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Title: Human Factors and Reliability

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Human Factors and Reliability

Mandy Bowles Tomaszewski

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NHS

Health Education England

Introduction

- People come to work, wanting, expecting, and planning to do a good job, but people tend to do what makes sense to them in their context.

- Understanding basic human factors and establishing controls to prevent common human factors issues helps ensure that a criticality accident will never happen again.

What Are Human Factors?

A scientific discipline that applies knowledge about human abilities, characteristics, and limitations to design processes, equipment, and environments.

Importance of Understanding Human Factors

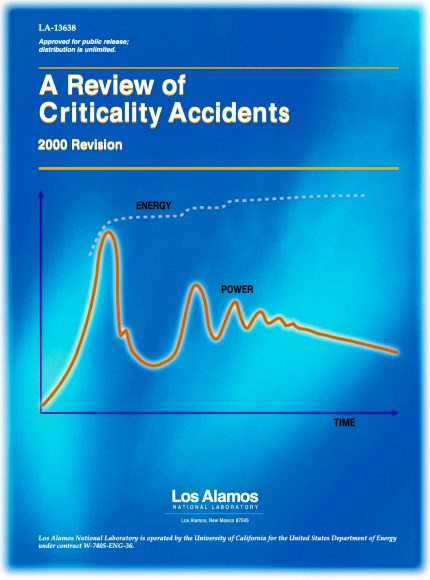
Fissile Material Ops are High-Risk, High-Consequence Systems

- Rely Heavily on Administrative Controls
- Rely Heavily on Training
  - Fissile Material Handler (FMH) Training Program
    - Mixture of Hands on Training and Classroom Programs

Importance of Human Factors to Criticality Safety

A Review of **60** criticality accidents from 1953 to 1999 concluded that the human element was not only present, but the **dominant cause** in all of the accidents *(LA-13638*)

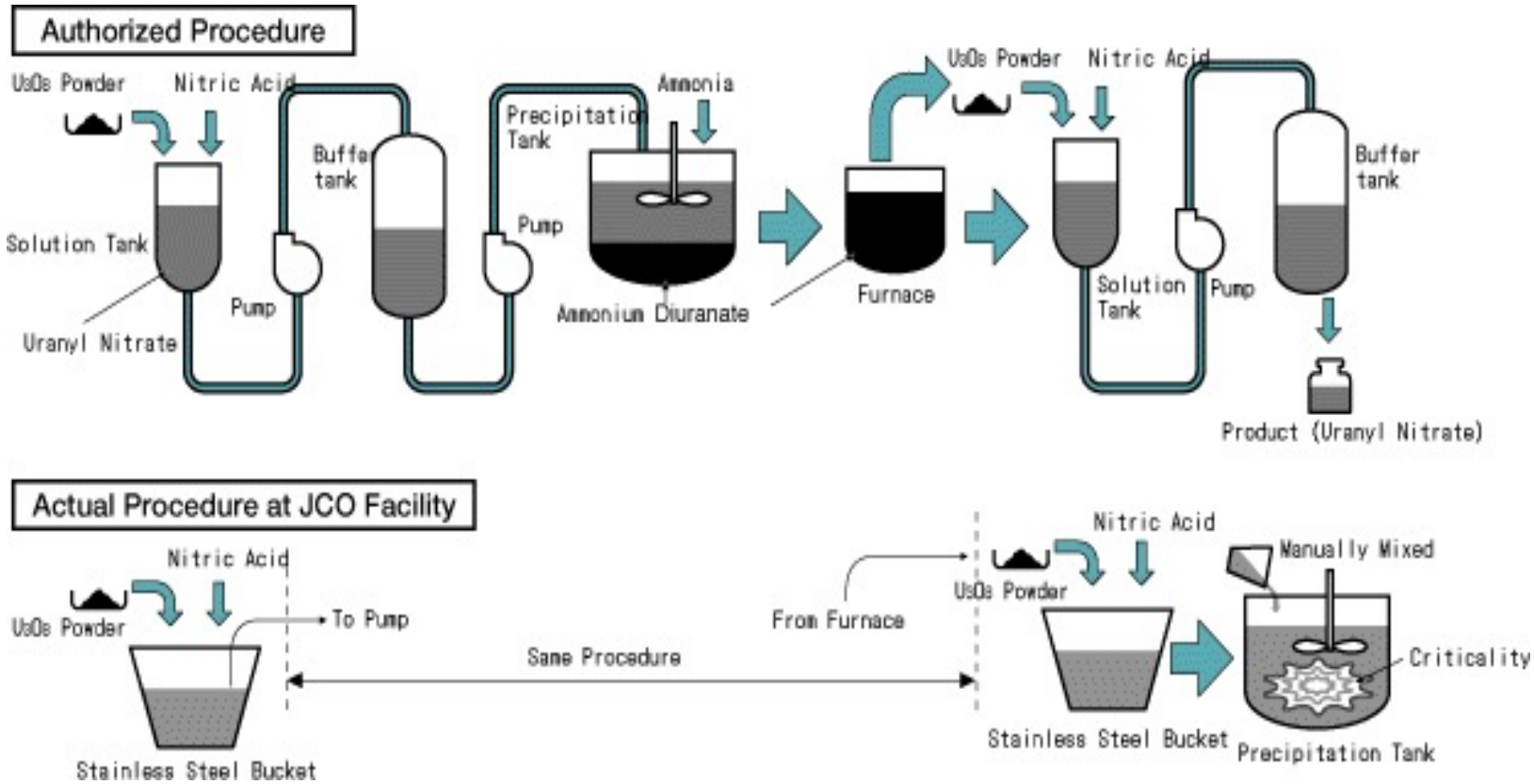
- Operations rely heavily on human involvement.
- Administrative controls require correct human action
- Humans must read and interpret procedures
- Humans execute the process
- People bring many issues to work with them that can impact the quality of work



