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# Inspection, Evaluation and Repair of Process Plant Equipment and Connected Piping

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Amsterdam (Netherlands)

# Inspection, Evaluation and Repair of Process Plant Equipment and Connected Piping

course code: E6053 From: 18 November - 6 December 2024 Venue: Amsterdam (Netherlands) - course Fees: 6750 Euro

## The Course

Petroleum refineries, petrochemical and process plants have hundreds of pieces of equipment and thousand of meters of piping that handle hazardous and corrosive fluids and operate at wide ranges of temperatures and pressures. Plant integrity and reliability can only be achieved if this equipment and connected piping are designed properly and they remain fit for continued service between scheduled turnarounds.

The design and fabrication of process equipment and piping systems are carried out in accordance with industry codes and standards. Fabrication and welding processes are subjected to defined examinations and inspections to ensure that any deficiencies found are resolved so as to meet the acceptance criteria of the respective codes.

Once the new equipment and piping are put in service, they get exposed to the process fluids and start to undergo deterioration such as corrosion at various rates depending on the materials of construction and service conditions. It is therefore essential to know their current condition and the degradation rate so that appropriate repairs and maintenance can be carried out in a timely manner to prevent failures. Effective inspection and evaluation of the inspection data are vital for this purpose. The integrity of the plant cannot be achieved without effective inspection.

Regular and reliable inspections are an integral part of any effective industrial plant maintenance program. The success of such a program relies greatly on the Non-Destructive Inspection (NDT or NDE or NDI) techniques used. Non-destructive inspection (NDT) techniques detect flaws that can cause potential failure in future. This way, NDT provides information on the integrity of the pipeline as well as a measure of its current safety margin. Hence, it is important to understand the scope and limitations of the common and advanced NDE tools that are available in order to maximize the effectiveness of each of the scheduled inspection activities.

Furthermore, in today’s competitive environment plant operators need to reduce maintenance costs by minimizing downtime. Effective inspection contributes significantly to this objective.

In this comprehensive and integrated course, you will gain a clear understanding of the damage and degradation mechanisms that affect process equipment and piping and progressively adversely affect their condition and fitness for continued service. You will also understand that effective inspection is the backbone of plant integrity and that it has significant impact on EHS and financial performance of the company. The course will increase you awareness of industry codes and best practices related to inspection, repair and alteration of process equipment and piping including ASME BPVC and various API codes, standards and recommended practices. The course also provides a sound and concise coverage of fitness-for-service assessment methodologies and API/ASME FFS standard to enable making run/repair/replace decision about the damaged equipment/piping. The course then covers the main industry codes and practices for repairs and alterations to enable you to achieve business focused repairs and lower maintenance costs.

## The Goals

### The objectives of the course are:

- To increase delegates awareness of the degradation and damage that affects equipment and piping in service and that knowledge of their condition and remaining safe life are crucial for safe and reliable plant operation.
- To highlight the important function and significance of effective inspection on plant integrity, financial and EHS performance.
- To make delegates aware of the benefits of risk-based inspection (RBI) and maximizing non-intrusive inspections (NII) on improved reliability and reduced maintenance costs.
- To provide a clear understanding of the fundamentals of nondestructive inspection and the major NDT methods, their capabilities and limitations.
- To make it clear that all deficiencies found by inspections must be evaluated and that some of the deficiencies may be deemed to be acceptable obviating the need for immediate repairs.
- To provide methodologies for performing fitness-for-service assessments of damaged equipment/piping with the objective of making run/repair/replace decisions.
- To increase awareness of applicable industry codes and best practices covering inspection, repair, and alteration of process equipment and piping.

## The Process

This comprehensive course is integrated and highly interactive. It links in-service damage mechanisms to the appropriate mix of inspection strategies methods and NDT techniques to obtain reliable and relevant inspection data, which is used in turn to assess the fitness-for-service (FFS) of the equipment/piping. It combines structured and focused presentations and discussions of topics covered with actual relevant examples. The results of the FFS assessment will then be used to make run/repair/replace decisions. Repair options and relevant industry codes and best practices can then be followed as appropriate to resolve deficiencies.

The course combines sound engineering principles, methods, and applicable codes & standards and best industry practices with practical workshops that cover worked examples to enforce the learnings. To maximize learnings, optional Question & Answer sessions are available at the end of each day to avail delegates the opportunity to ask additional questions relating to topics discussed as well as specific equipment/piping problems they may experience in their plants.

Delegates will receive hard copies as well as a CD of all course presentations as well as detailed lecture notes which will provide an invaluable reference document.

## The Benefits

- The delegates will gain sound and integrated understanding of the key aspects relating to inspection of process equipment and piping throughout their life cycle, and that inspection is the backbone of plant integrity.
- They will gain better understanding of the intent of the major industry codes and best practices pertaining to inspection, fitness-for-service assessment and repairs of process equipment and piping.
- Delegates will achieve a clear understanding and skills to perform fitness-for-service assessments and thus make value added contributions to the company performance through technically sound and business focused run/repair/replace recommendations.
- The delegates will gain better understanding of the common repair methods and their advantages and limitations to safeguard against related failure and to avoid excessive repair costs.

## The Results

- The company will achieve improved reliability through implementation of effective inspection strategies including risk-based inspection, optimum non intrusive inspection and use of advanced NDT methodologies.
- The company will achieve a measurable reduction in failure incidents and consequently improved EHS performance through effectively evaluating and ensuring pressure equipment and piping are fit for continued service between scheduled turnarounds.
- By using best industry practices for effective inspection, fitness-for-service assessment, and business-focused repairs the company will be able to achieve lower maintenance and repair costs while simultaneously improving reliability and complying with applicable codes and standards, and other regulatory requirements.

