Collecting Simulator Data for Human Reliability Analysis

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Recent HRA Research

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- Developing an integrated HRA method (Ongoing)
  - Work with the EPRI
  - Address method-to-method variability issue
- HRA data collection (Ongoing)
  - Topic of this presentation
- Benchmarking HRA methods with simulator exercises
  - International and domestic benchmark studies
  - Research work completed; reports to be generated
- Fire HRA
  - EPRI 1019196/NUREG-1921, "EPRI/NRC Fire Human Reliability Analysis Guidelines" – Spring 2012
- Spent fuel handling
  - NUREG/CR-7016, "Human Reliability Analysis-Informed Insights on Cask Drops", 2/2012
  - NUREG/CR-7017, "Preliminary, Qualitative Human Reliability Analysis for Spent Fuel Handling", 2/2012

HRA Data Program Goal

Bridging human performance data and HRA applications of the NRC's risk-informed programs

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Human Performance Data

HRA Applications

Focused HRA Applications and Data

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- Applications:
  - Baseline PRA models
  - Significance Determination Process (SDP)
  - Accident Sequence Precursor (ASP)

  SDP and ASP have more specific context information than the baseline PRA. It implies that data needs to have different levels of granularity.
- Data:
  - Licensed operator simulator training
  - Operating experience
  - Operator performance studies (e.g., Halden simulator exercises)
  - Initial licensing exams

Objectives and Tools

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Two different tools to address two different objectives

- Objectives 1: Inform Human Error Probability (HEP) estimates
  - For data of licensed operators simulator training and simulator-based research studies
  - Piloting the tool scheduled in April, 2012
- Objective 2: Improve understanding of operators' behavior in responding to plant malfunction(s)
  - An enhanced timeline tool capturing the scenario progress and the What's and Why's that affect the progress
  - For data of events that mobilize the NRC's inspection teams and simulator-based research studies

Tool for Informing HEP Estimates

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- A web-based tool
  - Data stored in the Idaho National Laboratory
- Collect licensed operator simulator training data
  - Under an MOU with an NRC licensee
- Data supports HEP estimates and human performance improvements
  - Support risk, operations, and training departments
- Welcome industry's collaboration

Approach to Data-Informed HEP Estimates

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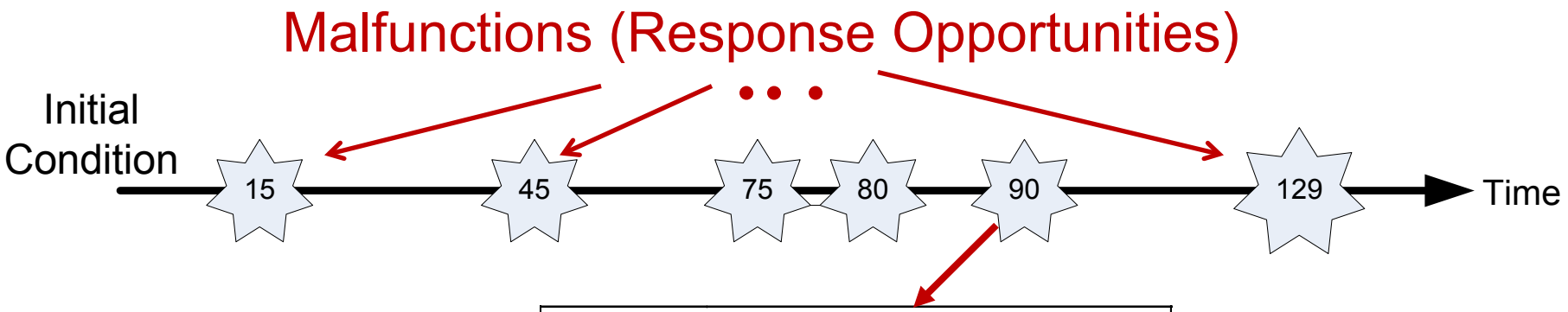
- Based on counting the number of failure and response opportunities
- Context specific HEPs

$$\text{HEP (Context)} = \frac{\text{\# of Failure (Context)}}{\text{\# of Response Opportunities (Context)}}$$

Counting the Response Opportunities



Loss of ECW 1A	
POSITION	**EXPECTED RESPONSE**
CREW	Recognize loss of EW flow to A train.
Crew	Secure ECW pump 1A
CT	Manually trip Diesel Generator prior to any of the following occurring:
CT	Diesel Generator tripping
Crew	Ensure CCP 1A is in service
Crew	Verifies Natural Circulation
SM	Determines need to cooldown
SM	Declare an Alert HA1/EAL2 due to damage to EW structure or notify ED that escalation is appropriate.

