Human Factors

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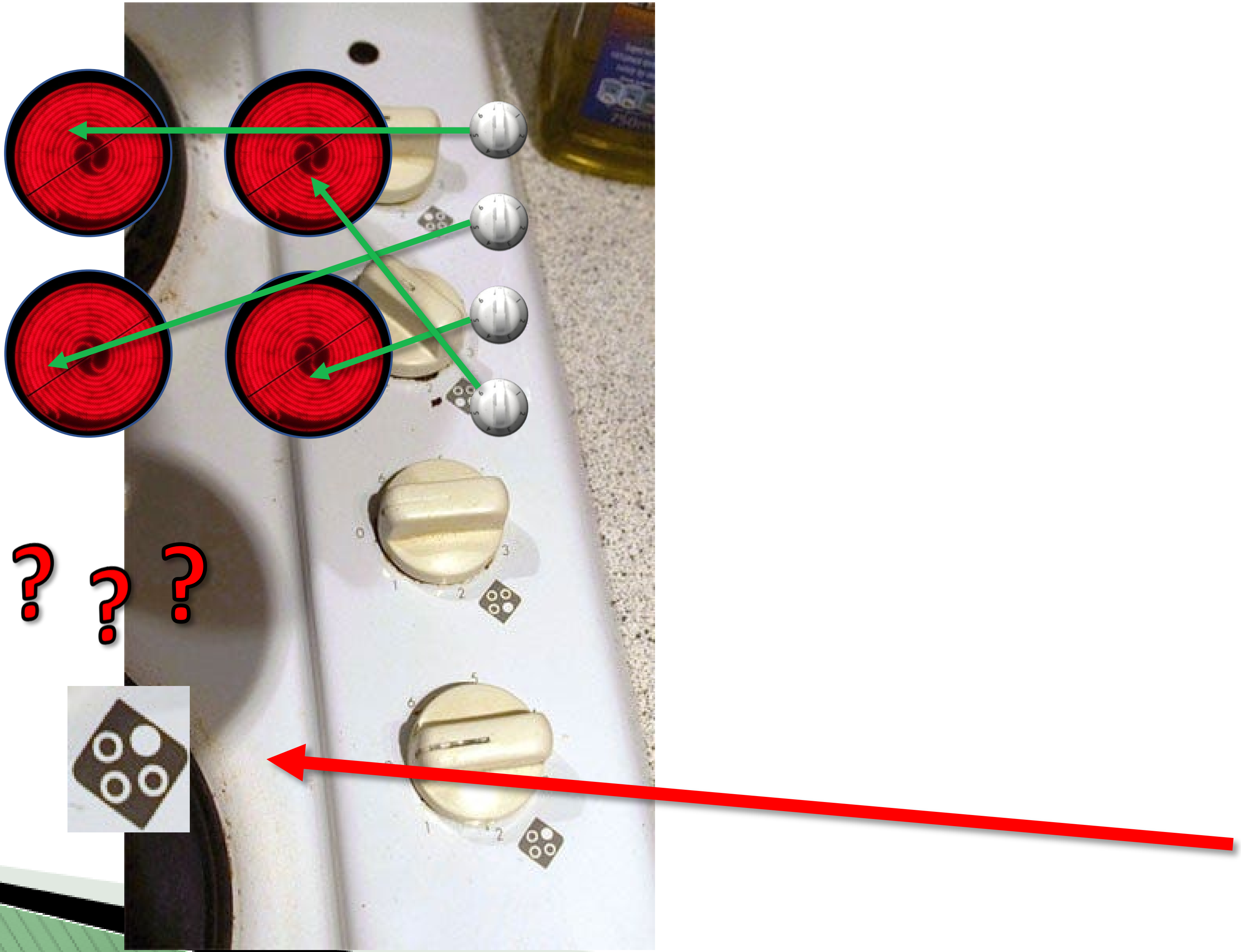
Accidental Release Prevention Engineer

Contra Costa Health – Hazardous Materials Programs




FRONT
REAR
OFF
HI
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OFF
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HOT SURFACE


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COOKTOP ON

Agenda

- Define Human Factors and other key concepts.
- Underlying reasons why human errors occur.
- How to analyze and categorize specific human errors to identify the conditions and situations that contribute to mistakes.
- Human performance issues and resulting incidents.
- What good looks like in an audit.

Regulatory Overview

CalARP - Cal. Code Regs. Tit. 19.

- Article 6 - **Program 3**
- Article 6.5 - **Program 4**

Section 2762.15. Human Factors Program.

(a) The owner or operator shall develop, implement and maintain an effective written Human Factors Program within eighteen (18) months of the effective date of this Article.

(b) The owner or operator shall include a written analysis of human factors where relevant in the design phase of a major change, incident investigations, PHAs, MOOCs, and HCAs. The analysis shall include a description of selected methodologies and criteria for their use.

Regulatory Overview

CalOSHA Process Safety Management (PSM)

- **§5189.** Process Safety Management of Acutely Hazardous Materials.
- **§ 5189.1.** Process Safety Management for Petroleum Refineries.

slido

What percentage of car accidents is caused by Human Error?

ⓘ Start presenting to display the poll results on this slide.

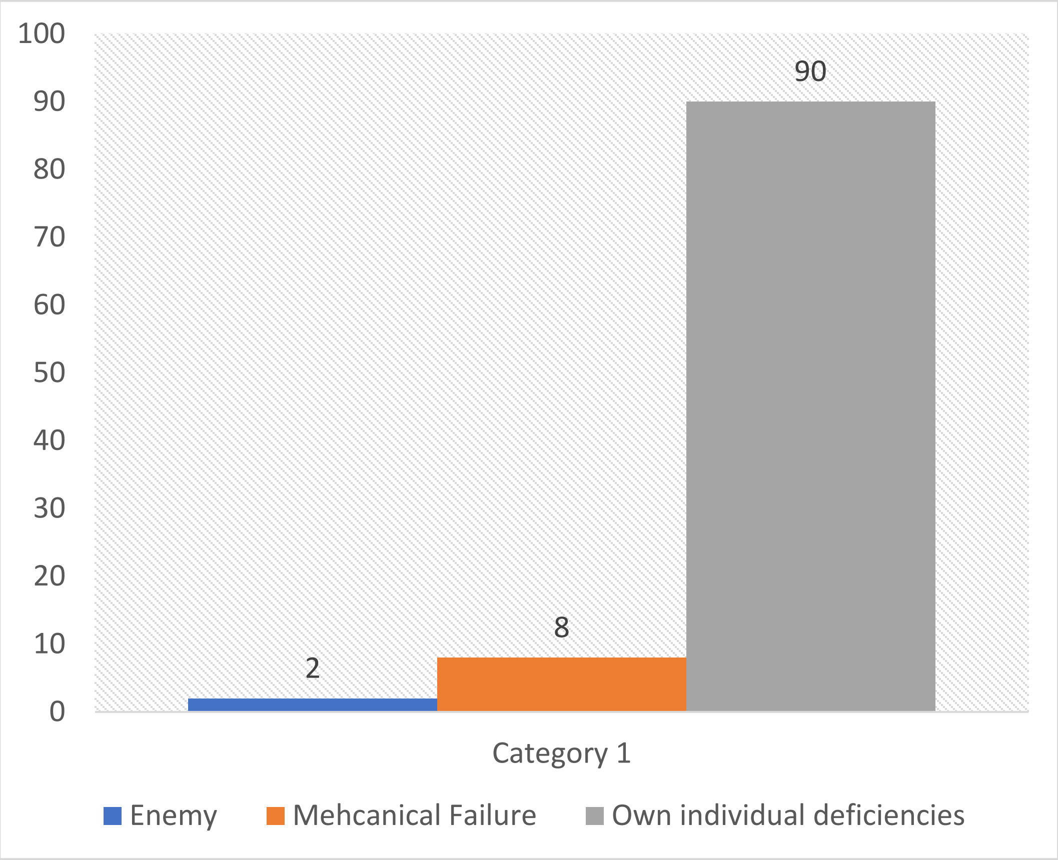
Table 2. Driver-Related Critical Reasons

