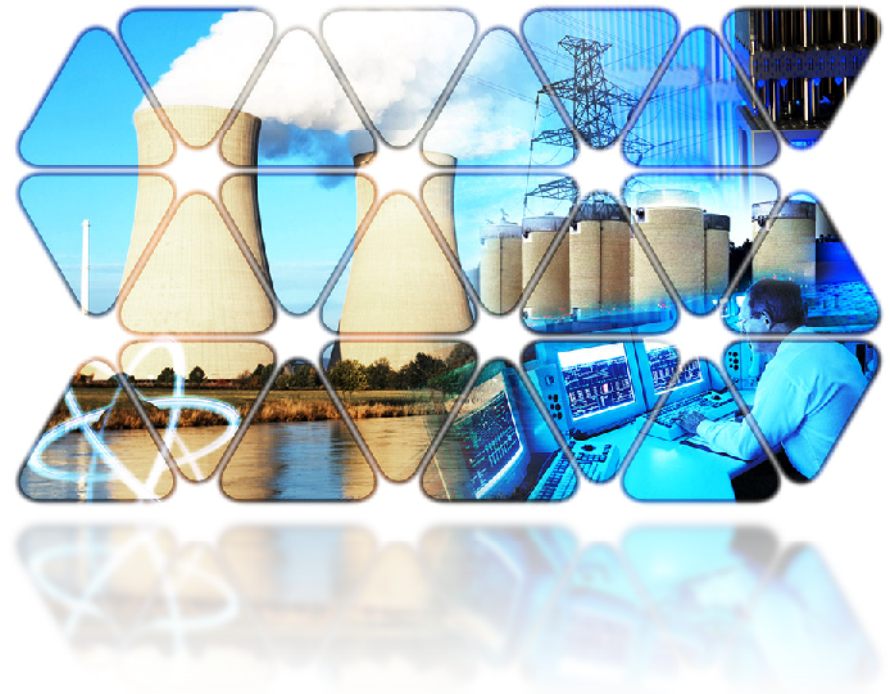


Spent Fuel Pool Seismic Evaluations

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NRC Meeting on Recommendation 2.1
October 21, 2015



Objectives

- Discuss NRC comments on Spent Fuel Pool White Paper
 - Structural considerations
 - Non-structural considerations
- Next Steps

Structural Comments

NRC Comment 1a

- Additional information should be provided to confirm on a plant-specific basis that SFPs do not have physical degradation

Response

- Licensees perform in-service inspection of SFP structures, systems, and components. NRC maintenance rule regulations (10CFR 50.65) require inspection and maintenance of the SFP:
licensee shall monitor the performance or condition of all structures, systems, or components associated with the storage, control, and maintenance of spent fuel in a safe condition, in a manner sufficient to provide reasonable assurance that these structures, systems, and components are capable of fulfilling their intended functions
- Any separate physical degradation assessment of the SFP Structure would be duplicative and unnecessary
- Physical degradation of SFP systems and components, judged susceptible to rapid drain-down, was included in the scope of 2.3 Seismic Walk-downs

Structural Comments (Cont'd)

NRC Comment 1b

- Additional information should be provided to confirm that plant design features and conditions do not preclude applicability of EPRI NP- 6041 Table 2-3.

Response

- There are only 2 conditions associated with the applicability of use of Column 1 (< 0.8 g peak S_a) of EPRI NP-6041 Table 2-3 for structures:
 1. The structure is required to have been designed to minimum of 0.1 g SSE, and
 2. The structure housing the SFP is required to have a seismic load resistance path consisting of one or more of the specified structural designs (reinforced concrete shear walls, reinforced concrete moment frames, structural steel frames, post-tensioned containments)
- SFP Survey confirmed that US Fleet of structures housing the SFP meet these two conditions

Structural Comments (Cont'd)

NRC Comment 1c

- Report should provide additional discussion demonstrating that potential effects of out-of-plane response for SFP walls and floor are not significant

Response

- At the low 0.8 g Peak Sa GMRS values, specific reviews not required based on EPRI NP-6041 screening table reviews
- Previous studies have specifically considered out-of-plane response and have confirmed seismic ruggedness of SFPs
 - NRC SFP Scoping Study (Peach Bottom) results indicate HCLPF (for out-of-plane response) of 0.5 PGA
 - NUREG 5176 documents HCLPFs (for out-of-plane response) of 0.65 PGA and 0.5 PGA for Robinson and Vermont Yankee, respectively

Structural Comments (Cont'd)

NRC Comment 2

- Report should identify the BWRs with Mark III containments as a separate design group and discuss these plants with the PWRs.

