DEFENSE NUCLEAR FACILITIES SAFETY BOARD
Washington, DC 20004-2901

February 8, 2021

The Honorable David G. Huizenga
Acting Secretary of Energy
US Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585-1000

Dear Acting Secretary Huizenga:

The Board completed a review of DOE Standard 1228-2019, *Preparation of Documented Safety Analysis for Hazard Category 3 DOE Nuclear Facilities*. The Board concludes that this standard contains inconsistencies compared to other safe harbor methodologies governing the preparation of safety bases for DOE nuclear facilities. These inconsistencies could lead to the development of documented safety analyses that lack appropriate rigor, and that do not identify complete control sets for the protection of the public and workers. The Board also concludes that this standard is inconsistent with Title 10, Code of Federal Regulations, Part 830, *Nuclear Safety Management*, in its use of the graded approach to develop a documented safety analysis.

The Board advises DOE to update DOE Standard 1228-2019 to address the inconsistencies noted in the enclosure to this letter. DOE would also benefit from providing its federal and contractor staff with supplemental training or guidance to ensure that implementation of DOE standards meets DOE expectations for safety basis preparation and the graded approach. The enclosed report is provided for your information and use.

Sincerely,

Joyce L Connery

Joyce L. Connery
Chair

Enclosure

c: Mr. Joe Olencz

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Staff Report

October 21, 2020

Staff Review of DOE Standard 1228-2019

Summary. A Defense Nuclear Facilities Safety Board (Board) staff team reviewed Department of Energy (DOE) Standard 1228-2019, *Preparation of Documented Safety Analysis for Hazard Category 3 DOE Nuclear Facilities* [1], to evaluate the standard's required and recommended approaches for the preparation of documented safety analyses (DSA) for hazard category (HC)-3 nuclear facilities. The staff team also reviewed the standard for consistency with Title 10, Code of Federal Regulations, Part 830, *Nuclear Safety Management* (10 CFR 830) [2], and with DOE Standard 3009-2014, *Preparation of Nonreactor Nuclear Facility Documented Safety Analysis* [3], which is an approved safe harbor methodology for preparing a DSA in accordance with 10 CFR 830.

Inconsistencies between DOE Standard 1228-2019 and DOE Standard 3009-2014 could lead analysts to identify different control sets depending on which standard they use. Specifically, DOE Standard 1228-2019 allows analysts to conduct a less rigorous safety analysis and to screen out additional chemical hazards from the hazard evaluation compared to what is required by DOE Standard 3009-2014. Use of DOE Standard 1228-2019 could thus result in hazards that are unidentified or under-estimated, and lead to controls not being identified for those hazards or controls that are not classified at the appropriate safety level.

During the review interaction, DOE staff discussed potential future initiatives by DOE that could ameliorate some of these concerns. For example, when DOE Standard 3009-2014 was initially approved, DOE implemented roll-out training and prepared a frequently asked questions document. AU-31 staff is considering a similar effort for DOE Standard 1228-2019. DOE has also initiated a focused look at the handling of chemical hazards in safety basis documents. While supplemental training or guidance materials could be beneficial, ultimately DOE should make appropriate updates to the standard itself to ensure consistency between it and DOE Standard 3009-2014 and 10 CFR 830.

Background. 10 CFR 830 requires that contractors responsible for a hazard category 1, 2, or 3 nuclear facility establish and maintain the safety basis of the facility, and perform work in accordance with the safety basis. DOE encourages contractors to apply a graded approach for preparation of the safety basis; generally speaking, the safety basis for a complex, high hazard facility will be developed with more rigorous methods and documented in greater detail than the safety basis for a simple, low hazard facility.[1]

[1] 10 CFR 830.7 states, "Where appropriate, a contractor must use a graded approach to implement the requirements of [10 CFR 830], document the basis of the graded approach used, and submit that documentation to DOE." Appendix A to Subpart B of 10 CFR 830 further states, "DOE expects a contractor to use a graded approach to develop a

10 CFR 830 also requires that contractors categorize the facility consistent with DOE Standard 1027-92 Change Notice 1, *Hazard Categorization and Accident Analysis Techniques for compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports* [4]. DOE uses the hazard categorization of the facility to help inform the level of rigor and detail used in preparation of the safety basis. Hazard categorization is determined from the inventory of radiological materials in the facility. Per DOE Standard 1027, HC-1 facilities have the potential for significant off-site consequences, HC-2 facilities have the potential for significant on-site consequences, and HC-3 facilities have the potential for significant localized consequences.

