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LESSON 8

Summary and Application

Study Guide

Topic: Summary and Application

Purpose: This lesson first reviews HRA concepts and applications then launches a discussion on NMSS uses, current issues, and future directions of HRA.

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

- Recall the basic concepts of HRA
- Describe the potential uses of HRA to support the NMSS mission
- Discuss current issues
- Discuss where HRA is heading in the future
- Demonstrate their understanding by application of HRA to an in-class problem

Definition of Human Error

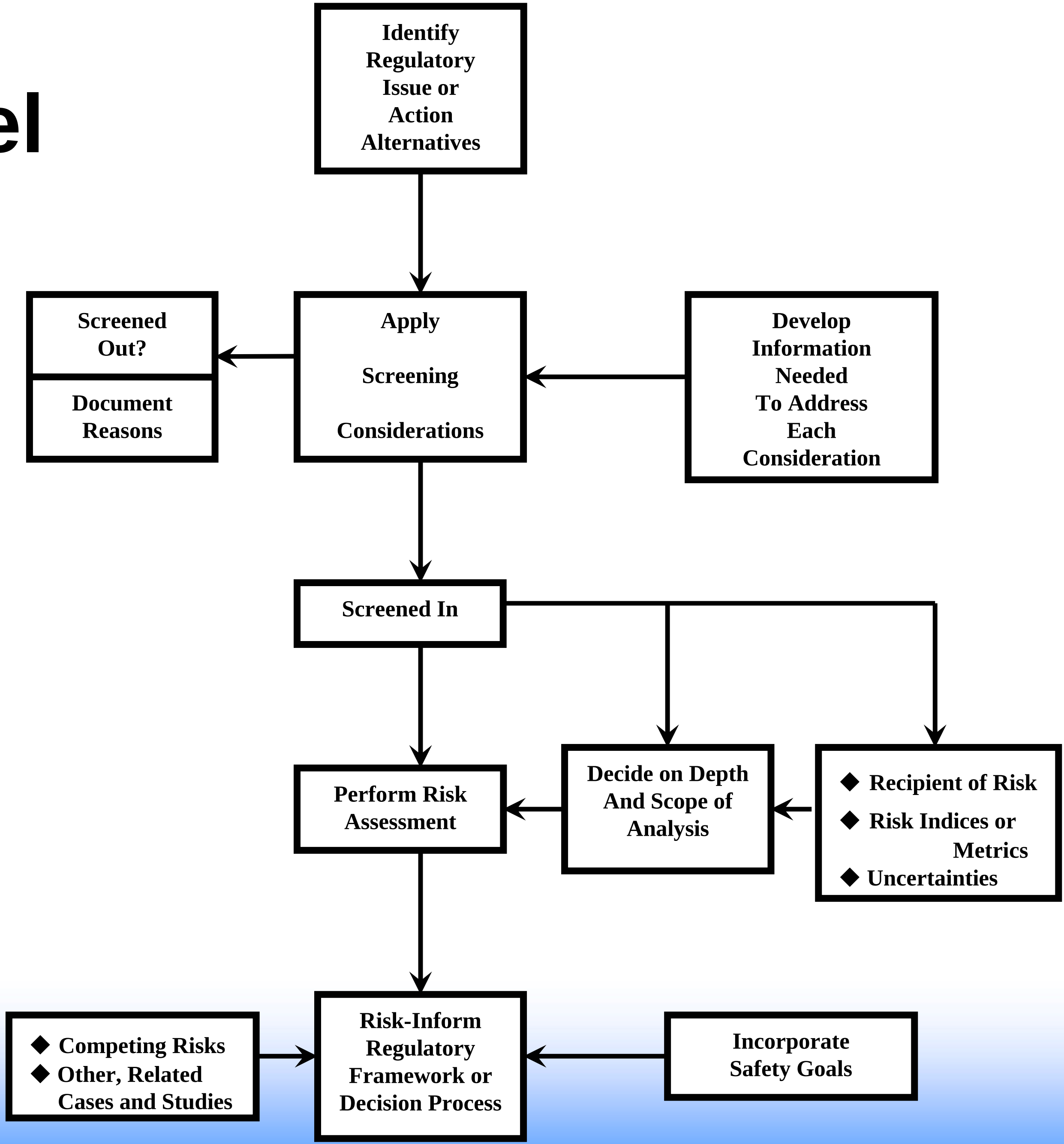
Human Error:

- **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
- We care about errors that **place** people, equipment and systems at **risk**

What is Human Reliability Analysis?

