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**DEFENSE NUCLEAR FACILITIES
SAFETY BOARD**

Washington, DC 20004-2901



April 5, 2011

The Honorable Thomas P. D'Agostino
Administrator
National Nuclear Security Administration
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585-0701

Dear Mr. D'Agostino:

The Defense Nuclear Facilities Safety Board (Board) is concerned that the nuclear weapon design agencies (DAs) have not adequately implemented the Department of Energy's (DOE) Standard DOE-NA-STD-3016-2006, *Hazard Analysis Reports for Nuclear Explosive Operations* (Standard 3016). DOE-NA-STD-3016-2006 defines the process by which the DAs provide the weapons response information required by the Pantex Plant to develop the safety bases and controls for its nuclear explosive operations. Shortcomings in implementing the standard have led to the use of weapon response information that has been neither adequately documented nor properly peer reviewed. As a result, the weapon response information cannot be verified as technically accurate.

In response to the Board's long-standing concerns regarding the development and documentation of weapon response information, the National Nuclear Security Administration (NNSA) on February 4, 2008, provided the Board with the *Assessment Report for Design Agency Implementation of DOE-NA-STD-3016-2006: Hazard Analysis Reports for Nuclear Explosive Operations*. This assessment identified several areas in which the DA's procedures failed to meet the criteria established in Standard 3016. NNSA tasked the DAs to address all findings by May 30, 2008.

The Board's staff undertook a comprehensive review of the implementation of Standard 3016 in the most recent weapon responses developed by each nuclear weapon DA. The enclosed report documents the results of that review.

The Board considers full implementation of Standard 3016 critical to nuclear safety at the Pantex Plant. Therefore, pursuant to 42 U.S.C. § 2286b(d), the Board requests a report within 90 days of receipt of this letter outlining any corrective actions to be taken to address weaknesses with the implementation of Standard 3016 as detailed in the enclosed report.

Sincerely,

Peter S. Winokur, Ph.D.
Chairman

Enclosure

c: Mrs. Mari-Jo Campagnone

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Staff Issue Report

January 24, 2011

MEMORANDUM FOR: T. J. Dwyer, Technical Director

COPIES: Board Members

FROM: C. Martin

SUBJECT: Review of Implementation of Department of Energy Standard 3016 at Lawrence Livermore, Los Alamos, and Sandia National Laboratories

This report documents a review by the staff of the Defense Nuclear Facilities Safety Board (Board) of the implementation of the weapon response requirements contained in the Department of Energy (DOE) Standard DOE-NA-STD-3016-2006, *Hazard Analysis Reports [HAR] for Nuclear Explosive Operations* (Standard 3016) by each nuclear weapon design agency (DA). During February 23–24, 2010, the staff evaluated Lawrence Livermore National Laboratory's (LLNL) implementation of Standard 3016 to develop the weapon response for the W84 Seamless Safety for the Twenty-First Century (SS-21) project. During June 8–10, 2010, the staff performed a similar evaluation for the weapon response for the B53 SS-21 project at Los Alamos National Laboratory (LANL). The staff conducted a third such evaluation at Sandia National Laboratories (SNL) during September 8–9, 2010. Additionally, the staff met with LLNL personnel on December 15, 2010, and with LANL personnel on December 17, 2010, to clarify technical details. The following staff members participated in this review: C. Martin, B. Laake, W. Von Holle, B. Broderick, T. Spatz, J. Anderson, J. Plaue, J. Shackelford, R. Rauch, and M. Moury. This report complements a letter from the Board to the National Nuclear Security Administration (NNSA) dated July 6, 2010, documenting deficiencies in the implementation of Standard 3016 at the Pantex Plant.

Background. In a letter to NNSA dated August 16, 2006, the Board expressed its concern regarding the (then draft) Standard 3016. Two years later, in a letter to NNSA dated December 16, 2008, the Board expressed its concern regarding whether application of the new procedures in Standard 3016 would consistently yield weapon response information that would be technically accurate, properly peer reviewed, and adequately documented.

On February 4, 2008, NNSA provided the Board with the *Assessment Report for Design Agency Implementation of DOE-NA-STD-3016-2006: Hazard Analysis Reports for Nuclear Explosive Operations*. This assessment reviewed the DAs' procedures for implementing Standard 3016, but not the actual implementation. The report offered the conclusion that the

DAs' procedures for implementing Standard 3016 had numerous shortcomings, and NNSA required the DAs to revise their procedures by May 30, 2008. NNSA has not conducted a comprehensive evaluation of the implementation of the procedures.

