Recommendation 2.1 (Seismic)

NRC Public Meeting

January 23, 2014

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- Background
- Screening Based on the SPID
- Safety/Risk Evaluations
- NPP Seismic Safety
- Interim Actions
- March Submittal Template Updates

Background—Generic Issue 199

- Effort initiated in 2005, *Implications of Updated Probabilistic Seismic Hazard Estimates in Central and Eastern United States (CEUS) on Existing Plants*
  - Evaluate impacts of updated seismic hazards estimates in the CEUS
  - Determined issue should be examined under the Generic Issues Program (GIP)

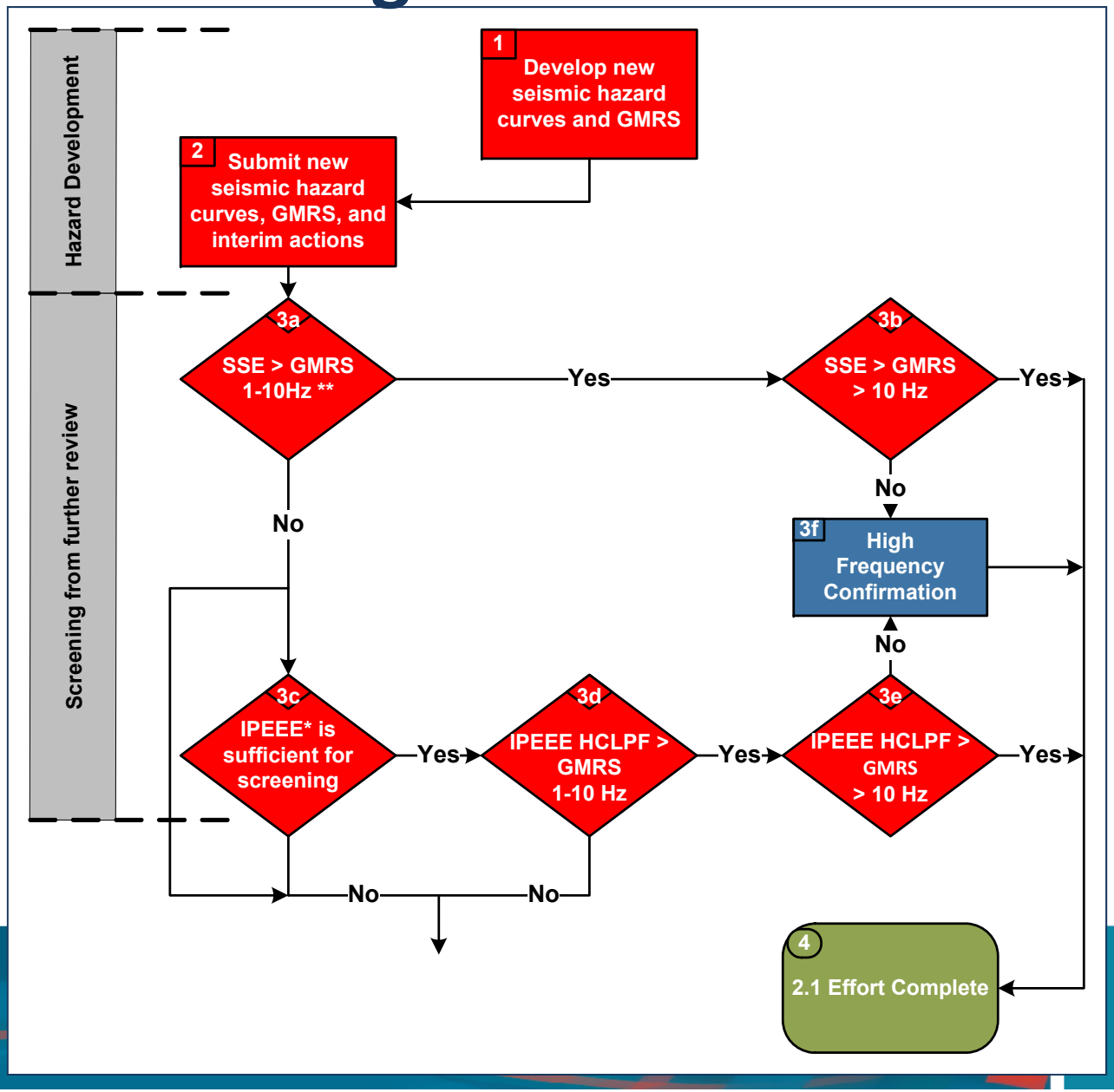
Background—Generic Issue 199

- GI-199 safety/risk assessment stage were summarized in Information Notice 2010-018
  - Overall seismic core damage risk estimates are consistent with the Commission's Safety Goal Policy Statement because they are within the subsidiary objective of 10^{-4}/year for core damage frequency.
  - An immediate safety concern did not exist and adequate protection of public health and safety was not challenged as a result of the new information.
  - The changes in seismic core-damage frequency (SCDF) … meet the numerical risk criteria for an issue to proceed to the Regulatory Assessment Stage of the GIP
- GI-199 resolution was subsumed into the Fukushima 50.54(f) letter

Background—50.54(f) Letter

- Request for information
  - Use latest models and methodologies to estimate ground motion levels corresponding to different recurrence rates (i.e., the seismic “hazard”)
  - Perform screening evaluation to determine whether a seismic PRA or enhanced seismic margin assessment should be done
- Phase 2 (post-50.54(f) letter)
  - Use seismic PRA results to determine whether additional safety enhancements are appropriate

Screening Based on the SPID



Screening Based on the SPID

- New seismic hazard estimates used to compute Ground Motion Response Spectrum (GMRS)
- Compare GMRS to original Safe Shutdown Earthquake (SSE) for screening in accordance with approved guidance (EPRI 1025287)
