



JENSEN HUGHES

Advancing the Science of Safety

INSIGHTS FROM THE APPLICATION OF THE HYBRID APPROACH TO SEISMIC HUMAN RELIABILITY ANALYSIS AT THE OCONEE NUCLEAR STATION

ELIZABETH COOK

September 25, 2017

OVERVIEW

- Hybrid Approach
- Analysis
- Insights
- Conclusion & Questions



HYBRID APPROACH TO SEISMIC HRA

- Utilizes more damage bins than the EPRI approach

Table 4-2
Damage state definitions for screening

Damage State Bin #	External Event Damage State Description
1	No damage to the plant safety-related SSCs or non-safety SSCs required for operation. Limited damage to non-safety, non-seismic designed SSCs like residences and office buildings.
2	No expected damage to the plant safety-related SSCs or to rugged industrial type non-safety SSCs required for operation. Damage may be expected to non-safety SSCs not important to plant operations and to the switchyard (e.g., LOOP expected). Some falling of suspended ceiling panels.
3	Widespread damage to non-safety related SSCs and/or some damage expected to safety related SSCs. Significant number of vibration trips and alarms requiring resetting.
4	Substantial damage to safety related and non-safety SSCs. This is particularly applicable to external events susceptible to a cliff-edge effect.

An Approach to Human Reliability Analysis for External Events with a Focus on Seismic. EPRI, Palo Alto, CA: 2016. 3002008093.



HYBRID APPROACH TO SEISMIC HRA

OCONEE SEISMIC BINS

- Step 1: Review the SEL (after screening) to identify SSCs whose failure can affect the PSFs for human failure events.
- Step 2: Rank order these SSCs
 - Level of difficulty/complexity
 - HCLPF
- Step 3: Define damage bins that include failures of the group of SSCs.
- Step 4: Describe the human performance context that is represented by the failure of the SSC group.
- Step 5: Develop a set of PSF adjustment rules specific to the presumed damage for each bin and apply these rules to the HEPs.



ANALYSIS

SCREENING

- Developed 6 bins
- Some of the bins “collapsed out”
- Applied the PSF adjustments to the remaining bins
- Screening was too conservative
- Could not live with MCR control failing at low g-levels



ANALYSIS

DETAILED

- Credited the Safe Shutdown Facility (SSF)
 - SSF is used for numerous scenarios at Oconee
 - FLEX Phase I
- Determined what the risk-drivers
 - Refined existing operator actions
 - Developed new operator actions
- Developed new FLEX actions



INSIGHTS

- Mindset Shift from Other HRAs
 - Scenarios are more severe and damage more widespread
 - No seismic procedure
- Identifying SSCs Important to Operator Actions
 - Increased interaction with the SPRA team in initial development
 - Gain understanding of application of HRA in the SPRA model



- Operator Interviews
 - Procedure pathways
 - Gaps
 - Transition from EOPs to FLEX
 - Shortcomings of procedural guidance with numerous SSC failures
 - Numerous rounds of interviews as model evolved/iterated
 - Presenting scenarios that operators do not train on due to the number of failures



INSIGHTS

- Utilization of FLEX
- Uncertainty
 - Timing adjustments are a major unknown
- Dependency Analysis
 - Joint HEP of 1E-05
 - Not a major factor due to the number of SSCs that are failing



CONCLUSION

SUMMARY OF PRESENTATION

- Hybrid approach for Seismic HRA
- Performed screening and detailed analysis
- Ultimately ended up crediting FLEX



QUESTIONS?

Contact

Liz Cook

+1 740-415-4114

ecook@jensenhughes.com

For More Information Visit

www.jensenhughes.com



JENSEN HUGHES

Advancing the Science of Safety

