Risk-Informing Dry Cask Reviews: Current Research

Brian Wagner, Reliability and Risk Engineer

Division of Risk Analysis,

Office of Nuclear Regulatory Research, U.S. NRC

Overview

- Background
- Benefits and challenges to risk-informing dry cask reviews
- Current research

Background

- Guidance
  - Probabilistic Risk Assessment (PRA) Policy Statement (1995)
  - Risk-Informed Decisionmaking for Nuclear Material and Waste Applications, Rev. 1 (2008)
  - NUREG-2150, Risk Management Task Force (2012)
- Previous dry cask risk studies (storage)
  - NUREG-1864 (2007)
  - Electric Power Research Institute dry cask PRA (2004)
- Previous dry cask risk studies (transportation)
  - NUREG-0170 (1977)
  - NUREG/CR-4829 (1987)
  - NUREG/CR-6672 (2000)
  - NUREG-2125 (2014)

Benefits to Risk-Informing Cask Reviews

- Dry cask PRAs have calculated risks to be low → additional margin may exist
  - Reduce regulatory burden on less risk-significant aspects
  - Focus resources on more risk-significant aspects
- PRAs use a systematic process → creates a framework to—
  - Identify more risk-significant aspects and areas where additional data and analyses would be useful
  - Test the sensitivity of analysis results to key assumptions
  - Evaluate the significance of new failure mechanisms

Challenges

- Limitations of previous studies (data, scope, cask type, site, etc.)
- Lack of failure data (behavior of spent fuel under accident conditions, potential for very low probability accidents and events)
- PRAs rely on generic analyses and, when necessary, conservative assumptions and parameters when data are not available
- Caution: Worker protection can be a significant consideration due to the limited energy in release scenarios limiting offsite releases

Current Research: Level 3 PRA Project

- Full-scope, comprehensive site Level 3 PRA
- Directed in SRM-SECY-11-0089 (2011)
- Objectives
  - Reflect technical advances since NUREG-1150, new scope considerations (e.g., spent fuel pools, dry cask storage)
  - New insights
  - Enhance staff PRA capability

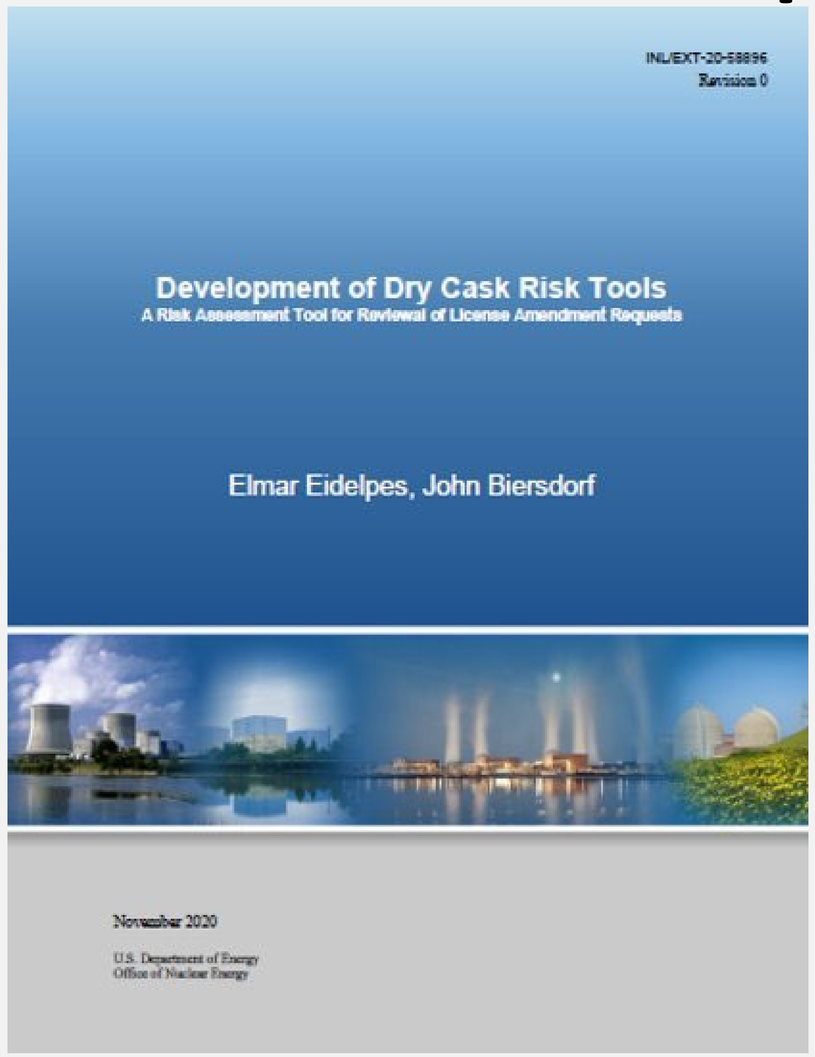
Current Research: Level 3 PRA Project (cont.)

