DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Washington, DC 20004-2901

March 2, 2012

Mr. Steven C. Erhart
Manager
Pantex Site Office
U.S. Department of Energy
P.O. Box 30030
Amarillo, Texas 79120

Dear Mr. Erhart:

The staff of the Defense Nuclear Facilities Safety Board (Board) reviewed the supporting calculations for some of the Technical Safety Requirements in select Safety Analysis Reports at the Pantex Plant. The Board notes that the staff identified a number of areas needing improvement. The results of the review are provided in the enclosed report. The Board is encouraged that Babcock &Wilcox Pantex managers have submitted a set of actions to the Pantex Site Office intended to address the issues identified by the Board's staff. The Board would like an update on the status of these actions during the next Board visit to the Pantex Plant.

Sincerely,

Peter S. Winokur, Ph.D.
Chairman

Enclosure

c: Mrs. Mari-Jo Campagnone

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Staff Issue Report

November 22, 2011

MEMORANDUM FOR: T. J. Dwyer, Technical Director

COPIES: Board Members

FROM: R. Rauch

SUBJECT: Review of Calculations Supporting the Safety Basis for the Pantex Plant

This report documents the results of a review by the staff of the Defense Nuclear Facilities Safety Board (Board) of the calculations that demonstrate the effectiveness and reliability of a sampling of Technical Safety Requirements (TSRs) for the Pantex Plant. Staff members D. Andersen, J. Anderson, M. Dunlevy, and R. Rauch performed the review during the course of calendar year 2011.

Scope. The staff reviewed the validity of the engineering methods, inputs, and assumptions used in the calculations supporting select TSRs and verified that the parameters used in these calculations were consistent with all applicable safety basis parameters (e.g., functional requirements, hazard and accident scenario parameters, and surveillance requirements or in-service inspections) for the selected TSRs. The staff also used the information in the documents reviewed to judge the effectiveness of the collective control strategy for certain accident scenarios. The staff reviewed a total of 15 TSRs, but the majority of the questions and concerns that emerged were associated with the following TSRs:

- For hazards addressed in the Sitewide Safety Analysis Report (SAR), the staff reviewed the TSRs that are credited to protect against vehicle impacts to nuclear material storage magazines and TSRs related to fire protection in nuclear facilities.

- The staff also reviewed the blast doors (TSR-level design features) that are part of the facility structure for nuclear explosive bays. The staff assessed the ability of the blast doors to protect against several accident scenarios in the Sitewide SAR, including vehicle impacts to a nuclear explosive bay and fires external to a nuclear facility. The staff also reviewed the TSRs credited to ensure that at least one set of blast doors remains closed at all times.

- The staff reviewed the TSRs that prevent impacts to nuclear explosives during mass properties operations, as discussed in the Mass Properties SAR.

Results. The staff identified weaknesses in four areas: the adequacy of the calculations, the development of the calculations, configuration management of safety basis reference documents, and the application of probabilistic estimates.

Adequacy of Calculations—The staff identified several weaknesses in the calculations reviewed. The staff grouped these weaknesses into three categories:

- *Babcock & Wilcox (B&W) Pantex subject matter experts (SMEs) did not document adequately the basis for the selection of certain non-conservative inputs, nor did they document adequately the justification for some of the methodologies used.* For example, the calculation of a vehicle impact to a nuclear material storage magazine used an impact duration of 0.2 s. The staff reviewed the source document for this value and found that it was the least conservative value in the range of potential impact durations provided. The SME responsible for the calculation was able to defend the selection of this value by citing the presence of earth overburden on the magazine. However, the calculation did not address explicitly the effect of the presence of earth overburden on the accident scenario in question.

- *Certain TSRs did not have sufficient technical bases to demonstrate that the TSRs could perform their credited safety functions.* For example, there was no technical basis to demonstrate that the blast doors for nuclear explosive bays could meet the TSR requirement to prevent a fire external to the facility from progressing to an internal facility fire for 2 hours.

- *Some inputs, assumptions, and methodologies in the calculations could not be defended without additional analysis.* For example, the calculation of a vehicle impact to the blast doors for nuclear explosive bays provided no basis for the assumed stopping distance of the vehicle. Following discussions with the staff, the responsible SME was able to validate the results of the original calculation using a software application to model the blast doors' response to a vehicle impact.

It should be noted that B&W Pantex was eventually able to defend the results of the calculations despite the weaknesses found by the staff. Most of the calculations reviewed by the staff contained sufficiently conservative inputs or methodologies to preclude the weaknesses from having a significant effect on the calculation results. Some of the identified weaknesses were significant enough to compel the responsible SME to redo the calculation; even in these cases, however, the results of the original calculation remained valid (according to new draft calculations).

