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Implementing API RP 580 Risk Bbased Inspection

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ABSTRACT

API RP 580 Risk-Based Inspection was recently issued in the spring of 2002. This recommended practice provides the basic elements for developing and implementing a Risk-based Inspection (RBI) program.

This paper will provide an introduction to the background and benefits of RBI as a tool for improving equipment reliability and managing asset integrity. The paper will cover the elements, data and resources necessary to implement a risk-based inspection program and how risk-based inspection fits into an overall plant mechanical integrity program.

Implementing API RP 580

Risk Based Inspection

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Inspection Options

- Don't inspect, fix when equipment fails or breaks
- Conduct a full inspection on all equipment at fixed intervals (primarily vessels, piping is often neglected)
- Compliance based on codes/standards
- Condition based approach (likelihood of failure)
- Risk-based approach
  - Qualitative
  - Semi-quantitative
  - Quantitative

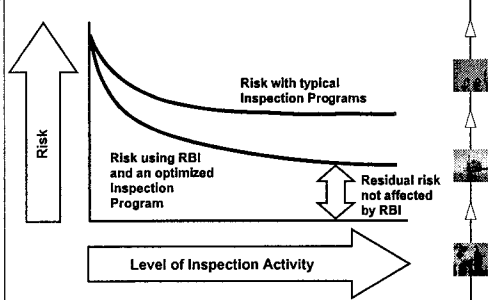
What is RBI?

- *Risk Based Inspection (RBI)* is a systematic tool that helps facilities make informed business decisions regarding inspection and maintenance spending
  - Systematically evaluates both the probability of failure and the associated consequence of failure
  - The probability of failure assessment must be based on all forms of deterioration that could reasonably be expected to affect the piece of equipment in a particular service

Why RBI?

- Most inspection codes/standards are based on *Likelihood of Failure (LOF)*, not *Consequence of Failure (COF)*
- Reduce risk of high consequences failures
- Improve the cost-efectiveness of inspection and maintenance resources
- Provide a basis for shifting resources from lower to higher risk equipment
- Measure and understand the risks associated with current inspection programs
- Measure risk reductions as a result of inspection practices

Basic Concept



Benefits of an RBI Program

- The basic benefits of an RBI program are:
  - The capability to define and measure risk, creating a powerful tool for managing many of the important elements of a process plant
  - Allows management to review safety in an integrated, cost-effective manner
  - Systematically reduces the likelihood of failures by making better use of the inspection resources

And

  - Improves the reliability of plant equipment

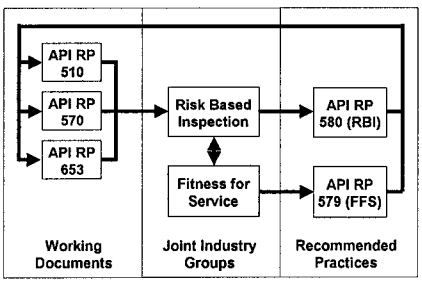
API RP Development Group

- **Group Composition (1997-2002)**
  - •Ow ner/User representatives from 22 + refining, chemical and exploration companies
  - •International r epresentation
  - •Consultants
    - – Consequence modeling expertise
    - – Materials/Corrosion engineers
    - – NDE specialist
    - – MI expertise

API 581 Project

- **Project initiated August 1993 with 16 sponsors**
- **22 sponsor companies as of January 2002**
- **Project value of $2,300,000 over 9 years**
- **Currently functioning as a user group**

Relationship of API Documents



Relationship to API Codes & Standards

- **API RP 580 Risk Based hspection has been integrated with**
  - •A PI 510 Pressure Vessel Inspection Code
  - •A PI 570 In-Service Piping Inspection Code
  - •A PI 653 Storage Tank Inspection Standard
- **An RBI assessment may be used toincrease or decrease inspection intervals**
- **RBI assessments shallbe reviewed and approved at intervals not to exceed 10 years (API 510)**
- **MOC – The assessment should berepeated each time equipment or process changes are made that could significantly affect degradation rates or cause premature failure (API 510)**

Regulatory Issues

- **Some jurisdiction accepts the following inspection codes:**
  - •A PI 510 Pressure Vessel Code
  - •A PI 570 Piping Code
  - •A PI 653 Aboveground Storage Tank
- **RBI is an acceptable practice of establishing inspection plans in the latest editions**
- **How will jurisdictions accept RBI?**
- **ASME has RBI for fossil and nuclear power industry**
- **European consortium is developing an RBI process**

Overview of API RP 580

- **Foreword**
- ***Section 1* - Introduction, Purpose and Scope**
- ***Section 2* - References**
- ***Section 3* - Definitions and Acronyms**
- ***Section 4* - Basic Concepts**
- ***Section 5* - Introduction to Risk Based Inspection**
- ***Section 6* - Planning the RBI Assessment**

