Tel No:+97126654546 | Fax No:+97126654182 | Email: training@cmc-me.com | www.cmc-me.com

# ME242:
# Root Cause Analysis for Maintenance Hardware Failure

## Training Description:

This intensive training course provides maintenance engineers, reliability professionals, technicians and technical supervisors with the knowledge and practical skills required to **identify, investigate and eliminate the root causes of hardware failures** in **industrial equipment** and **critical assets**. The training course focuses on structured Root Cause Analysis (RCA) methodologies, failure investigation techniques, reliability engineering principles and corrective action planning.

Participants will learn how to systematically collect and analyze failure evidence, distinguish symptoms from root causes, apply internationally recognized RCA tools and implement sustainable corrective and preventive actions. Through practical case studies, workshops and real-world maintenance scenarios, participants will develop the competence to improve equipment reliability, reduce maintenance costs, minimize downtime and enhance operational safety.

The training course integrates maintenance best practices with reliability-centered maintenance (RCM), Failure Mode and Effects Analysis (FMEA), Failure Modes, Effects and Criticality Analysis (FMECA) fault tree analysis and statistical failure analysis to support effective maintenance decision-making.

## Training Objectives:

**By the end of the training, participants will be able to:**

- ✓ Understand the principles of Root Cause Analysis (RCA) in maintenance environments
- ✓ Differentiate between symptoms, contributing factors, immediate causes and root causes
- ✓ Apply structured RCA methodologies for hardware failure investigations
- ✓ Collect, preserve and evaluate physical failure evidence
- ✓ Analyze mechanical, electrical, hydraulic, pneumatic and instrumentation failures
- ✓ Utilize RCA tools including 5 Whys, Fishbone Diagram, Fault Tree Analysis (FTA) and Cause Mapping
- ✓ Conduct Failure Mode and Effects Analysis (FMEA/FMECA)
- ✓ Interpret maintenance data and equipment history for failure trends
- ✓ Develop effective corrective and preventive maintenance strategies
- ✓ Improve equipment reliability, availability, maintainability and safety
- ✓ Reduce recurring failures and maintenance costs
- ✓ Prepare professional RCA investigation reports and recommendations

## Training Designed for:

This training course is intended for Maintenance Engineers, Mechanical Engineers, Electrical Engineers, Reliability Engineers, Asset Integrity Engineers, Maintenance Supervisors, Plant Engineers, Operations Engineers, Instrumentation Engineers, Maintenance Planners, Field Service Engineers, Maintenance Technicians, Quality Engineers, Production Supervisors, Reliability Specialists, Asset Management Professionals, Engineering Managers and Technical Support Personnel.

## Training Requirement:

"Hand's on practical sessions, equipment and software will be applied during the course if required and as per the client's request."

Contents can be adapted to your specific wishes. It is therefore possible to focus on specific modules of the training course as per client's learning needs and objectives. Further, it should be forwarded to us a month prior to the course dates.

## Training Program:

***DAY ONE:***

FUNDAMENTALS OF ROOT CAUSE ANALYSIS AND HARDWARE FAILURE

- Module 1: Introduction to Hardware Failure Analysis
  - Importance of failure investigations
  - Cost of recurring equipment failures
  - Reliability versus maintenance
  - Failure lifecycle
  - Types of industrial hardware failures
- Module 2: Principles of Root Cause Analysis
  - Definition of RCA
  - Objectives of RCA
  - Problem-solving methodologies
  - RCA investigation process
  - Identifying failure symptoms
- Module 3: Failure Mechanisms
  - Mechanical failures
  - Electrical failures
  - Thermal failures
  - Corrosion mechanisms
  - Fatigue failures
  - Wear mechanisms
  - Lubrication-related failures
- Module 4: Data Collection
  - Failure history review
  - Maintenance records
  - Inspection reports
  - Operator interviews
  - Equipment operating conditions
  - Failure evidence preservation
- Practical Workshop:
  - Identifying failure symptoms versus root causes
  - Equipment failure case study
  - RCA investigation planning

***DAY TWO:***

FAILURE INVESTIGATION TECHNIQUES AND RCA TOOLS

- Module 1: Failure Investigation Process
  - Incident response
  - Evidence collection
  - Visual inspection

- Sampling techniques
- Documentation methods

❖ Module 2: Root Cause Analysis Tools
❖ 5 Whys Technique
- Step-by-step application
- Practical examples

❖ Fishbone (Ishikawa) Diagram
- Categories of causes
- Building cause-and-effect diagrams

❖ Cause Mapping
- Developing logical failure maps
- Multi-cause investigations

❖ Pareto Analysis
- Prioritizing recurring failures
- Failure trend analysis

❖ Module 3: Fault Tree Analysis (FTA)
- Logic gates
- Event relationships
- Probability concepts
- Fault tree construction

❖ Module 4: Evidence Analysis
- Physical evidence interpretation
- Operating conditions
- Human factors
- Process factors
- Environmental factors

