


**EPRI** | ELECTRIC POWER RESEARCH INSTITUTE

U.S. Regulatory Information Conference

**EPRI Activities Related to Risk-Informing External Hazards**



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**W17 – Current Activities in Risk Informing External Hazards Analysis**

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**Presentation Overview**

- Significant EPRI work has been performed on external hazards in recent years
- Presentation will provide an overview of current on-going major activities in the following areas
  - High Winds Area
  - Seismic Area
  - External Flooding Area
  - Compilation and Analysis of External Hazards Information
- Additional activities on-going for specific applications

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**High Winds Risk-Informed Activities – Overview**

- Completion of *High Winds Risk Assessment Guidelines*, published June 2015 (EPRI 3002003107)
- Completion of *High-Wind Equipment List Walkdown Guidance* (EPRI 3002008092)
- Delivered training on high winds engineering
- Nuclear Energy Institute's (NEI) Tornado Missile Task Force and Tornado Missile Risk Evaluator (TMRE)
  - Ongoing technical support of regulatory interactions
- Development of simplified tools for tornado impact modeling
  - Tornado Missile Strike Calculator (TMSC)
  - Support High Winds HRA Activities (plant interviews, best practices)



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### High Winds Risk-Informed Activities – TMSC

- Developed as a more intuitive, user-friendly alternative to existing tornado missile probability software options
- Explicitly models site missile/"target" distributions including intervening structures
- Missile kinematics are employed in a probabilistic environment
  - Estimate damage probability due to atmospheric pressure change
  - Models both tornados and straight winds
- On-going development
  - Perform Verification & Validation efforts
  - Package/release as EPRI software tool
  - Provide workshop on TMSC tool



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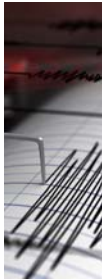
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### Seismic Risk-Informed Activities – Overview

- Completion of fragility-related reports on:
  - Coupled Floor Response Spectra (EPRI 3002010666)
  - High Frequency Inelastic Behavior (EPRI 3002010665)
  - Seismic Fragility Correlation (EPRI 3002010663)
  - Updated capacities using Earthquake Experience Data (EPRI 3002011627) and Seismic Qualification/Testing (EPRI 3002010668)
- Continued training on seismic PRA
- On-going support for risk-informed categorization process via 10 CFR 50.69 application
- Additional on-going fragility and seismic PRA research



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### Seismic Risk-Informed Activities – Fragility Guide

- A collection of EPRI seismic fragility documents from the past 25 years are being used for fragility analysis
- Developing a single document that combines past fragility knowledge and key new developments
  - Updating methods and data
  - Consolidating the guidance
  - Including updated insights



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**Ext. Flooding Risk-Informed Activities – Overview**

- Completion of *Paleoflood Evidence of Past Flooding Events: Investigation into the Available Sources of Paleoflood Evidence in Humid Environments* (EPRI 3002010667)
- On-going research on:
  - Probabilistic flood hazard assessment (PFHA) for Storm Surge
  - Practical aspects of external flooding PRA modeling
  - Development of external flooding walkdown guidance
- Supported NRC's 3<sup>rd</sup> Annual PFHA Research Workshop



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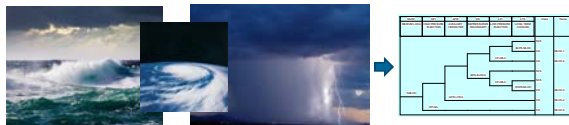
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**Ext. Flooding Risk-Informed Activities – PRA Model**

- EPRI is shifting focus toward the steps required to generate an external flooding PRA model
- Future research will cover topics that are needed for all external flooding PRAs
  - External flooding PRA walkdowns
  - Assessment of external flooding barriers
  - Development of the external flooding PRA model
- Capitalize on domestic/international lessons learned



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**External Hazards Compilation & Analysis - Overview**

- Process to proactively assess new U.S. hazard info
  - Motivated by industry interests and past/current regulatory activities
  - Variety of sources (e.g., actual events or methods changes)
  - Allows for generic evaluation of new information to reduce site burdens
- Includes a detailed process for cataloguing, monitoring, technical evaluation and reporting
- Currently includes the following external events:
  - Seismic events
  - External flooding (e.g., local intense precipitation; riverine flooding, storm surge, tsunami events)
  - Storm and storm-induced events (e.g., hurricanes, tornadoes, extreme straight winds, tornado missiles)
  - Snow, ice and extreme cold
  - Extreme heat

