

COURSE OVERVIEW RE0164

Advanced Root Causes Analysis and Techniques
Creative Problem-Solving & Failure Analysis Methodologies
(E-Learning Module)

Course Title

Advanced Root Causes Analysis and Techniques, Creative Problem-Solving & Failure Analysis Methodologies (E-Learning Module)

Course Reference

RE0164

Course Format & Compatibility

SCORM 1.2. Compatible with IE11, MS-Edge, Google Chrome, Windows, Linux, Unix, Android, IOS, iPadOS, macOS, iPhone, iPad & HarmonyOS (Huawei)

Course Duration

30 online contact hours
 (3.0 CEUs/30 PDHs)

Course Description



This course is designed to provide participants with a detailed and up-to-date overview of advanced root causes analysis and techniques, creative problem-solving and failure analysis methodologies. It covers the maintenance costs, maintenance development over time and classification of maintenance policies; the maintenance strategies; the factors which influence maintenance strategy; the root cause failure analysis, FMEA/FMECA, reliability centered maintenance and total productive maintenance; the maintenance methods and risk management; and the nature of failures and equipment failure patterns.

Further, the course will also discuss the types of failure mode and the characteristics of sporadic failures and chronic failures; the equipment failure patterns, the 6 failure patterns and the causes and main modes of failures; the failure process, FMEA, FMECA and failure consequence categories; the root cause analysis, corrective/preventive actions and the three levels of cause; the seven steps to identify the important causes using pareto analysis; the rolling element bearing failure analysis; the mechanical seals and its typical failure modes; the principles of lubrication; the abrasive wear, fatigue wear, lubricant film and plain bearing lubrication; and the hydrodynamic, hydrostatic and hybrid lubrication.



During this course, participants will learn the lubrication storage and handling; the total quality management, process quality management and measuring the results; the characteristics and requirements of performance indicator; the performance parameter hierarchy, performance measures and benchmarking; the role of the maintenance organization; the 12 steps of PPM implementation; the Six Sigma methodology and business process management system; and the Kepner-Tregoe as a systematic problem solving and decision-making method.

Course Objectives

The course should serve the following overall learning objectives:-

- Apply and gain a comprehensive knowledge on advanced root causes analysis and techniques, creative problem-solving and failure analysis methodologies
- Ability to demonstrate an in-depth understanding plant/equipment specification, functioning and related procedures to advice on selection of cost-effective procedures and to clarify queries and resolve issues
- Ability to suggest appropriate corrective actions and to supervises the implementation of corrective action as per procedures to ensure optimal equipment operation
- Able to increase their ability to generate innovation
- Exhibits an expert understanding of plan/equipment specification to support operation in assessing and implementing new technologies for improved quality and cost effectiveness in line with company's objectives
- Able to apply knowledge of engineering best practices/bench mark data in reviewing current practices and to recommend changes to enhance plant/equipment effectiveness and efficiencies
- Define maintenance and discuss its objective, facts and figures
- Identify the maintenance costs covering direct costs, stand-by costs, lost production costs and degradation cost
- Explain maintenance development over time and classification of maintenance policies covering failure-based, time-based, condition-based and reliability-based
- Compare maintenance strategies including proactive versus preventive/predictive
- Recognize the factors which influence maintenance strategy
- Discuss the terms and definitions of maintenance and apply root cause failure analysis, FMEA/FMECA, reliability centered maintenance and total productive maintenance
- Employ maintenance methods and risk management and describe the evolution of maintenance methods
- Identify the nature of failures and equipment failure patterns as well as machinery failure and non-repairable versus repairable equipment
- Recognize the types of failure mode and the characteristics of sporadic failures and chronic failures

- Describe the equipment failure patterns including age versus reliability patterns
- List the 6 failure patterns and identify the causes and main modes of failures
- Discuss the failure process, FMEA, FMECA and failure consequence categories
- Apply root cause analysis and identify its various types
- Carryout RCA techniques define the problem visually
- Implement corrective/preventive actions and discuss the process factors
- Carryout root cause failure analysis and identify the three levels of cause covering physical, human and latent causes
- Discuss the general principles of RCFA and the effective use of the analysis
- List the steps for root cause failure analysis and the seven steps to identify the important causes using pareto analysis
- Apply materials, repair, operations store management and discuss the manager's view of MRO storerooms
- Employ lubrication storage and handling and review the organization chart of MRO's
- Determine storekeeper attributes, procurement, cutting inventory costs, lead time and economic order quantity (EOQ)
- Implement physical storage, housekeeping, receiving, inspection and shipping and servicing of stored items
- Identify racks and bins, satellite storage, free-issue stores and vendor-managed storage
- Apply rolling element bearing failure analysis and discuss ball and roller bearing
- Identify the various types of ball and roller bearing as well as explain bearing failure modes and their causes
- Classify seal and discuss mechanical seals including its typical failure modes
- Determine the cause of mechanical seal distress and troubleshoot mechanical seals in a professional manner
- Discuss the principles of lubrication and the importance of lubricating
- List the basic lubricant requirements and the types of friction and wear
- Describe abrasive wear, fatigue wear, lubricant film and plain bearing lubrication
- Recognize the hydrodynamic, hydrostatic and hybrid lubrication covering its methods of supply, advantage, disadvantages, components and applications
- Employ lubrication storage and handling as well as identify the advantages of synthetic oils and the properties of mineral & synthetic oils and lube oils
- Recognize the effect of temperature on viscosity and the roadmap to a world class PPM
- Write the task list, maintenance schedule or work instruction

