

John T. Conway, Chairman
A.J. Eggenberger, Vice Chairman
John E. Mansfield

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

625 Indiana Avenue, NW, Suite 700, Washington, D.C. 20004-2901
(202) 694-7000



November 4, 2002

The Honorable Jessie Hill Roberson
Assistant Secretary for Environmental Management
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585-0113

Dear Ms. Roberson:

The staff of the Defense Nuclear Facilities Safety Board (Board) has completed a review of the Documented Safety Analysis (DSA) for the high-level waste Concentration, Storage, and Transfer (CST) facilities at the Savannah River Site. The CST DSA was prepared by the Westinghouse Savannah River Company to comply with Title 10 of the Code of Federal Regulations, Part 830 (10 CFR 830), *Nuclear Safety Management*, and was submitted to the Department of Energy's (DOE) Savannah River Operations Office for review and approval on June 27, 2002.

After reviewing the CST DSA, the Board's staff found that unmitigated accident scenarios were not adequately developed for several accidents involving the leakage or spill of high-level waste. The unmitigated accident analysis methodology used in the DSA improperly credits a number of operator actions for detecting and terminating waste release accidents. This methodology limits the calculated unmitigated consequences of an accident, and may not allow the proper selection of safety-class or safety-significant controls as necessary to adequately protect site workers and members of the public.

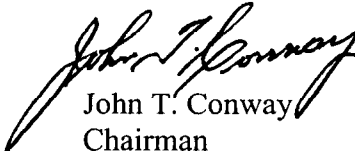
The Board believes that this approach is not in accordance with the guidance in the applicable DOE standard, DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analyses*. This standard states that unmitigated release calculations should represent a theoretical limit to accident consequences so that the physical release potential of a given process or operation can be conservatively estimated. A truly unmitigated analysis takes no credit for normal operating equipment or safety features.

The Board's staff also found that some values used as inputs for accident calculations may not be conservative and identified several other issues that merit further evaluation. The enclosed report summarizes the staff's observations relative to the CST DSA and is provided for your information.

On September 23, 2002, the Board issued a letter that discussed concerns with the improper implementation of safety analysis methodology at DOE defense nuclear facilities. Consistent with that letter, the Board believes that proper unmitigated or bounding accident analyses utilizing appropriately conservative input values should be included in the CST DSA. Such analyses allow the proper identification and selection of safety-class and safety-significant equipment and administrative controls. Any necessary equipment upgrades can then be prioritized on the basis of safety improvement, and a plan developed to ensure that the CST facilities can provide an adequate level of protection to site workers and members of the public for the remaining 20–30 years of facility life, as required by 10 CFR 830.

The Board would like to be briefed by appropriate representatives of DOE's Savannah River Operations Office and Westinghouse Savannah River Company in the next 30 days in response to the issues raised in the enclosed report.

Sincerely,



John T. Conway
Chairman

c: Mr. Mark B. Whitaker, Jr.
Mr. Jeffrey M. Allison

Enclosure

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Staff Issue Report

October 2, 2002

MEMORANDUM FOR: J. K. Fortenberry, Technical Director

COPIES: Board Members

FROM: L. M. Zull

SUBJECT: Documented Safety Analysis for the Concentration, Storage, and Transfer Facilities, Savannah River Site

This report documents the results of a review by the staff of the Defense Nuclear Facilities Safety Board (Board) of the Documented Safety Analysis (DSA) for the high-level waste (HLW) Concentration, Storage, and Transfer (CST) facilities at the Savannah River Site (SRS). Staff members H. W. Massie, J. L. Shackelford, W. G. Von Holle, T. D. Burns, and L. M. Zull performed this review between November 2001 and August 2002.

