

External Flooding PRA

Walkdown Guidance

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EPRI Research – XFPRA Walkdown Guidance

- External Flooding is a credible hazard to many sites
- An external flooding PRA model can be used to help identify the risks associated with these hazards
- EPRI is conducting research on performing a walkdown to support an external flooding PRA
- A draft guidance report will be available in 2018
- EPRI plans to pilot the guidance prior to publishing the final guidance with lessons learned from the pilot(s)

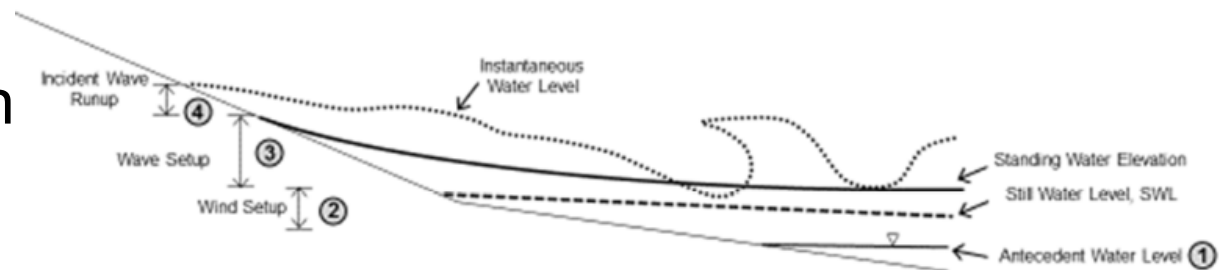
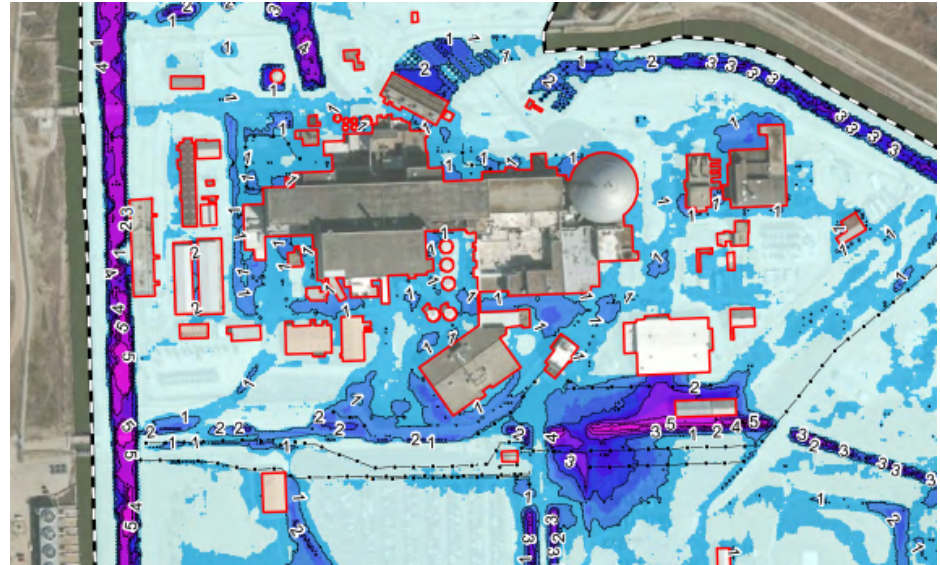


External Flooding PRA

- An External Flooding PRA (XFPRA) relies on a number of parts
 - Determine the applicable external flooding hazards to the site
 - Determine the flood parameters for each applicable flood mechanism
 - Develop a flood hazard curve to determine the frequency of the flood parameters
 - Create one or more scenarios that describe relevant portions of the flood hazard curve for each hazard
 - Evaluate the plant response for each scenario with a PRA model and quantify risks associated with each scenario
- For spatially-relevant hazards, plant walkdowns are an important part of a PRA
 - Walkdowns support the determination of the scenarios and evaluation of the plant response

