



**SFST Staff's Perspective on
Status of ISFSIs at North Anna Nuclear
Power Plant after the
Seismic Event of August 23, 2011**

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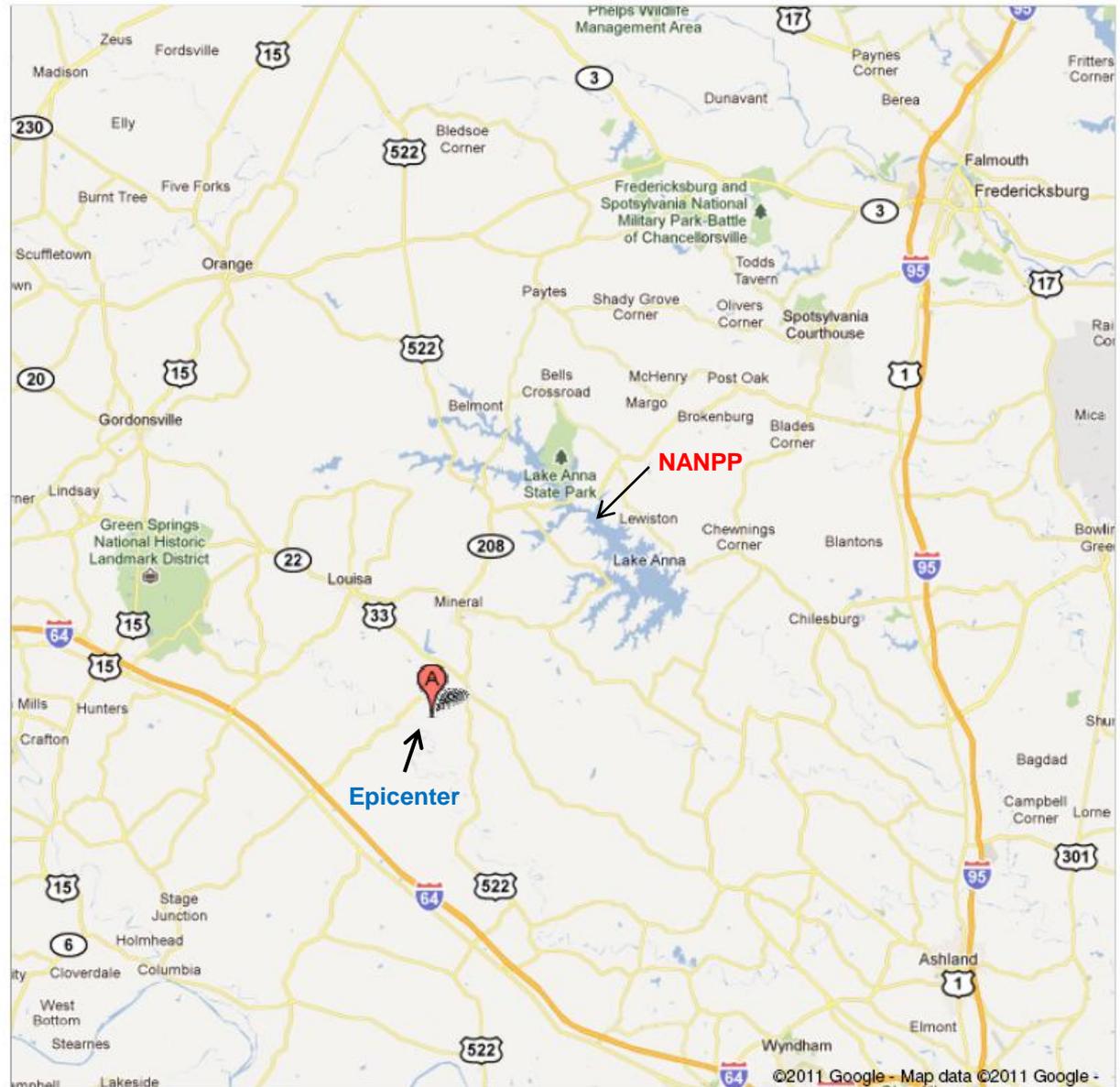
Presentation Outline