Production Pressure

Of the many technological and safety disciplines that overlay the nuclear energy industry, criticality safety stands out as unique – Unique because it is the discipline that most constrains productivity and is thus viewed as economically counterproductive. ~C.L. Brown, *Impact on Nuclear Criticality on Fuel Cycles (1981)*

Tokai Mura (Japan, 1999)



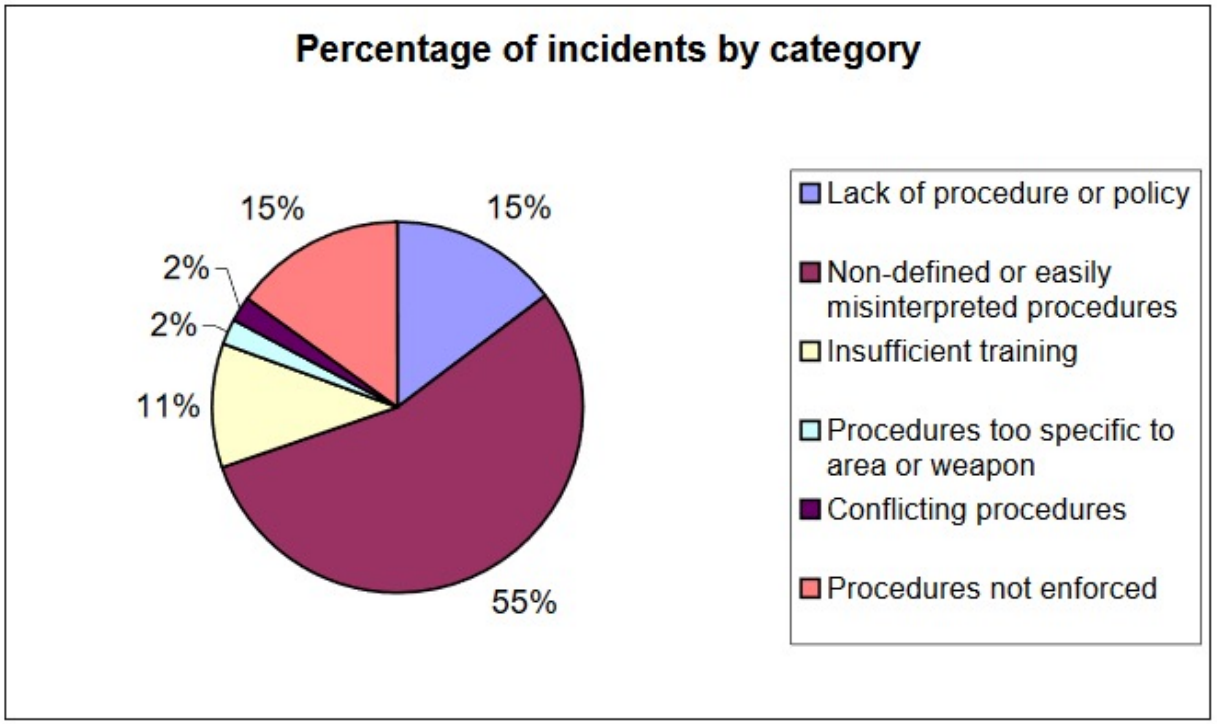
- Inadequate regulatory oversight
- Lack of appropriate safety culture
- Inadequate operator training and qualifications
- Company pressure

