

U.S. NRC PSA Use and Development: 2022 Update

WGRISK Annual Meeting

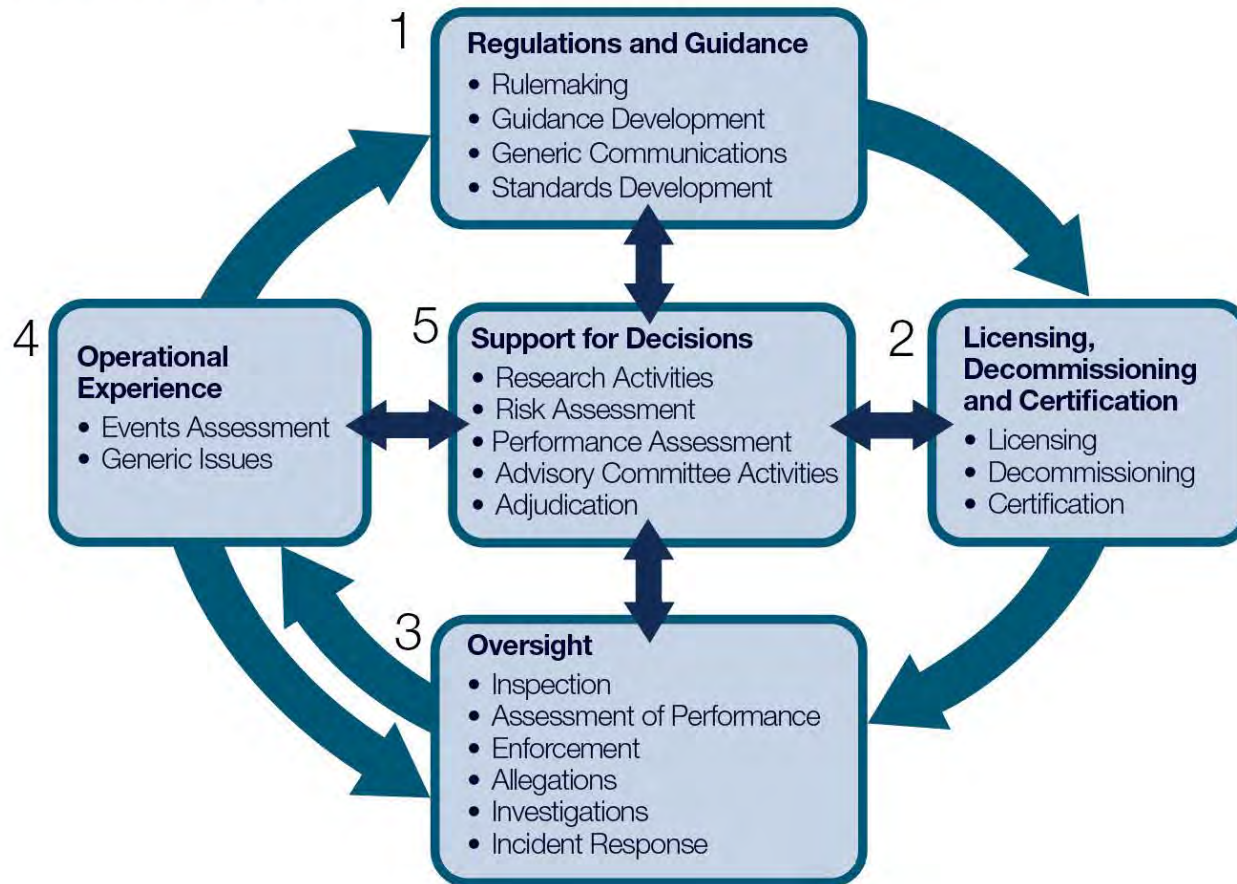
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Division of Risk Analysis
Office of Nuclear Regulatory Research