Background. The CST facilities include 49 large underground storage tanks; 3 evaporators; transfer lines; and associated equipment used to concentrate, store, and transfer HLW in the F-Area and H-Area Tank Farms at SRS. To comply with Title 10 of the Code of Federal Regulations, Part 830 (10 CFR 830), *Nuclear Safety Management*, Westinghouse Savannah River Company and its subcontractor, Westinghouse Safety Management Systems, prepared and submitted a draft CST DSA and Technical Safety Requirements (TSRs) to the Department of Energy's (DOE) Savannah River Operations Office for review and approval on June 27, 2002.

The Board's staff reviewed the safety strategy, inputs and assumptions, accident scenarios, and controls for the 23 design basis accidents (DBAs) in the DSA and TSRs. The staff also reviewed the supporting engineering calculations and discussed the analyses during an August 19–22, 2002, visit to the site. Although the hazard and accident analyses for the CST DSA are the most comprehensive performed to date, the staff identified several fundamental issues, summarized below.

Unmitigated Accident Analyses. The staff found that unmitigated accident analyses were not performed properly for several DBAs in the CST DSA. The applicable DOE standard, DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analyses*, provides guidance on the interpretation and implementation of 10 CFR 830. On page A-6 of DOE-STD-3009-94, it is stated that “. . .the unmitigated release calculation represents a theoretical limit to scenario consequences assuming that all safety features have failed, so that a physical release potential of a given process or operation is conservatively estimated.” In addition to not taking credit for safety features, it is

implied that credit should not be taken for normal process equipment when developing an unmitigated accident scenario.

Contrary to the guidance in DOE-STD-3009-94, the unmitigated accident analysis methodology employed in the CST DSA assumes that operators will detect and respond to accidents using normal process equipment where multiple means or opportunities exist, without crediting a specific system or component. The DSA also assumes that the simultaneous failure of multiple means of detecting an event is unrealistic, even if none of those means are credited and controlled as safety-related. This approach improperly limits the unmitigated consequences of several accident scenarios, and may not allow the proper selection of safety-class or safety-significant controls necessary to adequately protect members of the public and workers.

This problem is illustrated by the CST DSA's treatment of accidents that involve the release (leakage or spill) of HLW. Seven of 23 DBAs in the DSA involve the release of HLW. For all of the waste release accidents, the maximum amount of waste that could be released is assumed to be 15,000 gallons. For some accidents, such as the release of waste during transfer events, the unmitigated analyses assume that the operator can detect and terminate the release of waste within 41 to 60 minutes using normal process (nonsafety) instrumentation and equipment. Except for the seismic event, the unmitigated analysis concludes that none of the waste release accidents exceed the offsite evaluation guideline (EG) of 25 rem, while only a few of the accidents exceed the onsite EG of 100 rem. As a result, the contractor concluded that no safety-related equipment is necessary to mitigate the events that do not exceed the EGs.

Without taking credit for operator action, unmitigated releases larger than 15,000 gallons are credible and could result in doses that exceed the onsite or offsite EGs. According to DOE-STD-3009-94, it is not proper to take credit for normal process instrumentation and equipment for detecting and terminating the release of waste in the unmitigated accident analysis. Proper bounding scenario calculations require that no credit be taken for active systems for reducing the consequences of an event.

Input Values and Assumptions. The input values in the CST DSA were developed by plant engineers who reviewed equipment and operating data and spoke with operators and safety analysts. The Board's staff found that the values selected for most input parameters and assumptions appear to be conservative, but that some individual parameters and some values used in composite (calculated) parameters may not be conservative.

For example, the staff found that the composite parameter calculations for radiological source terms and hydrogen generation rates may not produce conservative values. Both of these parameters are calculated using equations that are based on several other input parameters, including the concentration of radionuclides in the waste sludge and slurry, weight percent (wt%) sludge in a sludge-slurry mixture, and supernate density. The radionuclides in the sludge and supernate are based on the highest value for each radionuclide found in the entire tank farms, and are believed to be conservative. However, the value selected for the weight percent sludge in a sludge-slurry mixture (16.7 wt%) is in the middle of the waste acceptance criteria range of 13–19 wt%. The value selected for the supernate density (1.4 g/cm³) is near the low end of the normal operating range of 1.3–1.7 g/cm³.

