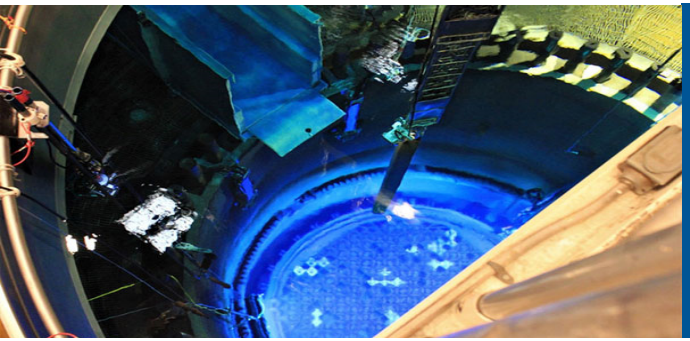
Public Webinar to Share Risk Insights from the NRC Staff's High Energy Arcing Fault LIC-504 Assessment

November 16, 2022



Objectives

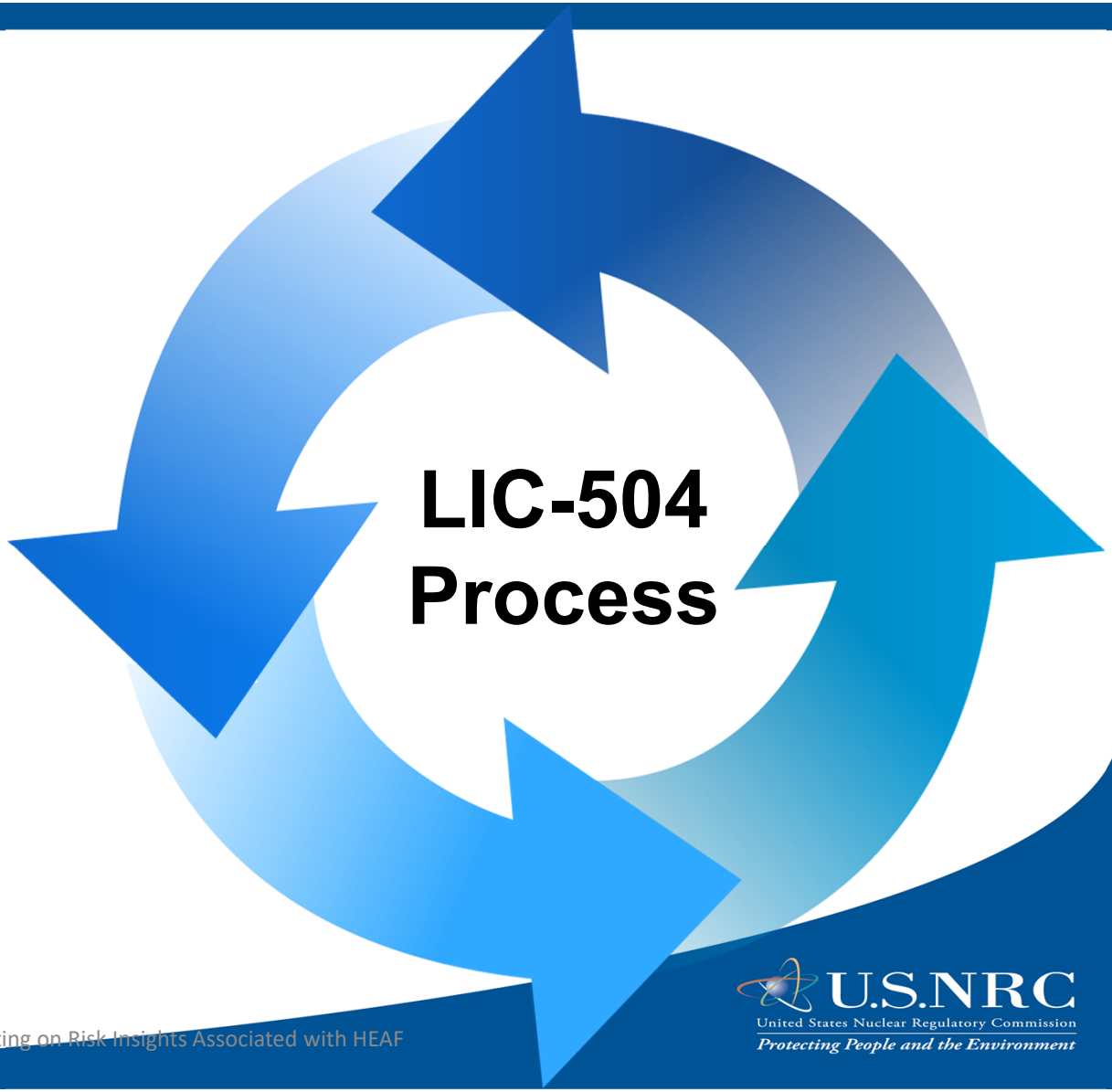
Consistent with the NRC's Principles of Good Regulation and our *Be RiskSMART* framework, NRC staff will be sharing risk insights from the NRC's regulatory response associated with the evaluation of High Energy Arcing Faults (HEAF).

