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Building a Risk Framework for Spent Fuel Dry Storage System

DSFM REG CON

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Division of Spent Fuel Management

NRC Risk-Informed Overarching Goals

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- Continue to assure adequate protection of public health and safety, while eliminating unnecessary conservatism in regulatory analyses.
- Enhance safety by focusing resources in areas commensurate with their importance to health and safety.
- Provide appropriate flexibility for licensees.

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Technical Analysis

- NMSS - Analyses tailored to fit problem:
  1) Magnitude of hazard,
  2) Complexity of the safety issues,
  3) Availability of data
- What are we looking at?
  - Engineered casks isolate nuclear material under a variety of normal and off-normal conditions
  1) Continue to maintain integrity of engineered storage casks over longer time periods than originally anticipated.
  2) Maintain ability to remove fuel without operational safety problems (10CFR 72.122(h)(1))

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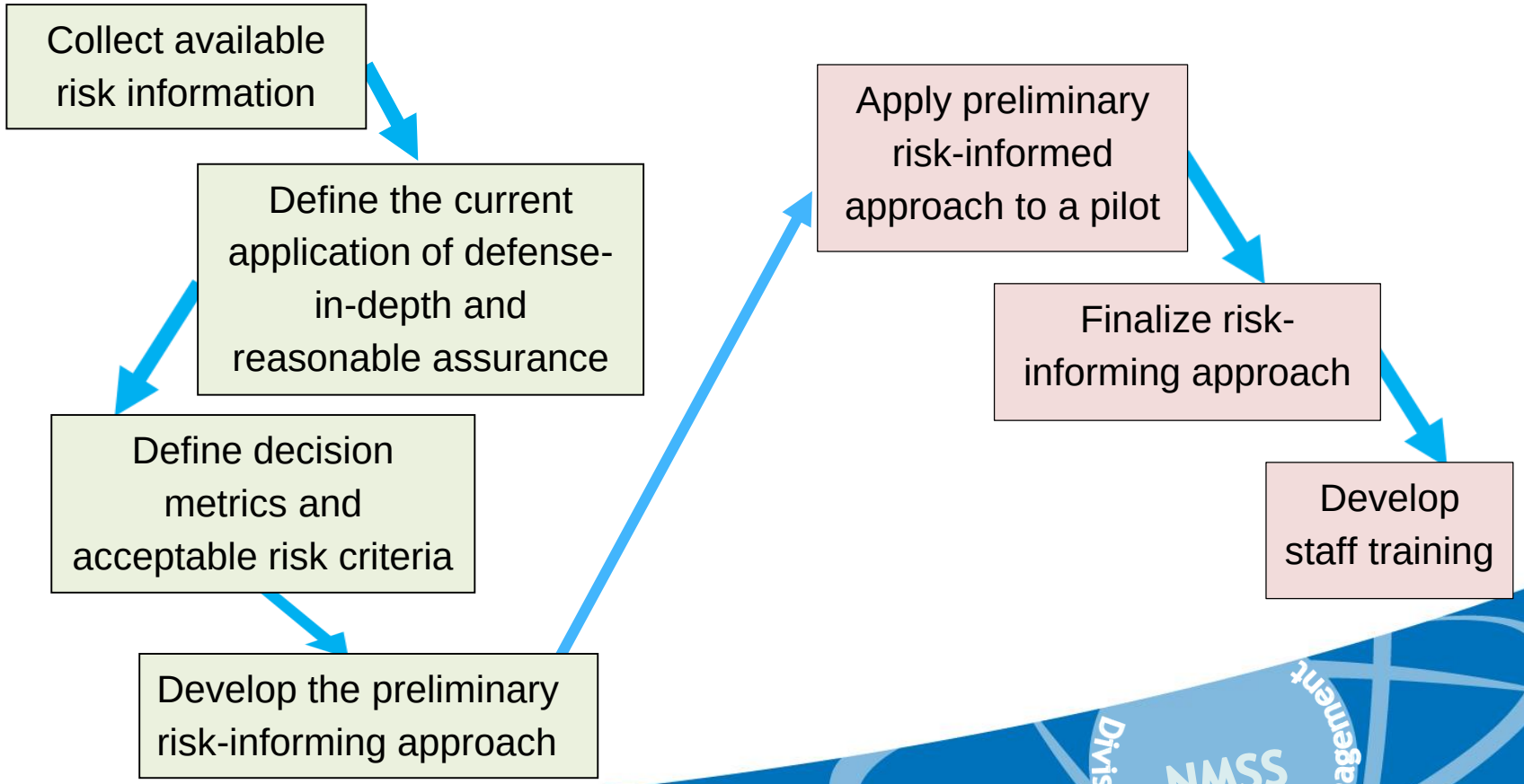
Accident Risk

