

Course No. 1286

# Failure Analysis & Root Cause Investigation Training Course

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**CORROSION, INSPECTION & NDT**  
**INDUSTRIAL ENGINEERING, MAINTENANCE & OPERATIONS**

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DURATION

**5 Days**

DELIVERY

**Classroom**



## Course Overview

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The Failure Analysis & Root Cause Investigation Training Course provides a comprehensive and practical framework for identifying why equipment, processes, components, and systems fail and determining the underlying causes that allowed the failure to occur. The course goes beyond identifying the immediate symptom or visible defect and focuses on structured investigation, evidence-based analysis, causal reasoning, and the development of corrective actions that address the source of failure rather than only its consequences.

Effective failure analysis is essential for organizations seeking to improve reliability, asset integrity, operational performance, safety, quality, and maintenance effectiveness. Equipment failures may result from material degradation, design weaknesses, incorrect operating conditions, inadequate maintenance, manufacturing defects, human factors, process deficiencies, or combinations of several contributing causes. A structured investigation enables organizations to distinguish between direct causes, contributing factors, and systemic root causes.

The course covers the complete failure investigation process, beginning with failure identification, evidence preservation, data collection, and problem definition. Participants will examine failure modes, physical evidence, material condition, operating history, maintenance records, inspection findings, process information, and environmental conditions. They will learn how to apply analytical techniques such as fault tree analysis, cause-and-effect analysis, the Five Whys, Pareto analysis, failure mode analysis, barrier analysis, and structured root cause investigation methods.

A strong emphasis is placed on converting investigation findings into practical corrective and preventive actions. Participants will learn how to validate root causes, distinguish technical causes from organizational and process-related contributors, evaluate the effectiveness of proposed actions, and communicate findings through professional investigation reports. The program supports organizations in reducing recurring failures, improving reliability strategies, strengthening maintenance and engineering decisions, and establishing a culture of learning from equipment and process failures.

## Objectives

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- Analyze the fundamental principles of failure analysis and root cause investigation and explain their role in reliability, asset integrity, maintenance, and operational improvement during the course.
- Identify failure symptoms, failure modes, immediate causes, contributing factors, and root causes using structured investigation methods.
- Evaluate physical evidence, inspection results, operating data, maintenance records, design information, and historical records to establish a reliable failure investigation database.
- Apply systematic techniques to define failure problems accurately and distinguish facts from assumptions during an investigation.
- Analyze mechanical, electrical, material, operational, maintenance, design, and human-related contributors to equipment and process failures.
- Apply root cause analysis tools such as the Five Whys, fault tree analysis, cause-and-effect analysis, Pareto analysis, and barrier analysis to selected failure scenarios.
- Evaluate failure mechanisms including fatigue, fracture, corrosion, wear, overheating, vibration, overload, material degradation, contamination, and improper operating conditions.
- Develop evidence-based corrective and preventive actions that address verified root causes and contributing factors.
- Improve failure investigation reports by documenting evidence, analysis, causal relationships, conclusions, recommendations, and action ownership.
- Assess the effectiveness of corrective actions and determine whether identified root causes have been adequately controlled.
- Strengthen collaboration between engineering, maintenance, operations, quality, inspection, reliability, and management teams during failure investigations.
- Develop a complete failure analysis and root cause investigation for a selected industrial failure and present technically justified recommendations by the end of the course.

## Who Should Attend

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The Failure Analysis & Root Cause Investigation Training Course is designed for professionals involved in engineering, maintenance, reliability, inspection, quality, operations, asset integrity, manufacturing, and technical problem-solving. It is particularly suitable for reliability engineers, maintenance engineers, mechanical engineers, electrical engineers, materials engineers, corrosion engineers, inspection engineers, quality engineers, process engineers, manufacturing engineers,

and technical specialists responsible for investigating equipment or process failures.

The course is also relevant to maintenance managers, reliability managers, engineering managers, asset integrity managers, quality managers, operations managers, production managers, maintenance supervisors, inspection supervisors, technical authorities, and project engineers. It is valuable for professionals responsible for rotating equipment, static equipment, electrical systems, instrumentation, production systems, manufacturing equipment, pipelines, pressure equipment, and other critical industrial assets.

Managers, asset owners, executives, and technical decision makers will benefit from the course by developing a structured approach to understanding recurring failures, evaluating investigation findings, prioritizing corrective actions, and improving organizational reliability. The program is particularly suitable for multidisciplinary teams that need to establish a consistent methodology for investigating significant failures and converting lessons learned into sustainable improvements.

## Learning Outcomes

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- Explain the principles, objectives, and stages of professional failure analysis and root cause investigation.
- Define failure events accurately and establish clear investigation boundaries, objectives, and evidence requirements.
- Distinguish between failure symptoms, failure modes, direct causes, contributing factors, and root causes.
- Collect, preserve, organize, and evaluate physical, technical, operational, and historical evidence.
- Analyze equipment operating conditions, maintenance history, inspection records, design information, and previous failures.
- Identify technical failure mechanisms such as fatigue, fracture, corrosion, wear, overheating, vibration, overload, and material degradation.
- Apply structured root cause analysis tools to identify causal relationships and determine the underlying causes of failures.
- Construct cause-and-effect relationships and fault trees for complex equipment and process failures.
- Evaluate human, procedural, organizational, maintenance, design, and operational contributors without relying on unsupported assumptions.