- Openness
  - Transparent and publicly available information on our evaluations and analysis.
- Clarity
  - Staff's evaluation considered a sample of sites with different design characteristics to understand generic implications to the fleet.
  - Characteristics were chosen to improve realism to support analysis and gather risk insights that could benefit the overall fleet.
  - Risk insights can significantly vary based on site, plant design and configuration, and plant operating characteristics.

Agenda

Time	*Topic*	*Speaker*
1:00pm	Meeting Kick-Off	S. Lingam – 5 mins
1:05pm	Opening Remarks	M. Franovich – 10 Mins
1:15pm	LIC-504 Assessment	R. Rodriguez – 15 mins
1:30pm	NRC Risk Insights	S. Weerakkody – 15 mins
1:45pm	Industry Remarks	Duke Energy – 15 mins
2:00pm	Industry Remarks	Constellation – 15 mins
2:15pm	Break	15 mins
2:30pm	Panel Discussion	Industry/NRC – 45 mins
3:15pm	Public Comments	NRC/Public – 30 mins
3:45pm	Adjourn	

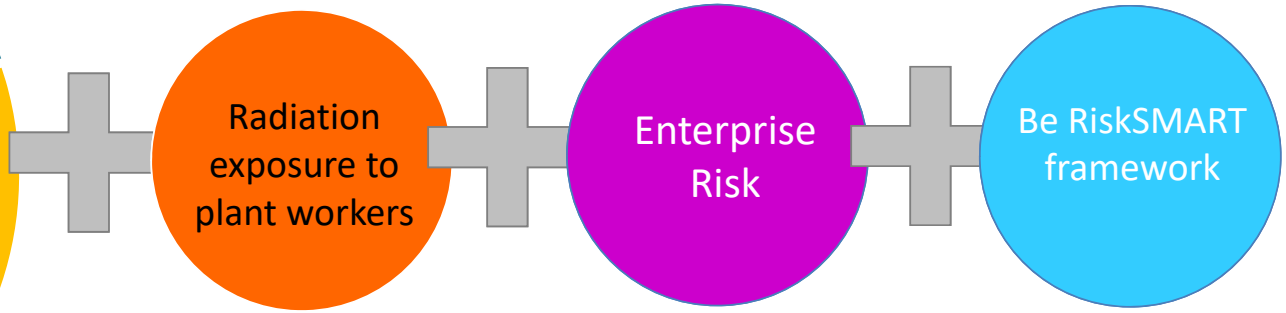
Mike Franovich
Director
Division of Risk Assessment
Office of Nuclear Reactor Regulation
US NRC



