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# Testing the Internal At-Power Application of the IDHEAS HRA Method

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# Study Objectives

- Evaluate whether IDHEAS AT-POWER can be practically applied to produce consistent and reasonable HRA results before its deployment.
- Identify strengths and weaknesses of the IDHEAS AT-POWER method to inform future developmental activities

# IDHEAS AT-POWER Overview

Understand  
Scenario

Identify and  
Define HFEs

Task Analysis  
and Develop  
CRD

Identify CFMs for  
Each Critical  
Task

Determine  
Decision Tree  
Paths for CFMs  
and Compute  
HEPs

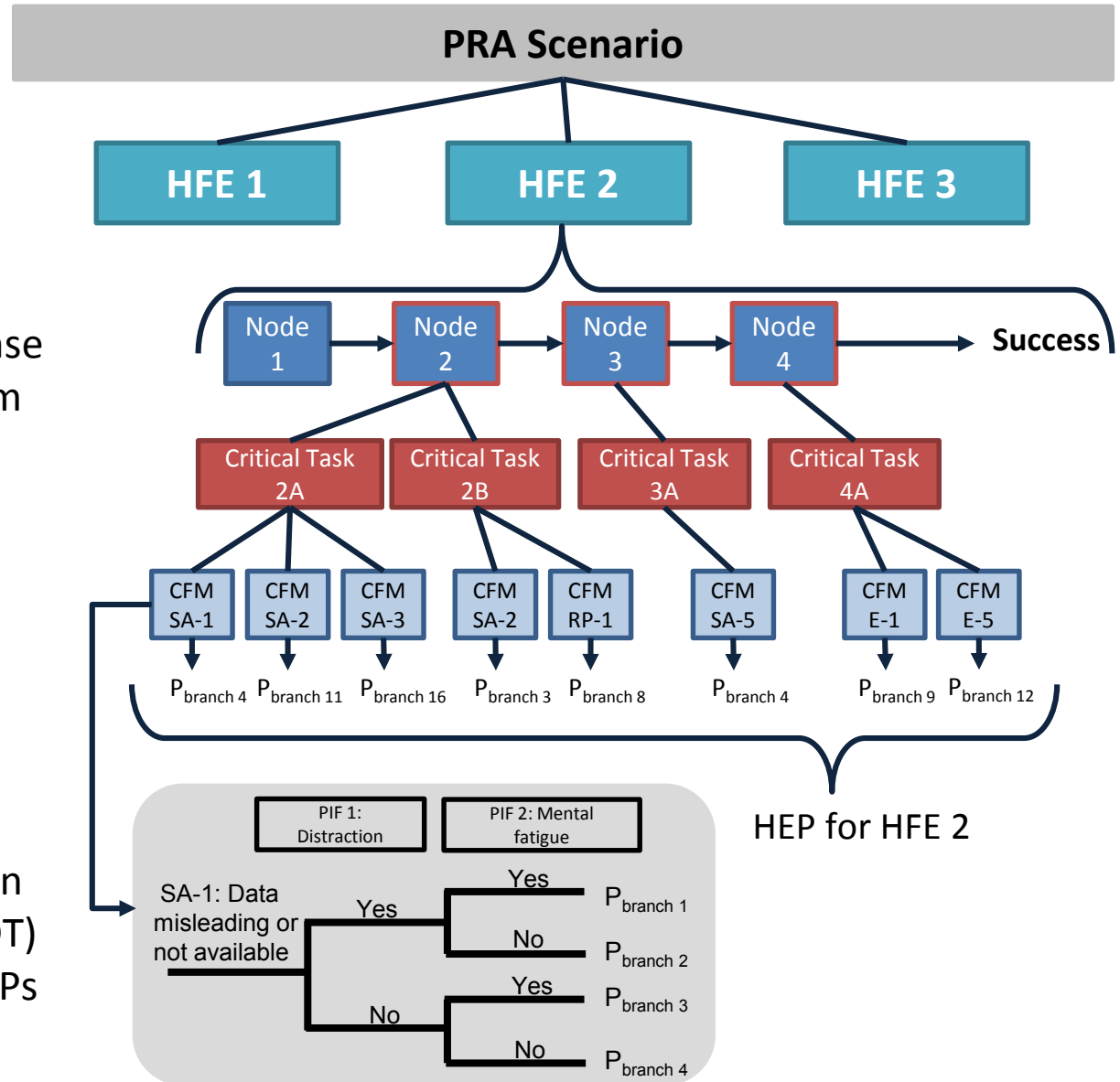
Model  
Integration

HFEs

Crew  
Response  
Diagram  
(CRD)