Response

- Interpret the NRC comment 2 as editorial:
 - Affects only the background description of SFPs
 - No effect on the justification for seismic adequacy for GMRS < 0.8g PSA
- Agree BWRs with Mark III containments have SFP structures different from earlier BWRs and they are closer to the PWR structural configuration
- Will change the white paper to reflect that distinction

Non-Structural Comments

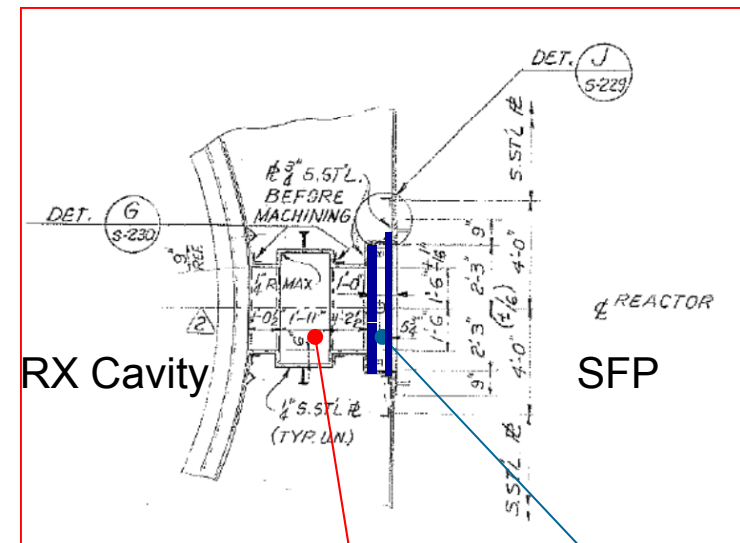
NRC Comments 1a and 1b.

- Minor clarifications are needed relating to (a) use of concrete blocks in refueling gate installation and (b) assumption regarding limited losses to adjacent cavities

Response

- Paper will clarify use of concrete blocks (plugs), which in some cases are installed for shielding purposes
- Paper will clarify assumptions pertaining to characterization of adjacent cavities in BWR (MI, MII, MIII) and PWR designs

Typical Section of a BWR Refueling Canal



Steel gates
Concrete blocks (plugs)

Non-Structural Comments (Cont'd)

NRC Comment 2

- Paper should be enhanced with a description of existing gate systems for comparisons with those in the NRC SFP Scoping Study

Response

- Paper Section 3.3.1.1 states that refueling gates have been shown to have high seismic ruggedness. Due to their ductile design (e.g. fabricated with steel with high elongation capacity), these gates are judged not to have controlling seismic capacities
- For refueling gates, hydrostatic pressure is a significant contributor to the total design demand. Although seismic pressures increase for the new GMRS demands, the increase in total pressure (hydrostatic + seismic) is not significant for plants with peak $S_a < 0.8$ g
- For higher seismicity sites with GMRS peak $S_a > 0.8$ g, seismic ruggedness of SFP gates will be confirmed.
- Paper will be revised to better emphasize gate ruggedness

Non-Structural Comments (Cont'd)