Although the identified weaknesses had relatively little impact on the safety basis proper, the staff believes they represent shortcomings in the quality of these documents that must be addressed. In general, the methodologies used in the calculations reviewed by the staff were either oversimplified or incomplete. At a minimum, not adequately documenting the basis for the inputs, assumptions, and methodologies may leave the site vulnerable to a loss of institutional knowledge. Given the small sample size of the review relative to the total number of TSRs in the Pantex safety basis (15 out of approximately 400 TSRs), the staff cannot rule out the

potential for shortcomings with greater impact. Therefore, the staff believes that the identified weaknesses indicate the need for a comprehensive technical review of the documents which demonstrate that the Pantex TSRs are able to perform their credited safety functions.

B&W Pantex issued a memorandum to the Pantex Site Office (PXSO) on October 18, 2011, detailing the actions it plans to take in response to the results of the staff's review. B&W Pantex plans to revise the criteria review and approach documents for the TSR assessment process (B&W Pantex must assess 20 percent of its TSRs each year as part of its contractor assurance system) to institutionalize a more rigorous calculation review. The intent of this improvement is to foster a more critical review of the calculations supporting the safety basis by placing greater emphasis on verifying the technical basis for the inputs, assumptions, and methodologies used in these calculations. The B&W Pantex memorandum also committed to addressing the specific calculation weaknesses identified by the staff.

Development of Calculations—The staff reviewed the latest revision of the procedures that govern the development of calculations used in the Pantex safety basis to determine whether those procedures were adequate to prevent a recurrence of the weaknesses discussed above. Two documents govern the development of most of the calculations supporting the Pantex safety basis: a work instruction titled *Originate and Perform a System Engineering Calculation* and Appendix K of the *Pantex Plant Authorization Basis Manual* (AB Manual). The latter document establishes the methods for preparing, reviewing, approving, and revising the calculations used in analyses for the Pantex safety basis in accordance with the quality assurance requirements of Subpart A of Title 10 of the Code of Federal Regulations, Part 830 (10 CFR 830).

The staff found that both documents were generally adequate to produce calculations of sufficient pedigree to support the safety basis. In fact, both contained specific steps that would have prevented many of the weaknesses identified by the staff had they been in place and followed at the time the calculations were performed. However, the staff did identify one shortcoming in Appendix K of the AB Manual: with the exception of vendor-supplied calculations, there is no requirement for the user to ensure that safety basis calculations produced before the implementation of 10 CFR 830 or produced by other organizations were developed using methods equivalent to those described in the AB Manual. In its October 18 memorandum, B&W Pantex committed to reviewing and revising, as necessary, the processes used at Pantex to direct the format and content of calculations.

Configuration Management of Safety Basis Reference Documents—The staff found that B&W Pantex has not implemented effective configuration management of the calculations supporting the safety basis. The results of some of the calculations referenced in the safety basis are used not only to support analyses in the safety basis proper, but also as inputs for other reference documents. For example, an analysis of human impact energies is used as a reference document for multiple analyses in the safety basis and is also used in one calculation to screen out certain tooling configurations from further evaluation. Instead of formally mapping and documenting the relationships among the reference documents in the safety basis, B&W Pantex's unreviewed safety question (USQ) evaluators rely on memory to identify the suite of reference documents affected by a change to a calculation. They acknowledged that this approach is a potential vulnerability in the USQ process.

In its October 18 memorandum, B&W Pantex stated that it plans to place all safety basis reference documents in a common location on a shared computer network to allow searching for all analyses affected by a revision to a calculation. The staff agrees this is an improvement over the previous approach, but believes that B&W Pantex should conduct a quality assurance validation of the proposed approach to ensure that it is sufficiently reliable to support the USQ process.

Application of Probabilistic Estimates—Many of the technical bases describing the effectiveness and reliability of the TSRs selected for review by the staff contained probabilistic estimates. The staff identified three issues—one generic and two specific—associated with the probabilistic estimates in the analyses reviewed.