Procedures

Common Problems

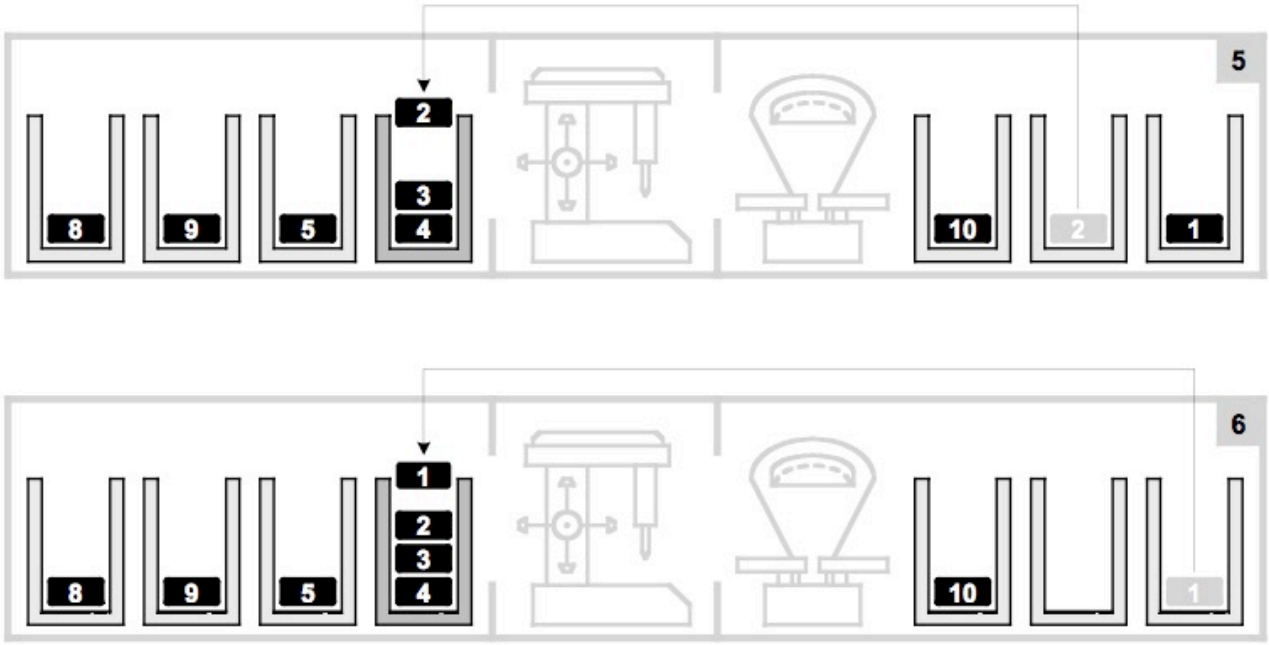
- Steps are ambiguous or vague
- Technically inaccurate information
- Mismatch between procedural steps and the order
- Information that is critical to the process is missing
- Lack of graphics for complex steps (diagrams, schematics)
- More than one instruction in a step
- Overuse of critical steps
- References to other procedures

Common Problems with Procedures



SAND2004-5416, *Human Error Mitigation Initiative*

Siberian Chemical Combine (Siberia, 1978)