The contractor made the argument that overconservatism in the values used for radionuclides in the waste sludge and slurry compensates for the use of less-than-maximum values for the weight percent sludge and supernate density. However, it is not clear that the radiological source terms and hydrogen generation rates calculated using the selected weight percent sludge and supernate density values would be conservative for all waste tanks and waste transfer situations. The site has agreed to provide information on whether the radiological source terms and hydrogen generation rates developed using the composite approach are bounding for all tanks.

In addition, values selected for some individual parameters are nonconservative without sufficient justification having been given for the selection. For example, the scenario durations used in calculating the total effective dose equivalent values for transfer errors were rounded down to a less conservative value in some cases. The use of these nonconservative estimates was defended on the basis that the final results were "not overly sensitive" to this assumption. Another example is the use of a supernate density of 1 g/cm^3 in calculating the consequences of waste aerosolization accidents, whereas the range is $1.3\text{--}1.7 \text{ g/cm}^3$. The DSA states that the 1 g/cm^3 supernate density value is nonconservative, but is offset by the use of a lower value for the surface tension. It is not clear that using a combination of nonconservative and overly conservative values produces a conservative result. The staff has requested additional information to support the conservatism of the aerosol calculations.

Finally, the staff notes that a nonbounding parameter value that is acceptable for use in one type of calculation or accident scenario may not be conservative for use in a different type of calculation or accident scenario. Parameter values ought to be examined to verify that they are appropriate for each accident scenario in which they are used.

Human Factors and Operator Actions. The staff found that credit for operator actions in the DSA accident scenarios is based on subjective judgment rather than a more rigorous basis, such as human factors studies. The human factors analysis presented in Chapter 13 of the DSA is an inadequate treatment of the human factors considerations required by DOE-STD-3009-94. This chapter provides only general human factors information at a superficial level. The justification for the lack of detail is that the facilities have been in operation for more than 40 years and predate modern human factors considerations. Additionally, it is asserted that long-term engineering and operating experience in the CST facilities is sufficient to ensure that any significant human factors considerations have been addressed. The controls outlined in Chapter 4 of the DSA credit a number of operator actions and human-machine interfaces. In particular, operator actions are credited for detecting accidents, isolating leak paths, monitoring tank liquid levels, and manually operating ventilation systems in a number of important accident scenarios. However, no focused human factors review appears to have been performed for these activities.

Administrative Programs. The staff observed that the DSA takes considerable credit for a number of programmatic administrative controls in the accident analysis, including the chemical inventory control program and the fire protection program. The DSA identifies 14 programs as controls required to protect general assumptions upon which the accident analyses are based. These programs are assumed to provide the required safety function (a

safety-class or safety-significant control), depending on the particular requirements of the accident. For example, in the scenario involving a fire in an evaporator cell, the resultant release is postulated to exceed the evaluation guidelines for offsite dose. The unmitigated event is categorized as “unlikely.” However, the mitigated event analysis credits the fire protection program with reducing the event frequency by more than two orders of magnitude, and evaluates the resulting likelihood as “beyond extremely unlikely.” As a result, the DSA credits the fire protection program with performing a safety-significant function. Several other examples exist in the DSA accident analysis. The basis for reducing the calculated likelihood of occurrence of certain accidents by several orders of magnitude using administrative programs is not clear.

Another example is found in the DSA’s evaluation of an HLW evaporator pot deflagration/explosion. The only credited controls are administrative programs that are evaluated as maintaining the consequences of an explosion below the EGs. No preventive controls are identified.

Safety-Related Equipment Modifications. As a result of the analysis in the CST DSA, the contractor plans to implement equipment modifications to provide safety-class and safety-significant controls required for some accidents. The contractor has also developed a list of additional proposed safety equipment upgrades that would be dependent on approval of funding. However, additional modifications may be necessary once a proper unmitigated accident analysis has been completed.