



NRC-011

# **Combined License Application Review North Anna 3 (NA3)**

## **Safety Panel March 23, 2017**

# Panelists

- **James Shea – Senior Project Manager**
- **Vladimir Graizer – PhD Geophysicist**
- **Manas Chakravorty – Senior Structural Engineer**
- **Matt Thomas – Reactor Systems Engineer**

# **Safety Panel Topics**

- **Mineral, Virginia Earthquake**
- **Certified Seismic Design Response Spectra (CSDRS) exceedances effect on Structure, Systems, and Components (SSCs) including reactor fuel**

# **NA3 Seismic Closure Plan 2014**

- **March 11, 2011, Fukushima event**
- **August 23, 2011, Mineral, Virginia earthquake**
- **Central Eastern United States-  
Seismic Source Characterization  
Model (CEUS-SSC) (2012)**
- **The EPRI Ground Motion Model  
(GMM) updated (2013)**

# Seismic Parameters

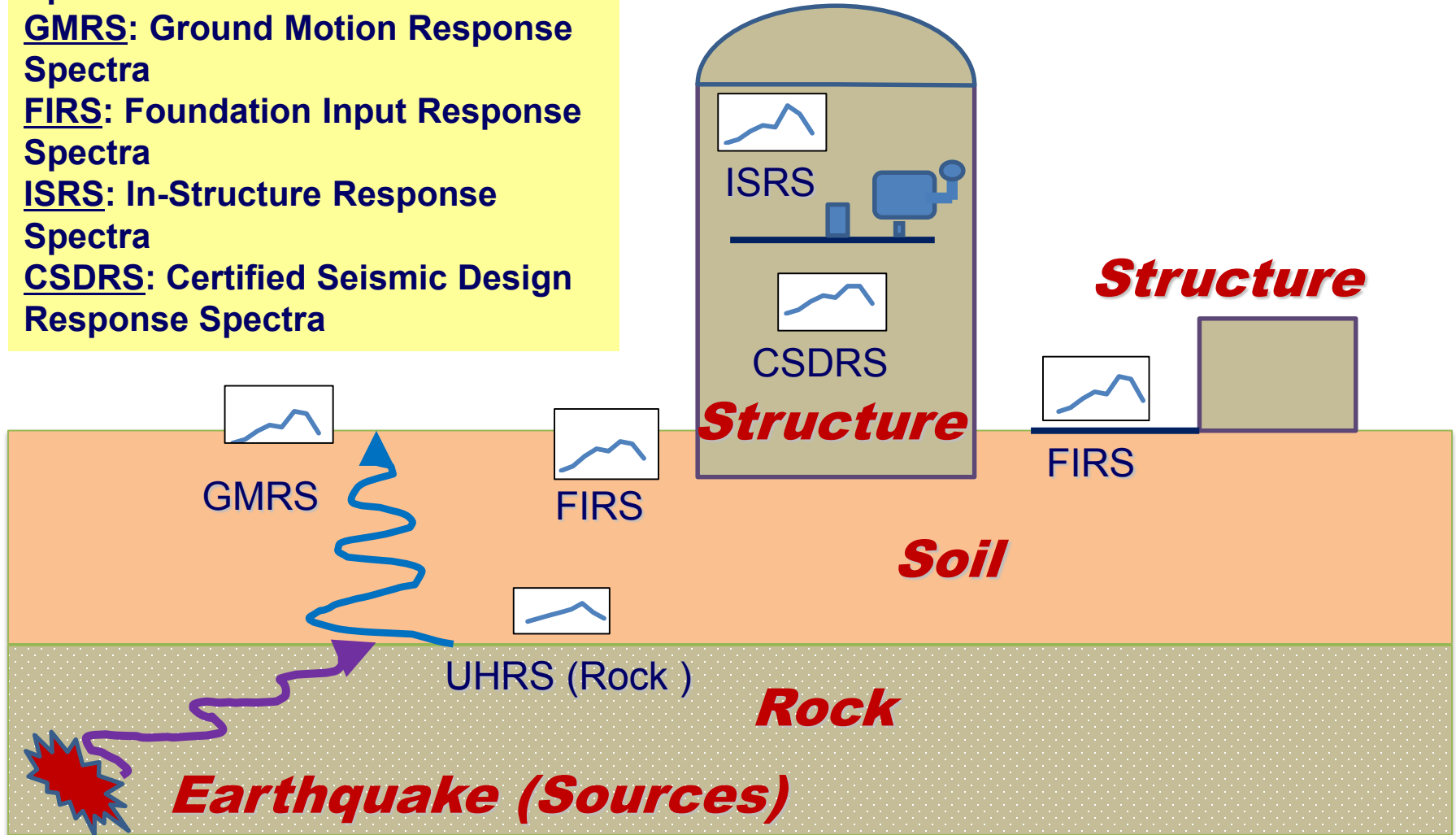
**UHRS: Uniform Hazard Response Spectra**

