LESSON 1

Introduction to Human Reliability Analysis for NMSS

Idaho National Laboratory

Study Guide

Topic: Introduction to HRA for NMSS

Purpose: Provide an overview to the key concepts to be taught in the course regarding risk, human error, and human reliability. Show how assessing human reliability is part of NRC's long-term plans and describe how HRA has been applied within NMSS.

Objectives: At the end of this lesson, learners will be able to:

- Define risk, human error, and human reliability assessment
- Describe the relevance of HRA to NMSS
- Recall several NRC HRA applications

Resources: Reason, Chapter 1; Gertman and Blackman, Chapter 1

Risk and the NRC

- ***What is risk?***
- ***Where does risk come from?***
- ***How can risks be identified?***
- ***How can risks be managed?***
- ***What is NRC's risk agenda?***

Definition of Risk Triplet

- ***What can happen (i.e., normal and/or off-normal conditions)?***
  - ***(possible scenario)***

- ***How likely is it?***
  - ***(frequency, probability)***

- ***What will be the outcome?***
  - ***(consequences)***

Techniques/Approaches for Assessing Risk

- ***Worst - case scenario analysis***
- ***Actuarial/probabilistic***
- ***Analytical***
  - ***Deterministic***
  - ***Probabilistic***

Approaches to Risk Management/ Assessment

- ***Traditional Approaches***
  - ***Maximum Credible Accident***
  - ***Design Basis Accident (DBA)***
  - ***Actuarial Analysis***
- ***Broad Identification and Overview of Hazards***
  - ***Hazard/Barrier Analysis***
  - ***Safety Review***
  - ***Checklist Analysis***
  - ***Relative Ranking***
  - ***Preliminary Hazard Analysis (PHA)***
  - ***What-If Analysis***

Approaches to Risk Management/ Assessment (cont.)

- ***Detailed analysis of wide range of hazards to identify possible scenarios***
  - ***What-If/Checklist Analysis***
  - ***Hazard and Operability Analysis (HAZOP)***
  - ***Failure Modes and Effects Analysis (FMEA)***
- ***In-depth analysis of specific scenarios; requires higher degree of analyst expertise, and increased time and effort***
  - ***Probabilistic Risk Assessment (PRA)/ Probabilistic Safety Assessment (PSA)***
  - ***Integrated Safety Analysis (ISA)***
  - ***Performance Assessment (PA)***

Approaches to Risk Management/ Assessment (cont.)

- ***Choice of method or combinations of methods will depend on***
  - ***Reason for conducting the analysis***
  - ***Results needed from the analysis***
  - ***Available information***
  - ***Complexity of the process being analyzed***
  - ***Personnel and experience available***

