

# **NTTF 2.1 Spent Fuel Pool Evaluations Status**

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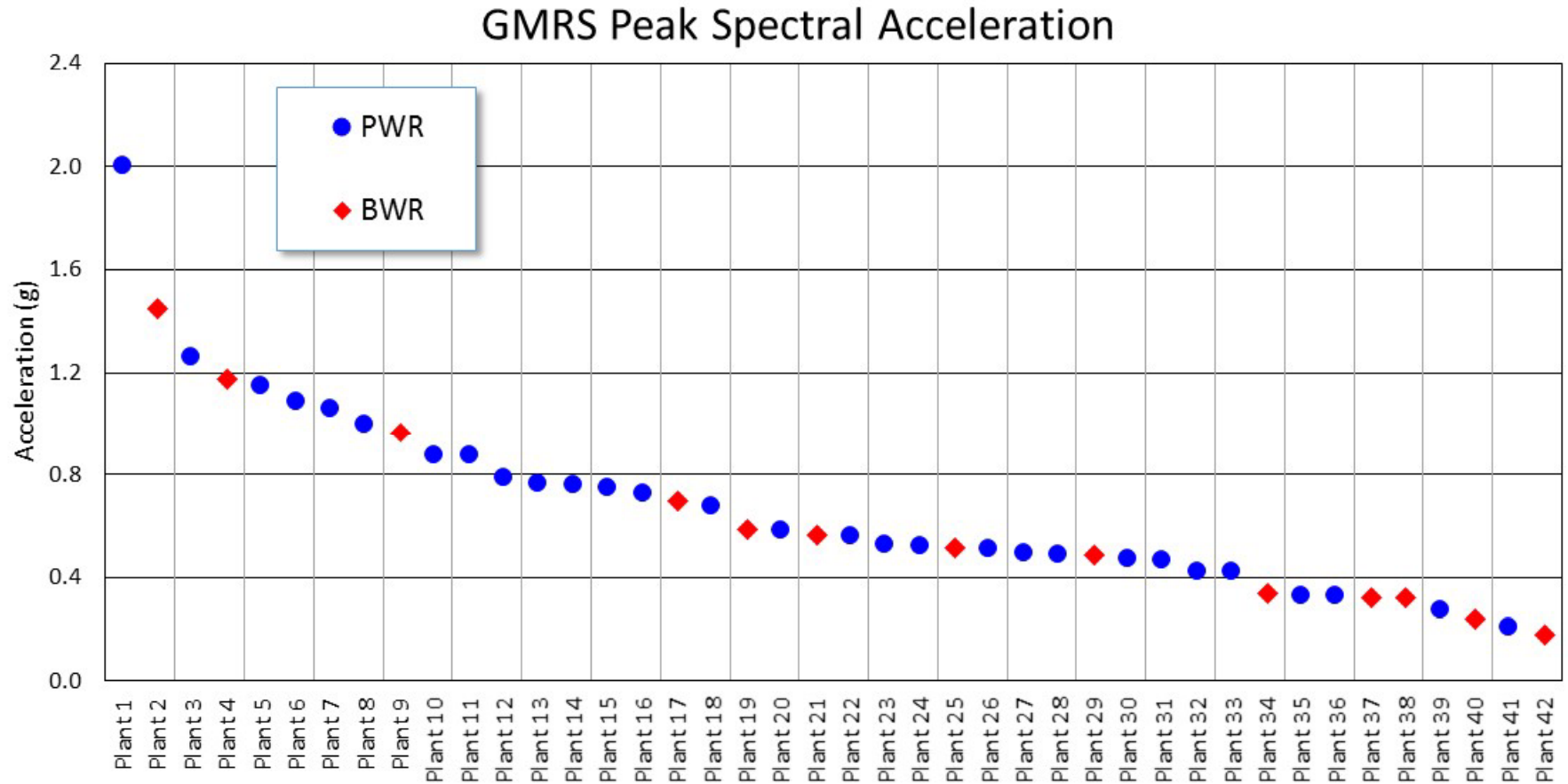
**NRC Meeting on Recommendation 2.1  
May 21, 2015**