- ❑ Fact Sheet – What we know about the Seismic Event at North Anna Nuclear Power Plant [NANPP]
- ❑ North Anna Independent Spent Fuel Storage Installation (ISFSI) Licensing Bases
- ❑ Seismic Design Details of Storage Casks
- ❑ Design Details of ISFSI Pad # 1, and Pad # 2
- ❑ Status of ISFSIs after the Seismic Event
- ❑ Preliminary Assessment by NMSS Staff
- ❑ GI-199 and Implications to NANPP ISFSIs
- ❑ Potential Generic Follow-up for ISFSIs after this Seismic Event
- ❑ Action Plan for NANPP ISFSIs
- ❑ Summary and Conclusion



The Epicenter of the Seismic Event

*[Approx. Eleven
Miles (18 Km)
Southwest of
NANPP]*

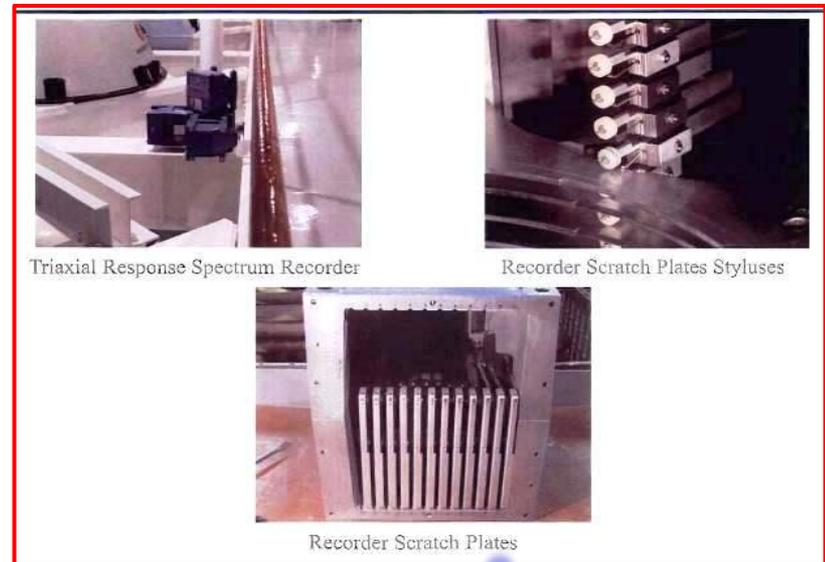


Fact Sheet – What we know about the Seismic Event?

- On August 23, 2011, NANPP declared an Alert due to significant seismic activity onsite from an earthquake which had a Magnitude $M_w^* = 5.8$
- The licensee conducted the 1st general walkdown of the plant as required by the NANPP abnormal procedure for seismic event
- The licensee conducted the 2nd walkdown after the Magnitude $M_w^* = 4.5$ aftershock

* M_w is defined as Moment Magnitude. Rather than relying on measured seismograph peaks, it is tied to the seismic moment of the earthquake and is proportional to slip on the fault multiplied by the area of fault surface that slips.

Fact Sheet – What we know about the Seismic Event? Contd..



- Reactor Seismic Response Spectrum Recorder (Engdahl-Scratch Plate) readings identified that the ground motions at certain frequencies, exceeded than what were postulated
- Kinematics Tri-axial Seismic Instrumentation also actively recorded the event
- Exceedance of the DBE is an unprecedented event at an operating unit, or at any licensed operating Independent Spent Fuel Storage Installation (ISFSI)

North Anna ISFSI Licensing Bases

- ❑ NANPP has two Design Bases Earthquake (DBE)* values
- ❑ Structures, Systems, and Components (SSCs) founded on top of rock anchored at 0.12g and SSCs founded on top of soil anchored at 0.18g
- ❑ NANPP has two corresponding Operating Basis Earthquake (OBE) values, anchored at 0.06g for rock and 0.09g for soil (OBE is $\frac{1}{2}$ of the DBE)

* Design Basis Earthquake means same as Safe Shutdown Earthquake (SSE) for NPP

Seismic Design details of Storage Casks

- The North Anna ISFSIs uses two spent fuel storage systems manufactured by Transnuclear (TN):
 - ❖ Vertical TN-32 metal casks under a 10 CFR Part 72 site specific license stored at ISFSI Pad # 1
 - FSAR defines the design acceleration values of Peak Ground Acceleration (PGA)* of 0.18g horizontal and 0.12g vertical
 - Sliding was not predicted to occur at these values
 - ❖ Horizontal TN-NUHOMS under a general license stored at ISFSI Pad # 2.
 - NUHOMS-HD components are designed to PGA values of 0.3g horizontal and 0.2g vertical

*

PGA is the maximum amplitude of the ground acceleration time-history. It is also referred to as Zero Period Acceleration (ZPA) of a single degree of freedom system with infinite stiffness.