- Apply total quality management, process quality management and measuring the results
- Identify the characteristics and requirements of performance indicator
- Discuss performance parameter hierarchy, performance measures and benchmarking
- Review maintenance effectiveness metrics, pump MTBF targets, measuring of results and overall equipment effectiveness (OEE)
- Recognize the role of the maintenance organization and the 12 steps of PPM implementation
- Define Six Sigma and identify the sigma levels and the companies using Six Sigma
- Explain Six Sigma methodology and business process management system
- Define DMAIC and DMADV as well as discuss the benefits and usage of Six Sigma
- Implement Six Sigma management and identify the key roles of Six Sigma, tools and techniques
- Use Kepner-Tregoe as a systematic problem solving and decision-making method
- Identify the Kepner-Tregoe tool and apply situation appraisal, plan the next steps and perform decision analysis

Who Should Attend

This course covers systematic techniques and methodologies in advanced root causes analysis and techniques, creative problem-solving and failure analysis methodologies for those who work with mechanical and rotating equipment at industrial plants, utilities, production oil/gas field or manufacturing facilities. General maintenance personnel, engineers and other technical staff from a wide variety of industries, skill-levels, company sizes and job titles will also find this course extremely useful.

Training Methodology

This Trainee-centered course includes the following training methodologies:-

- Talking presentation Slides (ppt with audio)
- Simulation & Animation
- Exercises
- Videos
- Case Studies
- Gamification (learning through games)
- Quizzes, Pre-test & Post-test

Every section/module of the course ends up with a Quiz which must be passed by the trainee in order to move to the next section/module. A Post-test at the end of the course must be passed in order to get the online accredited certificate.

Course Fee

As per proposal




Course Certificate(s)

Internationally recognized certificates will be issued to all participants of the course.

Certificate Accreditations


Certificates are accredited by the following international accreditation organizations: -

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USA International Association for Continuing Education and Training (IACET)

Haward Technology is an Authorized Training Provider by the International Association for Continuing Education and Training (IACET), 2201 Cooperative Way, Suite 600, Herndon, VA 20171, USA. In obtaining this authority, Haward Technology has demonstrated that it complies with the **ANSI/IACET 1-2013 Standard** which is widely recognized as the standard of good practice internationally. As a result of our Authorized Provider membership status, Haward Technology is authorized to offer IACET CEUs for its programs that qualify under the **ANSI/IACET 1-2013 Standard**.

Haward Technology's courses meet the professional certification and continuing education requirements for participants seeking **Continuing Education Units (CEUs)** in accordance with the rules & regulations of the International Association for Continuing Education & Training (IACET). IACET is an international authority that evaluates programs according to strict, research-based criteria and guidelines. The CEU is an internationally accepted uniform unit of measurement in qualified courses of continuing education.

Haward Technology Middle East will award **3.0 CEUs** (Continuing Education Units) or **30 PDHs** (Professional Development Hours) for participants who completed the total tuition hours of this program. One CEU is equivalent to ten Professional Development Hours (PDHs) or ten contact hours of the participation in and completion of Haward Technology programs. A permanent record of a participant's involvement and awarding of CEU will be maintained by Haward Technology. Haward Technology will provide a copy of the participant's CEU and PDH Transcript of Records upon request.

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British Accreditation Council (BAC)

Haward Technology is accredited by the **British Accreditation Council for Independent Further and Higher Education** as an **International Centre**. BAC is the British accrediting body responsible for setting standards within independent further and higher education sector in the UK and overseas. As a BAC-accredited international centre, Haward Technology meets all of the international higher education criteria and standards set by BAC.

Course Contents

- Understanding Maintenance
- What Is Maintenance?
- The Objective of Maintenance?
- Understanding Maintenance Cost
- Facts & Figures
- Direct Costs
- Stand-by Costs
- Lost Production Costs
- Degradation Cost
- Cost of Downtime
- Maintenance Development Over Time
- Growing Maintenance Expectations
- Maintenance Policies
- Classification of Maintenance Policies
- Run to Failure (Breakdown) Maintenance
- Run to Failure Maintenance - Disadvantages
- Preventive Maintenance
- Preventive Maintenance – Advantages
- Preventive Maintenance - Disadvantages
- Predictive Maintenance
- Comparison of Maintenance Strategies
- Proactive Maintenance
- Proactive versus Preventive/Predictive
- Which Maintenance is the Most Effective?
- Factors Which Influence Maintenance Strategy
- Maintenance Terms & Definitions
- MTBF (Mean Time Between Failure)
- MTTR (Mean Time to Repair)
- Reliability
- Availability
- Maintainability

