



# Using Integrated Risk-Informed Decisionmaking Process to Address HEAF Events at U.S. Nuclear Power Plants

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LIC-504



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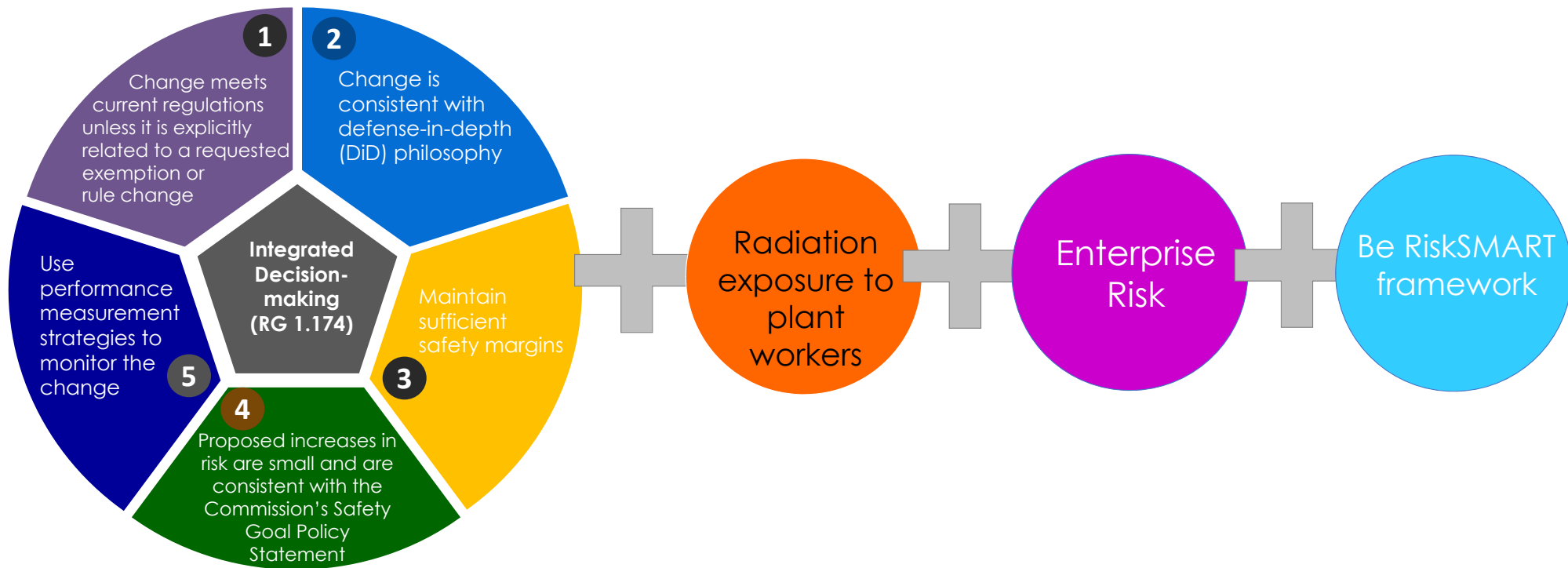
Sandia  
National  
Laboratory