ISFSI Pad # 1 [TN-32 Casks]



Design Details of ISFSI Pad # 1

- ISFSI reinforced concrete pad # 1 size is 224'x32'x2' and is designed to accommodate 28 TN-32 casks arranged in 14 rows of two casks with center to center spacing of 16'-0" in both directions (clear distance between adjacent casks is 8'-0")
- Concrete $f'_c = 3,000$ psi and Steel $F_y = 60$ ksi with Reinforcing #10 @ 12" each way at top and bottom of the slab
- American Concrete Institute (ACI) 349 code is used for the design
- A conservative value of 7'-0" diameter is assumed, using friction value $f = 0.25$ to analyze potential of sliding and overturning
- Seismic Factor of Safety (FS) = 1.17 against Sliding, and FS = 2.04 against Overturning

Design Details of ISFSI Pad # 1 Contd..

- Storage pad is founded on soil and is analyzed for five different cask loading patterns [Rock lies at least 30 feet below the grade level]
- Loading pattern with two casks placed at the center of the pad produced the maximum bending of the pad
- Dynamic analysis of the pad was performed using A Linear Continuum Mechanics Approach (CLASSI), and Structural Analysis Software System Interface (SASSI)
- Total 27 casks weighing 125 Tons fully loaded, are placed on ISFSI Pad # 1
- 25 of TN-32 casks moved due to the seismic event

Status after the Seismic Event ISFSI PAD # 1

□ TN-32:

- TN-32.21 cask moved 4.5” in SE direction from original location
- Six cask sets (12 casks) were closer than the separation distance specified in the FSAR
- No damage was observed to the pressure monitors in each cask
- No pressure monitoring system alarms during or after the earthquake
- No crack indications observed in the concrete pad or casks



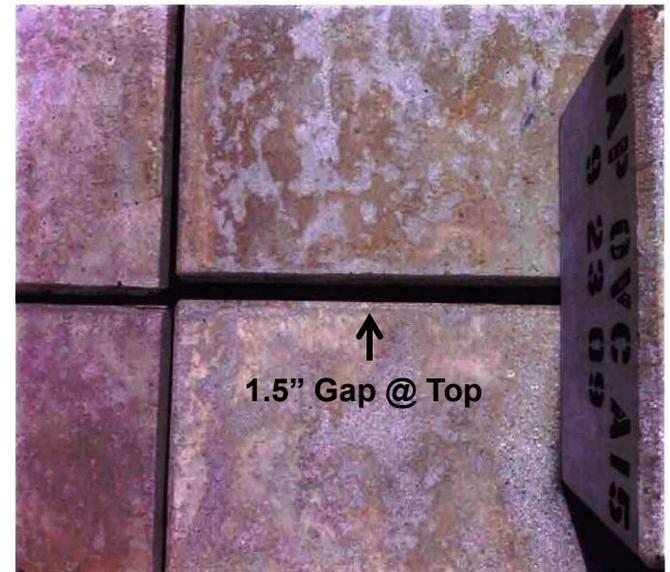
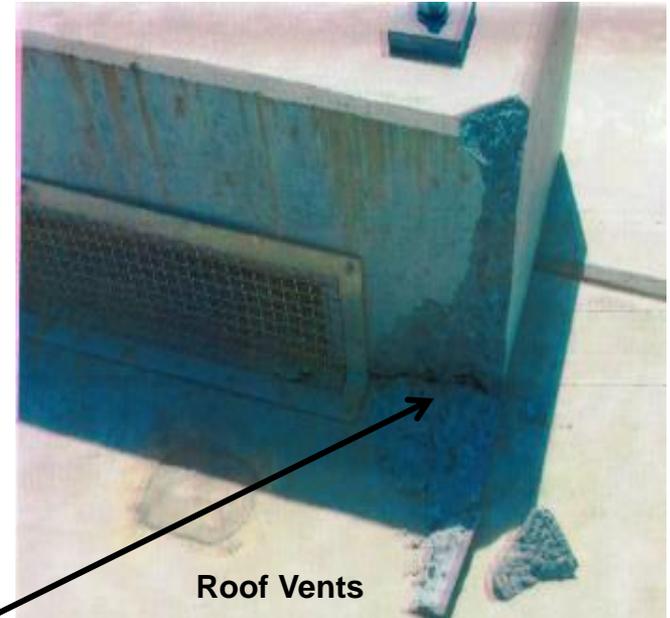
ISFSI Pad # 2 [TN-NUHOMS-HD Casks]



