

# **NTTF 2.1 Spent Fuel Pool Evaluations Approach For Sites with GMRS Peak $S_a > 0.8g$**

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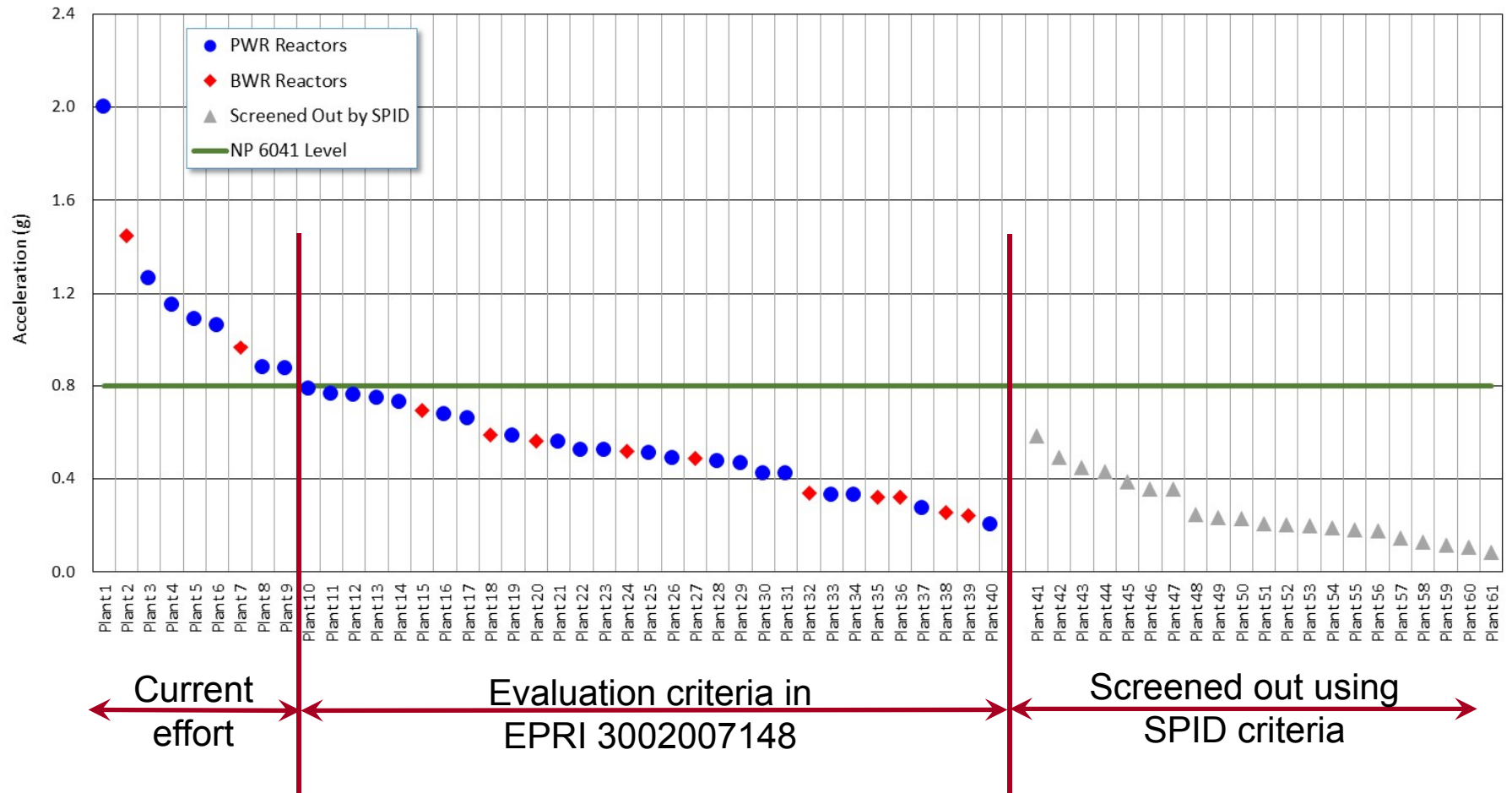


