



A Proposed Graded Approach for Dry Cask Storage

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A decorative blue graphic is located in the bottom right corner. It features a stylized atomic symbol with a white nucleus and three orbiting electrons in white. The text "Division of Spent Fuel Management" is written in white, curved along the bottom of the symbol. The acronym "NMSS" is written in white, bold, sans-serif font in the center of the symbol.

What is Graded Approach?

- Rating of review procedures in the Standard Review Plan* (SRP) evaluation areas for dry cask storage systems (DSS)s, and
- guidance for regulatory reviewer on the relative level of effort that typically should be applied in implementing the review based on the ratings of high, medium and low.

*NUREG-1536, Standard Review Plan for Spent Fuel Dry Storage Systems at a General License Facility

Current Objectives

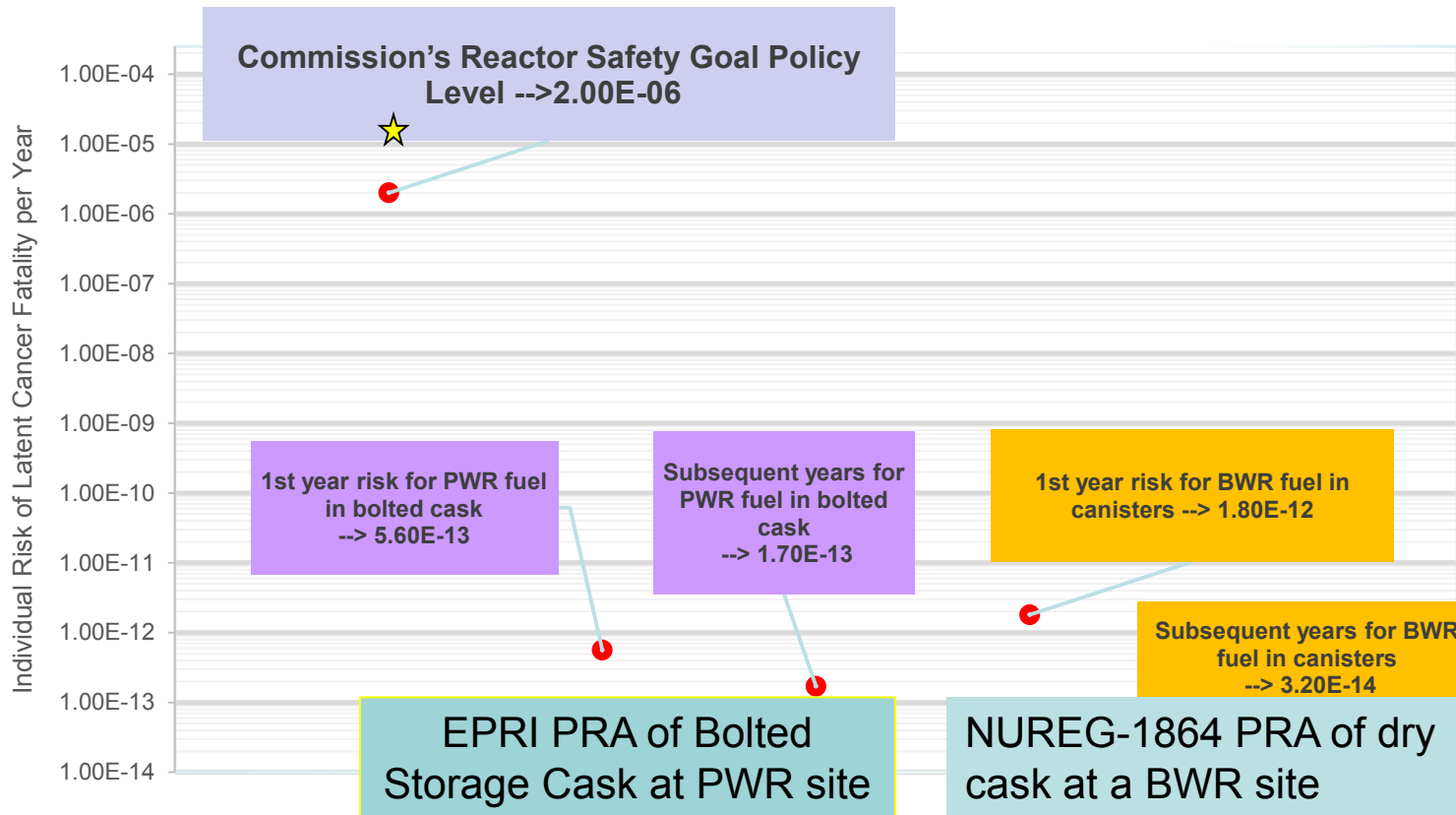
- Focus regulatory efficiency efforts on storage (10 CFR 72) at this time
- Propose a graded-approach framework that
 - Considers results of previous PRA studies, and safety functions and defense-in-depth
 - Improve guidance for casework activities by focusing regulatory evaluation on areas that impact safety
 - Increase efficiency of licensing actions while maintaining appropriate margins of safety and security

