NTTF 2.1 Spent Fuel Pool Evaluations

Approach For Sites with GMRS Peak Sa > 0.8g

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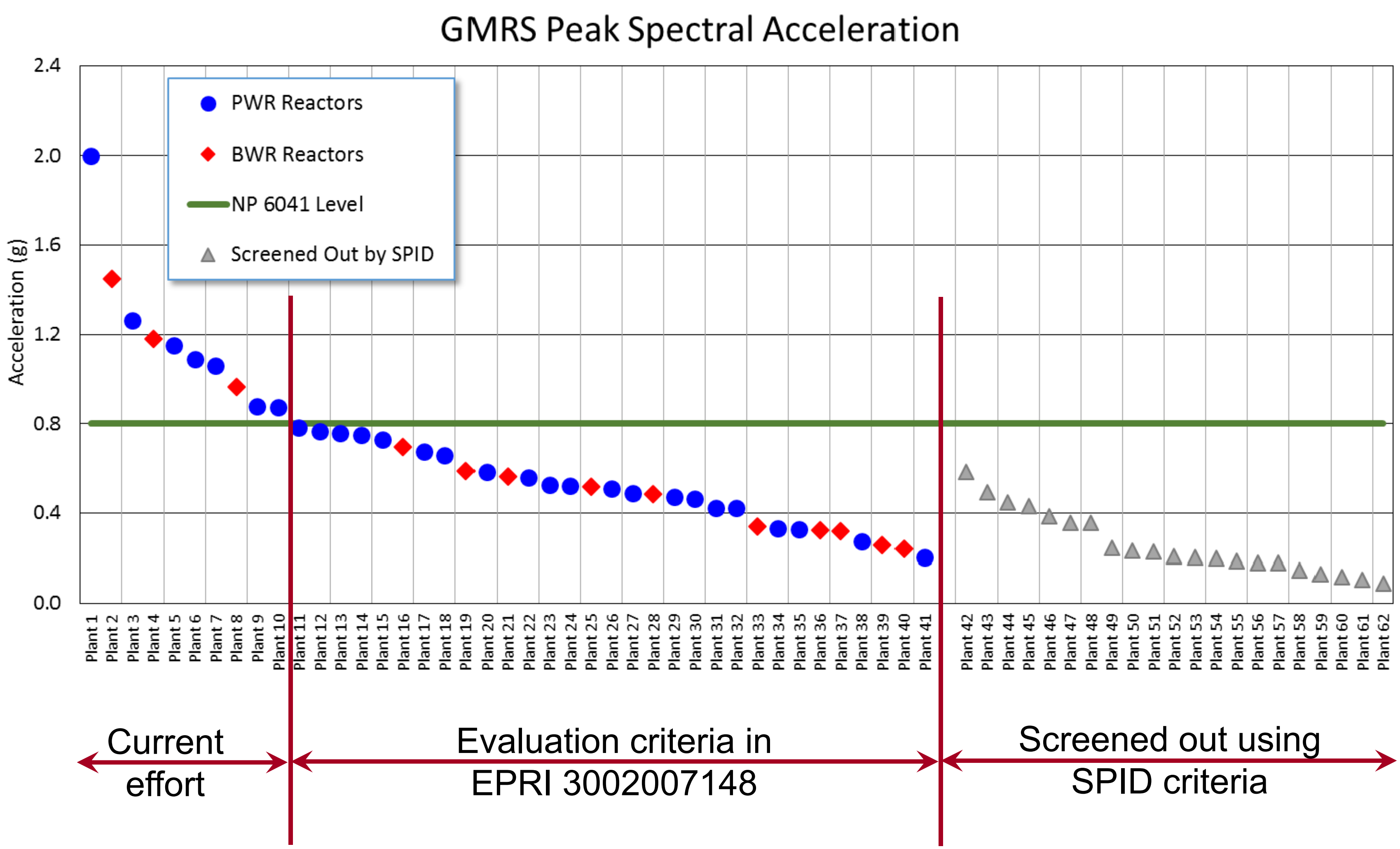
Discussion Outline