Risk Assessment Reform is on the Federal Agenda

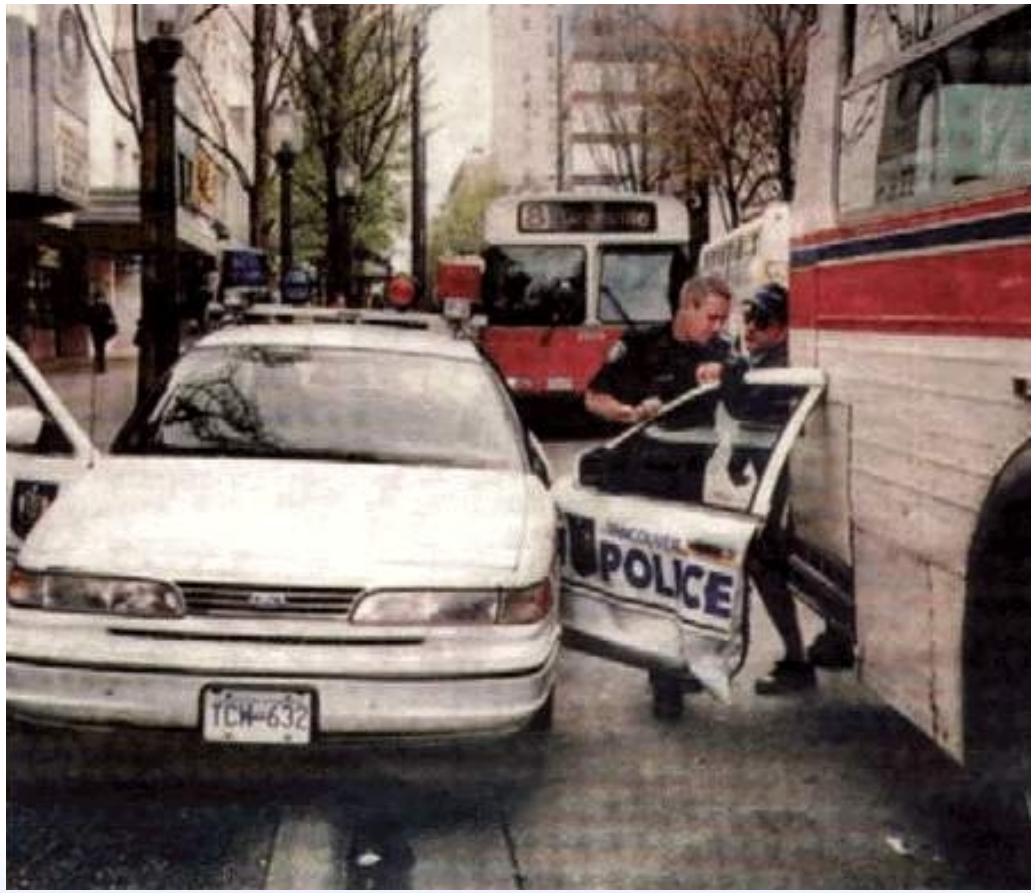
- ***Curb over-regulation***
- ***Separate scientific findings from policy and other issues***
- ***Identify open scientific uncertainties of risk***
- ***Assess costs and benefits for regulating risks***
- ***Publicize uncertainties and comparison to routine risks***

Definition of Human Error

Human Error:

- ***unwanted actions or inactions*** *that* ***arise from problems*** *in sequencing, timing, knowledge, interfaces, and/or procedures*
- ***that result in deviations*** *from expected standards or norms*
- *that* ***place*** *people, equipment and systems at* ***risk***

Some Errors are More Obvious than Others:



Human Error is a Significant Contributor to Risk

Accidents at Sea	90%
Chemical Industry	80-90%
Airline Industry	60-87%
Commercial Nuclear Industry	65%
Medical Misadministration for Prescription drugs	20%

What is Human Reliability Assessment?

The use of systems engineering and behavioral science methods in order to render a complete description of the human contribution to risk and to identify ways to reduce that risk

NRC Strategic Plan FY 2000 - 2005

- *STRATEGIC GOALS:* ***The NRC will conduct an effective regulatory program that allows our Nation to use nuclear materials safely for civilian purposes and in a manner that protects the public and the environment by working to achieve the following strategic goals: (specific to NMSS)***

  - *Prevent* ***radiation-related deaths and illnesses****, promote* ***the common defense and security****, and protect* ***the environment in the use of source, byproduct, and special nuclear material for medical, academic, and industrial purposes. (Nuclear Materials Safety)***

  - *Prevent* ***adverse impacts from radioactive waste to the current and future public health and safety and the environment, and promote common defense and security (Nuclear Waste Safety)***

Examples HRA in NMSS

- ***What are the HRA questions to be asked?***
  - ***What data exist or need to be collected?***
  - ***What existing or new failure modes are created by the change(s)?***
  - ***What credit was taken for human actions in Facility Safety Analysis Reports?***
    - ***How does it change?***
    - ***With what impact?***
- ***What do we learn as a result?***

Examples HRA in NMSS (Cont.)

Example 1: Paper mill using sealed sources to help estimate flow, and paper thickness, etc., wants to lighten training requirements, change surveillances, etc.

Questions

- ***Is anybody in particular assigned the responsibility to handle, account or control sealed sources?***
  - ***How are people trained to deal with sealed sources?***
  - ***Is there a database of previous events?***
  - ***What actions does the licensee take credit for in their safety analysis(es)? Does the proposed change delete, add, or merely change the tasks that now need to be performed?***
    - ***What failure modes were identified?***
    - ***Are new ones created if change is implemented?***
- ***What is the potential impact of human error on worker health, safety and efficiency?***

Examples HRA in NMSS (Cont.)

