MERCURY

Process Equipment Reliability & Failure Prevention Course



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Process Equipment Reliability & Failure Prevention is a 2-week course on degradation management, reliability-centered maintenance, and structural fitness assessment for continuous production systems. It is designed for engineers and integrity specialists safeguarding pressure containment boundaries, rotating machinery, and fluid networks. You will complete and take back the Equipment Reliability and Failure Prevention Dossier. Mercury Training Center delivers this course on Process Equipment Reliability & Failure Prevention.

About This Course

Unplanned plant shutdowns and structural breaches often stem from unmanaged degradation mechanisms and inadequate surveillance strategies. To follow this course, you should already review operating envelopes and inspect static containment hardware or turbomachinery. You practice by screening degradation pathways, running vulnerability calculations, and prioritizing surveillance actions across simulated refining and power facilities.

Who It Is For

- Asset integrity personnel responsible for evaluating wall-thinning trends, environmental cracking, and remaining operating life
- Surveillance technicians responsible for scheduling non-destructive evaluations and validating pressure boundary conditions
- Condition monitoring specialists responsible for tracking rotating assembly vibrations and lubrication performance indicators
- Reliability practitioners responsible for developing preventive maintenance intervals and conducting defect elimination analyses
- Plant inspectors responsible for auditing containment vessels and high-energy conduit runs against industry benchmarks

This course is not for junior technicians seeking entry-level machinery assembly training, who are better served by an introductory mechanical crafts course, nor for civil infrastructure supervisors seeking municipal pipeline maintenance practices, who are better served by a utility network engineering course.

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Competencies You Will Build

- Degradation Mechanism Screening: you identify active metallographic deterioration modes to prevent unexpected containment loss
- Reliability-Centered Maintenance Structuring: you establish maintenance logic trees to optimize asset availability and minimize downtime
- Risk-Based Inspection Planning: you prioritize surveillance intervals to allocate inspection resources toward high-consequence containment locations
- Fitness-For-Service Assessment: you evaluate localized thinning and crack-like flaws to verify safe operating limits
- Root Cause Failure Investigation: you reconstruct structural failure events to prevent systemic recurrence across production trains
- Integrity Operating Envelope Governance: you establish operational boundary controls to safeguard pressure containment against rapid degradation

What You Will Be Able to Do

By the end of the course you will be able to:

- From plant process records and stream chemistry data, classify active degradation mechanisms using industry damage catalogs
- Given baseline ultrasonic thickness records and corrosion rates, calculate remaining life and determine inspection intervals following API 580 principles
- Using non-destructive flaw sizing data, execute Level 1 fitness-for-service assessments in accordance with API 579 procedures
- From failed component metallographic reports, isolate initiating failure modes using root cause failure analysis fault trees
- Given asset criticality rankings and failure mode data, develop maintenance task intervals using reliability-centered maintenance decision logic
- Using operating temperature and pressure excursion logs, establish integrity operating envelopes to prevent premature thermal and fatigue failures

Course Content

Day 1: Plant Integrity Foundations and Degradation Identification

- Integrity Operating Envelopes and Boundary Excursion Control
- Overview of API 571 Metallurgical Degradation Mechanisms
- Uniform Wall Thinning and Localized Pitting Identification
- Flow-Accelerated Corrosion and Erosion-Corrosion Screening Methods
- High-Temperature Hydrogen Attack and Creep Damage Indicators

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Day 2: Mechanical Degradation and Stress-Assisted Cracking

- Vibration-Induced Fatigue in High-Energy Conduit Systems
- Thermal Shock and Cyclic Stress Damage Quantification
- Stress Corrosion Cracking and Environmental Embrittlement Assessment
- Microbiologically Influenced Corrosion in Cooling Water Circuits
- Degradation Register Development for Fixed Containment Assets

Day 3: Reliability-Centered Maintenance Principles

- Reliability-Centered Maintenance Decision Logic Frameworks
- Failure Modes and Effects Criticality Analysis Worksheets
- Run-to-Failure Versus Predictive Intervention Boundary Criteria
- Mean Time Between Failures and Availability Calculations
- Developing Task Intervals for Critical Rotating Machinery

Day 4: Rotating Machinery Health and Condition Monitoring

- Vibration Spectrum Analysis and Bearing Fault Diagnosis
- Lube Oil Degradation Profiling and Wear Particle Analysis
- Shaft Alignment and Dynamic Balancing Quality Standards
- Centrifugal Pump and Compressor Seal Integrity Surveillance
- Condition-Based Maintenance Trigger Formulation for Turbomachinery

Day 5: Risk-Based Inspection Methodology

- API 580 Risk-Based Assessment Framework and Principles
- Probability of Failure Calculation for Containment Assets
- Consequence Modeling for Toxic and Flammable Fluid Releases
- Inspection Coverage Optimization and Non-Destructive Testing Selection
- Surveillance Frequency Calibration for High-Criticality Circuits

