Identifying Human Failure Events for External Hazard Probabilistic Risk Assessment

Camille S. Levine • clevine1@umd.edu • Systems Risk and Reliability Lab, University of Maryland, College Park

Introduction

- This project is part of a larger initiative to identify and prioritize uncertainties in probabilistic risk assessment of nuclear power plants under external hazards.
- Traditional human reliability analysis (HRA) is not fully equipped to address human actions outside of the control room.
- After the catastrophic seismic and tsunami flooding events at Fukushima Dai-ichi, and subsequent safety enhancements, there still remains a need for assessment of external hazard mitigation procedures.
- Recent cognitive-based HRA methods, such as Information-Decision-Action in Crew Context (IDAC) or Phoenix, may be applicable to manual actions.
- These newer methods provide robust tools for qualitative analysis of human failure events.

Materials And Methods

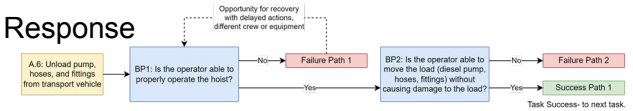
NUREG-7256, "Effects of Environmental Conditions on Manual Actions", contains task analyses for loading a portable pump, installing flood barriers, and building a sandbag berm. These decompositions were used to characterize the task structures.

Subtask 2.4 – Load Equipment from Outdoor Container on Transport Vehicle			
Open the large container door	Unsheltered	Fixed	Involves unlocking and opening the Sea-Van container.
Load equipment (i.e., hoses and fittings) on the transport vehicle	Unsheltered	Semi-fixed	Involves gathering (gripping and lifting) hoses and fittings from the storage container and loading them onto the transport vehicle. This subtask is assumed to be mostly unsheltered and to occur when opening the container.
Perform manual work with simple equipment (i.e., secure	Unsheltered		This task primarily involves physical

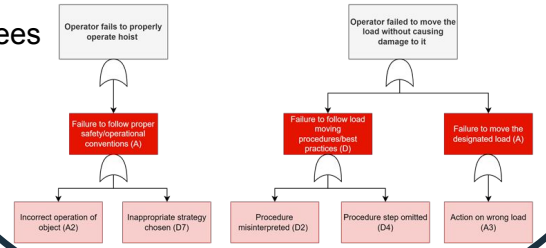
Research Highlights

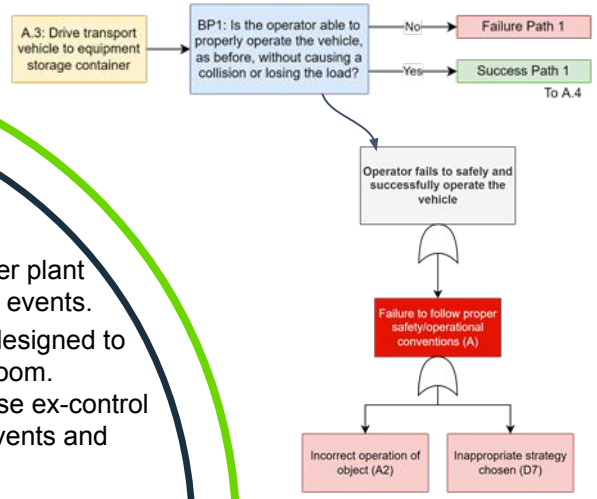
- Human actions are integral in nuclear power plant response and recovery from natural hazard events.
- Traditional human reliability methods are not designed to account for actions outside the control room.
- The Phoenix method was successfully applied to these ex-control room actions, identifying specific human failure events and underlying crew failure modes.

Crew Response Tree



Fault Trees





Models

Crew Response Trees were developed for each subtask; each branch point (blue) represents an opportunity for failure.

At the branch points, a fault tree characterizes the nature of the human failure event (red) and potential Phoenix crew failure modes (pink) that could cause the event.

Discussion

- Some modifications to the Phoenix method were made to add specificity and applicability to the method.
- Most of the human failure events had to do with failing an Action task (58%), then Decision making (21%), then Information (17%), and Coordination (4%).
- Certain crew failure modes were more frequently seen than others: for example, "Incorrect operation of an object" made up 22% of all the CFMs identified.
- Some of the method's crew failure modes were not used at all- especially those related to situation diagnosis and data gathering.
- Ultimately, the Phoenix and IDAC methods were relevant to ex-control room actions, and future work may include mapping out this analysis' causal factors.

Collaborators: Ahmad Al-Douri and Katrina M. Groth

This material is based upon work supported in part by the Department of Energy Office of Nuclear Energy under Award Number DE-NE0008974.