- ***Example 2: Licensee wants to change from HP monitoring of workers to just use of individual dosimetry.***

  (1) What were the failure rate(s), false positives and false negatives when HPs were used?

  (2) What are the expected failure rates associated when individual responsibility?

  (3) What data exist for conversion of HP to individual responsibility?

  (4) What actions were taken credit for in the original SAR? How do they change? With what impact?

NMSS Current Risk Activities

- ***NMSS established a task group on risk assessment and risk management in July 1999***
- ***Organizational changes made including the creation of an NMSS Risk Task Group and Steering Group in March 2000***

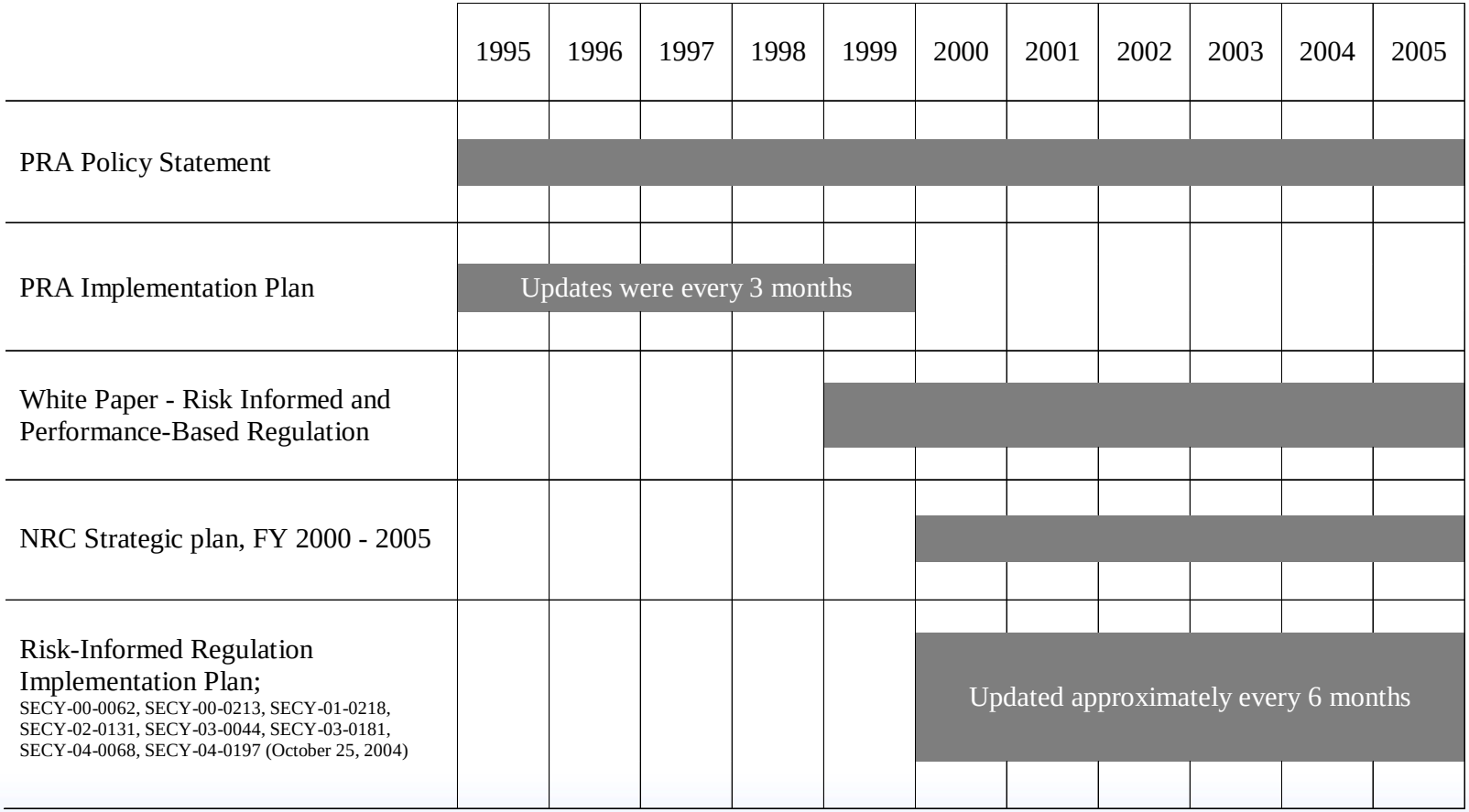
Current Risk Activities (continued)