- Background on SFP Evaluation at Sites with GMRS Peak Sa > 0.8g
- Proposed plan
- SFP Structural Evaluation
  - Comparison to NRC SFP Scoping Study
- SFP Non-structural Evaluation
- Proposed Schedule

Background



GMRS Peak Spectral Acceleration
Acceleration (g)
2.4
2.0
1.6
1.2
0.8
0.4
0.0
PWR Reactors
BWR Reactors
NP 6041 Level
Screened Out by SPID
Plant 1
Plant 2
Plant 3
Plant 4
Plant 5
Plant 6
Plant 7
Plant 8
Plant 9
Plant 10
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Plant 55
Plant 56
Plant 57
Plant 58
Plant 59
Plant 60
Plant 61
Plant 62
Current effort
Evaluation criteria in EPRI 3002007148
Screened out using SPID criteria

Proposed Plan for Sites with GMRS Peak Sa > 0.8g

- Finalize SFP seismic model for structural evaluation
- Perform plant-specific structural evaluations using FRS derived from on-going SPRA models
  - Calculate site-specific floor and wall capacities
  - FRS available for several plants and evaluation will be performed in 2016
  - Some plants may defer evaluation until calculated FRS results are available
- Confirm adequacy of non-structural evaluation criteria; update as required:
  - Piping, gates and seals, anti-siphoning, sloshing, evaporation/boil-off
- Issue updated EPRI report
  - Will include available plant-specific structural results
  - Will include sloshing and evaporation/boil-off estimates for all plants with Sa > 0.8g

SFP Structural Evaluation

- Fragility of SFP structure governed by the wall or floor panels
- Development of analytical model of the SFP wall/floor panels
  - Single-degree-of-freedom model (similar to Biggs)
- Evaluates both out-of-plane shear and flexural failure modes
- Uses yield-line theory for estimating flexural capacity
- References ACI code provisions for estimating shear capacity
- For shear-limiting panels, ductility not credited
- Hydrodynamic pressures developed in accordance with ACI-350, “Seismic Design of Liquid-Containing Concrete Structures and Commentary”
- Current model assumes same seismic input as NRC SFP Scoping Study
- HCLPF capacity estimated using CDFM approach
- Submitted to NRC for comment

Comparison of Floor Results to NRC Scoping Study

Parameter	Seismic Model	NRC Scoping Study
Floor Frequency	14.7 Hz	14 Hz
Dead load pressure	5,490 psf	4,900 psf
Vertical hydrodynamic pressure	4,533 psf	4,800 psf
Seismic vertical pressure	8,093 psf	7,990 psf
Peak displacement	0.2 in	0.4 in
HCLPF	0.68g PGA	Not reported, estimated to be ~ 0.7g PGA

Confirmation that proposed approach aligns with the NRC detailed analysis for Peach Bottom in the Scoping Study

SFP Wall Results

Parameter	Seismic Model
Wall frequency	13.6 Hz
Dead load pressure	2,400 psf
Horizontal seismic pressure	2,890 psf
Peak displacement	0.14 in
HCLPF	2.1g PGA (out of plane shear)

As the wall HCLPF (2.1g PGA) > floor HCLPF (0.68g PGA), the floor is the limiting SFP structural member

SFP Non-Structural Evaluation

- Confirm adequacy of non-structural evaluation criteria developed in EPRI 3002007148, "Spent Fuel Pool Integrity Evaluation" and update as required:
  - Piping, gates and seals, anti-siphoning, sloshing, evaporation/boil-off

- Issue updated EPRI report, based on earlier report for plants with Sa ≤ 0.8 g, and include: Appendix for seismic model, updated non-structural evaluation and criteria