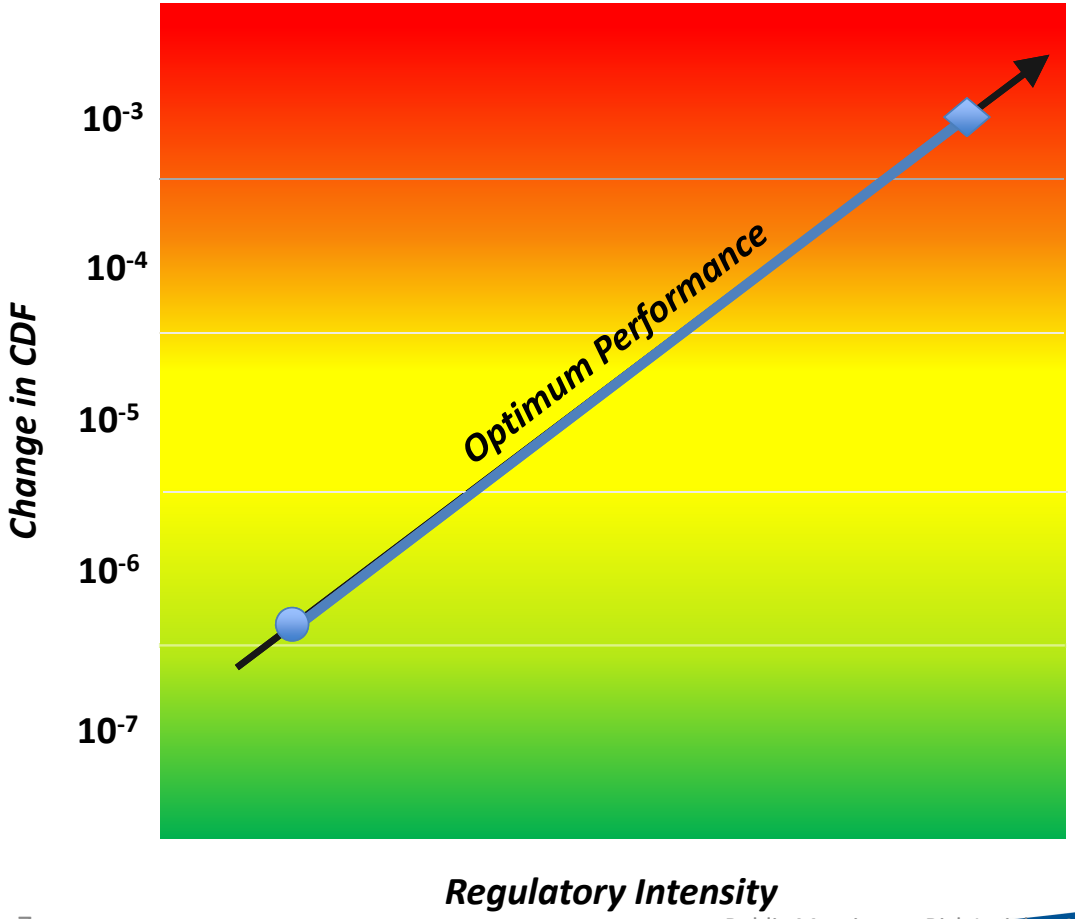
Refresher - Integrated Decision-Making Process for Emergent Issues (LIC-504)

- Developed as a lessons learned from Davis-Besse reactor vessel head degradation
- Provides a structured process and expectations to document decisions for issues that may warrant safety orders
- Provides guidance to apply integrated decisionmaking including risk, defense-in-depth, and safety margins considerations
- Has been used frequently for a range of emergent plant-specific and generic issues
- **Not** a substitute for other NRC processes