Critical Reason	Estimated (Based on 94% of the NMVCCS crashes)	
	Number	Percentage* ± 95% conf. limits
Recognition Error	845,000	41% ±2.2%
Decision Error	684,000	33% ±3.7%
Performance Error	210,000	11% ±2.7%
Non-Performance Error (sleep, etc.)	145,000	7% ±1.0%
Other	162,000	8% ±1.9%
Total	2,046,000	100%

*Percentages are based on unrounded estimated frequencies
(Data Source: NMVCCS 2005–2007)

Source: https://www.nhtsa.gov/

Human Performance



Human Factors vs HOP

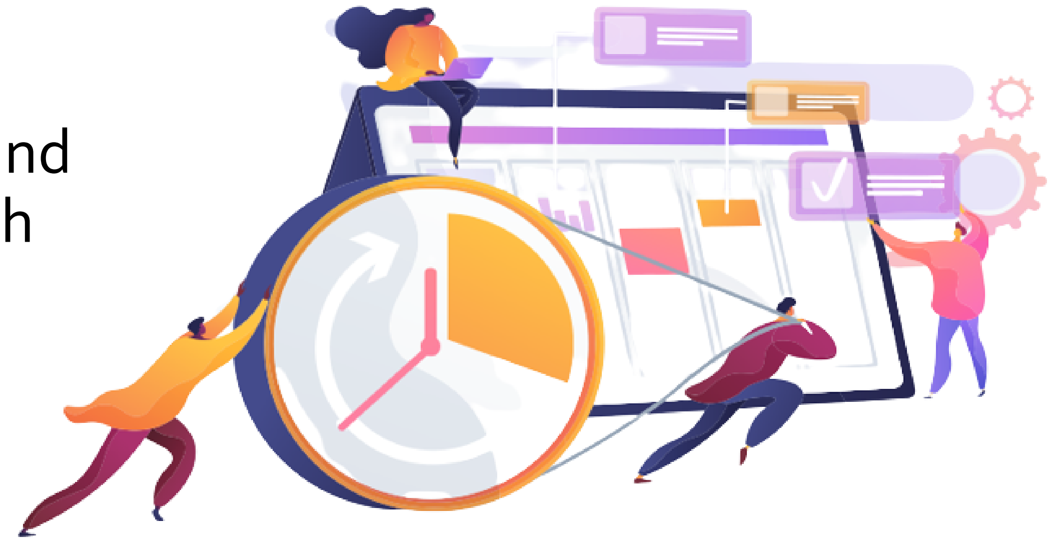
- **Human Factors:**

Study of how people interact with technology, tools, environments, and systems.

Underpins many different disciplines, including HOP.

- **Human and Organizational Performance:**

Seeks to create a culture of continuous learning and improvement to mitigate the risks associated with human variability.



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Human Factors Definition

Human factors science or technologies are **multidisciplinary fields** incorporating contributions from psychology, engineering, industrial design, statistics, operations research, and anthropometry.

It covers the science of understanding the properties of **human capability**, the application of this understanding to the **design**, **development**, and **implementation of systems and services**.

From the FAA AMT handbook HF addendum

Human Factors vs. Ergonomics

- **Human Factors:**

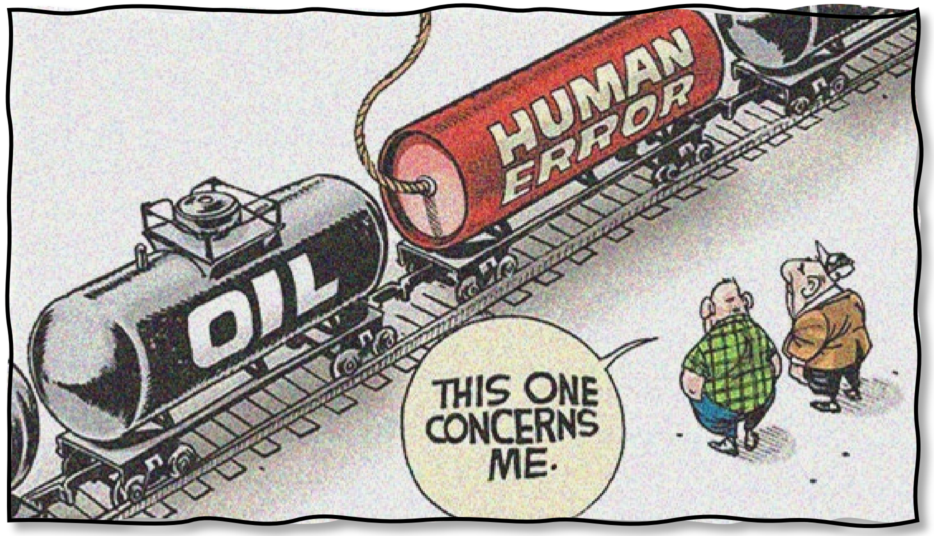
Optimization of system design.

- **Ergonomics:**

Design of efficient and comfortable products and environments.

Human Error

Human error is defined as a human action with unintended consequences.



