DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Washington, DC 20004-2901

January 26, 2024

The Honorable Jennifer Granholm
Secretary of Energy
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585-1000

Dear Secretary Granholm:

On November 1, 2023, the Defense Nuclear Facilities Safety Board (Board) received and considered your response to draft Recommendation 2023-1, *Onsite Transportation Safety*. On January 22, 2024, the Board—in accordance with 42 United States Code (USC) § 2286d(a)(3)—approved Recommendation 2023-1, *Onsite Transportation Safety*, which is enclosed for your consideration. This Recommendation is intended to strengthen the U.S. Department of Energy's (DOE) regulatory safety framework related to onsite transportation and to address safety deficiencies in Los Alamos National Laboratory's transportation safety document to ensure adequate protection of public health and safety.

The Board reviewed your response carefully and updated and strengthened the Recommendation. Notably, the Board decided to clarify and simplify the third sub-recommendation regarding causal analysis to provide DOE with greater flexibility in identifying corrective actions to preclude recurrence of the safety issues.

After you have received this Recommendation, and as required by 42 U.S.C. § 2286d(b), the Board will promptly make the Recommendation and any related Secretarial correspondence available to the public. The Board believes that Recommendation 2023-1, its supporting documentation, and risk assessment contain no information that is classified or otherwise restricted by DOE under the Atomic Energy Act of 1954, as amended. Please arrange to have this Recommendation and any related Secretarial correspondence placed promptly on file in your regional public reading rooms. The Board will also publish this Recommendation in the Federal Register.

The Board will evaluate DOE's response to this Recommendation in accordance with the Board's *Policy Statement on Recommendations*.

Sincerely,

Joyce L. Connery
Chair

Enclosure

c: Mr. Joe Olencz, Director, Office of the Departmental Representative to the Board

RECOMMENDATION 2023-1 TO THE SECRETARY OF ENERGY
Onsite Transportation Safety
Pursuant to 42 USC § 2286a(b)(5)
Atomic Energy Act of 1954, As Amended

Dated: January 26, 2024

Introduction. The Defense Nuclear Facilities Safety Board (Board) has evaluated Los Alamos National Laboratory's (LANL) safety basis for onsite transportation, detailed in the laboratory's transportation safety document (TSD); the safe harbors[1] for onsite transportation of radioactive materials identified in the U.S. Department of Energy's (DOE) *Nuclear Safety Management* rule, 10 Code of Federal Regulations (CFR) Part 830; and the ability of DOE's safety oversight framework to identify and correct safety issues with its safe harbors and the TSDs at its defense nuclear facilities.

The Board identified safety weaknesses in LANL's onsite TSD, stemming in part from weaknesses in the safe harbors that govern TSD development, and communicated its safety concerns to the Secretary of Energy in a January 6, 2022, letter. The National Nuclear Security Administration's (NNSA) management and operating contractor at LANL, Triad National Security, LLC, implemented compensatory safety measures for onsite transportation of radioactive materials in March 2023, following a letter of direction from the NNSA Los Alamos Field Office (NA-LA). Triad formally incorporated the compensatory measures into revisions of the LANL TSD and technical safety requirements (TSR), which NA-LA approved in August 2023, with two conditions of approval (COA) [2]. These measures and COAs represent an improvement to the safety of onsite transportation of radioactive materials at LANL; however, more work is necessary to ensure the LANL TSD appropriately identifies all hazards, analyzes all pertinent accident scenarios, and evaluates the effectiveness of all credited safety controls.

NA-LA had approved Triad's deficient TSD on the basis that it met the applicable safe harbors for safety analysis identified in 10 CFR 830. Until DOE revises the safe harbors for onsite transportation of radioactive materials to provide clear and effective safety requirements, the risk remains that LANL or other defense nuclear sites may regress to inadequate TSDs that fail to provide an effective set of safety controls. The Board has concluded the following:

1) The recently approved compensatory safety measures are welcomed; however, the LANL TSD requirements and their implementation do not ensure that onsite transportation activities at LANL are conducted in a manner that ensures adequate protection of public health and safety;

2) The requirements of the safe harbors do not ensure that onsite transportation activities are conducted in a manner that ensures adequate protection of public health and safety; and

[1] Table 1 of Appendix A to Subpart B of 10 CFR 830 lists acceptable methodologies for developing safety analyses to meet requirements in 10 CFR 830. Such methodologies are referred to as "safe harbors." Throughout this document the phrase "onsite transportation safe harbors" refers to both DOE Order 460.1D, *Hazardous Materials Packaging and Transportation Safety*, and DOE Guide 460.1-1, *Implementation Guide for Use with DOE O 460.1A, Packaging and Transportation Safety*, as they relate to the preparation of an onsite TSD for radioactive materials that are not of national security interest.

3) DOE failed to address known safety deficiencies in its safe harbors for onsite transportation of radioactive materials and neglected to take timely action to correct the safety issues with the LANL TSD.

Background. 10 CFR 830 specifies that onsite transportation of radioactive materials at DOE sites may be conducted either in accordance with Department of Transportation (DOT) regulations or under a specific type of documented safety analysis (DSA) known as a TSD. Table 1 in Appendix A to Subpart B of 10 CFR 830 identifies the following safe harbor methodology for preparing DSAs/TSDs for onsite transportation activities:

- Preparing a Safety Analysis Report for Packaging in accordance with DOE Order 460.1A, *Packaging and Transportation Safety*, October 2, 1996, or successor document; and

- Preparing a Transportation Safety Document in accordance with DOE Guide 460.1-1, *Implementation Guide for Use with DOE O 460.1A, Packaging and Transportation Safety*, June 5, 1997, or successor document.

Following a safety review of the LANL TSD, the Board identified safety issues with both the LANL TSD and the onsite transportation safe harbors in 10 CFR 830. The Board documented these safety issues in a letter to the Secretary of Energy dated January 6, 2022. DOE responded on September 13, 2022, stating its agreement with, and plans to address, the Board's safety concerns. However, DOE's response only partially addressed the safety concerns identified by the Board. Furthermore, DOE did not ensure that LANL took timely action to implement compensatory measures at LANL that are needed to provide adequate protection of workers and the public during onsite transportation activities in the absence of an adequate TSD.

Analysis. Attachment B, *Findings, Supporting Data, and Analysis*, provides additional detail and supporting analysis for this recommendation, the conclusions of which are discussed below.

LANL Transportation Safety Document—10 CFR 830 defines a DSA (including TSDs) as "a documented analysis of the extent to which a nuclear facility can be operated safely with respect to workers, the public, and the environment, including a description of the conditions, safe boundaries, and hazard controls that provide the basis for ensuring safety" [3]. The LANL TSD has fundamental flaws in critical safety areas and thus does not demonstrate that members of the public and workers are adequately protected during onsite transportation activities.

The LANL TSD does not adequately 1) identify all potential hazards, 2) analyze accident scenarios, and 3) demonstrate the effectiveness of its safety control set. These safety issues are particularly concerning given the high material-at-risk (MAR) allowed by the TSD, the proximity of LANL's onsite transportation routes to the public, and the nature of several credible accident scenarios. These factors result in high calculated unmitigated dose consequences to the public without an adequate safety control strategy. On January 31, 2023, Triad informed NA-LA that it would implement compensatory safety measures by late March 2023 and would submit a

revised TSD with updated TSRs by June 1, 2023. Triad implemented the compensatory measures procedurally on March 31, 2023, and submitted a revised TSD and TSRs that incorporated those measures to NA-LA for approval on June 1, 2023. NA-LA approved the revised TSD and TSRs on August 10, 2023, with two COAs which require Triad to address additional NA-LA comments in the 2023 and 2024 annual update of the TSD and TSRs [2]. The compensatory measures and COAs improve the safety of LANL onsite transportation operations and partially address the LANL-specific safety issues that the Board raised in January 2022. Therefore, DOE should ensure that Triad continues to implement these compensatory measures until it develops a TSD in full compliance with 10 CFR 830 that would resolve the safety issues of adequate protection identified in this recommendation.

Onsite Transportation Directives—The Board identified four primary safety concerns with the DOE directives related to onsite transportation. First, the onsite transportation safe harbors do not contain all applicable requirements from 10 CFR 830; therefore, they do not ensure that TSDs meet all 10 CFR 830 requirements. In DOE's response to the Board's January 6, 2022, letter, DOE asserted that 10 CFR 830 requirements apply "regardless of the methodology for DSA development that is used," and that, consequently, 10 CFR 830 requirements do not need to flow down into the onsite transportation safe harbors [4]. DOE's assertion is inconsistent with the role of safe harbors, which is to provide an approved DSA methodology such that if a contractor follows the safe harbors, then all the requirements of 10 CFR 830 will be fulfilled. This concern is illustrated by the LANL TSD: although the LANL TSD follows the safe harbor methodology specified in 10 CFR 830, it fails to properly derive hazard controls necessary to ensure adequate protection of workers and the public. Additionally, the lack of requirements in the safe harbors has led sites across DOE's defense nuclear facilities complex to seek supplementary guidance from other documents. Specifically, several sites supplement guidance from the onsite transportation safe harbors with methodologies from DOE Standard 3009-94 Change Notice 3, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analyses*, for development and analysis of unique, bounding accident scenarios, including quantitative analysis [5]. Examples include the 2011 Hanford TSD, the 2015 Lawrence Livermore National Laboratory (LLNL) TSD, and the 2017 Nevada National Security Site (NNSS) TSD. The sites' reliance on methods from another safe harbor to adequately evaluate accident conditions highlights the weakness of the onsite transportation safe harbors in meeting 10 CFR 830 requirements, particularly related to the evaluation of accident conditions.

Second, the onsite transportation safe harbors do not provide specific criteria against which to deterministically evaluate the effectiveness of the safety control set, leading to an incomplete understanding of the risk of onsite transportation operations.[2] Instead, they require that TSDs demonstrate an equivalent level of safety to DOT and Nuclear Regulatory Commission (NRC) regulations for offsite transportation. However, the onsite transportation safe harbors do not provide a clear definition of equivalent safety. In DOE's response to the Board's January 6, 2022, letter, DOE acknowledged that an improved methodology "to better

[2] By way of comparison, the safe harbor for DOE nonreactor nuclear facilities, DOE Standard 3009-2014, *Preparation of Nonreactor Nuclear Safety Documented Safety Analysis*, applies the concept of an evaluation guideline (25 rem total effective dose for a member of the offsite public), which "the safety analysis evaluates against," and "is established for the purpose of identifying the need for and evaluating safety controls" [16].

document analyses of equivalent safety" was warranted and committed to providing better guidance [4]. DOE has not provided a timeline for that new guidance in its response, nor in any subsequent communication.

