U.S.NRC
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Protecting People and the Environment

Perspectives on Probabilistic Flood Hazard Assessments in New Reactor Evaluations

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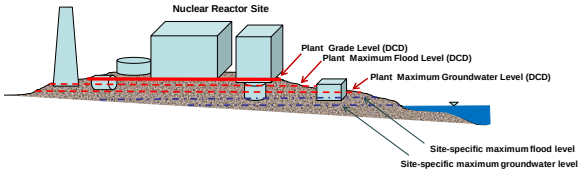
New Reactor Siting: Flood Hazard Evaluation

Present-Day New Reactor Approach:

Design Control Document (DCD) state the maximum surface and ground water levels for a generic site



Site-specific review at Combined License stage compares the site-specific water level to DCD. Sites with levels greater than the DCD level (even by a small amount) require a departure.

New Reactor Siting: Flood Evaluation (con't)

- All flood hazard mechanisms and flood protection, if needed, are evaluated:

  NRC's Standard Review Plan (SRP), NUREG-0800, Section 2.4:

  2.4.2 - Floods
  2.4.3 - Probable Maximum Flood on Streams and Rivers
  2.4.4 - Potential Dam Failures
  2.4.5 - Probable Maximum Surge and Seiche Flooding
  2.4.6 - Probable Maximum Tsunami Hazards
  2.4.7 - Ice Effects
  2.4.8 - Cooling Water Canals and Reservoirs
  2.4.9 - Channel Diversions
  2.4.10 - Flood protection

- Current SRP guidance (2007 revision) references numerous deterministic methods for hazard evaluation.

New Reactor Siting: Flood Evaluation (con't)

- Surface-water hazard and flood protection guidance documents have not been recently updated:
  - RG 1.59, Rev. 2, (1977)
  - ANS/ANSI-2.8 (1992)
  - RG 1.102 (1976)
- Deterministic methods, when properly applied, have proven over time to be safe for reactor siting.
- However, deterministic methods do not allow for calculation of initiating event frequencies (and hence risk targets) as required by NRC's risk-informed processes (e.g., SDP). In addition, post-Fukushima activities, while not requiring use of probabilistic methods, do permit their use (e.g., PRA in Integrated Assessment)

4

New Reactor Siting: Flood Evaluation (con't)

So…

What surface-water hazard and flood protection methods can be applied that are equally safe yet provide defensible initiating event frequencies to meet NRC's current and future needs?

5

PFHA Workshop: A Step Forward

- The Probabilistic Flooding Hazard Analysis (PFHA) workshop was held at NRC HQ on January 29-31, 2013.
- Over 250 people registered for the workshop. Speakers included technical experts from multiple federal agencies, universities, and private industry.
- Some of the workshop's objectives were to:
  - Assess, discuss, and inform participants on the state-of-the-practice for extreme flood assessments within a risk context
  - Seek ideas and insights on possible ways to develop a PFHA for use in probabilistic risk assessment (PRA).
  - Flood assessments must continue to consider combinations of flood-causing mechanisms associated with riverine flooding, dam and levee safety, extreme storm precipitation, hurricane and storm surges, and tsunamis.

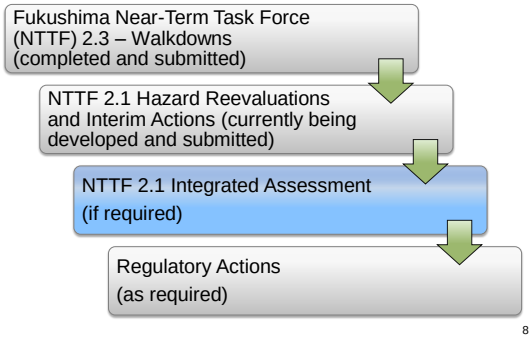
6

PFHA Workshop:

- Some preliminary workshop recommendations include:
  - Establishing understanding of commonality and differences in risk-informed approaches and decision criteria among the various Federal agencies.
  - Develop collaborative and coordinated efforts with other Federal agencies, industry, standard bodies, and other stakeholders to develop PFHA.
  - Implementation of approaches like the Senior Seismic Hazard Analysis Committee (SSHAC) process for flooding hazards.
- Web site has been developed:
  http://www.nrc.gov/public-involve/public-meetings/meeting-archives/research-wkshps.html
  - Final Program of the Federal Workshop on Probabilistic Flood Hazard Assessment (PFHA) (ML13024A242).
  - All presentations and streaming video of the workshop
- Conference proceeding NUREG is under development

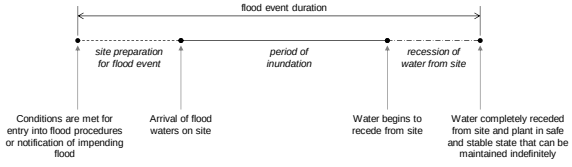
NTTF Integrated Assessment: New guidance to assess response

When is an Integrated Assessment required?



Integrated Assessment: Description

- The integrated assessment (IA)
  - evaluates the total plant response to external flood hazards (deterministic or probabilistic)
  - considers both the protection and mitigation capabilities of the plant
  - provides site/plant-specific risk insights
- The IA considers the entire flood event duration:



Integrated Assessment: Key Assumptions

1. In assessing flood protection and mitigation capability of a plant, credit can be taken for all available (onsite and offsite) resources, including:
   - permanently installed structures, systems, and components (SSCs) and personnel
     - both safety and non-safety related SSCs
     - use in nontraditional ways
   - temporary protection and mitigation measures
2. Human performance takes on added importance during flooding events compared to normal operations.

Integrated Assessment: Key Assumptions

3. Flood frequencies
   - For many flood mechanisms, widely accepted and well-established methodologies are not available for assigning initiating event frequencies for rare floods (i.e., floods with frequencies less than 1/1000 yrs).
   - The integrated assessment does not require the computation of initiating flood-hazard frequencies.
   - Using initiating event frequencies to screen out flood events in lieu of evaluation of flood protection features at the site is not acceptable.
   - Given appropriate justification, the use of the flood event frequency is acceptable as part of a PRA to evaluate total plant response.

Integrated Assessment (con't)

- Evaluates the reliability of plant-specific flood protection measures and mitigation capabilities.
- Evaluates the reliability of manual actions (human performance).
- Is a valuable new tool for assessing the plant-specific response to external flood hazards.
- As PFHA methods become available, these results can be incorporated into the Integrated Assessment framework for evaluating the total plant response to flooding hazards.

Conclusions

- Flooding hazard assessment for nuclear power plants using present-day deterministic methods, when properly applied, have proven over time to be safe and reliable.
- Improved methods for estimating the initiating event frequencies, including aleatory and epistemic uncertainties, of flooding hazards at nuclear facility sites are needed.
- Develop and apply an expert judgment process similar to the Senior Seismic Hazard Analysis Committee (SSHAC) to assess:
  - lack of data for rare hydrological events
  - formulation of flooding scenarios
  - aleatory and epistemic uncertainties