In February 2018 DOE issued a project justification statement to develop a new technical standard for the preparation of DSAs for HC-3 facilities [5]. The intent was to develop a new safe harbor methodology[2] to provide an appropriate graded approach for implementing the requirements of 10 CFR 830. DOE issued the new standard in May 2019. The project justification statement said that the "proposed new standard is intended to be available for inclusion in Table 2 of Appendix A as a new safe harbor methodology that defines an approach for Hazard Category 3 nuclear facilities to meeting the requirements of 10 CFR 830, Subpart B." Appendix A to 10 CFR 830 states that acceptable methodologies for preparing DSAs are set forth in Table 2. DOE did not add DOE Standard 1228-2019 to the list of safe harbors to Table 2 in 10 CFR 830 in its recent revision to the rule. However, the Foreword of DOE Standard 1228-2019 does still state the standard "provides an acceptable DOE-approved methodology for meeting the 10 CFR Part 830 requirements for the preparation of DSAs for HC-3 nonreactor nuclear facilities" and that it "may be used as an acceptable safe harbor methodology as set forth in Appendix A to 10 CFR 830 Subpart B."

The staff review team began its review of the new standard in late 2019. Several discussions were held in March through September 2020 with personnel from the DOE Office of the Associate Undersecretary for Environment, Health, Safety and Security (AU) Office of Nuclear Safety Basis and Facility Design (AU-31). During the review interactions, AU-31 personnel indicated that their intent when drafting DOE Standard 1228-2019 was that an analyst implementing that standard would arrive at the same control set as an analyst implementing DOE Standard 3009-2014 for the preparation of a DSA for an HC-3 facility.

Discussion. The staff review team identified the following safety items. Additional observations are discussed in Appendix A of this report.

Inappropriate Application of the Graded Approach to HC-3 Facilities—DOE Standard 1228-2019 allows application of the graded approach based on hazard categorization of a facility, irrespective of the hazards involved or the importance to safety of particular controls. By contrast, 10 CFR 830.3 defines the graded approach as follows:

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documented safety analysis and describe how the graded approach was applied. The level of detail, analysis, and documentation will reflect the complexity and hazard associated with a particular facility."

[2] Table 2 of appendix A of 10 CFR 830, subpart B, provides the list of "safe harbors," which are described in that appendix as "acceptable methodologies for preparing a documented safety analysis."

Graded approach means the process of ensuring that the level of analysis, documentation, and actions used to comply with a requirement in this part are commensurate with:

1. *The relative **importance to safety**, safeguards, and security;*
2. *The magnitude of **any** hazard involved;*
3. *The life cycle stage of a facility;*
4. *The programmatic mission of a facility;*
5. *The particular characteristics of a facility;*
6. *The relative importance of radiological and **nonradiological hazards**; and*
7. *Any other relevant factor.* [emphasis added]

Of note, this definition does not limit grading to radiological hazard ("magnitude of any hazard involved"), and focuses first on "importance to safety." However, the Foreword of DOE Standard 1228-2019 states, "The principal purpose of this Standard is to clarify the graded approach with respect to 10 CFR Part 830 as it applies to development of DSAs for HC-3 nuclear facilities." DOE Standard 1228-2019 section 1.3 goes on to state, "Use of the graded approach in initial DSA preparation and subsequent updates, is particularly appropriate for HC-3 nuclear facilities given the lower magnitude of radiological hazards present than those present in HC-1 and HC-2 nuclear facilities."