Third, the onsite transportation safe harbors do not provide guidance on methods to control public access during onsite transfers conducted under TSDs. Restricting public access is important from both regulatory and safety perspectives, because onsite transfers may use roads open to the public. If public access is not properly restricted, the public could be closer to onsite transportation activities than intended. Members of the public could initiate an accident (e.g., vehicle crash) and could receive a higher radiation dose by being in the vicinity of a transport accident if a release occurred. Additionally, the onsite transportation safe harbors do not provide detailed guidance on controlling onsite traffic of site personnel. Similar to the concern with members of the public, site personnel traveling onsite in government or personal vehicles could initiate an accident during onsite transfers of radioactive material. At LANL in particular, the high operational tempo needed to accomplish its greatly expanded pit manufacturing mission will inevitably increase onsite traffic. Therefore, it is incumbent upon DOE to develop requirements and guidance on the control of site traffic during onsite transfers of radioactive material to ensure TSDs adequately address that hazard.

Finally, DOE Standard 1104-2016, *Review and Approval of Nuclear Facility Safety Basis and Safety Design Basis Documents*, does not contain specific guidance for federal review and approval of TSDs. As a result, DOE oversight personnel do not have specific criteria to evaluate whether a TSD ensures safety and complies with the onsite transportation safe harbors, as they would have for a DOE Standard 3009-compliant DSA. In response to the Board's January 6, 2022, letter, DOE stated it would "review DOE-STD-1104 to determine whether improvements are warranted" [4]. DOE's response did not provide a timeline for that evaluation. To ensure adequate and consistent reviews by DOE oversight personnel across the defense nuclear complex, DOE should add review and approval criteria specific to TSDs to DOE Standard 1104-2016.

DOE Oversight—DOE and NNSA failed to independently identify deficiencies in the onsite transportation safe harbors and the LANL TSD. Additionally, DOE and NNSA did not ensure that timely corrective actions were taken when the Board identified transportation safety concerns and have struggled to resolve safety concerns when collaboration across program offices is required.

DOE issued DOE Guide 460.1-1, the 10 CFR 830 safe harbor methodology for preparing TSDs, in 1997 and has not updated it since. Practitioners at DOE's defense nuclear facilities have at least tacitly recognized the deficiencies in the guide for many years. As discussed above, several sites use DOE Standard 3009-94 to supplement the onsite transportation safe harbors in developing their TSDs.

Additionally, NNSA did not resolve safety issues with the LANL TSD. In 2007, an NNSA safety basis review team identified several of the safety issues discussed in this Recommendation. Personnel from the NNSA Packaging Certification Division, who were part of the safety basis review team, "concluded that the TSD as submitted did not provide an

adequate level of analysis to support the conclusions that for non DOT compliant packages the overall transport system provided an equivalent level of safety" [6]. To address these issues, NA-LA directed the contractor to provide quantitative analysis, which was included in subsequent revisions of the TSD. However, in Revision 9, which became effective in November 2012, the LANL management and operating contractor completely rewrote the safety analysis, removing the quantitative analysis. When approving the 2012 revision, and each subsequent revision, NA-LA failed to identify the safety issues that had previously been corrected. Additionally, NNSA's Office of Packaging and Transportation conducted an assessment of LANL's packaging and transportation program in July 2015. This assessment provided an opportunity for NNSA to identify the weaknesses in the LANL TSD, but it did not. Finally, DOE's response to the Board's January 6, 2022, letter, stated that "NNSA uses the Biennial Review process to review field office performance in meeting requirements for the review and approval of TSDs" [4]. However, these biennial reviews did not identify the weaknesses in NA-LA's review and approval of the LANL TSD.

The Board brought the safety concerns with the LANL TSD and the onsite transportation safe harbors to DOE's attention in its January 6, 2022, letter; however, DOE did not take timely action to address them. It took more than a year for LANL to implement any compensatory measures to address the Board's safety concerns. More than ten months passed before NA-LA transmitted a letter requesting that Triad consider a wide-ranging list of potential compensatory measures. NA-LA considered Triad's first response on December 9, 2022, unsatisfactory. After additional discussions between Triad and NA-LA personnel, Triad sent a new letter to NA-LA on January 31, 2023, in which Triad agreed to implement a set of compensatory measures that represented an improvement to the safety posture of onsite transportation operations. It is noteworthy, however, that Triad's letter did not acknowledge that the compensatory measures were needed to address any safety issues.

Further, given the safety concerns identified with the onsite transportation safe harbor and LANL TSD, DOE would greatly benefit from conducting a complete extent of condition review of all sites' TSDs. While the DOE Office of Environmental Management did conduct an extent of condition review for a subset of sites under its purview in 2021, it was done before the Board's letter highlighted the specific safety issues, and therefore the review's scope and approach were not informed by the Board's conclusions. Moreover, the review was not formally documented.

Finally, the Board is concerned with DOE's ability to address safety issues that require collaboration across program offices. DOE's September 13, 2022, letter that responded to the Board's January 6, 2022, letter acknowledged that DOE would need to evaluate "how we communicate across offices, engage with the field, and share operating experiences across the Department." The Board concurs with DOE's recognition and need for such an evaluation, and for DOE to take corrective actions to ensure effective collaboration in developing appropriate requirements in the revised onsite transportation safe harbors.

In summary, DOE's historical management of the safe harbors for onsite transportation of radioactive materials and the LANL TSD in particular indicates deficiencies in DOE's ability,

as the regulatory authority, to recognize transportation safety issues and ensure that timely action is taken to address them.

Recommendations. To ensure adequate protection during onsite transportation activities at DOE sites with defense nuclear facilities, the Board recommends that DOE carry out the following actions, organized by topical area below:

1. **LANL Transportation Safety Document.**

    a. Revise the LANL TSD to address the safety concerns identified in this Recommendation and to comply with a revised safe harbor methodology per sub-Recommendation 2.a.

    b. Ensure compensatory safety measures remain in place until implementation of the LANL TSD revised per sub-Recommendation 1.a above.

2. **Onsite Transportation Directives.**

    a. Rewrite DOE safe harbors for onsite transportation—DOE Order 460.1D, *Hazardous Materials Packaging and Transportation Safety*, and DOE Guide 460.1-1, *Implementation Guide for Use with DOE O 460.1A, Packaging and Transportation Safety*—to:

        i. Provide requirements and guidance to ensure TSDs comply with all applicable 10 CFR 830 safety basis requirements including requirements related to accident evaluation and hazard controls.

        ii. Include robust evaluation criteria to ensure TSDs demonstrate that safety controls are effective at reducing risk.

        iii. Include implementation guidance for restricting public access to transportation routes, and controlling onsite traffic, during onsite transportation of radioactive materials.

    b. Change DOE Standard 1104, *Review and Approval of Nuclear Facility Safety Basis and Safety Design Basis Documents*, to incorporate requirements and guidance for DOE review and approval of TSDs.

    c. Conduct an extent of condition review of TSDs for DOE sites with defense nuclear facilities to identify any near-term actions necessary to ensure safety until the safe harbors are revised and implemented.

3. **DOE Oversight.**

    a. Perform an independent causal analysis for the safety issues identified in this Recommendation, including the effectiveness of DOE oversight of contractor TSDs, DOE's management of its onsite transportation directives, and DOE's evaluation of and actions in response to the safety issues identified in prior Board

correspondence on onsite transportation safety. Identify and implement corrective actions to address appropriate causal analysis results that preclude recurrence of the safety issues.

Joyce L. Connery
Chair

RECOMMENDATION 2023-1 TO THE SECRETARY OF ENERGY
Onsite Transportation Safety

Attachment A - Risk Assessment for Draft Recommendation 2023-1

In making its recommendations to the Secretary of Energy and in accordance with 42 United States Code (USC) § 2286a.(b)(5), the Defense Nuclear Facilities Safety Board (Board) shall consider, and specifically assess risk (whenever sufficient data exists). This risk assessment supports Recommendation 2023-1, *Onsite Transportation Safety*. The Board's Policy Statement 5, *Policy Statement on Assessing Risk*, states:

> *Risk assessments performed in accordance with the Board's revised enabling statute will aid the Secretary of Energy in the development of implementation plans focused on the safety improvements that are needed to address the Board's recommendations.*

This recommendation identifies safety issues with (1) the Los Alamos National Laboratory (LANL) transportation safety document (TSD), (2) the Department of Energy's (DOE) onsite transportation safe harbors that contain the methodology for development of the safety basis for onsite transportation of radioactive materials, and (3) inadequate oversight from DOE and the National Nuclear Security Administration (NNSA) in identifying and addressing these deficiencies and safety issues.

Development of a safety basis is one of the primary mechanisms by which DOE ensures adequate protection of workers and the public. To that end, DOE Policy 420.1, *Department of Energy Nuclear Safety Policy*, states that DOE is committed to "[e]stablishing and implementing nuclear safety requirements," with the "[k]ey nuclear safety elements to be addressed [to] include hazard identification, assessment and control" [7]. The issues identified in Recommendation 2023-1 with regard to the onsite transportation safe harbors demonstrate that DOE has not met this commitment for onsite transportation of radioactive material.

Therefore, TSDs that are developed following this methodology may not contain sufficient analysis to establish appropriate hazard controls. This issue is illustrated by the LANL TSD. The LANL TSD does not provide adequate analysis to demonstrate that significant public consequences are not credible and does not identify and analyze various credible hazards.

Since the current LANL TSD does not calculate the likelihood and consequence of a vehicle accident, the Board used data from previously approved LANL TSDs. The July 2007 through March 2012 revisions of the LANL TSD contained quantitative analysis of the risk of LANL onsite transportation activities [8]. Those older revisions of the TSD referenced the "Area G Transuranic [TRU] Waste Transportation Accident and Fire" scenario from the Area G safety basis dated April 2003.[1] In this accident scenario, a vehicle crashes or rolls over, causing a fire and spilling the waste containers [9]. The postulated material-at-risk (MAR) in this scenario was the maximum inventory for a waste transportation truck at the time (about 17.7 kg plutonium 239, or Pu-239, equivalent). The estimated unmitigated dose consequence to the public was about 190 rem total effective dose (TED).

[1] The current revision of the Area G safety basis does not include a similar transportation accident scenario.

From November 2012 through June 2023, the LANL TSD had a MAR limit of 20 kg Pu-239 equivalent, the corresponding estimated dose consequence to the public is about 217 rem TED. The 2003 Area G accident scenario estimated the unmitigated likelihood of the accident to be 10^{-3} instances per year (once per thousand years). Additionally, the July 2007 through March 2012 revisions of the TSD noted that the distance to the site boundary for some onsite transportation routes is closer than the distance to the site boundary for Area G. As a result, as noted in those TSDs, the unmitigated dose consequence for those transportation activities could be substantially higher. The current LANL TSD identifies some engineered controls (e.g., the package and enclosed cargo compartment[2]) that may provide some confinement in an accident. However, these safety controls are not designed to withstand the hypothetical accident conditions described in the relevant Department of Transportation and Nuclear Regulatory Commission regulations. Therefore, the reduction in risk they provide is not known. Additionally, the current LANL TSD allows for transfers of up to 1.9 kg Pu-239 equivalent without either a package or enclosed cargo compartment.

The Area G TRU waste transportation and fire accident scenario is just one of many potential onsite transportation accidents at LANL involving significant MAR quantities. From discussions with NNSA Los Alamos Field Office (NA-LA) personnel, the Board understands that LANL averages between 30 and 40 shipments of hazard category 2 quantities[3] of material per year.