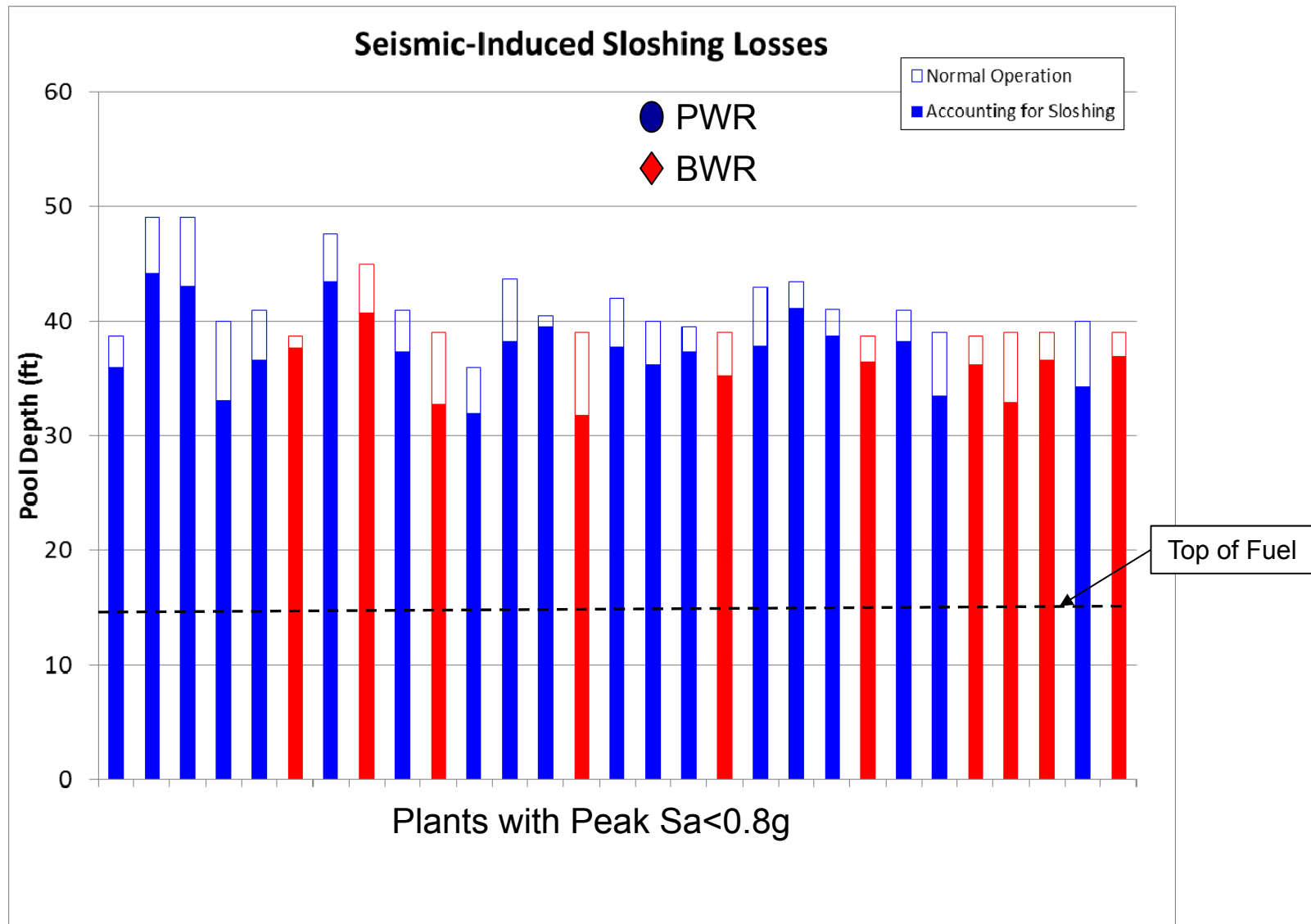
NRC Comment 3

- Median value approach for evaluating SFP water loss due to sloshing does not acceptably represent the plant-specific potential for water loss.

Response

- Industry survey of SFP geometry and SPID approach will be used to calculate sloshing losses on a plant-specific basis
- The SPID approach is judged to be conservative
- GMRS demands will be considered
- The paper will be revised to describe the results and conclusions
- Distribution of results rather than median results will be presented

Non-Structural Comments (Cont'd)



Non-Structural Comments (Cont'd)

