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Elements of a Highly Effective Piping Inspection Plan (PIP)

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“Pipe burst caused 2009 Utah refinery explosion” – BIC Magazine, April 11, 2014.

Result – $1,000,000 fine

“Corroded pipe ruptured at Regina’s Co-op refinery, causing a fire and explosion that injured 52 people” – CTV Regina Oct 6, 2011

Result – $280,000 fine; cost of damage and lost production from the incident is estimated at $100 million

“Production halted at Alberta oil sands mine after fire breaks out” – The Globe and Mail, January 6, 2011.

Result – $279,000,000 (Repair and lost production)

Introduction

Observations over the last 20 years in addressing Integrity Management issues related to both equipment and associated piping have revealed the following issues when addressing piping:

- **Many owner/users do not have a formal piping inspection program, or if there is one, it only meets minimum standards.**
- **Program technical requirements not clearly defined or changed over time.**
- **Required front-end tasks not addressed.**
- **Assessment and implementation of work processes not optimal.**
- **Sustainment programs lack long-term follow-through.**

Agenda

- **Present detailed outline for the PIP outlining the content and scope of the program.**
- **Program consists of 12 steps addressed through a combination of procedures and guidelines.**
- **Program elements presented are based on a combination of experience, a review of API 570, and concepts from API 580 and API RP 581.**

Program Development Steps

1. Determine and implement the PIP management structure
2. Determine level of PIP resources
3. Obtain data
4. Determine piping program scope
5. Systemize piping
6. Define piping circuits
7. Document and verify piping circuits
8. Determine relative risk of piping circuits
9. Develop NDE and visual inspection (VI) application guideline
10. Develop circuit inspection work packages (IWP)
11. Perform Visual and NDE inspections
12. Implement PIP sustainment program

Determine PIP Management Structure

- PIP management structure:
  - Assign staff member assigned with responsibility and authority to manage the program
  - Team members should include individuals from Inspection, Integrity Management, and Operations
  - Admin support
- Corporate-level integrity engineers should provide advice only
- Determine PIP Audit criteria and frequency

Determine PIP Resource Requirements

- Develop a budget for the for engineering, drafting, walkdowns, inspection, and data entry for the site PIP.
- Experience has shown that a ratio of 2.5 to 3 circuits per vessel defined within the inspection scope can quantify the number of circuits to be addressed.
- The number of circuits can then be used to determine labor requirements for implementation.

Obtain Data

- Drawings (PFDs, P&IDS, construction ISOs, etc.)
- Fixed Equipment count
- Line lists
- Piping specifications
- Previous relevant inspection/repair histories
- Process system design basis
- Process system operating rules in case of a derate or full outage
- Financial consequence (cost of lost production)

Determine Piping Program Scope

- **Scope should include only piping within the facility boundary limits – pipelines are excluded.**
- **All piping within boundary limits should be considered.**
- **Depending on facility type, production requirements, revenue expectations, and budgetary considerations, utility piping could be excluded.**
- **Typically, 2”-diameter-and-above piping would be included; consideration should be given to high-risk, small-bore piping and tubing, as necessary.**

Systemize Piping

- **From API 570: "Complex process units or piping systems are divided into piping circuits to manage the necessary inspections, calculations, and recordkeeping."**
- **Organize piping segments into like groupings or systems that can be managed effectively by a piping integrity program.**
- **Document corrosion systems into Corrosion Loop Diagrams (CLD) using Process Flow Diagrams (PFD).**

Define Piping Circuits

- **Assemble the specific piping segments included in each circuit and the boundaries where they start and stop.**

- **Criteria for defining these circuits could be, at a minimum, the criteria contained in API 570.**

Piping Circuitization Criteria

- **Material of construction/piping specification**
- **Operating and design pressures and temperatures**
- **ANSI flange rating**
- **Process fluids**
- **Whether or not the circuit is a deadleg, an injection or mixing point, subjected to intermittent service, or requires some additional consideration**
- **The corrosion rate and remaining service life of, at least, the limiting examination point on the circuit**
- **The maximum interval for external inspection (absent risk assessment)**
- **The maximum interval for internal inspection (absent risk assessment)**
- **Any unusual or localized corrosion damage mechanism that would require specialized inspection techniques**
- **Particular circuit features that might subject it to rapid corrosion increases in the event of a process upset or loss of injection fluid flow.**