- Accident risk guidelines do not officially exist for NMSS.
- There is no analogs to CDF and LERF for spent fuel dry storage.
- No accident has ever occurred that compromised the integrity of package during dry storage or transportation of spent fuel.

Implementation Plan for Risk-Informing Regulatory Activities for Dry Cask Storage



Available PRAs of Dry Storage

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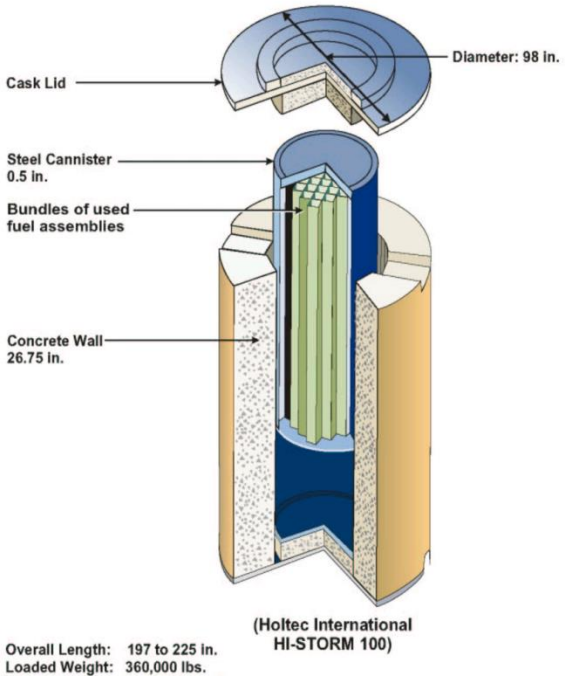
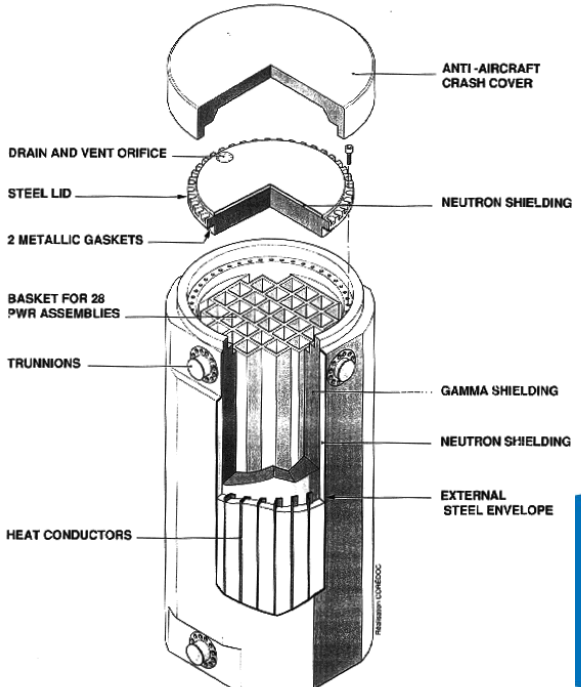
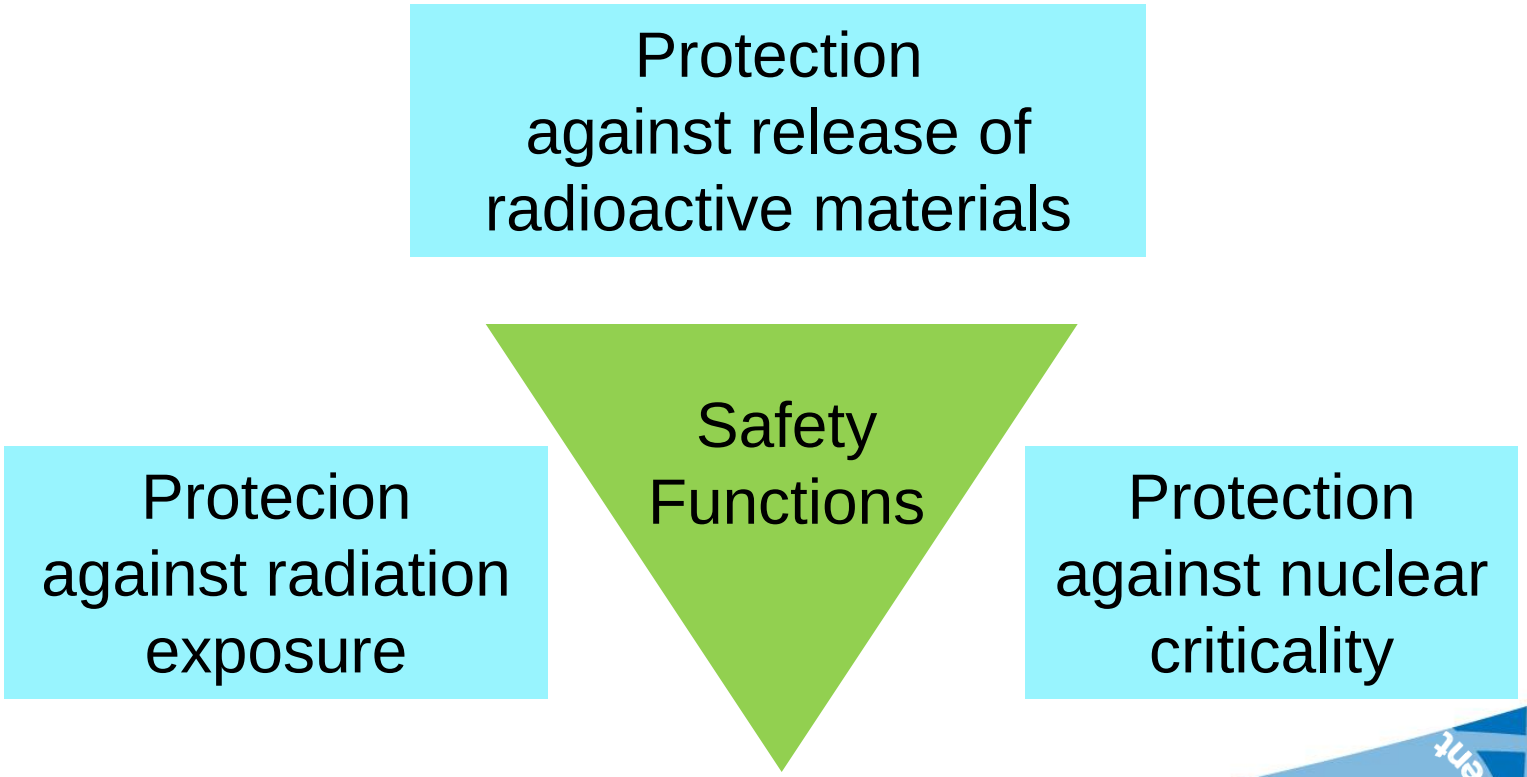
- NUREG-1864, A Pilot Probabilistic Risk Assessment of a Dry Cask Storage System at a Nuclear Power Plant (ML071340012)
- EPRI-1009691, Probabilistic Risk Assessment of Bolted Storage Casks





Three Main Safety Functions in Dry Spent Fuel Storage



Defining Defense-in-Depth

Three levels of safety

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Level 1, Prevention

- prevent criticality
- prevent radioactive material release
- limit radiation exposure

Level 2, Mitigation

- accident assessment
- perform remedial actions
- repair confinement

Level 3, Emergency Actions

- accident detection/assessment
- notification
- protective response

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Current NMSS Risk Criteria

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Quantitative Health Guidelines (QHG) for NMSS Regulated Facilities

Population at Risk	Risk Metric	Increased Latent Cancer Risk/cask	Risk Limit (BEIR-V)	Regulation
Worker	Annual dose	*1E-05	0.25 mSv (25 mrem)	NMSS (QHG)
Public	Annual dose	*2E-06	0.04 mSv (4 mrem)	NMSS (QHG)

"Risk-Informed Decisionmaking for Nuclear Material and Waste Application" Revision 1, Office of Nuclear Regulatory Research, Office of Nuclear Material Safety and Safeguard, February 2008.