Issues with the Implementation of Standard 3016. After the DAs revised their procedures to address NNSA's findings, the Board's staff reviewed the implementation of Standard 3016 at each DA. The Board's staff identified the following issues:

Documentation of Technical Bases for Weapon Response—LLNL and LANL failed to document the technical basis for some weapon response information as required by Paragraph 6.2.3 of Standard 3016, which states:

The basis information (e.g., experimental data, modeling results, test results, calculations) that the DAs use to provide reference and support for developing weapon response for the PPC [production plant contractor] is kept at the DA, and is maintained in accordance with requirements of the DA's DOE/NNSA-approved Quality Assurance Program (QAP) as required in 10 CFR 830.120, Subpart A, and DOE O 414.1C, "Quality Assurance," or superseding directives. Source data and methods used in developing weapon response must be traceable. All information used within, or to support, the weapon response bases documentation (including all references) shall be accurate and available to support the DOE/NNSA HAR review.

For example, at LLNL, the staff noted the lack of a clear and well-documented technical justification for important weapon response estimates. Specifically, the likelihood that the strong link for the W84 would not be in the reset position prior to dismantlement operations comprised a critical element in determining the acceptability of the risk of the operations. Given the limited amount of operational data available (relative to the extremely high reliability assigned to the correct position of the strong link), the value used in the analysis cannot be substantiated with defensible statistical arguments. Rather, LLNL interpreted this sparse data set using expert judgment to develop the estimate. This issue is related to an issue raised by the Board regarding the use of quantitative risk assessment in nuclear safety applications, as outlined in Recommendation 2009-1, *Risk Assessment Methodologies at Defense Nuclear Facilities*. A key objective of that Recommendation is to ensure adequate transparency, defensibility, and repeatability in the development of such estimates.

The staff found that LLNL did not maintain traceability of the information used in its W84 weapon response basis to the level of rigor required by its own implementing procedure. NWP-QIP-001, *Nuclear Weapon Engineering Program Procedure for Weapon Response Documents: Development, Review and Approval*, requires that documentation of weapon response include "equations and models sufficient to effectively review [the analysis], test data and it [sic] applicability, assumptions and controls (and their basis), expert judgment, and use of existing previously reviewed [weapon response] assessments and the basis for its use . . . [and] must be sufficiently detailed such that the [weapon response] can be reconstructed by similarly capable individuals so as to validate the assessment." The staff identified several instances in which the basis document implied the existence of a reference to support a conclusion but

provided no specific citation. The staff also identified several inaccuracies in the W84 technical basis that rendered the statements made illogical or incorrect. The staff believes these inaccuracies were the result of inadequate attention to detail in documentation of the technical basis and do not indicate legitimate errors that would render the technical basis deficient. However, the staff noted that the LLNL peer review process failed to identify and correct these inaccuracies.

At LANL, scientists and engineers aggregated the results from an expert elicitation process with the results of an expert judgment assessment for some B53 weapon response data. The process used was poorly documented, making it impossible for independent reviewers (such as NNSA and the Board’s staff) to understand the process or to judge the correctness of the results.

Expert Judgment/Elicitation—The DAs are not effectively utilizing the expert elicitation process. Paragraph 6.2.4 of Standard 3016 states:

Expert elicitation may be of the greatest value and should be considered in the following situations:

- Empirical data is not reasonably obtainable or the analysis is not practical to perform.
- Multiple diverse sources of applicable data must be assessed.
- Uncertainties are large and significant.
- More than one conceptual model can explain and be consistent with the available data.
- Technical judgments are required to assess whether calculations are appropriately conservative.
- Source data includes the use of unpublished, un-reviewed, or draft information.

Although both LLNL and SNL have procedures for conducting expert elicitation, personnel from each organization stated that they do not plan to perform expert elicitation. Both of these DAs rely solely on expert judgment to develop weapon response information, even if the criteria for considering the use of expert elicitation have been met. Use of expert judgment is reasonable when sufficient data exist and the thresholds for response are well defined; this is how engineering heuristics are developed and applied. But this often is not the case for weapon response data, and, as in the LLNL example cited earlier, the DAs often must interpret limited data gathered under idealized conditions to estimate the response thresholds for particular insult conditions. In such cases, as noted in Standard 3016 and NUREG-1563, *Branch Technical*

Position on the Use of Expert Elicitation in the High-Level Radioactive Waste Program, November 1996, which is referenced in Standard 3016, formal elicitation of multiple experts is more appropriate and provides information not available through expert judgment.