History

1900s

History

1900s

1941

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History

1900s

1941

1957

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History

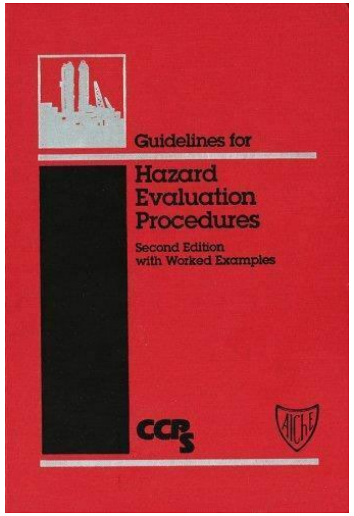
1900s

1941

1957

1979

History



1900s

1941

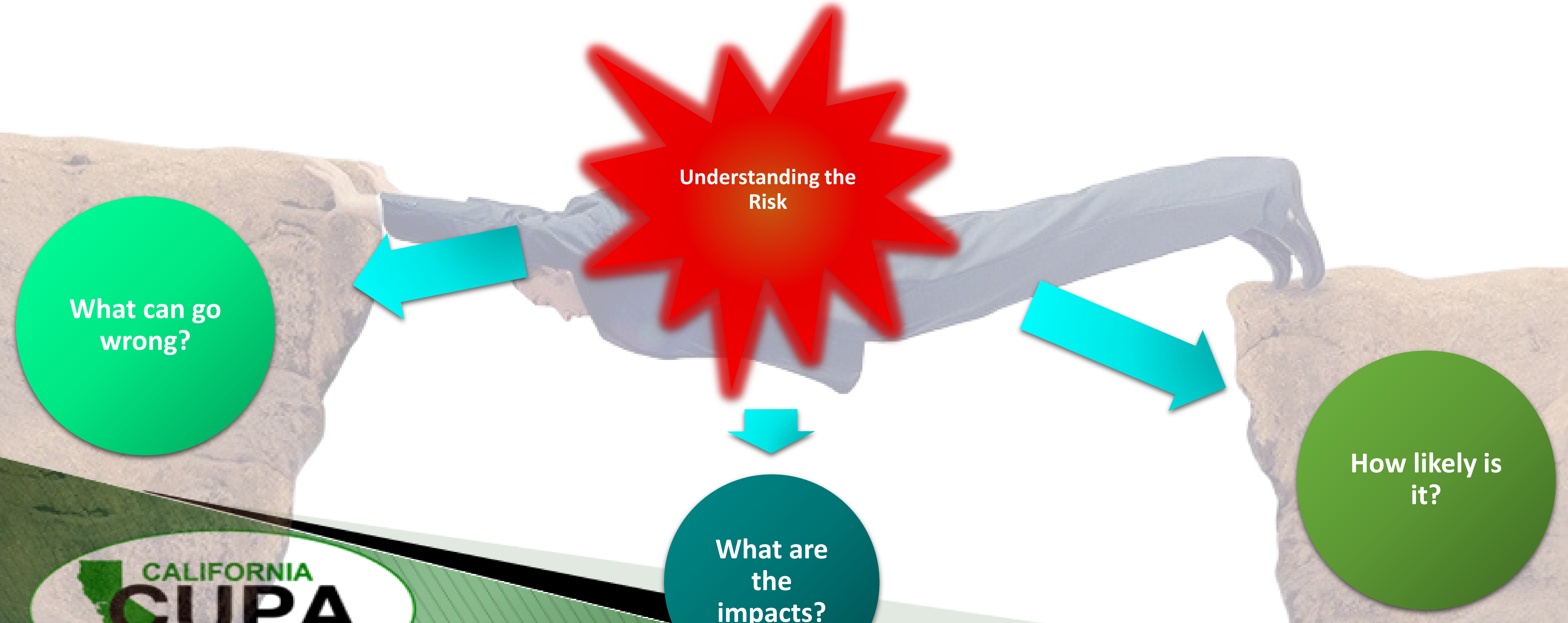
1957

1979

1985

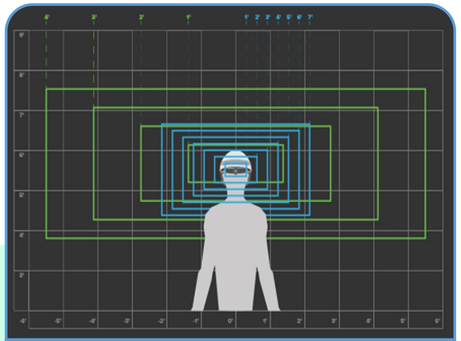
Understanding Human Factors

What is Human Factors Analysis



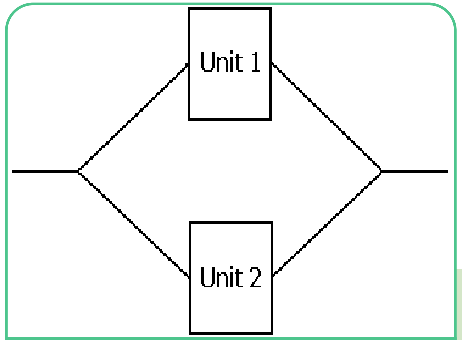

HYDRAULIC OIL
HYDRAULIC OIL
HYDRAULIC OIL

Benefits of Understanding Human Factors



Better Designs

Improved Performance



System Reliability

Effective Incident Investigations

More Effective Management Systems

People

Physical

Psychological

Physiological

Psychosocial

Environment

Physical




Organizational




Actions

Steps to Perform a Task

Sequence of Activity

Certification Requirements

Number of People Involved

Information Control Requirements

Knowledge requirements

Skill Requirements

Altitude Requirements

Inspection Requirements

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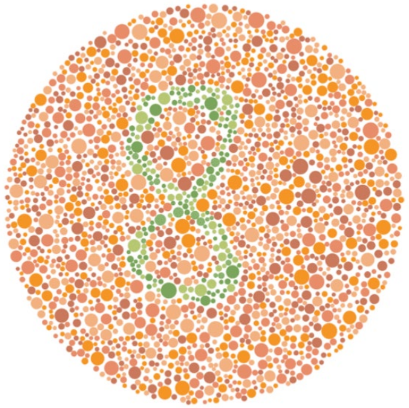
Resources

Procedures	Technical Manuals	Other people	Test equipment	Tools
Computers/Software	Paperwork/Signoffs	Scaffolding	Task lighting	Training
	Materials	Fixtures	Quality systems	

Common Examples



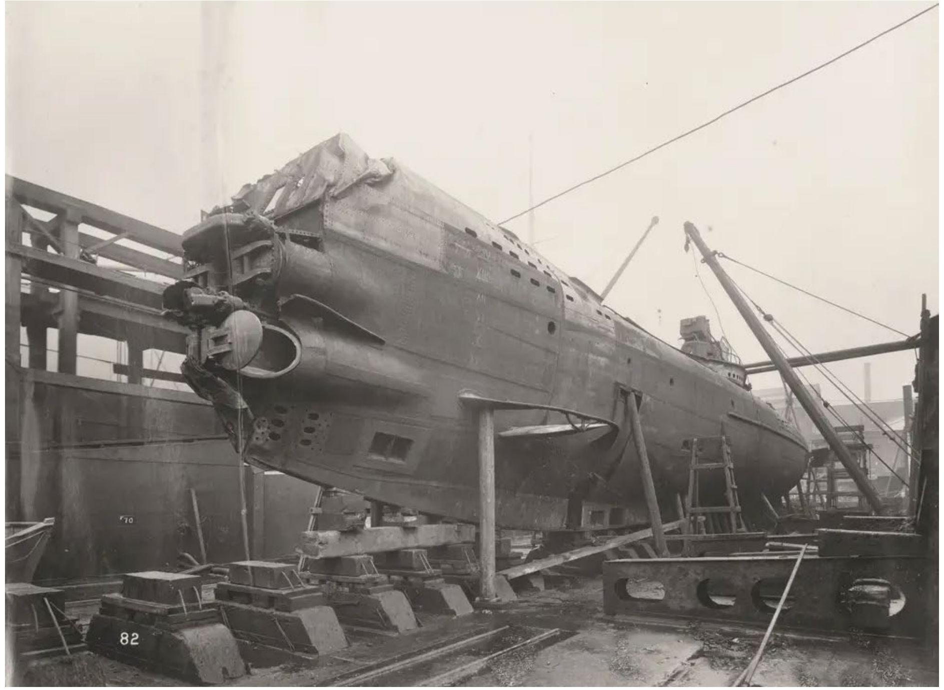
Common Examples

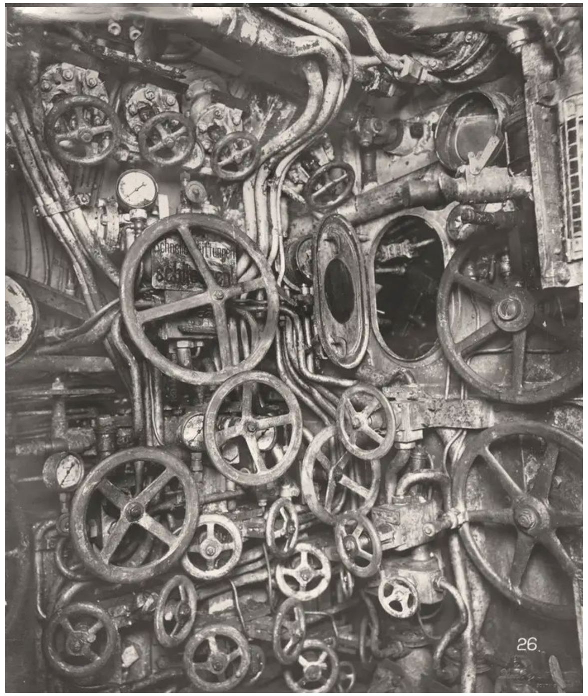
Person Approach

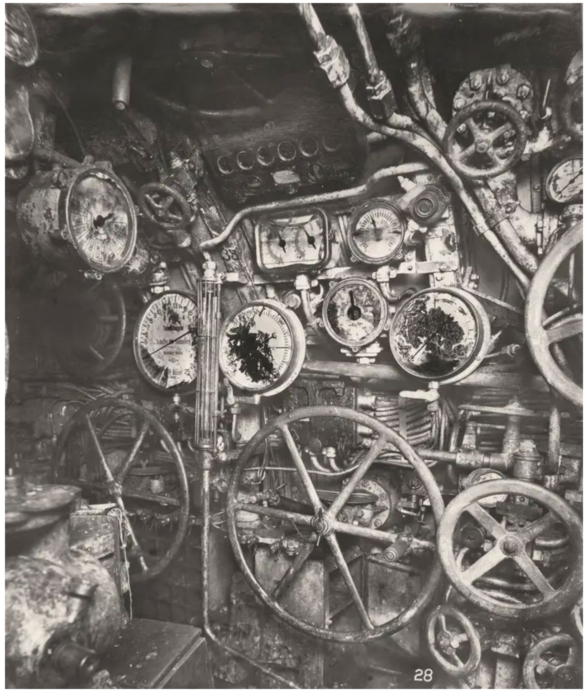
	Omission	Commission
Intentional	Skipped a step; no benefit. Cutting corners.	Did a little more/less because they thought it was the right thing to do.
Unintentional	Forgot to perform a step. Due to lack of knowledge/training.	Pressed the wrong button. Incompatible materials.