# Presentation Outline

- Project Status
- NP 6041 Evaluation
- SFP Design Survey
- Benchmarking/Validation of Approximate Methods
- Non-Structural Considerations
- Summary of phased approach
- Next Steps

# Distribution of 42 Sites Requiring SFP Reviews



## Background: SPID Discussion of SFP Structure Seismic Capacity

- “Previous evaluations in NUREG-1353, NUREG-1738 and NUREG/CR-5176 characterized the generally robust nature of the design of SFPs”
- Evaluations reported in NUREG/CR-5176 for two older plants concluded that “...seismic risk contribution from spent fuel pool structural failures is negligibly small.”
- “Tearing of the stainless-steel liner due to overall structural failure of the fuel pool structure would be precluded by the successful completion of the structural evaluations. Tearing of the stainless-steel liner due to sliding or other movement of the fuel assemblies in the pool is considered to be very unlikely [NRC NUREG-1353]”
- The SPID defines that either the checklist in NUREG-1738 can be used to demonstrate that the SFP structure is sufficiently robust or another approach can be used if sufficiently justified.

## Approach for NTTF 2.1 Review of Spent Fuel Pool Structure Adequacy to New Seismic Hazard

- Alternate approach and justification for SFP structure seismic adequacy being undertaken by the industry
- Graded Approach
  - Seismic Adequacy Approach of Lower GMRS Plants (peak 5% damped spectral acceleration,  $<0.8g$ ) based on development of HCLPF on a plant specific basis
  - Assessment of Higher GMRS Plants using representative analyses to verify seismic adequacy
- EPRI is developing SFP structure white paper(s) to:
  - Present a justification for the seismic adequacy verification for those nuclear plant sites with lower GMRS
  - Present a justification for the seismic adequacy verification for sites with higher GMRS

# SFP Structure Seismic Evaluation for Lower GMRS Sites

- EPRI Proposed Seismic Evaluation Approach
  - Overarching methodology will consist of using the new site specific GMRS as the review level earthquake (RLE) for the SFP structure
  - HCLPF for the SFP structure will be evaluated based on current criteria for structure capacity/responses
  - Use 6041 screening tables for structures to develop HCLPF capacity
    - EPRI 1019200, Seismic Fragility Applications Guide Update, December 2009
  - Define the high frequency screening table capacity for HCLPF
    - EPRI NP-7498, Industry Approach to Seismic Severe Accident Implementation Policy, November 1991

# Spent Fuel Pool Structures at Existing US Plants

- SFP structures all consist of reinforced concrete structures
  - Typically these are shear wall structures as the fundamental load path mechanism
  - Some SFP structures may have steel frame members and concrete frame members acting in the load path
- SFP itself is a rectangular reinforced concrete shear wall structure
  - Range of SFP structure parameters (length, width, depth, wall thicknesses, rebar sizes, etc.) are being surveyed and results do not show large variations

# EPRI 6041 Structure Screening Criteria

Table 2-3

SUMMARY OF CIVIL STRUCTURES SCREENING CRITERIA FOR SEISMIC MARGIN EVALUATION  
(Page 1 of 2)

