Overview of API Risk-Based Inspection Technology

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Roland Goodman
American Petroleum Institute
Why RBI?

- Rigid regulatory regimes (time-based inspection intervals)
- Optimize run times and minimize risk
- Prioritize inspection activities
- Time- and condition-based intervals focus only on probability of failure
What is Risk?

- “A probability or threat of a damage, injury, liability, loss, or other negative occurrence that is caused by external or internal vulnerabilities, and that may be neutralized through preemptive action.”

http://www.businessdictionary.com/definition/risk.html

- Risk is something we live with every day.
Definitions

- **Risk** – The combination of the probability of an event and its consequence

- **Probability of Failure** - Likelihood of an event occurring within the specific timeframe considered

- **Consequence of Failure** – Outcome of an event occurring in terms of loss or injury

- **Failure** – Inability of an object to perform its required function (e.g., loss of containment)
Another Definition

Probability of Failure

times

Consequence of Failure

equals

Risk
Why RBI Works

- In most processing facilities, a large percent of the total risk for a process unit will be concentrated in a relatively small percent of the equipment items.
- These potential high-risk components can require greater attention through a revised inspection plan.
- The cost of the increased inspection effort may be offset by reducing excessive inspection efforts in the areas identified as having lower risk.
Types of RBI Analysis

- **Qualitative** – simple, brief prioritization of equipment, utilizes experience and judgment

- **Semi-quantitative** – more accurate, more detailed prioritization and planning

- **Quantitative** – most in depth analysis including reliability and financial analysis, utilizes logic models, fault trees, event trees, etc.
Risk Matrix
Managing Acceptable Risk

Focus on High Risk Items to Drive Risk Down

Acceptable Risk Profile

Avoid Unnecessary Inspection Cost
Risk Profile

RISK vs LEVEL OF INSPECTION ACTIVITY

- Risk with Typical Inspection Programs
- Risk Using RBI and Optimized Inspection Program
- Residual Risk Not Affected by RBI
API Risk-Based Inspection

- API RBI provides the basis for making informed decisions on inspection frequency, the extent of inspection, and the most suitable type of NDE

- In most processing plants, a large percent of the total unit risk will be concentrated in a relatively small percent of the equipment items
API Risk-Based Inspection

- API 580 provides guidance on developing a risk-based Inspection program for fixed equipment and piping in the hydrocarbon and chemical process industries.

- API 581 provides quantitative RBI methods to establish an inspection program for fixed equipment.

- The intent of these two standards is for API 580 to introduce principals and minimum requirements, while API 581 provides quantitative calculation methods and specific requirements to determine an inspection plan based on risk.
API Risk-Based Inspection

- API RBI is a semi-quantitative RBI procedure
  - Requires involvement of plant personnel; they must be involved and commit to the process
  - Requires extensive documentation that permits auditing by regulatory bodies
  - Based on the latest available technology
  - Requires specific expertise to implement

- API RBI is formulated to reduce risk, not save inspection costs; cost benefit of API RBI results from focusing inspection funds on critical equipment thereby ultimately increasing availability, i.e. avoiding unplanned shutdowns
API Risk-Based Inspection

- Practitioners of API RBI require training and experience to become effective in using the process, refresher courses are recommended.
- Inspection planning for certain equipment types such as heavy wall reactors, fired heaters, equipment subject to cyclic loading and/or high temperatures are more effectively handled using FFS techniques.
- Piping complexity presents a significant challenge to API RBI because of the volume of piping circuits and the complexity of the damage mechanism, i.e. general vs. local corrosion.
RBI Process

1. Define the scope
2. Establish the team
3. Create an equipment list
4. Collect general equipment data
5. Collect consequence data
6. Collect probability/inspection data
7. Develop an inspection plan and risk benefit
Hints for a Successful RBI Study

- Use a group facilitated approach
- Provide process flow diagrams, populated with key data
- Get people knowledgeable about the unit(s) involved
- Consider maintenance and operational issues as well as inspection history and findings
- Group equipment logically, i.e. corrosion groups
- Use existing electronic information whenever possible
- Make conservative assumptions and document them
  - Evaluate preliminary results and risk ranking
  - Identify variables driving risk
  - Update/Improve data, as necessary/appropriate
Reassessment and Updating

- API 580 highlights reasons for why and when an assessment will be re-evaluated
- Reasons to conduct an RBI reassessment:
  - Deterioration mechanisms and inspection activities
  - Process & hardware changes
  - RBI assessment premise change
  - Effect of mitigation strategies
- When to conduct an RBI reassessment
  - After significant changes
  - After a set time period
  - After implementation of risk mitigation strategies
  - Before and after maintenance turnarounds
Reassessment and Updating

- Additional Reasons for re-evaluation
  - Changes in RBI technology or improvements that affect the risk calculation
  - Changes in code that affect the recommendations
  - Changes in law or regulatory policies
  - Change in company risk policy
  - Process changes, includes debottlenecking, changes in feed, changes in catalyst, changes in alloying, etc.
  - Considerations as learned from a failure in that plant or another plant with a similar process
  - Extension of run length between turnarounds
Reassessment and Updating

- Re-evaluation of risk for equipment with inspection
  Findings were noted
- Consider severity and type of damage compared to expectations
- Determine if the risk assessment needs to be modified based on findings
- Determine if MOC or process/debottlenecking requires re-evaluation or further consideration
- Recalculate risk and begin inspection planning activity
- Prompt user for new RBI date (after latest inspection date), plan date and notification of last RBI analysis date
Inspection Results

- Inspection results and findings should be compared to expectations of damage
  - Thinning rate and type (general or localized)
  - Cracking severity (if found)

- Where there any inspection findings that could impact the RBI assessment?

- Are there any MOC considerations that could impact the risk assessment?

- Any new information or findings should be noted and returned to the RBI analysis team
Barriers to Implementation of RBI

- Up front involvement of regulatory bodies
- Understanding of RBI methodology
- Credibility of RBI methodology – not a tool to justify taking risks
- Resources
  - Team; operations, process, material/corrosion, inspection & maintenance, mechanical etc.
  - Coordinator
  - Management champion