**GMRS: Ground Motion Response Spectra**

**FIRS: Foundation Input Response Spectra**

**ISRS: In-Structure Response Spectra**

**CSDRS: Certified Seismic Design Response Spectra**



# **Safety Panel Topic 1**

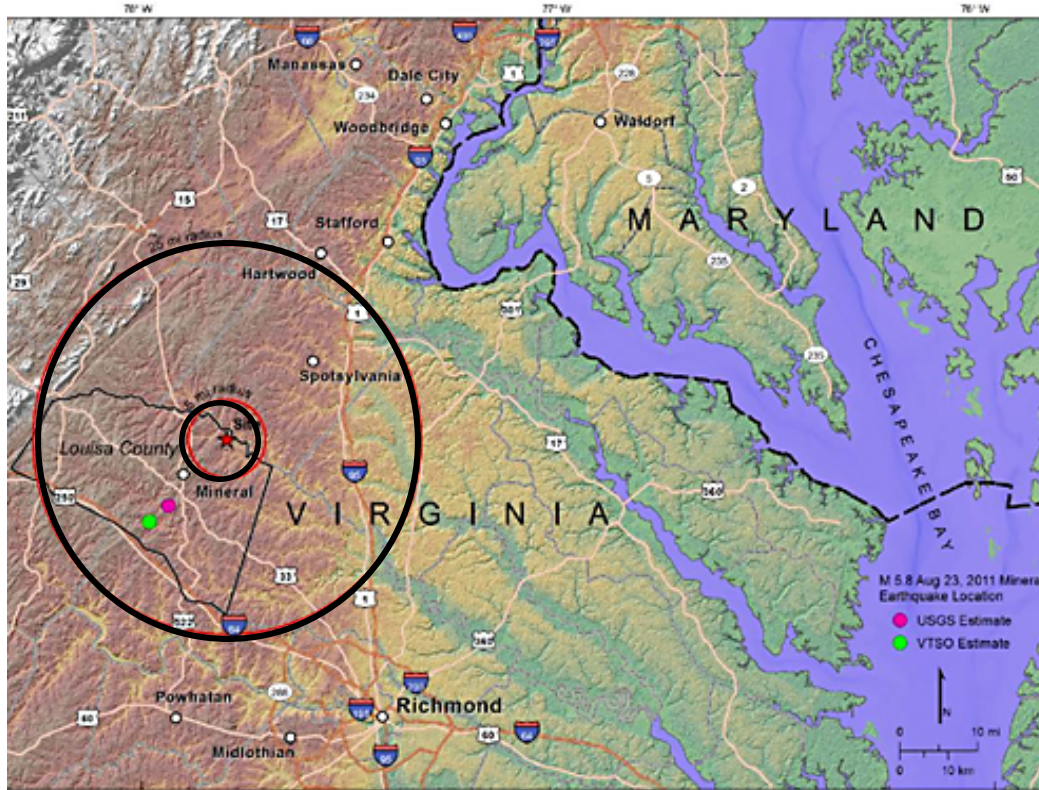
- **Mineral Virginia Earthquake**
- **ESBWR CSDRS Exceedance**

**Vladimir Graizer – PhD Geophysicist  
Office of New Reactors**

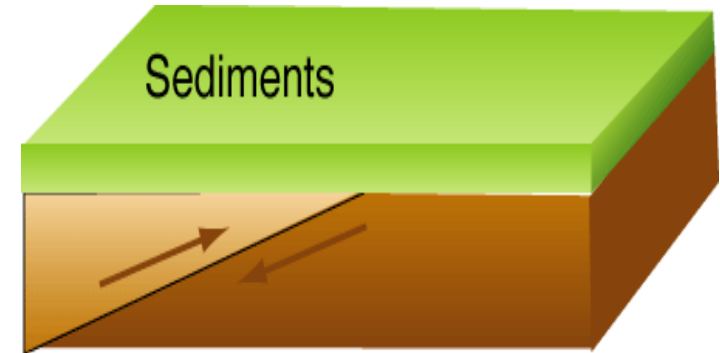
# **Mineral, Virginia Earthquake August 23, 2011**