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

Usage Model



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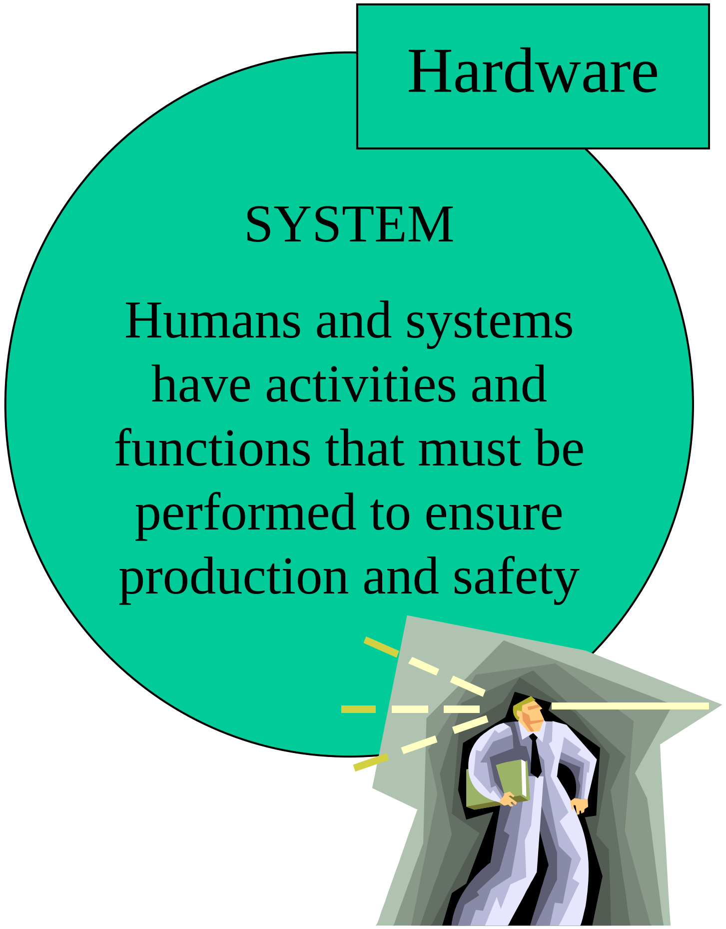
HRA in Risk Assessment: The BIG Picture



- ***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.***

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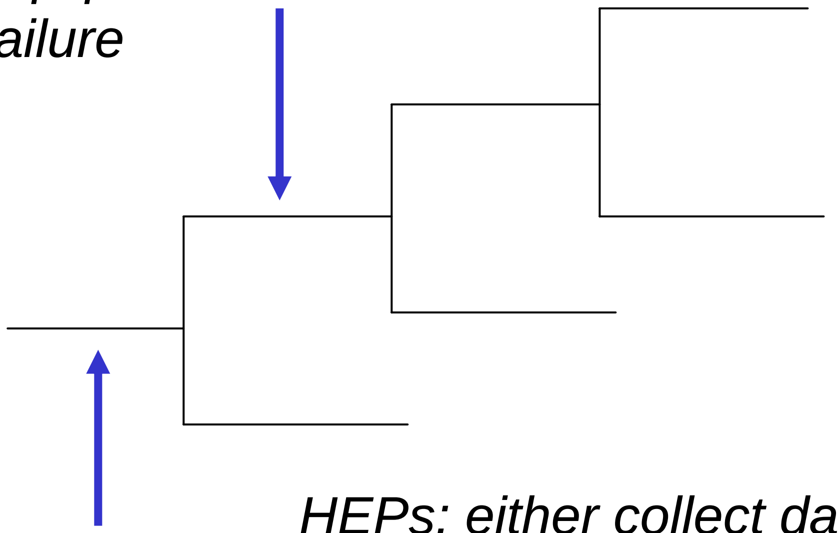
HRA in Risk Assessment: The BIG Picture