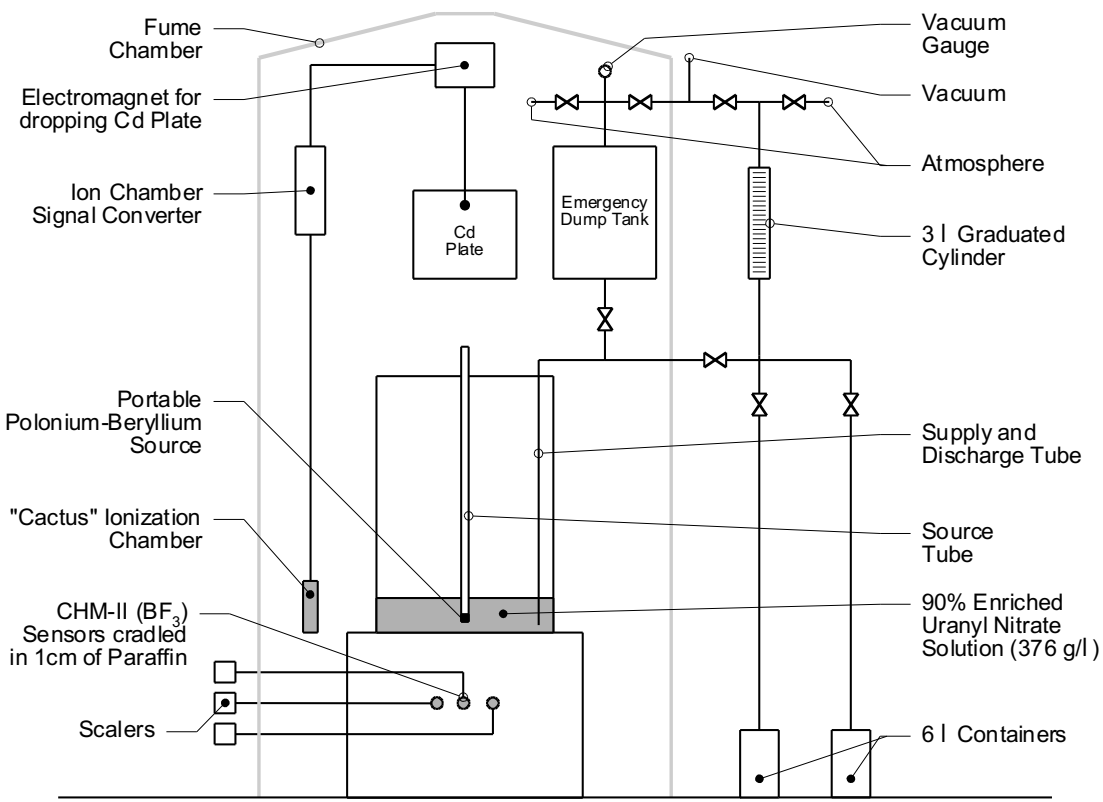
- Written Procedures Prohibited
- Production Pressure
- Lack of Experienced Operators

Environment

- Holidays
- Work Load
- Stress
- Unfamiliarity

- PPE
- Pressure
- Exhaustion
- Impossible Tasks

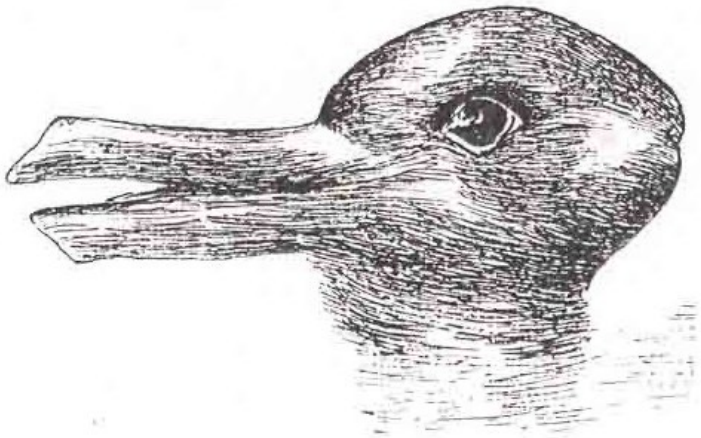
Mayak (Russia, January 2, 1958)