Risk-informed decision-making is used in NRC regulatory processes

How We Regulate



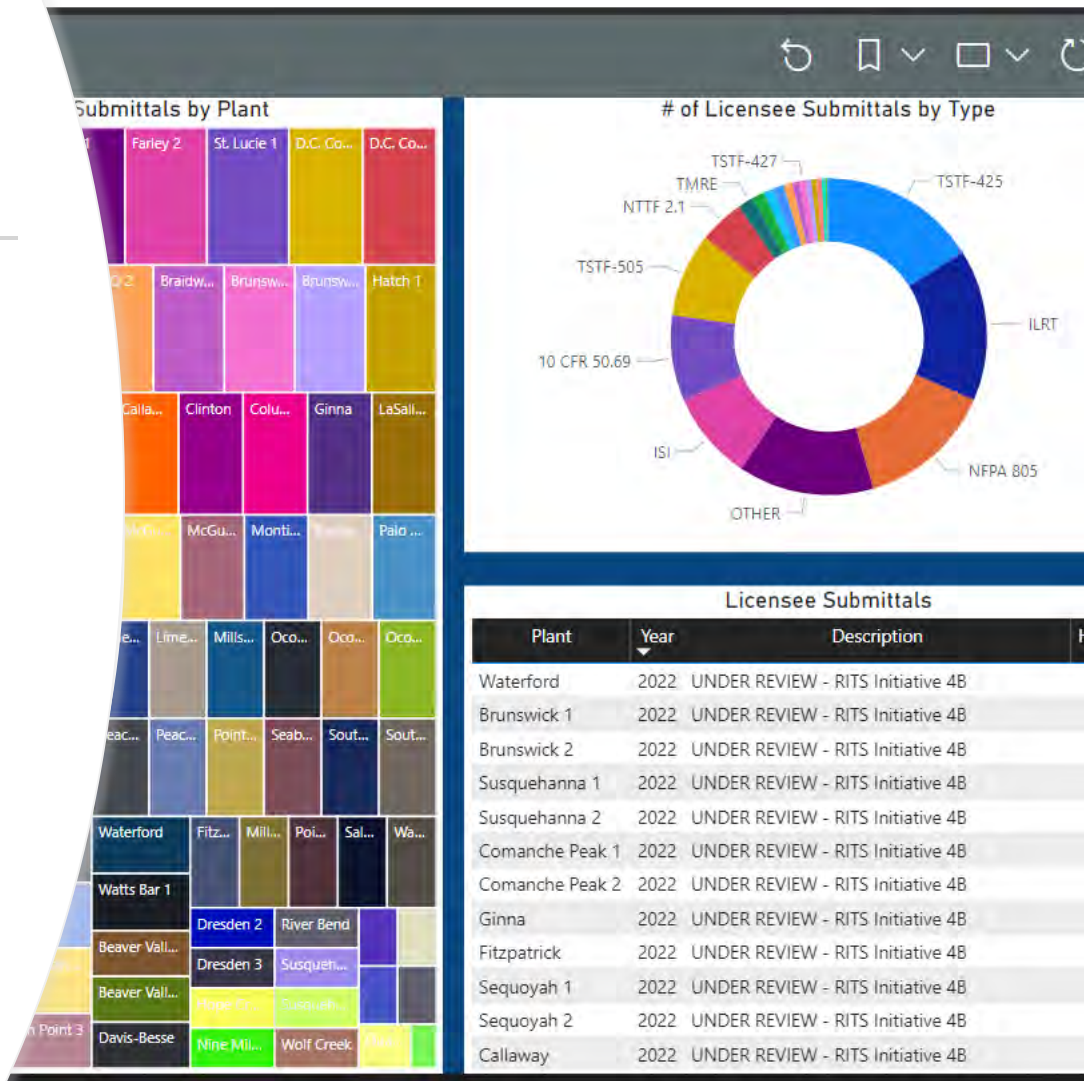
Guidance and Standards on use of PSAs in Risk Informed Decision making

New guidance (e.g., Regulatory Guides, NUREGs) is developed to support the increased use of PSAs in risk-informed activities.