System approach

Latent Conditions

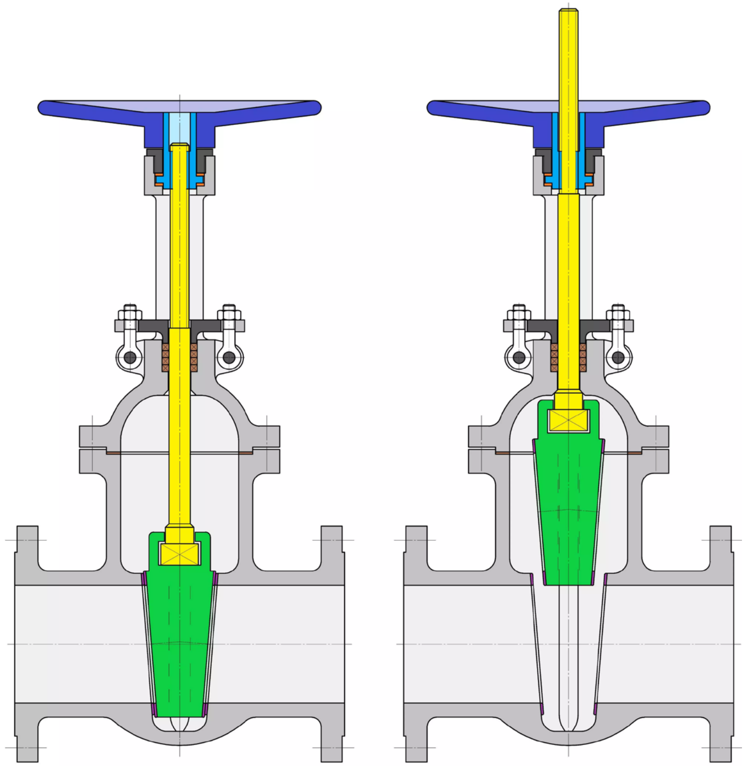


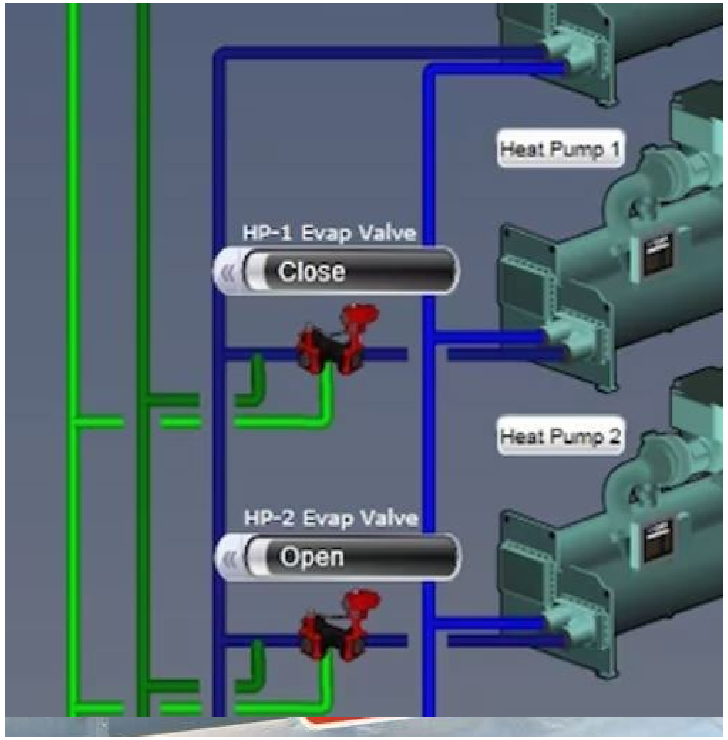




Tyne & Wear Archives & Museums

Latent Conditions





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How to prevent this accident from happening again?

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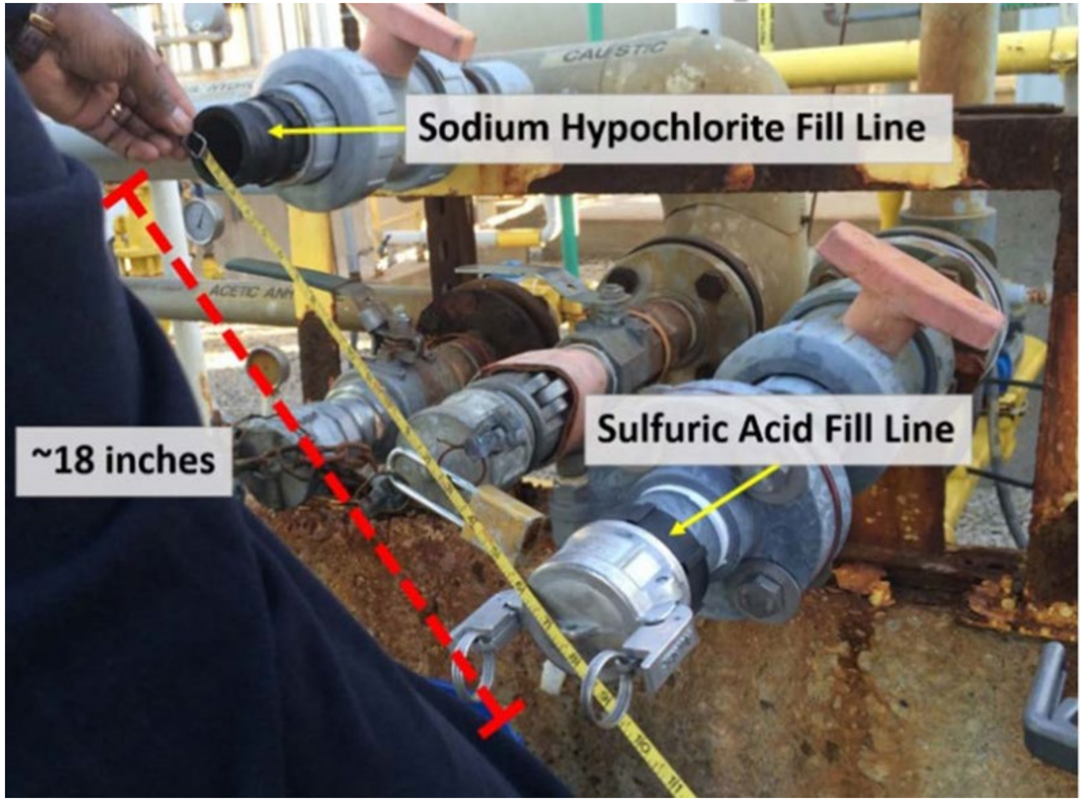
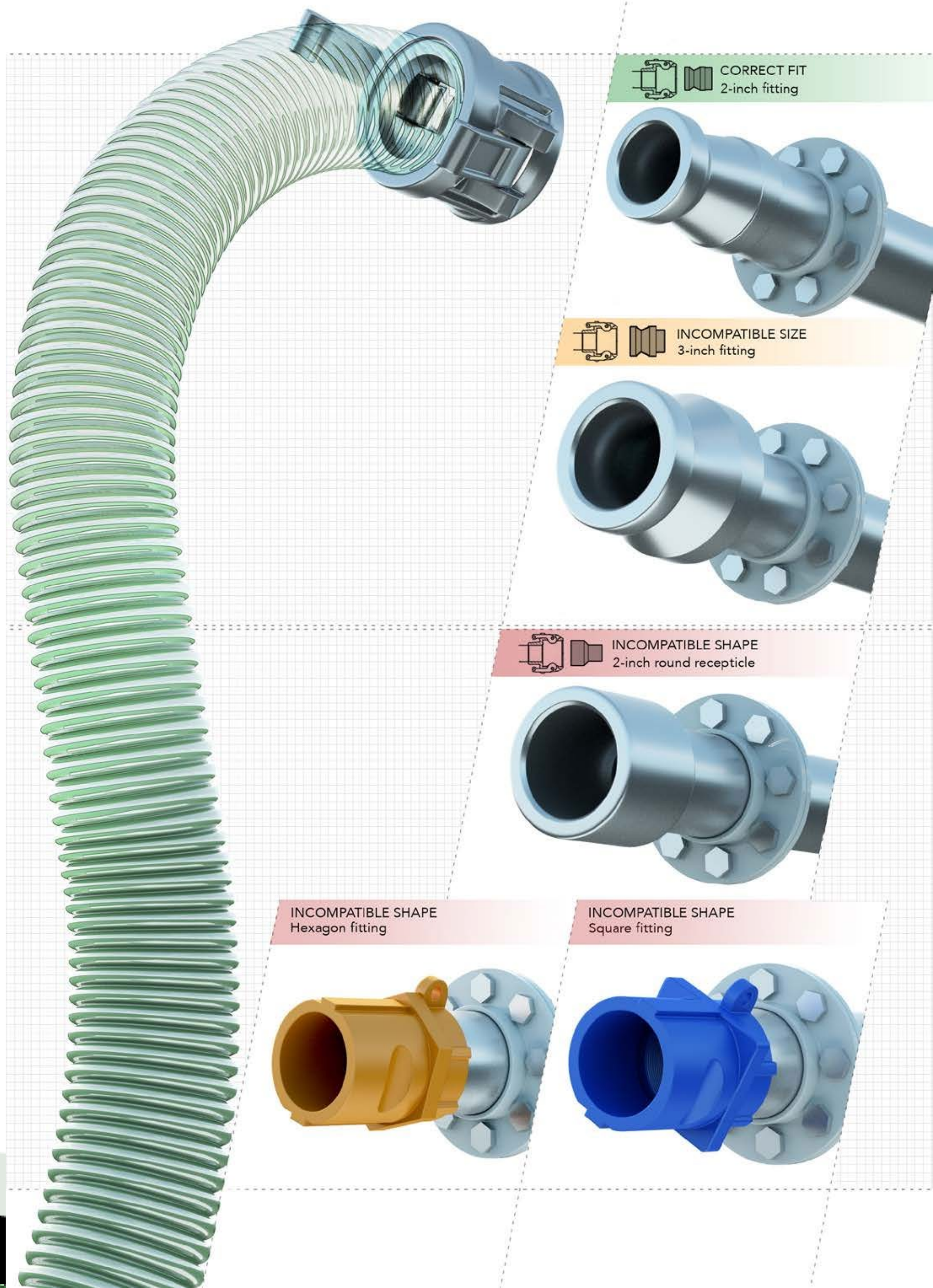
MGPI - Atchison, Kansas





