Seismic Hazard Updates for Operating Nuclear Power Plants in the Central and Eastern U.S.

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U.S.NRC
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NRC Team:

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- Risk Analysts: Steven Alferink, Sunwoo Park, De Wu

Background: Seismic Hazard Reevaluations

- SECY-11-0093 "Near-Term Report and Recommendations for Agency Actions Following the Events in Japan," July 12, 2011 (ML11186A959)
  - NTTF Recommendation 2.1 initiated the seismic hazard reevaluation
  - Staff completed these reviews in 2019
- NUREG/KM-017 , "Seismic Hazards Evaluations for U.S. Nuclear Power Plants: Near Term Task Force Recommendation 2.1 Results," December 2021 (ML21344A126)

Results From NTTF Activities

- NTTF 2.1 seismic hazard reevaluation activities demonstrated that the nuclear power plants continue to operate safely
- NRC and the nuclear power plant licensees derived important insights related to seismic risk
  - Walkdowns
  - Expedited Seismic Evaluation Process (ESEP)
  - High Frequency Evaluation
  - Seismic Probabilistic Risk Assessments (SPRAs)

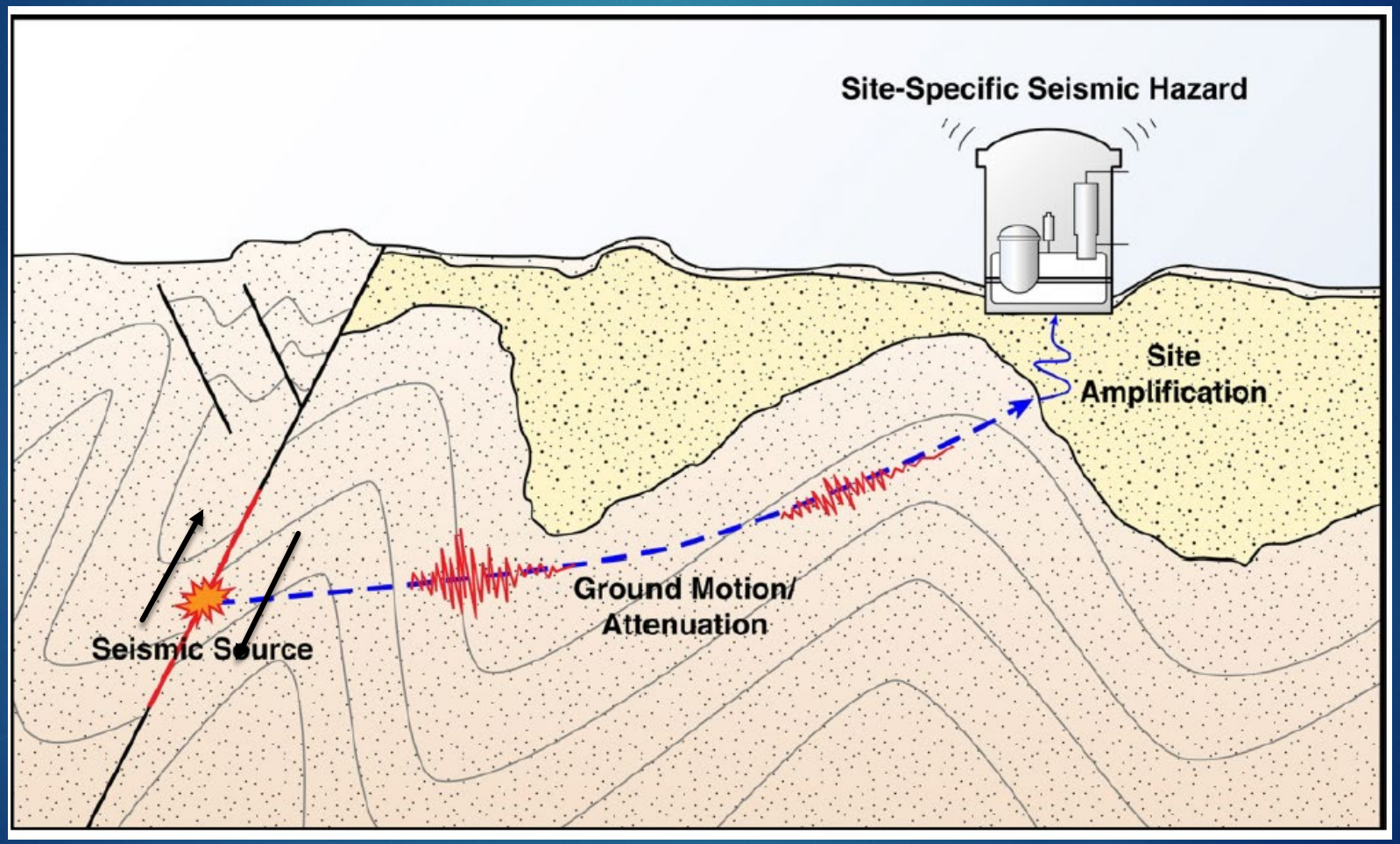
Results from NTTF Activities

- Process for the Ongoing Assessment of Natural Hazards Information (POAHNI)
  - NTTF 2.2 advised rulemaking requiring that nuclear power plant licensees confirm seismic and flooding hazards every 10 years
  - SECY-16-0144, "Proposed Resolution of Remaining Tier 2 and 3 Recommendations Resulting from the Fukushima Dai-ichi Accident," dated December 26, 2016 (ML16286A552)
  - Office of Nuclear Reactor Regulation's Office Instruction LIC 208, "Process for the Ongoing Assessment of Natural Hazards Information," issued November 2019 (ML19210C288)

Meeting Purpose:

- Describe approach for updating seismic hazard curves for CEUS NPP sites using the NRC process for ongoing assessment of natural hazards information (POANHI)
  - Update incorporates
    - New seismic ground motion attenuation models: NGA-East
    - Updated seismic site response methods used to better capture uncertainty
- Provide schedule for updated hazard curves and report