Document and Verify Piping Circuits

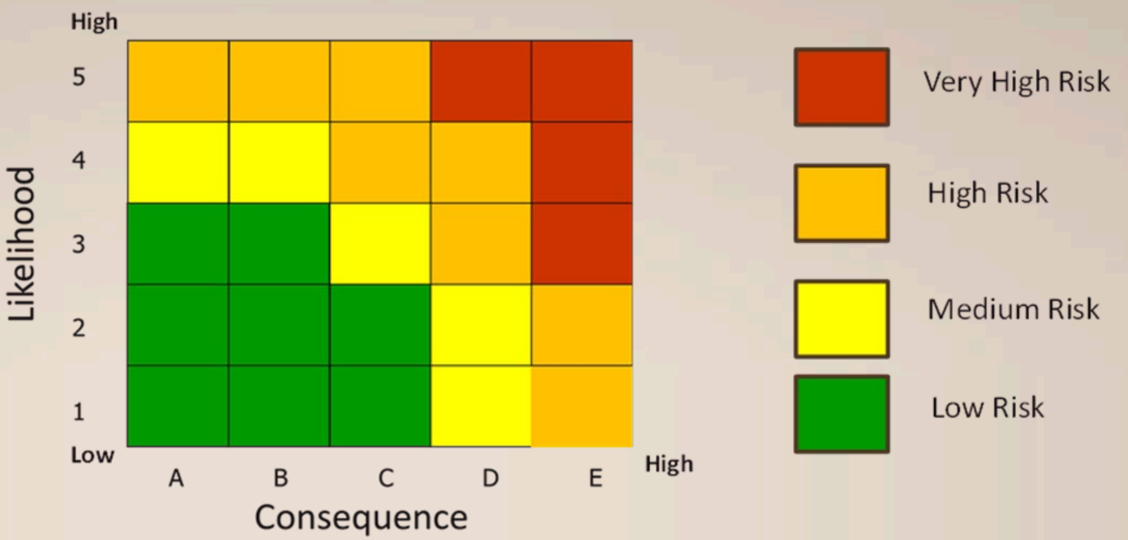
- **Define piping circuits by marking up P&IDs, identifying the circuits with coloured lines overlaying on the P&IDs and tags indicating the circuit identification.**

- **Subsequently, the circuitized P&IDs should undergo a site walk-down to verify their accuracy. The circuits can then be adjusted as necessary and P&IDs red-lined to conform to as-is design.**

Risk Rank Piping Circuits

- **Risk rank using consequence criteria from API-570 and using probability of failure metrics from a review of Damage Mechanisms (DM) and, if applicable, Corrosion Rates (CR).**
- **If available, results of an acceptable operational risk analysis should be considered.**

Risk Plot



Generate Tailored NDE and VI Guidelines

- Assumes 3rd party will perform inspections.
- Many inspection technologies and methodologies can be applied to examining piping integrity.
- Develop a guideline to ensure the most practical and the most effective approaches are applied when examining piping within the piping scope.
- Assure examination results are quantifiable and understand how results compare to each other in the context of the piping program.

Develop Circuit Inspection Work Packages (IWP)

- **Assign appropriate inspection techniques based on likely internal and external DMs.**
- **Set inspection intervals based on failure likelihood and consequence levels.**
- **If desired, group circuits based on circuit similarity and risk.**
- **Develop inspection ISOs and assign CMLs.**

Perform Visual and NDE Inspections

- **Schedule and perform Visual Inspections and Non-destructive Examinations.**
- **Record, quality check, and load results into inspection database (IDB).**
- **Based on the inspection results, the circuit's risk ranking should be revised should results indicate that the probability of failure is higher or lower than initially assumed.**
- **It is recommended that Owner/User (or independent 3rd Party) manage the activities of the inspection contractor.**

Implement PIP Sustainment Program

- **Ensure that IWPs are kept current based on inspection results and/or changes to design or operations.**

- **Highly recommend assignment of individual with the responsibility and *authority* to manage on-going program.**

- **Consider use of management Key Performance Indicators to assure continuous oversight.**

Benefits - Qualitative

- **Correct inspections are executed at appropriate intervals and at optimum locations to ensure piping integrity is both known and as predictable as reasonably possible.**

- **A well-planned and -executed PIP can cost-effectively support regulatory requirements and audits.**

Benefit – Positive Return on Investment

- Results anticipated from the implementation of a PIP addressing 2,000-plus circuits at a Canadian refinery were forecast to save more than 7 million dollars in inspection costs over a twenty-year period.

- The cost of the program implementation referenced above was less than 3% of the anticipated savings.

Thank You

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