ExxonMobil Baton Rouge Refinery - Baton Rouge, Louisiana

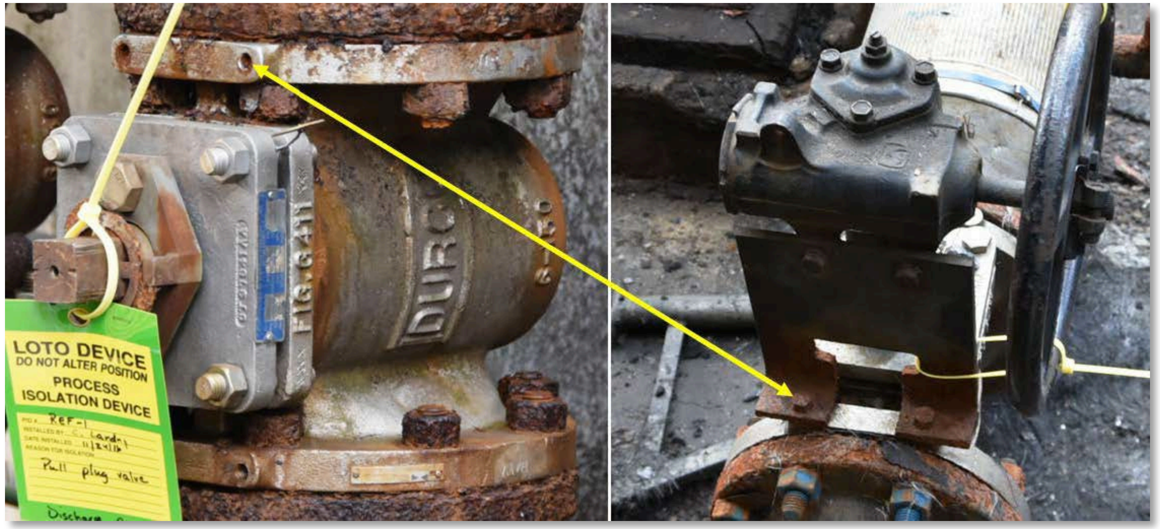
97%

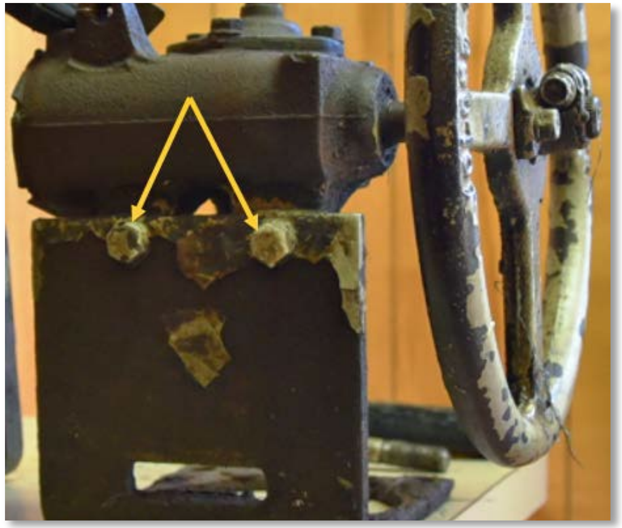
slido

What CalARP prevention program requirement was directly involved in this incident?

ⓘ Start presenting to display the poll results on this slide.

ExxonMobil Baton Rouge Refinery - Baton Rouge, Louisiana





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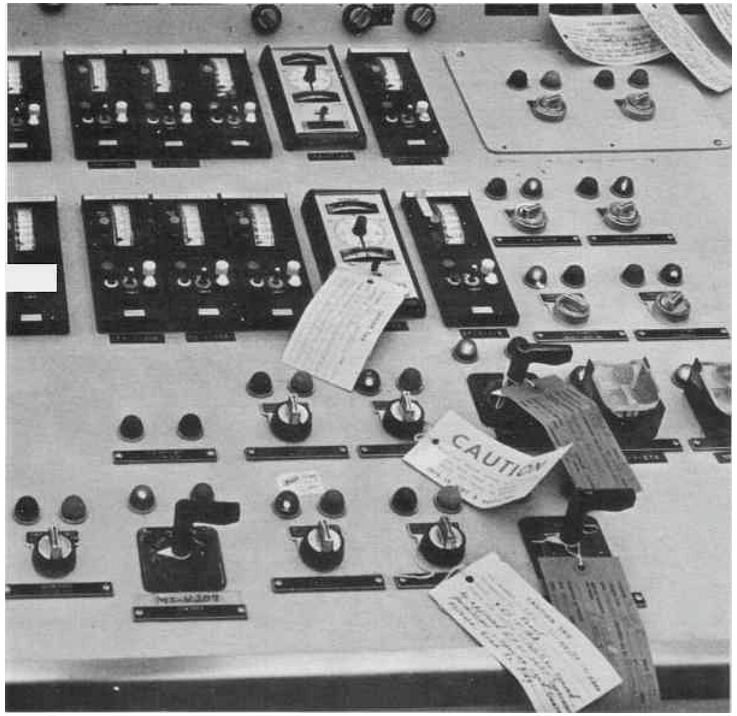
The Three Mile Island Accident

