

€ TRAINING

Process Equipment & Piping Systems:
Application, Design & Operation



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Introduction:

The mechanical integrity and reliability of process equipment and piping systems can only be achieved if they are designed by competent engineers and operated and maintained effectively within the design envelope, namely, the integrity operating window IOW.

This course provides the appropriate mix of fundamentals, methodologies, best industry practices, and practical tools to enhance the competencies and improve the performance of design, operation, and maintenance technical professionals individually and collectively to add value to the organization and improve the plant safety and reliability.

Course Objectives:

At the end of this course the participants will be able to:

- Increase the awareness and understanding of mechanical integrity of process equipment and piping systems depends jointly on the proper design, operation, condition assessment, and maintenance of the equipment, underscoring their vital individual and team roles in managing change.
- Get practical and sound methods and tools to enable them to carry out basic design calculations for pressure equipment following applicable industrial codes, standards, and best practices.
- Get a clear understanding of the degradation mechanisms that process equipment could be subjected to over their operating life, how to identify them, predict and determine their impact, and what appropriate measures can be taken to prevent and control the resultant damage.
- Gain the knowledge and failure analysis skills they need to conduct damage and failure analysis to prevent similar failures from happening.
- Enhance the knowledge and skills in hazard identification and analysis, and risk assessment and management.

Targeted Audience:

- Process, Mechanical and Chemical Engineers
- Operation and Maintenance Engineers
- Project Engineers
- Supervisors and Managers
- Technical Personnel involved in the inspection

Course Outlines:

Unit 1: Key Design Considerations, Guidelines, and Practices:

- Process Equipment - An Overview
- Plant Integrity and Reliability
- Interdependence of engineering, operation, and maintenance
- Management of change
- Fitness for Purpose
- Service conditions, equipment sizing, and functional performance

- Business-Focused-Facilities - Appropriate quality at lowest life cycle cost
- Safety by Design
- Worst foreseeable credible scenarios, safeguarding, best industry practices
- Codes, Standards, Industry Practices
- Compliance with Regulations and Acts - HS&E requirements and considerations

Unit 2: Design and Operation of Pressure Equipment:

- Pressure Vessels and Reactors
- Materials of construction and standards
- Basic Design Methodology
- ASME Boiler and Pressure Vessel Code Sections
- Storage Tanks
- Types and application; cone roof tanks, floating roof tanks
- Basic design methodology
- Overview of API 650
- Piping Systems
- Materials of construction and standards
- Basic Design Methodology - hydraulic design, pressure integrity, mechanical integrity
- ASME B31.1 and B31.3
- Piping flexibility and support
- Piping system components - valves and fittings; classes, ratings
- Worked Examples
- Overpressure Protection
- Types and application of pressure-relieving devices
- Code requirements
- Sizing methodology: API 520 and 521
- Specific operation and maintenance requirements:

Unit 3: Design and Operation of Thermal Equipment:

- Process Heaters
- Types and configuration; box type, vertical cylindrical type
- Thermal and mechanical design
- API 560, API 530
- Boilers
- Types and configuration; water tube, firetube and waste heat recovery boilers
- Fundamentals of design and operation
- Operating efficiency and testing
- ASME B&PVC Section 1 and Section 4, ASME PTC-4
- Heat Exchangers
- Types and application; Shell & Tube Heat Exchangers, Plate Heat Exchangers, Air Cooled Heat Exchangers
- Thermal and mechanical design
- Overview of TEMA standards, API 660, API 661
- Operation, fouling, and effectiveness

Unit 4: Design and Operation of Fluid Handling Equipment:

- Pumps
 - Types and application; Centrifugal, Positive Displacement
 - Performance characteristics

- Selection and design considerations and standards; ANSI, API 610
- Worked examples
- Compressors
 - Types and application; Centrifugal, Screw, Reciprocating
 - Design considerations and standards
 - Operation and troubleshooting
- Electric motors
 - Types and application
 - Operation and troubleshooting
- Condition Monitoring
 - Vibration monitoring
 - Lubricating oil analysis
- Troubleshooting
 - Methodology and guidelines
 - Reliability improvement

Unit 5: Degradation and Condition Assessment of Process Equipment:

- Degradation processes
- Corrosion, erosion, fatigue, hydrogen attack
- Overview of API 571
- Industrial Failures and Failure Prevention
- Inspection and Testing
- Inspection strategies, plans, and coverage - The real function of inspection
- Nondestructive Testing NDT methods and their characteristics and applicability
- Risk-Based Inspection RBI
- Overview of API 580 and API 581
- Fitness-For-Service Assessment
- Overview of API 579
- Worked examples
- Maintenance Strategies and Best Practices
- Optimum mix of reactive, preventive and predictive methods
- Reliability Centered Maintenance RCM

Unit 6: Failure Mechanics:

- Wear & Failure Mechanisms
- Imperfections and Defects
- Corrosion Mechanisms
- Failure Modes
- Fatigue
- Fretting
- Creep & Thermal fatigue
- Stress Corrosion Cracking, Other modes
- Material properties, and selection
- Carbon & Alloy steels
- Nickel, Titanium, and Specialty alloys
- Aluminum, aluminum alloys
- Copper, copper alloys
- Plastic piping
- Alternative options-linings, cladding
- Limitations and safeguards

- Material selection - economics-life cycle costing

Unit 7: Failure Prevention By Design:

- Failure Causes - Design, Operation; Maintenance, Other Causes
- Material properties, and selection
- Physical properties and limitations of components
- Physical properties of steel and alloy piping and tubing
- Physical properties of fittings
- Basic Design
- Pressure Vessels
- Piping Systems
- Liquid Storage Tanks
- Operation and Maintenance of Process Equipment
- Damage Mechanisms Affecting Process Equipment

Unit 8: Process Equipment Failures:

- Failures in Pressure Vessels, Piping, and Boilers
- Strength reduction through material loss
- Case histories
- Piping System Vibration
- Mechanical & Flow-Induced Resonance
- Transient Hydraulic pulsation
- Pipe supports and restraints
- Wind Loading
- Industry Practices for Failure Prevention

Unit 9: Inspection, Assessment, and Maintenance:

- Inspection Strategies Plans and Procedures - Risk-Based Inspection API 580
- Developing an RBI Plan
- Fitness-For-Service Assessment API 579
- NDT Methods and Techniques
- Probability of Detection
- Damage Characterization
- Selecting the correct techniques
- Pigging of Pipelines
- Smart pigging
- Cleaning
- Operational procedures
- Operation and Maintenance
- Maintenance Programs
- Repair and Alteration of Pressure Equipment and Piping
- Rating Piping and Pressure Vessels
- Estimation of the Consequences of Pressure Vessels and Piping Failures
- Failure Analysis Techniques