- Guidance also provided for comparing GMRS with IPEEE capacity response spectrum for screening

Background on SSE and GMRS

	SSE	GMRS
Purpose	Deterministic ground motion used for design of NPPs.	Probabilistic ground motion, used to evaluate seismic risk and licensing of new NPPs
Earthquakes considered	Historically documented earthquakes, both regionally and locally.	Large databases of earthquakes in the CEUS created initially in the 1980s and updated in the CEUS-SSC.
Seismic acceleration level	Typically estimated using Modified Mercalli Intensity derived from described damage and felt effects from historical earthquakes. Additional margin often added to arrive at SSE PGA.	A PSHA used to evaluate probability of potential ground motions that could occur in the next 10,000 to 100,000 years.
Response spectrum shape	Standardized shapes	Uniform hazard type shape

Background on SSE and GMRS

- The SSE and GMRS addresses only one item in the seismic design basis; the input ground motion
- The complete design basis is a “package” of a number of critical parameters. Examples include:
  - Damping criteria for structures, piping, and components
  - Bounding ground motion time history estimates for analysis
  - Criteria for Soil Structure Interaction (SSI)
  - Enveloping criteria for floor response spectra
  - Definitions of load combinations and stress allowables
- Since the seismic design basis for a particular plant is a “package” of numerous requirements, changes to the seismic input ground motion do not correlate directly to changes in overall plant seismic safety.

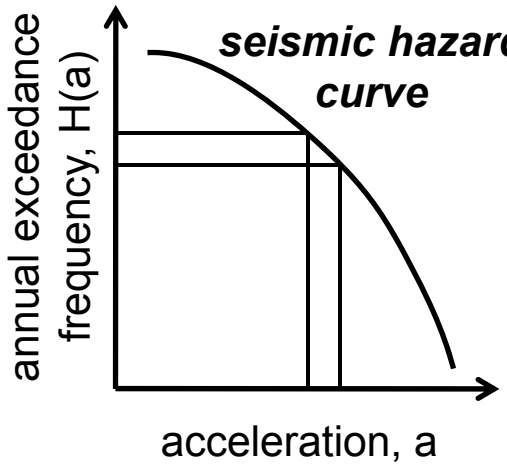
Screening Based on the SPID

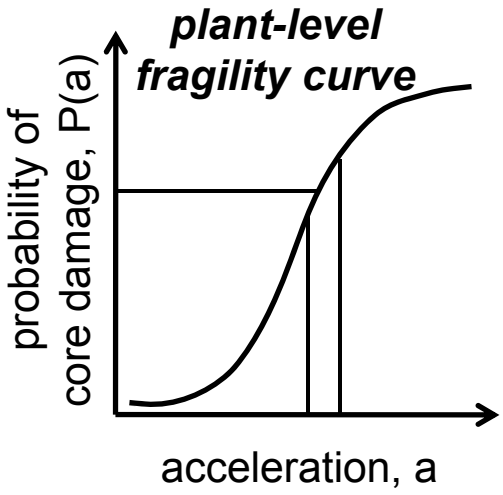
- The SPID screening process is a good tool for identifying plants where the new seismic hazard estimates are clearly inconsequential
- As recommended in the 50.54(f) letter, a plant risk evaluation (SPRA or NRC SMA) is a more effective way to evaluate the safety implications