Crew  
Failure  
Modes  
(CFM)

Decision  
Tree (DT)  
and HEPs



# Scope of Testing

- The teams were provided with a description of a PRA scenario and the HFE(s) to be analyzed
- Testing focused on:
  - Task analysis and development of CRDs
  - Identification of CFMs for critical tasks
  - Assessment of PIFs (choice of DT path)
- Time reliability analysis, model integration and dependency were not tested

# Study Methodology Overview (1/2)

- Study design
  - Testing scenario and human failure events (HFEs)
  - Testing criteria
  - Information package (CFM DTs w/o HEP values)
  - Four testing teams of 2-3 analysts
- Training workshop
  - Training on method and brief on scenarios
  - Initial interview with designated operator
- HFE analysis
  - Worked in teams over 3 month period
  - Telephone interview with designated operator
  - Sent follow-up questions as needed

# Study Methodology Overview (2/2)

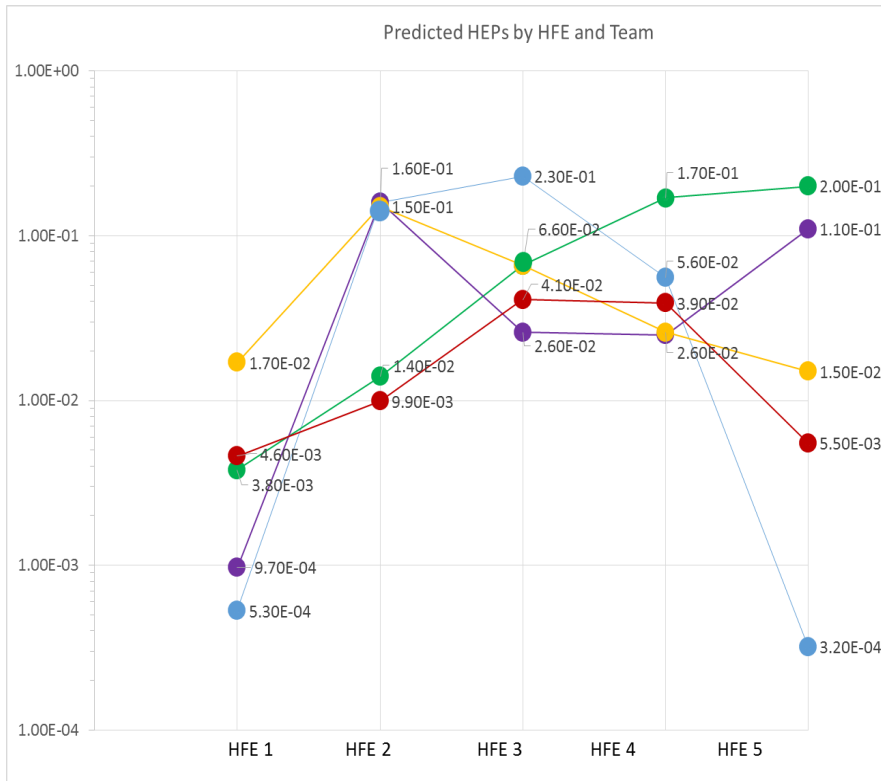
- Analysis output
  - Used template to document results
  - Post-analysis questionnaire
  - Expected HEPs
- Reasonableness check
  - HEPs calculated by project team provided to testing teams
  - Teams given opportunity to revise analysis but none chose to
  - Initial interview with designated operator
- Evaluation workshop
  - Reviewed each team's analysis
  - Provided feedback on experience using the method