	2021	2022	2023 and beyond
Regulatory Guidance	RG 1.177, (risk-informed Technical Specifications)	Trial use RG 1.247 to endorse ASME/ANS RA-S-1.4, (Non LWRs) and NEI 20-09	RG 1.200, Rev. 4
	RG 1.175 (risk-informed inservice testing)		Enhancement of guidance on the treatment of uncertainties
	RG 1.178 (risk-informed inservice inspection)		Catalog of state-of-practice PRA methods
PRA Standards / Industry Guidance	ASME/ANS RA-S-1.4, Non LWRs	ASME/ANS-RA-1.1, Level 1/LERF	ASME/ANS RA-S-1.2, Level 2
			ASME/ANS RA-S-1.3, Level 3
			ASME/ANS RA-S-1.5, Advanced LWR
			ASME/ANS RA-S-1.6, low power and shutdown

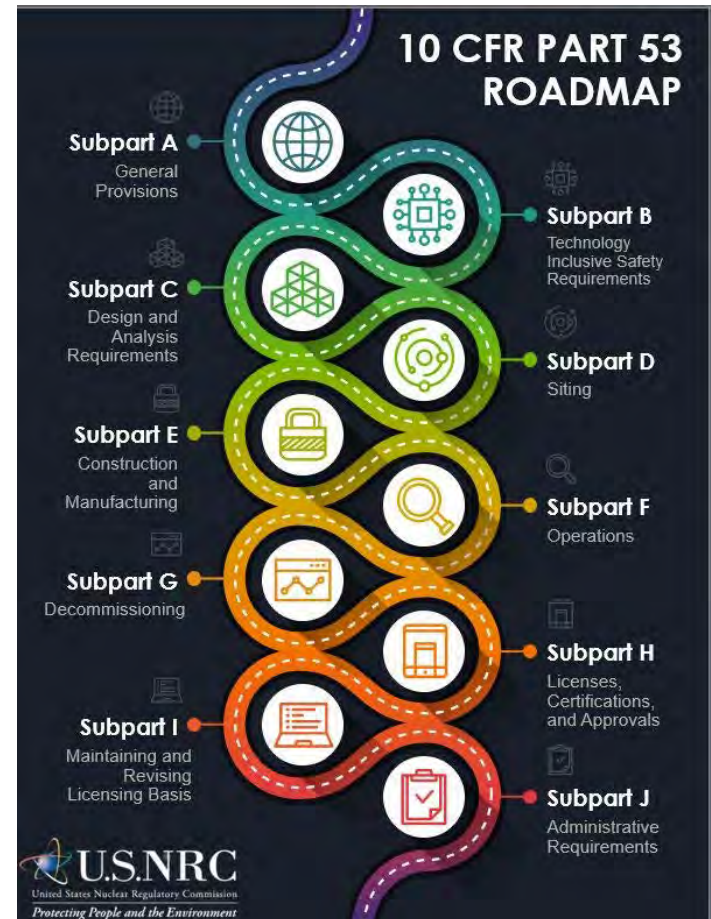
Regulatory Activities: Operating Reactors

- Risk-Informed Technical Specifications Completion Times (TSTF-505)
- 10 CFR 50.69: Risk-Informed Categorization and Treatment of Structures, Systems and Components
- Risk-Informed Integrated Leak Rate Testing (ILRT) Extension
- Risk-Informed Process for Evaluations



Regulatory Activities: New and Advanced Reactors

- Expected publication of RG 1.247, "Acceptability of Probabilistic Risk Assessment Results for Advanced Non-Light Water Reactor Risk-Informed Activities," in 2022.
- Rulemaking activities:
 - Part 50 - Emergency Preparedness Requirements
 - Part 53 - Risk Informed, Technology-Inclusive Regulatory Framework
 - Part 73 - Alternative Physical Security Requirements
- Licensing reviews: Kairos Hermes test reactor; pre-application activities



Research Activities: PSAs and Operating Experience



SAPHIRE and SPAR

Expand model capabilities
(e.g., FLEX, IDHEAS-G ECA)