Overview of API RP 580

- *Section 7* - Data and Information Collection for RBI Assessment
- *Section 8* - Identifying Deterioration Mechanisms and Failure Modes
- *Section 9* - Assessing Probability of Failure
- *Section 10* - Assessing Consequence of Failure
- *Section 11* - Risk Determination, Assessment and Management

Overview of API RP 580

- *Section 12* - Risk Management with Inspection Activities
- *Section 13* - Other Risk Mitigation Activates
- *Section 14* - Reassessment and Updating RBI Assessments
- *Section 15* - Roles, Responsibilities, Training and Qualifications
- *Section 16* - RBI Documentation and Recordkeeping
- *Appendix A* - Deterioration Mechanisms

Purpose

- The purpose of API RP 580 is to provide users with the basic elements for developing and implementing a RBI program
- An introduction to the concepts and principles of risk based inspection for risk management
- Expected outcomes include:
  - Ranking by r isk of equipment
  - Detailed inspection plans
  - List of other m itigation measures
  - Expe cted risk after inspection and other mitigation implemented

Scope

- Equipment covered:
  - Pres sure vessels: all pressure containing components
  - Proce ss piping: pipe and piping components
  - Storage tank s: atmospheric and pressurized
  - Rotating equipm ent: pressure containing components
  - Boilers and heaters: pressurized components
  - Heat ex changers (shells, heads, channels and bundles)
  - Pres sure relief devices
- Not covered
  - Instrum entation systems
  - Electri cal
  - Structural

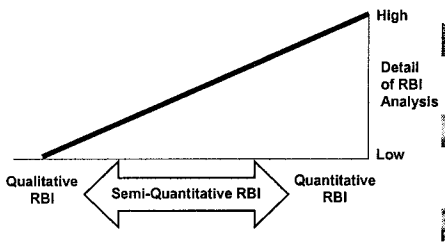
Introduction to RBI

- Types of assessment
- Precision vs. accuracy
- Managing risks
  - Inspections
  - Operational risks
  - Relationship to other in itiatives

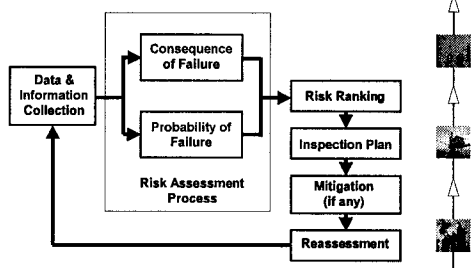
Levels of API RBI Analysis

Level 1	*Qualitative Risk Analysis* – simple, brief prioritization of equipment
Level 2	*Semi-Qualitative Risk Analysis* – more accurate, more detailed prioritization and planning
Level 3	*Qualitative Risk Analysis* – most in depth analysis including reliability and financial analysis

Introduction to Risk Based Inspection



Introduction to Risk Based Inspection



Key Questions to Ask Before Beginning

- Will regulatory jurisdiction accept RBI?
- Is management willing to invest resources to achieve benefits?
- Are sufficient resources and expertise available for assessment?

RBI Assessment Planning

- Why is the assessment being done?
- How will the RBI assessment be carried out?
- What knowledge and skills are required for the assessment?
- Who is on the RBI team?
- What are their roles in the RBI process?
- Who is responsible and accountable for what?
- Which facilities, assets and components are in?
- What data is to be used in the assessment?
- When will the assessment be completed?
- How long will the assessment remain in effect and be updated?
- How will the results be used?

RBI Work Process Steps

- Define the scope
- Establish theteam
- Create an equipment list
- Collect general equipment data
- Collect consequence data
- Collect likelihood/inspection data
- Perform the analysis andvalidation
- Develop an inspectionplan and mitigation options
- Determine risk reduce benefits

Data and Information Collection for RBI

- General data required:
  - •Type of equipm ent
  - •Material s of construction
  - •Inspection, repair and replacements records
  - •Proce ss fluid compositions
  - •Inv entory of fluids
  - •Operating conditions
  - •Safety systems
  - •Detection s ystems
  - •Deterioration mechanisms, rates and severity
  - •Personne l densities
  - • Coating, cladding and insulation data
  - •Busines s interruption cost
  - •Equipm ent replacement costs
  - •Env ironmental remediation costs

Data and Information Collection for RBI

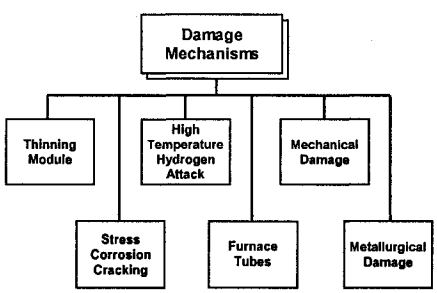
- Data quality
  - Good quality dat a is critical to the relative accuracy of an RBI study
  - Valid ation step is required to review data for errors
  - Experi enced personnel are needed for this step
- The codes and standards specify data required to conduct an RBI study
- Many other sources of information exist in an operating facility
- Do not waste time on trivial data