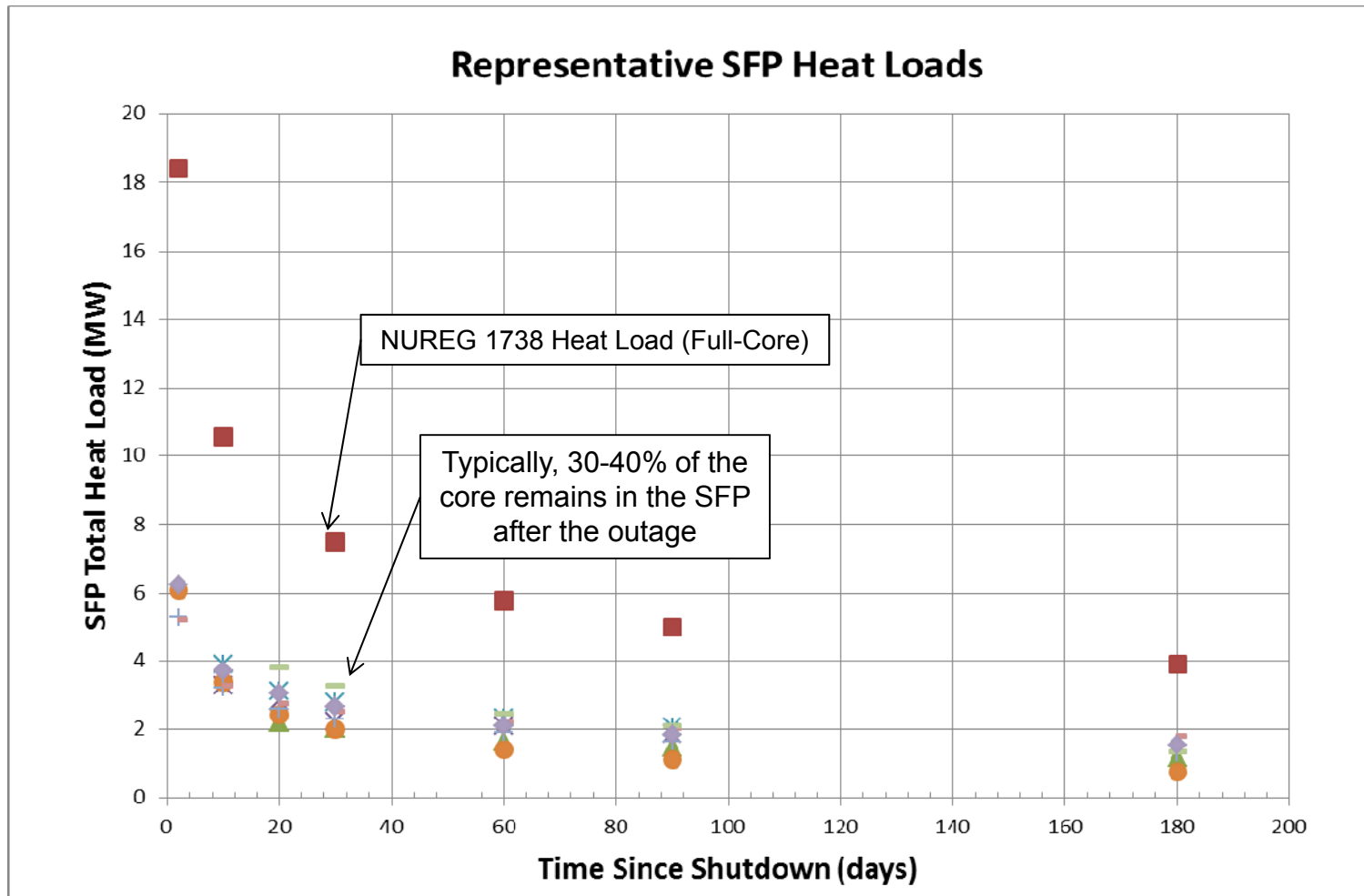
NRC Comment 4

- Should be confirmed that the NUREG-1738 approach does not underestimate the amount of evaporative SFP water loss and expand basis for assumed spent fuel pool heat loads.