The generic issue involved several probabilistic estimates that lacked a clear technical basis. Most of the estimates in this category are the control failure rates or initiating event probabilities used to demonstrate the adequacy of the credited control set at the end of an accident analysis. For example, the discussion of adequacy of controls that follows the external fire accident scenario in the Sitewide SAR multiplies the probability of an external fire (1E-3 fires/year) by the probability of failure of the outside combustible control program (1E-4 failures/opportunity) or the failure of the administrative control that requires at least one set of bay blast doors to be closed (the facility door control, 1E-4 failures/opportunity) to show that the selected control set is adequate on a failure-per-year basis. There are no references to support either of the two control failure rates. The safety basis analyst assigned the first failure rate based on a qualitative judgment and the second failure rate because the actions required to implement the control are "inherent to the processes and training at Pantex." There is little additional discussion in the SAR to help the reader understand why these controls are adequate.

Although the SAR gives no reference for the control failure rates cited above, B&W Pantex appears to have derived these values and many of the other failure rates used in the safety basis from the Hazard and Barrier Analysis Guidance Document issued by the Department of Energy (DOE) Office of Operating Experience Analysis and Feedback (EH-33) in November 1996. The EH-33 document includes failure rates for skill-based operator errors, errors of commission, errors of omission, and failures of administrative controls. Section 2.5 of the document describes the appropriate use of these numbers as "semi-quantitative." This description is based on the relative uncertainty of the conditions present during the events from which these failure rates were developed and on the subjectivity associated with the credit to be taken for the knowledge and training levels of the individuals involved in the event. In the staff's judgment, the qualitative discussion supporting many of these control failure rates is too limited to allow relying on them to defend the adequacy of the final control set.

During the staff's review, B&W Pantex representatives acknowledged that they would have to bolster the qualitative discussion surrounding the estimates and either improve the technical basis for these estimates or eliminate them altogether. Regarding the former case, the safety basis improvement project B&W Pantex initiated in 2010 was intended to enhance the "Adequacy of Controls" sections of the safety basis and provide sufficient qualitative information to support discussions in the safety basis that rely on probabilistic estimates of marginal pedigree. Additionally, PXSO has established a performance target in the Fiscal Year

2012 Performance Evaluation Plan for B&W Pantex to develop a probabilistic risk assessment capability. The staff supports any efforts to improve the technical basis of probabilistic estimates, provided these estimates are applied in a manner consistent with the safe harbor methodology specified in DOE Standard 3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analyses*. The standard presents a hazard and accident analysis methodology based primarily on quantitative arguments. These arguments can be supplemented by quantitative analysis, depending on the magnitude of the hazard in question and the complexity of the surrounding system. For these situations, the staff suggested the performance target discussed above serve as a pilot application of the draft technical standard (*Development and Use of Probabilistic Risk Assessments in Department of Energy Nuclear Safety Applications*) that DOE issued in response to the Board's Recommendation 2009-1, *Risk Assessment Methodologies at Defense Nuclear Facilities*.

The first of the specific issues identified by the staff involves the basis for the external fire frequency (1E-3 fires/year) discussed above. The staff found that this number was derived from the number of *internal* fires initiated in all Pantex nuclear facilities over a 19-year period. B&W Pantex representatives acknowledged that this was a mistake; the external fire scenario should have applied an external fire frequency of 1 fire/year, as discussed in Chapter 1 of the Sitewide SAR. The staff also found several inconsistencies among the various sub-scenarios for the external fire event analyzed in the Sitewide SAR. For example, the fire department's response was credited for some sub-scenarios, while the facility structure was credited for others. In effect, both controls (along with the outside combustible control program) would be relied upon for any fire external to a Pantex nuclear facility. In its October 18 memorandum to PXSO, B&W Pantex committed to revising the external fire scenario to address this issue.

The second specific issue identified by the staff involves the calculation for the frequency of a vehicle weighing greater than 80,000 lb impacting a nuclear facility. The Pantex safety basis concludes this is an incredible event; therefore, no controls are in place to protect against this scenario. The calculation supporting this conclusion applies several modifying factors, including reduction of the frequency by two orders of magnitude to account for such factors as the relatively benign driving terrain at Pantex. B&W Pantex safety basis analysts were unable to provide a basis for the magnitude of some of the reductions taken. The staff, citing the arbitrary nature of these reductions, asked whether B&W Pantex had considered implementing an engineered barrier to protect the facilities in question.

In a January 13, 2012, memorandum to PXSO, B&W Pantex managers stated that they plan to update the vehicle impact scenario to better reflect the factors that make the heavy vehicle impact event incredible. The staff plans to review this safety basis change when it has been submitted to PXSO. As a more robust solution to this concern, the staff suggested that B&W Pantex install a vehicle barrier outside facilities that are vulnerable to an impact from a heavy vehicle. The installation of vehicle barrier would render moot any issues with the calculation of the frequency of heavy vehicle impact.