THE SAFETY CASE AND THE RISK-INFORMED PERFORMANCE-BASED APPROACH FOR MANAGEMENT OF US COMMERCIAL LOW-LEVEL RADIOACTIVE WASTE (LLRW)

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Abstract: This paper describes the US Nuclear Regulatory Commission (NRC) staff approach to safety analysis and performance assessment for LLRW disposal. The paper presents a comparative assessment of the approach with the IAEA safety case (e.g.; IAEA Safety Series #SSG-23; [1]) and implementation aspects being developed in coordination with participating members, through IAEA - PRISM/PRISMA projects [2]. For the past two decades, NRC staff developed and used comprehensive technical guidance, NUREG-1573 [3], on performance assessment methodology for disposal of LLRW in support of 10 CFR Part 61 (NRC’s Licensing Requirements for Land Disposal of Radioactive Waste). Currently, NRC is amending its regulations that govern low-level radioactive waste disposal facilities to require new and revised site-specific technical analyses (Federal Register /Vol. 80, No. 58 /Thursday, March 26, 2015; [4]). Such analyses would facilitate the development of site-specific criteria for LLW disposal acceptance. NRC staff issued a draft guidance (NUREG-2175; [5]) on conducting technical analyses (e.g., performance assessment, inadvertent intruder assessment, assessment of the stability of a low-level waste disposal site, performance period analyses) to demonstrate compliance with the performance objectives in the proposed amendment of 10 CFR Part 61. The paper presents some aspects of NRC’s technical guidance in NUREG-1573 and the draft guidance in NUREG-2175 and provides a brief comparison with IAEA SSG-23. In summary, we show alignment in the “Safety Assessment” approach which is an essential constituent of the IAEA safety case. We identify overlaps with the US NRC’s “Performance Assessment” approach, as well as with NRC’s “Risk Assessment” methodology. We also note the important role of “Uncertainty Analysis” in the safety case and in supporting regulatory decision-making. Although there are harmonies and many similarities, there are also some differences between the IAEA and NRC safety case approaches. These differences are outlined and discussed briefly in the paper. Our reviews and assessments indicate that the NRC guidance documents provide detailed technical discussion and specific approaches to demonstrate compliance with the NRC’s proposed performance criteria required for site-specific analysis at different analytical timeframes.

1. Introduction:

NRC regulations for shallow land disposal of LLW were promulgated in 1982 under Part 61 of Title 10 of the U.S. Code of Federal Regulations (NRC’s Licensing Requirements for Land Disposal of Radioactive Waste). These regulations were initially developed considering a hypothetical reference disposal facility located within the United States. The NRC is currently amending 10 CFR Part 61 to require new and revised site-specific technical analyses, to permit the development of site-specific criteria for low-level radioactive waste (LLRW) acceptance based on the results of these analyses, and to facilitate implementation and better align the requirements with current health and safety standards. In summary, the new and revised requirements specify: a). technical analyses for demonstrating compliance with the public dose limits; b). technical analyses for demonstrating compliance with dose limits for protection of the
inadvertent intruder; c). requirements for development of site-specific waste acceptance criteria; d). implementation of current dosimetry in the technical analyses; and e). requirements for the “safety case” including the identification and description of defense-in-depth protections.

2. US NRC Approaches to Risk and Performance Assessment for LLW Disposal and Key Aspects of NRC Safety Case:

The NRC regulatory approach for ensuring the safety of LLW land disposal facilities is to establish performance objectives that ensure protection of the general population from releases of radioactivity (10 CFR 61.41); protection of individuals from inadvertent intrusion (10 CFR 61.42); and stability of the disposal site after closure (10 CFR 61.44). The performance objectives are demonstrated via technical analyses, including a performance assessment, inadvertent intruder assessment, site stability analysis, and performance period analysis, and compliance with technical requirements. A performance assessment (PA) is a type of risk analysis that addresses (a) what can happen, (b) how likely it is to happen (e.g.; including uncertainties), and (c) what are the resulting impacts (e.g.; consequences). The requirements for a performance assessment are set forth in 10 CFR 61.13(a).

