomplished in the APSF, and are now being delayed.

- One tank in the F-Canyon at Savannah River contains approximately 14,400 liters of a solution of americium and curium. These elements, which are highly radioactive, are raw materials for production of californium-252 (Cf^{252}) in the High Flux Isotope Reactor at Oak Ridge. There are continuing needs for Cf^{252}. Dispersal of the americium and curium material through loss of integrity of the tank and its appendages, such as might be caused by corrosion or seismic action, would create an almost insurmountable problem of spread of radioactive contamination. The original Implementation Plan foresaw conversion of the dissolved elements by November 1999 to a vitreous form suitable for storage until use. Difficulties with the melter planned for the operation caused deferral of the operation to September 2002 according to the revised Implementation Plan. At present the activity is alleged to be under-funded, though a Request for Proposal has been issued seeking a commercial contract for the action. The most optimistic estimate of a completion date is November 2004.

- About 6,000 liters of a solution of neptunium-237 (Np^{237}) are in tanks in the H-Canyon at the Savannah River Site. This isotope is the raw material for production of plutonium-238 (Pu^{238}), which has such uses as a heat source for production of electricity for some NASA missions. Initial plans were to vitrify this material by September 2003. The revised Implementation Plan stated that instead it was to be converted to oxide through use of the HB-Line Phase 2 facility. The revised Implementation Plan deferred the estimated date of completion to December 2005. An additional six-month delay is now foreseen, though that view may still be optimistic since adequacy of funding so far in the future cannot be assured.

- About 230,000 liters of highly-enriched uranyl nitrate solution are held in tanks outside the H-Canyon at the Savannah River Site. The quantity of solution will continue to increase as a result of stabilization of spent Mark 16/22 fuel elements. This solution is a hazard because freezing, evaporation, or chemical change could lead to a uranium concentration and a threat of accidental criticality. The intent has been to add depleted uranium to this solution, reducing the enrichment to a range suitable for use in fuel elements for Tennessee Valley Authority's light water reactors. Though the Tennessee Valley Authority has concurred in principle with the arrangement, an agreement to proceed has been held up by allegedly insufficient out-year funding by DOE to execute its share of the agreement. Meanwhile, the estimated costs have been increasing. An original date of December 1997 had been set for conversion of the uranium to oxide. The revised Implementation Plan delayed that date by six years to December 2003. There is no credible date for removal of the hazard. Assigned storage space for the solution is now nearly full.

- About seven tonnes of heavy metal, principally highly-enriched uranium, is still in irradiated Mark 16/22 fuel elements at the Savannah River Site. A campaign to process Mark 16/22 fuel elements was to have been completed by December 2000, according to the original Implementation Plan. The revised Plan changed that date to December 2001. The processing is now only about 25% complete, because of an alleged shortage of personnel and some technical issues delaying restart of the H-Canyon second solvent extraction cycle. Mark 16/22 fuel element processing stopped in September 1999 and will not resume until startup of second cycle operations, which is now scheduled for April 2000. The stated completion date is now about May 2003, though processing may have to be halted again in the future because of inadequate additional space for storage of uranium solutions (see the previous item).

- The Plutonium Finishing Plant (PFP) at the Hanford Site contains more than 300 kilograms of plutonium in 4,300 liters of solution. This was to have been stabilized by January 1999 through use of a vertical denitration calciner. Technical problems and allegedly insufficient financial resources hampered completion of the vertical calciner and treatment of the solution by that date, and attempts to improve the schedule through use of a prototype calciner were also inadequate. The plan has recently been changed, and it is now intended that the plutonium will be precipitated and thermally stabilized by December 2001, by means of the magnesium hydroxide process. Although this process has already been used to stabilize thousands of liters of solution at the RFETS, DOE and its contractor at Hanford are still trying to prove it will work with the PFP solutions. The story of inability to treat plutonium solutions at PFP has been typical of a sequence of ineffective activities at that Plant, generally the result of poor management.