Non-Structural Drain-Down Mechanisms

Potential Rapid Drain-Down Mechanism	EPRI Report Approach (Sa ≤ 0.8g)	Current Effort (Sa > 0.8g)
Piping Connections	Past risk evaluations have found SFP piping, evaluated to SSE demands, to be rugged. Plants will confirm evaluation of SFP piping to SSE.	Confirm ruggedness under higher seismic demands. Considering a plant-specific review of selected cases as necessary to confirm rugged design.
Fuel Transfer Gate	Gates and seals have rugged designs with adequate capacity for GMRS Sa ≤ 0.8g. No further evaluation needed.	Confirm ruggedness under higher seismic demands. Considering a plant-specific review of of selected cases as necessary to confirm rugged design.
Siphoning	Anti-siphoning devices are rugged and not a significant contributor to rapid drain-down. NP-6041 required evaluation of active valves with extended operators. Plants to perform evaluation, if applicable.	Will utilize same approach. Plants to perform evaluation of extended operators, if applicable.
Sloshing	Plant-specific evaluation performed; Plants confirm SFP parameters enveloped.	Will perform plant-specific evaluation using same methods.
Evaporative Losses	Plant-specific evaluation performed; Plants confirm SFP parameters enveloped.	Will perform plant-specific evaluation using same methods.

Proposed Schedule

	Task Description	2016										
		F	M	A	M	J	J	A	S	O	N	D
1	Finalize SFP Seismic Model	■	■	■								
2	Perform Plant-Specific Structural Evaluations				■	■	■	■				
3	Develop Non-Structural Criteria (revise, as needed, existing criteria)						■	■	■			
4	Complete Report									■	■	■
5	NRC Communication			■			■			■		■

Summary

- Current endorsed criteria being implemented at sites with GMRS peak Sa ≤ 0.8g
- Developing evaluation criteria for remaining sites
  - Submitted the proposed structural capacity method for review
  - Requesting NRC concurrence on the general method and assumptions
  - Described plans for applying the structural capacity method
  - Described plans for developing the non-structural criteria
- Outlined the development schedule

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Backup – Non-Structural Criteria for Plants with SA ≤ 0.8g

Potential Rapid Drain-Down Mechanism	Evaluation	Applicability Criteria
Scope of Evaluation	Evaluations in Section 3.2 are applicable to plants with GMRS peak Sa ≤ 0.8g.	Site-specific GMRS has a peak Sa ≤ 0.8g.
Piping Connections	Past risk evaluations have found SFP piping, evaluated to SSE demands, to be rugged.	Attached piping up to the first valve designed (or evaluated) to the SSE.
Fuel Transfer Gate	Gates and seals have rugged designs with adequate capacity for GMRS with peak Sa ≤ 0.8g.	No additional criteria.
Siphoning	Anti-siphoning devices are rugged and not a significant contributor to rapid drain-down. In accordance with NP-6041 Table 2-4 [10], in cases where active anti-siphoning valves are used, confirmation that extremely large extended operators (attached to 2-inch or smaller piping) be walked down to confirm lateral support.	• Anti-siphoning devices exist in applicable piping systems • In cases where active anti-siphoning devices are attached to 2-inch or smaller piping and have extremely large extended operators, the valves should be walked down to confirm adequate lateral support.
Sloshing	Site-specific sloshing analyses show that inventory losses are minor. For plants with peak Sa less than 0.8g, a conservative estimate of SFP inventory lost to sloshing is 3 feet. This lost inventory is accounted for in estimating evaporative losses (below).	• Maximum pool dimension (length or width) is less than 125 ft. • SFP pool depth greater than 36 ft. • GMRS peak Sa < 0.1g at 0.3 Hz.
Evaporative Losses	Estimated time to heat up and boil-off and uncover more than 1/3 of the SFP fuel assemblies is more than 72 hours.	• SFP surface area greater than 500 ft^2. • Licensed core thermal power less than 4,000 MWt / unit.