Latent Failure: What Lies Beneath

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SPRING23 +19TH GCPS
A Joint AIChE and CCPS Meeting

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PROCESS RISK MANAGEMENT

Presenter

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The Road Ahead

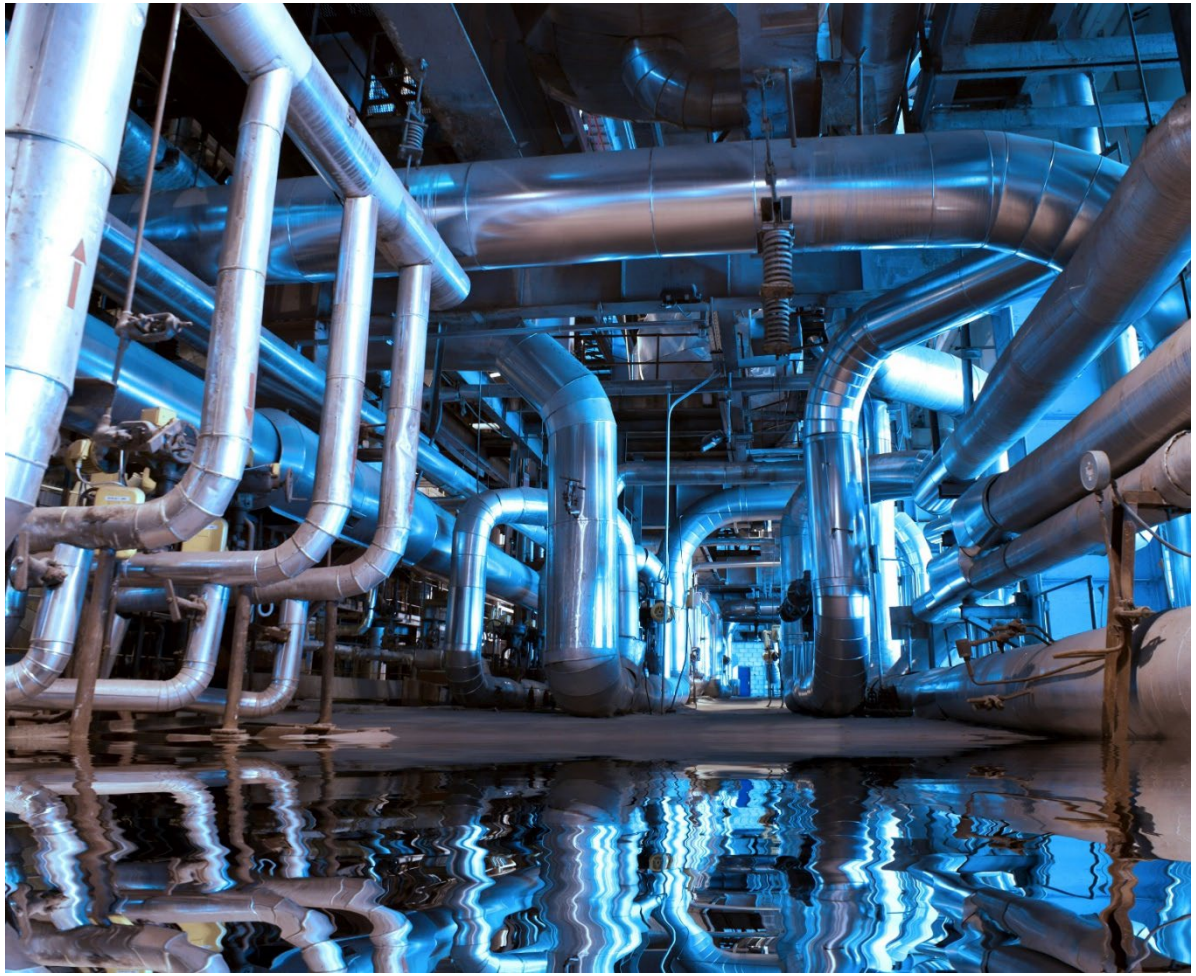
- Why Asset Integrity?
- Common Failures, Incident Review, and Proposed Solutions
  - Pressurized Equipment with “Less Hazardous” Fluids
  - Material Verification and QAQC for Small Components
  - ITPM Program Development for Rotating Equipment
  - Managing Instrument Functionality
  - Computerized Asset Management Systems
- Takeaways

Why Asset Integrity?

Why Asset Integrity

- Critical element of effective PSM Programs
- Often mis-interpreted to only apply to fixed equipment
- Small elements can “fly under the radar”
  - For many reasons!
  - Three in particular are…

“Under the Radar”



#1 – Large Quantities!