In the TSD and technical safety requirements submitted in June 2023 and approved in August 2023, NNSA's management and operating contractor at LANL, Triad National Security, LLC, established a reduced MAR limit of 8.8 kg Pu-239 equivalent for onsite transfers at LANL [10] [11]. Using this value for the Area G TRU waste transportation accident scenario, the estimated unmitigated dose to the public would be about 96 rem TED.

Given the high dose consequence and likelihood of potential accident scenarios for onsite transportation of radioactive materials at LANL, together with the lack of analysis in the LANL TSD to show the effectiveness of safety controls, the Board has determined this recommendation is justified and necessary from a risk perspective.

[2] An enclosed cargo compartment is "an enclosure with floor, walls on all sides, and a roof in which materials are transferred" [22].

[3] This term comes from DOE Standard 1027-1992, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*. This standard determines which of four hazard categories—1, 2, 3, or less than 3—applies to a facility, based on the amount of nuclear material it contains. In this case, a hazard category 2 quantity equates to approximately 1 kg or more of plutonium-239, or equivalent.

RECOMMENDATION 2023-1 TO THE SECRETARY OF ENERGY
Onsite Transportation Safety

Attachment B - Findings, Supporting Data, and Analysis

Background. Department of Energy (DOE) Order 460.1D, *Hazardous Materials Packaging and Transportation Safety*, states that DOE has "broad authority under the Atomic Energy Act of 1954 (AEA), as amended, to regulate activities involving radioactive materials…including the transportation of radioactive materials" [12]. In most cases, DOE uses commercial carriers that are regulated by the Department of Transportation (DOT) and/or the Nuclear Regulatory Commission (NRC). However, in some cases, DOE "exercises its AEA authority to regulate certain Departmental shipments, including…onsite transfers" [12].

The order also states that onsite transfers of hazardous materials must be conducted in accordance either with "49 CFR [Code of Federal Regulations] Parts 171-180 and the relevant federal regulations governing each mode of transportation," or a transportation safety document (TSD) [12]. Per DOE Order 460.1D, a "TSD must describe the methodology and compliance process to meet equivalent safety for any deviation from 49 CFR Parts 171-180 and 49 CFR Parts 350-399" and "[f]or onsite transfers involving nuclear facility Hazard Category 2 or 3 quantities, the TSD must comply with the Safety Basis Requirements of 10 CFR Part 830, Subpart B" [12].

Additionally, 10 CFR 830, Subpart B, requires that each DOE contractor prepare a documented safety analysis (DSA) for transportation activities not covered by DOT regulations. Table 1 in Appendix A of 10 CFR 830, Subpart B, provides the acceptable methodologies for preparing a DSA; these methodologies are called "safe harbors." For transportation activities not involving materials of national security interest (MNSI)[1], Table 1 identifies DOE Order 460.1A and DOE Guide 460.1-1, *Implementation Guide for Use with DOE O 460.1A, Packaging and Transportation Safety*, as the safe harbors [13]. The order contains the methodology for preparing a safety analysis report for packaging, and the guide contains the methodology for preparing a TSD.

The Defense Nuclear Facilities Safety Board (Board) conducted a safety review of the Los Alamos National Laboratory (LANL) TSD, and identified safety issues with both the LANL TSD and the onsite transportation safe harbors.[2] The Board communicated these safety concerns in a letter to the Secretary of Energy dated January 6, 2022, and requested that DOE provide a written report and briefing within 120 calendar days (May 6, 2022). On May 12, 2022, DOE responded with a letter stating that it was addressing the Board's safety concerns, but the final

[1] DOE defines MNSI as "Hazardous materials used in the development, testing, production, and maintenance of nuclear weapons and other materials that have been designated as critical to the national security of the United States" [31].

[2] Table 1 of Appendix A of 10 CFR 830, Subpart B, lists acceptable methodologies for developing safety analyses to meet requirements in 10 CFR 830. Such directives are referred to as "safe harbors." Throughout this document the phrase "onsite transportation safe harbors" refers to both DOE Order 460.1D, *Hazardous Materials Packaging and Transportation Safety*, and DOE Guide 460.1-1, *Implementation Guide for Use with DOE O 460.1A, Packaging and Transportation Safety*, as they relate to the preparation of an onsite TSD for radioactive materials that are not of national security interest.

report was still in process, and DOE anticipated transmitting the report by July 6, 2022. On September 13, 2022, the Board received DOE's written report, and DOE briefed the Board on its response on November 4, 2022.

DOE's September 13, 2022, cover letter stated that DOE agreed with and planned to address the Board's safety concerns. However, the enclosed report only partially addressed the safety concerns identified by the Board. For instance, the response asserted that it was unnecessary to flow down requirements from 10 CFR 830 to the onsite transportation safe harbor, as the requirements apply regardless. However this is inconsistent with the role of safe harbors in 10 CFR 830, which describes them as acceptable methodologies for preparing a DSA (meaning that if a contractor follows the safe harbors, then all the requirements of 10 CFR 830 will be fulfilled). Further, the response acknowledged that DOE's safe harbor for development of safety bases for onsite transportation of radioactive materials was deficient but then incongruously contended that the LANL TSD was acceptable because it met the deficient safe harbor.

During this time, the management and operating contractor responsible for the LANL TSD, Triad National Security, LLC (Triad), took no compensatory safety actions to ensure the safety of the public and workers during onsite transfers of radioactive material. On October 11, 2022, the National Nuclear Security Administration's (NNSA) Los Alamos Field Office (NA-LA) sent a memorandum to Triad requesting that it develop an impact assessment of a list of potential compensatory measures, propose revisions to those measures, and propose additional measures, as applicable, within 60 days. Triad responded to the NA-LA memo on December 9, 2022, stating that there would be "minimal impact on cost, scope, and schedule of Laboratory operations," because "the recommended compensatory measures are already included in the TSD implementation procedures as part of normal day-to-day operations" [14]. Triad further stated that it would provide the revised TSD and associated technical safety requirements (TSR) to NA-LA by June 1, 2023 [14]. In follow-up discussions with Board personnel, NA-LA indicated that Triad's response was unsatisfactory.

Following further engagement with NA-LA, Triad sent a new response to NA-LA on January 31, 2023 [15]. It discussed what quantities of radioactive materials would constitute high material-at-risk (MAR) transfers and provided detailed compensatory measures for high MAR transfers. Triad implemented these compensatory measures procedurally on March 31, 2023, and submitted to NA-LA for approval a revised TSD and TSRs which incorporated those measures on June 1, 2023 [1], which NA-LA approved in August 2023, with two conditions of approval (COA) [2].

Findings.

1. LANL Transportation Safety Document.

Per 10 CFR 830, the purpose of a DSA (or a TSD, which is a specific type of DSA) is to "provide reasonable assurance that a DOE nuclear facility can be operated safely in a manner that adequately protects workers, the public, and the environment" [3]. Further, DOE Standard 3009-2014 says "although all elements of the DSA preparation are important, three elements—

hazard analysis, accident analysis, and hazard control selection—are fundamental, because they determine the hazard controls needed to provide protection for workers, the public, and the environment" [16]. The LANL TSD has flaws in all three fundamental elements, and thus it does not demonstrate that members of the public or workers are adequately protected during onsite transportation activities.

Inadequate Hazard Identification—10 CFR 830, Subpart B, states that the safety basis must "identify and analyze the hazards associated with the work" [3]. The LANL TSD does not contain sufficient analysis for a number of transportation-related hazards.

Cliffs Along Transportation Routes—The LANL TSD acknowledges that packages used for onsite transportation may not survive a 30-foot drop and states additional controls are identified to compensate. Many onsite transfers at LANL occur along the Pajarito corridor, a specific section of Pajarito Road on the LANL footprint near facilities such as Area G, the Plutonium Facility, and the Transuranic Waste Facility (TWF). There are steep cliffs along one side of the road, with drops of significantly more than 30 feet in some locations. However, the LANL TSD makes no mention of the specific hazard of the cliffs [17]. During the Board's review of the LANL TSD, Triad personnel identified guardrails and run-off distances along that route and stated that falling down a cliff was not a credible accident scenario. However, neither the guardrails nor the run-off distances are identified, credited, or shown to be sufficient to prevent drops down the cliffs in the LANL TSD. Therefore, the hazard posed by the cliffs along the transfer route is neither identified nor adequately controlled with the specific controls within the LANL TSD.

Incompatible Materials—The LANL TSD identifies incompatible materials as a potential hazard in Table 7-1, *P&T Hazardous Materials and Associated Design Basis Conditions*. However, Table 7-4, *Design Basis Conditions and Packaging Performance Envelope for P&T Activities*, asserts that the packages meet Type B equivalent level of safety for incompatible materials and thus no additional safety controls are needed. The Type B requirement in 10 CFR 71.43 states there must be assurance that "there will be *no significant chemical, galvanic, or other reaction* among the packaging components, *among package contents*, or between the packaging components and the package contents" (emphasis added). To meet this requirement, the LANL TSD would need to provide assurance that incompatible materials will not be present in packages, but it currently does not.

LANL's *Packaging Evaluation Program* document states "the *incompatible materials* requirements are satisfied through shipper inspection…[and] specified in P&T-WI-001" [18]. However, there is no corresponding section of P&T-WI-001 to verify that package contents meet the requirements under 10 CFR 71.43 [19]. Furthermore, the TWF TSRs state that when a container is found that contains oxidizing chemicals or chemical incompatibilities, it is to be removed immediately from TWF, per Limiting Condition of Operation 3.2.3, Condition A, which would rely on onsite transportation to do so [20], thus violating the Type B requirements.

Given that there is no inspection of package contents prior to transfer specifically dedicated to ensuring that incompatible materials are not present, and that the TWF TSR requires removal of containers containing incompatible materials, it can be assumed that transfers of

incompatible materials may occur. Therefore, the LANL TSD assertion that no additional safety controls need to be developed to account for this hazard is not supported.

Pyrophoric Materials—The LANL TSD previously asserted that pyrophoric materials were not applicable. In other words, the hazard of pyrophoric materials did not need to be further analyzed and controlled, because they would never be transported. However, in August 2020, LANL transported pyrophoric material that was not recognized as pyrophoric at the time of transfer. In early March 2021, after titanium metal fines caused sparking in the Plutonium Facility, additional suspect pyrophoric containers were transported from TWF back to the Plutonium Facility (the originator facility). After the fact, Triad completed an analysis that concluded the transported materials were not pyrophoric.

The titanium sparking event resulted in a positive unreviewed safety question determination, and in July 2021, NA-LA approved an addendum to the TSD and a revision to the TSRs. The additional packaging control requires "that either a 12-inch POC [pipe overpack container] or a SAVY 4000 container inside a DOT 7A Type A drum be used to transport potentially pyrophoric material"[3] [21]. Triad's analysis concluded the packaging configurations would not be "adversely impacted by the oxidation of limited quantities of pyrophoric material" [21]. These containers are also limited to specific quantities of potentially pyrophoric material, per the specific administrative control (SAC) [22].