Factors Considered in LIC-504 Implementation



LIC-504 Graded Recommendations - Examples



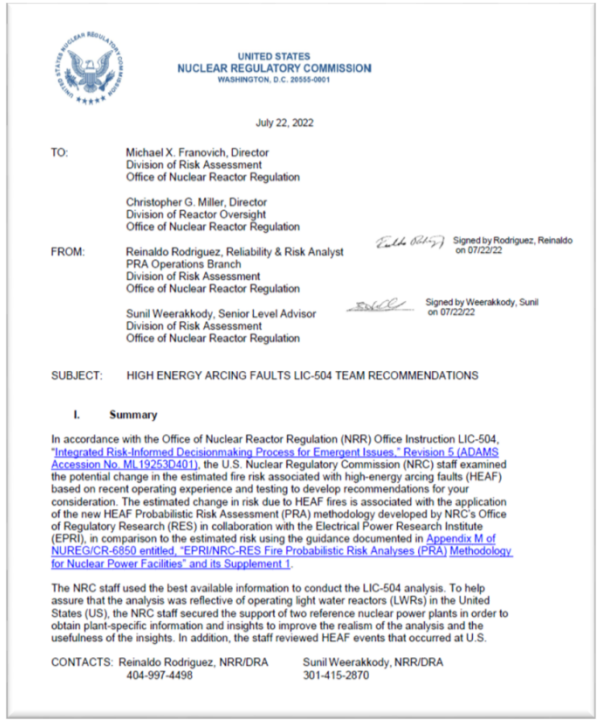
Weigh a Spectrum of Regulatory Options

- Immediate regulatory action - compensatory measures
- Formal backfit analysis (≥ 10^{-4})
- 50.54(f) letters
- Bulletin
- Information Notice/Outreach
- Smart inspection samples - within baseline program
- No Actions

Use RIDM –
Not numbers alone

LIC-504 Assessment

Reinaldo Rodriguez
Reliability and Risk Analyst
Division of Risk Assessment
Office of Nuclear Reactor Regulation
US NRC



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

July 22, 2022

TO: Michael X. Franovich, Director
Division of Risk Assessment
Office of Nuclear Reactor Regulation

Christopher G. Miller, Director
Division of Reactor Oversight
Office of Nuclear Reactor Regulation

FROM: Reinaldo Rodriguez, Reliability & Risk Analyst
PRA Operations Branch
Division of Risk Assessment
Office of Nuclear Reactor Regulation
Signed by Rodriguez, Reinaldo on 07/22/22

Sunil Weerakkody, Senior Level Advisor
Division of Risk Assessment
Office of Nuclear Reactor Regulation
Signed by Weerakkody, Sunil on 07/22/22

SUBJECT: HIGH ENERGY ARCING FAULTS LIC-504 TEAM RECOMMENDATIONS

I. Summary

In accordance with the Office of Nuclear Reactor Regulation (NRR) Office Instruction LIC-504, "Integrated Risk-Informed Decisionmaking Process for Emergent Issues," Revision 5 (ADAMS Accession No. ML19253D401), the U.S. Nuclear Regulatory Commission (NRC) staff examined the potential change in the estimated fire risk associated with high-energy arcing faults (HEAF) based on recent operating experience and testing to develop recommendations for your consideration. The estimated change in risk due to HEAF fires is associated with the application of the new HEAF Probabilistic Risk Assessment (PRA) methodology developed by NRC's Office of Regulatory Research (RES) in collaboration with the Electrical Power Research Institute (EPRI), in comparison to the estimated risk using the guidance documented in Appendix M of NUREG/CR-6850 entitled, "EPRI/NRC-RES Fire Probabilistic Risk Analyses (PRA) Methodology for Nuclear Power Facilities" and its Supplement 1.

The NRC staff used the best available information to conduct the LIC-504 analysis. To help assure that the analysis was reflective of operating light water reactors (LWRs) in the United States (US), the NRC staff secured the support of two reference nuclear power plants in order to obtain plant-specific information and insights to improve the realism of the analysis and the usefulness of the insights. In addition, the staff reviewed HEAF events that occurred at U.S.