Framework for Data-Informed HEP Estimates

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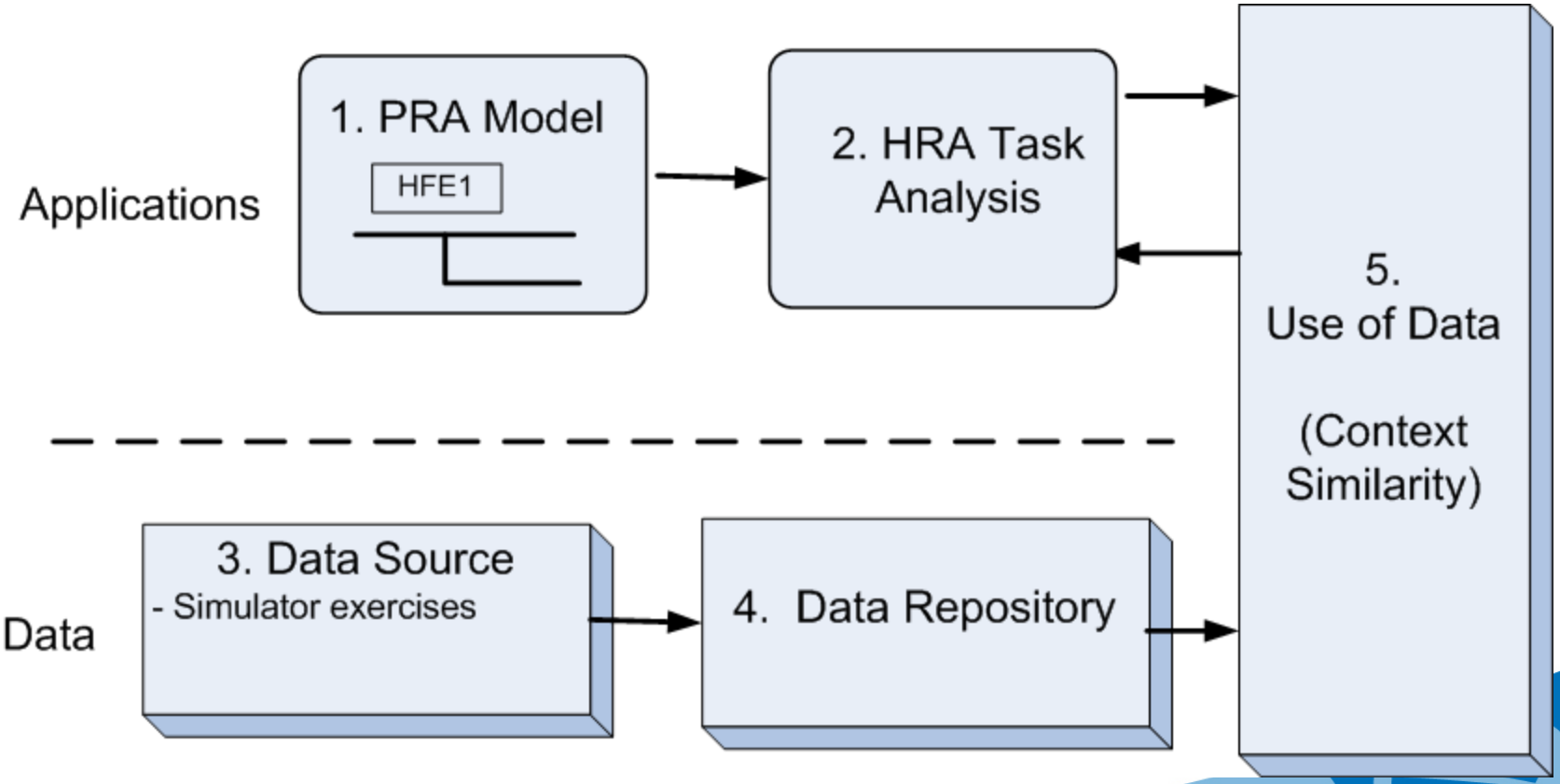

Key Information of a Response Opportunity

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- Context
  - The human performance challenges in responding to each malfunction
  - Characterized by a set of factors classified according to human information processing in crew context
- Performance results
  - SAT, SATΔ, or UNSAT (including human error recovery)
- Types of inappropriate acts
- Causes of inappropriate acts