## The Core Competencies

### Delegates will enhance their competencies in the following areas:

- Gain essential and integrated knowledge about the in-service degradation and damage mechanisms that affect process equipment and piping systems.
- Understand the significance of effective inspection in defining the condition of the equipment/piping.
- Understand the fundamentals and benefits of risk-based inspection and how to apply this methodology effectively.
- Better understand and apply the methodologies of fitness-for-service assessments to significantly reduce the probabilities of failure and downtime, and help improve plant performance.
- Awareness of industry codes, standards and best industry practices in plant integrity management through planning and conducting effective inspection, maintenance and repairs to process equipment/piping.
- Enhance competence and productivity thereby improving their performance level and making additional value added contributions to their organizations.

## The Programme Content

### Inspection the Backbone of Plant Integrity

- Significance of inspection throughout the life cycle
    - Inspection – Why? What? Where? How? When?
    - The real function of inspection
    - Regulatory requirements
    - Impact on plant integrity, safety, reliability and business performance
- Inspection and the construction codes
    - Manufacturing , fabrication and repair/alteration deficiencies
    - QA/QC requirements in fabrication and welding
    - ASME BPVC requirements – Examination vs. inspection
    - ASME Code Case 2235-3 for Use of Ultrasonic Examination in Lieu Of Radiography
    - Fraudulent/substandard materials in code construction
- Degradation and damage mechanisms affecting pressure equipment and piping
    - Overview of API 571- Damage Mechanisms Affecting Fixed Equipment in the Refining Industry
- Areas of vulnerability in petroleum refineries
    - Injection points
    - Corrosion under insulation (CUI)
    - Soil-to-air interface
    - Integrity of structures and supports

- In-service inspection – the big picture
    - Non Intrusive Inspections
    - Shutdown inspections
- Inspector qualification and competence
    - API inspector certification
    - API Body of Knowledge

## Inspection Strategies, Plans, Methods and Techniques

- Inspection Strategies and Systems
    - External and internal inspections – limitations, costs and benefits
    - Inspection plans and procedures
    - Statutory requirements
- Risk-based inspection (RBI)
    - Fundamentals and benefits
    - Overview of API RP 580 - Risk Based Inspection
    - Overview of API RP 581 - Risk-Based Inspection Technology
- Non-destructive testing (NDT)
    - Highlights of main NDT methods and their application
    - Overview of ASME BPVC Section V – Nondestructive Examination
- Advanced Inspection Techniques and best practices
    - Guided Wave Ultrasonic Long Range Inspection
    - Advanced Phased Array for weld inspection
- On-line monitoring - Sensors typically used are strain gages, thermocouples, displacement transducers, and pressure transducers.
- Case studies – Equipment incidents resulting from inadequate inspection

## Inspection Codes Standards and Best Practices

- Pressure vessel inspection - API 572, API 510
- Fired boilers and heaters inspection
    - API 573 – Inspection of Fired Boilers and Heaters
    - ABSA AB 507 – Guidelines for the Inspection of Installed fired Heaters
    - FTIS -Furnace tube inspection system (Quest TruTec)
- Inspection of Heat Exchanger, Condenser & Fin Fan Coolers Tubes
- Aboveground storage tanks inspection
    - ANSI/API RP 575 - Guidelines and Methods for Inspection of Existing Atmospheric and Low-pressure Storage Tanks, Second Edition
    - STI SP001- Standard for Inspection of Aboveground Storage Tanks
    - API 653 - Tanks Inspection, Repair, Alteration, and Reconstruction
    - API 12R1, Setting, Maintenance, Inspection, Operation, and Repair of Tanks in Production Service
- Piping and components inspection
    - API 574 - Inspection Practices for Piping System Components
    - API 570 - Piping Inspection Code: In-service Inspection, Repair, and Alteration of Piping Systems
- Pressure relieving devices – Code and regulatory requirements and best practices
    - API RP 576 - Inspection of Pressure-Relieving Devices
- Pressure testing – Code requirements and best practices
    - Hydrostatic testing
    - Pneumatic testing
- API Standard 936 – Refractory Installation Quality Control Guidelines - Inspection and Testing Monolithic Refractory Linings and Materials

- API Inspector Certification

## Evaluation and Analysis of Inspection Data

- Inspection data verification and evaluation
    - Data completeness
    - Data quality
- Data Management and Risk Assessment
    - Inspection Data Management System (IDMS)
    - Software System for Managing and Assessing Inspection Data
- Reliable assessment of damages
    - Corrosion Rate calculations
    - Remaining Life Calculations
- Fitness-for-service (FFS) assessment and remaining life determination
    - Fundamentals and industry practices
    - Overview of API Std 579-1/ASME FFS-1
- Inspection, Maintenance and Repair (IMR) Plan
    - Appropriate mitigation activities
- Workshop – Worked examples – Fitness-for-service of corroded pressure vessels and storage tank

## Repair and Alteration of Process Equipment and Piping

- Repair codes, standards and best practices – API 510, 570, 653
- API 578 Positive material identification (PMI)
- Post Construction Codes – Overview of ASME PCC-2
- Repairs and Modifications
    - Temporary and Permanent Repairs
    - Welded Repairs – ASME BPVC IX
    - Mechanical Repairs
    - Specialized Repair Methods - Composites
- Hot tapping and line stops – Key Considerations, Practices and Procedures
    - API 2201 – Safe Hot Tapping Practices in the Petroleum & Petrochemical Industries
- Rerating
    - Assessing Need for Rerating
    - Minimum Required Thickness Determination
    - MAWP Determination
    - Authorization and Registration