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HEAF LIC-504

STEP 1 – NO IMMEDIATE SAFETY CONCERN

STEP 2 – DETAILED EVALUATION USING DRAFT METHODOLOGY

HEAF LIC-504 – Scope

Copper and aluminum HEAF zones of influence should be treated the same based on the current state of knowledge.

The LIC-504 assessment was then focused on examining the change in estimated HEAF risks associated with the use of the new HEAF PRA methodology.

HEAF LIC-504 – Work Completed

- Visited one BWR and one PWR
- Assistance provided by each reference plant licensee was essential and added credibility and realism to the team's analyses
- The team generated risk-informed insights and recommendations
- Publicly available memo with WG recommendations was issued on July 22, 2022 (ADAMS Accession No. ML22201A000).

HEAF LIC-504 – Staff Insights

THE RISK OF HEAF COULD BE HIGHER OR LOWER THAN CALCULATED UNDER THE PREVIOUS METHODOLOGY

RISK COULD VARY SIGNIFICANTLY BASED ON PLANT CONFIGURATION

FOR CERTAIN CONFIGURATIONS, THE ESTIMATED RISK FROM NON-ISO-PHASE BUS DUCTS COULD BE NOTABLY HIGHER THAN PREVIOUSLY MODELED

CONCLUDED THERE IS NO SIGNIFICANT INCREASE IN TOTAL HEAF RISK, THAT WARRANTED THE NEED FOR ANY ADDITIONAL REGULATORY REQUIREMENTS

HEAF LIC-504 – Recommendations

Issue	Information Notice
Incorporate	Risk insights into NRR's ongoing PRA configuration control initiative.
Consider	Integrating risk insights into NRR's inspection program in accordance with ROP's change control processes.
Communicate	Risk insights with internal and external stakeholders.

HEAF LIC-504 – Next Steps

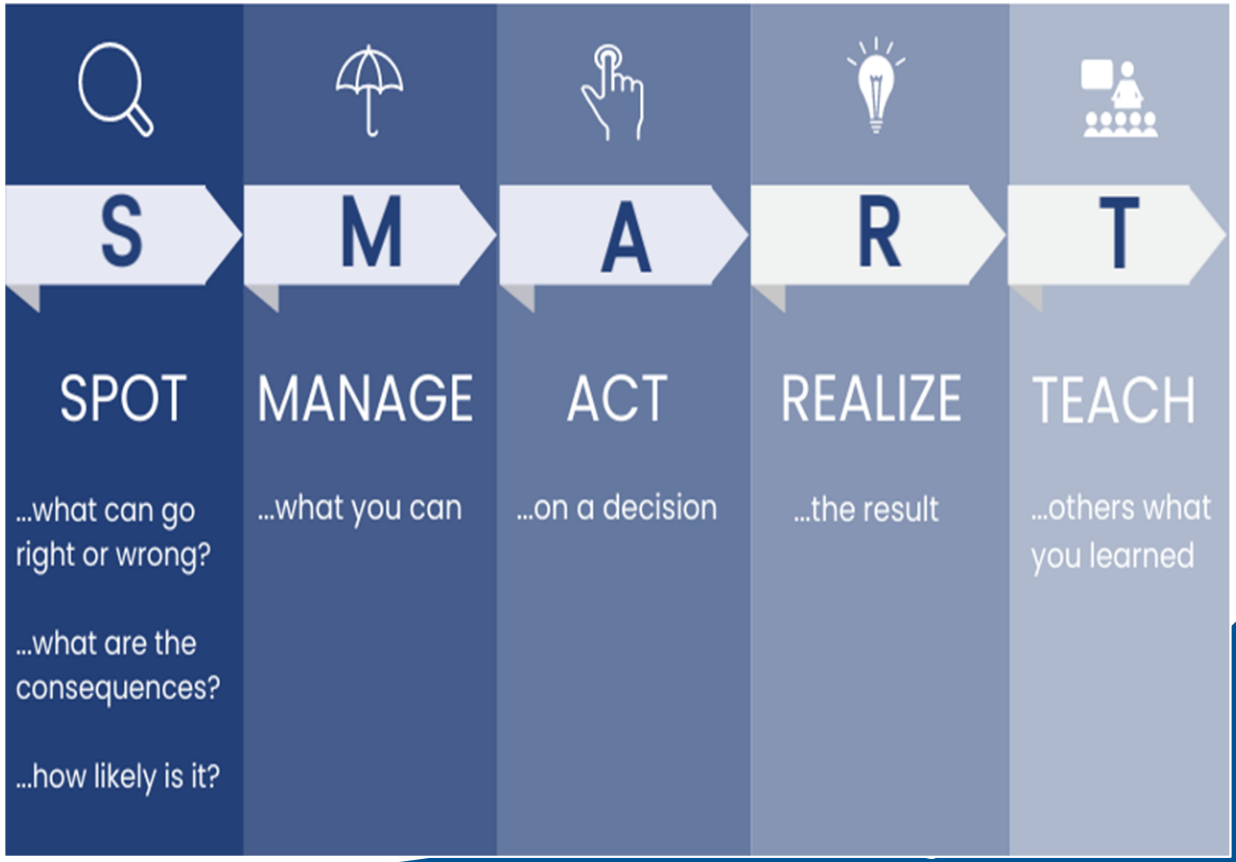
Info Notice	Complete
Information Notice (Winter 2022)	Supporting technical assessments (RES/EPRI) (December 2022)