However, the analysis which supports the addendum to the TSD, and the subsequent revision to the TSRs, uses a limited definition of pyrophoric material that only addresses small pieces of special nuclear material metal. This definition would not consider other potentially pyrophoric payloads such as plutonium oxide dispersed within powdered sodium. In this case, since the special nuclear material is not metal pieces, the mixture would not be classified as potentially pyrophoric per the addendum and revised TSRs. Therefore, additional analysis is needed to ensure that all potentially pyrophoric materials are analyzed in the TSD.

Inadequate Accident Analysis—10 CFR 830, Subpart B, requires that a DSA must evaluate "normal, abnormal, and accident conditions," which will then support the derivation of controls [3]. DOE Standard 1104-2016 expands upon what is necessary to determine that accident analysis is adequate. Namely, the DSA reviewer must be able to reach the conclusion that the "accident analysis methodology is clearly identified and appropriate, including identification of initial conditions and assumptions" and the "accident analysis clearly substantiates the findings of hazard analysis for the design/evaluation basis events and demonstrates the effectiveness of safety class SSCs [structures, systems, and components]" [23].

The LANL TSD does not contain any detailed accident analysis. Instead, the TSD develops Table 7-5, *Derived Controls for P&T Design Basis Conditions*. Within this table, "only drops/impacts, crush, puncture, and fire conditions were considered" because these are the Type B packaging requirements that are not met by the packages used for transfers under this TSD [17]. These are listed in the third column of the table in the TSD. The fourth column contains a brief event description, and the fifth and sixth columns list the preventive and

[3] Pipe Overpack Containers (POCs) and SAVY 4000 containers are two types of robust packages used routinely at LANL in various applications.

mitigative controls, respectively, for each of these events. An example from the table is provided below.

Table 7-5. Derived Controls for P&T Design Basis Conditions

Event No.	Hazard [type]	DBC for P&T Activities	Event Description	Preventive Control (Type)	Mitigative Control (Type)
2	Fuel(s): Transfer / other vehicle fuel (including unmanned aerial system) [flammable material, explosive material] Ignition Source(s): • Short in transfer vehicle system wiring [electrical energy] • Static discharge [electrical energy] • Transfer vehicle engine [thermal energy]	Drop/Impact, Crush, Puncture, Fire	Operator error results in leak/spill of vehicle fuel and subsequent fire and/or explosion that breaches one or more packages	• Packaging (DF) • Enclosed Cargo Compartment (DF) • Tie-Down System (DF) • Restricted Access to Transfer Route (SAC) • Training and Qualification of Transport Vehicle Driver (SAC) • Road Condition Restrictions (SAC) • Safety Escort Vehicle Requirements (SAC) • Communications Requirements for Trip Commander (SAC) • Combustible Material Limits (SAC)	• Nuclear Material Limit (SAC) • Restricted Access to Transfer Route (SAC) • Training and Qualification of Transport Vehicle Drivers (SAC) • Communications Requirements for Trip Commander, Convoy Vehicles, and the ERO (SAC) • Emergency Preparedness (SMP)
			Vehicle malfunction results in leak/spill of vehicle fuel and subsequent fire and/or explosion that breaches one or more packages	• Packaging (DF) • Enclosed Cargo Compartment (DF) • Tie-Down System (DF) • Training and Qualification of Transport Vehicle Driver (SAC) • Vehicle Inspection Prior to Transfer and Routine Maintenance (SAC) • Road Condition Restrictions (SAC)	• Nuclear Material Limit (SAC) • Restricted Access to Transfer Route (SAC) • Training and Qualification of Transport Vehicle Drivers (SAC) • Communications Requirements for Trip Commander, Convoy Vehicles, and the ERO (SAC)

Figure B-1. *Example of Table 7-5 from the LANL TSD*

The LANL TSD provides no further description of these accidents; there is no discussion of event frequency, estimated unmitigated or mitigated dose consequences, either qualitative or quantitative, nor any discussion of initial conditions or assumptions. Moreover, the TSD does not discuss how each of the controls listed in the fifth and sixth columns *specifically* function in each of the events for which they are credited (as discussed in the *Inadequate Control Set* section below). The LANL TSD, with its brief description of events and list of controls, does not constitute formal accident analysis and therefore does not clearly demonstrate alignment with requirements in 10 CFR 830.

The NNSA safety basis review team for Revision 3 of the LANL TSD raised a similar concern. NNSA approved Revision 3 of the LANL TSD with various conditions of approval including the condition that "LANL shall develop additional analysis…that includes *quantitative estimates of the likelihood* of credible scenarios leading to the release of nuclear materials both with and without TSD controls in place, as well as an *estimate of what radiological dose a member of the public* located at the most likely site boundary could receive" (emphasis added) [6]. The resulting quantitative analysis was included until Revision 9 of the LANL TSD, which made major changes, including an entire rewrite of the safety assessment section.

Inadequate Control Set—10 CFR 830, Subpart B, requires that DSAs "derive the hazard controls necessary to ensure adequate protection of workers, the public, and the environment" and "demonstrate the adequacy of these controls to eliminate, limit, or mitigate identified hazards" [3]. The LANL TSD does not evaluate the effectiveness of hazard controls in relation to each specific accident scenario for which the controls are credited. Rather, the LANL TSD describes generic safety functions for each design feature and SAC, instead of specific safety functions in the context of each accident scenario. Appendix A to 10 CFR 830, Subpart B, states that safety SSCs "require formal definition of minimum acceptable performance in the documented safety analysis" which "is accomplished by first defining a safety function" [3]. DOE Standard 3009-2014 expands on the definition of safety functions: "Safety function descriptions state the objective of the SSC in *a given accident scenario*" (emphasis added) [16].

Due to the lack of specific evaluation, the LANL TSD credits controls for accident scenarios where the safety function is unclear or nonexistent. For example, the LANL TSD credits the straps that hold the package to the vehicle (i.e., tie-down system) as a preventive control in fire scenarios not initiated by package movement, for which the tie-down system appears to provide no preventive safety function. Further, due to the generic evaluation of controls, the LANL TSD fails to compensate for the absence of the enclosed cargo compartment[4] (ECC) design feature and the package design feature in some allowed transfers. For instance, the LANL TSD permits transfer of large packages which would not fit within an ECC. In these cases, the LANL TSD credits a SAC that prohibits all traffic as a replacement for the ECC safety function. However, the SAC does not address numerous accidents where prohibition of traffic would not replace the safety functions of an ECC (e.g., vehicle drop-off, vehicle impact from other convoy vehicles, fire events from vehicle malfunctions). Additionally, while the TSD limits the quantity of MAR for transfers without an ECC to 1.9 kg plutonium (Pu) 239 equivalent, it provides no quantitative analysis for this lower MAR limit.

The LANL TSD also permits transfers of large objects that "may not fit inside any known package that meets the criteria" in the TSD [24]. In this situation, items such as large pieces of equipment or gloveboxes would be sealed with tape, plastic wrap, or other means, but this sealing method does not provide the same safety function as a package. In some cases these items may also be transported without an ECC. The transfer of large objects then can involve the loss of at least one, if not two, design features, without additional analysis, and therefore the remaining control set for these accident scenarios may not be effective.

Significant Public Consequences—As previously discussed, the LANL TSD does not adequately identify all potential hazards, does not adequately analyze accident scenarios, and does not demonstrate the effectiveness of its safety control set. These safety issues are particularly concerning given the high MAR limits, the proximity of transportation routes to the offsite public, and the nature of several credible accident scenarios (e.g., vehicle fire events). These factors result in the possibility of high unmitigated dose consequences to the offsite public.

[4] An enclosed cargo compartment is "an enclosure with floor, walls on all sides, and a roof in which materials are transferred" [22].

The July 2007 through March 2012 revisions of the LANL TSD contained quantitative analysis of the risk of LANL onsite transportation activities. These older revisions of the TSD referenced the Area G transuranic (TRU) waste transportation accident and fire scenario from the Area G safety basis dated April 2003. In this accident scenario, a vehicle crashes or rolls over, causing a fire and spilling the waste containers. The postulated MAR in that scenario was the maximum inventory for a truck at the time, which was about 17.7 kg Pu-239 equivalent, and the estimated unmitigated dose consequence to the public was about 190 rem. From November 2012 to June 2023, the LANL TSD allowed up to 20 kg Pu-239 equivalent MAR; therefore, the corresponding estimated dose consequence to the public would have been about 217 rem. The 2003 Area G accident scenario had an estimated likelihood of 10^{-3} instances per year (once per thousand years). Additionally, the July 2007 through March 2012 revisions of the LANL TSD noted that the distance to the site boundary for some onsite transportation routes is closer than the distance to the site boundary for Area G; therefore, the July 2007 through March 2012 revisions stated the unmitigated dose consequence for those transportation activities could be substantially higher.

The MAR limit within the November 2012 to June 2023 versions of the LANL TSD was based on "an analysis of historical and potential future operations," with a review of several years of data of onsite transfers, and the "maximum amount of material transferred during this time frame was approximately 18 kg Pu-239 equivalent material" [17], thus the "MAR limit of 20 kg Pu-239 equivalent is bounding for historical operations, and is expected to be bounding for future operations" [22]. However, as stated in DOE Standard 1189-2016, *Integration of Safety Into the Design Process*, a step in an inherently safe design process is to consider the "removal or reduction of hazards before controls need to be developed," for example, through "reducing the amount of hazardous material present at any one time" [25]. Rather than basing the MAR limit on historical operations, consideration should be given to reducing MAR to the lowest practicable amount. Other sites' TSDs contain much lower MAR limits than LANL's. For example, LLNL and NNSS both specify a MAR limit of 5 kg Pu-239 equivalent.

Current Compensatory Measures—Given the deficiencies in the LANL TSD, it cannot be relied upon to ensure adequate protection of the public or workers during onsite transportation activities. Therefore, until the LANL TSD is revised to address the above safety concerns and/or is revised to comply with an improved safe harbor methodology, compensatory measures are warranted to ensure safety.

As discussed previously, on October 11, 2022, NA-LA transmitted a memo to Triad, with an enclosure containing proposed compensatory measures, requesting that Triad develop an impact assessment of the proposed compensatory measures, propose revisions to those measures, and propose additional measures, as applicable, within 60 days. The majority of NA-LA's proposed compensatory measures were related to improvements to existing SACs that would have minor impact on overall safety posture. For instance, NA-LA proposed a compensatory measure to revise the language of the road condition restrictions SAC to include a requirement to check the weather within two hours. While more prescriptive wording in SAC language would be an improvement, this action is already in place per implementing procedures, and therefore this change would have a minor impact. The most impactful proposed compensatory measures from NA-LA were related to MAR limits, packaging, and traffic restrictions. Triad's second

response to the NA-LA letter on January 31, 2023, outlined the compensatory measures it planned to implement within 60 days and incorporate in the TSD and TSRs by June 1, 2023. Triad implemented these compensatory measures procedurally on March 31, 2023, and submitted for NA-LA approval a revised TSD and TSRs which incorporated those measures, on June 1, 2023 [10] [11].