Think about how many flanged piping joints are present even in a single small facility.

“Under the Radar”

#2 – Outdated Impressions

- “Mechanical Integrity” does not only apply to fixed equipment.
- “Asset Integrity” applies to rotating, instrumentation and controls, and electrical equipment too!
- If it helps keep process fluids in the pipe, it’s an asset whose integrity matters.

“Under the Radar”

#3 – “Should”

- Use of this term in RAGAGEP means one of multiple ways to mitigate a risk
- It does NOT mean optional risk mitigation!

Up Next

- Common “Stealthy” Items that, if suffering a latent or unknown failure, can cause problems!
- Incident reviews where these “stealthy” items were contributing factors
- Suggestions to ways to incorporate these items into existing programs

Pressurized Equipment Containing “Less Hazardous” Fluids

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Why?

- Asset integrity programs have traditionally ignored or placed lese emphasis on inspection and testing of equipment in “less hazardous service”
  - Such as API 570 Class 3 and 4 fluids
  - Steam, lubricating oil, nitrogen are a few examples.
  - API 570 even lists the inspection of Class 4 piping as “optional”
    - **Optional inspection does NOT correlate to optional risk mitigation.**

Examples

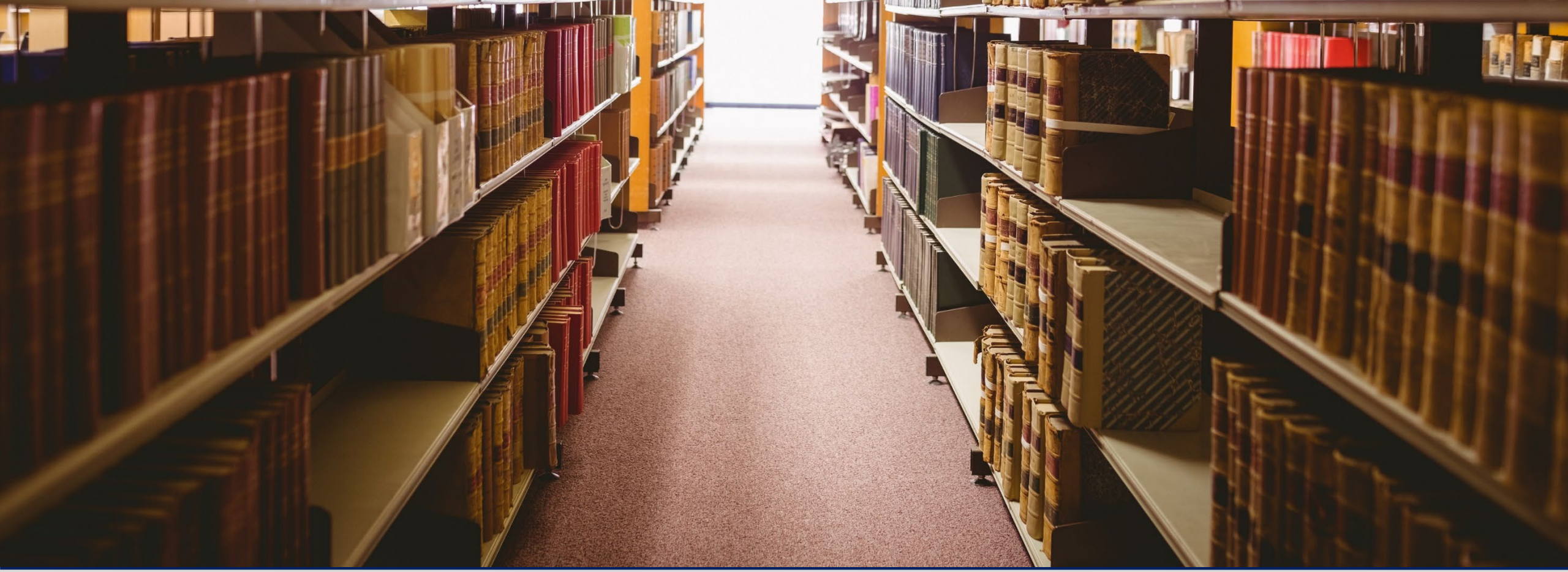
- Wynnewood Refinery, Oklahoma
  - Wickes Steam Boiler explosion killed two workers in 2012.
  - OSHA cited facility that Boiler should have been covered and managed by the facility PSM program.
  - Facility appealed to the 10th Circuit Court of Appeals.
  - Final ruling issued in 2020 confirmed that interconnecting equipment equipment, such as the steam boiler, should be included in the PSM program.
  - Ruling also upheld another finding that a vessel or piping does not need to have a documented potential catastrophic loss of containment consequence to be included within the PSM boundary.