NRC HEAF-Related Risk Insights

Sunil Weerakkody
Senior Level Advisor
Division of Risk Assessment
Office of Nuclear Reactor Regulation
US NRC

Be riskSMART

Be
…clear about
the problem



Use of "Teaching" and "Managing" Elements to Generate Recommendations During LIC-504 Review

Sources of Operating Experience: IN 2017-4 and NEA/CNIR(2013)(6)

48 HEAF events described in the OECD report entitled "Fire Protection Topical Report No. 1, Analysis of High Energy Arcing Faults," June 2013.

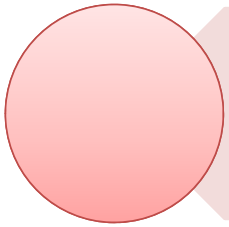
Six HEAF events are discussed in NRC Information Notice (IN) 2017-04, "High Energy Arcing Faults in Electrical Equipment Containing Aluminum Components," August 2017.

HEAF events, even those that are not initially risk significant have the potential to cause subsequent failures due to explosion effects, smoke, and ionized gases. These subsequent failures can create a chain of consequential events that could pose special challenges to operators.

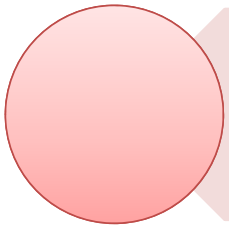
Therefore, public health and safety and enterprise risk is best served by increased focus on preventing HEAF events (as opposed to mitigation).

Sources of Operating Experience – HEAF Event at Maanshan Nuclear Power Plant

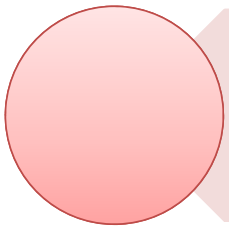
- NRC report entitled, "Operating Experience Assessment: Energetic Faults in 4.16 kV to 13.8 kV Switchgear and Bus Ducts That Caused Fires in Nuclear Power Plants [NPPs]1986-2001," February 2002 (ADAMS Accession No. ML 021290364) provides details regarding the Maanshan nuclear power plant HEAF event which is the most risk-significant (when Conditional Core Damage Probability is used as the metric) relevant to US LWRs.



HEAFs that can lead to SBOs are likely to initiate at buses or switchgear that are essential to supply alternating current power from both offsite power and emergency diesels (or other emergency supply).



Resources focused to minimize the likelihood of HEAF occurrence at those switchgear and buses (e.g., improved preventive and predictive electrical maintenance) can significantly reduce HEAF related risks.