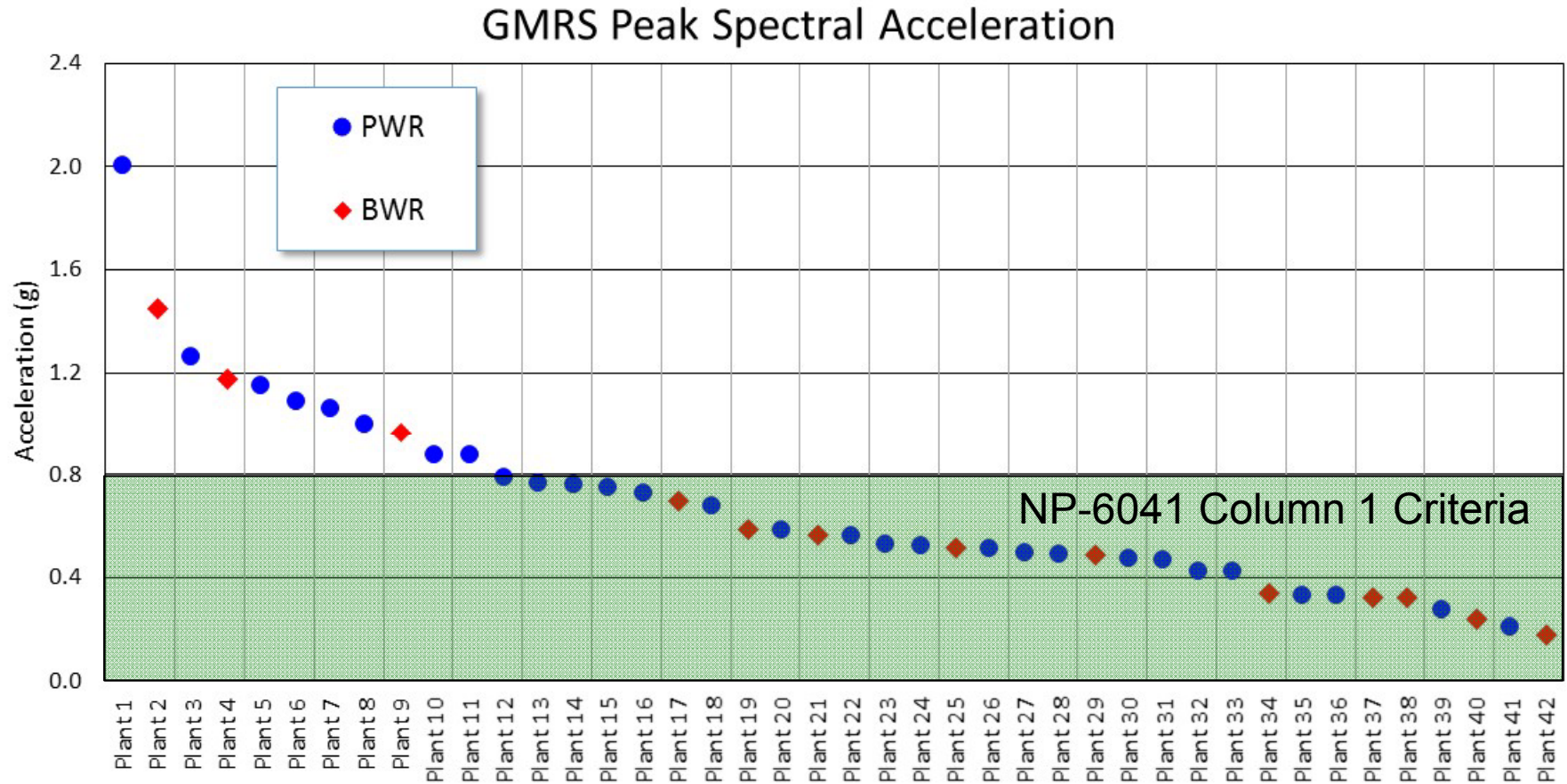
Type of Structure	5 Percent-Damped Peak Spectral Acceleration		
	<0.8g	0.8 - 1.2g	>1.2g
Concrete containment (post-tensioned and reinforced)	no	(a)*	(b)
Freestanding steel containment	(c)(d)	(c)(d)	yes
Containment internal structures	(e)	(f)	yes
Shear walls, footings and containment shield walls	(e)	(f)	yes
Diaphragms	(e)	(g)	yes
Category I concrete frame structures	(e)	(f)	yes
Category I steel frame structures	(e)	(h)	yes
Masonry walls	yes	yes	yes
Control room ceilings	(i)	(i)	yes



## EPRI 6041 Table 2-3 Footnotes

- Footnote “e” (Column 1 for Shear Wall and Steel Frame Structures)
  - Evaluation not required for Category I structures if design was for a SSE of 0.1g PGA or greater
- Footnote “f” (Column 2 for Shear Wall and Steel Frame Structures)
  - Evaluation not required for Category I structures if design was by dynamic analysis for an SSE of 0.1g PGA or greater, and if the structure complies with ACI 318-71 or ACI 349-76 or later editions’ ductility detailing requirements