Using hazard categorization as the sole basis for grading the level of detail or rigor applied to preparing the safety analysis, as described in the Foreword and section 1.3 of DOE Standard 1228-2019, is inappropriate. Rather, contractors should consider the particular hazards involved or the importance to safety of specific controls when determining the level of rigor to apply to preparation of the DSA. The hazard categorization of a facility may provide limited or no information regarding hazard scenarios. For example, a facility could contain significant quantities of hazardous chemicals with hazard scenarios that warrant safety controls to protect the offsite public, co-located worker, or facility worker. The hazard categorization of the facility has no bearing on chemical hazards (and vice versa) and should not factor in to the level of detail in the analysis of those hazards.

Similarly, hazards to the facility worker may be more related to the specific operational tasks the worker performs than to the facility's hazard categorization. Also, the importance to safety of a control relates to the specific hazard(s) it controls and safety function(s) it performs more so than to a facility's hazard categorization. For example, workers in an HC-3 facility may face hazards specific to glovebox operations they conduct. The addition of other radiological operations in adjacent rooms that results in changing the facility hazard categorization to HC-2 may have little bearing on the hazards faced by the first set of workers. The level of rigor to demonstrate those workers are adequately protected should be the same regardless of the overall facility hazard categorization, and should correspond appropriately to the level of hazard of the operations and the importance to safety of the glovebox and other controls.

Additionally, the staff review team identified two topics of note in DOE Standard 1228-2019 in which the standard's application of a graded approach may not be appropriate.

- DOE Standard 1228-2019 contains requirements regarding the identification and evaluation of initial conditions[3] that are less rigorous than those in DOE Standard 3009-2014. DOE Standard 1228-2019 requires that initial conditions be identified. By contrast, DOE Standard 3009-2014 requires that the "initial conditions and assumptions for the analysis shall be documented and evaluated to determine if controls are needed to maintain the validity of the evaluation." During the staff team's review, AU-31 staff stated that this was an intentional reduction in rigor between the two standards, consistent with a graded approach to DSA development. A comprehensive evaluation of initial conditions is needed to identify whether credited controls are required to protect those assumptions. In addition, as stated above, the standard's approach to the graded approach is inconsistent with 10 CFR 830.3.

- DOE Standard 3009-2014 contains more specific requirements than DOE Standard 1228-2019 related to control effectiveness evaluations for existing facilities. Both standards require engineering evaluations to demonstrate the capability of credited controls to meet or exceed their performance criteria. If the controls cannot meet the performance criteria, both standards require the analysis to identify the deficiencies and any compensatory measures "necessary to ensure the safety function of the controls." The standards differ, however, in specifying how the evaluations for existing facilities are performed.

  DOE Standard 1228-2019 provides *guidance* that the evaluation should include discussion of the relevant design capabilities of the control, augmented with other tests, calculations, or reliability information as needed. Evaluations per DOE Standard 1228-2019 may be qualitative and based on engineering judgment. In contrast, DOE Standard 3009-2014 *requires* the evaluation to address the relevant design capabilities of the control, and provides three acceptable methodologies for demonstrating the effectiveness of the control. AU-31 staff indicated that this change was an intentional reduction in rigor in the new standard based on an overall lower level of radiological hazard associated with HC-3 facilities and consistent with a graded approach. The Board's staff team finds that control effectiveness reviews are important to ensure the selected control set is adequate to perform the intended safety functions. Moreover, the importance to safety of a particular control may be unrelated to the facility's overall radiological hazard if it primarily protects the facility worker, or if it protects the worker or the offsite public from chemical hazards. In addition, as stated above, the standard's approach to the graded approach is inconsistent with 10 CFR 830.3.