Measures taken to minimize the possibility of a HEAF at one emergency bus, causing failure of the redundant electrical train, due to consequential failures (e.g., due to smoke, or design deficiencies), will also minimize the SBO related HEAF risks.

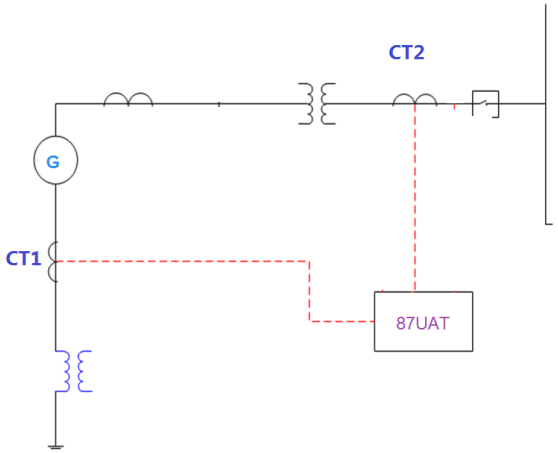
Sources of Operating Experience – NRC/RES Accident Sequence Precursor Database

	Plant/ Event Date (ADAMS Accession No.)	Risk Metric and Impact on Plant
1	Maanshan (ML021290364)	CCDP = $2x10^{-3}$ SBO
2	Fort Calhoun (ML12101A193)	ΔCDP = $4x10^{-4}$ The issue was modeled as a degraded condition that considered the potential for common cause failures of other breakers associated with the degraded condition.
3	Robinson 3/28/10 (ML112411359)	CCDP = $4x10^{-4}$ Partial LOOP and potential loss of reactor coolant pump (RCP) seal cooling
4	Diablo Canyon, Unit 1 (ML20112H532)	CCDP = $4x10^{-4}$ LOOP
5	Brunswick, Unit 1 (ML17109A269)	CCDP = $3x10^{-5}$ LOOP
6	Waterford (ML20140A222)	CCDP = $3x10^{-5}$ Partial LOOP
7	Cooper (ML18068A724)	ΔCDP =$4x10^{-5}$ Partial LOOP. This event was evaluated as concurrent degraded conditions and, therefore, used a ΔCDP as the metric.
8	Shearon Harris (ML20156A243)	CCDP = $4x10^{-6}$ Reactor and turbine trip
9	Turkey Point 3 (ML18038B063)	CCDP = $3x10^{-6}$ Loss of a 4kV Bus
10	Arkansas Nuclear One 2 ,(ML15238B714)	CCDP = $2x10^{-6}$ Partial LOOP

The ASP program evaluates potentially risk-significant events and degraded conditions that occur at US nuclear power plants (NPPs) and documents details of a subset of events that are characterized as accident sequence precursors in their database. These accident sequence precursors provide relevant risk-informed insights because they constitute the small subset of US HEAF events that were of relative high-risk significance.

Sources of Operating Experience - EPRI Report No. 3002015459, "Critical Maintenance Insights on Preventing HEAF"