- M5.8 11 miles from NA3 Site**
- Central Virginia Seismic Zone**
- Exceeded Design Basis  
Earthquake for NA1&2**
- Staff requested reassessment of  
the NA3 Probabilistic Seismic  
Hazard Analysis (PSHA)**

# North Anna Site and Mineral, Virginia Earthquake



From NA3 FSAR Figure 2.5.2-228



**Mechanism of the earthquake was blind reverse fault with hypocenter located at the depth of 5 miles.**



# **Variance from ESP**

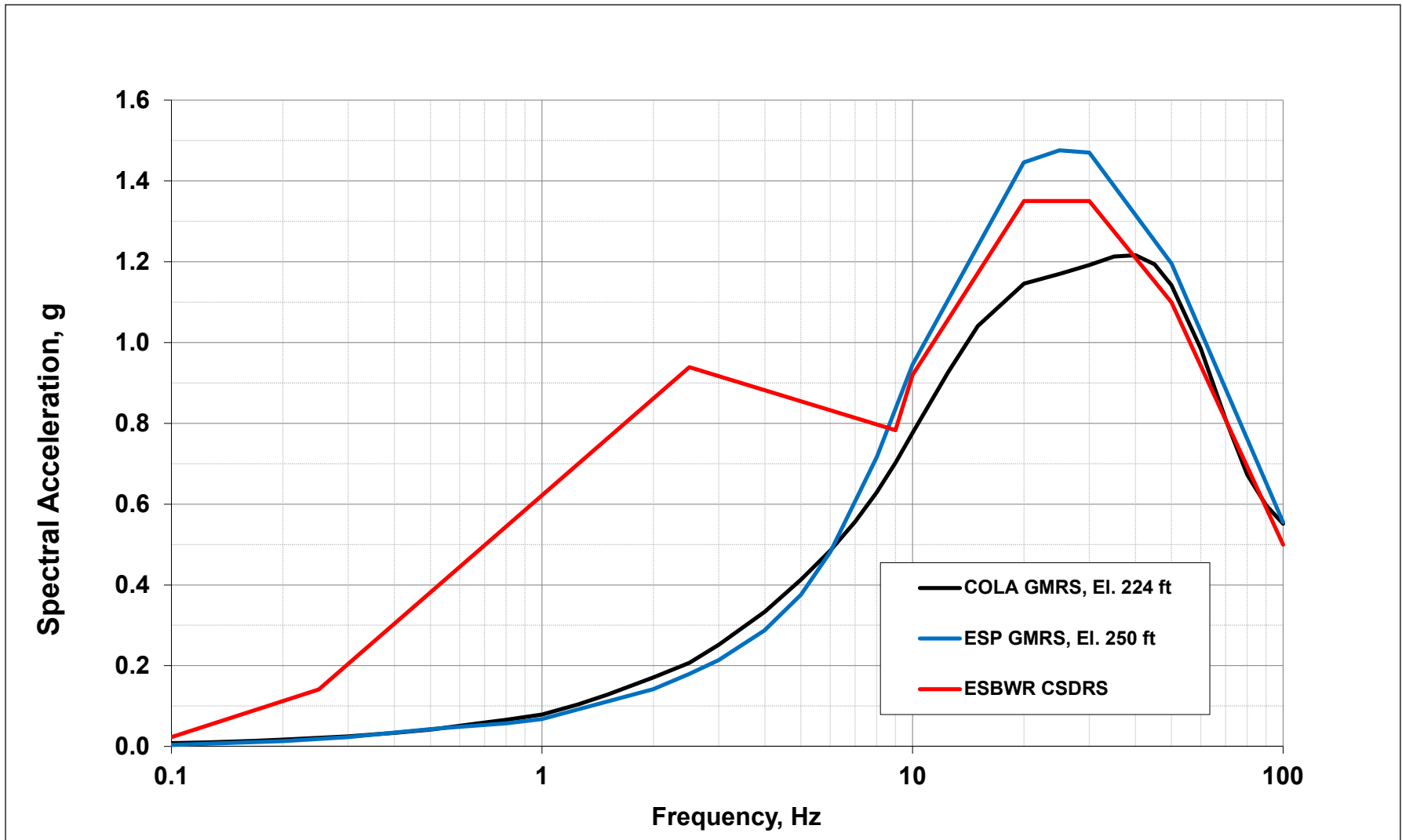
**Variance NA3 (2013) ESP VAR 2.0-4:  
The applicant took a variance from  
values in the ESP because of:**