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

Equipment/Hardware failure

Hardware: collect your failure rates from the data



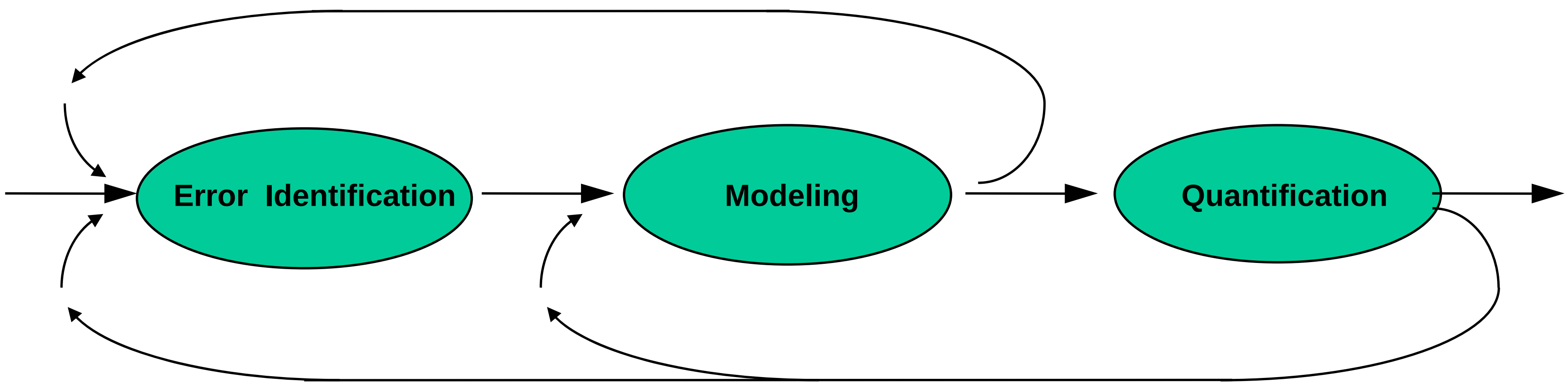
HEP

HEPs: either collect data or apply an HRA method

Assumptions of HRA:

- *Human error can be identified*
- *Human error can be modeled*
- *PSFs affect task performance*
- *Human behavior can be described by cognitive models*
- *Interdependency of tasks and task parameters exist*
- *Human systems interaction(s) are important*
- *Different types of errors exist*
- *Human performance is probabilistic in nature*
- *Human error can be quantified*

Requirements for Human Reliability Analysis



taxonomies
context
error producing conditions
cognitive error
errors of commission

dynamic event trees
fault trees
event trees
generic error models

data availability
data bases
simulation
empirical approaches
consensus expert judgment

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Error Identification: Current Approaches and Future Developments

- ***Importance of context and error producing conditions***
- ***Taxonomies***
- ***Thorough examination of errors of commission***

Error Modeling:

- ***Fault and event trees***
- ***Generic error models***
- ***Influence diagrams***
- ***Dynamic event trees***
- ***Failure mode and effects analysis***

HRA Quantification: Includes Issues of Data Validity, Reliability, and Availability

- *How good are the methods and the data that are available?*
- *What is the availability of data?*
- *What data bases exist?*
- *Are the data applicable for next generation plants and for non plant applications?*
- *Are there simulations available?*
- *Are there empirical approaches being taken?*

Specific Strengths of Risk Analysis Methods

- ***Rigorous, systematic analysis tool***
- ***Information integration (multidisciplinary)***
- ***Allows consideration of complex interactions***
- ***Develops qualitative design insights***
- ***Develops quantitative measures for decision making***
- ***Provides a structure for sensitivity studies***
- ***Explicitly highlights and treats principal sources of uncertainty***

Principal Limitations of Risk Analysis Methods

- *Adequacy of data basis*
- *Level of understanding of physical processes and behavioral-cognitive processes*
- *Sensitivity of results to analytical assumptions*
- *Modeling constraints and approximations*
- *Bounds on analytical tasks, including truncation*
- *Risk Assessment/HRA is often only a snapshot analysis—there may be a need for a "living" risk assessment/HRA*
  - *Model typically reflects a "frozen" configuration*
    - *All modifications or specific configurations may not be addressed*
- *Lack of completeness*

Example: Risk of Fixed Nuclear Gauges (NUREG-1669)

- ***Nuclear gauges used to improve quality and lower cost for industrial and commercial products***
- ***Improper control can lead to exposure to radiation by personnel handling the gauges***
- ***Poor control can result in steel industry recycling, then decontaminating at huge expense***
- ***Risk to licensees and recyclers is incompletely understood***