NA-LA approved the revised TSD and TSRs on August 10, 2023, with two COAs [2]. The first COA directed Triad to resolve NA-LA's comments regarding Type A packaging and the use of functionally equivalent versions of DOT markings. Triad completed this action and submitted the newly revised TSD and TSRs on October 4, 2023 [26]. The second COA directed Triad to resolve additional NA-LA comments on the TSD and TSRs by the 2024 annual update and provide NA-LA with periodic briefings on the status. These additional NA-LA comments covered multiple topics, including hazard identification and control effectiveness, and addressed some of the Board's safety concerns with the LANL TSD.

In the case of the compensatory measure of reduced MAR limits, while any reduction in MAR would be an improvement, given the high unmitigated dose consequences, a significant reduction in MAR would be preferable. To this end, Triad's January 31, 2023, letter defined high MAR TRU waste shipments as TRU waste transfers that exceed 1.9 kg Pu-239 equivalent and/or 10 g heat source plutonium. It stated all TRU waste transfers with greater than this quantity of MAR would be conducted using an ECC. Previously, transfers of up to 5 kg Pu-239 equivalent could be conducted without an ECC; therefore, Triad's compensatory measure effectively lowers the MAR limit for non-ECC transfers from 5 to 1.9 kg Pu-239 equivalent. Further, Triad stated that no TRU waste transfers would exceed 8.8 kg Pu-239 equivalent or 80 g heat source plutonium. Previously, the LANL TSD had a limit of 20 kg Pu-239 equivalent for all shipments of radioactive materials. Triad's letter did not articulate compensatory measures for high MAR transfers other than TRU waste, and rather stated Triad would engage with NA-LA to develop transfer-specific controls if there is a need to perform such transfers before an updated TSD is implemented. However, the MAR limits approved in August 2023 do not distinguish between TRU waste and other radioactive materials, apart from the special case of heat source plutonium, and limit transfers of all radioactive materials other than heat source plutonium to 8.8 kg Pu-239 equivalent [10] [11].

Further, NA-LA's list of proposed compensatory measures also specified that reductions in MAR be considered in conjunction with packaging. Triad's January 31, 2023, letter stated that heat source plutonium TRU waste shall be transferred in POCs, a relatively robust form of package. While Triad also stated that other plutonium (e.g., non-heat source) TRU waste packages would meet Type A requirements, this assumption was already part of the TSD package performance envelope. The TSD and TSR approved in August 2023only require POCs for packages that contain greater than 10 g of heat source plutonium [11] [10]. This may allow transfers of up to 80 g of heat source plutonium in non-POCs as long as each individual package within the shipment contains less than 10 g.

Finally, NA-LA's list of proposed compensatory measures included a traffic restriction for certain (e.g., high MAR) shipments. Triad's January 31, 2023, letter stated that public access

would be restricted on transfer routes and that all traffic would be restricted during transfers when an ECC is not used; however, both of these safety controls were previously in place.

Overall, the compensatory measures incorporated in the TSD and TSRs approved in August 2023, and the resolution of NA-LA's comments covered by the two COAs, represent an improvement in the safety posture of onsite transportation operations. However, to demonstrate adequate protection of the public and workers at LANL, the hazard analysis, accident analysis, selection of controls, and development of TSRs for onsite transportation need to be reevaluated in accordance with the requirements of 10 CFR 830.

2. Onsite Transportation Directives.

The onsite transportation safe harbors do not ensure that TSDs meet 10 CFR 830 requirements or that TSDs contain sufficient analysis and hazard controls for safe operations. Additionally, DOE Standard 1104-2016, *Review and Approval of Nuclear Facility Safety Basis and Safety Design Basis Documents*, does not contain specific guidance for federal review and approval of TSDs.

Noncompliance with 10 CFR 830—The onsite transportation safe harbors lack requirements or guidance for several 10 CFR 830 requirements, most significantly those pertaining to accident evaluation and hazard controls. The table in Attachment C shows an analysis of missing or inadequate requirements and guidance in the onsite transportation safe harbors.

On September 13, 2022, DOE responded to the Board's January 2022 letter. DOE asserted that 10 CFR 830 requirements apply "regardless of the methodology for DSA development that is used," and consequently stated that 10 CFR 830 requirements do not need to flow down into the onsite transportation safe harbors [4]. However, this assertion is inconsistent with the purpose of safe harbors, which is to "provide approved methodologies for meeting the DSA requirements of 10 CFR Part 830," as stated in DOE Standard 1104-2016 [23]. This means that if a contractor follows the safe harbors, then the contractor is assured that all the requirements of 10 CFR 830 will be fulfilled. Given that the onsite transportation safe harbors do not clearly address several 10 CFR 830 requirements, TSDs will not meet the fundamental 10 CFR 830 requirements by solely following the safe harbor methodologies. This is illustrated in the LANL TSD, discussed earlier in this report.

This section will discuss the most important 10 CFR 830 requirements that are not covered by DOE Guide 460.1-1, and then will illustrate how other sites' TSDs have supplemented the guide with methodology from DOE Standard 3009-94. Additionally, this section includes discussion of several DOE directives in comparison to the onsite transportation safe harbors. These include DOE Order 461.2, *Onsite Packaging and Transfer of Materials of National Security Interest*, and DOE Order 461.1C, *Packaging and Transportation for Offsite Shipment of Materials of National Security Interest*.

Evaluation of Accident Scenarios—10 CFR 830 requires evaluation of "normal, abnormal, and accident conditions, including consideration of natural and man-made external

events, identification of energy sources or processes that might contribute to the generation or uncontrolled release of radioactive and other hazardous materials" [3]. Systematic evaluation of accident conditions is a necessary component of safety bases to demonstrate adequate protection of the public and workers, as the safety bases are used to determine the need for safety controls. However, the onsite transportation safe harbors do not have requirements or detailed guidance related to the development and evaluation of specific or detailed accident scenarios.

DOE Guide 460.1-1 mentions accidents when discussing how TSDs should develop safety controls. It states that TSDs should include "control requirements appropriate for the level of containment and communication provided that take into account the possibility and consequences of credible accidents" [13]. However, the guide does not elaborate on how TSDs should determine the credibility of accidents or consider their risks.

Instead of evaluating accidents, there is vague guidance related to the development and evaluation of "design basis conditions" (DBC), which are the conditions that packages should be able to withstand for certain insults (e.g., fall, fire, penetration).[5] While determining the conditions that packages can withstand is important, this evaluation is not the same as evaluating accident scenarios. The guide does not discuss identifying initial conditions, assumptions, or specific initiators of various package insults. Further, the guide does not advise that TSDs consider scenarios where multiple package insults could occur (e.g., a vehicle crash with fire that results in a package both falling down some distance and being exposed to fire).

Evidence of the lack of requirements and guidance for accident analysis in the safe harbors can be seen in TSDs across the complex. Several sites supplement guidance from the onsite transportation safe harbors with methodologies from DOE Standard 3009-94 for development and analysis of unique, bounding accident scenarios, including quantitative analysis. Examples include the 2011 Hanford TSD, the 2015 Lawrence Livermore National Laboratory (LLNL) TSD, and the 2017 Nevada National Security Site (NNSS) TSD. For instance, the Hanford TSD states that "the accident analysis demonstrates consistency with the guidance in DOE-STD-3009-94" [27]. The LLNL TSD states that DOE-STD-3009-94 was used in "the development of the hazard analysis, accident analysis, selection of controls, and development of" TSRs [28]. The NNSS TSD states that the "analysis process used to evaluate NNSS onsite transportation hazards is patterned after the approach of DOE-STD-3009" [29]. The sites' reliance on methods from another safe harbor to adequately evaluate accident conditions highlights the weakness of the onsite transportation safe harbors.

A comparison of the onsite transportation safe harbors to the DOE order for onsite transfers of MNSI further illuminates the weaknesses in the safe harbors. For onsite transfers of

[5] For instance, the guide provides an example of hazardous material that is required to be in a package where the DBC for a fall is 30 feet (i.e., the package can survive a 30-foot drop). The TSD would then evaluate whether the package can survive a 30-foot drop; otherwise, "additional administrative controls would need to be imposed on the transport system to ensure an adequate level of safety during transport" [13]. The guide further describes how TSDs can include site- and route-specific information in developing and evaluating DBCs. Continuing from the previous example, an evaluation of onsite transportation activities may determine that the greatest fall possible on the transfer route is 10 feet. In this case, if the TSD also imposed a control prohibiting lifting the package above 10 feet during handling, then the DBC would be a fall of 10 feet. From there, the guide includes an expectation that either the package will be shown to survive a 10-foot drop, or additional administrative controls would be needed.

MNSI, DOE Order 461.2 states that the "safety assessment must document all credible onsite accident conditions" [30]. Additionally, it states, "[f]or higher hazard (e.g., hazard category II [*sic*]) transfers, it is recommended that a more quantitative analysis be applied (i.e., DOE-STD-3009). For lower hazard transfers the assessment may be considerably more qualitative" [30]. In contrast, DOE Guide 460.1-1 does not include specific requirements and guidance for accident evaluation, such as that in DOE Standard 3009-2014.

Comparing DOE Guide 460.1-1 to DOE Order 461.1C illustrates this issue further. This order establishes the requirements for offsite shipments of MNSI that do not comply with DOT and NRC regulations. Regarding accident analysis, it states, "the DSA must include analysis of the bounding accidents that could occur (i.e., design basis accidents or DBAs), per the requirements of DOE Standard 3009-2014" [31].

Hazard Controls—The onsite transportation safe harbors have no guidance related to the 10 CFR 830 requirement to demonstrate the adequacy of hazard controls "to eliminate, limit, or mitigate identified hazards" [3]. While DOE Guide 460.1-1 states that controls "should ensure that the packaging operates within its established performance envelope," it provides no guidance or direction on how to evaluate the effectiveness of a control to do so [13]. LLNL and NNSS supplemented their TSDs with guidance from DOE Standard 3009-94 and demonstrated the effectiveness of controls to reduce risk through mitigated hazard and accident analyses. In these analyses, the sites documented the reduction in frequency or consequence caused by applying the safety controls. Further, unlike the onsite transportation safe harbors, both DOE Order 461.1C and DOE Order 461.2 provide additional guidance on the 10 CFR 830 requirement to demonstrate the adequacy of controls for transport of MNSI. DOE Order 461.1C refers to the methodology in DOE Standard 3009-2014 to meet this requirement. DOE Order 461.2 is less specific but does state that the safety assessment portion of the TSD may select controls and "provide analysis, factoring in the control application" [30].

Appendix A to 10 CFR 830, Subpart B also states that developing functional requirements and applicable performance criteria provides assurance that the hazard control will perform its safety function. There is no discussion in DOE Guide 460.1-1 on functional requirements or performance criteria for controls. However, LLNL and NNSS, both of which used DOE Standard 3009-94 to supplement their TSDs, documented specific functional requirements for their credited controls.