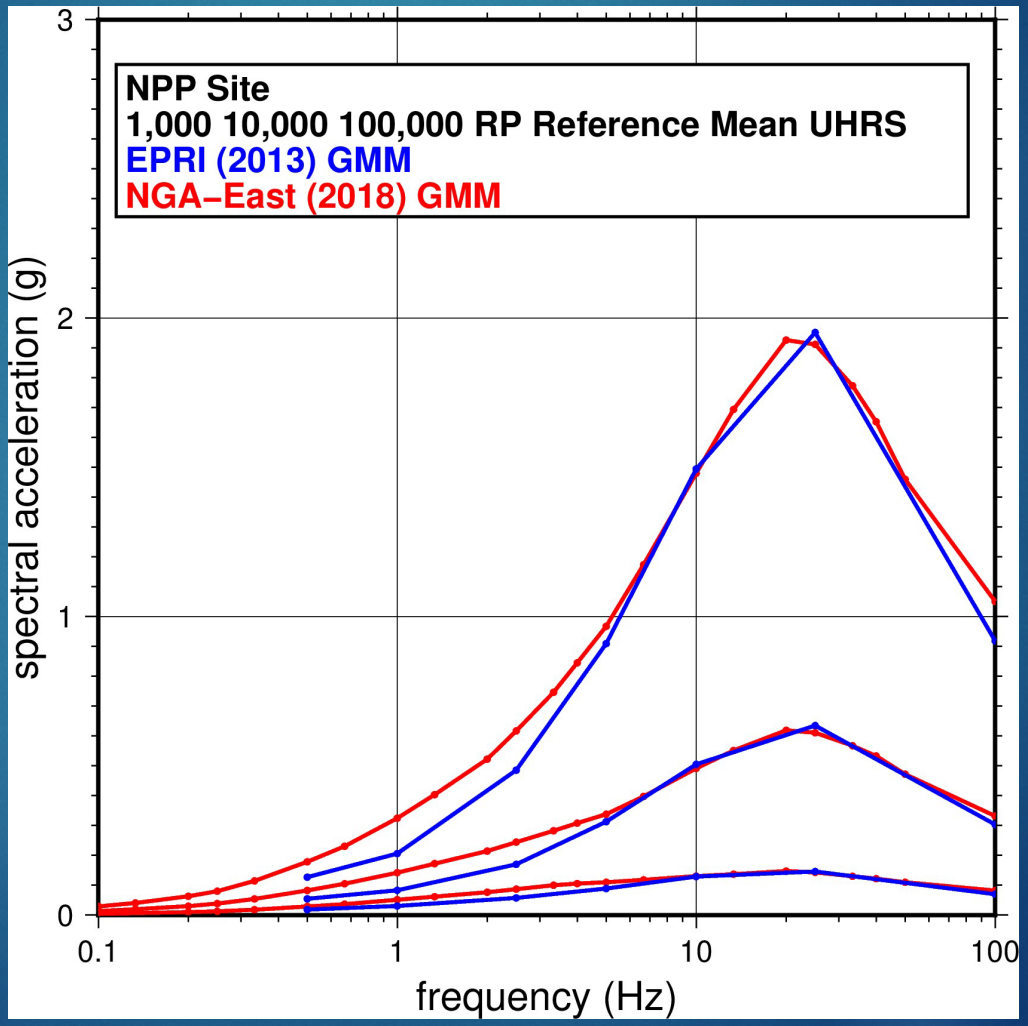
Seismic Hazard Characterization



Recent Seismic Hazard Updates: NGA-East GMM

- NGA-East is a ground motion model (GMM) for the Central and Eastern United States
  - Captures larger range of uncertainty than previously NRC endorsed model
  - Developed jointly with industry, NRC, DOE, and USGS using SSHAC process
- NGA-East GMM used for multiple critical facility siting evaluations
- NGA-East GMM replaces older EPRI ground motion model for the Central and Eastern United States

