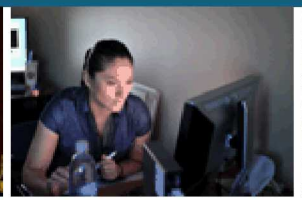
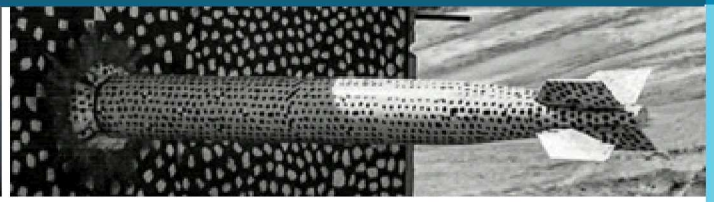
SAND2019-6503C

Investigating Cyber Threats in a Nuclear Power Plant





PRESENTED BY

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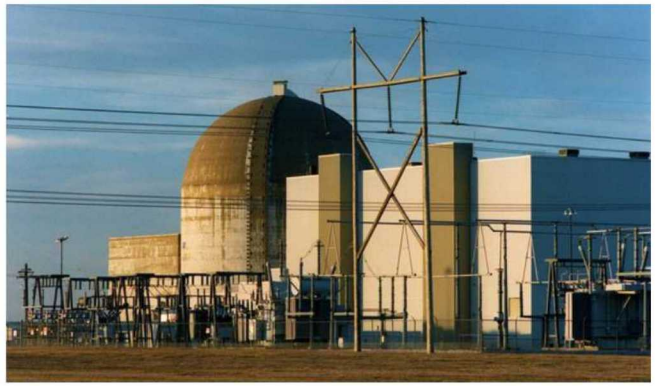
Cyber Threats and Nuclear Power Plants

- Cyber attacks are a national security threat; estimated 160,000 cyber incidents in 2017.
- Nuclear Power Plants are attractive targets to attack because of potential for immediate biological consequences and overall public fear of after-effects of nuclear-materials release.
- Attacks can be two-pronged
  - Cause the plant to fail
  - Spoof the control room instruments so that operators do not recognize that there is a problem
- **How difficult is it for operators to**
  - **recognize contradictory information,**
  - **determine which information is correct and**
  - **aptly respond to the actual plant conditions?**



The Wolf Creek Nuclear power plant in Kansas in 2000. The corporation that runs the plant was targeted by hackers.
DAVID EULITT / CAPITAL JOURNAL, VIA ASSOCIATED PRESS

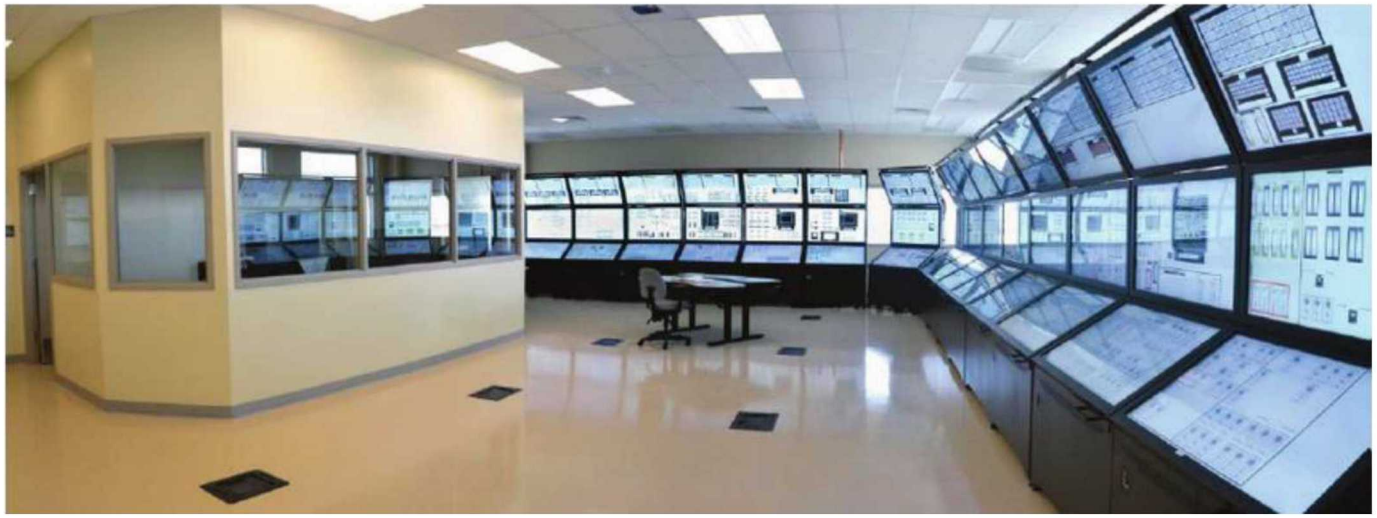
HF Human Factors
integrating the human with the system