Finally, 10 CFR 830 requires a safety basis to "define the process for maintaining the hazard controls current at all times and controlling their use" [3]. The onsite transportation safe harbors do not contain guidance for implementing this requirement. DOE Guide 421.1-2A, *Implementation Guide for Use in Developing Documented Safety Analyses to Meet Subpart B of 10 CFR 830*, states an "expectation associated with any of the safe harbors is that the safety classification guidance for safety SSCs (i.e., safety class and safety significant SSCs) and specific administrative controls (SACs) of DOE-STD-3009 will be used in developing the DSA" [32].

Unlike the onsite transportation safe harbors, DOE Order 461.1C provides several requirements to meet this expectation for transport of MNSI. Due to the proximity to the public

for offsite shipments, DOE Order 461.1C requires all such controls to be identified as safety SSCs and requires the application of "the requirements associated with safety-class controls for these 'safety SSCs'" [31]. In comparison, the safe harbors for onsite transportation have no discussion of, or requirements related to, the applicability of other DOE directives' requirements for TSD controls (e.g., applicability of the design criteria for safety SSCs from DOE Order 420.1C, *Facility Safety*). Additionally, DOE Order 461.1C requires identification of SACs for administrative controls necessary for public safety, worker safety, or defense in depth for transport of MNSI. In comparison, the safe harbors for onsite transportation do not mention SACs, and therefore have no discussion of, or requirements related to, the applicability of requirements contained in DOE Standard 1186-2016, *Specific Administrative Controls*.

Inadequate Evaluation Criteria—An important component of evaluating the level of safety documented in a safety basis is having an objective metric to assess the effectiveness of safety controls at reducing risk. For instance, both the 1994 and 2014 revisions of DOE Standard 3009 apply the concept of an evaluation guideline (25 rem total effective dose for a member of the offsite public), which "the safety analysis evaluates against" and "is established for the purpose of identifying the need for and evaluating safety class controls" [16]. For non-reactor facilities, NRC has criteria similar to DOE Standard 3009, namely for credited controls to reduce the frequency of an event to highly unlikely or its consequence to less severe than 100 rem for the worker and 25 rem for the offsite public. For DOT transportation regulations pertinent to DOE's offsite shipments of radioactive materials, the evaluation criteria apply to the package design itself. For instance, for Type B packages,[6] 10 CFR 71, Subpart E, has a requirement to demonstrate "no loss or dispersal of radioactive contents," during normal conditions of transport, and to limit radioactive material releases to less than specific amounts during defined hypothetical accident conditions [33].

The onsite transportation safe harbors, in contrast, do not provide specific quantitative criteria to evaluate the effectiveness of the safety control set, and thus to understand the risk of onsite transportation operations. Instead, they require that TSDs demonstrate an equivalent level of safety to DOT and NRC regulations for offsite transportation. Specifically, DOE Order 460.1D states that the TSD must "describe the methodology and compliance process to meet equivalent safety for any deviation from 49 CFR Parts 171-180 and 49 CFR Parts 350-399" [12]. As noted above, DOT and NRC offsite transportation regulations primarily rely on credited packages to provide containment for radioactive materials during pre-defined normal transport and hypothetical accident conditions. DOE Guide 460.1-1 elaborates on this expectation of containment: "For hazardous materials, such as Type B radioactive materials, the transport system would be expected to prevent loss of containment both for normal handling and for all credible onsite accidents" [13]. However, while the guide allows for options other than the use

[6] "'Type A package' means a packaging that, together with its radioactive contents limited to A_1 or A_2 as appropriate, meets the requirements of §§ 173.410 and 173.412 and is designed to retain the integrity of containment and shielding required by this part under normal conditions of transport as demonstrated by the tests set forth in § 173.465 or § 173.466, as appropriate." [39]
"'Type B package' means a packaging designed to transport greater than an A_1 or A_2 quantity of radioactive material that, together with its radioactive contents, is designed to retain the integrity of containment and shielding required by this part when subjected to the normal conditions of transport and hypothetical accident test conditions set forth in 10 CFR part 71." [39]
"A_1 and A_2 values are given in in §173.435 or are determined in accordance with §173.433." [39]

of credited Type B packages (i.e., it does not mandate the use of Type B packages), it does not describe specifically how to demonstrate an equivalent level of safety for this containment expectation for transportation of packages that cannot survive normal handling or credible onsite accidents (i.e., non-equivalent packages).

In the absence of clear guidance on what constitutes equivalent safety, several sites across the DOE defense nuclear facility complex used quantitative accident analysis to demonstrate that credited controls sufficiently reduced the risk from credible accidents. Sites varied in the thresholds they used; some used 25 rem, and others used 5 rem for the dose to the public. Sites that included a co-located worker analysis used a threshold of either 5 rem or 100 rem. Notably, one site that used the 5 rem threshold stated that this demonstrated equivalent safety to DOT/NRC transportation regulations. The 2017 NNSS TSD states that it achieves equivalent safety by accomplishing several things, including "no release of contents under 'credible accident' scenarios," and if a "release is possible, radiological dose consequences cannot exceed 5 rem to any person in close proximity to the accident within 30 minutes of the incident" [29].

Additionally, the DOE order for offsite transportation of MNSI instructs analysts to perform quantitative accident analyses, rather than demonstrating equivalent safety. DOE Order 461.1C states that safety bases "must include analysis of the bounding accidents that could occur (i.e., design basis accidents or DBAs), per the requirements of DOE Standard 3009-2014" [31]. The requirements of DOE Standard 3009-2014 include using 25 rem as the evaluation guideline for accident analysis. Similarly, the order for onsite transportation of MNSI recommends analysts perform quantitative accident analyses, rather than demonstrating equivalent safety. DOE Order 461.2 states that the TSD "must substantiate the conclusion that a credible accident must not cause individuals to receive a total effective dose (TED) greater than the levels referenced in DOE-STD-1189, *Integration of Safety into the Design Process*, public protection criteria per Appendix A, section A.2.1" [30]. The cited section defines 25 rem to the public as exceeding the evaluation guideline and 5 rem to the public as challenging the evaluation guideline.

The Board communicated the concern with the lack of a clear definition of equivalent safety in its January 6, 2022, letter. In response, DOE acknowledged that improved methodology "to better document analyses of equivalent safety" was warranted and committed to providing better guidance [4]. While this is one method to resolve the concern of inadequate evaluation criteria (i.e., by better defining equivalent safety), other options exist for providing evaluation criteria, such as using the quantitative methodology provided in DOE Order 461.1C, DOE Order 461.2, and DOE Standard 3009-2014.

Methods to Restrict Public Access—The onsite transportation safe harbors do not provide clear guidance on methods to control public access during onsite transfers conducted under TSDs. Multiple correspondences between LANL contractors and DOT have yielded different interpretations of how to restrict public access. This suggests the need for the DOE onsite transportation safe harbors to clearly specify methods for restricting public access.

DOE Guide 460.1-1, Attachment 2, is a copy of a 1991 letter from the DOT chief counsel to the director of the Transportation Management Division of DOE. The crux of this letter is

defining what constitutes a "public highway" and when transportation of hazardous materials is considered "in commerce." This is important because "government agencies offering hazardous materials for transportation in commerce or transporting hazardous materials in furtherance of a commercial enterprise are subject to" the Hazardous Materials Transportation Act, which includes all of the Hazardous Materials Regulations (HMR) [13]. In other words, if a road is considered in commerce, it would not be permissible to conduct onsite transfers of radioactive material in accordance with a TSD; instead, all HMRs would need to be met.

A road on government property may still constitute a road in commerce if public access is not controlled. As the 1991 DOT letter states, "[i]f a road is used by members of the general public (including dependents of Government employees) without their having to gain access through a controlled access point, transportation on (across or along) that road is in commerce. On the other hand, if access to a road is controlled at all times through the use of gates and guards, transportation on that road is not in commerce" [13]. The letter provides several examples and specifically states that relying on signs alone to restrict public usage would not be enough to consider the road not in commerce.

During the Board's review of the LANL TSD, it became apparent that the guidance contained in the 1991 DOT letter did not provide enough clarity for implementation. The issues raised in the 1991 letter continue to be discussed. For instance, in 2006, a member of the LANL Packaging and Transportation group requested DOT to clarify whether the 1991 letter was still valid "[g]iven the vintage of this correspondence" [34], and the chief of standards development in the DOT Office of Hazardous Materials Standards responded affirmatively [35].

Additionally, LANL personnel provided the Board with a letter that the president of Regulatory Resources (a subcontractor located in Los Alamos) sent to DOT in 2018 to request that DOT "confirm the use of signage as a means to achieve public access restriction" [36], and DOT's response [21]. This 2018 letter did not refer to the 1991 DOT letter. DOT responded that "[s]hipments that occur on private roads whose access is restricted to the public (e.g., limited to authorized personnel), whether by signage (as you described and presented in your letter) or physical barriers, are not subject to the requirements of the HMR" [37]. This response appears to contradict the 1991 letter included in DOE Guide 460.1-1. However, LANL personnel stated that they currently use flaggers to continuously restrict public access to roads during onsite transfers. They further stated that if they decided to apply the guidance in the 2018 letter, they would first declare an Unreviewed Safety Question and obtain DOE approval prior to relying solely on signs to restrict public access.

These communications between individual entities and DOT suggest the need for the DOE onsite transportation safe harbors to be more specific regarding the methods necessary to restrict public access. Adequately restricting public access is important from both regulatory and safety perspectives. If public access is not properly restricted, then the public could be closer to onsite transportation activities than analyzed. Therefore, a member of the public could initiate an accident (e.g., vehicle crash), and could receive a higher radiation dose by being in the vicinity of a transport accident if a release occurred.

Additionally, the onsite transportation safe harbors do not provide detailed guidance on controlling onsite traffic of site personnel. Similar to the concern with members of the public, site personnel traveling onsite in government or personal vehicles could initiate an accident during onsite transfers of radioactive material. At LANL in particular, the high operational tempo needed to accomplish its greatly expanded pit manufacturing mission will inevitably increase onsite traffic. Therefore, it is incumbent upon DOE to develop requirements and guidance on the control of site traffic during onsite transfers of radioactive material.

DOE Review and Approval of TSDs—DOE Standard 1104-2016, *Review and Approval of Nuclear Facility Safety Basis and Safety Design Basis Documents*, does not contain guidance for the review and approval of TSDs. The standard mentions transportation only once as an example of other safe harbors allowed by 10 CFR 830 and states that the format of the safety evaluation report (SER) should be based on the safe harbor methodology used. DOE Standard 1104-2016 is divided into topical areas and these "areas and associated criteria established in this Standard form the foundation for reviewing and documenting DSA and TSR approval in an SER" [23]. The lack of guidance related to TSDs is problematic, because field office personnel do not have a set of specific criteria to evaluate whether a TSD ensures safe operations and complies with the onsite transportation safe harbors, as they would have for a DOE Standard 3009-compliant DSA.

In response to the Board's January 6, 2022, letter, DOE stated that it would "review DOE-STD-1104 to determine whether improvements are warranted" [4]. The Board concludes that adding criteria specific to TSDs to DOE Standard 1104-2016 is necessary to ensure adequate and consistent reviews by field office personnel across the DOE defense nuclear complex.