- ***Evaluating and adjusting ongoing initiatives to make NMSS activities more risk informed***
  - ***ISAs for fuel cycle facilities***
    - ***Summary reviews are ongoing***
  - ***Byproduct material risk analysis***
    - ***An analysis documented in NUREG-6642 and there has been a 1-day training course (P-405) for the staff on how to use findings of NUREG-6642***
  - ***Risk Assessment for dry cask storage***
    - ***A draft report from a study was published June 2002***
  - ***Package performance***
    - ***Ongoing to address issues from NUREG/CR-6672***
    - ***Performance of UF_6 cylinders report completed, evaluation of the risk insights on going***
  - ***Yucca Mountain Review Plan, Revision 1***

Introduction to NRC Policy on the Use of Risk Information

- ***References:***
  - ***Federal Register, "Use of Probabilistic Risk Assessment Methods in Nuclear Regulatory Activities: Final Policy Statement," Volume 60, Number 158, August 16, 1995.***
  - ***SRM-SECY-98-144, "Staff Requirements - SECY-98-144 - White Paper on Risk-Informed and Performance-Based Regulation," March 1999.***
  - ***NUREG-1614, "U.S. Nuclear Regulatory Commission Strategic Plan, FY 2000 - 2005," Draft, Volume 2, Part 1 and Part 2.***
  - ***SECY-04-0197 "Update of the Risk-Informed Regulation Implementation Plan," October 25, 2004 (to be updated approximately every 6 months).***
    - ***SECY-04-0068, April 23, 2004***
    - ***SECY-03-0181, October 27, 2003***
    - ***SECY-03-0044, March 21, 2003***
    - ***SECY-02-0131, July 12, 2002***
    - ***SECY-01-0218, December 5, 2001***
    - ***SECY-00-0213, October 26, 2000***
    - ***SECY-00-0062, March 15, 2000***

Timeline of NRC Policy on the Use of Risk Information



Risk-Informed and Performance-Based Regulation

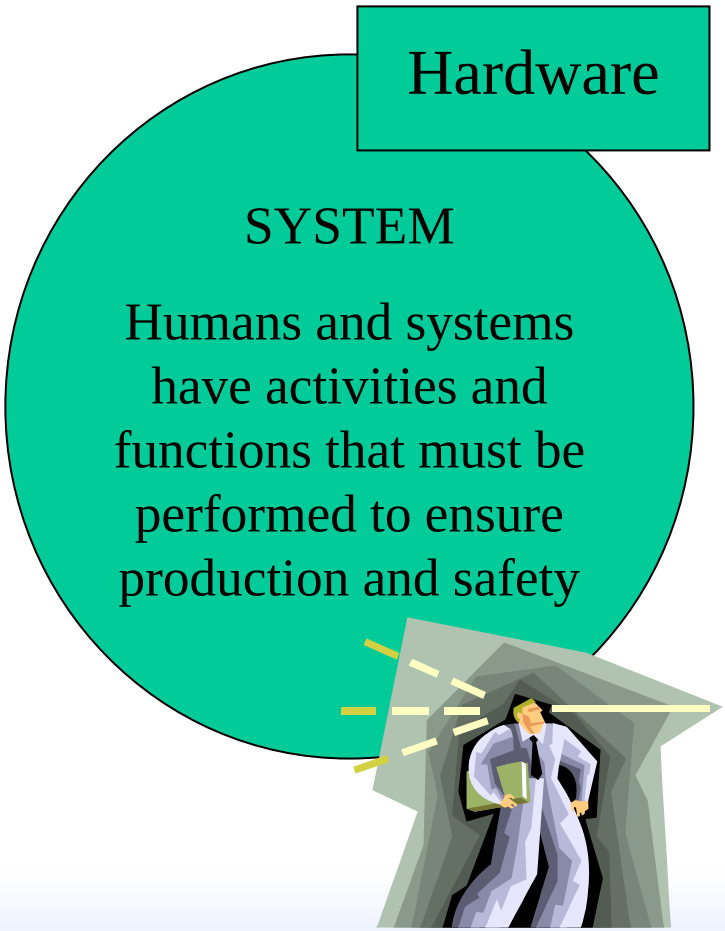
Risk-Informed Approach

Risk insights are considered together with other factors to establish requirements that better focus licensee and regulatory attention on design and operational issues commensurate with their importance to public health and safety