Uses of Nuclear Gauges

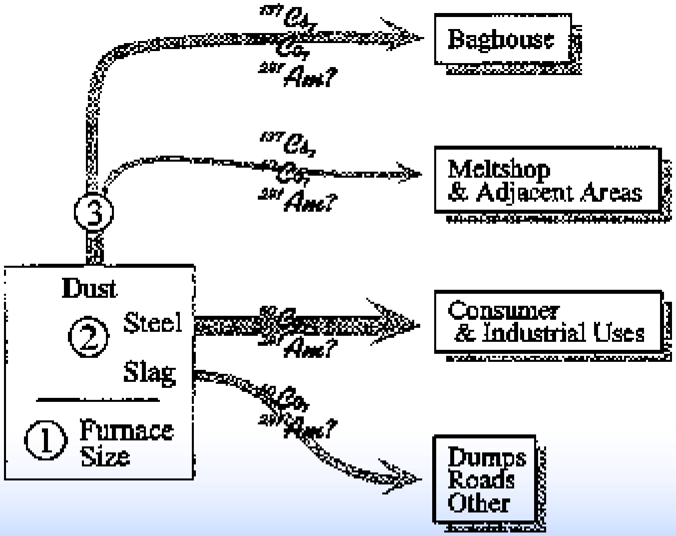
- ***Measure density of materials in pipes***
- ***Measure material amount in tanks***
- ***Measure amount of material on conveyor belts***
- ***Measure thickness of films***

What is the Risk of Nuclear Gauges?

- ***Focus is on the recycling stream***
- ***Gauges breached in scrapyards or melted in steel mills***
- ***Gauges locked on by mistake during maintenance***
- ***Discarded in landfills***

Steel Mills

- ***Most discoveries of dangerous sources (Cs, Co, and Am) were found in steel mills***
- ***Scap metal is valuable and likely to be recycled***
- ***Industry trade association and steel and scrap dealers have requested more stringent control of licensees***
- ***Risk of melting radioactive material is proportional to consuming scrap metal***



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Types of Control

ICC or Hard Controls

- ***"In use"***
- ***Dedicated storage***
- ***Returned to vendor***

Soft Controls

- ***Labels***
- ***Inventory***
- ***Education***
- ***Regulatory penalties***

Although Immediate and Continuous Control is Desirable…

- *Licensees have leeway to devise their own control programs*
- *Lack of collective experience shared across industries*
- *Challenges:*
  - *Maintenance shutdowns*
  - *Facilities closed suddenly*
    - *Gauges discarded when facility is dismantled*

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Desired Forms of Control on Gauges

- *Periodic inspection*
- *Inspections related to events*
- *Inventory (periodic updates and tracking)*
- *Training by vendor or as regulatory requirement*
- *Well maintained records*
- *Contractor training*

Increased Risk

- ***Workforce reductions***
- ***High facility turnover***
- ***Phased-out or abandoned facilities***
- ***Dismantling facilities***
- ***Monitoring system malfunction***
- ***Alarms deactivated because of high false alarm rate***

Gauges and Human Error

- ***Most pathways leading to exposure involve human performance and human error, not material or component failure***
- ***Factors affecting likelihood of error***
  - ***Organizational work practices***
  - ***Lack of training***
  - ***Lack of awareness***
- ***Analysis in NUREG-1669 is excellent example of the value of qualitative human reliability analysis to determine causes and solutions to problems in handling radioactive materials***

How can HRA be used to support NMSS staff?

#13 In class Exercise

- ***Divide into three groups***
- ***Take 10 minutes***
- ***Each group should generate a list of potential areas where human error analysis or HRA could help them in their jobs***

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What constitutes a quality HRA?

- ***NRC Staff need to establish the quality of an HRA submittal by considering general criteria, as well as criteria associated with specific methods***
- ***A criteria checklist developed from your class text is included under Appendix G***

Application of HRA Methods

#14 In class exercise

- ***Generate a list of previous NMSS events or issues***
- ***Vote on the selection of two problems/issues***
- ***Break into two groups***
- ***Based upon what we have covered in class the past two days, each group will select an HRA method and apply it to the problem they have been assigned***
- ***Each group will select a presenter***
- ***Presentations will be directly after lunch***

HRA Conclusions

- ***Integrated approach***
- ***Formal procedure***
- ***Means to estimate the human's contribution to risk***