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DEFENSE NUCLEAR FACILITIES SAFETY BOARD

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June 26, 2006

Mr. C. Russell H. Shearer
Acting Assistant Secretary for Environment, Safety, and Health
1000 Independence Avenue, SW
Washington, DC 20585-1000

Dear Mr. Shearer:

The Defense Nuclear Facilities Safety Board (Board) has been following the implementation of Department of Energy (DOE) Standard 1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports, Change Notice 1* (Standard 1027). This standard provides the safe harbor methodology for hazard categorization for compliance with 10 Code of Federal Regulations (CFR) 830, *Nuclear Safety Management*, and describes the processes to be used in arriving at the preliminary and final hazard categories for nuclear facilities. These hazard categorizations in turn dictate the rigor of the safety analysis required for compliance with the rule.

Since hazard categorization is the first step in safety analysis for a facility, it is important for the standard that guides this process, as well as its implementation, to be clear and consistent across the complex. In the course of the Board's review, however, it has become evident that there is a lack of clarity in aspects of Standard 1027, as well as inconsistency in the interpretation and application of the ground rules described in the standard.

The enclosures to this letter identify examples of the lack of clarity and inconsistent application of Standard 1027. The identified inconsistencies may have resulted in nonconservatism in the hazard categorization of facilities, analysis of accident scenarios, and selection and implementation of safety-related controls. Further review of Standard 1027 and of how it has been applied in the DOE complex may identify other areas in need of improvement.

The Board believes additional guidance is needed to ensure that defense nuclear facilities apply Standard 1027 consistently and correctly. Therefore, pursuant to 42 U.S.C. § 2286b(d), the Board requests that, within 120 days of receipt of this letter, DOE issue a report that addresses the following:

- A review of Standard 1027 for areas that might benefit from improvement, including the problems described in the enclosure to this letter.
- Identification of any defense nuclear facilities affected by problems identified during the review of Standard 1027.

- The path forward to address these problems in any affected nuclear facilities and to prevent these problems in the future.

Sincerely,

A. J. Eggenberger
Chairman

c: The Honorable Linton Brooks
The Honorable James A. Rispoli
Mr. Mark B. Whitaker, Jr.

Enclosure

Enclosure

During several reviews of DOE Standard 1027, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports, Change Notice 1* (Standard 1027), the Board's staff identified multiple issues associated with the implementation of the standard. These include lack of clarity in requirements for exclusion of sealed sources from facility inventory, inconsistencies in expectations regarding implementation of Nuclear Criticality Safety (NCS) controls, and an unclear technical basis for the calculation of threshold values listed in the standard.

Sealed-Source Exclusions. While facility hazard categorizations are based largely on inventory, Standard 1027 does permit excluding from the materials at risk inventory that meets certain criteria, such as Department of Transportation (DOT) special-form testing for sealed sources (49 CFR 173.469) or American National Standards Institute (ANSI) Standard N43.6, *Sealed Radioactive Sources—Classification*. DOT special-form fire testing requirements for sealed sources include being heated in air at greater than or equal to 800 °C for 10 minutes and then being cooled. The test requirements for ANSI sealed sources vary from no test for class 1, to 600 °C and 800 °C for 1 hour, respectively, for classes 5 and 6. The ANSI standard further states that these temperature-based performance requirements do not take into account direct exposure of the source to fire and that the manufacturer and user must consider the probability of fire and possible results, including the consequences of loss of integrity.

It is, however, important that these sources be capable of surviving a fire, as fire is usually the dominant accident scenario for nuclear facilities; analyses typically predict temperatures in the 400 °C to 600 °C range or higher for fires with moderate combustible inventories and without fire suppression. Another evaluation-basis fire is represented by the time-temperature curve given in ASTM International Standard E119, *Standard Test Methods for Fire Tests of Building Construction Materials*; this curve reaches 800 °C after about 25 minutes and 925 °C in 60 minutes.

With the possible exception of ANSI class 5 and 6 sealed sources, it appears the above testing requirements would not demonstrate that the integrity of sealed sources is maintained under a representative unmitigated fire scenario (e.g., 400 °C to 600 °C range or higher). However, some DOE sites have credited generic sealed-source encapsulation, as permitted by Standard 1027, for excluding radioactive inventory from consideration as material at risk, thereby making it possible to downgrade Hazard Category 2 and 3 nuclear facilities to Radiological facility status.

In some cases, the exclusion has also been inappropriately extended to include radioisotope sources not intended to be treated as sealed sources. For example, Pu^{238} heat sources have been excluded from facility inventories for hazard categorization purposes; however, such sources do not fall within the definition of sealed sources in 10 CFR 835, *Occupational Radiation Protection* because of the potential internal doses to workers and the public should the integrity of the source be compromised.