Status after the Seismic Event ISFSI PAD # 2

□ TN-NUHOMS-HD:

- Total Twenty Six (26) HSM-HD 32PTH are placed, out of which 13 HSM are loaded
- Slight non-structural damage was observed on the loaded modules HSM-01, HSM-03
- Most of the observed damage was superficial and on unloaded HSMs
- Slight damage around the outlet vents and some surface cracking indications were observed near roof vents
- Some modules showed gaps between them of approximately 1.5" versus the required 1.0" maximum gap
- It is unknown at this point, whether 1.5" gap existed prior to the seismic event



Preliminary Assessment of ISFSIs by SFST Staff

- There are no immediate safety issues:
 - The casks withstood the earthquake event
 - The spent fuel continues to be surrounded by several tons of steel and concrete, and sealed in an inert helium environment
 - Damage to concrete components appear to be cosmetic, and does not impact structural integrity or radiation shielding capability

Preliminary Assessment of ISFSIs by SFST Staff Contd...

- Inlet and outlet vents were inspected by the licensee and no exterior blockage was found
- Radiation surveys performed by the licensee indicate no changes to cask surface dose rates
- No abnormal temperature differences noted during thermal performance measurements for all loaded casks

GI-199 and Implications

- ❑ Geographic areas located east of the Rocky Mountain Front (East of approximately 104° West Longitude) are generally known as the Central and Eastern United States (CEUS)
- ❑ Generic Issue 199 (GI-199), “Implications of Updated Probabilistic Seismic Hazard Estimates in CEUS on Existing Plants”
- ❑ A study by the NRC/NRR staff shows that probability for earthquake ground shaking above the Design Basis Earthquake (DBE) for some nuclear power plants may be higher than previously understood for some currently operating CEUS sites

GI-199 and NANPP ISFSIs

- ❑ In CEUS Forty Eight (48) ISFSIs are collocated at the Reactor Sites [Majority are at Operating Reactor Sites, and few at now Decommissioned Reactor Sites]
- ❑ A preliminary review by the SFST staff indicated that DBE used for cask designs at the existing ISFSI locations in the CEUS have adequate safety margin (DBE/SSE)
- ❑ NANPP is located in Virginia (CEUS), hence it is already covered by ongoing GI-199 seismic related issues

Potential Generic Follow-up for ISFSIs after this Seismic Event

- ❑ New seismic hazard information currently treated as a beyond design basis event (could be changing in future?)
- ❑ Two approaches traditionally used to assess the effects:
 - Seismic Margin Assessment (SMA)
 - Seismic Probabilistic Risk Assessment (SPRA)
- ❑ NRC quick estimates demonstrated that seismic risks may have increased sufficiently to warrant reevaluation
 - All 104 US plants were included in GI-199 review
 - Reevaluation methods are being discussed among NRC and the licensees, but could center around SMA and SPRA
- ❖ Adequacy of the casks, as well as support pad design will be assessed by the ISFSI licensees (General or Site-specific as applicable), when updated seismic demand is available in future

Action Plan for NANPP ISFSIs

- ❑ In collaboration with the NRC Region II office, SFST plans to collect all technical and licensing data pertinent to the ISFSIs & the seismic acceleration details of the 8-23-11 event
- ❑ As needed, schedule a site visit to NANPP to survey the in-situ condition of ISFSIs, and review relevant technical documents, available at the site
- ❑ Assess the continued technical adequacy of the TN-32, ISFSI pad #1, TN NUHOMS-HD 32PTH, ISFSI pad # 2

Summary and Conclusion

- ❑ As of now, the quality of the strong motion recording data and the technical accuracy of the information available to the SFST staff is unknown
- ❑ The effective seismic accelerations at the top of the ISFSI pad are yet unknown to the SFST staff
- ❑ Licensee is still assessing the ground motion recording data, and will determine the accelerations for ISFSIs
- ❑ Information from the NANPP when available, will be used to evaluate the adequacy of ISFSIs
- ❑ There are no immediate safety issues for ISFSIs as a result of this seismic event



United States Nuclear Regulatory Commission

Protecting People and the Environment

Questions From the Audience