AU-31 staff also noted that DOE Standard 1228-2019 states "a DSA is still required to provide a systematic evaluation of hazards and an appropriate set of controls commensurate with the results of the hazard evaluation." However, an analyst using the standard to prepare a safety analysis may inappropriately grade the level of rigor in documenting the hazard analysis and demonstrating the adequacy of controls. In turn this could result in hazards that are unidentified

[3] Appendix A.3 of DOE Standard 3009-2014 provides the following description of initial conditions: "Both hazard and accident analyses make use of initial conditions (ICs). ICs are specific assumptions regarding a facility and its operations that are used in defining accident scenarios. As discussed in Sections 3.2.2 and 3.2.3 of this Standard, facilities are analyzed as they exist (or are designed) when quantifying meaningful release mechanisms."

or under-estimated, and lead to controls not being identified for those hazards or to controls that are not classified at the appropriate safety level.

Inappropriate Screening of Chemical Hazards from Hazard Evaluation—DOE Standard 1228-2019 permits screening of chemical hazards beyond what is permitted by DOE Standard 3009-2014. 10 CFR 830.204 requires that the facility DSA "Evaluate normal, abnormal, and accident conditions, including…identification of energy sources or processes that might contribute to the generation or uncontrolled release of radioactive and other hazardous materials." DOE Standard 3009-2014, Appendix A.2, *Chemical Hazards*, describes a screening process "to select for DSA evaluation only those chemicals of concern (i.e., type and quantity that have the potential for significant health effect on the facility worker, co-located worker, or public) that are present in the facility or activity and present hazard potentials outside the routine scope of the hazardous material protection program." Screening hazards from the hazard evaluation effectively removes them from consequence evaluation, and screened hazards need not be considered when identifying credited safety controls to protect workers and the offsite public. Appendix A.2 of DOE Standard 3009-2014 provides the following examples of chemicals that may be screened and excluded from the DSA's hazard evaluation:

- *Chemicals with no known or suspected toxic properties. This exclusion may be claimed when a chemical is not listed in [Occupational Safety and Health Administration] or [Environmental Protection Agency] toxic chemical regulations or is not assigned a [Protective Action Criteria] 2 or 3 value on the website of the Subcommittee on Consequence Assessment and Protective Actions (SCAPA);*

- *Materials that have a health hazard rating of 0 or 1, based on National Fire Protection Association (NFPA) 704, Standard System for the Identification of the Hazards of Materials for Emergency Response, or equivalent ratings from Global Harmonization System of Classification and Labeling of Chemicals;*

- *Materials that are commonly available and used by the general public, including any substance to the extent it is used for personal, family, or household purposes and that is present in the same form, quantity, and concentration as a product distributed for use by the general public (e.g., bleach, motor oil); and*

- *Small-scale use quantities of chemicals similar to the intent of 29 C.F.R. § 1910.1450, Occupational Exposure to Hazardous Chemicals in Laboratories (i.e., containers that are designed to be easily and safely manipulated by one person)….*

Section 3.1.1.4 of DOE Standard 1228-2019 refers to Appendix A.2.3 of DOE Standard 1228-2019 for guidance on screening hazardous chemicals from the hazard evaluation. Appendix A.2.3 states, "DOE-STD-3009-2014, Appendix A.2, 'Chemical Hazards', describes screening criteria for chemicals that may be excluded from DSA hazard evaluations. It is possible that ***chemicals exceeding these criteria may also be screened out*** if adequately managed by a hazardous material protection program" (emphasis added). The Board's staff finds Standard

1228-2019's expansion of the screening criteria provided in DOE Standard 3009-2014 to be inappropriate. This modification to the screening criteria could lead to the failure to identify credited safety controls for protection of the public and the workers that would be required by DOE Standard 3009-2014 and by 10 CFR 830.

During the review interaction, AU-31 staff shared the perspective that DOE Standard 1228-2019 was in fact consistent with DOE Standard 3009-2014, as well as other DOE documents. For example, DOE Handbook 1224-2018, *Hazard and Accident Analysis Handbook* [6], and the DOE Standard 3009-2014 Frequently Asked Questions document on the DOE website [7], both have similar language as DOE Standard 1228-2019 regarding chemical hazard screening. The Board's staff team acknowledges that those documents are similar to DOE Standard 1228-2019 in this regard, but reiterates that it is inappropriate to expand the screening criteria provided in DOE Standard 3009-2014 in this way. Ancillary documents should not be used to modify requirements and criteria provided in the safe harbor methodology for meeting the requirements of 10 CFR 830. AU-31 staff noted that there was a diversity of opinion within DOE regarding chemical hazards, and that an effort has been initiated within DOE to further study the issue.