After filling an unknown (one or more) number of 6 liter bottles the experimenters decided on a more expeditious plan:

- Removed the neutron source
- Unbolted the tank from the stand
- Lifted the tank off the stand
- Moved it to an area to pour the contents into the bottles manually

Perception / Attention



Selective Attention Experiment

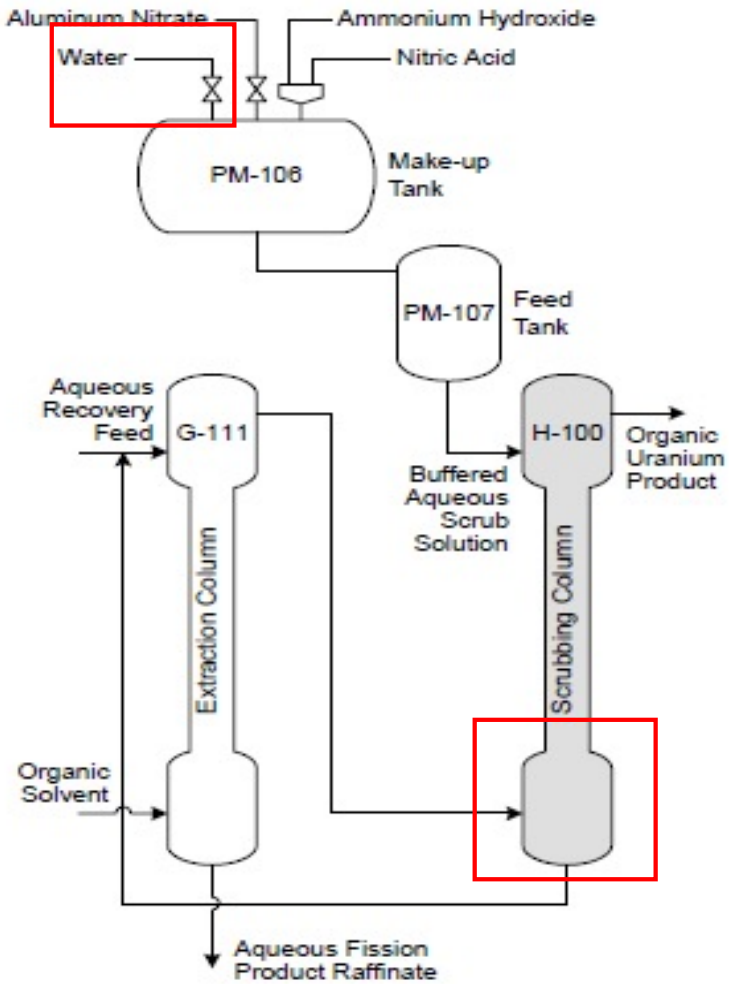
https://www.youtube.com/watch?v=vJG698U2Mvo

Reliability

- Human Reliability
  - Active Failures
    - Adherence to Admin. Controls
  - Latent Conditions
    - Interpretation and Use of Procedures
- Equipment Reliability
  - None of the accidents were due solely to equipment failure
  - Hardware
    - Valves Leak, Dials Fail
  - Software
    - Failure of Mass Tracking Software

Idaho Chemical Combine Accident (Idaho, 1978)

- Water valve leaked slowly
- Extra water went unnoticed
- The chart recorder for the make-up tank that would have shown the solution level had run out of paper
- Density recorder and alarm on aqueous feed tank had not been installed
- Procedure not updated
- Procedure requiring sampling not followed



Competing Requirements

In addition to satisfying NCS requirements, the typical handler may be responsible for:

- Mission deliverables
- Training and development
- Material control & accountability
- Classification and security
- Fire protection
- Radiation protection
- Chemical safety
- Electrical safety
- Sharps management

Obviously, some requirements are going to be in tension, if not outright conflict.

More Examples

- Car Window, Old Crank Vs New Button
- Color Blindness
- Having Different Limits Throughout a Room
- Definitions
- Waste
- Material Control and Accountability
- Gradually More Limiting Controls
- Safe Measurements (nominal)

Questions?