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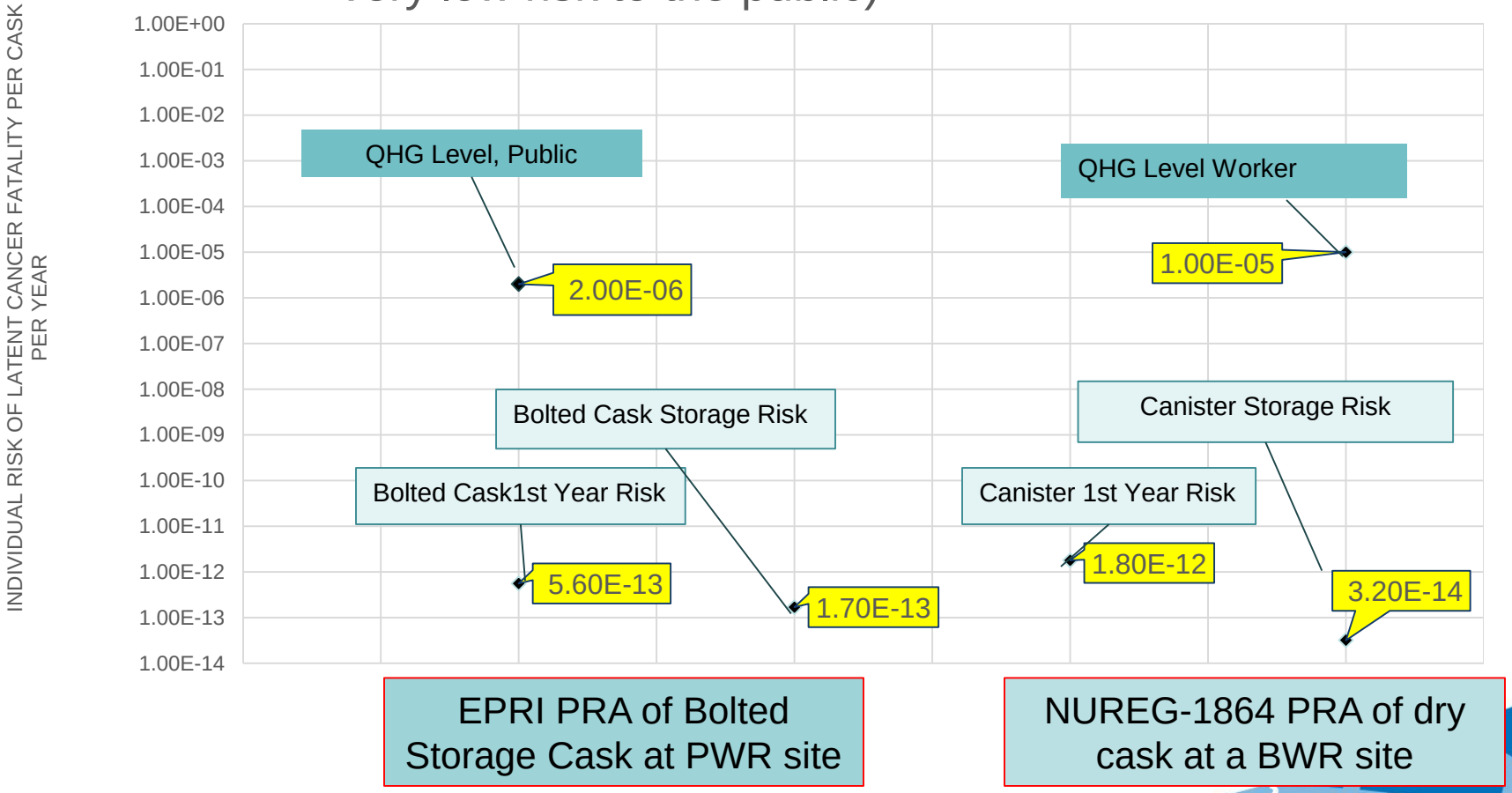
Latent Cancer Fatality Risk