The “safety case” in 10 CFR 61.2 is defined broadly the as a “collection of information that demonstrates the assessment of the safety of a land disposal facility.” This includes the technical analyses discussed above as well supporting evidence and reasoning on the strength and reliability of the technical analyses and the assumptions made therein and information on defense-in-depth. The safety case also includes a description of the safety relevant aspects of the site, the design of the facility, and the managerial control measures and regulatory controls. Under 10 CFR 61.10, the information provided in a license application comprises the key components of the safety case and must also include general and technical information as required in the proposed rule. There are also requirements for other information associated with institutional, financial, and monitoring activities. Thus, a safety case for a shallow land disposal facility is envisaged by NRC to cover aspects of the suitability of the site and the design, construction and operation of the facility, the assessment of radiation risks and assurance of the adequacy and quality of all of the safety related work associated with the disposal facility. The NRC staff provides detailed guidance on the contents of a license application in NUREG-1200 [6]. The guidance in NUREG-1200 is supplemented by detailed guidance on conducting the technical analyses in NUREG-1573 [3], which is complemented by new and revised guidance in NUREG-2175 [5]; see for example Sections 2.0 through 6.0 of NUREG-2175. The guidance also provides acceptable methods to identify and describe capabilities of defense-in-depth protections and develop waste acceptance criteria.

Licensing decisions are based on whether there is reasonable assurance that the performance objectives can be met. Defense-in-depth protections, such as siting, waste-forms, radiological source-term, engineered features, and natural features of the disposal site, combined with technical analyses and scientific judgment form the safety case for licensing a LLW disposal facility. The insights derived from technical analyses include supporting evidence and reasoning on the strength and reliability of the layers of defense relied upon in the safety case. These insights provide input for making regulatory decisions. The licensee must conclude that the safety case demonstrates that public health and safety will be adequately protected from the
disposal of LLW (including long-lived LLW). A clear case for the safety of a disposal facility also serves to enhance the communication among stakeholders.

The NRC staff recommends that licensees include a plain language description of the following aspects in their safety case:

1) **Strategy for Achieving Safe Disposal of Radioactive Waste:** The safety strategy should include an overall management strategy for the various activities required in the planning, operation, and closure of a land disposal facility, including siting and characterization, facility and disposal site design, development of the technical analyses, operations, waste acceptance, environmental monitoring, and institutional control.

2) **Description of the Disposal Site and Facility:** The description of the disposal site and facility should describe the relevant information and knowledge about the disposal system and should provide the basis for the technical analyses.

3) **Description of the Technical Analyses Demonstrating Performance Objectives:** The description of the technical analyses should summarize the performance assessment, inadvertent intruder assessment, site stability analyses, performance period analyses, and analyses of the protection of individuals during operations.

4) **Strategy for Institutional Control of the Disposal Site:** The institutional control strategy should summarize the institutional information required by 10 CFR 61.14.

5) **Description of Financial Qualifications of the Licensee:** The description should summarize the financial information required by 10 CFR 61.15.

6) **Description of Other Information:** Depending upon the nature of the wastes to be disposed of and the design and proposed operation of the land disposal facility, the description may need to summarize other information required by 10 CFR 61.16.

7) **Safety Arguments:** The safety arguments should draw together the key findings from the technical analyses to highlight the main evidence, analyses, and arguments that quantify and support the claim that the land disposal facility will ensure protection of public health and safety.

The NRC staff envisions that the safety case for a land disposal facility would evolve over time as new information is gained during the various phases of the facility’s development and operation. Therefore, the NRC staff expects that the safety case will be updated as new information that could significantly impact the safety of the facility is learned. Requirements at 10 CFR 61.28(a) specify that the application for closure of a licensed land disposal facility must include a final revision to the safety case that includes any updates to reflect final inventory and closure plans. The extent of the final revisions to the safety case may vary depending on the licensee’s operation and closure of the land disposal facility and the amount of new information that is developed that could significantly impact safety of the facility.
3. Comparative Analysis of US NRC Approaches with IAEA-SSG-23 Safety Case:

From the IAEA perspective, the purpose of a safety case is to provide a sufficient level of detail regarding the description of all safety relevant aspects of the site, the design of the facility, and the managerial control measures and regulatory controls to inform the decision whether to grant a license for the disposal of LLW and provide the public assurance that the facility will be designed, constructed, operated, and closed safely (IAEA, [1]). NRC’s requirements and guidance address the significant components of the safety case discussed in IAEA SSG-23. Although not specifically addressed by the revision to 10 CFR Part 61 discussed herein, it is noted that communication with the public and stakeholders, as discussed in SSG-23, is a basic practice in developing NRC regulations or key guidance documents as well as in making licensing decisions. Further, because NRC guidance is implementing guidance, the NRC guidance is more detailed in terms of addressing the long-term considerations of site performance.

4. Summary & Conclusions

A comparison of NRC’s recent implementation of the safety case for LLW disposal with IAEA’s Safety Guide SSG-23 shows harmony and consistency between the approaches. Further, NRC’s regulatory requirements and guidance documents provide a comprehensive analysis of safety functions and safety features of a disposal facility to satisfy the invoked long-term site performance requirements.

REFERENCES