10 CFR 72.236 Specific requirements for spent fuel storage cask approval and fabrication

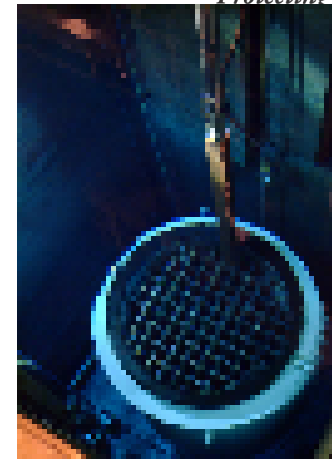
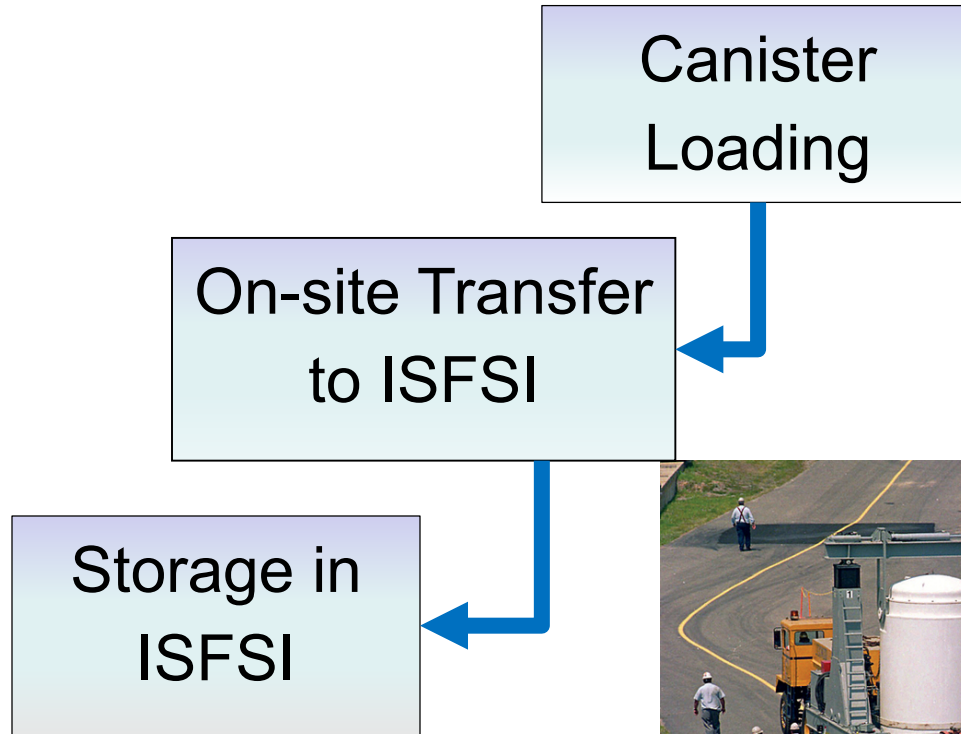
- a) Specifications: fuel type, max initial enrichment, min. acceptable cooling time, max. heat output, max. fuel load limit, fuel condition, required inerting atmosphere.
- b) Design bases and design criteria for SSCs important to safety.
- c) Cask must be designed and fabricated so that the spent fuel is maintained in subcritical condition under credible conditions.
- d) Radiation shielding and confinement features must be sufficient to meet 70.104 and 72.106.
- e) Storage cask must provide redundant sealing of confinement systems.
- f) Cask must provide adequate heat removal capacity without active cooling system.
- g) Designed to store the spent fuel safely for the term proposed in the application, and permit maintenance as required.
- h) Cask must be compatible with wet or dry spent fuel loading and unloading facilities.
- i) Cask must be designed to facilitate decontamination to the extent practicable.
- j) Cask must be inspected to ascertain that there are no...defects that could significantly reduce its confinement effectiveness.
- k) Cask must be conspicuously and durably marked: model number, id number, empty weight.
- l) Cask and its systems important to safety must be evaluated by appropriate tests or other means acceptable to the NRC, to demonstrate that they will reasonably maintain confinement of radioactive material under normal, off-normal, and credible accident conditions.
- m) Compatibility with removal of the stored spent fuel from a reactor site, transportation, and ultimate disposition by the DOE.
- n) Safeguards Information shall be protected against unauthorized disclosure...