Expand detail of generic
SPAR models



Accident Sequence Precursor Program

Data visualization dashboard
More explicit consideration of
external hazards risk

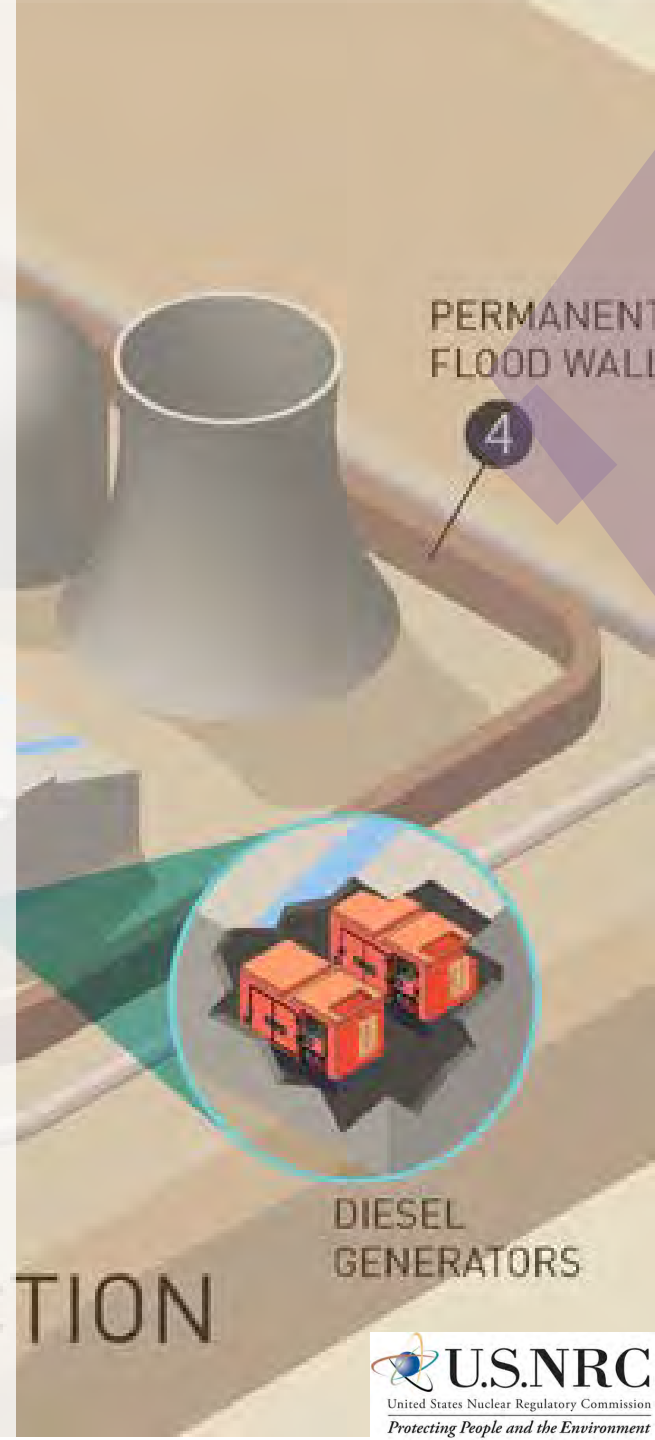


Operating Experience

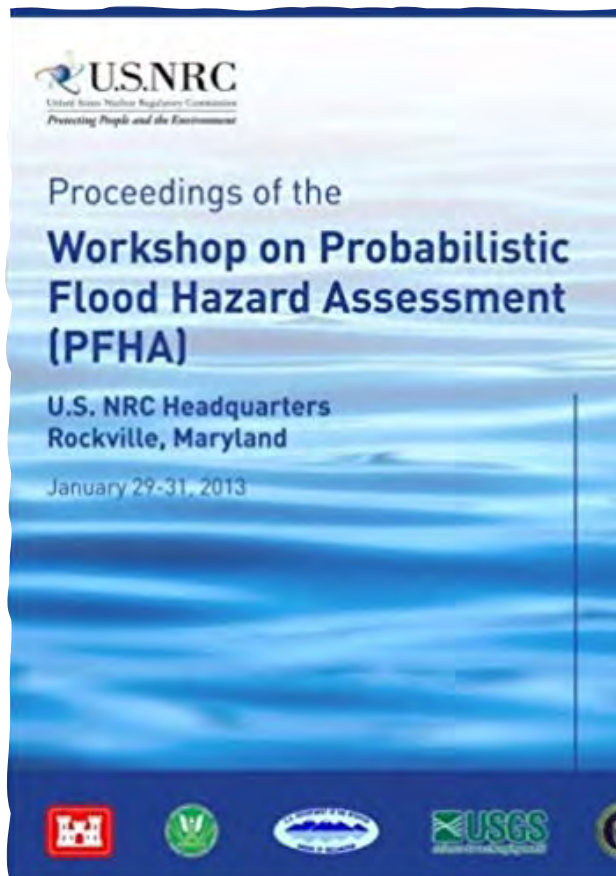
Feasibility study on predictive
maintenance using Machine
learning/Artificial Intelligence
FLEX reliability data

Research Activities: Probabilistic Flood Hazard Assessment

- Develops tools and guidance to risk-inform new and advanced reactor design basis as well as licensing and oversight of operating reactors
- Collaborations: Federal agencies (e.g., DOE Laboratories, USGS, USACE, NOAA); Industry (e.g., EPRI); International (e.g., IRSN, NEA/WGEV)
- 2022 Activities:
 - 7th Annual PFHA Research Workshop, February 18-22-25, 2022 (Virtual)
 - Completed Riverine Flooding PFHA Pilot Study
 - Continue with PFHA Pilot Studies for site-scale flooding (LIP), and coastal flooding. Expect to complete these studies in Q3-2022



Recent PFHA Research Publications (2021-22)



- NRC Research Information Letter (RIL) 2021-01 – “Proceedings of the 5th Annual NRC PFHA Research Workshop”, <https://www.nrc.gov/docs/ML2102/ML21027A213.pdf>
- NRC Research Information Letter (RIL) 2022-03 – “A Simulation-Based Dynamic Analysis Approach for Modeling Plant Response to Flooding Events”, <https://www.nrc.gov/reading-rm/doc-collections/research-info-letters/2022/index.html>
- NRC Research Information Letter (RIL) 2022-04 – “Technical Basis for Extending Flood Frequency Curves Beyond Current Consensus Limits”, <https://www.nrc.gov/docs/ML2204/ML22040A117.pdf>
- NUREG-2240 – “Flood Penetration Seal Testing Protocol Research”, <https://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr2240/index.html>
- USGS Scientific Techniques and Methods Report 4-B6 – “Paleoflood Analyses for Probabilistic Flood Hazard Assessments—Approaches and Review Guidelines”, <https://pubs.er.usgs.gov/publication/tm4B6>
- ORNL Technical Report ORNL/TM-2021/2231 – “Multi-Mechanism Flood Hazard Assessment: Example Use Case Studies”, <https://doi.org/10.2172/1826019>