- Develop corrective and preventive actions that directly address verified root causes and contributing factors.
- Prepare professional failure investigation reports containing evidence, analysis, root causes, conclusions, and recommendations.
- Evaluate corrective action effectiveness and develop a practical follow-up process to prevent recurrence.

## Course Outline

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### DAY 01

## Fundamentals of Failure Analysis and Investigation

- Introduction to failure analysis and root cause investigation.
- The role of failure investigation in reliability and asset integrity management.
- Defining failures, incidents, defects, degradation, and performance deviations.
- Failure symptoms, failure modes, failure mechanisms, and root causes.
- Establishing investigation objectives, scope, boundaries, and responsibilities.
- Preserving physical evidence and controlling the investigation scene.
- Collection of equipment, material, process, operational, and maintenance evidence.
- Review of design specifications, drawings, operating records, inspection data, and maintenance history.
- Establishing a factual timeline of events before, during, and after failure.
- Distinguishing facts, observations, assumptions, and hypotheses.

#### PRACTICAL APPLICATION

Develop an investigation plan and evidence collection framework for a selected industrial equipment failure.

### DAY 02

## Failure Mechanisms and Technical Failure Analysis

- Principles of mechanical and material failure.
- Fatigue failure and cyclic loading.

## DAY 02 — CONTINUED

- Brittle and ductile fracture mechanisms.
- Corrosion-related failures and material degradation.
- Wear, erosion, abrasion, and surface deterioration.
- Overheating, thermal damage, and temperature-related failures.
- Vibration, resonance, misalignment, imbalance, and mechanical loading.
- Overload and abnormal operating conditions.
- Material defects, manufacturing deficiencies, fabrication problems, and welding-related failures.
- Electrical, instrumentation, control, and process-related failure mechanisms.
- Relationship between failure mechanism, material condition, operating environment, and equipment design.

**PRACTICAL APPLICATION**

Analyze representative failure cases and identify the most probable physical failure mechanisms based on available evidence.

## DAY 03

## Root Cause Analysis and Investigation Techniques

- Principles of root cause analysis and causal reasoning.
- Difference between immediate causes, contributing causes, and root causes.
- The Five Whys technique and its appropriate application.
- Cause-and-effect diagrams and causal factor analysis.
- Fault tree analysis for complex failure events.
- Pareto analysis for recurring failure patterns.
- Barrier analysis and identification of failed or missing controls.
- Failure Mode and Effects Analysis principles and relationship to failure investigations.
- Human factors, procedural weaknesses, management systems, and organizational contributors.
- Identifying recurring patterns and systemic causes.
- Avoiding common investigation errors, including premature conclusions and unsupported assumptions.

## DAY 03 — CONTINUED

**PRACTICAL APPLICATION**

Conduct a structured root cause investigation using multiple analytical techniques and develop a verified causal chain.

**DAY 04**

## Corrective Actions, Reliability Improvement, and Failure Prevention

- Translating root causes into effective corrective actions.
- Difference between corrective, preventive, and containment actions.
- Prioritizing corrective actions according to risk, recurrence potential, and operational impact.
- Engineering modifications and equipment design improvements.
- Maintenance strategy improvements and preventive maintenance optimization.
- Inspection, monitoring, and condition-based maintenance improvements.
- Operating procedure and process control improvements.
- Training, competency, communication, and human performance considerations.
- Management system and organizational improvements.
- Establishing action ownership, deadlines, verification methods, and performance indicators.
- Evaluating corrective action effectiveness and recurrence prevention.

**PRACTICAL APPLICATION**

Develop a corrective and preventive action plan for a recurring industrial failure and establish methods for verifying its effectiveness.

**DAY 05**

## Failure Investigation Reporting, Decision-Making, and Implementation

- Structure and content of professional failure investigation reports.
- Presenting evidence, analysis, causal relationships, and technical conclusions.
- Documenting root causes and contributing factors clearly and objectively.

## DAY 05 — CONTINUED

- Communicating complex technical findings to management and non-technical stakeholders.
- Integrating failure investigation with reliability, maintenance, quality, inspection, and asset integrity programs.
- Developing organizational lessons learned from significant failures.
- Establishing failure databases and historical knowledge for recurring problem analysis.
- Using failure trends to improve maintenance and reliability strategies.
- Monitoring implementation of corrective actions and measuring effectiveness.
- Developing a sustainable root cause investigation process within the organization.
- Management review and decision-making based on failure investigation findings.

**FINAL WORKSHOP**

Conduct a complete Failure Analysis & Root Cause Investigation for a selected industrial failure, including problem definition, evidence collection, failure mechanism analysis, causal analysis, root cause identification, corrective and preventive actions, effectiveness verification, lessons learned, and preparation of a professional final investigation report.

## Register or Request More Information

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Course page: <https://quest-training.com/courses/failure-analysis-root-cause-investigation-training-course>

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