Two US  
Reference  
Plants

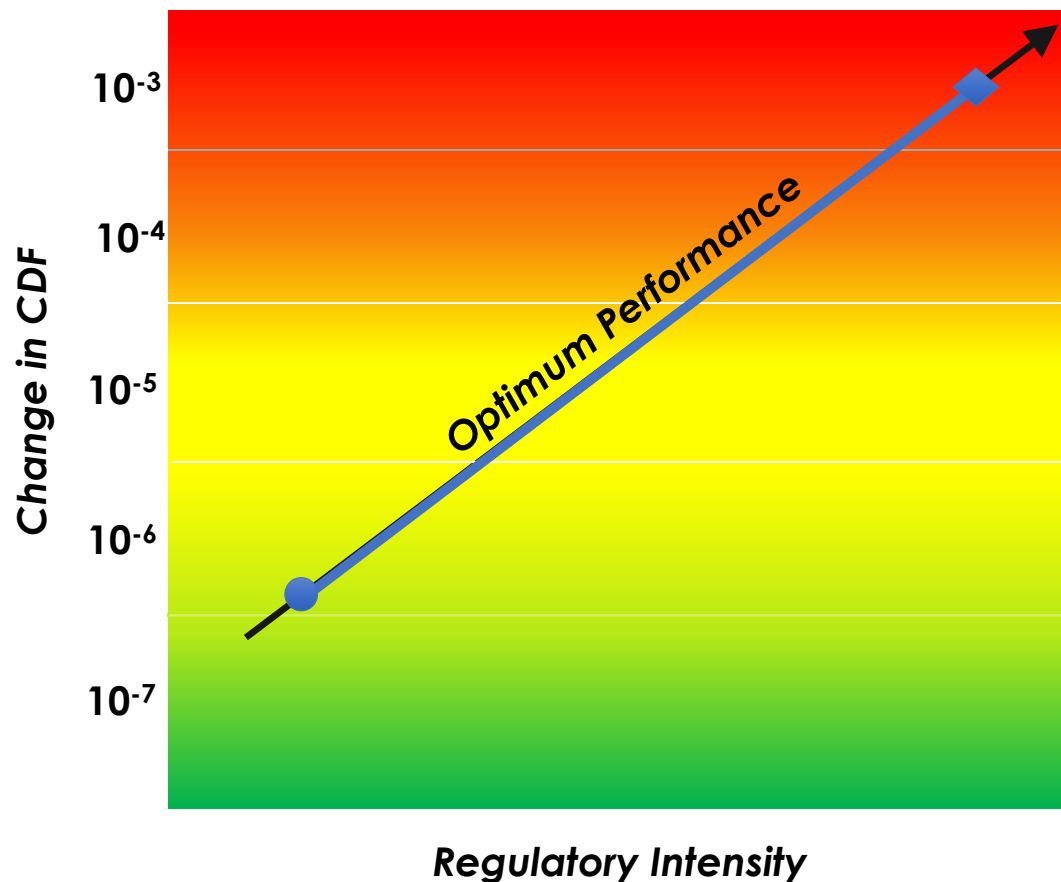
# Refresher - Integrated Decision-Making Process for Emergent Issues ([LIC-504](#))

- Developed as a lessons learned from a 2001 Davis Besse reactor vessel head degradation Event
- 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
- Most recent update (Revision 5, NRC ADAMS Accession No. ML19253D401) has incorporated significant changes (e.g., consideration of Enterprise Risk) based on lessons learned from the use of previous versions.
- Recent LIC-504 assessments have incorporated some elements of NRC's Be RiskSMART framework (NUREG/KM-0016) to develop recommendations.

# Factors Considered in LIC-504 Implementation – Refresher on LIC-504 Process



# LIC-504 Risk-Informed Regulatory Actions (examples)



## Weigh a Spectrum of Regulatory Options

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

**Use RIDM – not numbers alone; Facility DID and SM are also considered**

# Applying the Be Risk Smart Framework

## Two coordinated tracks

- **NRR LIC-504 Assessment**
  - Developed and documented risk-informed options to disposition HEAF issues for management consideration.
    - Updated HEAF PRA Methodology, which was the primary input to examine the change in estimated risk significance.
- **Research Activities**
  - In coordination with EPRI, developed and validated a HEAF PRA methodology that characterizes the thermal heat transfer from an arc.

## Some Features of the Updated HEAF PRA Method (Enhanced realism)

- Credits the ability of electric raceway fire barriers to prevent potential damages to cables;
- Substantial changes to zones of influence of HEAFs for non-isophase bus ducts and for low and medium voltage switchgears;
- Uses updated HEAF frequencies; and
- Enables modelling of more realistic HEAF damage potential that considers factors such as arc duration

# 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

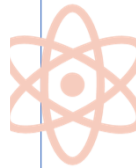


STEP 1 – NO IMMEDIATE SAFETY CONCERN  
(NRC ADAMS ACCESSION NO. ML21272A262).