Background

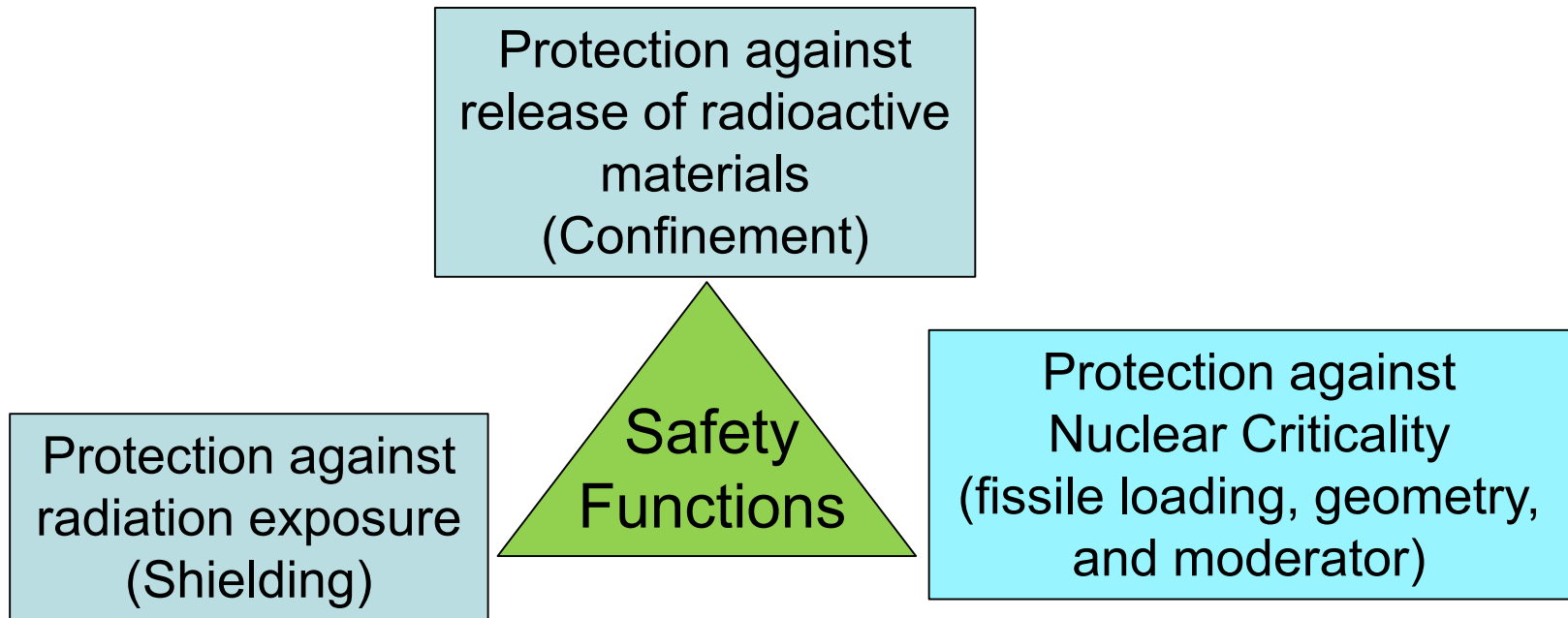
Comparison of EPRI and NRC PRA Studies Dry Cask Spent Fuel Storage Latent Cancer Fatality Risk per Cask