Identifying Deterioration Mechanisms and Failure Modes

- Leads to loss of containment
- Critical to success
  - Role of corrosion/m aterials engineer review
  - Understanding NDE and d amage mechanisms
  - Im pact of operating conditions
  - Norm al, upset, start-up, shutdown, etc.
  - Understanding operation s vs. chemical and mechanical deterioration mechanism identification

Identifying Deterioration Mechanisms and Failure Modes

- Categorized into four (4) types of damage
  - Thinning (includes internal and external)
  - Stress corrosion cracking
  - Metallurgic al and environmental
  - Mechanic al
- Refer to Appendix A in RP 580 for summary of damage causes
- API 571 is being developed and will provide more detailed guidance on damage mechanisms



Assessing Probability of Failure (POF)

- Probability of specific scenario:
  - From a loss of containment due to a deterioration mechanism
  - POF x Probability of scenario = Probability of specific consequence
  - Should addre ss all possible failure mechanisms
  - Should addre ss multiple mechanisms considering conditions
  - Must be cred ible, repeatable, well-documented
  - Quantify the effe ctiveness of the past inspection ad maintenance program and a proposed future inspection and maintenance program

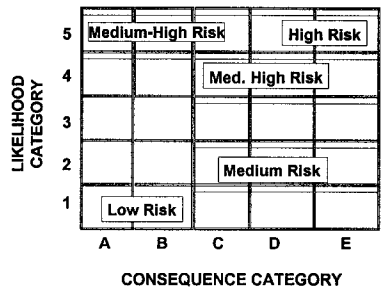
Assessing Consequences of Failure

- Loss of containment
  - Safety and health impact
  - Env ironmental impact
  - Production loss es (business interruption)
  - Maintenance and reconstruction costs
- Other functional failures can be included
- Units of measure
  - Safety, cost, affected area, environmental, volume of fluid release, etc.

Consequence of Failure

- Predict cloud size, shape, concentration
- Uses flammable effect modeling for:
  - •Fires
  - •Explosion s
- Estimates the toxic impact
- Post leak response:
  - •Rate the dete ction, isolation system
  - •Program will estimate duration of leak
  - •Leak dur ation used in toxic calculation

Risk Matrix



Risk Management with Inspection Activities

- Identifying risk management opportunities from RBI and probability of failure results
  - Identify the risk driver
  - Inspection oppor tunities through LOF
- Establishing an inspection strategy based on risk assessment
  - Mode of fail ure of the deterioration mechanism
  - Time interval between the onset of deterioration and failure, i.e. speed of deter ioration
  - Detection capabili ty of inspectio n technique
  - Scope of i nspectio n
  - Frequency of inspectio n
- Use RBI to determine future risk based on various inspection options (What-If)

Roles, Responsibilities, Training and Qualifications

- Team leader / facilitator
- Equipment inspector or inspection specialist
  - •Data gathering
  - •Inspection effectiveness translation
  - •Im plementing the inspection plan
- Materials and corrosion specialist
- Process specialist
- Operations and maintenance personnel

Roles, Responsibilities, Training and Qualifications

- Training
  - •Leader s
    - Thorough understanding of risk analysis and of the methodology via training, experience or education
  - •Support staff
    - Basic RBI methodology training
    - Effective implementation
- Document qualifications and training

Documentation

Documentation and Recordkeeping

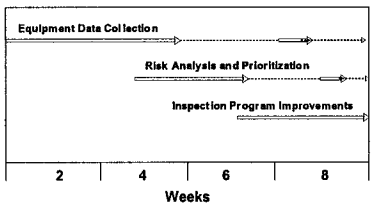
- Fully document the assessment
  - Type of assessment
  - Team members performing the assessment
  - Timeframe over which the assessment is applicable
  - The inputs and sources used to determine risk
  - Assumptions made during the assessment
  - Risk assessment results (including information on probability and consequence)
  - Follow-up mitigation strategy, if applicable, to manage risk
  - The mitigated risk levels (i.e. residual risk after mitigation is implemented)
  - Reference to codes or standards that have jurisdiction over extent or frequency of inspection

Inspection Plan

- An inspection plan includes consideration for:
  - Which equipment needs inspection
  - Identification of the mechanisms driving the inspection
  - Interval for inspection
  - Locations and coverage required
  - Methods/techniques to be used for inspection
  - In addition an inspection plant should include:
    - The acceptable limits for the inspection findings
    - Follow-up with fitness for service analysis, if necessary

RBI Schedule & Milestones

- The Project Manager must develop a timeline and outline the requirements for the study
  - Typically, a three (3) month timeline is the minimum



Summary

- Determine objectives of assessment
- Resources for assessment
- Type of assessment – qualitative or quantitative
- What software to use
- Data validity
- Inspection plans
- Document, document, document
- Should be an evergreen process of constant reassessment