(A net result of protecting the worker is very low risk to the public)



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Proposed Regulatory Framework for Dry Spent Fuel Storage

- Adopt Confinement Breach Frequency (CBF) as a surrogate for measurement of risk.
- Set CBF limit for cask preparation. (inside facility)
- Set CBF limit for storage in ISFSI. (outside facility)
- Propose risk-informed regulatory guidance based on CBF limits.

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Confinement Precludes

1. Unacceptable risk of criticality.
2. Unacceptable release of radioactive materials to the environment.
3. Unacceptable radiation dose to the public or workers.
4. Significant impairment of retrievability or recovery of stored nuclear materials.

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Example
SSC Important to Safety

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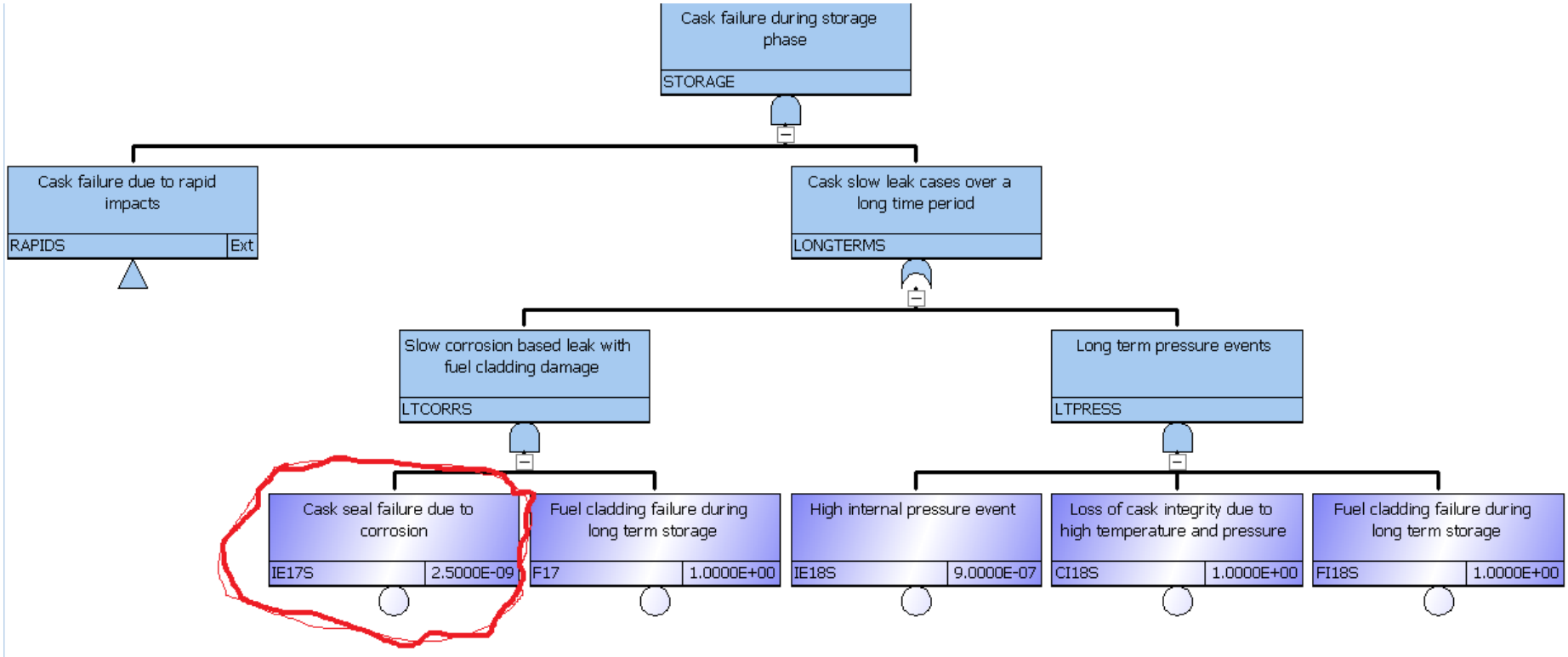
	Safety Function			Phase of Operation			Defense-in-depth		
SSC within Scope of License Renewal	Sub-Criticality	Radiation Protection	Confinement of Material	Loading	Storage (ISFSI)	Unloading	Level 1	Level 2	Level 3
Dry Storage Casks	X	X	X	X	X	X	X		
Spent Fuel Assemblies	X		X	X	X	X	X		
Reinforced Concrete Pads					X		X		
Earthen Berm*		X			X		X	X	