Three Phases of Operation



Dry Storage System Safety Functions



Defense-in-Depth

Level 1, Prevention

(10CFR72, SRP, AMP, MAPS)

- Prevent criticality
- Prevent release of radioactive material
- Limit radiation exposure

Level 2, Mitigation

- Assessment of failures
- Perform remedial actions
- Perform repair

Level 3, Emergency Actions

(10CFR72.32, Emergency Plan)

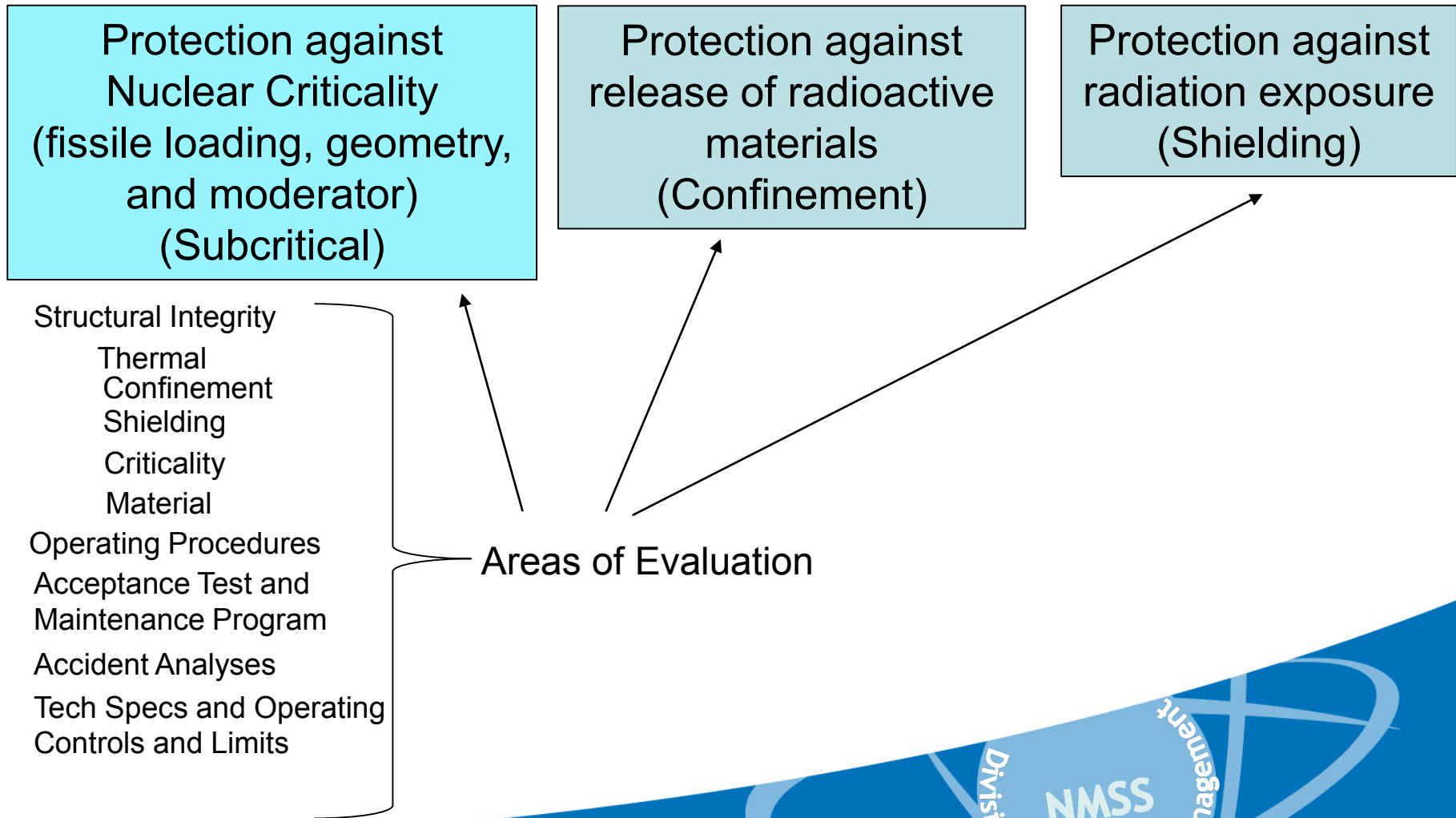
- Accident detection/assessment
- Notification
- Protective response