Context

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- Characterized by seven classes of factors
  - Detecting, understanding, deciding, action, communication/teamwork, supervision, and workload managing
  - Each class consists of less than 10 specific factors
- E.g., Detecting class consists of
  - Large number of simultaneous alarms
  - Missing/Degraded information
  - Misleading information
  - Unfamiliar/unrecognizable alarm pattern
  - Small or gradual change
  - Status of automatic control system/automatic control actions not clearly indicated (e.g., complex interlocks)
  - No reason to check
  - Others

Types of Inappropriate Acts

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- Characterized by 4 classes of factors
  - Failure to detect
  - Failure to understand
  - Planning/decision failure
  - Action failure
- E.g., “Failure to Detect” class consists of
  - Key alarms not detected
  - Key parameter value not detected
  - Automated system status/change not detected
  - Critical data not checked with appropriate frequency
  - Decided to stop collecting critical data
  - Wrong data source attended to
  - Other

Causes of Inappropriate Acts

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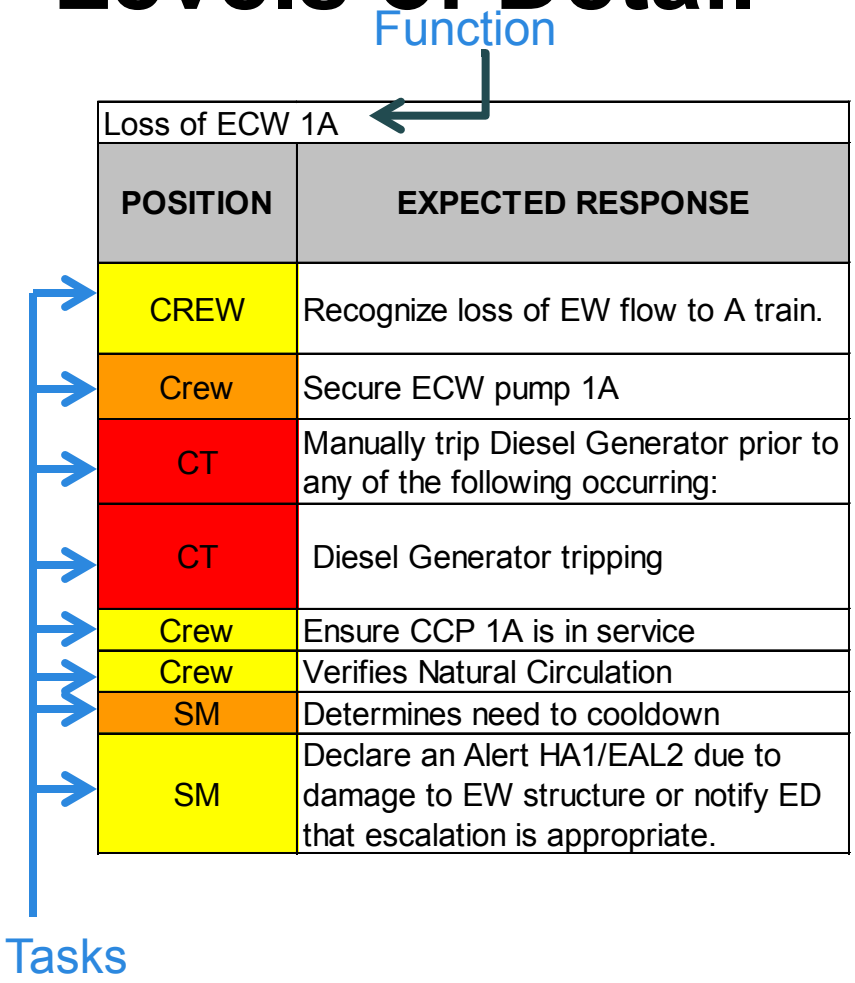
- Characterize by 6 classes of factors
  - Monitoring, Diagnosis, Procedure, Manipulation, Communication, and Supervision
- E.g., Procedure class consists of
  - Procedural adherence less than adequate (LTA)
  - Procedure / reference document technical content LTA
  - Procedure / reference document format/design LTA
  - Procedure / reference document development and maintenance LTA
  - No procedure / reference documents
  - Others
- Factors are hierarchically structured

Data Collection in Two Levels of Detail



- Context and Performance Results are collected for every Task and Function
  - The function's context is aggregated from the tasks' contexts
- The types and causes of inappropriate acts are collected only when SATΔ or UNSAT
  - Could be in either function or task level
- Can inform human failure events modeled with various levels of detail