Conclusion. Inconsistencies between DOE Standard 1228-2019 and DOE Standard 3009-2014 and 10 CFR 830 could lead analysts to identify different control sets depending on which standard they implement. Inconsistencies between DOE Standard 1228-2019 and 10 CFR 830 include:

- The application of a graded approach to DSA development based solely on facility hazard categorization as opposed to the magnitude of the hazard involved and the importance to safety of controls; and

- The screening of hazardous chemicals from consideration in the hazard evaluation.

These inconsistencies allow analysts to conduct a less rigorous safety analysis, including inadequate evaluations of initial conditions and control effectiveness, and to screen out additional chemical hazards from the hazard evaluation than would be required by DOE Standard 3009-2014. In turn this could result in hazards that are unidentified or under-estimated, and lead to controls not being identified for those hazards or to controls that are not classified at the appropriate safety level.

Appendix A: Additional Observations

During its review of Department of Energy (DOE) Standard 1228-2019, *Preparation of Documented Safety Analysis for Hazard Category 3 DOE Nuclear Facilities* [1], the staff review team identified four areas that could benefit from additional guidance in the standard or in implementation training by DOE. Personnel from the DOE Office of the Associate Undersecretary for Environment, Health, Safety and Security (AU) Office of Nuclear Safety Basis and Facility Design (AU-31) agreed with the staff team about the majority of these concerns. AU-31 personnel discussed with the staff team some potential future initiatives (e.g., training, frequently asked questions document) that could be useful in clarifying these items.

Beyond Design Basis Accidents. Title 10, Code of Federal Regulations, Part 830, *Nuclear Safety Management* (10 CFR 830), section 830.204 requires that the facility's documented safety analysis (DSA) "Evaluate normal, abnormal, and accident conditions, including…consideration of the need for analysis of accidents which may be beyond the design basis of the facility" [2]. DOE Standard 3009-2014, *Preparation of Nonreactor Nuclear Facility Documented Safety Analysis* [3] flows down this requirement, while DOE Standard 1228-2019 does not. Hazard category (HC)-3 facilities do not require an accident analysis in the DSA because they typically do not contain sufficient radiological material to challenge the DOE evaluation guideline of 25 rem total effective dose to the maximally exposed offsite individual. For that reason, analysts may not identify a set of so-called "design basis accidents" for the facility. Nevertheless, the requirement in 10 CFR 830 is not limited to HC-1 and HC-2 facilities, and analysis of accidents beyond the design basis of the facility could still prove illuminating for operators of HC-3 facilities. DOE should clarify that the requirement to consider the need to analyze accidents beyond the design basis of the facility applies to HC-3 facilities.

Nuclear Criticality Safety. Chapter III of DOE Order 420.1C, *Facility Safety*, applies to "nuclear facilities and activities that involve or will potentially involve radionuclides in such quantities that are equal to or greater than the single parameter limits for fissionable materials" [8]. DOE Standard 1228-2019 states, "Nuclear criticality is not expected to occur in a HC-3 nuclear facility (i.e., consistent with the hazard potential for HC-3 as given in [DOE Standard 1027-92, Change Notice 1])." The format and content guidance provided for the preparation of DSAs in DOE Standard 1228-2019 does not list a chapter for the nuclear criticality safety program (typically chapter 6 of DSAs prepared in accordance with DOE Standard 3009), and generally speaking the standard presumes that a HC-3 facility DSA will not need to discuss nuclear criticality safety in much detail, if at all.