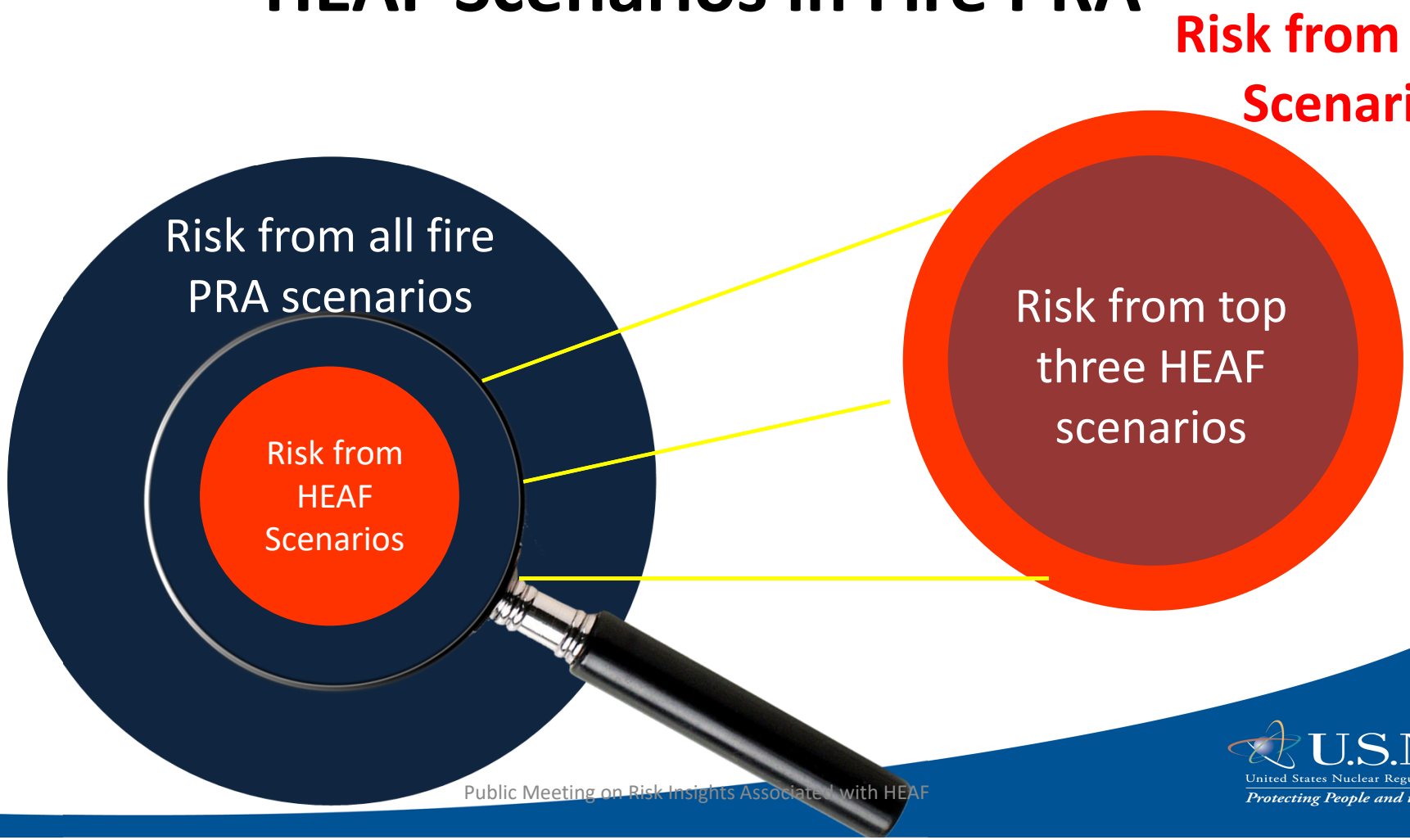
Unit Auxiliary Transformer (UAT) Differential Protection



Maintenance of the Unit Auxiliary Transformer breakers is particularly important because their failure could lead to an extended duration generator-fed fault at the first switchgear bus. Operating experience has shown that this breaker is more likely to fail during automatic bus transfers.

For critical switchgear, such as feeder circuit breakers that carry higher currents, and switchgear that is part of a bus transfer scheme, proper maintenance of connections on both the bus side and the circuit breaker side is especially important.

HEAF Scenarios in Fire PRA



Reducing Risk Associated with Risk-Significant HEAF Events, If They Occur

In general, HEAFs leading to station blackouts (SBOs) constitute the highest HEAF related risks. Therefore, effective use of plant design and operational changes that have been adopted to enhance the mitigation of beyond design basis accidents (10 CFR 50.155, "Mitigation of beyond-design-basis events" rule) are likely to reduce HEAF related risks.


Q&As and Comments