- Different building elevations than assumed in ESP**
- New CEUS-SSC model (NUREG-2115 2012) and new Ground Motion Model (EPRI, 2013)**
- Mineral, Virginia earthquake**

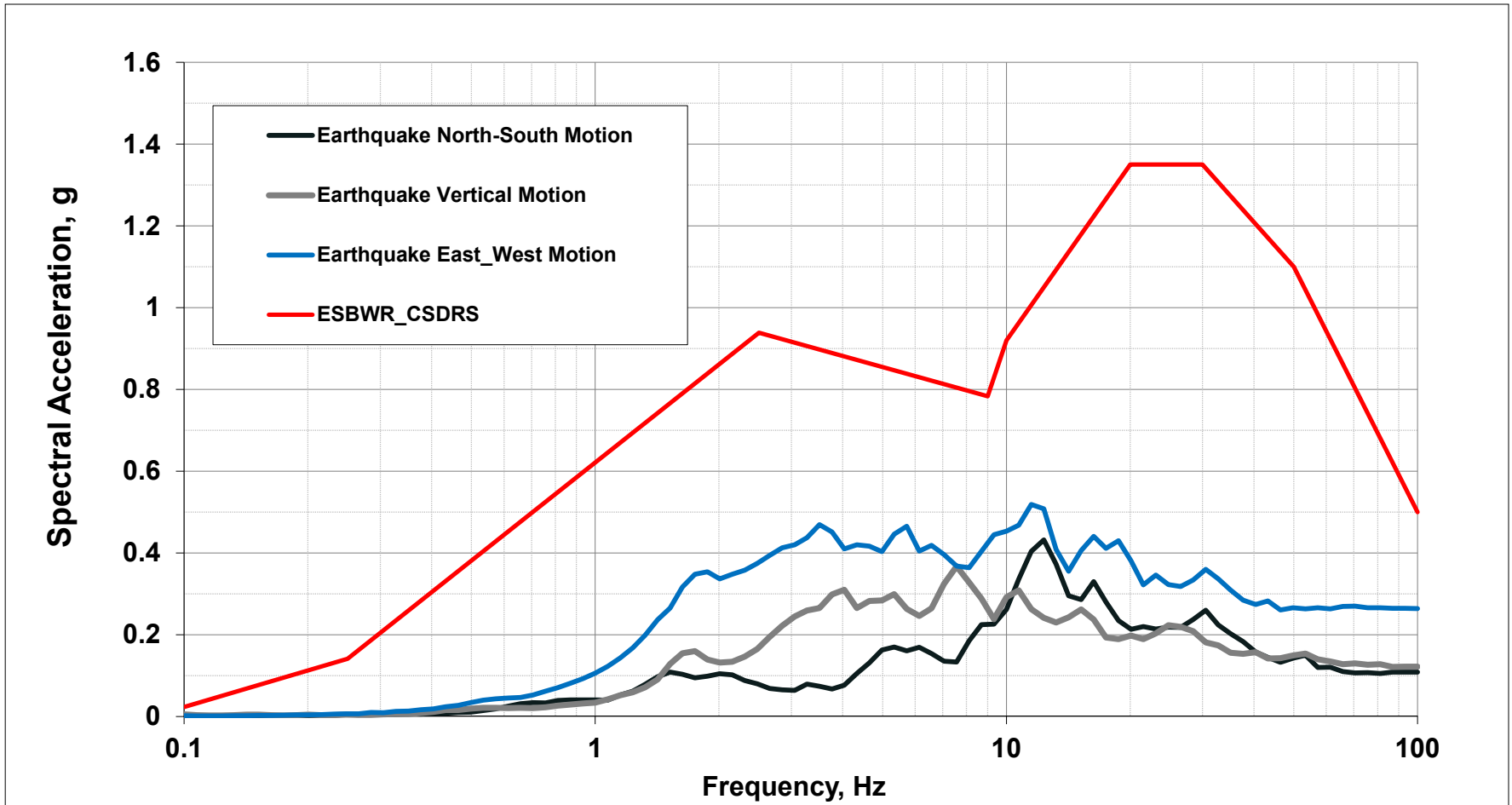
# **Vibratory Ground Motion**

- **Staff performed independent PSHA based on updated models**
- **Staff confirmed that the site-specific COLA ground motion response spectra (GMRS) envelope the North Anna 3 site variations (FSER Chapter 2 Section 2.5.2)**

