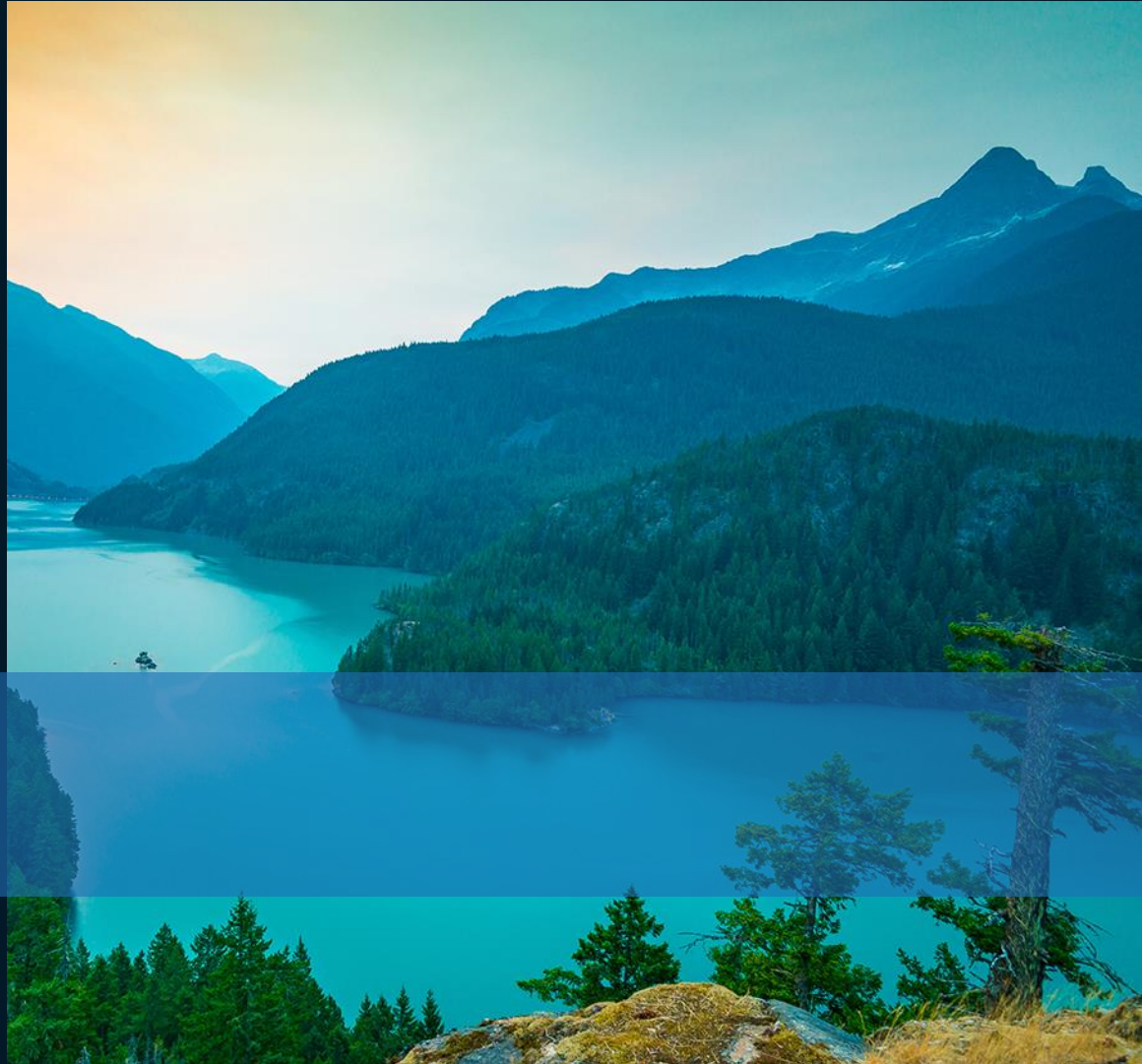


Spent Fuel Performance Margins: Radiation Safety

NEI/NRC Workshop

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Washington DC



Agenda

- Goal
- Dose Rates and Safety
- Dose at Site Boundary (V-1)
 - Compliance with Safety Requirements
 - Regulation and Guidance
 - Comments on Guidance
 - Occupational Exposure
 - The Consequences
 - Proposed Change to Guidance Documents (V-1)
- Guidance on Modeling Details (V-2)
- Discussions

Goal

- Discuss Radiological Safety
- Discuss proposed reviews and revisions of guidance documents, for the purpose of ensuring activities that have no radiological safety significance are eliminated.

Dose Rates and Safety

- Radiological Safety Demonstration
 - Dose Rates can be measured, and are measured
 - Acceptance Criteria (Dose Limits) are clear
- Demonstrating compliance with the safety requirements is done with measurements, informed by analyses
- Vast amount of dose experience for dry storage of spent fuel
 - more than 3000 systems loaded with dose rates taken and compliance demonstrated
- Main safety criteria
 - Public: 25 mrem/year at the “site boundary”, including contribution from casks and from the plant
 - Occupational: 5 rem/year for each person

Dose at the Site Boundary (V-1)

- Dose at the Site Boundary depends on
 - Number of loaded casks (Site specific)
 - Type of casks (cask vendor specific)
 - Distance to Site Boundary (Site Specific)
 - Fuel loaded into the casks (Site Specific)
- Compliance with Dose at the site boundary is responsibility of the site (the licensee)
 - Demonstrated by measurements that are informed by calculations

Compliance with Safety Criteria

- Two criteria to be satisfied:
 - Site boundary dose limits
 - Occupational exposure ALARA

Compliance with Safety Criteria

Site Boundary Dose Rates

Typically accomplished in the following steps:

- Step 1:
 - Offsite dose calculations performed (typically by cask vendor) to demonstrate compliance (in calculational space)
 - Level of detail and sophistication can vary significantly depending on site conditions
- Step 2:
 - Calculations of dose rates on transfer cask and storage cask at locations specified in the CoC, consistent with Step 1
- Step 3:
 - Licensee develops cask loading plans/procedures consistent with Steps 1 and 2

Compliance with Safety Criteria (cont.)