# Testing Scenarios and HFEs

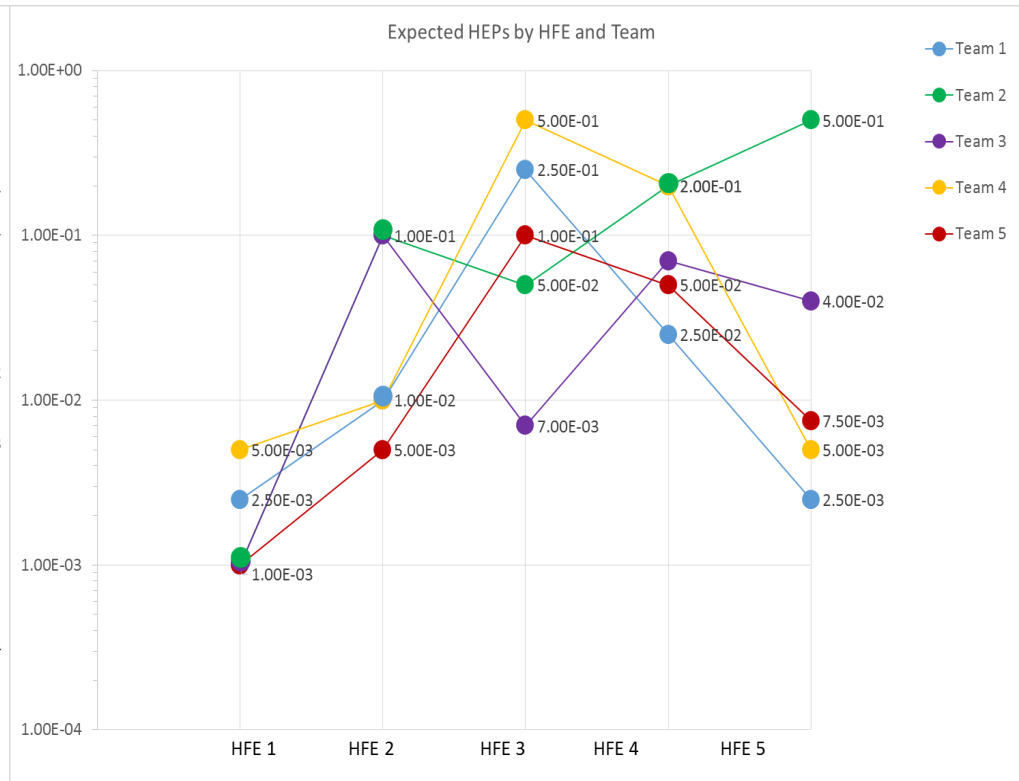
- Uncomplicated Steam Generator Tube Rupture
  - **HFE 1:** Failure to isolate the ruptured steam generator and control pressure below the SG PORV setpoint before SG PORV opening
- Loss of Feedwater with Misleading AFW Flow Indicator
  - **HFE 2:** Failure to establish B&F within 45 minutes of the reactor trip, given that the crews initiate a manual reactor trip before an automatic reactor trip
- Electrical Fire resulting in Loss of RCP Seal Cooling and Delayed Seal Injection
  - **HFE 3:** Failure to restore CCW to the RCP thermal barrier heat exchangers by re-opening FCV-626
  - **HFE 4:** Failure to trip the RCPs during a loss of all seal cooling and injection
  - **HFE 5:** Failure to depressurize the RCS during a small loss of coolant accident (SLOCA)