*Provide protection for nearby population

Example

Perform Importance Evaluation



Importance of individual components can be evaluated by setting their failure probability to 1.0, and observing the change in confinement breach probability.

Example

Accidental Load Drop During Unloading

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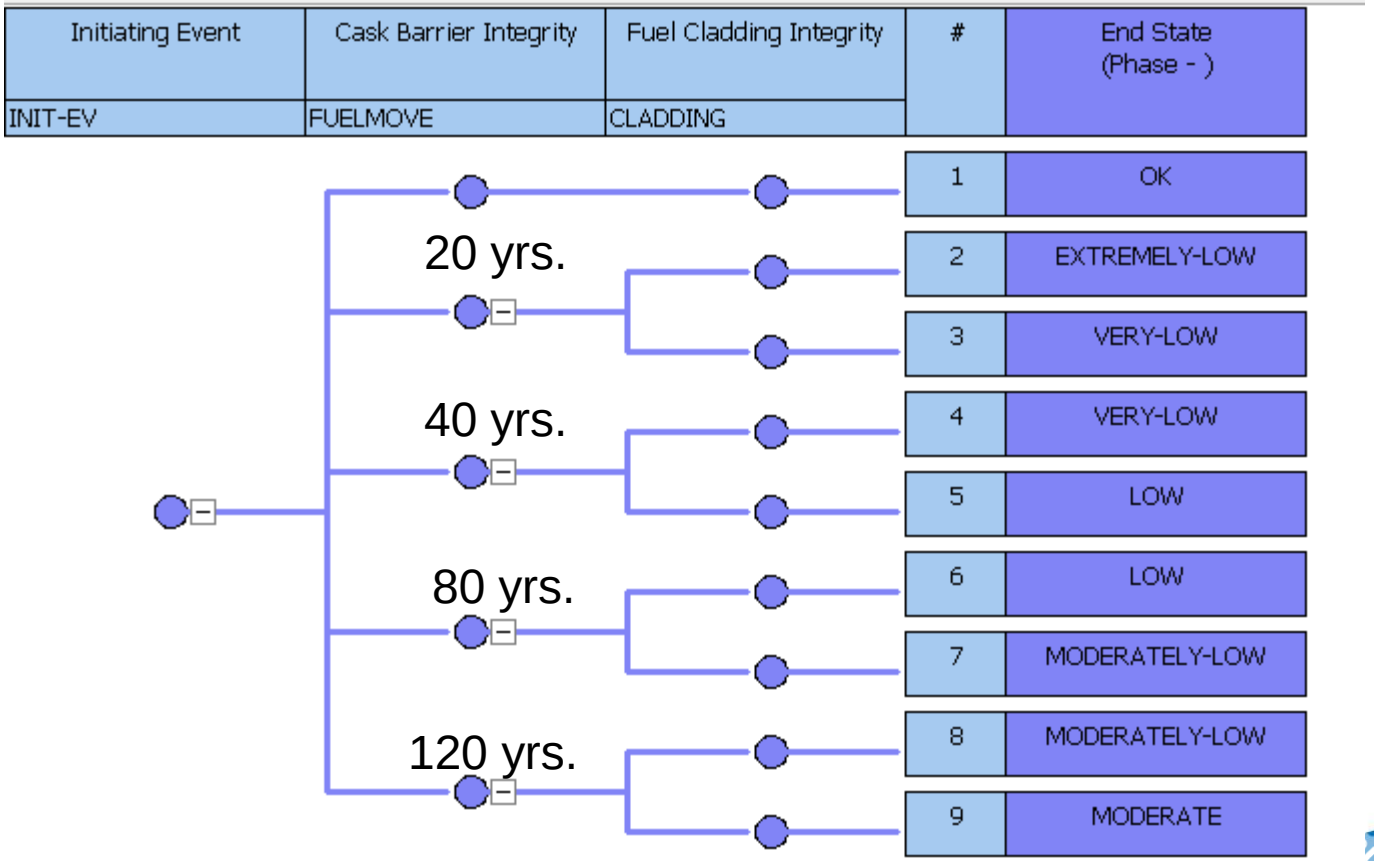
What is the increase in risk for storing spent fuel?