Site Boundary Dose Rates (cont.)

- Step 4 (for each cask):
 - Transfer cask is loaded, measurements are taken
 - If limits are met, process continues to next step
- Step 5 (for each cask):
 - Storage casks are loaded, measurements are taken
 - If limits are met, cask is placed on ISFSI
- Step 6:
 - After all casks of a campaign are loaded, dose rates at the site boundary are reviewed to again confirm limits are met (formal compliance demonstration).

Compliance with Safety Criteria (cont.)

Regulation and Guidance

- From 10CFR72.236

(d) Radiation shielding and confinement features must be provided sufficient to meet the requirements in § 72.104 and 72.106.

- From NUREG 1536/(2215) Section 6.4 (with sections highlighted)

In general, the DSS shielding evaluation should provide reasonable assurance that the proposed design fulfills the following acceptance criteria:

1. The radiation shielding features of the proposed DSS are sufficient for it to meet the radiation dose requirements in 10 CFR 72.104 and 72.106(b). **The applicant demonstrates this with:**

- a. **A shielding analysis of the surrounding dose rates that contribute to occupational exposure and off-site doses at large distances (for a single storage and transfer cask with bounding fuel source terms at various cask locations), and**

- b. A shielding analysis of a single cask and a generic array of casks at large distances.

Compliance with Safety Criteria (cont.)

Comments on Guidance

- Calculated dose rates in the FSAR, around a single cask or from a cask array, provide NO indication if 72.104 regulatory requirements can be met or not for an ISFSI site, since this depends on site specific parameters
 - For a small ISFSI far away from the site boundary, limits can be easily met even if dose rates around a cask are comparatively high
 - But for a large ISFSI close to the site boundary, even casks with very low dose rates can be a challenge, and may require additional shielding (e.g. a berm)
- Additionally, using BOUNDING source terms in the FSAR further increases the discrepancy between FSAR calculations and site-specific dose rates, which may result in erroneous conclusions drawn from the FSAR.

Compliance with Safety Criteria (cont.)

Occupational Exposure

- Crew dose (dose to the loading crew for loading a single cask) are presented in the FSAR
- NRC still expects update and maintenance of the FSAR information, for changes to the designs and/or content
- Licensees have their established RP and ALARA processes, further informed by industry experience, to plan and perform loading operations.
- FSAR crew dose information does not provide any relevant information in that context.

The Consequences

- Including information in the FSAR triggers a cascade of activities, on the part of the vendor, NRC and licensee:
 - The FSAR needs to be maintained essentially indefinitely
 - May also inform limits specified in the Technical Specifications
 - Forever subject to 72.48 review
 - Reviewed by NRC, generating a Safety Evaluation Report
 - Used and maintained by the licensee as the licensing basis
- Any change to a cask design or content, even very small, triggers this cascade
- This should not be necessary for something that is not used or needed to demonstrate safety

Information for Licensees

- The licensee needs to know that the system is capable of meeting the regulatory requirements
 - This needs to be known before the casks are loaded, i.e. before measurements can be taken to demonstrate safety.
- This is achieved through site-specific site boundary dose analyses, taking into account all previously discussed site specific and cask parameters
- For additional verification, licensees may consult general industry experience, from the 3000+ cask loaded
- Dose rates reported in the FSAR play *no* role here

Proposed Change to Guidance (V-1)

- In the FSAR, provide dose rates for a typical cask design with representative content, showing values on the surface and at various distances for a single cask. The associated analyses establish the methodology to determine site boundary dose
 - Parameters for those calculations should be clearly specified
 - Additionally, present qualitative discussions of the impact of any possible variations of those parameters on the results
 - Cask type, content, ISFSI size, distance to side boundary
 - Impact on dose rates (small, factor 2, factor 5, factor 10,)
- Occupational exposure evaluations are provided to demonstrate that worker dose can be reasonably controlled ALARA
 - Licensee RP and ALARA programs, informed by industry experience control worker dose, not the SAR
- SAR presentation of off-site dose and occupational exposure are to demonstrate ability to meet site limits, and not for demonstration of compliance with the regulations.

Guidance on Modeling Details (V-2)

- Guidance specifies lots of expectations on modeling approaches and the corresponding levels of details, often characterized as a need to be “appropriate or bounding”.
 - Without any appropriate concept on what is “appropriate”, the expectation often defaults to bounding.
 - Example: consider dimensional tolerances in shielding analyses
- Higher levels of details and/or bounding modeling approaches substantially increase the modeling effort
 - See the “The Consequences” slide for additional discussions on the consequences of this
- Over 3,000 loaded systems provide measured data for comparison - typically 50% lower than calculated.
- Recommendation
 - Review and revise the guidance on modeling, taking into consideration the industry experience on dose rates from the radiation protection programs.