# Predicted vs. Expected HEPs

## Predicted HEPs

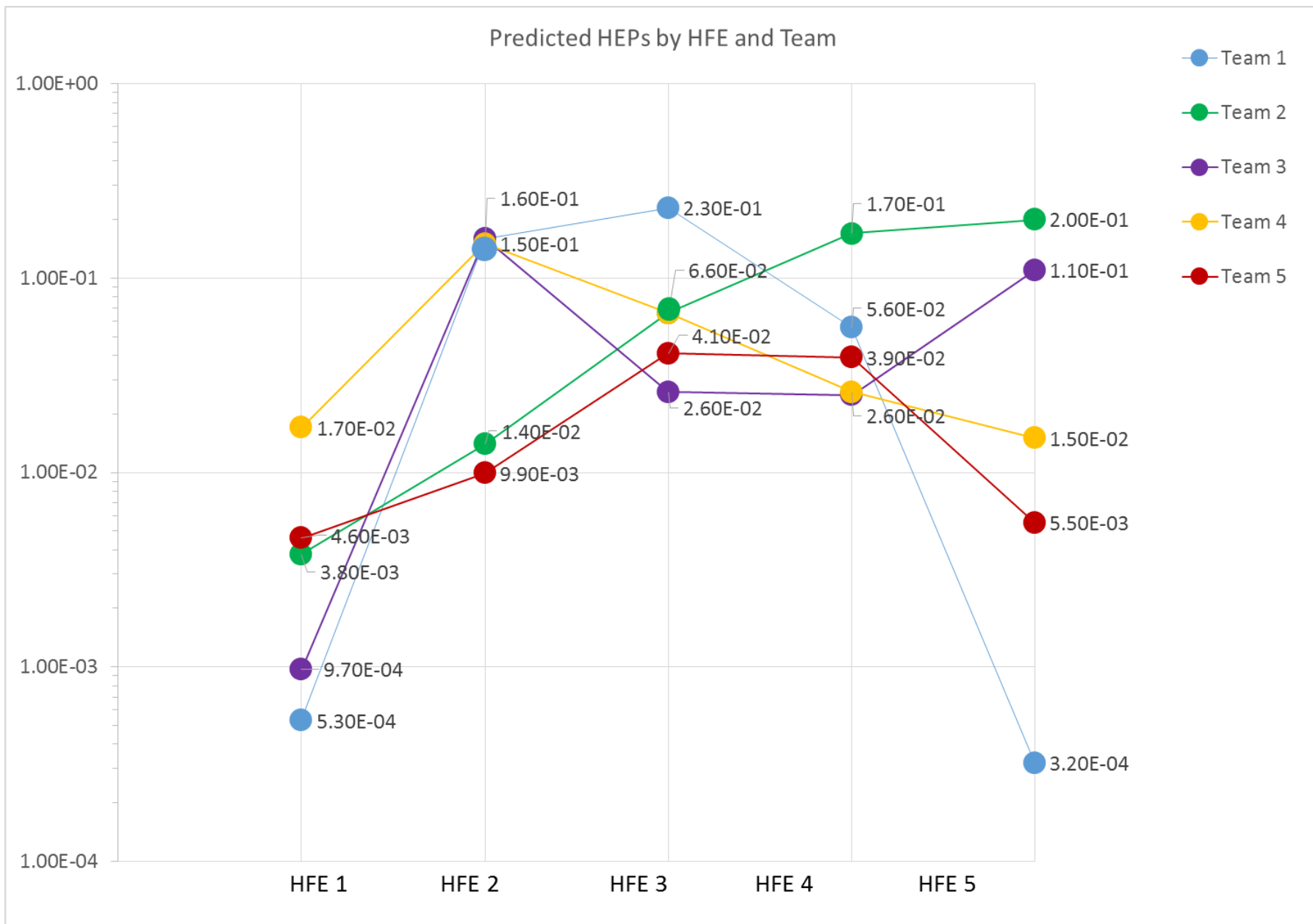


## Expected HEPs

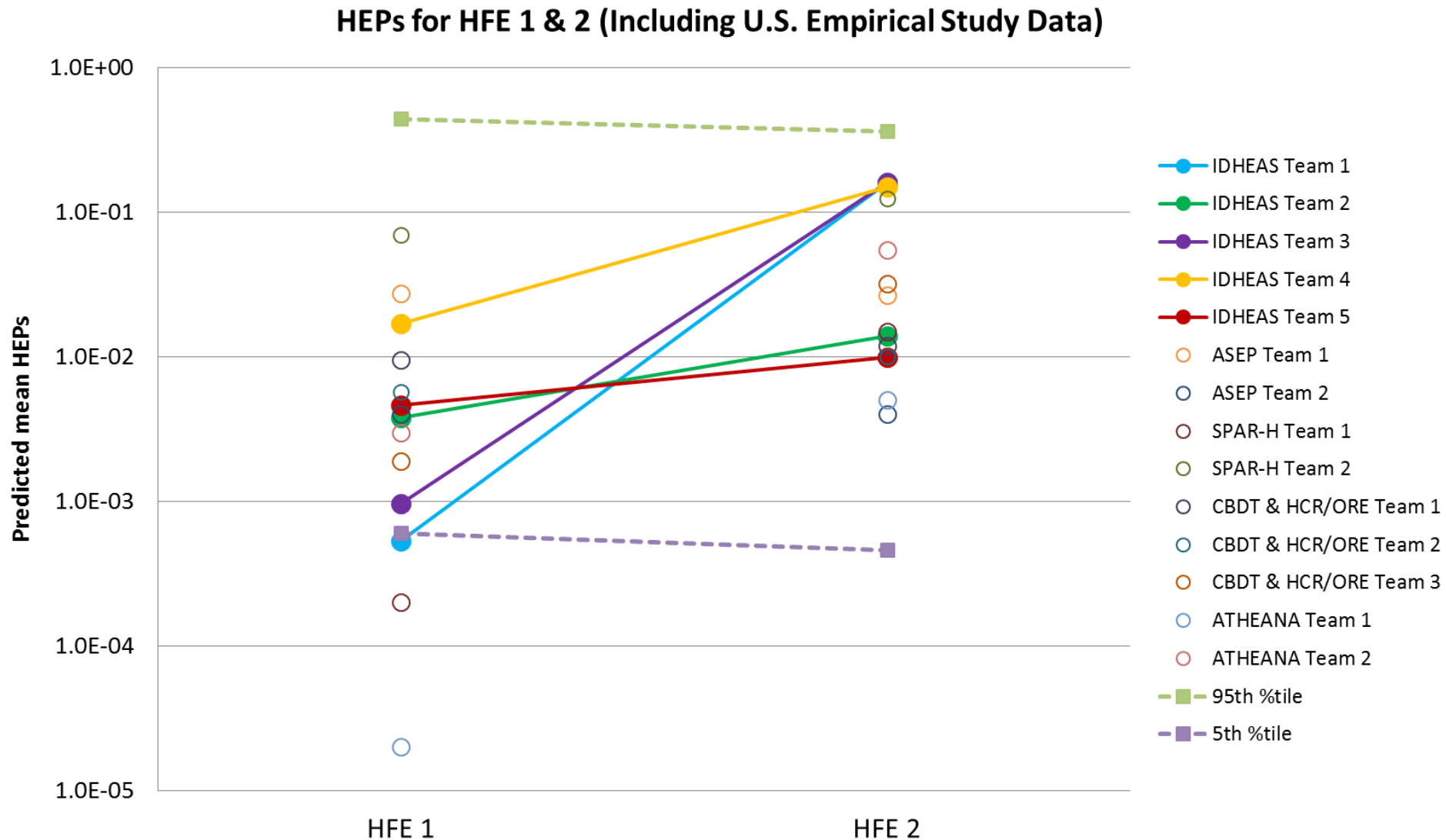




# Predicted HEPs



# Comparison to US Empirical Study



# Observations from the Quantitative Results

- Variability observed in both expected and predicted HEPs
- Correlation between expected and predicted HEPs
- No team was consistently conservative or optimistic
- Differentiation across HFEs varied across teams
- Predicted HEPs converged with results from the US Empirical Study

# Observations from the Qualitative Analysis

- Predicted procedural paths and performance drivers converged with simulator data for HFEs 1 and 2
- More variability for HFEs 3 and 4
  - Procedural paths were not well defined
  - Analysts were not familiar with the scenarios
- Identification of critical tasks
- Modelling of execution tasks
- Modelling of recovery

# Preliminary Evaluation Summary (1/2) Sandia National Laboratories

- All teams generally applied the method as intended and were able to produce reasonable results
- Validity
  - Results of HFEs 1 and 2 converge with the US Study
  - Most predicted HEPs comparable to expected HEPs
  - No team produced consistently optimistic or conservative HEPs
  - Ability to capture a broad range of failure modes, contextual conditions, and influences
- Inter-analyst consistency
  - Variability in procedural path, critical task identification, task decomposition, recovery modelling, CFM and PIF assessment
  - Caused by judgment in addressing scenario complexity and uncertainty, unclear guidance or misinterpretation of guidance

# Preliminary Evaluation Summary (2/2) Sandia National Laboratories

## ■ Traceability

- Clear link between qualitative analysis and quantitative results
- Easy to identify differences in results
- Dependent on quality of documentation

## ■ Usability

- Not easy to learn and resource intensive to use
- Significant operations input
- 2x the amount of time of other HRA methods currently in use
- May improve with experience and use of computerized software tool

## ■ Utility

- Thorough and defensible analysis
- CFMs help analysts think broadly about possible failures

# Additional Observations

- Sensitivity of binary decision trees
- Subjective judgment in method application
  - Interpretation of unclear procedural directives
  - Interpretation of guidance for CFM selection and PIF assessment
- Treatment of execution
  - Holistic treatment of execution
  - Two generic categories: simple and complex

**Thanks!**

Questions and Comments?