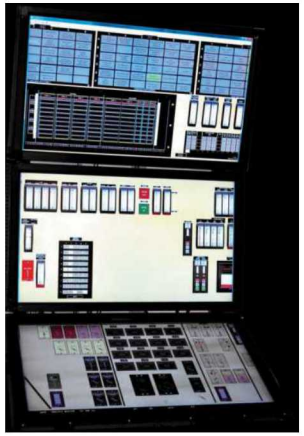
Study Motivation

- We need an effective way of exploring the human response to cyber attacks.
  - Human-in-the-Loop study with actual operators
- The Human Systems Simulation Laboratory (HSSL) at Idaho National Laboratory is a promising facility to explore aspects of cyber attacks
- **Goals of the Study**:
  - Determine if the HSSL is a practical facility to implement these studies
  - Initial look at how operators respond to cyber attacks

Human Systems Simulation Laboratory (HSSL)

- Located at Idaho National Laboratory
- Includes full-scale representation of a Nuclear Power Plant control room equip with touch screens, mouse mobility and auditory alarms
- Historically used for usability studies; **proposed for this study to explore Human Factors aspects of cyber attacks**





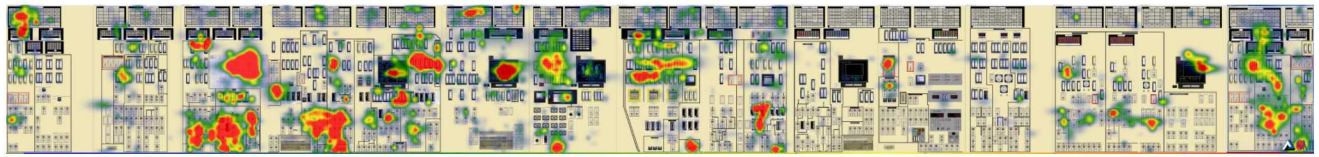
Human Factors
integrating the human with the system

Human-in-the-Loop study using HSSL

- Participants
  - 2 licensed Nuclear Power Plant operators with 60 years of combined experience
- Controls
  - Realistic simulated scenarios involving abnormal plant conditions
  - Displays presented correct information OR were manipulated to display incorrect information
- Procedure
  - Participants received refresher training on simulator
  - Participants completed ten simulated scenarios over the course of three days
    - For some of the scenarios, displays were purposely manipulated to show incorrect information
  - At the end of each scenario, participants asked to talk through their actions and decisions and completed several questionnaires on workload and stress level

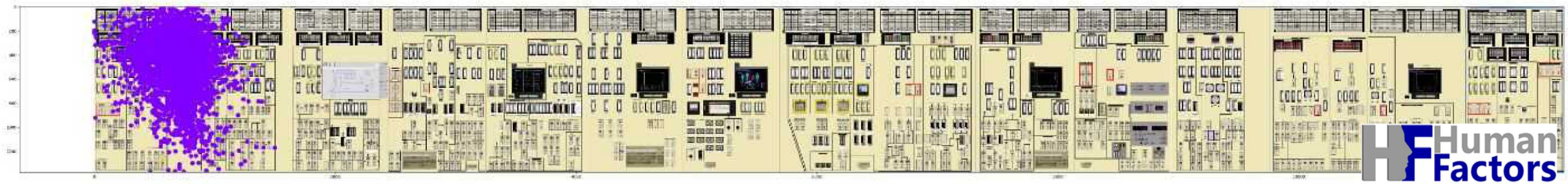
Human-in-the-Loop study using HSSL

- Measures
  - Audio/video
  - Simulator logs
  - Experimenter notes
  - Eye-tracking
  - Questionnaires
  - Applied Cognitive Task Analysis Methodology
    - Human Factors approach to understand cognitive demands and skills required for a task



Results

- The participants were able to keep the plant in a safe condition
  - The simulator logs showed that plant automation intervened before the operator did in some instances
- Eye tracking results showed that operators looked in vicinity of displays that presented incorrect information
- Using the Applied Cognitive Task Analysis approach, we discovered that the operator's job is to keep the plant safe by following procedures, not by diagnosing issues



Discussion & Future Work

- We were able to discover valuable results regarding operator performance using HSSL
- Even with incorrect display information, operators could rely on plant safety systems and correct execution of procedures to keep the plant safe

- Future work will include:
  - Collaborating with licensed operators in designing simulated scenarios and running studies
  - Focusing on misleading operators in terms of choosing the wrong procedure (instead of asking them to diagnose the situation)

Acknowledgements

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Questions?

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