Research and Development of Human Reliability Analysis at the NRC

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U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

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Purpose of the Research

- Understand Human Errors under imperfect, unexpected, or extreme conditions
- Improve human reliability analysis (HRA) methods and process
- Gain insights from doing HRA

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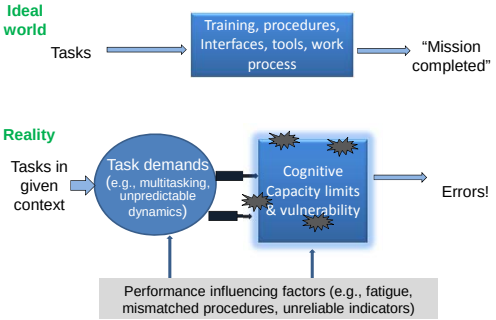
What causes well-trained, experienced operators to make errors?



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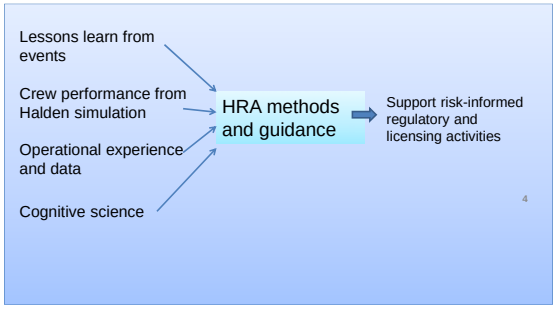
HRA Research and development



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learning from Halden Crew performance - examples

Learned:	Incorporated in HRA:
Complex cognitive activities in extreme conditions	Built-in cognitive models
Important crew aspects	Identification of crew failure modes
Multitasking challenges performance	Task analysis identifying multitasking

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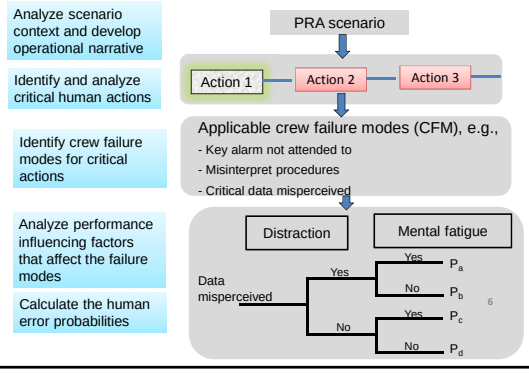
HRA process

- An Integrated Human Event Analysis System (IDHEAS)



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Using IDHEAS to analyze the Electrical Fire Event

Example context challenging personnel performance

Context	Description
Plant status	Electrical fire, multiple failures (e.g., CCW cooling to Rx coolant pumps)
Critical actions	Timely restoration of CCW cooling to the RCPs
Procedures	Mismatched procedures, open to interpretation
Unfamiliar scenario	Unexpected responses
Multitasking	Crew responded to fire alarms and loss of CCW
Distraction	Crew was distracted by the electrical fire
Time urgency	Restore CCW within 13 minutes of indications

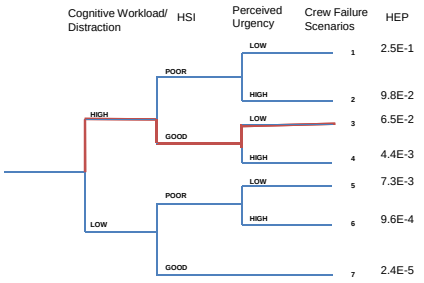
Examples of applicable crew failure modes

- Key alarm not attended to
- Critical data dismissed
- Critical data misperceived
- Misinterpret procedures
- Choose inappropriate strategies
- Delayed implementation
- Action executed incorrectly
- Critical data not communicated

Electrical Fire Event (cont.)

Example of analyzing the likelihood of human errors

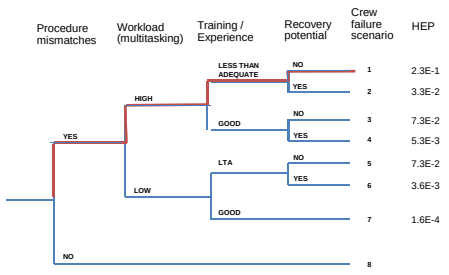
Key Alarm Not Attended To



Electrical Fire Event (cont.)

Example of analyzing the likelihood of human errors

Misinterpret Procedure

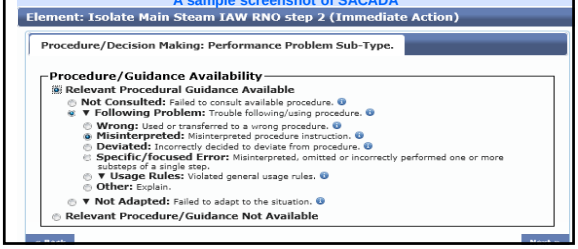


Database for HRA

- SACADA (Scenario Authoring, Characterization, and Debriefing Application)

- A human performance data collection system for operator simulator exercises to
  - Provide data support to HRA
  - Help identify the what's and how's to improve human performance

A sample screenshot of SACADA



SACADA can be used for…

- Authoring:
  - Design simulation scenarios
- Characterizations:
  - Characterize the human performance challenges of the tasks in the scenarios
- Debriefing:
  - Guide post-simulation performance evaluation and document the results
  - Include task performance results, performance deficiencies, causes of deficiencies, team error recovery, impact on scenario, remediation, and the corresponding INPO performance fundamental classification
- Reporting:
  - Post simulation reports, training cycle report, and annual reports
  - Output data for statistical analyses
  - Custom output, e.g., output for crew notebook

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Insights an HRA can provide

- Operative narrative of imperfect, unexpected, and non-typical conditions that challenge human performance
- Identification of human actions that may lead to undesired or unsafe plant status
- Potential ways that crews may fail required actions
- Performance influencing factors that impact crew performance
- Likelihood of personnel performing the actions

Conclusions

- HRA is a meaningful tool supporting safety regulation
  – for imperfect, unexpected, or extreme conditions
- The outcomes and process of doing HRA provide systematic understanding of personnel performance
- HRA research and development incorporate lessons learned from events, crew performance simulation, operational data, and cognitive science.