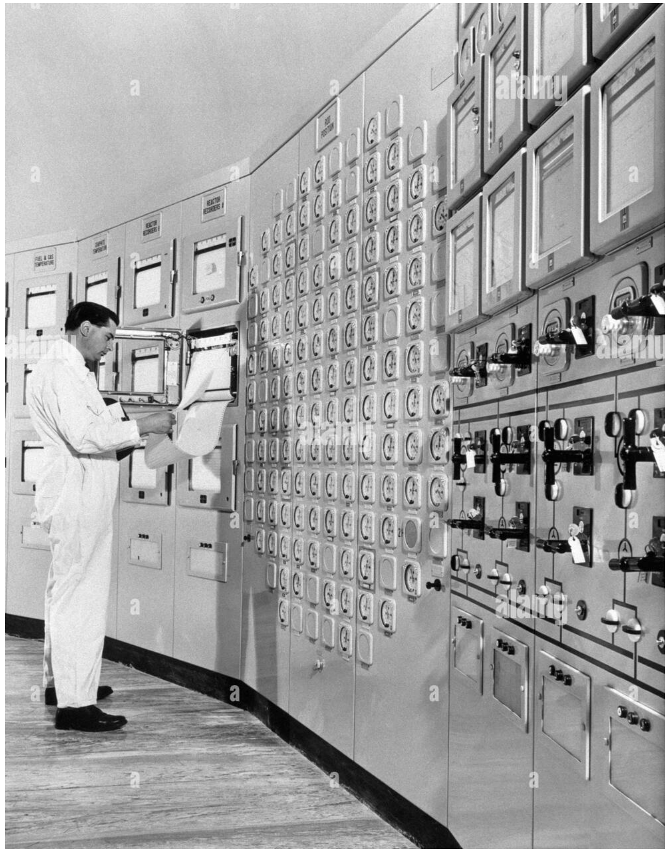
https://www.youtube.com/@kylehill

d Program
nference
2023

BREAK TIME!

Three Mile Island - Londonderry Township, Pennsylvania





Human Factors Analysis Techniques

Error-likely Situation Checklist

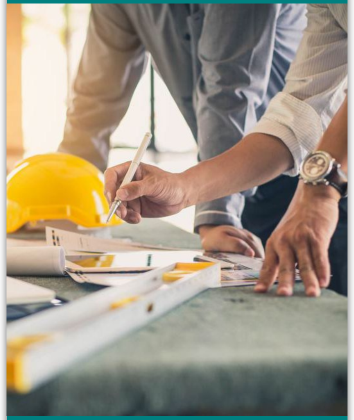
- Reactive/Proactive
- Can be applied to situation-specific and general issues.
- Low level of effort

Walkthrough Analysis

- Reactive/Proactive
- Situation-specific
- Low-Medium level of effort

Guide Word Analyses

- Reactive/Proactive
- Situation-specific
- Medium level of effort



Quantitative Human Reliability Analysis

- Reactive/Proactive
- Situation-specific
- Requires a Subject Matter Expert on the system being studied and on Human Reliability Analysis.
- High level of effort

Management System Checklist

- Reactive/Proactive
- Can be applied to situation-specific and general issues.
- Varying level of effort

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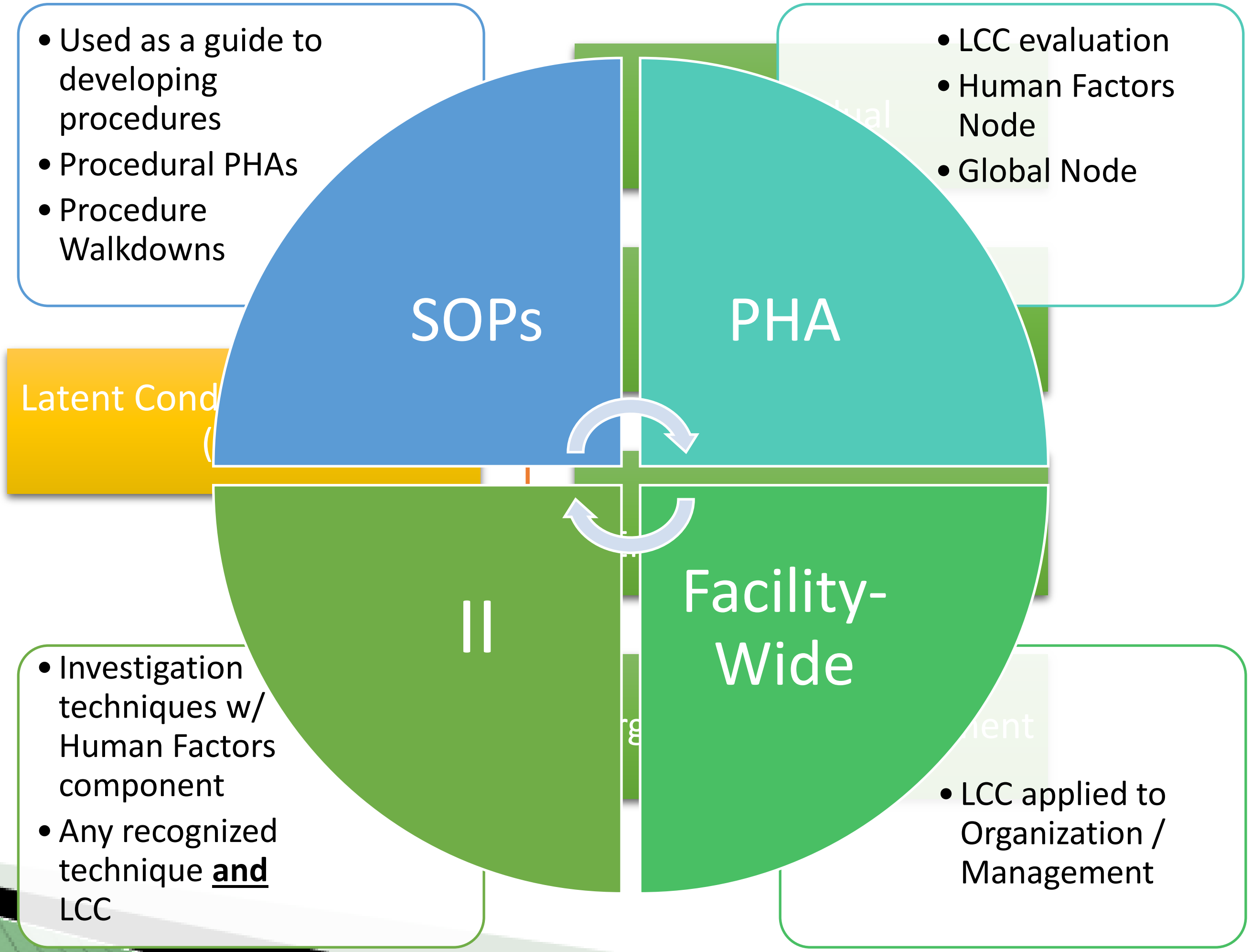
What Does “Good” Look Like During an Audit?

Contra Costa County (CCC) Approach to Human Factors



Training



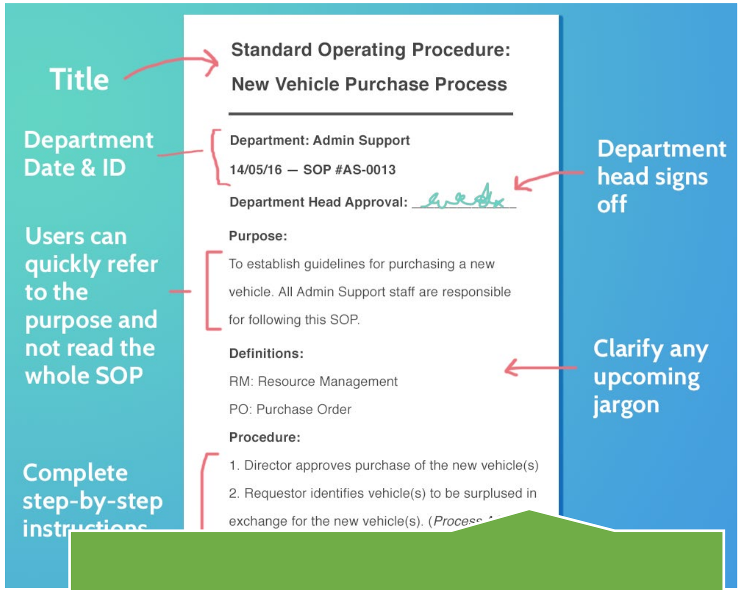

PHAs

- When to apply the LCC
  - Before the PHA
    - 1. Conduct Process Walkdown
    - 2. Complete LCC
  - During the PHA
    - Complete the LCC for each node (HAZOP)

Operating Procedures

Content

Step Writing



Page Format

User-Centered Design Process

Reasons Why People Don't Follow Procedures

- If they were followed to the letter, they could not get done in time *(Practicality).*
- People usually find a better way to do the job (optimization).
- People are not aware that a procedure exists for the job *(Accessibility).*
- People assume they know what is in the procedure.