Treatment of Criticality. With regard to criticality, Standard 1027 states that Hazard Category 2 facilities include those containing fissile material in quantities greater than the limits for criticality emergencies specified in American National Standards Institute (ANSI) and American Nuclear Society (ANS) 8.1-1983, R88, *Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors*. For aqueous solutions of uranium-233 (U^{233}), U^{235}, and plutonium-239 (Pu^{239}), these values are 500, 700, and 450 grams, respectively. Standard 1027 allows credit to be taken if segmentation or "nature of process" precludes the potential for a criticality accident. Facilities that exceed these fissile mass limits but do not meet either of the criteria are to be designated as Hazard Category 2 because of the potential for criticality alone.

DOE-Headquarters appears to consider the presence of defined Nuclear Criticality Safety (NCS) controls in a facility as implying the potential for criticality. This, combined with the explicit treatment of criticality potential in Standard 1027, has been interpreted to mean that whenever the need for an NCS control is identified, the facility is to be designated Hazard Category 2 by default.

The current approach endorsed by DOE-Headquarters has proven to be a potential impediment to implementation of appropriate controls. Some contractors have chosen to avoid the use of formal NCS controls in order to avoid an automatic designation of Hazard Category 2 for a given facility or activity. The purpose of Standard 1027 is to establish guidance for the preparation and review of hazard categorization and accident analyses; it is not to determine whether controls are required. For DOE-Headquarters to assert that derived controls affect the hazard categorization contradicts the statement in Standard 1027 that the graded approach "does not relieve the contractor....from the obligation to maintain and operate the facility safely and efficiently." Designation of a facility as less than Hazard Category 2 should not hinder the contractor from implementing controls that protect assumptions.

The Board notes that the NCS requirements, when implemented properly, provide a robust set of controls for fissile material handling regardless of the hazard categorization of the facility, DOE should revisit the rationale for the automatic Hazard Categorization 2 designation for facilities with a potential for criticality.

Technical Basis for Threshold Values. Standard 1027 allows a facility initially categorized as Hazard Category 2 to be categorized as Hazard Category 3 in the final categorization process. This can be accomplished by adjusting the threshold quantities against which the facility inventory is compared if the release fractions can be shown to be significantly different from those used in calculating the threshold quantities listed in Attachment 1 to the standard. However, the standard does not explicitly extend this allowance to facilities initially categorized as Hazard Category 3.

In 2002, the Office of Environment, Safety, and Health (EH-1) issued a Nuclear Safety Technical Position, NSTP 2002-2, *Methodology for Final Categorization for Nuclear Facilities from Category 3 to Radiological* (NSTP), to address the lack of a specific allowance for adjusting the threshold quantities. According to the technical position, for a facility initially categorized as Hazard Category 3, the threshold values may be revised for the purposes of final hazard categorization if the release fractions are substantially different from those used in the calculation of the threshold values listed in Attachment 1 to the standard.

The methodology for the derivation of and adjustment of Hazard Category 2 threshold values, including release fractions to be used, is described wholly within Standard 1027. However, similar information for the Hazard Category 3 threshold values is not given in Standard 1027. Rather, Standard 1027 makes a vague reference to a user's manual for a radionuclide database that does not explicitly discuss the assumptions used in calculating the threshold values. EH-1's NSTP cites another document, *Technical Background Document to Support Final Rulemaking Pursuant to Section 102 of the Comprehensive Environmental Response, Compensation, and Liability Act: Radionuclides: A Report to the Emergency Response Division, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency (EPA).* As with Standard 1027, this document does not provide specifics for adjusting Hazard Category 3 threshold values.

Ultimately, through nested references, both Standard 1027 and the EH-1 NSTP lead to the same technical basis for the release fractions used in calculating the Hazard Category 3 threshold quantities. The staff notes that the technical basis and release fractions for calculating the Hazard Category 3 threshold values are different than those used for Hazard Category 2 threshold values. However, because Standard 1027 and the NSTP are vague, a site analyst could easily assume that the Hazard Category 3 threshold values could be adjusted using the methodology and release fractions for Hazard Category 2 listed in Standard 1027.

One example illustrates this point. On August 11, 2003, the Nevada Site Office approved the Lawrence Livermore National Laboratory Core Library for operation as a radiological facility. A review of the June 2, 2003 request from the contractor, however, revealed that the Hazard Category 3 threshold values for several radionuclides including nickel-63, technetium-99, europium-152, and europium-154 were adjusted assuming that a release fraction value of 10^{-3} was used in calculating the threshold values listed in Standard 1027. However, 10^{-3} is the release fraction used to calculate the Hazard Category 2 threshold values. According to the EPA model, the actual release fraction used in calculating the Hazard Category 3 threshold values is 10^{-2} for these nuclides. The result is that the threshold values against which the facility inventory was compared were a factor of 10 higher than they would have been had the correct release fractions been used.