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## Recent References - External Events (Seismic)

### Seismic Assessment

#### Equipment Evaluation and Performance

3002009504	2017	Seismic Evaluation Guidance: Spent Fuel Pool Integrity Evaluation
3002009119	2016	SQLG Walkdown Screening and Seismic Evaluation DVD Training Course Revision 4.6
3002004396	2015	High Frequency Program: Application Guidance
3002002997	2014	High Frequency Program: Seismic Testing Summary and Application Guidance
3002000706	2013	High Frequency Program: Phase 1 Seismic Test Summary
1022682	2011	EPRI/SQLG Damage-Indicating Parameter Information

#### Fragility Analysis

3002011627	2017	Updated Equipment Seismic Capacities from Experience Data for Use in the Fragility Calculators
3002010664	2017	Review and Compilation of SGARTS Test Data for Use in Seismic Fragility Evaluations
3002010666	2017	Coupled Analysis of Primary/Secondary System to Generate Floor Response Spectra: Quantifying Reduction Factors for Lumped-Parameter Response Spectra Amplitudes
3002010665	2017	High Frequency Seismic Inelastic Effects on Equipment Anchorage: Quantifying Increase in Anchorage Acceleration Capacities at High Equipment Frequencies
3002010663	2017	Compilation of Earthquake Failures in Selected Categories of Equipment for Application to Seismic Probabilistic Risk Assessments
3002008099	2016	Seismic Fragility Strength Equation Recommendations for Embedded Anchors
3002008098	2016	Development and Application of a New Seismic PRA Methodology for Determining Seismic Fragilities Using Seismic Earthquakes
3002002804	2014	Assessment of Lumped Mass and Finite Element Structural Models for Seismic Analysis Applications

#### Seismic Probabilistic Risk Assessment

3002005289	2015	Seismically Induced Fire and Flood PRA - Phase I
3002000709	2013	Seismic Probabilistic Risk Assessment Implementation Guide
1020756	2010	Sunny Seismic Probabilistic Risk Assessment Plant Report Review

Risk and Safety Management Catalog: <https://www.epri.com/#/pages/product/000000003002012459/>

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## Recent References - External Events (Non-seismic)

### External Events Other Than Fire and Seismic

#### External Flooding Hazard

3002010667	2017	Paleoflood Evidence of Past Flooding Events: Investigation into the Available Sources of Paleoflood Evidence in Humid Environments
3002008111	2016	Probabilistic Flooding Hazard Assessment for Storm Surge with an Example Based on Historical Water Levels
3002008113	2016	Evaluation of Deterministic Approaches to Characterizing Flood Hazards
3002005292	2015	External Flooding Hazard Analysis: State of Knowledge Assessment
3002004400	2014	Local Precipitation Frequency Studies: Development of 1-Hour/1-Square Mile Precipitation-Frequency Relationships for Two Example Nuclear Power Plant Sites
3002003013	2014	Reverse Probabilistic Flooding Hazard Analysis Pilot: Proof-of-Concept Study for a Nuclear Power Plant Tornado-Missile/High Winds (Including Tornado Missiles)

#### High Winds (Including Tornado Missiles)

3002008092	2016	Process for High Winds Walkdown and Vulnerability Assessments at Nuclear Power Plants
3002003107	2015	High Wind Risk Assessment Guidelines
1018054	2008	Full-Scale Tornado Missile Impact Tests
1018053	2008	Full-Scale Tornado Missile Concrete Impact Tests

#### Human Reliability Analysis (HRA)

3002008093	2016	An Approach to Human Reliability Analysis for External Events with a Focus on Seismic
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#### Probabilistic Risk Assessment for External Hazards

3002010670	2017	External Hazards: Information Compilation and Analysis – 2017 Catalog of Relevant Information Sources
3002010357	2017	External Hazards: Information Compilation and Analysis – 2016 New Information Report
3002008097	2016	External Hazards: Information Compilation and Analysis – Catalog of Relevant Information Sources
3002005287	2015	Identification of External Hazards for Analysis in Probabilistic Risk Assessment: Update of Report 1022997

Risk and Safety Management Catalog: <https://www.epri.com/#/pages/product/000000003002012459/>

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