Safety/Risk Evaluations

- To evaluate impacts of updated seismic hazards estimates under GI-199, NRC made risk estimates in the Safety/Risk assessment
- Similar calculations are being performed by industry using the latest seismic hazard estimates
- The risk estimates provide a more appropriate estimate of the impact of the new hazards by accounting for the updated hazards and the plant capacity.

Computing SCDF





Over a small range of accelerations, the SCDF contribution is the product of:

- The frequency of earthquakes with accelerations in the range, and
- The probability of core damage given acceleration within the range

SCDF = sum of the contributions over all acceleration ranges.

Industry SCDF Approach Consistent with NRC 2010 Safety/Risk Assessment Approach*

- For fleet of US plants, combine mean seismic hazard curves (EPRI 2013/2014) with the mean plant-level fragility curve developed from IPEEE information to estimate SCDF. Assessments include:
  - Weighting approach for contribution of key structural frequencies
  - Adjustment of several IPEEE plant level fragilities
  - Comparison to fleet SCDF range from IPEEE (1990's) and from GI-199 (2010)

* Information Notice 2010-018, *Implications of Updated Probabilistic Seismic Hazard Estimates in Central and Eastern United States on Existing Plants*

Safety/Risk Evaluations

- Preliminary calculations suggest that the NPP fleet risk is similar to the fleet risk estimated in the GI-199 Safety/Risk assessment
  - Indicates NPP fleet seismic risks are not significantly different from previously understood
  - Could be helpful in prioritizing detailed SPRA or NRC SMA evaluations

NPP Seismic Safety

- Seismic margin inherent in seismic design
- Earthquake experience
  - Industrial facilities
  - Nuclear Power Plants
- Interim Actions
  - FLEX Implementation
  - Expedited Seismic Evaluation Process

NPP Seismic Safety

- As noted earlier, there are a number of critical parameters in a plant's seismic design basis.
- These parameters, as well as conservative design practices, contribute to the significant margin in a plant's seismic design.
- Plant enhancements have improved seismic safety over time (e.g. block wall upgrades, anchorage upgrades)

NPP Seismic Safety

- Earthquake experience at industrial facilities demonstrates that engineered structures, systems, and components are robust, even for large ground motions.
  - Equipment performance data collected by SQUG over the last 20 years demonstrates positive equipment performance.
  - Lessons learned from that experience data has been applied in NPPs.

NPP Seismic Safety

- Earthquake experience at nuclear power plants demonstrates that NPPs structures, systems, and components are robust, even for ground motions that exceed the seismic design basis.
- Positive evidence of seismic robustness was demonstrated by each of the following plants.
  - Kashiwazaki-Kariwa – Chūetsu Offshore Earthquake (2007)
  - Onagawa – Great Japan Earthquake (2011)
  - North Anna – Mineral, VA Earthquake (2011)

