TapRooT® as a Proactive Process Safety Management Tool

Gas Processors Association
GCC Chapter
November 3, 2010
Presentation Overview

• Need for an expert system
• System overview
• System uses
• System description
• Case study
The Need for an Expert System
The Need for an Expert System

• Not everyone is an expert
• We tend to focus on what we know
• We tend to have operational biases
Characteristics of a Root Cause Analysis Expert System

- It is a closed loop process
- It is time-based
- It is well structured
Characteristics of a Cause Analysis Expert System

- Produces actionable root causes
- Identifies generic causes
- Includes corrective actions
- Based in human factors theory
Immediate vs. Root vs. Generic Causes

Root Causes: Deal with specific people and circumstances in the department.
System Overview
System Overview

- Event flow chart
- Human performance guide
- Root cause dictionary
- Corrective action helper
System Uses

- Process incident investigation
- HAZOP
- Process Review
System Description
System Overview
Incident Investigation

- Chart events
- Select causal factors
- Select root causes
- Select generic causes
- Select corrective actions
- Implement
System Overview
Process Review

- Chart events
- Plan audit
- Select causal factors
- Select root causes
- Select generic causes
- Select corrective actions
- Implement
The ‘Swiss cheese’ model of accident causation

- Some holes due to active failures
- Equipment
- Maintenance
- Training
- Procedure
- Hazards
- Other holes due to latent conditions
- Successive layers of defences, barriers, & safeguards
Case Study
Oily Water Sewer System (OWSS) Process

1. Liquid Effluents produced within process areas
2. Pure HC?
   - Yes: Direct to closed circuit HC system
   - No: Direct to Oily Water Sewer System (OWSS)
3. Critical there are no pure HC sources
4. Liquid freely drains into OWSS Network via catch-basins & pipe
5. Liquid freely drains into OWSS Sump
6. OWSS Sump pumps liquid to treatment when liquid rises to a prescribed level
**Oily Water Sewer System Schematic**

- **MH:** Manhole
- **C.B.:** Catch Basin
- **C.O.:** Cleanout
- **$:** Water Seal

- **Vent**
- **Disposal Facilities**

**Sump Pit**

- HC Spillage
- Storm Water
- Fire Water
- Plant Washdown
- Accidental Spillage
- Equipment Leaks
- Equipment Drain Points
- Fluid Sample Collection Points

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Oily Water Sewer System Process Audit

Liquid Effluents produced within process areas

Pure HC?

Yes → Direct to closed circuit HC system → Process pure HC Liquid Effluent

No → Liquid freely drains into OWSS Network

Critical there are no pure HC sources

Gravity feed via catch-basins & pipe

Liquid freely drains into OWSS Sump

OWSS Sump pumps liquid to treatment

Audit Scope

When liquid rises to a prescribed level

Audit Scope
OWSS Audit – Significant Issues

- Liquid Effluents produced within process areas
  - Pure HC?
    - Yes: Direct to closed circuit HC system
    - No: Direct to Oily Water Sewer System (OWSS)
- Process pure HC Liquid Effluent
  - Liquid freely drains into OWSS Network
  - Liquid freely drains into OWSS Sump
- OWSS Sump pumps liquid to treatment

Additional issues:
- Pure H2S stream directed toward OWSS
- Pumps often stay on when they should shut off
- Mtce. has not repaired faulty level indicator
- Operators let pumps run without shipping sump
OWSS Audit – Significant Issue and Supporting Data/Facts

- Pure HC stream directed toward OWSS
  - Sump pit designed for oily water only
  - Pure HC is flammable liquid
  - Implications of design change not identified
  - Original design called for a pit for pure HC streams
  - Pit designed for oily water only due to budget cut
OWSS Audit – Significant Issue and Supporting Data/Facts

- Pumps often stay on when they should shut off
- Level indicator is inaccurate at times
- Single level indicator controls both pumps
- Sump pit inspections not considered critical
- Indicator shows levels higher than they truly are
- Ultrasonic level indicator controller set to design values
- Graphical level display in control room with pump run/stop
- E.g. DOS readout shows 6.85 ft sump level, 2 ft in fact
- Low level shutoff set so pump impeller always immersed
OWSS Audit – Significant Issue and Supporting Data/Facts

1. Mtec. have not repaired faulty level indicator
2. Maintenance not aware of faulty level indicator
3. Control Room Operators thought it was a minor issue
4. Operators felt issue could wait until next scheduled PM
OWSS Audit – Significant Issue and Supporting Data/Facts

1. Operators let pumps run without dipping sump.
   - Confirmation of liquid level in sump is vital.
   - Pump suction must be immersed in liquid to be safe.
   - No training on sump pit control system.
   - No training on sump pit operation.

2. Not dipping sump was common and known by Mgmt.
   - No space on the checklist to record dipping the sump.

3. Several sumps missing dip sticks.
   - Dip sticks needed to check sump pit levels.

4. No Job Safety Analysis done on Sump Pit/Pumps.
   - Operator must return dip stick after job is completed.
   - Operators must walk long distances to borrow stick.
Significant Issue (CF) #4 - Operators run pumps more than 10 minutes without dipping sump

Root Causes

• **Arrangement/Placement NI** - Poor situation of equipment contributed to the CF;

• **Enforcement NI** – Operators routinely failed to dip sumps on long pump operation and mgmt tacitly condoned

• **Procedures NI** - *Situation not covered* - Procedure does not require dipping sump and recording value. Nor is there space on the checklist to record levels;

• **Work Package NI** – No JSA done on this task;

• **No training** - No Operator training is carried out on sump pit operation or control system;
Significant Issue (CF) #4 - Operators run pumps more than 10 minutes without dipping sump

Root Causes

- **Enforcement NI**
- **Presence not covered**
- **Work Package NI**
- **Procedures NI**
- **No Training**
- **Arrangement & Placement NI**

Action Recommendations

- Add checking sumps to dept KPI and BBS, include checking sumps in reward/celebration calculations.
- Conduct JSA on sump pit.
- Revise procedure to reflect policy.
- Add a space in the procedure for operators to record dip values.
- Develop and carry out operator training on OWSS. Ensure training is consistent with procedures and JSA.
- Arrange for each sump to have a suitable dip stick.
Summary

An expert system meeting the criteria outlined can be used to audit the human performance side of PSM proactively, identify significant issues, provide the structure to uncover both specific and generic root causes, and assist with the development of corrective actions to prevent and/or minimize process safety-related incidents. TapRooT fulfills these requirements.
Thank you
Operator leaves plant

Stop button didn't work

Operator didn't check that flow stops

Assumes it shuts down but flow continues

Stop button failures have happened 3 times at 2 other company plants

<1 minute later

Tank overflows, spilling 100 barrels of product

Operator in a hurry to get home

Procedure requires check before leaving area
Causal Factor

An error or equipment failure that, if corrected, could have prevented the incident from occurring or would have significantly reduced its consequences.

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Root Cause

A root cause is the absence of best practices or the failure to apply knowledge that would have prevented the problem or significantly reduced the consequences.
A comprehensive set of definitions that helps determine definitively what root causes were involved with an issue and that ensure both internal consistency in an investigation or audit and external consistency between investigators/auditors.
An aid for developing useful, effective complete corrective actions; provides ideas for addressing root causes; provides ideas for addressing generic causes; provides references for more detailed, in-depth research.