# Discussion Outline

- Background on SFP Evaluations
- Report Update for Higher GMRS Sites
  - SFP Structural Evaluations
  - SFP Non-structural Evaluations
- Path forward
  - Complete guidance
  - Implementation schedule

# Background

GMRS Peak Spectral Acceleration



## Report Update for Higher GMRS Sites

- EPRI 300200714 provides seismic evaluation criteria for sites where the GMRS Peak  $S_a \leq 0.8g$
- The updated EPRI report maintains the existing guidance for lower GMRS sites and adds criteria for sites with GMRS Peak  $S_a > 0.8g$ 
  - Structural evaluations
    - SFP seismic structural evaluation method provided
    - Plants perform site-specific structural evaluations using the evaluation method and site specific parameters (geometry, material properties, GMRS-based in-structure response spectra)
  - Non-structural evaluations
    - Generic evaluations provided for refueling gates, piping penetrations, siphoning conditions, sloshing, and boil off
    - Plants confirm applicability criteria

# Updated Report Outline

## Product Description

### Executive Summary

*New administrative section for EPRI reports*

### Section 1: Introduction and Purpose

*Minor updates*

### Section 2: Characteristics of Spent Fuel Pools

### Section 3: Seismic Review of Spent Fuel Pools at Low GMRS Sites

### Section 4: Seismic Review of Spent Fuel Pools at High GMRS Sites

### Section 5: Conclusions

### Section 6: References

### Appendix A: Spent Fuel Pool Data

### Appendix B: Sample Spent Fuel Pool Heat Up and Boil-Off Calculation

New  
criteria for  
sites with  
GMRS  
Peak  
 $S_a > 0.8g$

### Appendix C: Sample Spent Fuel Pool HCLPF Calculation

## Appendix C: Sample Spent Fuel Pool HCLPF Calculation

- Applied insights from NRC SFP Scoping Study
  - Fragility of SFP structure governed by the wall and floor panels
  - Used the Scoping Study example to benchmark an analytical model of SFP wall and floor panels
- Analytical model of the SFP wall and 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
  - Does not credit ductility for shear-limiting panels
  - Determined hydrodynamic pressures in accordance with ACI-350
  - Submitted to NRC for review in April 2016
  - Discussed in April 20, 2016 public meeting

## Section 4: Seismic Review of SFPs at High GMRS Sites

- Section 4 provides guidance for performing site-specific SFP wall and floor analyses using the methods from Appendix C
  - Guidance for determining all of the site-specific parameters necessary to perform the wall and floor plate analyses
    - Geometry
    - Material properties
    - Seismic demands
  - Guidance for performing the site-specific calculations
    - Stiffness, natural frequency, estimated forces, load combinations
    - HCLPF calculations
    - HCLPF comparison with GMRS
- Site specific submittal would describe the analyses and confirm that the  $HCLPF > GMRS$