Flood Parameters of Interest

- Stillwater elevation
- Wave run-up elevation
- Hydrodynamic/debris loading
- Sediment deposition or erosion
- Groundwater
- Warning time
- Period of inundation
- Period of recession



Walkdown Focus

- External flooding equipment list (XFEL)
 - A list of the components that could be required to mitigate the event
- External flood operator actions list (XFOAL)
 - Actions personnel take to provide flood protection prior to the arrival of the flood
 - Actions the personnel take after the flood arrives to mitigate the event that may be impacted by the flood
- External flood protection features
 - Barriers to prevent flood waters from affecting plant equipment
 - Sumps or basements that may provide water retention
 - Drainage systems



Leverage Existing Information

- Internal Flooding PRA model
 - SSCs for inclusion in the XFEL including height above the floor
 - Propagation paths for flooding
- Individual Plant Examination of External Events (IPEEE)
 - May provide expected sequence of events for applicable flood mechanisms
 - SSCs for inclusion in XFEL and operator actions in the XFOAL
- Deterministic walkdowns performed for Recommendation 2.3 of the NRC's 50.54(f) letter to utilities
 - Evaluated the site based on deterministic flood parameters for the applicable floods

Leverage Existing Information (cont.)

- Flood Hazard Reevaluation Report (FHRR)
 - Per the NRC 50.54(f) letter under Recommendation 2.1, sites reevaluated their flooding hazards using the current guidance for new reactor sites
 - Includes site topography, important SSCs, and spatial and temporal data relevant to flooding
 - Includes current design and licensing bases flood protection features
- Mitigating Strategies Assessment (MSA)
 - FLEX strategies may have been based on a plant's design/licensing basis flood requirements rather than using the current guidance as was used in the FHRR
 - MSAs demonstrated how the FLEX mitigating strategies could be employed during flooding based on the events evaluated in the FHRR.

Leverage Existing Information (cont.)

■ Focused Evaluations or Integrated Assessments

- Sites with a reevaluated hazard that exceeds the current license bases or design basis were required to submit an integrated assessment to evaluate the plant response to the unbounded flood parameters
- Following guidance in NEI 16-05, this can take the form of a focused assessment or integrated assessment
- This report will contain an assessment of flood protection and may include (for the integrated assessments) an analysis of flood hazard frequency

External Flooding Equipment List (XFEL)

- Walkdown team requires certain information on SSCs in the XFEL including:
 - Applicable flood mechanisms that could impact the SSC
 - Location and elevation
 - Normal position and PRA-desired position
- The walkdown would confirm the location and evaluate the SSC's susceptibility to failure from external flooding

External Flood Operator Actions List

- Warning time may provide the ability for operators to take measures to protect against the flood
 - Install flood barriers
 - Build sandbag barriers
 - Movement of portable equipment
- Other actions may be impacted by the flood
 - Increased travel time due to flooding or flood propagation
- The walkdown should confirm that human actions are feasible and determine an appropriate adjustment to timing to perform actions
 - Identify primary and alternate travel paths
 - Confirm materials are available to perform actions
 - Identify any dangers the flooding could present

External Flood Protection Features

- Identify plant features that would protect against flooding including active and passive items such as:
 - Levees
 - Temporary or permanent flood barriers
 - Sump pumps and portable pumps
 - Watertight doors
- Identify features that could retain water
 - Sumps
 - Basements or building levels without important SSCs
- The walkdown should identify important information on the barriers such as:
 - Flood parameters that could defeat the barrier
 - Actions required for active features
 - Retention capability

Next Steps

- Use the Corrective Action Process to address any deficiencies noted during the walkdown
- Create the external flooding scenarios (for example, based on flood height that overtops a levee or other flood barrier)
- Develop propagation of water in the external flooding scenarios to determine which equipment is directly failed by the flood and the time available for human action
- Perform the human reliability analysis to assess the probability of failure of human actions
- Model the external flooding scenarios in a PRA model and assess the risk to the site from the applicable hazards
- Identify any vulnerabilities and determine actions the site can take to reduce those vulnerabilities



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