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Dry Storage System Safety Functions - continued



Graded Approach for Reviewing Licensing Action (casework)



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Regulatory Review Guidance for Dry Storage System

Areas of Evaluation (NUREG-1536)	Consequence			Phase of Operation		
	Confinement	Shielding	Prevent Criticality	Loading	On-site Transport	Storage
Structural	TBD	TBD	TBD	X	X	
Thermal	TBD	TBD	TBD	X		
Confinement	TBD	TBD	TBD		X	
Shielding	TBD	TBD	TBD	X	X	
Criticality	TBD	TBD	TBD	X		
Material	TBD	TBD	TBD	X		X
Operating Procedures	TBD	TBD	TBD	X	X	
Acceptance Test and Maintenance Program	TBD	TBD	TBD	X		X
Radiation Protection	TBD	TBD	TBD	X	X	
Accident Analyses	TBD	TBD	TBD	X	X	
Technical Specifications and Operating Controls and Limits	TBD	TBD	TBD	X	X	
Quality Assurance	TBD	TBD	TBD	X	X	X

EXAMPLE

Review Procedures in Evaluation Areas

Regulatory Review Guidance could also assign Grades for Review Procedures in a Evaluation Area

7. Criticality Evaluation

7.5 Review Procedures

7.5.1 Criticality Design Criteria and Features

7.5.2 Fuel Specification

7.5.3 Model Specification

7.5.4 Criticality Analysis

7.5.5 Burnup Credit

Proposed Methods for Assigning Grades to Review Procedures (DRAFT)

1. Informed by results from existing PRAs
2. Safety function, defense-in-depth (DiD), and impact of noncompliance
3. Expert knowledge from panel of experts (insights from technical reviewers and dry storage system vendors)

Method for Assigning Grade to Review Procedures

by PRA Data or Consequence* (NUREG-1536)

- **High**

- Qualitative: Likely to occur or significant consequences.
- Quantitative: $>10^{-3}/\text{yr.}$ or >25 rem to worker or > 1 rem to public per year.

- **Medium**

- Qualitative: May occur or moderate consequences.
- Quantitative: $<10^{-3}/\text{yr.}$ but $>10^{-5}/\text{yr.}$ or 5-25 rem to worker or 0.1 rem to public per year.

- **Low**

- Qualitative: Occurrence improbable or minimal consequences.
- Quantitative: $< 10^{-5}/\text{yr.}$ or less than 5 rem to worker or 0.1 rem to public per year. (10 CFR 20 dose limits)

* NUREG-1536, Standard Review Plan for Spent Fuel Dry Storage Systems at a General License Facility, Appendix B.