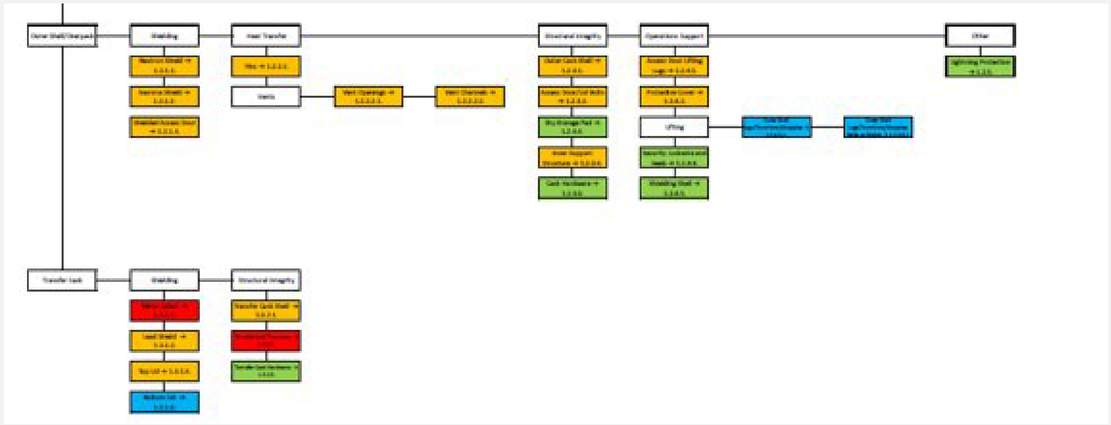
- Dry cask PRA model improvements (based on NUREG-1864 model)
  - Detailed event identification
  - Refined analysis of several scenarios
  - Additional structural analysis
  - Enhanced consequence analysis
- Results
  - Generally consistent with past dry cask PRAs
  - Provide updated insights on main risk contributors
  - Provide basis for additional analysis as needed
- Status
  - Technical work essentially complete
  - Report under review, aiming to release a draft publicly this year

Current Research: Spent Fuel Storage Job Aid/Risk Tool

- Goal is to use risk information to focus license amendment reviews
- Risk tool (ADAMS Accession No. ML20350B659) includes risk insights from available risk studies, safety margin investigations, selected NRC safety evaluation reports, and input from NRC senior technical reviewers
  - Tree diagram: Provides preliminary estimation of risk significance (on a component-by-component basis)
  - Rationale: More detailed description of risk information
- Job aid provides a step-by-step approach for using the risk tool
- Status:
  - Pilot application reviews ongoing
  - Reviewing insights from pilots
  - Continuing risk-informing discussions and implementing in safety reviews to ensure appropriate risk focus

Current Research: Spent Fuel Storage Job Aid/Risk Tool





Gate 1.2.4.3.1. Outer Shell Lugs/Trunnions/Grapples

Outer shell lugs, trunnions, or grapples refer to the most outer attachments used to lift and move the dry storage cask. Although the term "outer" is used, the attachment point can be located within the outer shell. The risk significance of the LAR item that includes a modification of these components is directly related to the question of whether the outer shell is moved after it was loaded (e.g., within a secondary containment) with SNF, or if the equipment is only used for moving the outer shell or overpack during installation at the storage pad where it resides for long-term storage. If the outer shell is moved after loading, the risk associated with a modification of the lugs, trunnions, or grapples is qualitatively determined as medium, since it could lead to an increase of the drop frequency of the cask, and consequently to an increased probability of a release of radioactive material to the environment, but also considering the large safety margins (an overpack is likely to survive severe accidents, such as an airplane impact). The risk significance of an LAR item that includes a modification of the outer shell lugs, trunnions, or grapples is determined as low when an outer shell or overpack is moved in empty state only.

Current Research: Risk-Informing Chloride-Induced Stress Corrosion Cracking

- Enhance the staff's understanding of important technical issues key to successful aging management of chloride-induced stress corrosion cracking (CISCC)
- Understand the effects of materials and environmental parameters on CISCC growth rates
- Assess mitigation and repair methods
- Investigate risk-informing CISCC
  - Review literature relevant to CISCC evolution and risk sequence
  - Evaluate risk and consequence assessments to identify critical parameters for CISCC
  - Perform a CISCC probabilistic assessment
  - Can inform inspection frequencies