During the review discussions, AU-31 personnel clarified that DOE Order 420.1 must still be followed and the wording in DOE Standard 1228-2019 is merely intended to convey what would be typically applicable to a HC-3 facility. The Board's staff review team is concerned the language regarding criticality safety in DOE Standard 1228-2019 could be misinterpreted such that a contractor would not identify or maintain a criticality safety program for HC-3 facilities that rely on nature of the process or segmentation arguments to preclude criticality hazards. DOE should clarify DOE Standard 1228-2019's documentation requirements for nuclear criticality safety in applicable DSAs.

Atmospheric Dispersion Analysis. DOE Standard 1228-2019 is only applicable to facilities with offsite radiological dose consequences that do not challenge the evaluation guideline. Section 3.1.2.2 of DOE Standard 1228-2019 states, "A bounding estimate of the unmitigated radiological consequences to the maximally exposed offsite individual shall be performed to confirm applicability of this standard." Appendix A.2 of the standard provides guidance on performing a bounding estimate, and Table A-1 provides default atmospheric dispersion coefficient (χ/Q) values at various receptor distances for use in calculating radiological dose consequences.

During the review, the staff team noted Table A-1 of the standard includes wake effects, but does not provide guidance on situations when it would be appropriate to use the χ/Q value that enables wake effects. Further, crediting wake effects in dispersion analyses is not applicable to all accident conditions and is inconsistent with the conservative offsite dose calculation methodology (option 2) described in DOE Standard 3009-2014. If DOE wants to change the allowable default conservative methodology, an evaluation should be performed to determine if enabling wake effects along with other parameters that reduce the radiological dose consequences produces a conservative result. After that evaluation, DOE could consider appropriate changes to both DOE Standard 1228-2019 and DOE Standard 3009-2014 to ensure consistent and conservative application of dose consequence calculations. In the meantime, additional guidance could help an analyst be sure to choose conservative parameters when performing a bounding estimate of unmitigated radiological consequences to determine the applicability of DOE Standard 1228-2019 to the facility.

Plausible Operational Events. DOE Standard 1228-2019 has a footnote that states, "Events that are "operational" (i.e., not [natural phenomena hazards] or man-made external events) may not be plausible and therefore can be excluded from evaluation if the event is either: 1) a process deviation that consists of a sequence of many unlikely human actions or errors for which there is no reason or motive…or 2) a process deviation for which there is a convincing argument, given physical laws, that it is not possible." DOE Standard 3009-2014 contains a similar allowance. The staff review team notes neither DOE Standard 1228-2019 nor DOE Standard 3009-2014 provide expectations for how contractors should document determinations that operational events are not plausible. Further, DOE Standard 3009-2014 notes plausibility determinations should not be based on quantitative criteria or a frequency cutoff, while DOE Standard 1228-2019 does not provide that context. Additional guidance could assist analysts in documenting determinations that an operational event is implausible, and ensure that a cutoff frequency is not used as the basis for determining the implausibility of an operational event.

References

[1] Department of Energy, *Preparation of Documented Safety Analysis for Hazard Category 3 DOE Nuclear Facilities*, DOE Standard 1228-2019, 2019.

[2] Title 10 Code of Federal Regulations Part 830, *Nuclear Safety Management*, 2020.

[3] Department of Energy, *Preparation of Nonreactor Nuclear Facility Documented Safety Analysis*, DOE Standard 3009-2014, 2014.

[4] Department of Energy, *Hazard Categorization and Accident Analysis Techniques for compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*, DOE Standard 1027-1992 Change Notice 1, 1997.

[5] Department of Energy, *Project Justification Statement for a New Standard for Preparation of a Documented Safety Analysis for Hazard Category 3 Nuclear Facilities*, February 2018.

[6] Department of Energy, *Hazard and Accident Analysis Handbook*, DOE Handbook 1224-2018, 2018.

[7] Department of Energy, "DOE-STD-3009-2014 Frequently Asked Questions Updated July 2019," July 2019, available: https://www.standards.doe.gov/related-items/doe-std-3009-2014-frequently-asked-questions-updated-2019, accessed 30 September 2020.

[8] Department of Energy, *Nuclear Facility Safety*, DOE Order 420.1C Change Notice 3, 2019.