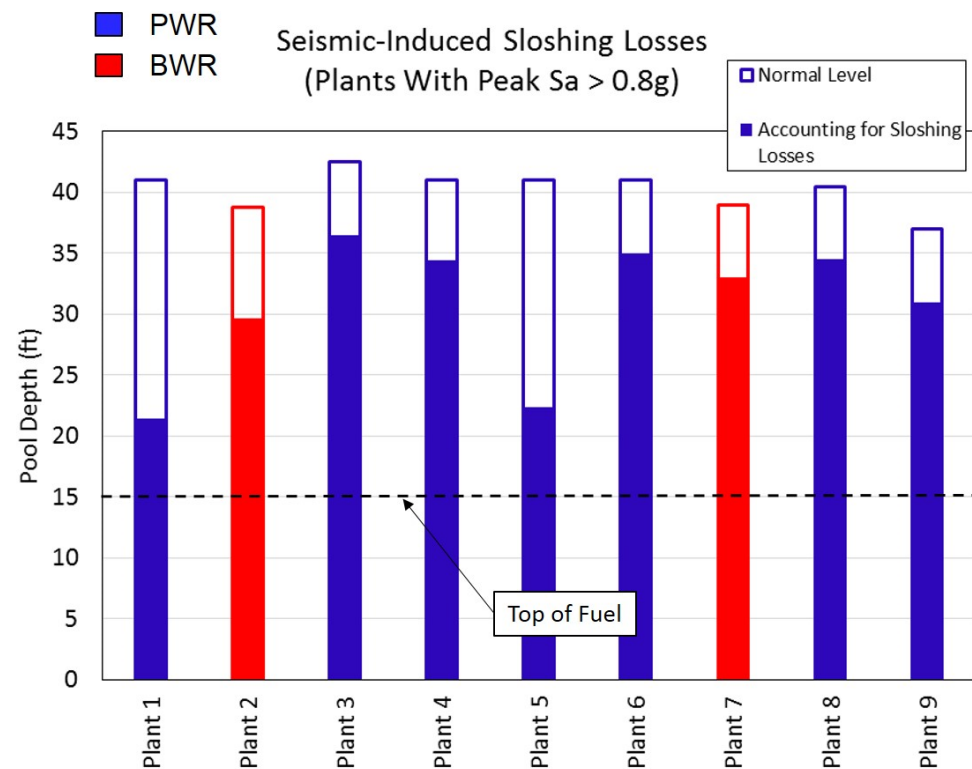
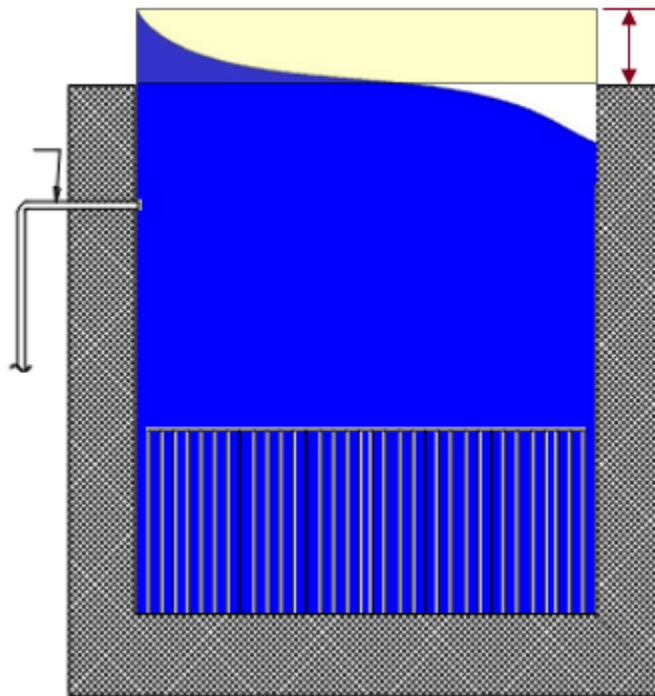
## Section 4: Seismic Review of SFPs at High GMRS Sites

- Section 4 also provides generic evaluations for non-structural items similar to the criteria for lower GMRS sites
  - Generic evaluations for refueling gates, piping penetrations, siphoning conditions, sloshing, and boil off
    - Refueling gates are adequately rugged
    - Piping penetrations are relatively high in the SFPs (no more than 6 ft from the top); therefore it is easier to assume they fail than to confirm seismic ruggedness to the GMRS
    - Anti-siphoning devices are required
    - Conservative sloshing estimates performed
    - Boil off estimates performed starting with the remaining inventory after accounting for losses through piping penetrations and sloshing
  - Plants confirm applicability criteria