- Approximately 700 kilograms of plutonium exist at PFP in the form of metal or alloys. The facility has spent a significant amount of time pursuing various alternative strategies for processing and packaging this material and now plans to brush loose oxide from the

metal and package it in welded double containers in accordance with DOE-STD-3013 by March 2001, a noteworthy improvement over the original Implementation Plan's date of May 2002. The oxide from brushing and some severely corroded metal would be thermally stabilized to oxide as called for by the standard and added to the material in the following item.

- About 1,500 kilograms of plutonium exist at PFP in the form of oxide. About one year ago the staff at PFP began stabilizing this material through use of two muffle furnaces. The throughput of two furnaces was not enough to deal with the quantity of material in existence, but it was initially claimed that available funds were inadequate for installation of additional furnaces. It is now planned that three additional furnaces are to be brought on line by February 2000, and four more double capacity furnaces in May 2002. The oxide will be packaged to meet DOE-STD-3013 after stabilization. The original Implementation Plan proposed completion of packaging by May 2002. The present plan would accomplish the job by about May 2004.

- Several dozen kilograms of plutonium exist at the PFP dispersed in approximately 1,600 polystyrene cubes, called polycubes. This material was used in the past in criticality studies. The polycubes have become friable through the effects of radiolysis and have become a contamination dispersal hazard. The method of treatment and stabilization of this material was under discussion for some time with various alternatives being considered. At present it is planned to oxidize the material in the muffle furnaces with the polystyrene converted to gas and the plutonium converted to stable oxide and then packaged as above. The original Implementation Plan proposed completion of treatment by some method by January 2001. Although the current goal is treatment by August 2002, this date may be delayed when the throughput of the muffle furnaces is determined in February 2000.

- Hundreds of kilograms of plutonium are in residues of various forms at PFP. These were to have been packaged and disposed of by different methods by May 2002 according to the original Implementation Plan. Cementation of sand, slag, and crucible materials began, but that process was shut down several years ago after only 240 kilograms had been treated. It is now planned that the activity will be completed by April 2004.

- The K-East and K-West fuel storage basins at the Hanford Site contain approximately 2,100 tonnes of spent uranium fuel from past operation of the N-Reactor. At one time this material was to have been chemically processed in the Purex plant, but it was left stranded when DOE decided about ten years ago to decommission Purex. The spent fuel at these basins has been corroding for some decades and since the Basins are very near the Columbia River and have been known to leak during the past, remediation of this situation has been high on the Board's priority list. Progress toward remediation had seemed adequate some time ago, but with the change of contractors at Hanford a few years ago progress appeared to stall. Resumption of progress has recently been noted, but years of schedule loss have occurred. This activity has consumed a large part of the

financing that had been planned for other activities at the Hanford Site such as cleanup of PFP. The planned date of cleanout of the Basins had been December 1999 according to the original Implementation Plan. It is now anticipated that removal of fuel from the Basins will be completed by December 2003, and removal of sludge from oxidation will have been accomplished by August 2005. By that time cleanup of these Basins will have cost between one and two billion dollars.

- About one tonne of plutonium metal and oxide at the Los Alamos National Laboratory was recently declared to be excess to the needs of the defense program, and it awaits repackaging in accordance with DOE-STD-3013. According to the original Implementation Plan repackaging should take place by May 2002. At present there is no plan for repackaging any of the material.

- More than one tonne of plutonium exists in residues at the Los Alamos National Laboratory. The original Implementation Plan estimated that all would have been stabilized and repackaged by May 2002. All high risk items have been processed at this time. Although newly produced residues are being properly packaged, little work is being done at this time to take care of legacy residues. The estimated date for dealing with the legacy materials is now September 2005.

The above are not all of the materials referred to in Recommendation 94-1, but they are the major ones for which remediation schedules have fallen well behind those contemplated by the Recommendation and by the original Implementation Plan.

Fiscal Problem

The most common reason given for failure to meet schedules has been insufficient financial support. That being so, the Board does not understand why the Department of Energy has not obeyed the statutory requirement in the Atomic Energy Act as amended in 42 U.S.C. § 2286d(f)(2),

> (2) If the Secretary of Energy determines that the implementation of a Board recommendation (or part thereof) is impracticable because of budgetary considerations, or that the implementation would affect the Secretary's ability to meet the annual nuclear weapons stockpile requirements established pursuant to section 91 of this Act [42 U.S.C. § 2121], the Secretary shall submit to the President, to the Committees on Armed Services and on Appropriations of the Senate, and to the Speaker of the House of Representatives a report containing the recommendation and the Secretary's determination.