How?

- Perform high-quality Process Hazard Analyses (PHAs)!
- Use the PHA to identify
  - Hazards caused by equipment failure
  - Safeguards dependent on this equipment
- Use prioritization functions within existing systems
  - Less-frequent activities (such as inspection) may be prudent

What Exactly is a High-Quality PHA?

- Get the right people in the room
  - Operators, controls and instrumentation, rotating or process engineers, health and safety processionals
  - Some representatives may not need to dedicate to the study full-time, but their input is invaluable
- Analyze worst-case consequences, pay attention to all systems.
- Evaluate and document all safeguards.
- Make concise recommendations and follow through.
- Document the study thoroughly
  - Comments often help someone reading the report understand the team's thought process during the study



Material Verification and QA/QC for Small Components

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Why?

- Small components like piping, gaskets, and hoses are commodity products.
  - Often tested only at the lot level
- Incompatible materials or inadequate quality control (QA/QC) can lead to hazardous consequences.

Example: Philadelphia Energy Solutions Refinery Fire, 2019

- Single piping elbow with excess nickel and copper content ruptured in an HF Alkylation Unit.
- Elbow was stamped and adequate at installation in 1973
- Updated ASTM standards indicated requirements on nickel and copper content in carbon steel piping.
- The system was inspected, but no inspection was done on this particular elbow, which corroded far faster than other components.
- Refinery permanently closed following this event.

Image Source: https://www.csb.gov/philadelphia-energy-solutions-pes-refinery-fire-and-explosions-/

Example: DPC Enterprises Festus, MO, 2002

- Hose Failure at a Chlorine repackaging facility causing Chlorine cloud, traffic stoppage, and partial evacuation
- Hose was specified as Hastelloy, but post-accident testing revealed it to be stainless steel braid.
- Visual inspection would not have differentiated the two materials.

Image Source: https://www.csb.gov/dpc-enterprises-festus-chlorine-release/

Figure 1. Railroad tank car unloading station #3.

Figure 2. Failed stainless-steel transfer hose.

How?

- Additional testing
- Reactivity charts can be useful starting points to prioritize
  - Ensure it includes materials of construction
- Verification can be
  - Visual
  - Records review
  - Non-destructive testing
- Develop a retroactive PMI Program
  - Reference new guidance in API 578 (4th Ed., published February 2023)

ITPM Program Development for Rotating Equipment

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Why?

- Rotating Equipment is often part of the pressure boundary.
- Failures can still result in loss of containment!
- No Industry-consensus RAGAGEP exists for inspection and testing of most rotating equipment.
  - ISO 18436 *Condition monitoring and diagnostics of machine systems* covers certification of personnel, but not ITPM tasks.

Examples

- Compressors
  - Reciprocating
  - Axial / Centrifugal
- Pumps
  - Blocked-in / Deadhead

How?

- Perform high-quality PHAs!
- Include a rotating equipment engineer when discussing credible consequences.
- Develop internal guidance.

Managing Instrumentation Functionality

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Why?

- Instruments are often overlooked until after failure has occurred.
- Instruments are often the first, and most important, indicators of an upset condition!
- Starting an instrumentation ITPM program can be daunting.

What?

- Perform high quality PHAs!
- This will help prioritize equipment by criticality.
  - Safety Instrumented System devices (regulatory, too!)
  - BPCS Instruments
  - PHA Safeguards against high severity consequences
  - PHA Safeguards against many consequences
  - Other considerations, like environmental or reliability

How?

- Instrument Testing
  - How to test?
  - Which portions can be tested?
  - When and how often to test?

Computerized Asset Management Systems

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Why?

- IDMS and CMMS are increasingly common methods to manage mechanical program integrity.
- These programs are only as effective as the data entered into them, and the competencies of the system users.

How?

- Make systems more accessible!
  - Remove barriers like poor software functionality or connectivity.
  - Stress roll-out and user training
- Quality Control of Data
  - Bad data will always yield poor results
  - Efforts to save time and resources may cost more time and resources in the long term if decisions are made with poor data.


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Takeaways

What Do I Do Now?

- Deep Breath!
- Utilize high-quality PHAs to guide and improve prioritization efforts for new ITPM activities
  - Do you currently have high-quality PHAs?
- Prioritize program implementation or modifications to prevent overwhelming users
  - Right-size inspection and risk mitigation for “less hazardous” systems.
  - Implement retroactive PMI on highest risk materials first.
  - Document and implement internal best practices for rotating equipment ITPM.
  - Don’t try to test all instruments at once! Prioritize by criticality.
  - Focus on training users to embrace computerized asset management tools.

Thank you!

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Questions?

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