A Prototype Screen

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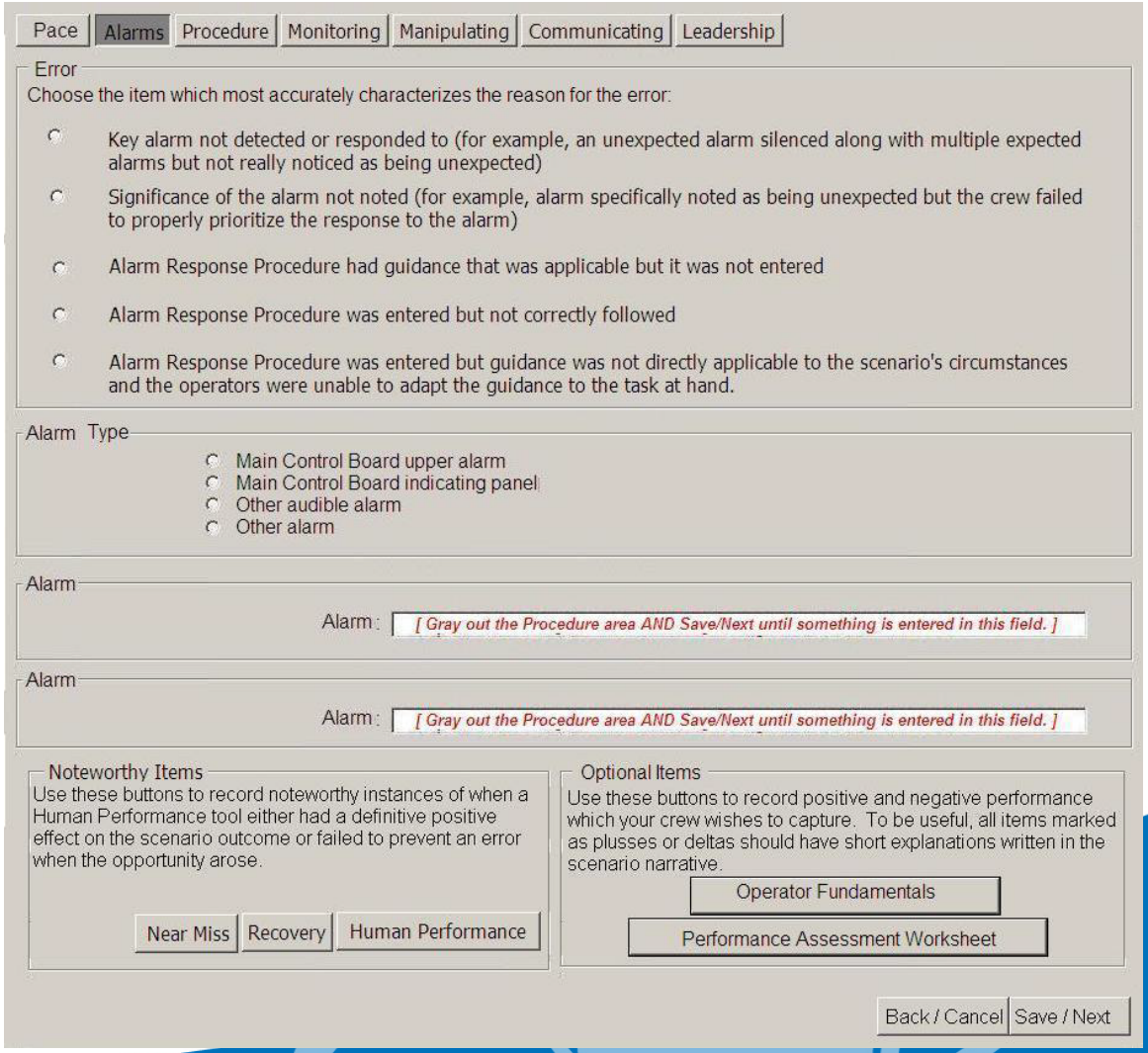
Interface for quick identification of the factors



Benefits To Industry

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- Risk department
  - HEPs with stronger data support
  - Based on plant-specific and/or aggregated (generic) data
- Operations and Training departments
  - Systematic trending analysis for effective human performance improvement
  - Systematically and electronically track individuals' performance

Summary

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- NRC is developing tools for collecting human performance data
  - For improving HRA and human performance
- Seek more collaboration with industry
  - Review the tools – April 2012
  - Collaborate with NRC on data collection
  - Prefer signing a MOU

Key MOU Items (ML110730582)

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- NRC funds the method and tool development
  - Solicit input from the licensee
- The licensee enters data
  - Data stored in the Idaho National Lab with controlled access
  - Data are proprietary to the licensee
- NRC can access the data and publish results
  - Solicit input from the licensee
  - No plant and individual identifications will be revealed
- The licensee is protected from regulatory action due to nonwillful violations identified under the MOU

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