To its credit, LANL did perform expert elicitation for the B53 weapon response to mechanical insults to the high explosive because experimental information was lacking. However, LANL considered the results to be of limited value because of the large variances among the data. LANL did not apply statistical analysis of the data to extract useful technical conclusions. The Board's staff believes this would have been possible with a more carefully designed and executed expert elicitation process.

In parallel with this effort, the LANL Explosives group (DE-1), performed its own assessment using experts, experiments, and historical data. Although the resulting data are a key input to the weapon response, DE-1 used its own processes and procedures to develop and review this assessment, rather than processes verified as complying with Standard 3016.

Technical Peer Reviews—The DAs' peer review processes lack both rigor and independence. Paragraph 6.2.4 of Standard 3016 states:

Peer reviews are performed in order to ensure completeness and accuracy and to limit the potential bias of weapons response information, while bringing in additional sources of expertise. Peer reviewers shall have the requisite technical knowledge to understand and challenge the information, but must not have been involved in the development of the information. Each organization providing formal weapon response, in accordance with this standard, shall perform peer reviews of the information prior to its release. Each organization shall do so in accordance with a DA procedure that describes the peer review process including criteria for establishing and maintaining the requisite training, qualification, and independence of the peer reviewers. This procedure shall be included in the DA's QAP [quality assurance plan] submitted for DOE/NNSA approval per 10 CFR 830.120, Subpart A and DOE O 414.1C, or superseding directives.

At LLNL, the Board's staff identified several issues related to the peer review of weapon response. LLNL failed to document any potential conflicts of interest among the W84 peer review team, even though the team lead was LLNL's representative on the W84 product realization team, and several members of the peer review team produced experimental data used to develop the weapon response. The LLNL procedure provides three options for documenting a weapon response peer review; however, the method chosen in this case, a signature page at the end of the technical basis document, is reserved for "very simple WR [weapon response] assessments." In the staff's opinion, this was not an appropriate choice for the W84 weapon response. The staff believes that all comments made by peer reviewers, along with information on how the comments were resolved, ought to be included in the peer review documentation to enable external reviewers to determine whether peer review teams conducted their reviews with sufficient rigor. This is not currently required by any of the options in the procedure. The staff

also noted that LLNL does not keep records of the credentials of all “second tier” experts (e.g., academics) that provide input supporting the development of weapon response, although doing so is currently required by LLNL’s procedure.

The LANL procedure lacks guidance for peer reviewers on how to perform a thorough review. Thus, LANL could not demonstrate that any given part of the weapon response had been technically reviewed unless the reviewers had raised an issue. LANL also produces no documentation that the complete weapon response document has actually been peer reviewed. By reviewing successive versions of the B53 weapon response, the staff found instances in which calculations had been deleted from the body of the document but were still referenced in the weapon response tables, technical footnotes had been deleted but still used to support textual comments, and referenced table entries were missing. LANL personnel attributed all of these instances to changes made between revisions but not discovered because peer reviewers had not reexamined other parts of the document. Thus LANL is publishing parts of the weapon response that have never been technically reviewed as required by Standard 3016 and that lack effective configuration management. Additionally, LANL does not verify the qualifications of subject matter experts that serve as technical peer reviewers.

Within the Weapon Systems Engineering division at SNL, the staff found that peer reviewers are marginally independent (one of the peer reviewers was the SNL lead for the project team for this SS-21 project and had the same direct line manager as the individual that prepared the weapon response data), but there is no formal guidance for the peer review, and reviewer comments are captured only if they can not be resolved. The peer review process of the Weapon Systems Engineering division is limited to checking assumptions and reviewing the accuracy of facts. As described in NUREG-1563, for work of this importance an adequate peer review would include commenting “on the validity of the assumptions, the appropriateness and limitations of the methodology and procedures, the accuracy of the calculations, the validity of the conclusions, and the uncertainty of the results and consequences of the work.”

In addition to the peer review conducted by the Weapon Systems Engineering division at SNL, an independent technical review is conducted by the Surety Assessment division. The mission of this division includes providing outside assessments of the safety of weapon systems. While these assessments are not performed in a manner to satisfy the peer review requirements of Standard 3016, they do have significant value. A similar independent safety review group does not exist at LLNL or LANL.

Incorporation of Weapon Response Information into Pantex HARs—The DAs do not confirm that weapon response information is correctly incorporated into Pantex HARs. Paragraph 6.2.5 of Standard 3016 states: “The DAs shall work with the PPC to ensure appropriate use of the weapon response information.”