# Distribution of 42 Sites Requiring SFP Reviews

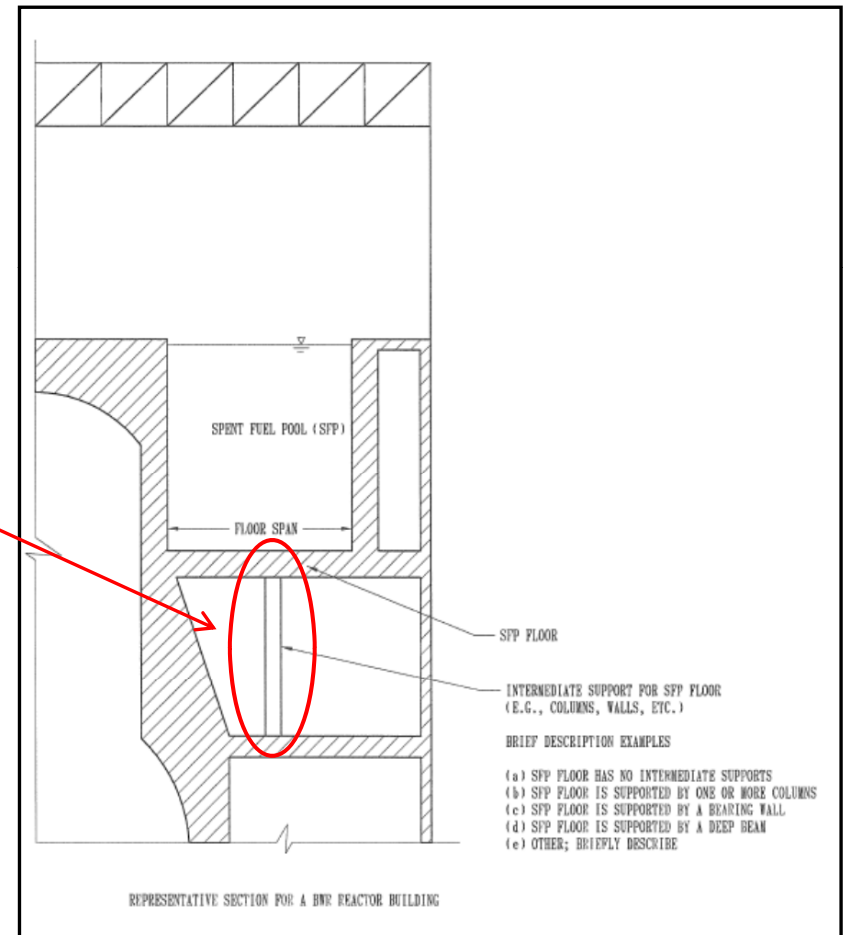


## SFP Structure Seismic Adequacy Verification for Lower GMRS Sites

- Basis exists to use current seismic approach for HCLPF to GMRS comparisons based on the first column of the EPRI 6041 Table 2-3 for structures
- US SFP structures all meet the requirements for Column 1, resulting in a 0.8g spectral acceleration HCLPF capacity
- 31 out of 42 sites required to review SFP structure would demonstrate seismic adequacy using GMRS
- Remaining 11 sites would rely on the alternate methodology based on analyses of representative SFP structures