❖ Practical Exercises:
- Building Fishbone Diagrams
- Conducting 5 Whys investigations
- Developing Fault Trees

*DAY THREE:*

RELIABILITY ENGINEERING AND FAILURE MODES ANALYSIS

❖ Module 1: Reliability Fundamentals
- Reliability concepts
- Failure distributions
- MTBF
- MTTR
- Availability calculations

❖ Module 2: Failure Modes and Effects Analysis (FMEA)
- FMEA methodology
- Failure mode identification
- Risk Priority Number (RPN)
- Severity assessment
- Occurrence assessment
- Detection assessment

- Module 3: Failure Modes, Effects and Criticality Analysis (FMECA)
  - Critical equipment identification
  - Criticality ranking
  - Risk mitigation
- Module 4: Maintenance Strategy Selection
  - Preventive maintenance
  - Predictive maintenance
  - Condition-based maintenance
  - Reliability-centered maintenance (RCM)
- Practical Exercises:
  - Developing an FMEA worksheet
  - Equipment criticality analysis
  - Maintenance strategy optimization

***DAY FOUR:***

ADVANCED FAILURE ANALYSIS OF INDUSTRIAL HARDWARE

- Module 1: Mechanical Failure Analysis
  - Bearing failures
  - Gear failures
  - Shaft failures
  - Coupling failures
  - Pump failures
  - Compressor failures
  - Valve failures
- Module 2: Electrical Hardware Failures
  - Motor failures
  - Generator failures
  - Transformer failures
  - Switchgear failures
  - Cable failures
  - Protection system failures
- Module 3: Instrumentation and Control Failures
  - Sensor failures
  - PLC hardware failures
  - Control system components
  - Signal transmission failures
- Module 4: Material Failure Analysis
  - Fracture analysis
  - Metallurgical failures
  - Corrosion assessment
  - Fatigue crack analysis
  - Surface wear analysis
- Practical Exercises:
  - Analysis of real industrial failure cases
  - Failure pattern recognition
  - Group investigation exercise

*DAY FIVE:*

CORRECTIVE ACTIONS, PREVENTION, AND CONTINUOUS IMPROVEMENT

- Module 1: Developing Corrective Actions
  - Corrective versus preventive actions
  - Elimination of root causes
  - Action prioritization
  - Cost-benefit analysis
- Module 2: Verification of Effectiveness
  - Performance monitoring
  - Failure recurrence tracking
  - KPI measurement
  - Continuous improvement
- Module 3: RCA Documentation
  - Writing professional investigation reports
  - Executive summaries
  - Technical findings
  - Supporting evidence
  - Recommendations
- Module 4: Building a Reliability Culture
  - Organizational learning
  - Knowledge management
  - Lessons learned
  - Continuous reliability improvement
  - Maintenance excellence programs
- Final Practical Exercises:
  - Comprehensive industrial hardware failure investigation
  - Team RCA presentation
  - Development of corrective action plans
  - Instructor feedback and discussion
- Course Conclusion
- POST-ASSESSMENT and EVALUATION

## Training Methodology:

The course combines a variety of interactive learning approaches to maximize knowledge transfer and practical application, including:

- Expert-led lectures
- Interactive group discussions
- Industrial case studies
- Root Cause Analysis workshops
- Hands-on FMEA and FTA exercises
- Equipment failure investigations
- Team-based problem-solving activities
- Maintenance data analysis
- Reliability assessment exercises
- Group presentations and peer review

This interactive training course includes the following training methodologies as a percentage of the total tuition hours:

- 30% Lectures, Concepts, Role Play

- 70% Workshops & Work Presentations, Techniques, Based on Case Studies & Practical Exercises, Gamification, Software & General Discussions
- Pre and Post Test

## Training Certificate(s):

CMCT Internationally recognized certificate(s) will be issued to each participant who completed the course.

## Training Fees:

USD$ TBA - This rate includes participant's manual, hand-outs, buffet lunch, coffee/tea on arrival, morning & afternoon of each day.

*Note: The 5% VAT (Value Added Tax), will be effective starting 01st of January 2018 as per the new regulation from the UAE Government. The VAT applies for all quotation both for local and abroad.*

## Training Timings:

Daily Timings:

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|---|---|
| 07:45 - 08:00 | Morning Coffee / Tea |
| 08:00 - 10:00 | First Session |
| 10:00 - 10:20 | Recess (Coffee/Tea/Snacks) |
| 10:20 - 12:20 | Second Session |
| 12:20 - 13:00 | Recess (Prayer Break & Lunch) |
| 13:00 - 14:00 | Last Session |

For training registrations or in-house enquiries, please contact:
Aisha Relativo - Training & Career Development Manager
aisha@cmc-me.com / training@cmc-me.com
Tel.: +971 2 665 3945 or +971 2 643 6653 | Mob.: +971 52 2954615