Performance-Based Regulation

A performance-based requirement relies upon measurable (or calculable) outcomes (i.e., performance results) to be met, but provides more flexibility to the licensee as to the means of meeting those outcomes

HRA in Risk Assessment: The BIG Picture

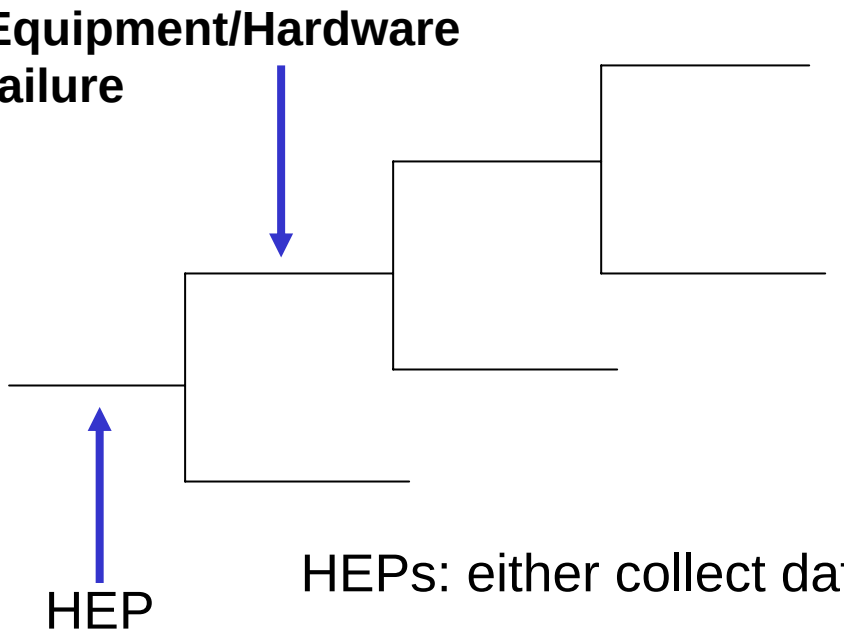


- ***Risk assessment looks at these activities and interactions and identifies the pathways by which the system mission might fail, and integrates all failure modes.***

- ***In NMSS applications, people might be the predominant system, not the hardware. This is different than most typical risk assessments.***