Response

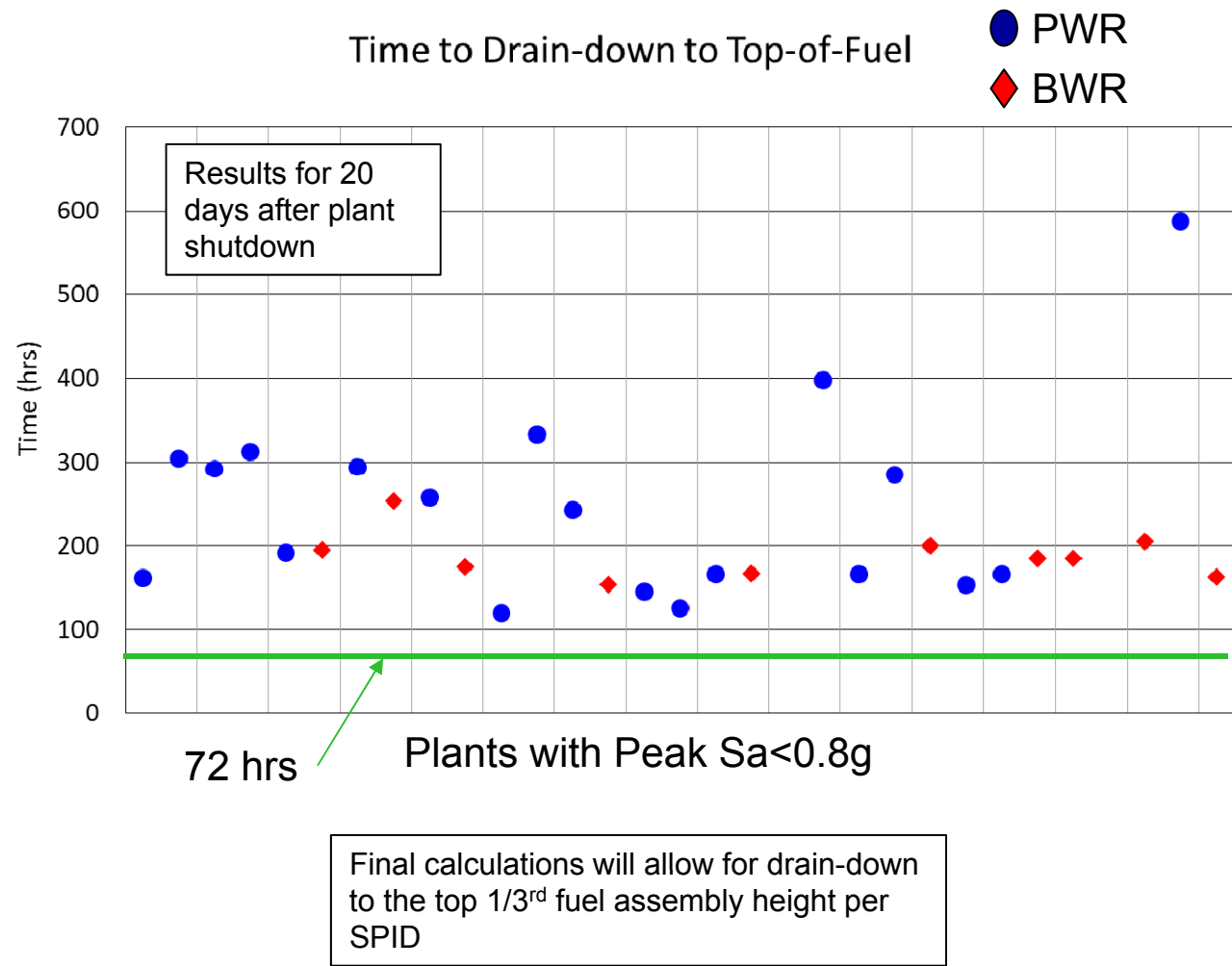
- The NUREG-1738 approach was referenced in the paper due to the inherent conservatism in SFP heat loads (e.g. small pool with a full-core off-load)
- Shift to a more realistic approach, where plant-specific heat-up and evaporation calculations have been performed
- Inputs will be based on realistic plant geometry and heat loading
- Calculation methods will be consistent with the SPID (Appendix EE to EPRI Report 1025295)
- Paper will be revised to include results of plant-specific evaporation calculations and bases for assumed heat loads

Comparison of NUREG 1738 and Plant Heat Loads



Results

- Results indicate plants with GMRS peak $S_a < 0.8g$ have more than 72 hours before uncovering tops of fuel assemblies (at 20 days after shutdown)
- Plant-specific pool geometry assumed
- GMRS sloshing effects considered in accordance with SPID (conservative)
- Heat-up and Boil-off calculations performed in accordance with SPID (Appendix EE of EPRI 1025295)
- Operator actions and Mitigation Strategies not accounted for





Together...Shaping the Future of Electricity

Appendix A from EPRI 6041 – Basis for Table 2-3 guidance

The "Panel" believes that for earthquakes less than 0.3g pga selected for screening, it is very unlikely that non-ductile details will be a problem. However, for earthquakes greater than 0.3g pga, potential structural problems should be investigated. In a margin review for a ground acceleration greater than 0.3g pga, the construction drawings and design criteria should be carefully reviewed. Simplified analyses conducted to determine if potential non-ductile problems exist that would require a margin evaluation may be justified.