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Potential Applications of Risk Information

Support Aging Management Review:

- Rank SSCs based on their risk importance
- Possibly modifying monitoring/inspection requirements based on risk.
- Potential for setting license renewal interval based on risk.

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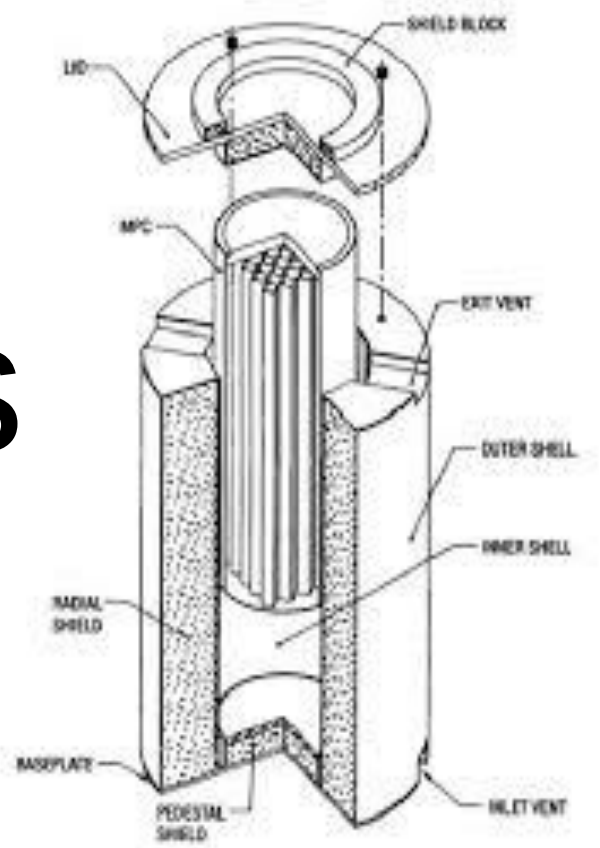
Questions



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http://www.nucleartourist.com/systems/dry_cask.htm

References

- NUREG-1864, “A Pilot Probabilistic Risk Assessment of a Dry Cask Storage System at a Nuclear Power Plant.” (ML071340012)
- Probabilistic Risk Assessment of Bolted Storage Casks (EPRI-1009691)
- “Risk-Informed Decisionmaking for Nuclear Material and Waste Applications,” Revision 1, February 2008. (ML080720238)
- NUREG-1536, Rev. 1 “Standard Review Plan for Spent Fuel Dry Storage Systems at a General License Facility.” (ML101040620)

Acronyms and Abbreviations

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ALARA – As low as reasonably achievable
BEIR – Committee on the Biological Effects of Ionizing Radiation
CBF – Confinement breach frequency
CDF – Core damage frequency
EPRI – Electric Power Research Institute
ISFSI – Independent spent fuel storage installation
LERF – Large early release frequency
NRC – US Nuclear Regulatory Commission
NRR – Office of Nuclear Reactor Regulation
Mrem - millirem
MRS – Monitored retrievable storage
mSv - milliSeiver
NMSS – Office of Nuclear Material Safety and Safeguards
PRA – Probabilistic Risk Assessment
QHG – Qualitative Health Guideline
SSC – Systems, structure, components
TEDE – Total Effective Does Equivalent