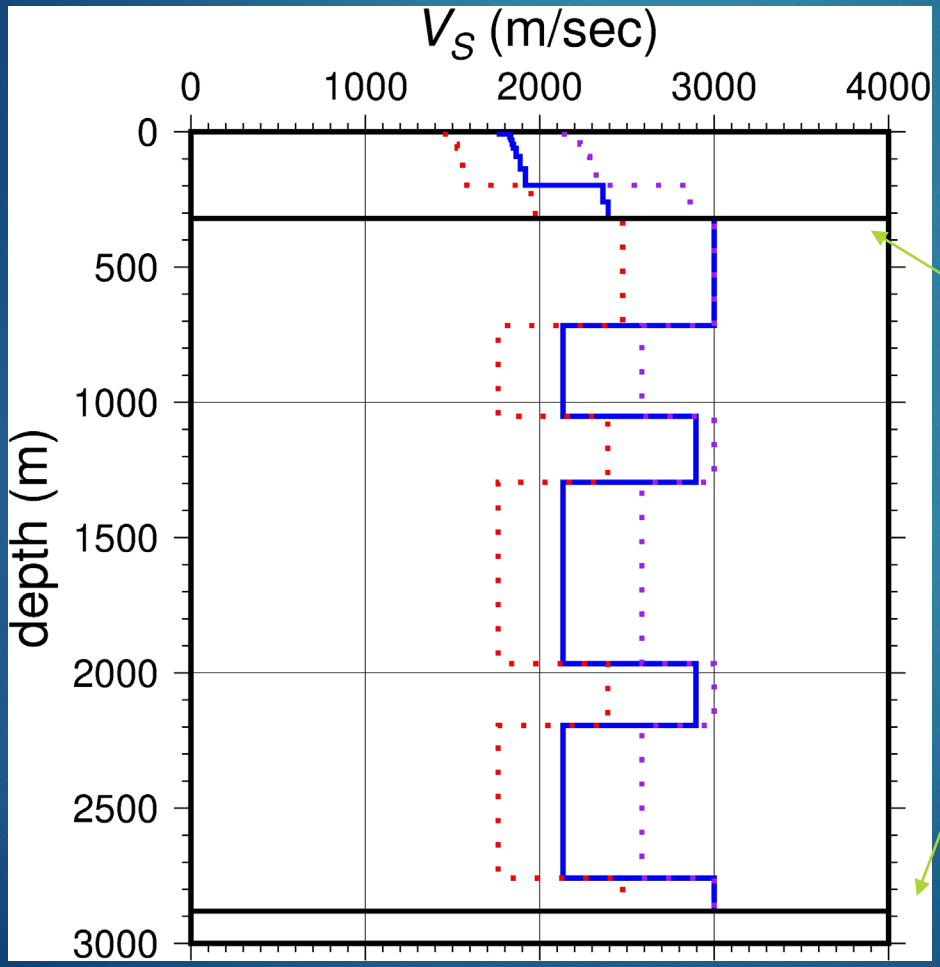
Impact of NGA-East Model



Recent Seismic Hazard Updates: Site Response Analysis

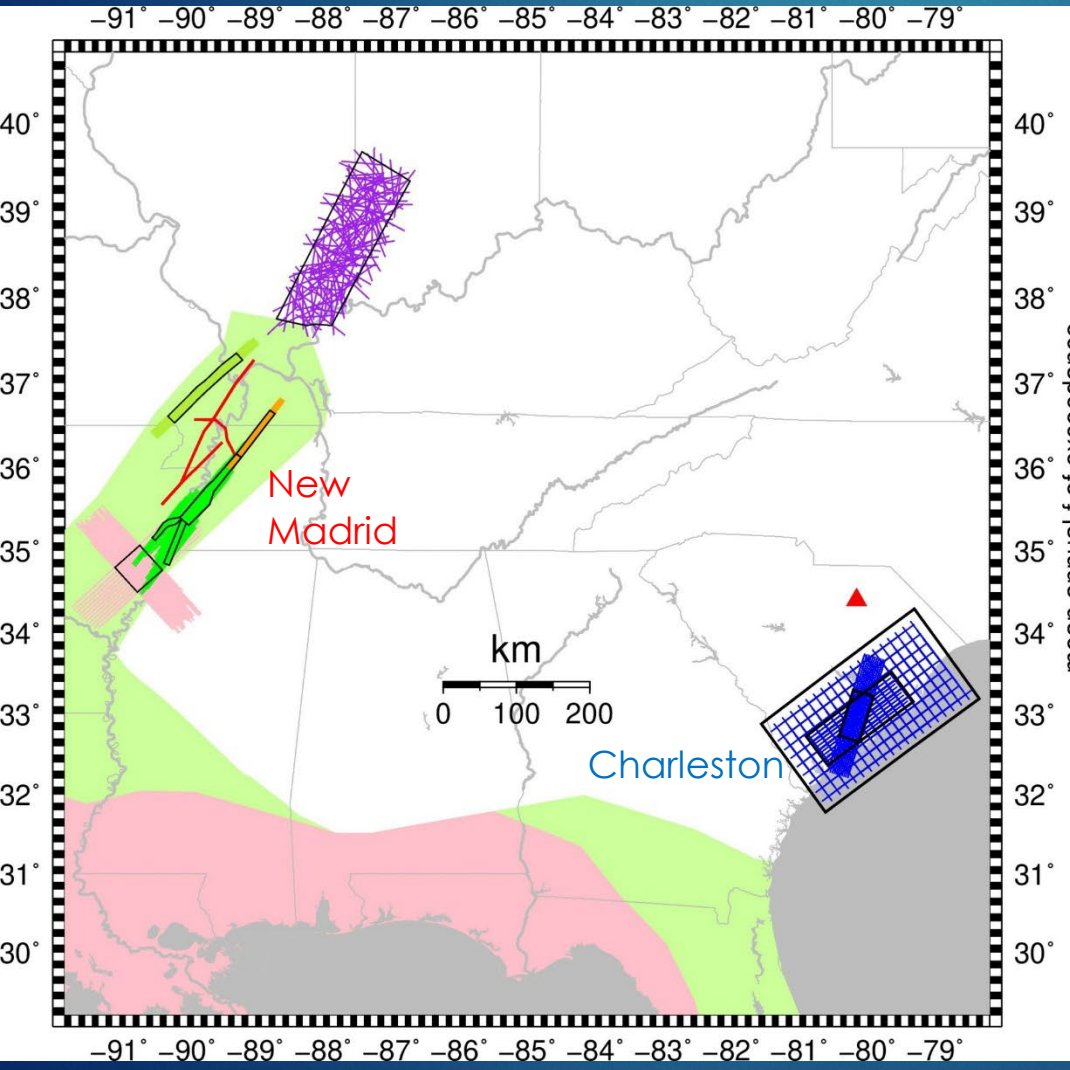
- CEUS NPP sites licensed in the 1970s and early 1980s have less detailed subsurface information on soil and rock properties below the plant foundation level
- Updated site response analysis approach captures larger range of uncertainty for important modeling inputs
  - Add more site profiles to capture depth to basement rock layer
  - Add more models to capture nonlinear response of soil and rock to higher input ground motions
  - Use more relationships to capture local site attenuation parameter – kappa
- Site response logic tree now has many more alternative branches and nodes

