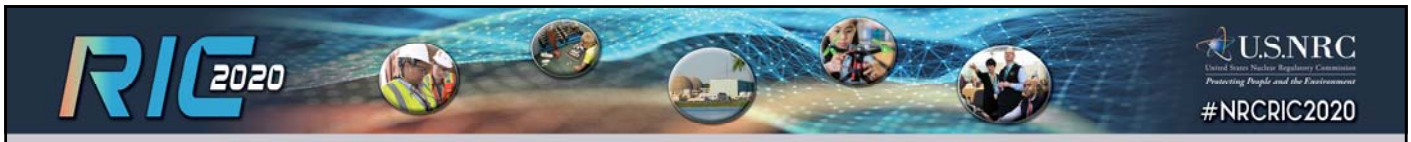


External Hazard Risk Analysis for Advanced Light-Water Reactor Reviews

Successes, Challenges, and Lessons Learned

Alissa Neuhausen
Reliability and Risk Analyst
U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation

1

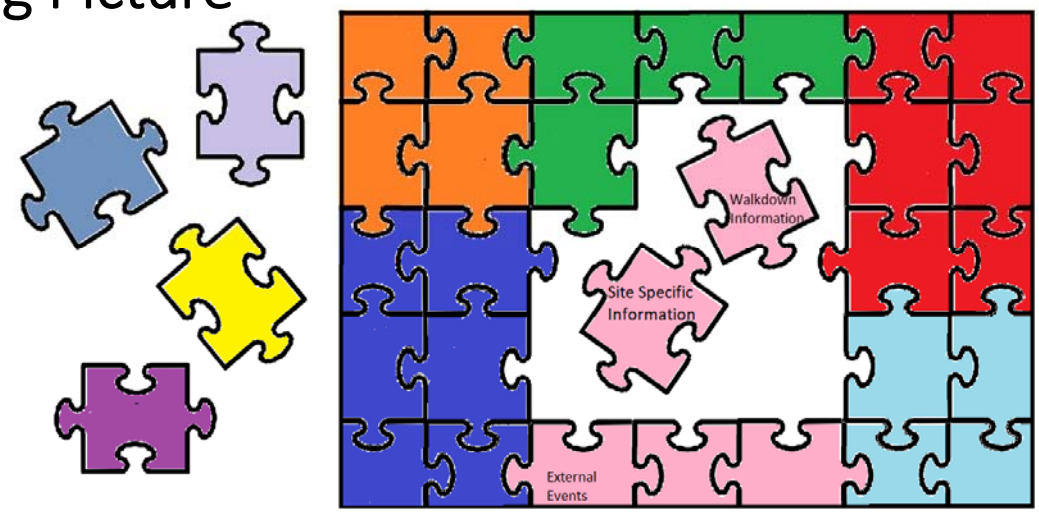
Objectives

Provide an overview of the U.S. NRC's external hazard risk analysis for new reactors

Describe observations, insights, and lessons learned from new reactor licensing reviews

*For this presentation: new reactor = ALWR

Big Picture



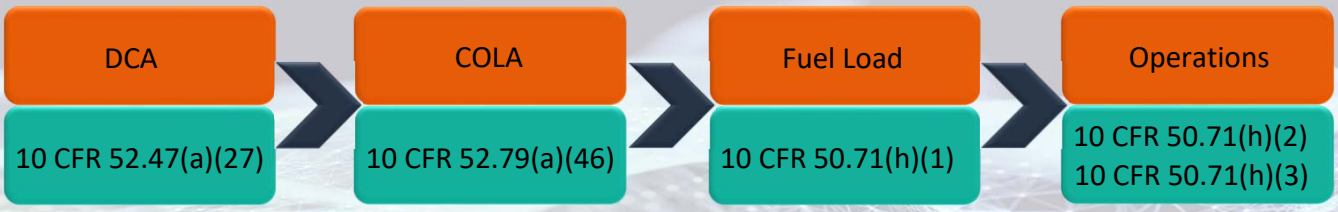
3

Background

External hazard analysis for new reactors typically includes:

- external floods
- high winds
- seismic hazards
- other external hazards

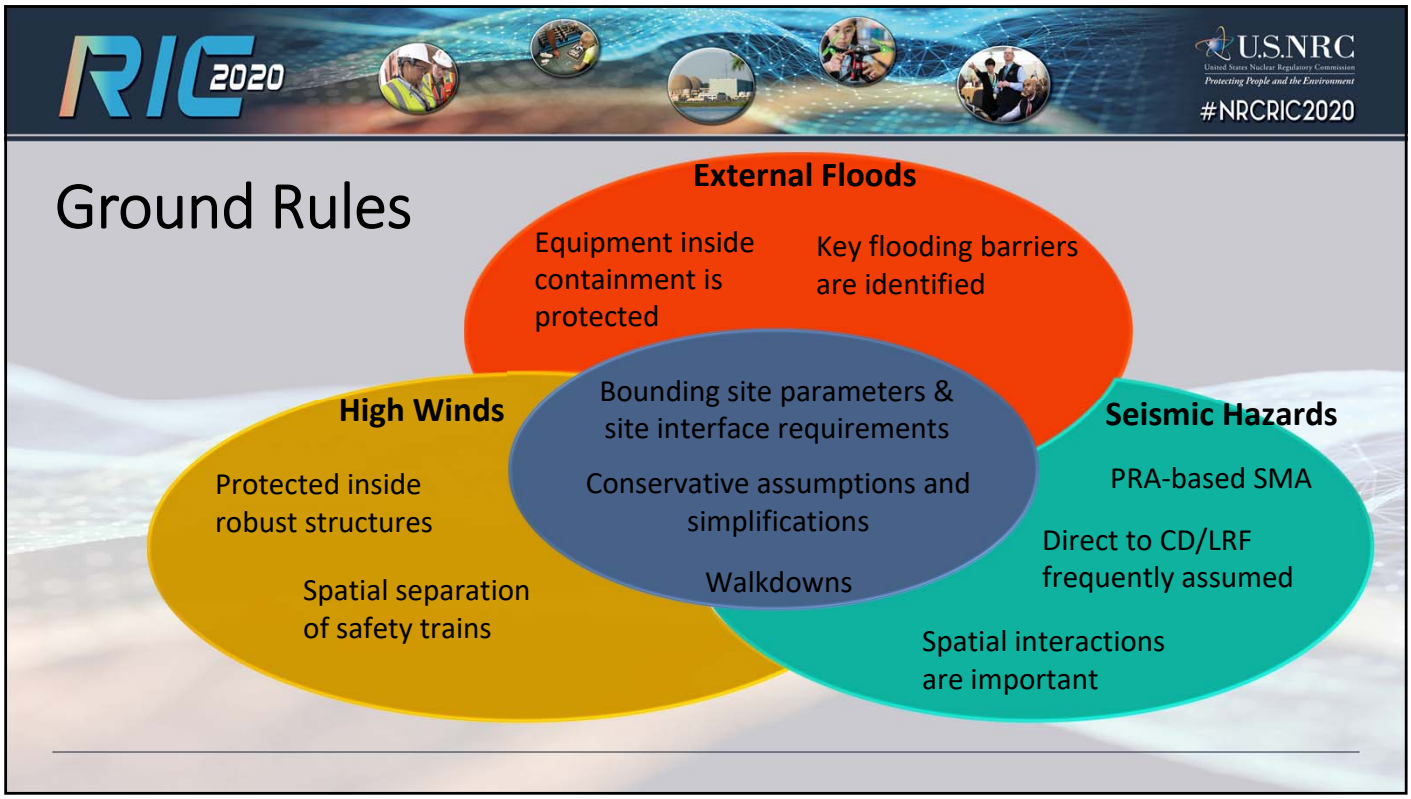
Regulations



A seismic PRA is required no later than initial fuel load.


RIC 2020
U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment
#NRCRIC2020
DCA Stage
COLA Stage
Application is generic; it is expected to be used at multiple sites.
Site-characteristics and other site-specific data are unavailable.
Aspects of the plant layout are unavailable.
Quantitative and qualitative risk assessments use assumptions for site and layout.
Assumptions listed in DCD must be verified.
PRA-based SMA includes site- and plant-specific updates.
As-built information is unavailable.
Plant operating experience is unavailable.

6


RIC 2020
U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment
#NRCRIC2020
Ground Rules
External Floods
Equipment inside containment is protected
Key flooding barriers are identified
High Winds
Protected inside robust structures
Spatial separation of safety trains
Bounding site parameters & site interface requirements
Conservative assumptions and simplifications
Walkdowns
Seismic Hazards
PRA-based SMA
Direct to CD/LRF frequently assumed
Spatial interactions are important

7

Review Elements

Staff reviews PRA description and results to identify/verify:

- Risk insights and vulnerabilities
- Input to operational programs
  - E.g., D-RAP, RTNSS, tech specs
- Commission's goals (CDF <1E-4/yr; LRF < 1E-6/yr)
  - LERF replaces LRF upon transition to fuel load PRA
- Commission's subsidiary goals (Conditional Containment Failure Probability <0.1; Containment intact for 24 hours)

8

Successes

- Completed multiple DC reviews (e.g., ABWR, ESBWR, AP1000, APR1400).
- Substantial progress was made on DC review of NuScale.
- PRA-based SMA was used in lieu of SPRA to determine risk insights and vulnerabilities.
- Risk estimates are lower for new reactors than operating reactors.

Observations and Insights

- As internal events risk is reduced, external hazards contribute more to risk profile.
- The scope of information left to COL applicants varies among DCs.
- Risk-informed reviews allow staff to focus resources commensurate with safety significance.

Challenges

- Identification of appropriate assumptions for the DCA
- Consideration of external hazards for risk-informed applications
- Less reliance on numbers for first-of-a-kind designs; more emphasis on sensitivity and uncertainty analyses
- No new reactor designs in operation yet (in U.S.)

Lessons Learned

- External events are comparably more significant because of very low internal events risk.
- Criteria for establishing risk significance of SSCs should be reconsidered for applicability to passive and evolutionary designs.
- Seismic risk may limit the lower bound on CDF.