Procedures Examples

Safety Information

Visual division

Procedure

a **Standard operating procedure**

*Esterification/Methylation of Carboxylic Acids using **TMS-diazomethane***

Safety considerations

*TMSD is a flammable liquid and vapor that is very **toxic or fatal when inhaled**.*

Caution! *Trimethylsilyldiazomethane should be regarded as* ***extremely toxic*** *and should only be manipulated by the individuals trained in its proper safe use and storage. All procedures must be carried out in a well-ventilated chemical fume hood and all skin contact should be avoided.*

- Make sure that eyewash stations and safety showers are close to the chemical fume hood.
- Never manipulate TMS-diazomethane reactions at **large scales** *(*above 10 mL*)*.
- Use *proper techniques* and methods when transferring TMSD to a reaction mixture to avoid the spill & exposure.
- As a precautionary measure, keep a small bottle/beaker of acetic acid inside chemical fume hood to quench any spillage or deactivating the remaining TMSD in the syringe.
- Use an oval shape and correct size bar for stirring reaction mixture to avoid flask breakage. Use a plastic or glass dish underneath the reaction flask as a secondary containment or for cooling purposes.

Transferring TMSD

To transfer TMSD using a syringe, you will need a small amount of positive pressure in the reagent container in order to draw the reagent into syringe. Ensure that excess pressure is released through the mineral oil bubbler that is attached to the gas line. If possible use Schlenk line (SL) nitrogen for the TMSD manipulation. SL is equipped with a pressure release system, where the inert gas line is vented through an oil bubbler.

1. First, secure the TMSD containing bottle with proper clamp and do not over tighten the bottle (use cotton or other compatible material for the extra safety, and use a secondary containment for reagent bottle).
2. Insert a fine needle from an inert gas source with a bubbler outlet into the bottle keeping the needle tip above the liquid level. **Do not over pressurize the bottle containing TMSD**. The goal of this technique is to equalize the pressure in the reagent bottle. (A different technique is to use inert gas pressure to compel reagent into the syringe, but that has the danger of blowing the plunger out of the syringe body and spilling out TMSD) Flush dry syringe with inert gas, depress the plunger and insert the needle into the Sure/Seal bottle.

Procedures examples

Clear sequence

Safety Information

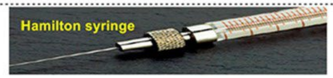
b

Standard operating procedure

*Esterification/Methylation of Carboxylic Acids using **TMS-diazomethane***

Transferring TMSD

1. TMSD is a flammable liquid and vapor that is ***very toxic or fatal when inhaled***. Only those trained in its proper safe use and storage should perform this procedure.
    a. Perform procedure is well-ventilated chemical fume hood and avoid skin contact
    b. Make sure eyewash stations and safety showers are close to the chemical fume hood.
    c. Never manipulate TMS-diazomethane reactions at large scales (above 10 mL).
    d. Keep a small bottle/beaker of acetic acid inside chemical fume hood to quench any spillage or deactivating the remaining TMSD in the syringe.
    e. Use an oval shape and correct size bar for stirring reaction mixture to avoid flask breakage. Use a plastic or glass dish underneath the reaction flask as a secondary containment or for cooling purposes.
    f. See Hazard control (Appendix) in event of exposure
2. To prepare to transfer TMSD using a syringe
    a. You will need a small amount of positive pressure in the reagent container to draw the reagent into syringe.
    b. Ensure that excess pressure is released through the mineral oil bubbler that is attached to the gas line.
    c. If possible, use Schlenk line (SL) nitrogen for the TMSD manipulation.
        i. SL is equipped with a pressure release system, where the inert gas line is vented through an oil bubbler.
3. Secure the TMSD containing bottle with proper clamp
    a. Do not over tighten the bottle
    b. Use cotton or other compatible material for extra safety
    c. Use a secondary containment for reagent bottle
4. Insert a fine needle from an inert gas source with a bubbler outlet into the bottle keeping the needle tip above the liquid level.
    a. **Do not over pressurize the bottle containing TMSD.**
        i. The goal of this technique is to equalize the pressure in the reagent bottle.
5. Flush dry syringe with inert gas
6. Depress the plunger
7. Insert the needle into the Sure/Seal bottle.
8. Pull plunger to fill syringe to 60-70% of syringe volume with TMSD, and up to a maximum of 5 mL of liquid.
    a. **NOTE**: Pulling too hard or too fast can cause air bubbles to enter between the plunger and syringe body.
    b. **NOTE:** Simple glass syringes are more prone to causing gas bubbles and may drip. Disposable plastic syringes (**Fig. 2**) have a good seal on the plunger and work well. Glass syringes with Teflon-tipped plungers (gastight) syringes are best.



Procedures Examples

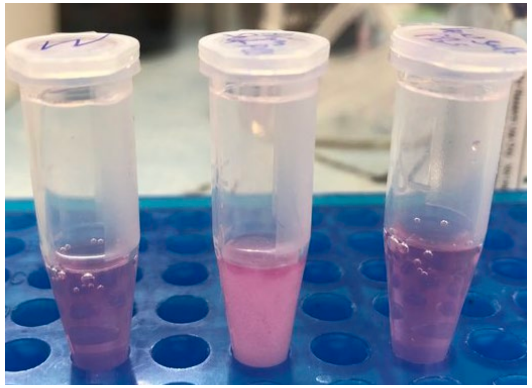
Do this

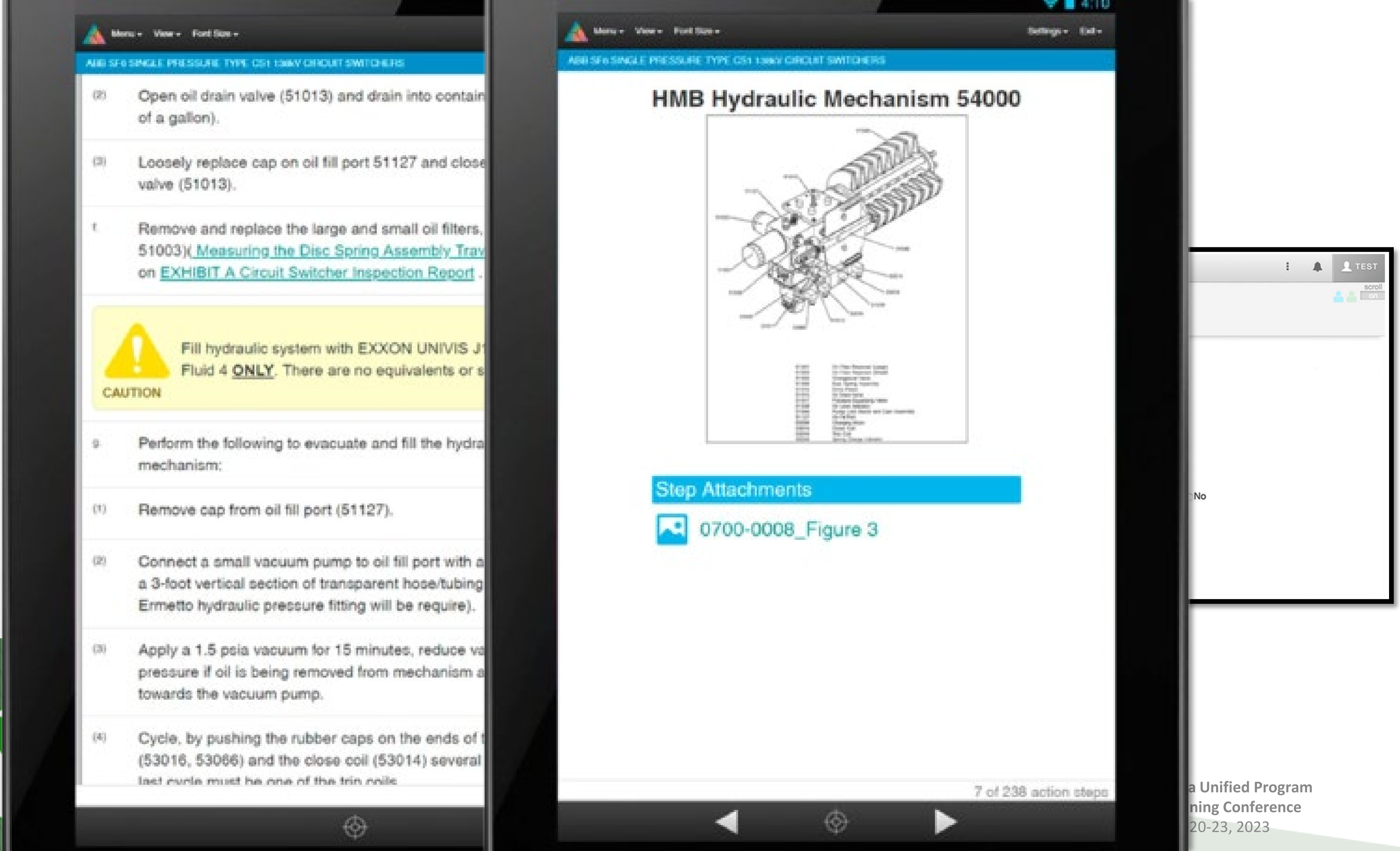
Cells:

After harvesting the cells, add 1ml of Trizol to the cell pellet.
Vortex the pellet well and store at -80ºC.
After thawing the stored pellet in ice, isolate the RNA.

Not this

Cells: After harvesting the cells, add 1ml of Trizol to the cell pellet. Vortex the pellet well and store at -80ºC. Before isolating RNA, thaw the stored pellet in ice.




Menu View Font Size
ABB SF6 SINGLE PRESSURE TYPE CS1 138kV CIRCUIT SWITCHERS
(2) Open oil drain valve (51013) and drain into contain
of a gallon).
(3) Loosely replace cap on oil fill port 51127 and close
valve (51013).
Remove and replace the large and small oil filters,
51003)(Measuring the Disc Spring Assembly Trav
on EXHIBIT A Circuit Switcher Inspection Report .
CAUTION
Fill hydraulic system with EXXON UNIVIS J1
Fluid 4 ONLY. There are no equivalents or s
Perform the following to evacuate and fill the hydra
mechanism:
(1) Remove cap from oil fill port (51127).
(2) Connect a small vacuum pump to oil fill port with a
a 3-foot vertical section of transparent hose/tubing
Ermetto hydraulic pressure fitting will be require).
(3) Apply a 1.5 psia vacuum for 15 minutes, reduce va
pressure if oil is being removed from mechanism a
towards the vacuum pump.
(4) Cycle, by pushing the rubber caps on the ends of t
(53016, 53066) and the close coil (53014) several
Menu View Font Size Settings Exit
ABB SF6 SINGLE PRESSURE TYPE CS1 138kV CIRCUIT SWITCHERS
HMB Hydraulic Mechanism 54000
Step Attachments
0700-0008_Figure 3
7 of 238 action steps
TEST
No

Incident Investigation

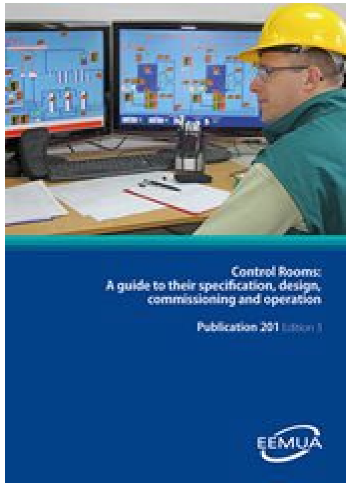
Fatigue Management

API Recommended Practice 755

Normal Operations	Outages	Exception Process
Total Hours shall not exceed: • **14 Hours** per Shift • **92 Hours** per work-set	Total Hours shall not exceed • **14 Hours** per shift • **182 Hours** per Work-set	• Utilized when exceeding hours-of-service • Involves immediate supervisor and another management representative • Documents risk assessment and mitigation plan
Work-set	**Work-set**	**High Risk Exception Process**
Work-set considered complete when an employee is off work for at least: • **46 hours** (**4+ Night shifts**) • **34 hours**	Work-set considered complete when an employee is off work for at least: • **34 hours**	Work more than 18 hours in a single shift • Return to work prior to having 8 hours off • Work more than one extended shift (greater than 14 hours) per work-set • Senior site management shall be notified no later than following business day

Control Room

- ISO 11064 consists of 8 parts, under the general title ***Ergonomic design of control centres*.**
- EEMUA Publication 201 Control rooms**: a guide to their specification, design., commissioning and operation**



Recommendations

Level 1	Level 2	Level 3	Level 4	Level 5
Operator is at fault for reaching into equipment while still in operation.	The operator believed that lifting the guard would disable the machine.	Operator had already received training; the machine used in training was interlocked.	The machine was not fully tested before being placed in operation.	The equipment was needed quickly; the purchasing process did not require a safety interlock on the equipment.
FOCUS OF RECOMMENDATIONS			MORE EFFECTIVE TO PREVENT REOCCURRENCE	
Discipline the operator	Re-train the operator on how to operate the equipment in question.	Operator training should be completed on the specific equipment that will be used on site.	Revise the procedure for introducing new equipment into the workplace to include a safety checklist.	Revise the purchasing process to include a risk assessment process for specific equipment selected for purchase.

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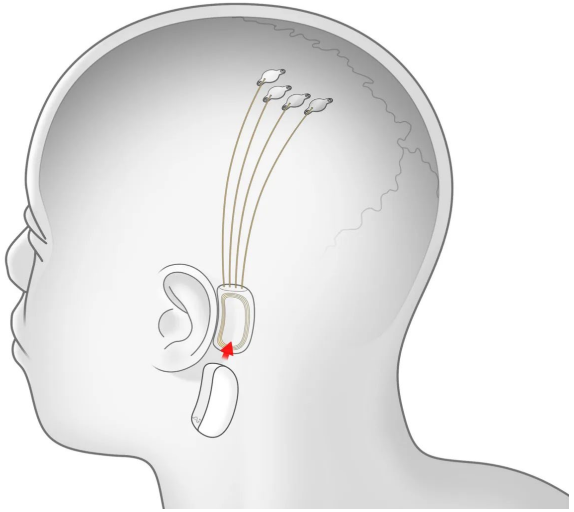
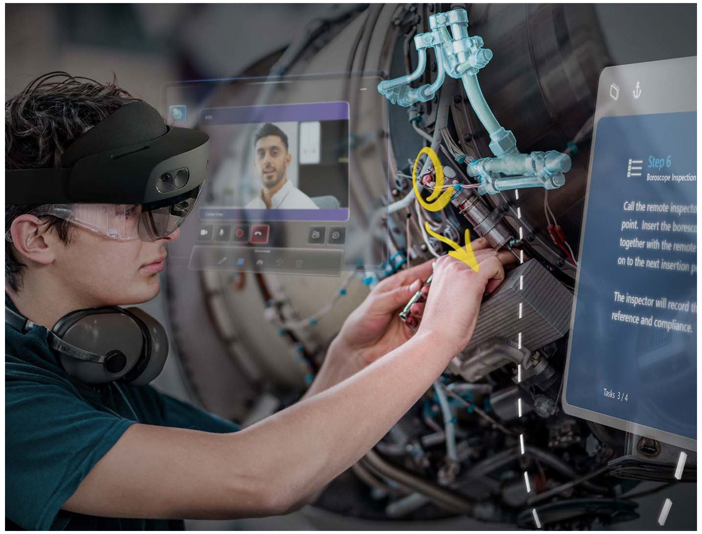
Where Human Factors are headed





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Common Issues

- Poorly timed training.
- Field issues (e.g., labeling, access).
- Written program lacks detail.
- Personnel do not understand it.
- Procedure formatting.
- Documentation.

Conclusion

Latent conditions:

- Underestimated
- Challenging to discover
- Time consuming to address

We cannot change the human condition, but we can change the conditions under which humans work

Look for:

- Training records
- Procedure formatting
- Analysis Methods used
- Employee participation
- Documentation

ANY QUESTIONS?

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