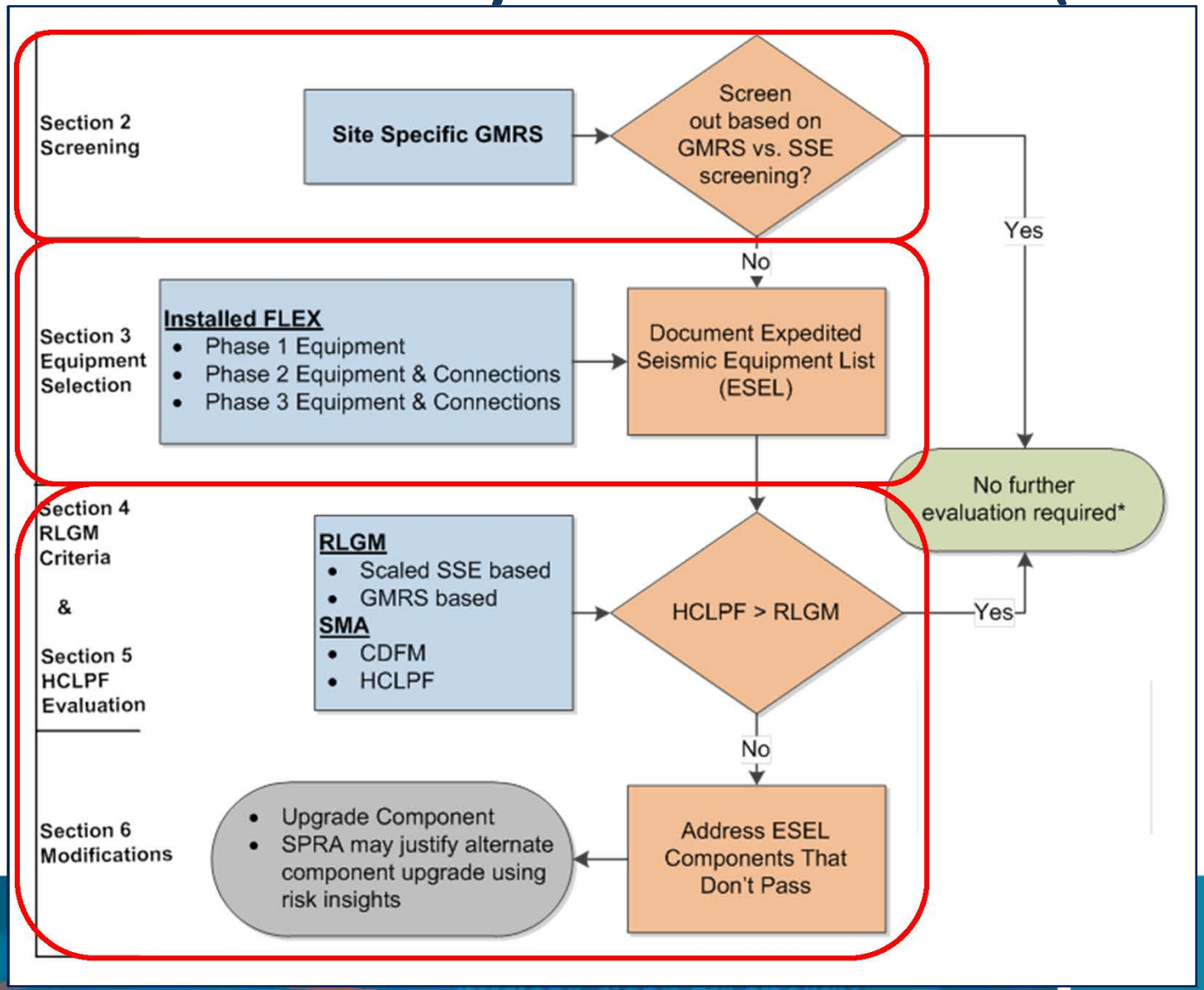
NPP Seismic Safety – Interim Actions (FLEX)

- FLEX implementation provides additional strategies for coping with beyond design basis events
  - Plants have already bolstered their capability to respond to beyond design basis events by procuring additional portable equipment
  - Full FLEX implementation will further enhance this capability through design changes and procedural guidance

NPP Seismic Safety – Interim Actions (ESEP)

- Expedited Seismic Evaluation Process (ESEP)
  - Enhanced seismic evaluation for critical installed FLEX equipment using beyond design basis seismic inputs
  - Evaluations to be complete this year
  - Enables safety enhancements sooner

NPP Seismic Safety – Interim Actions (ESEP)



March Submittal Template Updates

- Previous public meetings with NRC on the March submittal template focused on explaining the amount of detail expected by NRC, primarily in Sections 1 and 2 and Appendix A.
- Some limited information was included in Sections 3, 4, and 5.

March Submittal Template Updates

- Revisions to the template are consistent with the SPID and include:
  - Potential additional information in Section 2 for perspective and context or as a contributor to the overall risk assessment
  - Additional information specific to plants using their IPEEE HCLPF capacity for screening

March Submittal Template Updates

- Revisions to the template (cont)
  - Breaking the screening evaluation into sections addressing specific SPID criteria
    - 1 Hz to 10 Hz frequency range
    - > 10 Hz frequency range
    - Spent Fuel Pool evaluation applicability
  - Additional information on interim actions
- Working to achieve a common understanding of submittal expectations by February 5

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