

## Course Name: **Pressurized Vessels and Pipes**

Code:

DATE:

### Course Objective:

- Latest techniques to determine the fitness-for-service of operating tanks, vessels, piping systems and pipelines; and make cost-effective run-repair-replace decisions based on the principles of API recommended practice 579 “Fitness-for-Service”
- Balanced approach between the fundamental technical principles of structural integrity, stress and fracture analysis, and their practical application to field conditions
- Provides the participants with the tools necessary to recognize and assess defects in pressure vessels, storage tanks and piping
- Presents and applies the fundamentals rules of the ASME code to operating equipment and systems
- Introduces the participants to the practical application of the ASME and API rules for structural integrity of static equipment and pipelines, and their use to assess remaining life
- Applies API/ASME 579 “Fitness-for-Service” through practical examples to analyze degraded conditions and make cost-effective repair or use-as-is decisions
- Applies the step-by-step 3-level approach of API/ASME 579 to evaluate inspection results and recognize potential failure modes
- Technical basis for reliability-based (risk-based) evaluation of remaining life
- Latest developments in defect assessment techniques, starting with simple rules (level 1) and progressing to the more comprehensive evaluation techniques (level3)
- Participants will be able to evaluate the structural integrity of corroded or damaged equipment, and assess their remaining life. Degradation mechanisms include: brittle fracture, general metal loss, local wall thinning, pitting, blisters and laminations, mechanical defects (dents, gouges, misalignment, and distortion), crack-like flaws (stress corrosion cracking, weld flaws, crack-like defects), fatigue, and fire damage

### Who Should attend?

This training program is intended for technical professionals, supervisors and managers responsible for ensuring the integrity and cost-effective operation of in-service pressure equipment, storage tanks, piping

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and pipelines throughout their life cycle including design, operation, and maintenance in the petroleum, petrochemical, process and power industries:

- Plant engineers and designers, corrosion and materials engineers, project engineers
- Reliability and integrity supervisors and engineers including safeguarding/MOC engineers
- Inspection engineers and inspectors responsible for monitoring and assessing the condition of pressure equipment and piping systems
- Maintenance and operations supervisors and engineers responsible for shutdown planning and implementation, maintenance and repairs/alterations of pressure vessels, heat exchangers, storage tanks, piping and pipelines

## Course Outline:

### Foundations of Fitness-For-Service Assessment

- Introduction
- Overview of API codes and standards
- Overview of ASME codes and standards with historical background
- Overview of Mechanical Integrity of Pressure Vessels & Piping System
- Fitness For Service
- Overview of API 579 contents, objectives and applications
- How to apply API 579 for cost-effective run-or-repair decisions
- Fitness-for-Service assessment procedure
- An overview of what is new in the latest release
- Structure and Contents of the FFS Standard
- List of Parts and Annexes and examples of major Parts
- PART 1 – Introduction
- PART 2 – Fitness-For-Service Engineering Assessment Procedure

### Background of Stress Calculations for FSS Assessment

- ANNEX A – Thickness, MAWP & Stress Equations for a FFS Assessment
- Calculation of  $t_{min}$ , MAWP (MFH) & Membrane Stress
- Pressure Vessel & Boiler Components: Shells, Heads, Nozzles
- Piping components & Boiler Tubes
- Storage Tanks
- ANNEX G – Damage Mechanisms
- Deterioration and Failure Modes

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- Pre-Service and In-Service Deficiencies
- NDE (NDT) Techniques
- PT, VT, MT, ET, UT, RT
- PART 3 – Assessment of Existing Equipment for Brittle Fracture
- Overview of Brittle Fracture Mechanism
- Data Requirements
- Assessment Techniques and Acceptance Criteria (Levels 1-3)
- Remaining Life Assessment and Remediation

## Metal Loss, Corrosion, Pitting and Blisters

- PART 4 – Assessment of General Metal Loss
- Overview of Corrosion Mechanisms
- Data Requirements
- Assessment Techniques and Acceptance Criteria (Levels 1-3)
- Remaining Life Assessment and Remediation
- Worked example
- PART 5 – Assessment of Local Metal Loss
- Overview of Local Metal Loss Mechanisms
- Data Requirements
- Assessment Techniques and Acceptance Criteria (Levels 1-3)
- Remaining Life Assessment and Remediation
- Worked example
- PART 6 – Assessment of Pitting Corrosion
- Overview of Pitting Corrosion Mechanisms
- Data Requirements
- Assessment Techniques and Acceptance Criteria (Levels 1-3)
- Remaining Life Assessment and Remediation
- Worked example
- PART 7 – Hydrogen Blisters, HIC & SOHIC
- Overview of Hydrogen Damage
- Data Requirements
- Assessment Techniques and Acceptance Criteria (Levels 1-3)
- Remaining Life Assessment and Remediation

## Local Damage, Cracks, Creep

- PART 8 – Weld Misalignment & Shell Distortions
- Overview of Weld Misalignment & Shell Distortions

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- Data Requirements
- Assessment Techniques and Acceptance Criteria (Levels 1-3)
- Remaining Life Assessment and Remediation
- Worked example
- PART 9 – Assessment of Crack-Like Flaws
- Overview of Fracture Mechanics
- Elements of RSTRENG
- Data Requirements
- Assessment Techniques and Acceptance Criteria (Levels 1-3)
- Remaining Life Assessment and Remediation
- Worked example
- PART 10 – Assessment of Components Operating in the Creep Range
- Overview of Creep Damage Mechanisms
- Data Requirements
- Assessment Techniques and Acceptance Criteria (Levels 1-3)
- Remaining Life Assessment and Remediation
- Worked example

## Fire and Mechanical Damage

- PART 11 – Assessment of Fire Damage
- Overview of Fire Damage
- Data Requirements
- Assessment Techniques and Acceptance Criteria (Levels 1-3)
- Remaining Life Assessment and Remediation
- Case study – Example of fire damage assessment
- PART 12 – Assessment of Dents, Gouges, and Dent-Gouge Combinations
- Overview of Mechanical Damage
- Data Requirements
- Assessment Techniques and Acceptance Criteria (Levels 1-3)
- Remaining Life Assessment and Remediation
- PART 13 – Assessment of Laminations
- Overview of Laminations and their Role
- Data Requirements
- Assessment Techniques and Acceptance Criteria (Levels 1-3)
- Remaining Life Assessment and Remediation
- Software review
- Various software packages considered for FFS
- Overview and Wrap Up

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**Course Duration: (5 ) Day**

**Venue:**

**Time:**

**Numbers of hours: Hours**

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