In any case, simultaneous implementation of all elements of Recommendation 94-1 to schedules previously committed seems to be impossible under present circumstances allegedly because of budgetary constraints. Given this fiscal reality, DOE is faced with the need to:

1. advise Congress and the President of the shortfall in funds to satisfy all the safety enhancements to meet Recommendation 94-1, and

2. prioritize and schedule tasks to be undertaken with available funds according to consideration of risks.

Recommendation

In the Board's view, material remaining in liquids generally poses the greatest hazard, because of higher possibility of dispersal and because of potential criticality. Among these liquids the highly enriched uranium solutions stored in tanks outside the H-Canyon at the Savannah River Site require the most attention because of criticality concerns. Following the solutions in importance are unstabilized plutonium oxides and plutonium metal remaining in containers with normal atmosphere, especially at locations in moist climates. Closely following in importance are various plutonium-bearing residues which are not as well isolated or packaged as they should be. Accordingly, the Board recommends the following technical actions in descending order of priority.

1. Stabilize the uranium solution in tanks outside the H-Canyon at the Savannah River Site, to remove criticality concerns. This should not await plans to convert the uranium to fuel for Tennessee Valley Authority's nuclear reactors.

2. Remediate the highly-radioactive solutions of americium and curium in the F-Canyon at the Savannah River Site. The currently-planned deferral of vitrification of this material is highly undesirable.

3. Remediate the solution of neptunium now stored in H-Canyon at the Savannah River Site.

4. Convert remaining plutonium solutions to stable oxides or metals, and subsequently package them into welded containers with inert atmosphere. The principal remaining solutions are in H-Canyon at the Savannah River Site, and the Plutonium Finishing Plant at the Hanford Site.

5. Treat the plutonium-bearing polycubes at PFP to remove and stabilize the plutonium.

6. Continue stabilization of spent nuclear fuel at Savannah River.

7. Stabilize and seal within welded containers with an inert atmosphere the plutonium oxides produced by various processes at defense nuclear facilities, and which are not yet in states conforming to the long-term storage envisaged by DOE-STD-3013. These oxides are found at the F Area of the Savannah River Site, the RFETS, the Plutonium Finishing Plant at the Hanford Site, the Lawrence Livermore National Laboratory, and the Los Alamos National Laboratory.

8. Enclose existing and newly-generated legacy plutonium metal in sealed containers with an inert atmosphere. Removal of loose oxide should of course take place just before sealing.

9. Remediate and/or safely store the various residues which are found at all three of the production sites, as well as the Lawrence Livermore National Laboratory and the Los Alamos National Laboratory.

It is assumed that the schedule for remediation of the spent fuel in the K-Basins at the Hanford Site will continue as currently planned.

The ordering of priorities should not be understood as implying a lack of importance attached to those lower in the sequence. It is simply a recognition that under the circumstances the greater hazards should be addressed first and with greatest firmness. All elements of the original Recommendation 94-1 retain their importance and none are to be considered unessential.

Also, the Board's staff has been discussing with DOE staff an ordering of tasks subject to Recommendation 94-1 in accordance with ease of their performance. Those actions which can readily be conducted within present resources should certainly go forward, as long as items of high safety priority receive the proper attention.

The severity of the problems which are the subject of this Recommendation and Recommendation 94-1 and the urgency to remediate them argue forcefully for the Secretary to avail himself of the authority under the Atomic Energy Act to "implement any such Recommendation (or part of any such Recommendation) before, on, or after the date on which the Secretary transmits the implementation plan to the Board under this subsection." *See*, 42 U.S.C. § 2286d(e). The Board suggests that the Secretary avail himself of this provision.

In addition, because stabilization of materials remaining from the Weapons Production Program continues to be of such importance, the Board recommends that:

10. An estimate be made of the total funding shortfall for timely completion of all 94-1 commitments according to the accepted Implementation Plans, and

11. Congress and the President be notified of the shortfall in accordance with statutory requirements.

John T. Conway, Chairman