# NA3 GMRS and ESBWR CSDRS



# Mineral Earthquake Compared to ESBWR CSDRS



# Conclusion

- **The site-specific GMRS adequately represents the seismic hazard at the NA3 site and meets the relevant regulatory requirements provided in 10 CFR Part 52 and 10 CFR Part 100**

# **Safety Panel Topic 2**

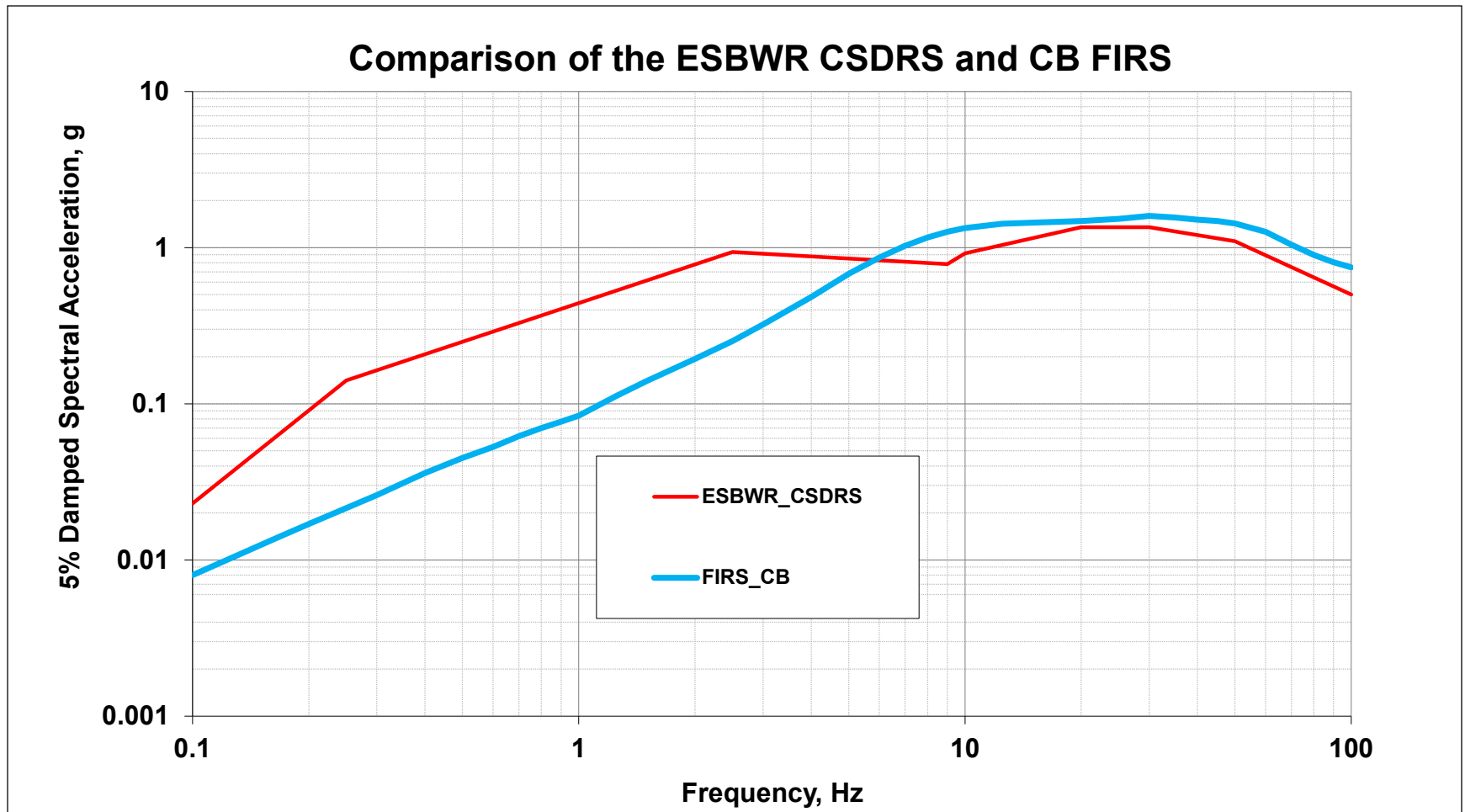
**CSDRS exceedances and its effect  
on NA3 site specific SSCs**