HRA in Risk Assessment: The BIG Picture

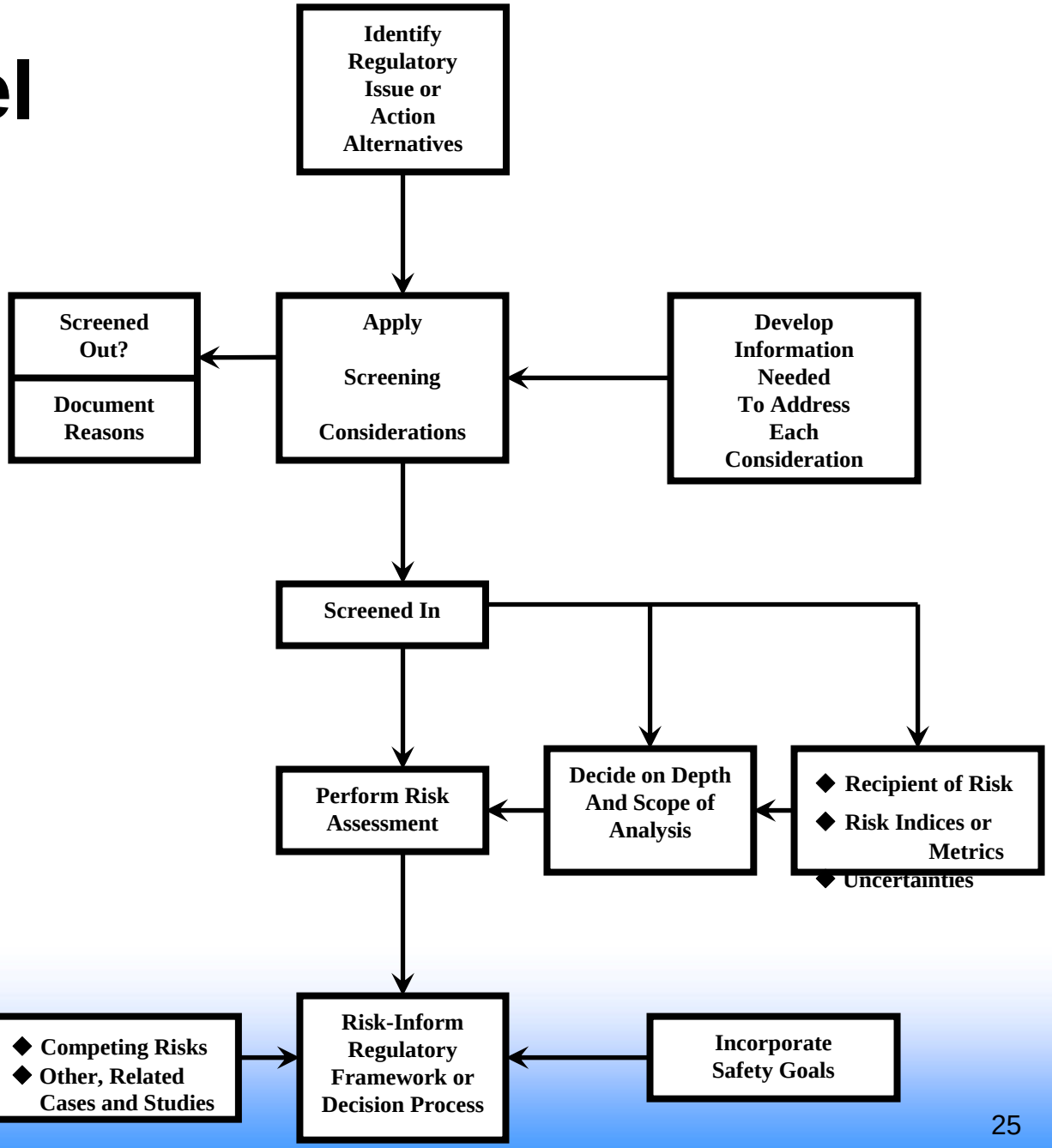
Event tree and Fault tree structure(s) allows visualization of the effects of combinations of failures.



Hardware: collect your failure rates from the data

HEPs: either collect data or apply an HRA method

Usage Model



NMSS Risk-Informed Evaluation and Decision Process

Recent NRC HRA Applications Include:

- ***Medical applications (NMSS)***
- ***Errors of commission (RES)***
- ***Improving human performance data and database systems (RES)***
- ***Waste management, transportation, and dry cask (NMSS)***
- ***Review of operating events (RES)***
- ***HRA for preclosure of Yucca Mountain (NMSS)***
- ***Reactor Oversight Process (NRR)***
- ***Pressurized Thermal Shock***
- ***Fire Analysis***

HRA in Support of a Risk-Informed Approach

A risk-informed approach enhances deterministic analyses and leads to better decision-making by:

- ***allowing explicit consideration of a broader set of potential challenges to safety***
- ***providing a logical means for prioritizing these challenges based on risk significance, operating experience, and/or engineering judgment***
- ***facilitating consideration of a broader set of resources to defend against these challenges***
- ***explicitly identifying and quantifying sources of uncertainty in the analysis (does not necessarily reflect all important sources of uncertainty)***
- ***providing a means to test the sensitivity of the results to key assumptions***

Lesson Summary

Key Points:

- ***Risk is the likelihood of a hazard causing loss or damage***
- ***There are a wide variety of methods for assessing risk***
- ***Human error is a significant contributor to about 80% of all accidents***
- ***NRC has strategic goals, plans, and a model for using risk information***
- ***NRC has successfully used HRA for various applications***
- ***HRA supports a Risk-Informed Approach***