Day 6: Fitness-For-Service and Flaw Assessment

- API 579 Fitness-For-Service Level 1 Evaluation Protocol
- Assessment of General and Localized Metal Loss
- Pitting Damage Metrics and Maximum Allowable Working Limits
- Evaluation Criteria for Weld Misalignment and Shell Bulges
- Documentation of Structural Fitness Findings and Safe Derating

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Day 7: Advanced Non-Destructive Surveillance and Verification

- ASME BPVC Section V Non-Destructive Examination Guidelines
- Phased Array Ultrasonic and Time-of-Flight Diffraction Uses
- Guided Wave Screening for Insulated Conduit Circuits
- Digital Radiography for Real-Time Wall Loss Profiling
- Probability of Detection Calibration for Complex Welded Geometries

Day 8: Root Cause Failure Investigation

- Evidence Preservation Protocols for Fractured Plant Hardware
- Morphology of Brittle, Ductile, and Fatigue Fractures
- Fault Tree Construction and Five-Why Incident Tracing
- Human and Organizational Factor Analysis in Failure Events
- Corrective Action Tracking and Defect Elimination Metrics

Day 9: Overpressure Protection and Mitigation Strategies

- Pressure Relieving Device Reliability Under API 576
- Testing Frequencies and Set-Pressure Verification Procedures
- Mitigating Water Hammer and Rapid Hydraulic Transients
- Temporary Clamping and Composite Wrap Repair Standards
- Engineered Containment Re-rating and Integrity Audits

Day 10: Applied Reliability and Mitigation Practicum

- Exercise Conducting API 571 Damage Mechanism Identification on Refining Data
- Exercise Performing Level 1 Fitness-For-Service Assessment on Thinning Vessels
- Exercise Building Root Cause Failure Trees for Turbomachinery Outages
- Exercise Developing Risk-Based Surveillance Plans for Petrochemical Headers
- Completing and Presenting the Equipment Reliability and Failure Prevention Dossier

Case Studies and Exercises

The following are suggested activities used during the course.

- Case study: an unpredicted wall thinning event in a chemical fractionation overhead circuit; you evaluate ultrasonic scan records, identify sour water corrosion mechanisms, and establish updated surveillance frequencies.
- Case study: repeated shaft fatigue cracking in a power generation boiler feed pump; you examine fracture beach marks, reconstruct transient hydraulic loads, and reformulate preventive maintenance intervals.
- Exercise: a localized corrosion pocket on an amine regeneration column; you gather wall thickness measurements, perform an API 579 Level 1 assessment, and determine temporary operating pressures.
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Exercise: an offshore gas separation train requiring surveillance reprioritization; you apply API 580 risk ranking matrices, assign quantitative probabilities of failure, and draft an audit plan.

What You Take Back

You return with the Equipment Reliability and Failure Prevention Dossier to upgrade surveillance routines across your facility. In your first month back, you use it to identify active damage mechanisms, assess degraded hardware fitness, and prioritize maintenance interventions based on documented operating risks.

- Degradation mechanism screening matrix categorized by stream chemistry and temperature boundaries
- Reliability-centered maintenance task allocation worksheet and interval calculation templates
- API 579 Level 1 fitness-for-service calculation guide for localized thinning and pitting
- Root cause failure analysis investigation checklist and corrective action tracking register

Quick Answers FAQ

What should I know before Process Equipment Reliability & Failure Prevention training?

You should understand basic plant asset configurations, fluid mechanics concepts, and routine maintenance terms. Experience reading inspection logs or equipment drawings will help you execute the calculations and degradation assessments.

How does Process Equipment Reliability & Failure Prevention training differ from equipment design courses?

Design courses focus on initial sizing, structural calculations, and construction fabrication codes. This course focuses on in-service deterioration, damage mechanism identification, reliability-centered maintenance, risk-based inspection, and fitness-for-service evaluations.

Why do plants implement risk-based inspection and fitness-for-service protocols?

Plants implement risk-based inspection and fitness-for-service to safely extend operating run lengths, avoid catastrophic containment loss, and allocate maintenance budgets toward hardware posing the highest operational and environmental risks.

What work product do I take back from Process Equipment Reliability & Failure Prevention?

You return with the completed Equipment Reliability and Failure Prevention Dossier, providing actionable degradation screening protocols, fitness-for-service worksheets, and reliability-centered maintenance templates ready for plant deployment.

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For Your Manager

This 2-week training equips your team member to systematically screen in-service degradation mechanisms, perform Level 1 fitness assessments, and prioritize maintenance tasks using established reliability frameworks. The employee returns with the completed Equipment Reliability and Failure Prevention Dossier, which will be implemented immediately to review high-risk production circuits, update inspection intervals, and reduce unscheduled plant downtime.