# SFP Design Survey

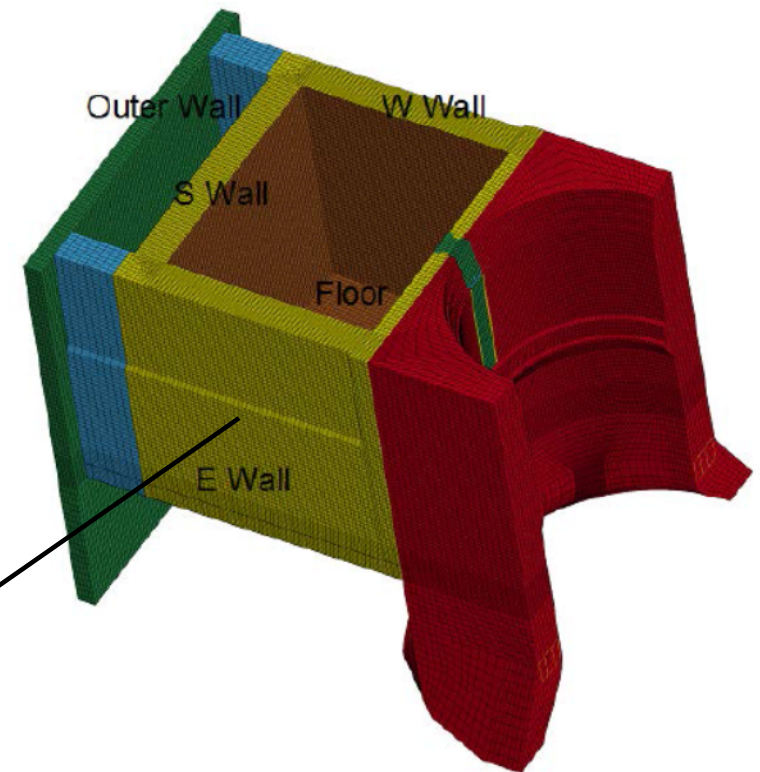
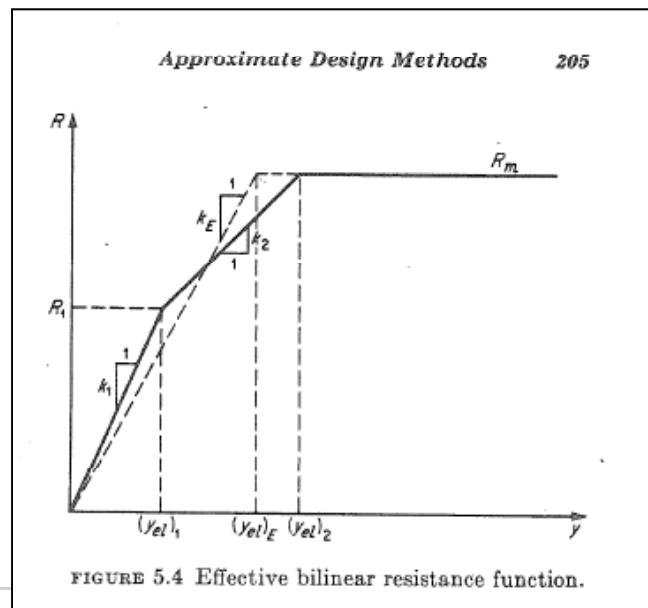
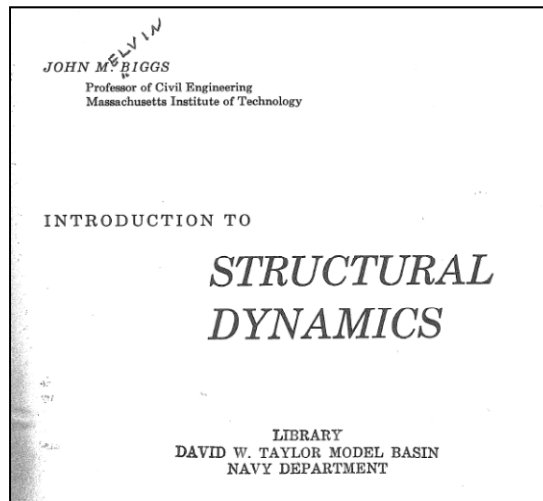
- Improves understanding of range of designs
- Design information requested:
  - Location of SFP (aux building, fuel handling, reactor bldg)
  - Elevation of SFP floor slab
  - Pool dimensions (L x W x D)
  - Characterization of intermediate supports
  - Wall and floor thicknesses and reinforcement design
  - Design material properties
  - Liner thickness
  - 2.3 Seismic SFP walk-down results



## Benchmarking/Validation of Approximate Method

- An approximate method is used to estimate the HCLPF and seismic fragility of an SFP
- The approach checks for out-of-plane shear and flexural failure modes
- The method is generic and can be applied to all SFPs if ISRS are known
- Benchmarking/validation is important for improving confidence in results