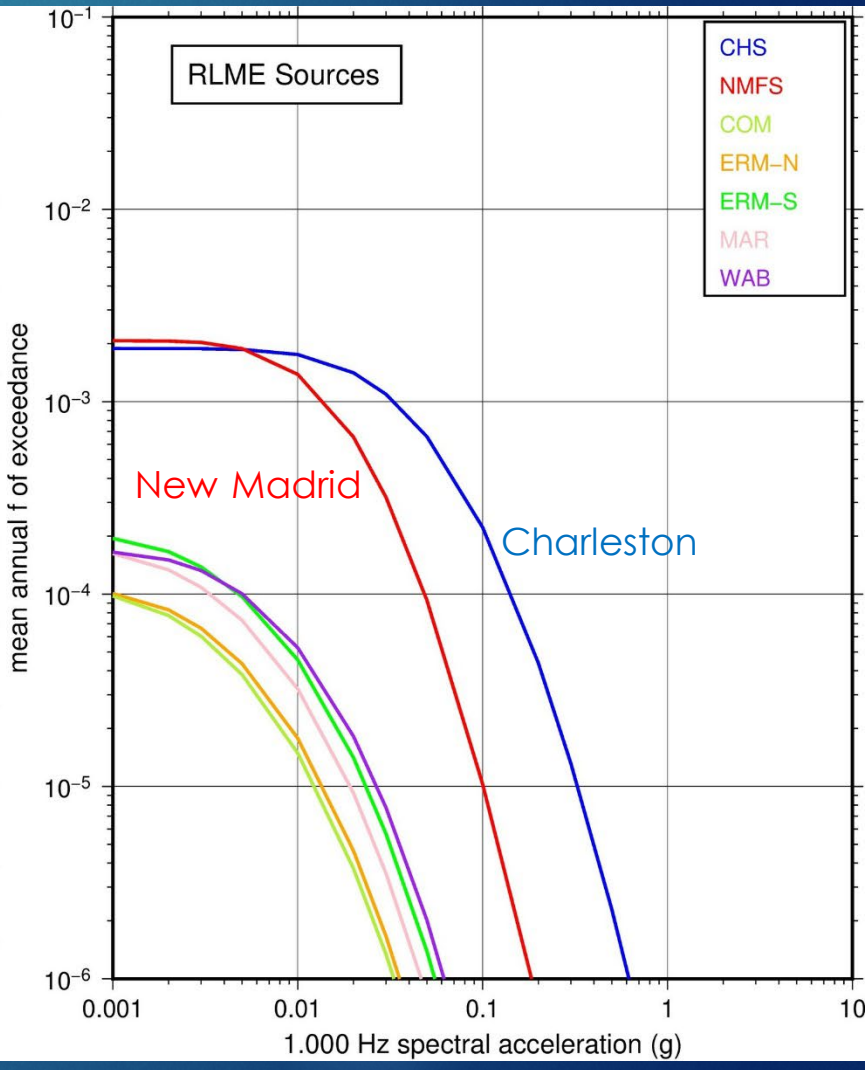
Impact of Site Response Updates



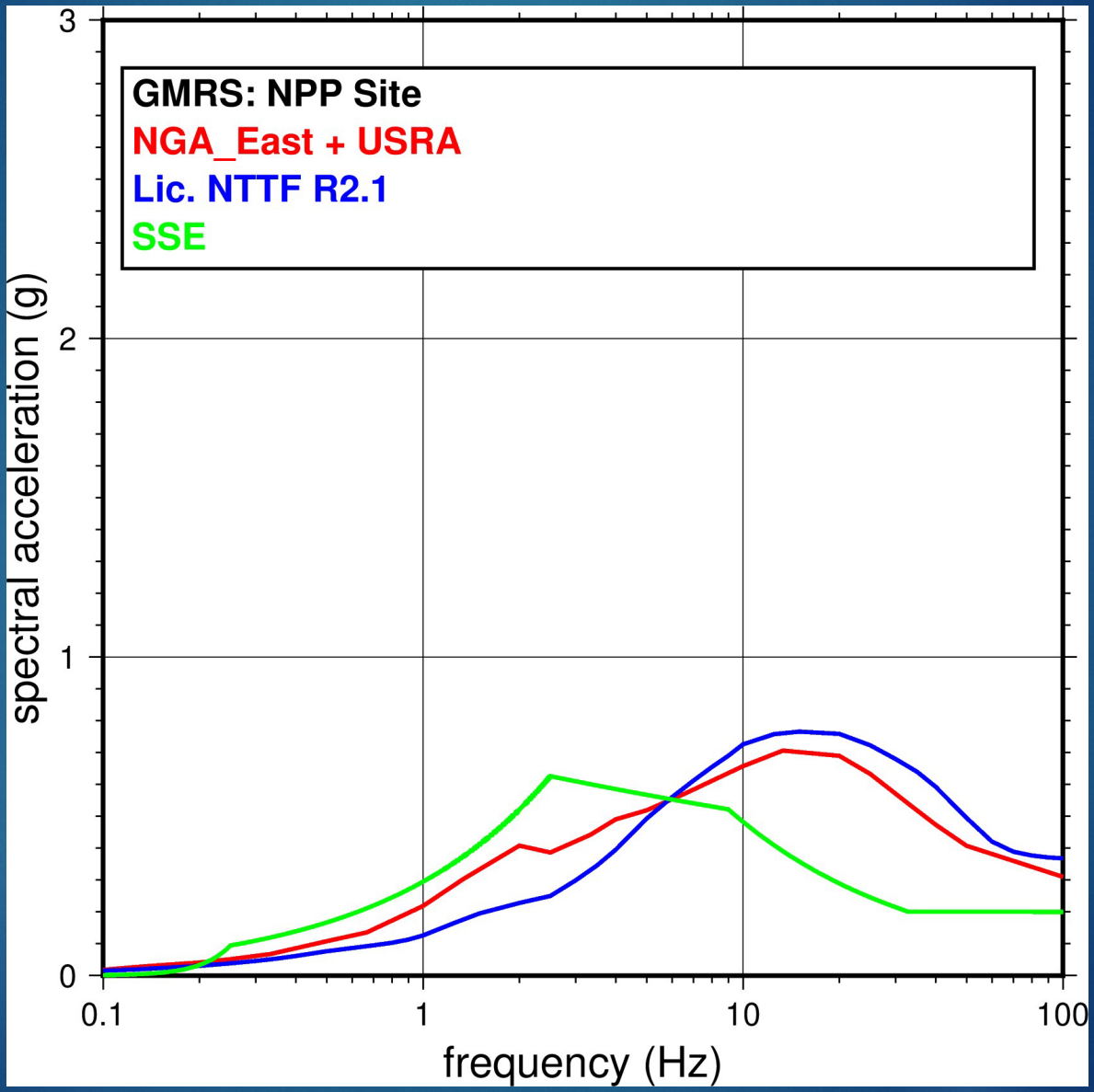
Two alternative basement rock horizons

Probabilistic Seismic Hazard Curves





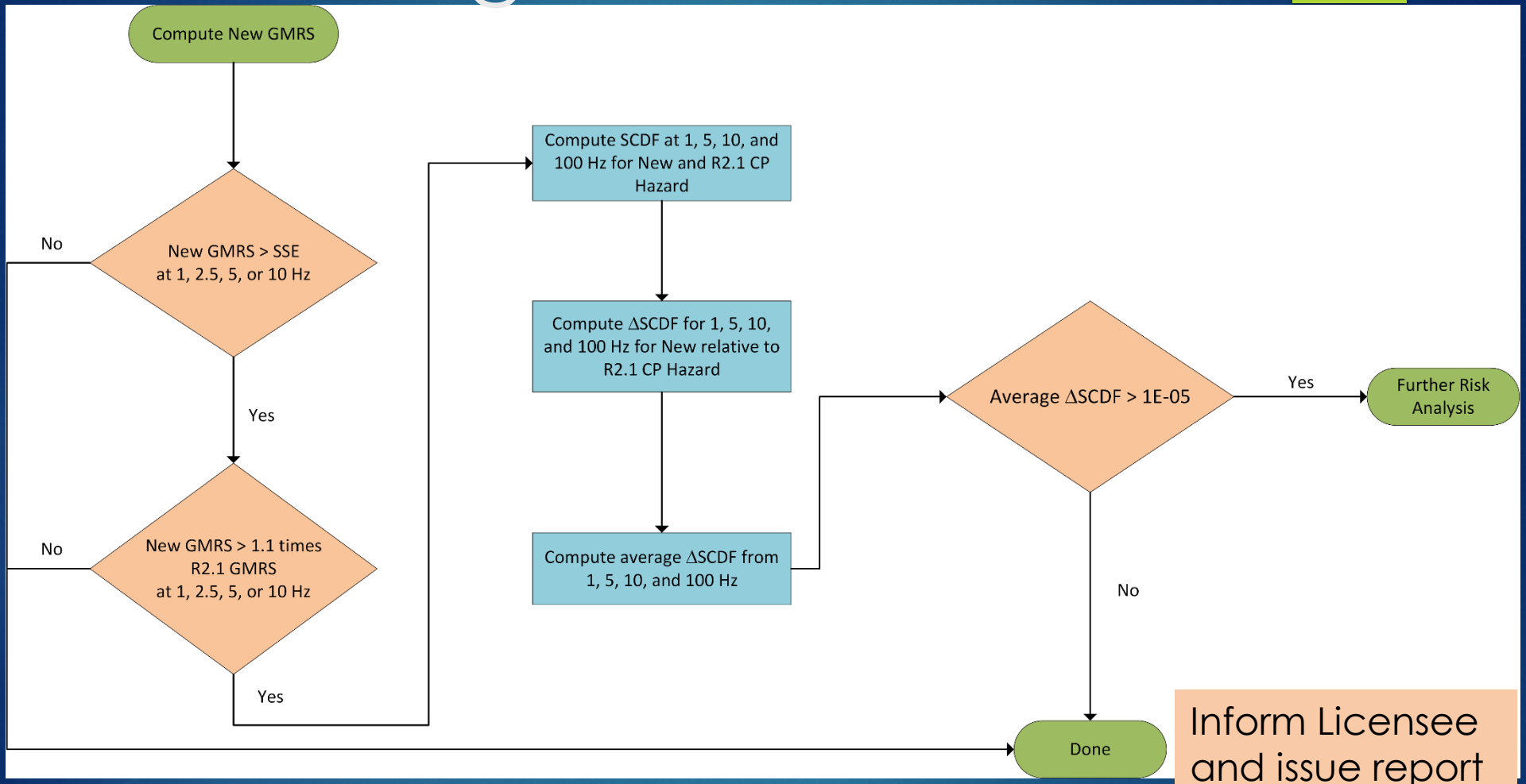
Example: GMRS comparison for NPP Site



Seismic Screening under POANHI

Step 1	Step 2	Step 3	Step 4	Step 5
Develop hazard curves and GMRS for CEUS NPP site	Do screening evaluation	Prepare hazard report and cover letter	Discuss results with NRC Senior Management Review Panel (SMRP)	Contact Licensee to notify about issuance of hazard report or to discuss seismic risk evaluation

Screening Flow Chart



Hazard Screen for New GMRS

Risk Screen

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Further Risk Analysis