3. DOE Oversight.

DOE and NNSA failed to identify safety deficiencies in both the DOE directives related to onsite transportation and the LANL TSD. Additionally, DOE and NNSA neglected to ensure that timely corrective actions were taken when the Board identified safety concerns and have struggled to resolve safety concerns when collaboration across program offices is required.

DOE Oversight of Directives—DOE issued DOE Guide 460.1-1, the 10 CFR 830 safe harbor methodology for preparing TSDs for onsite transfers of radioactive materials, in 1997 and has not updated it since then. DOE initially issued 10 CFR 830, Subpart B, in 2001, four years after the guide was written. As noted in previous sections, the guide does not contain sufficient guidance to meet several 10 CFR 830 safety basis requirements, which is probably due to being written before 10 CFR 830, Subpart B, was established. As discussed below, DOE did not act on indications of weaknesses with the onsite transportation safe harbors that presented themselves over many years, and its process for revising directives likewise failed to identify these weaknesses.

Safety basis personnel at DOE's defense nuclear facilities have at least tacitly recognized the safety deficiencies in DOE Guide 460.1-1 for many years, but DOE has not taken action to improve the guide. For example, many DOE sites supplemented guidance from the onsite transportation safe harbors with methodologies from DOE Standard 3009-94 for development

and analysis of unique, bounding accident scenarios, including quantitative analysis. DOE Guide 421.1-2A states that DOE Standard 3009 "is a safe harbor for any of the specialized areas covered by the other safe harbors (with the exception of Hazard Category 1 nuclear reactors) and can be used in lieu of any of them" [32]. While there is no issue with using DOE Standard 3009 methodology when developing TSDs, DOE failed to recognize that its widespread use to supplement the onsite transportation safe harbors' methodology indicated safety deficiencies in the safe harbors. Field offices responsible for reviewing and approving these TSDs could have reached out to the Office of Primary Interest (OPI) for DOE Guide 460.1-1, alerting them to the safety issues with the guide.

As another example, DOE revised DOE Order 461.1C in 2016. Previous to this revision, the methodology for developing TSDs for offsite shipments of MNSI was similar to the current DOE Guide 460.1-1. One key change was the addition of an appendix that states that "DOE Standard 3009-2014…is an approved methodology for demonstrating compliance with 10 CFR Part 830. DSAs developed by OST [Office of Secure Transport] must comply with the requirements of DOE Standard 3009-2014, except for deviations that are specifically identified in this Appendix" [31]. DOE failed to recognize the corresponding weaknesses in the onsite transportation safe harbors and take action to address them.

Additionally, DOE's process for revising directives failed to identify the weaknesses in the onsite transportation safe harbors. DOE's directives review process described in DOE Order 251.1, *Departmental Directives Program*, assumes the OPI for each directive will review them periodically and propose revisions, as needed, to the Directives Review Board; however, DOE does not require these reviews to be done with a specific periodicity, and OPIs are not required to actively reach out to field elements to solicit feedback. In the case of onsite transportation safety directives, with the DOE Office of Environmental Management designated as the OPI for DOE Guide 460.1-1, this process failed to identify and correct the safety deficiencies in the onsite transportation safe harbors.

NNSA Oversight of the LANL TSD—In addition to DOE's failure to correct the safety deficiencies in the transportation directives, NNSA has not resolved safety issues with the LANL TSD specifically. NA-LA and NNSA headquarters packaging and transportation organizations have had multiple opportunities throughout the years to do so, and yet lasting corrective actions were not taken.

The NNSA safety basis review team tasked with review and approval of Revision 3 of the LANL TSD in 2007 consisted of subject matter experts from the Los Alamos Site Office (LASO) (the predecessor organization to NA-LA), the NNSA Service Center, and an independent contractor [6]. Personnel from the NNSA Packaging Certification Division, who were part of the safety basis review team, "concluded that the TSD as submitted did not provide an adequate level of analysis to support the conclusions that for non DOT compliant packages the overall transport system provided an equivalent level of safety" [6]. The associated SER therefore contained several conditions of approval, which included requiring additional analysis supporting the basis for the MAR limit in subsequent TSDs. This additional analysis was to include "quantitative estimates of the likelihood of credible scenarios leading to the release of nuclear materials both with and without TSD controls in place, as well as an estimate of what

radiological dose a member of the public located at the most likely site boundary could receive as a result of these release scenarios with the TSD controls in place" [6]. Subsequent revisions of the TSD included such quantitative analysis. However, Revision 9, which became effective in November 2012, contained an entire rewrite of the safety analysis which removed the quantitative analysis. When approving this revision, and each subsequent revision, NA-LA failed to identify the same safety issues that had previously been corrected.

Subsequent reviews by NNSA years later failed to detect and correct the same safety issues. NNSA's Office of Packaging and Transportation conducted an assessment of LANL's packaging and transportation program in 2015. While its assessment was primarily focused on MNSI, it also reviewed the LANL TSD. During this review, the team concluded that "LANL has an approved 10 CFR 830 compliant TSD and TSRs that meet 460.1C requirements" [38].

Finally, as discussed in DOE's response to the Board's January 6, 2022, letter, on the safety deficiencies in DOE's onsite transportation safety harbors and the LANL TSD, NNSA stated that it "use[s] the Biennial Review process to review field office performance in meeting requirements for the review and approval of TSDs" [4]. However, despite these biennial reviews, NNSA did not identify the safety deficiencies in the LANL TSD.

In conclusion, despite multiple instances of NNSA engagement with the LANL TSD, both at the field office level and NNSA headquarters level, NNSA failed to resolve issues with the LANL TSD.

DOE Oversight of Identified Safety Issues—Even after the Board expressed safety concerns with the LANL TSD and the onsite transportation safe harbors in its January 6, 2022, letter to the Secretary of Energy, DOE did not take timely action to address these safety concerns.

Regarding the LANL TSD, more than a year elapsed between the Board issuing its letter identifying safety deficiencies and Triad issuing its letter informing NA-LA that it would institute compensatory measures for its onsite transportation activities. NA-LA did not begin work on developing proposed compensatory measures through a baseline assessment of TSDs at other NNSA sites until July 2022, six months after the Board sent its letter. NA-LA then transmitted a letter to Triad on October 12, 2022, over 10 months after DOE received the Board's letter, which contained a wide-ranging list of potential compensatory measures for Triad to evaluate. Triad's first response on December 9, 2022, was unsatisfactory. After additional discussions with NA-LA personnel, Triad sent a new letter to NA-LA on January 31, 2023, that agreed to implement a set of compensatory measures that represented an improvement to the safety posture of onsite transportation operations. Nevertheless, this letter did not acknowledge that the compensatory measures were needed to address any safety issues.

Further, given the safety concerns identified with the onsite transportation safe harbor, it would have been prudent for DOE to conduct a complete extent of condition review of all sites' TSDs. While DOE's Office of Environmental Management had previously conducted an extent of condition review for a subset of sites under its purview in 2021, it was not formally

documented and was done prior to receiving the Board's letter highlighting the specific safety issues.

Finally, the Board is concerned with DOE's ability to address safety issues that require collaboration across program offices. DOE's September 13, 2022, letter that responded to the Board's January 6, 2022, letter frankly acknowledged that it would need to evaluate "how we communicate across offices, engage with the field, and share operating experiences across the Department."

Attachment C - Analysis of Gaps in Onsite Transportation Safe Harbors related to 10 CFR 830 Requirements

Topical Area	10 CFR 830, Subpart B Requirement	DOE Order 460.1D and/or DOE Guide 460.1-1 Reference	Analysis of Gaps
Hazard Identification	830.204 (b)(2) – "Provide a systematic identification of both natural and man-made hazards associated with the facility"	DOE Guide 460.1-1 Section 5.3.1.d. states that the TSD is expected to include "a description of the process and analysis [that] is used to ensure that equivalent safety requirements are established. This should include a technically justified basis for equivalency. For example, this *could* include a hazards analysis associated with the transfer." (emphasis added) DOE Guide 460.1-1 Section 5.3.2.c: "This section should identify the physical location of the site and associated facilities on legible maps…All features of the site which are mentioned in any part of the document, such as…transportation hazards, should be clearly identified on one or more maps." DOE Guide 460.1-1 Section 5.4.1: "A site seeking to establish a graded approach to compliance with DOE O 460.1A should develop a hierarchy in which hazardous material are grouped into a series of hazard levels." The Guide then discusses "low hazards", "higher hazards", and "hazardous materials, such as Type B radioactive materials."	The order does not contain requirements or guidance for this requirement. While the guide discusses identifying transportation hazards on maps and lists hazard analysis as one part of an acceptable way to establish equivalent safety, the guide does not discuss how to systematically identify hazards, including natural and man-made hazards. Further, while the guide discusses developing a hierarchy of hazardous materials, it does not describe how to use this process to identify hazards.
Hazard Categorization	830.202 (b) (3) – "Categorize the facility consistent with DOE-STD-1027-92"	DOE Order 460.1D 4.b.(3)(b): "For onsite transfers involving nuclear facility Hazard Category 2 or 3 quantities, the TSD must comply with the Safety Basis Requirements of 10 CFR 830, Subpart B." DOE Guide 460.1-1 Section 5.1.2: "Such an integrated approach should include hazard classification of the material." DOE Guide 460.1-1 Section 5.4.1: "A site seeking to establish a graded approach to compliance with DOE O 460.1A should develop a hierarchy in which hazardous material are grouped into a series of hazard levels."	By requiring that TSDs for transfers of Hazard Category 2 and 3 quantities follow the Safety Basis Requirements in 10 CFR Part 830, Subpart B, the order implicitly requires TSDs to categorize the operations under the hazard categorization scheme of DOE Standard 1027-92. However, the guide does not discuss or invoke the hazard categorization scheme in DOE Standard

Topical Area	10 CFR 830, Subpart B Requirement	DOE Order 460.1D and/or DOE Guide 460.1-1 Reference	Analysis of Gaps
		The guide then discusses "low hazards", "higher hazards", and "hazardous materials, such as Type B radioactive materials."	1027-92. Instead, the guide allows sites to develop their own hierarchy of hazard classification or levels. The guide frames these levels in terms of low hazards, higher hazards, and hazardous materials such as Type B radioactive materials, which is not the same type of framework as the DOE Standard 1027-92 hazard categorization scheme.
Hazard Controls	830.204 (b) (4) – "Derive the hazard controls necessary to ensure adequate protection of workers, the public, and the environment, demonstrate the adequacy of these controls to eliminate, limit, or mitigate identified hazards, and define the process for maintaining the hazard controls current at all times and controlling their use"	DOE Guide 460.1-1 Section 5.1.2 "Such an integrated approach should include hazard classification of the material, hazard containment, hazard communication, and control measures commensurate with the hazard of the material being transported, *such as*…control requirements appropriate for the level of containment and communication provided that take into account the possibility and consequences of credible accidents. These control requirements should result in minimal acceptance of risk above the risks accepted in the context of existing Hazardous Materials Regulations" (emphasis added). DOE Guide 460.1-1 Section 5.3.1.d. states that the TSD is expected to include "a description of the process and analysis [that] is used to ensure that equivalent safety requirements are established. This should include a technically justifiable basis for equivalency. For example, this could include… a discussion of mitigating measures proposed to ensure the equivalent safety requirements will be employed." DOE Guide 460.1-1 Section 5.4.2 "Before non-equivalent packaging may be used for onsite transport, a performance envelope should be established for the packaging and specific control and communication requirements should be developed which ensure that the transport system will operate safely within the performance envelope." DOE Guide 460.1-1 Section 5.4.2.c. "controls should be commensurate with the hazard represented by the package being transported, and should ensure that the packaging operates within its established	While the guide indicates that hazard controls should be developed as needed, it does not present or require a method to determine adequacy of these controls to eliminate, limit, or mitigate hazards. The guide does not define a process for maintaining the hazard controls or controlling their use. The guide states that TSDs should establish control requirements that will result in "minimal acceptance of risk above those accepted in the context of existing Hazardous Materials Regulations." However, the guide does not include a clear and consistent definition of what equivalency to these regulations entails.