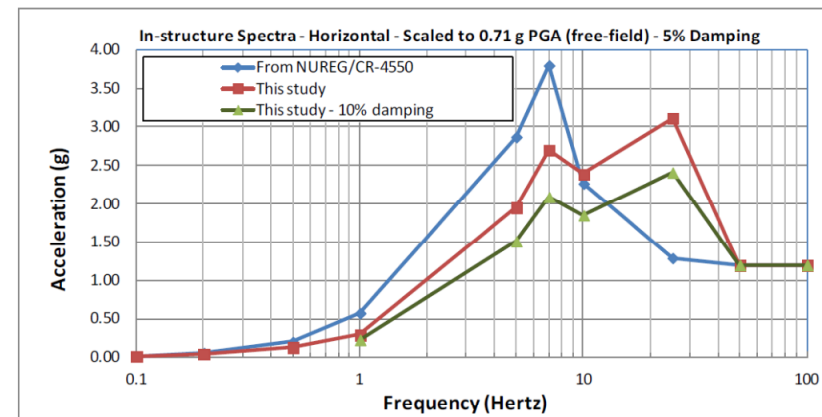
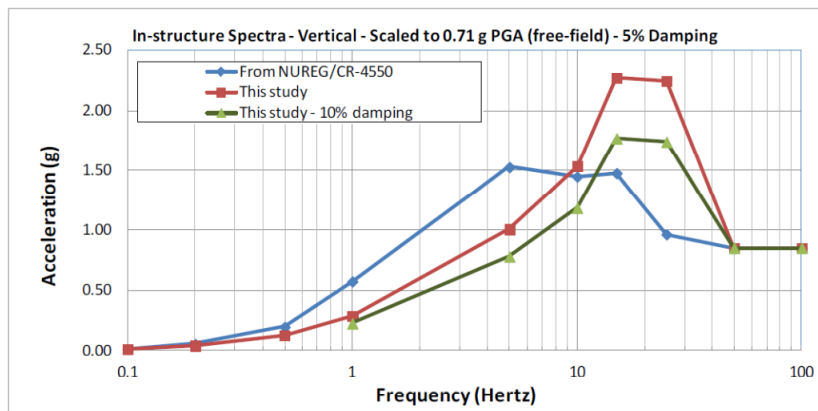
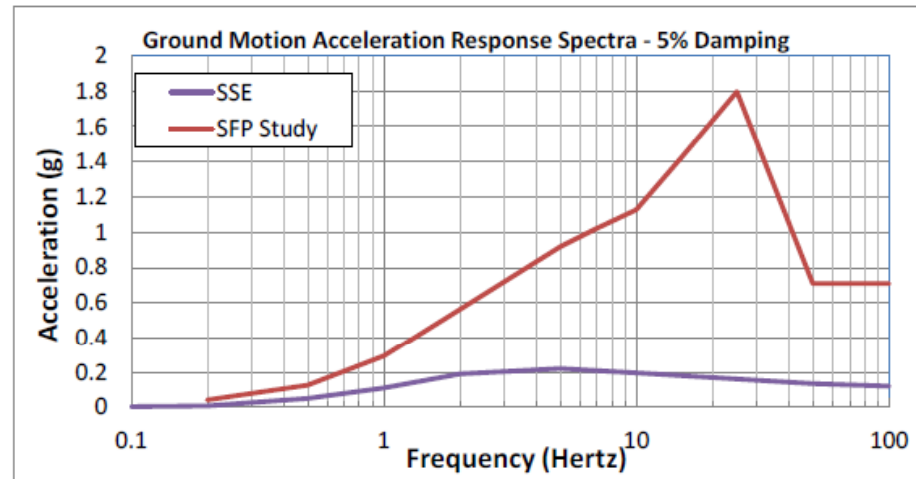
# Approximate Method



- Pool walls and floors approximated with resistance functions (e.g., Biggs)
- Enables estimation of frequency response and deflections under seismic demands

# Seismic Demands

- NRC Scoping Study ISRS utilized
- Equivalent acceleration based on maximum ISRS value (10% damping)
- Hydrodynamic pressures computed
- Demands combined using 100-40-40



# Phased Approach to SFP Evaluations

## ■ Phase 1 (2015-2016):

- Evaluation of non-structural considerations
- NP 6041 evaluation of structural elements below 0.8g
- Industry SFP design survey
- Finalize benchmarking/evaluation

## ■ Phase 2 (2016-2017):

- Identify two representative sites for detailed evaluation
- Perform analysis when ISRS from the two representative sites (above 0.8g) are provided from SPRA model(s)





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