Alternate Method to Assigning Grades to Review Procedures

by Safety Function, DiD and Impact to Safety
(Importance to Safety,* NUREG/CR-6407)

- Category A – Critical to Safety **High**

Category A items include structures, components, and systems whose failure could directly result in a condition adversely affecting public health and safety. The failure of a single item could cause loss of primary containment leading to release of radioactive material, loss of shielding, or unsafe geometry compromising criticality control.

- Category B – Major impact on Safety **Medium**

Category B items include structures, components, and systems whose failure or malfunction could indirectly result in a condition adversely affecting public health and safety. The failure of a Category B item, in conjunction with the failure of an additional item, could result in an unsafe condition.

- Category C – Minor impact on Safety **Low**

Category C items include structures, components, and systems whose failure or malfunction would not significantly reduce the packaging effectiveness and would not be likely to create a situation adversely affecting public health and safety.

*NUREG/CR-6407, Classification of Transportation Packaging and Dry Spent Fuel Storage System Components According to Importance to Safety

Guidance for Review*

(NUREG-1536)

- **HIGH** priority means the NRC staff review should ensure all items in the applicant's submittal are complete and correct as specified in the review procedure. This represents the most comprehensive review where many of the analytical methods, assumptions, and supporting references are evaluated. The reviewer may need to perform independent confirmatory analysis to validate the results of the safety analysis calculations.
- **MEDIUM** priority means the NRC staff should review the applicant's submittal for completeness and correctness in key areas. This represents a review in which key analytical methods, key assumptions, and key supporting references are checked and evaluated. It is expected a reviewer would spend approximately 30 percent of his or her review time focused in the medium review procedures.
- **LOW** priority means the NRC staff review should ensure that the applicant's submittal contains all of the requested information. A limited review of selected portions of the application for correctness would be performed. Given its relative significance, the reviewer should generally consider the applicant's analysis to be completed and accurate and forego independent confirmation, unless there is a reason to believe otherwise. However, if a problem is detected, the reviewer must thoroughly evaluate and resolve the issue.

*NUREG-1536, Standard Review Plan for Spent Fuel Dry Storage System at a General License Facility

Summary

- Graded-approach regulatory framework will rate review procedures in the SRP for each DSS design (or class of DSS designs).
- The rating will provide guidance to NRC reviewer regarding the relative level of effort typically applied for areas of review
- The review guidance from graded-approach will focus regulatory reviews at areas of higher safety importance
- The process will also identify regulatory requirements (low safety significant) that may not need to be included in the CoC.

Path Forward

- Kick off RIRP approach (Completed 7/22/2016)
- Develop the draft “Graded Approach” framework
 - Proposed draft guidance/basis for assigning grades to SSCs and NEI identifies pilot (10/28/2016)
 - Hold work shop with NEI, members of the public and industry (11/21/2016)
 - Revise the grade approach framework based on workshop feedback
- Provide internal NRC training for staff (2/7/2017)
- Receive pilot application based on the preliminary graded approach (3/17/2017)
- Complete safety review of pilot application (12/15/2017)
- Finalized framework (4/13/2018)
 - Incorporate lessons learned from the pilot (1/12/2018)
 - Engage stakeholders to solicit input (2/15/2018)
 - Issue finalize framework for graded approach (4/13/2018)
 - Receive NEI guidance document for endorsement (8/15/2018)
- Complete review of NEI guidance document (11/15/2018)
- Develop Staff Training (FY 2019)

References

- NUREG/CR-6407 Classification of Transportation Packaging and Dry Spent Fuel Storage System Components According to Importance to Safety.
- NUREG-1536, Rev 1, Standard Review Plan for Spent Fuel Dry Storage Systems at a General License Facility
- Regulatory Guide 7.10, Appendix A.
- Risk-Informed Decisionmaking for Nuclear Material and Waste Applications, Revision 1, February 2008.
- NUREG-1864, A Pilot Probabilistic Risk Assessment Of a Dry Cask Storage System At a Nuclear Power Plant.
- Probabilistic Risk Assessment (PRA) of Bolted Storage Casks: Updated Quantification and Analysis Report, EPRI, Palo Alto, CA: 2004. 1009691.

Questions?



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