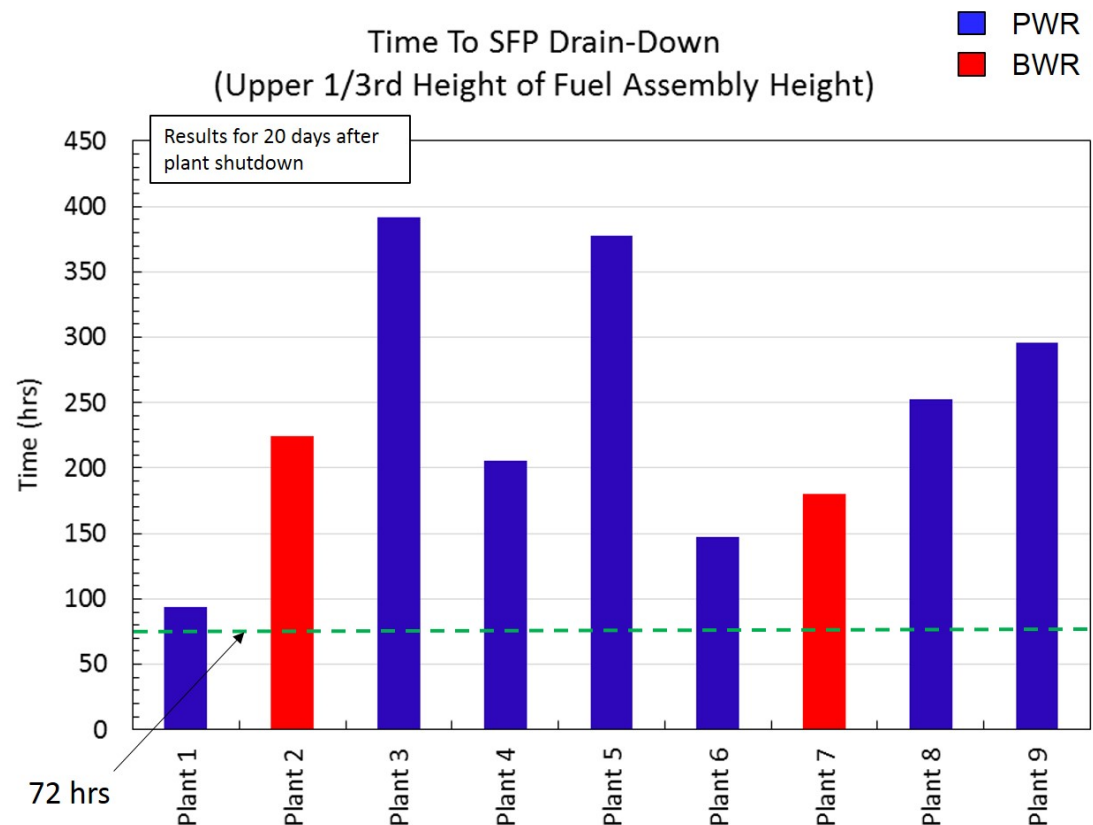
# Sloshing Estimates

Seismic induced sloshing inventory losses evaluated using criteria in EPRI 1025287, site-specific SFP geometry, and site-specific GMRS accelerations



## Boil Off Estimates – Adequate Inventory Up To 72 Hr

- Boil off estimates evaluated starting with the remaining inventory after accounting for losses through piping penetrations and sloshing and using the calculation methods in Appendix B of the EPRI SF report
- All plants have more than 72 hours before exceeding the inventory acceptance threshold in the SPID



# Non-Structural Drain-Down Mechanisms

Potential Rapid Drain-Down Mechanism	EPRI Report Approach ( $S_a \leq 0.8g$ )	Current Effort ( $S_a > 0.8g$ )
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 no penetrations lower than 6 ft. Assume inventory losses down to 6 ft.
Fuel Transfer Gate	Gates and seals have rugged designs with adequate capacity for GMRS $S_a \leq 0.8g$ . No further evaluation needed.	Gates and seals have rugged designs with adequate capacity for GMRS $S_a > 0.8g$ . No further evaluation needed.
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.	Use same approach. Plants to perform evaluation of extended operators, if applicable.
Sloshing	Plant-specific evaluation performed; Plants confirm SFP parameters enveloped.	Plant-specific evaluation performed; Plants confirm SFP parameters enveloped.
Evaporative Losses	Plant-specific evaluation performed; Plants confirm SFP parameters enveloped.	Plant-specific evaluation performed; Plants confirm SFP parameters enveloped.

## Path Forward

- Complete guidance following feedback from NRC
  - Expect final publication at the end of January 2017
  - NEI will submit final report to NRC for endorsement
- Implementation schedule
  - Licensee submittals due December 31, 2017 (per NRC Letter dated October 27, 2015)



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