Neither LLNL nor LANL has a mechanism for reviewing how Pantex uses its weapon responses. Formerly, Chapter 11.4 of the NNSA *Design and Production Manual* required the DAs to officially review the proposed operations and authorization basis documentation to ensure that weapon response information had been understood and appropriately addressed; however, that requirement was dropped when Chapter 11.4 was revised. Additionally, under

Chapter 11.4 Revision 1, the DAs served as members of the Pantex Site Office (PXSO) Safety Basis Review Team, but that is no longer the case; they now serve only as “technical advisors.” The DAs do have representatives on the Hazard Analysis Task Teams (HATTs), which develop the Pantex HARs; but only active SS-21 projects have HATTs.

SNL personnel admitted they make little effort to ensure that HARs use the weapon response correctly, although a proposed revision to the Realize Product Procedure, *Pantex Weapon Response Data Preparation and Review*, includes the following statement that should address this deficiency: “[SNL will] ensure weapon response is used correctly in the HAR.”

Characterization of Probabilities and Uncertainties—The DAs provide no uncertainty data for the point estimates given to the PPC. Section 8 of Standard 3016 states:

Probability estimates for weapon responses, safety function failures, and intermediate events as part of an accident sequence should:

- Provide reasonably approximate, order-of-magnitude point-estimates commensurate with the secondary role that estimation of accident scenario probabilities play in the safety basis documentation,
- Characterize the degree of uncertainties from the range of variability in supporting information that was used to develop the point-estimate probability,
- Be reasonably conservative, and
- Be associated with properly and thoroughly defined events.

Neither LANL nor LLNL currently supplies any information to Pantex other than the point estimates. As stated in the Board’s July 6, 2010, letter concerning Pantex HARs, Pantex uses the probabilities of initiating events along with the point estimates for weapon response to screen events from further analysis; therefore, some events could be improperly screened if the uncertainty in point estimates is not considered. Furthermore, uncertainty information is needed in judge the margin of safety associated with the selected controls.

Software Tools for Weapon Response Data—No formal software quality assurance process is applied to the weapon response development software. All three DAs use a software system created and maintained by SNL (the Weapon Response Basis database) to maintain weapon response data. This system has been in development and use since 2003. The DAs’ weapon response staffs input all information required to generate the weapon response technical basis and summary documents, such as scenarios, rules, assumptions, and control notes, into the database. The software then generates the actual documents. Once the documents have been generated, quality control consists merely of reviewing and signing off on them. This procedure could create a problem in that when changes are made to the weapon response, the database generates a new version of each report, but the DAs review only the changes; they perform no

comprehensive review to ensure that unintentional changes have not occurred. In the staff's opinion, this software meets the criteria for safety software, but it was not developed using formal software quality assurance controls as required by DOE Order 414.1C, *Quality Assurance*. This deficiency is reportedly being corrected in the next version of this software.

NNSA Oversight of Weapon Response. The staff's review revealed that there is virtually no NNSA oversight of weapon response development at the DAs.

The Livermore Site Office (LSO) does not review whether the contractor's technical basis for weapon response is developed according to LLNL's implementing procedure. LSO would only conduct a "for cause" review if the Pantex contractor or PXSO expressed dissatisfaction with the product. Neither the Pantex contractor nor PXSO routinely reviews the LLNL technical basis documents during HAR development and approval.

At LANL, the Los Alamos Site Office (LASO) provides little oversight of weapon response development work. The LASO team lead responsible for oversight of all weapons activities at LANL stated that he was unable to review any weapon response work, including Information Engineering Releases used to transmit weapon responses to Pantex, because he did not have a classified computer and did not routinely review paper copies. LASO's Quality Control staff was familiar with Standard 3016 and explained that because LANL completed the first full implementation of the standard in fiscal year (FY) 2010, the Quality Control staff was scheduling an assessment for early FY 2011. Because LASO lacks the necessary technical capability, it plans to have a member of the PXSO staff perform the assessment. Neither the Pantex contractor nor PXSO routinely reviews the LANL technical basis documents during HAR development and approval.

There is little NNSA oversight of weapon response from the Sandia Site Office (SSO). SSO does perform a structural review of the contractor's QAP to determine whether all elements, including those related to the development of weapon response, are in place, but does not perform any technical oversight of the weapon response development process. SSO does not oversee the training of contractor staff that develop weapon response data or perform duties related to nuclear explosive safety. SSO asserted that oversight of the weapon response development and review processes should be either an NNSA headquarters function or a PXSO responsibility.