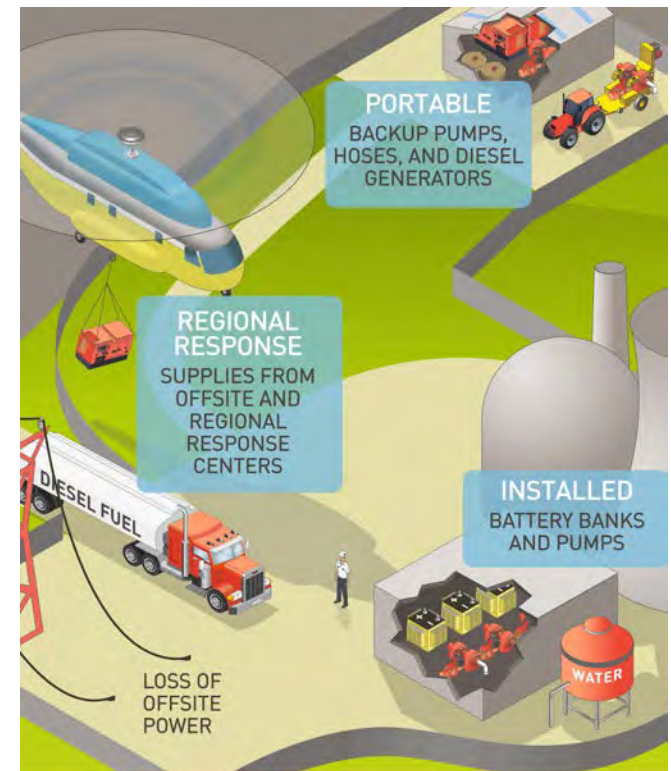
Research Activities: Fire PSA



- Electrical Cabinet HRRs and Fire Modeling
 - Developing Test Plan with NIST to test Oxygen Limited fires in electrical enclosures (Summer 2022)
- Planning Additional Updates to NUREG-1805 Supplements (2022)
 - Cable Tray Flame Spread model
 - Multiple Transient HRR model
 - Sprinkler and Underground Piping System Hydraulic model
- High Energy Arcing Fault (HEAF)
 - NRC-RES and EPRI have formed a Working Group to update and develop more realistic HEAF Fire PRA guidance (2022)
 - Three New Joint NRC/EPRI Reports to be published by the WG in 2022:
 - HEAF Target Fragility
 - HEAF Zone of Influence (ZOI) Modeling
 - HEAF Fire PRA Methodology

Research Activities: Human Reliability Analysis

- Published RIL 2021-14 – Integrated Human Event Analysis System Dependency Analysis Guidance (IDHEAS-DEP) – The method for conducting dependency analysis in support of IDHEAS-ECA
- Released draft IDHEAS-DATA – The data basis behind the IDHEAS-ECA quantification. Plan to finalize as a RIL in 2022
- Modifications have been made to IDHEAS-ECA based on user feedback and public comments. Plan to finalize NUREG in 2022



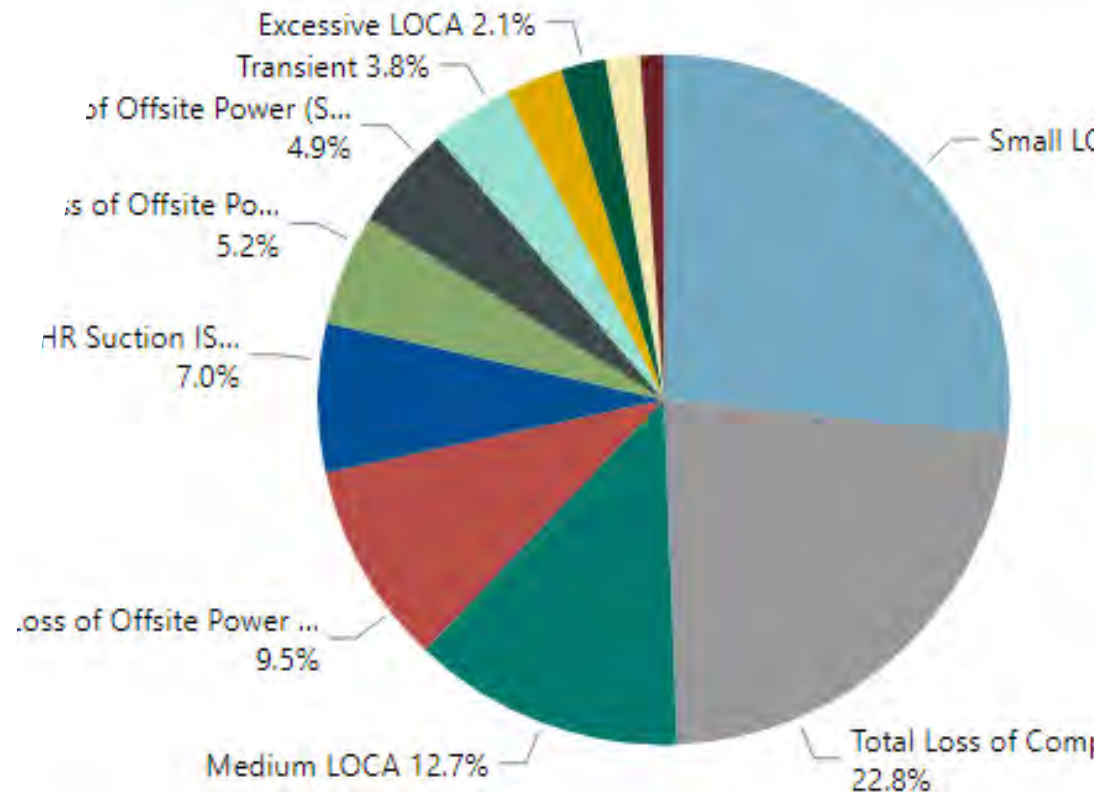
Research Activities: Level 3 PRA Project Status