**Manas Chakravorty – Senior  
Structural Engineer  
Office of New Reactors**

# **CSDRS exceedances affect NA3 site specific SSCs**

- **Staff evaluation of the NA3 site specific SSCs analysis evaluated in FSER Chapter 3 Section 3.7 and Section 3.8**
- **NA3 Departure 3.7-1**
- **NA3 Exemption 3**

# NA3 Site Foundation Input Response Spectra (FIRS)





# **Site-Specific Analyses**

**Because of this exceedance, the applicant performed:**

- **Site-specific analysis to establish seismic demand using FIRS**
- **Site-specific evaluations of Category 1 structures, systems, and components**

# Site-Specific Evaluation

- **Soil-structure interaction (SSI) analysis was performed to establish the site-specific seismic demand**
- **Site-specific seismic demand including the In-Structure Response Spectra (ISRS) exceed DCD seismic demand**

# Site-Specific Evaluation

- **Staff reviewed the standard design using the site specific seismic and standard design non-seismic loads which identified some site-specific design changes**
- **Site-specific required changes include arrangement of rebar, the size of shear ties, welds, anchor bolts and a steel girder**

# Site-Specific Evaluation

- **Staff verified by audit and confirmatory analysis that site-specific seismic demands using the standard methodology required some minor changes to the standard ESBWR**
- **With these structural design changes, the design met ESBWR acceptance limits**

# Site-Specific Evaluation

- **Site-specific ISRS that exceed standard design ISRS are used for qualification of equipment and components**
- **ITAAC ensure that the Seismic Category I SSCs are qualified to the seismic design basis loads**

# Conclusion

- **Staff confirmed that site-specific seismic loads and non-seismic standard loads with the identified design changes do not exceed structural acceptance limit of the ESBWR standard design**
- **Therefore, with the identified changes, the ESBWR design is acceptable at the NA3 site**

# **Safety Panel Topic 3**

## **Fuel Assembly and Control Rod Structural Response**

**Matt Thomas –  
Reactor Systems Engineer  
Office of New Reactors**

# **Increased Seismic Loads**

- **NA3 site-specific seismic exceedances (NA3 DEP 3.7-1) cause increased accelerations at the fuel assembly and control rods**
- **Staff requested the applicant to perform an analysis to demonstrate that fuel assembly and control rod capacity limits are not exceeded under site-specific conditions**



# **Fuel and Control Rod Review**

- **The staff reviewed the applicant's site-specific analysis of the fuel assembly and control rod structural response using SRP 4.2 Appendix A**
- **The staff conducted an audit of the site-specific calculations to confirm that the applicant followed the DCD methodology**

# Conclusion

- **The staff found that the increase in the combined loading of the fuel assembly and control rod remains bounded by the approved capacity limits; therefore, the fuel assemblies and control rods meet GDC-2**

# Acronyms

- **CB – Control Building**
- **CEUS-SSC – Central and Eastern U.S. Seismic Source Characterization**
- **COL – Combined Operating License**
- **COLA – Combined Operating License Application**
- **CSDRS – Certified Seismic Design Response Spectra**

# Acronyms

- **DCD – Design Control Document**
- **DEP – Departure from Standard Design**
- **EPRI – Electric Power Research Institute**
- **EPRI-SOG – Electric Power Research Institute – Seismic Owners Group**
- **ESBWR – Economic Simplified Boiling Water Reactor**

# Acronyms

- **ESP – Early Site Permit**
- **FIRS – Foundation Input Response Spectra**
- **GDC – General Design Criteria**
- **GDC-2 – Appendix A to 10 CFR Part 50 - Criterion 2—Design bases for protection against natural phenomena**
- **GMRS – Ground Motion Response Spectra**

# Acronyms

- **ISRS – In-Structure Response Spectra**
- **ITAAC – Inspections, Tests, Analyses, and Acceptance Criteria**
- **NA3 – North Anna 3**
- **NA1&2 – North Anna Units 1&2**
- **PSHA – Probabilistic Seismic Hazard Analysis**
- **SRP – Standard Review Plan**

# Acronyms

- **SSCs – Structures, Systems, and Components**
- **SSE – Safe Shutdown Earthquake**
- **SSI – Soil-structure interaction**
- **UHRS – Uniform Hazard Response Spectra**
- **VAR – Variance to NA3 ESP**