Topical Area	10 CFR 830, Subpart B Requirement	DOE Order 460.1D and/or DOE Guide 460.1-1 Reference	Analysis of Gaps
		performance envelope. The hazard levels and associated performance requirements documented in Chapter VII of the TSD will greatly facilitate development and justification of appropriate transport controls. Controls may include establishment of special communication requirements (e.g., radio contact with emergency response personnel) which are required to compensate for packaging inadequacies."	
Evaluation of Accident Conditions	830.204 (b) (3) – "Evaluate normal, abnormal, and accident conditions, including consideration of natural and man-made external events, identification of energy sources or processes that might contribute to the generation or uncontrolled release of radioactive and other hazardous materials, and consideration of the need for analysis of accidents which may be beyond the design basis of the facility"	DOE Guide 460.1-1 Section 5.1.2 "Such an integrated approach *should* include hazard classification of the material, hazard containment, hazard communication, and control measures commensurate with the hazard of the material being transported, *such as*…control requirements appropriate for the level of containment and communication provided *that take into account the possibility and consequences of credible accidents*" (emphasis added). DOE Guide 460.1-1 Section 5.4.2.b. "To establish the performance envelope of the packaging, evaluation of design basis conditions (DBCs) is recommended. DBCs should be site-specific and possibly route-specific conditions under which the packaging should be able to provide containment during onsite transport. DBCs to be considered for a particular hazardous materials transport will depend on the hazard level of the material." "Chapter VII of the TSD should include guidance on which DBCs should be developed for each hazard level, and should establish minimum performance requirements for each hazard level. Examples of DBCs which may be appropriate for some hazard levels are shock, vibration, collision, fall, fire, penetration, and immersion. Others may also be appropriate." "To illustrate how the performance requirements established in Chapter VII of the TSD can be used to develop an appropriate DBC, a particular hazardous material may be grouped into a hazard level that requires a packaging to be able to survive a 3-ft drop with no loss of containment. For this hazardous material, a 3-ft drop would then become the DBC for falls, without regard to conditions along the transport route or during	The order does not contain requirements or guidance for this requirement. The guide discusses including control requirements that consider the frequency and consequence of credible accidents, but does not require such evaluation of accidents. Further, the guide does not describe what type of accidents must or should be included. The guide also discusses analyzing transport conditions and ensuring that packages are not exposed to conditions they cannot survive, such as a large drop-off. While this could constitute an analysis of transportation conditions, such analysis does not necessarily evaluate the initiators, frequency, or consequences of accident conditions.

Topical Area	10 CFR 830, Subpart B Requirement	DOE Order 460.1D and/or DOE Guide 460.1-1 Reference	Analysis of Gaps
		handling which might expose the packaging to a fall from a higher distance. If the packaging could not survive a 3-ft drop, additional administrative controls would need to be imposed on the transport system to ensure an adequate level of safety during transport. Guidance regarding appropriate administrative controls should be provided in Chapter VII of the TSD." "As an example of how physical limitations of a site may be incorporated into a DBC, a particular hazardous material may be grouped into a hazard level that requires a packaging to be able to survive a 30-ft drop. For this particular hazardous material shipment, an evaluation of the transport route may show that, for any accident which could occur along the transport route, the packaging could never fall more than 10 ft. If a control on the packaging is also imposed requiring that the packaging never be elevated more than 10 ft during handling, the DBC need only consider a 10-ft fall."	
Technical Safety Requirements	830.205 (a) (1) – "Develop technical safety requirements that are derived from the documented safety analysis" 830.205 (a) (2) – "Prior to use, obtain DOE approval of technical safety requirements and any change to technical safety requirements"	No requirement or guidance in the order or guide. Neither document mentions technical safety requirements.	The order and the guide lack requirements and guidance regarding technical safety requirements. While DOE has other directives related to technical safety requirements (e.g., DOE Guide 423.1-1B, *Implementation Guide for Use in Developing Technical Safety Requirements*), the safe harbors do not reference those other relevant DOE directives.

References

[1] Triad National Security, LLC, *Submittal of PT-SA-002-R15, P&T Transportation Safety Document, and PT-TSR-001-R13, Technical Safety Requirements,* NSP-23-042, 2023.

[2] Los Alamos Field Office, *Approval of Submittal of PT-SA-002-R15 Packaging and Transportation Safety Document and PT-TSR-001-R13 Technical Safety Requirements,* NNSA-2023-004544, August 10, 2023.

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

[4] J. Hruby, *Department letter responding to the Board letter of January 6, 2022, regarding the adequacy of the LANL onsite transportation safety document and the onsite transportation safe harbors,* September 13, 2022.

[5] Department of Energy, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analyses,* DOE Standard 3009-94 Change Notice 3, 1994.

[6] Los Alamos Site Office, *Transmittal of Safety Evaluation Report Approving Annual Update of Transportation Safety Document (TSD) and Technical Safety Requirements (TSRs),* March 22, 2007.

[7] Department of Energy, *Department of Energy Nuclear Safety Policy,* DOE P 420.1, 2011.

[8] Los Alamos National Laboratory, *Transportation Safety Document,* P&T-SA-002, R8.1, 2012.

[9] Los Alamos National Laboratory, *TA-54 Area G Documented Safety Analysis,* ABD-WFM-001, R.0, April 2003.

[10] Triad National Security, LLC, *Packaging and Transportation Transportation Safety Document,* P&T-SA-002-R15, 2023.

[11] Triad National Security, LLC, *Packaging and Transportation Technical Safety Requirements,* PT-TSR-001-R13, 2023.

[12] Department of Energy, *Hazardous Materials Packaging and Transportation Safety,* DOE Order 460.1D Chg 1, June 2022.

[13] Department of Energy, *Implementation Guide for Use with DOE O 460.1A, Packaging and Transportation Safety,* DOE G 460.1-1, June 1997.

[14] Triad National Security, LLC, *P&T Transportation Safety Document Impact Assessment,* NSP-22-094, December 9, 2022.

[15] Triad National Security, LLC, P&T Transportation Safety Document Compensatory Measures, January 31, 2023.

[16] Department of Energy, *Preparation of Nonreactor Nuclear Facility Documented Safety Analysis,* DOE-STD-3009-2014, November 2014.

[17] Triad National Security, LLC, *Transportation Safety Document (TSD),* P&T-SA-002, R12, April 2017.

[18] Triad National Security, LLC, *Packaging Evaluation Program,* P&T-PLAN-018, R12, May 7, 2020.

[19] Triad National Security, LLC, *Transportation Safety Document Authorized Shipper / Transfer Evaluator Instructions,* P&T-WI-001, R19, July 24, 2020.

[20] Triad National Security, LLC, *Technical Safety Requirements for Transuranic Waste Facility (TWF),* TSR-TWF-002, Rev 2.4, April 2020.

[21] Los Alamos Field Office, *Approval of P&T-SA-002-R12 Addendum 3-R0, Analysis of Transport of Pyrophoric Material, and P&T-TSR-001-R10-.1, Technical Safety Requirements,* NNSA-2021-002752, July 2021.

[22] Triad National Security, LLC, *Packaging and Transportation Technical Safety Requirements,* P&T-TSR-001-R10.1, May 17, 2021.

[23] Department of Energy, *Review and Approval of Nuclear Facility Safety Basis and Safety Design Basis Documents,* DOE-STD-1104-2016, December 2016.

[24] Los Alamos National Laboratory, *Packaging Evaluation Program,* P&T-PLAN-018, R12, May 2020.

[25] Department of Energy, *Integration of Safety into the Design Process,* DOE-STD-1189-2016, December 2016.

[26] Triad National Security, LLC, *Submittal of P&T-SA-002-R16, P&T Transportation Safety Document and PT-TSR-001-R14, Technical Safety Requirements,* NSP-23-091, October 4, 2023.

[27] Hanford Site, *Hanford Sitewide Transportation Safety Document,* DOE/RL-2001-36, Revision 1-E, May 2011.

[28] Lawrence Livermore National Laboratory, *Lawrence Livermore National Laboratory Transportation Safety Document,* UCRL-MA-152462-REV-5, December 2015.

[29] National Security Technologies, LLC, *Nuclear Onsite Transportation Safety Document for the Nevada National Security Site,* OTSD-NSAF.100, Rev. 3, June 2017.

[30] Department of Energy, *Onsite Packaging and Transfer of Materials of National Security Interest,* DOE O 461.2, November 2010.

[31] Department of Energy, *Packaging and Transportation for Offsite Shipment of Materials of National Security Interest,* DOE O 461.1C, December 2019.

[32] Department of Energy, *Implementation Guide for Use in Developing Documented Safety Analyses to Meet Subpart B of 10 CFR 830,* DOE G 421.1-2A, December 2011.

[33] Title 10 Code of Federal Regulations, Part 71, Subpart E, *Package Approval Standards.*

[34] J. Lowery, *Letter to Director of Office of Hazardous Materials Standards at U.S. Department of Transportation,* Los Alamos: Los Alamos National Laboratory Packaging and Transportation, May 17, 2006.

[35] J. A. Gale, *Response Letter to Joseph Lowery, Ref. No. 06-0135,* Washington: Standards Development, Office of Hazardous Materials Standards, U.S. Department of Transportation, July 11, 2006.

[36] W. Winters, *Letter to Standards and Rulemaking Division, Pipeline and Hazardous Materials Safety Administration of the U.S. Department of Transportation,* Los Alamos: Regulatory Resources Inc., November 29, 2018.

[37] D. Der Kinderen, *Response Letter to Letter from Wade Winters President of Regulatory Resources Inc., Reference No. 18-0152,* Washington: Standards Development Branch, Standards and Rulemaking Division, U.S. Department of Transportation, April 16, 2019.

[38] NNSA Office of Packaging and Transportation, *Assessment Report for DOE Orders 461.1B, 461.2 and 460.1C Compliance Review at Los Alamos National Laboratory,* March 2016.

[39] Title 49 Code of Federal Regulations Part 173, *Shippers - General Requirements for Shipments and Packages.*