STEP 2 – DETAILED EVALUATION USING DRAFT  
OF UPDATED HEAF PRA METHODOLOGY (NRC  
ADAMS ACCESSION NO. ML22158A071)

# HEAF LIC-504 - Work Completed



Visited one BWR and one PWR; Use of best available information provided by each reference plant was instrumental in staff's ability to enhance realism of results.



Reviewed accident sequence precursors associated with HEAFs in US plants and the Maanshan Event (NRC ADAMS Accession No. ML02120364). and EPRI Report No. 3002015459, HEAF scenarios of reference plant PRAs to develop risk-informed insight.



Reviewed EPRI Report No. 3002015459, HEAF scenarios of reference plant PRAs, and NEA/CSNI/R(2013)6 to develop risk-informed insights.



The team issued Publicly available memo on July 22, 2022 (NRC ADAMS Accession Nos. ML22201A000-A0003) documenting teams' analyses and recommendations.

HEAF LIC-504 - Staff  
Insights (Based on analyses  
best available information  
from reference plant using  
the draft updated HEAF  
PRA methodology)

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

RISK VARIES SIGNIFICANTLY BASED ON PLANT  
CONFIGURATION

FOR CERTAIN CONFIGURATIONS, THE ESTIMATED  
RISK FROM BUS DUCTS CAN BE NOTABLY  
HIGHER THAN PREVIOUSLY MODELED

CONCLUDED THERE IS NO SIGNIFICANT  
INCREASE IN TOTAL HEAF  
RISK, **NOT** WARRANTING THE NEED FOR ANY  
ADDITIONAL REGULATORY REQUIREMENTS

HEAF LIC-504 – Some risk-informed Insights (Based on review of ASP events, Maanshan HEAF event and EPRI report 3002015459).

HEAFS LEADING TO STATION BALCKOUT SCENARIOS CONSTITUTE THE HIGHEST HEAF RELATED RISKS. THEREFORE, PLANT DESIGN AND OPERATIONAL CHANGES THAT HAVE BEEN ADOPTED TO ENHANCE THE MITIGATION OF BEYOND DESIGN BASIS ACCIDENTS NRC ORDER [EA-12-049] ARE LIKELY TO REDUCE HEAF RELATED RISKS.

HEAFS THAT CAN LEAD TO SBOS ARE LIKELY TO INITIATE AT BUSES OR SWITCHGEAR THAT ARE ESSENTIAL TO SUPPLY AC POWER FROM BOTH OFFSITE POWER AND EMERGENCY DIESELS (OR ANOTHER 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 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.TION

WITH RESPECT TO CIRCUIT BREAKERS, MAINTENANCE OF THE UNIT AUXILIARY TRANSFORMER (UAT) BREAKER IS PARTICULARLY IMPORTANT BECAUSE ITS FAILURE CAN LEAD TO AN EXTENDED DURATION GENERATOR-FED FAULT AT THE FIRST SWITCHGEAR BUS. OPERATING EXPERIENCE HAS SHOWN THIS BREAKER TO FAIL DURING AUTOMATIC BUS TRANSFERS.

WITH RESPECT TO SWITCHGEAR, 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 DUCT SIDE AND THE CIRCUIT BREAKER SIDE IS ESPECIALLY IMPORTANT.

# 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

## Webinar

Insights with internal and external stakeholders. (Fall 2022)

## Info Notice

Information Notice. (Winter 2022)

## Complete

Supporting technical documents (RES). (December 2022)

# CONCLUDING REMARKS

The NRC has successfully developed a process to address safety issues that emerge as a result of world-wide nuclear power plant operating experiences in an efficient and effective manner. NRR developed an Office Instruction entitled, “LIC-504, Integrated Risk-Informed Decisionmaking for Emergent Issues” that describes this process, which enables NRC staff to use best available information to assess risk (quantitative or qualitative), defense-in-depth, and safety margins. This process allows for the NRC to disposition issues in a timely manner, consistent with risk-informed decision-making principles.