- Utilize available plant-specific seismic risk insights; Examples:
  - Dominant risk contributors
  - Safety enhancements performed by licensee via permanent plant modifications
- If issues resolved, inform licensee and issue final letter and hazard report
- If issues remain, enter formal regulatory process

Hazard Report

- Information report that documents updated seismic hazard results
- Provides background, methodology, and bases for updated seismic hazard curves
- Hazard curves and site properties provided as figures and tables in the report

CEUS NPP Schedule

PLANT SITE	Initial Screening Evaluation (CY)
Vogtle	4th Qtr 2022
Robinson	4th Qtr 2022
Watts Bar	1st Qtr 2023
Sequoyah	1st Qtr 2023
Browns Ferry	1st Qtr 2023
North Anna	1st Qtr 2023
Summer	2nd Qtr 2023
Peach Bottom	2nd Qtr 2023
D.C. Cook	2nd Qtr 2023
Dresden	2nd Qtr 2023
Oconee	3rd Qtr 2023
Beaver Valley	3rd Qtr 2023
Callaway	3rd Qtr 2023

ACRONYMS

- CEUS: Central and Eastern United States
- ESEB: Expedited Seismic Evaluation Process
- GMM: Ground Motion Model
- GMRS: Ground Motion Response Spectra
- HCLPF: High Confidence of Low Probability of Failure
- NGA East: Next Generation Attenuation for Central and Eastern North America
- NPP: Nuclear Power Plant
- NTTF: Near Term Task Force
- POANHI: Process for the Ongoing Assessment of Natural Hazards Information
- PSHA: Probabilistic Seismic Hazard Analysis
- RLME: Repeated Large Magnitude Earthquake
- SCDF: Seismic Core Damage Frequency
- SMRP: Senior Management Review Panel
- SPRA: Seismic Probabilistic Risk Assessment
- SSE: Safe Shutdown Earthquake