Phase 1		Phase 2	
	Initial model/documentation		Revised model/documentation
	Internal technical review		Internal technical review
	L3PRA management review		L3PRA management review
	TAG/PWROG review		Model/documentation complete

	Level 1	Level 2	Level 3
Reactor, at-power, internal events	Complete	Complete	Complete
Reactor, at-power, internal floods	Complete		
Reactor, at-power, internal fires	Complete	Complete	Phase 2 Revised model/documentation
Reactor, at-power, seismic events	Complete	Complete	Phase 2 Revised model/documentation
Reactor, at-power, high winds	Complete	Complete	Phase 2 Revised model/documentation
Reactor, at-power, other hazards	Complete	N/A	
Reactor, LPSD, internal events	Phase 2 Revised model/documentation	Phase 2 Revised model/documentation	Phase 2 Revised model/documentation
Spent fuel pool (all hazards)	Phase 2 Revised model/documentation		Phase 1 Initial model/documentation
Dry cask storage (all hazards)	Phase 2 Revised model/documentation		
Integrated site risk (all hazards)	Phase 1 Initial model/documentation		

Examples of Other Activities

- Development of risk tools for dry cask storage licensing
- Development of dashboards and Apps to facilitate risk communication
- CCF modeling enhancements
- Risk Informed awareness workshops and seminars
- 2022 Regulatory Information Conference



INITIATING EVENTS CONTRIBUTING 10% OR MORE TO C

Small LOCA	26.6%
Total Loss of Component Cooling Water	22.8%
Medium LOCA	12.7%

Acronyms

- ASME: American Society of Mechanical Engineers
- ANS: American Nuclear Society
- CCF: common cause failure
- CFR: Code of Federal Regulations
- DOE: Department of Energy
- ECA: event and condition assessment
- EPRI: Electric Power Research Institute
- FLEX: diverse and flexible strategies
- HEAF: High Energy Arcing Fault
- HRA: human reliability analysis
- HEP: human error probability
- HRR: heat release rate
- IDHEAS: Integrated Human Event Analysis System
- IRSN: Institut de radioprotection et de sûreté nucléaire
- LWR: light-water reactor
- NEA: Nuclear Energy Agency
- NIST: National Institute of Standards and Technology
- NOAA: National Oceanic and Atmospheric Administration
- NRC: Nuclear Regulatory Commission
- PFHA: Probabilistic Flood Hazard Assessment
- PRA: probabilistic risk assessment
- PSA: probabilistic safety assessment
- RES: Office of Nuclear Regulatory Research
- RIL: Research Information Letter
- RG: Regulatory Guide
- SAPHIRE: Systems Analysis Programs for Hands-on Integrated Reliability Evaluations
- SPAR: Standardized Plant Analysis Risk
- USACE: The United States Army Corps of Engineers
- TSTF: Technical Specifications Task Force
- USGS: The United States Geological Survey
- WGEV: Working Group on External Events

Questions?