- Root Cause Failure Analysis
- FMEA/FMECA
- Reliability Centered Maintenance
- Total Productive Maintenance
- Maintenance Methods & Risk Management
- Risk in Maintenance
- Risk Quantification
- Dealing with Risk
- The Evolution of Maintenance Methods
- Nature of Failures & Equipment Failure Patterns
- What is “Machinery Failure”?
- Non-Repairable versus Repairable Equipment
- The Nature of Failure
- Failure Terminology
- What is “Failure Mode”?
- Types of Failure Mode
- How Failures Appear?
- Sporadic Failures
- Chronic Failures
- So What?
- The Failure Characteristics
- Equipment Failure Patterns
- Age Versus Reliability Patterns
- 6 Failure Patterns
- Equipment Failure Countermeasures
- Causes of Failures
- Design Failure
- Material Selection Deficiencies
- Manufacturing Defects
- Assembly & Installation Errors
- Excessive Demands
- Human Errors
- The Failure Mechanisms

- Main Modes of Failure
- Ductile Failure
- Brittle Failure
- Metal Fatigue
- Metal Fatigue - Case Study
- Metal Creep
- Metal Creep - Case Study
- Wear
- Adhesive Wear
- Abrasive Wear
- Erosive Wear
- Corrosion
- Corrosion - Case Study
- Corrosion Fatigue
- The Failure Process
- FMEA (Failure Modes & Effects Analysis)
- Preventing Failure
- FMECA & RCM
- Failure Modes, Effects & Criticality Analysis (FMECA)
- Failure Consequence Categories
- Introduction to Root Cause Analysis
- What is Root Cause Analysis?
- RCA versus RCFA
- Why Perform Failure Analysis?
- We Perform Root Cause Analysis to Prevent Turnbacks & Customer Escapes from Recurring
- Types of RCA
- Some Other Definitions
- RCA Techniques
- What is the Problem
- Visual Definition of Problem
- Where do “Gaps” Arise?
- Types of Problems
- “Just do it” Issues

- “Dig Deeper” Issues
- Problem Statement
- Concern
- Requirement
- Evidence
- Impact
- How to Solve a Problem?
- What are Corrective/Preventive Action?
- Implement Corrective/Preventive Actions
- Use Data to Determine
- What is Root Cause?
- The Root Cause
- Components of Process
- What are the Process Factors?
- Root Cause Failure Analysis (RCFA)
- The Philosophy
- Primary Causes of Engineering Disasters
- Symptom Approach versus Root Cause
- The Three Levels of Cause
- General Principles Of RCFA
- Effective Use of the Analysis
- Personnel Requirements
- When to be Used
- Do Not Attempt to Fix Blame
- Top Reasons Why We Need RCFA
- Steps for Root Cause Failure Analysis
- Appoint the RCFA Team
- Clearly Define the Problem
- Collection of Data
- Event Investigation – Brainstorming
- The Four Basic Rules in Brainstorming
- Event Investigation – The 5 Whys
- Event Investigation – Pareto Analysis



- Diagram Analyze
- Event Investigation – Cause & Effect (Fishbone) Diagram
- Creating Fishbone Diagrams
- Most Appropriate Categories
- Event Investigation – Fault Tree Analysis
- Event Investigation – Failure Mode & Effect Analysis (FMEA)
- Generate Recommendations to Decision Making
- Tracking for Results
- Works Execution Management
- Organization Structures
- Vocabulary
- The Practical Result of Planning
- Functions of Maintenance Manager
- What Maintenance Managers do?
- Reaching Organizational Goals by Managing Resources
- Management & Supervisor Functions
- Planning Activities
- Management & Supervisor Functions
- Organizing Activities
- Leading Activities
- Controlling Activities
- What Resources are Available and should be Managed by the Supervisor?
- Financial
- Human/People
- Physical
- Information
- Resources
- Management Roles
- Management Skills
- Managerial Activities Study
- Allocation of Activities by Time
- Coping with “Temporariness”
- Declining Employee Loyalty



- Managers Dilemma
- Message
- Human Resources
- Modern Maintenance Management
- Roles & Responsibilities of Maintenance Planner
- Maintenance Planners Attributes
- Maintenance Planner does Not
- Scheduling
- Scheduling Team (Planner/Maintenance/Production)
- Reliability Engineer
- The Importance of Teams
- What is a Team?
- Good Teams
- Global Virtual Teams
- Meeting
- Tips for Effective Group Meeting
- Maintenance Implementation Strategies
- Implementation Strategies
- Incorrect Strategies
- The Implications of Management Style
- Communication
- Modern Maintenance Management
- The Three Requirements for Fundamental Improvement
- Increase Motivation
- Increase Competency
- Improve the Work Environment
- The Maintenance Organization
- Organizational Design (OD)
- Vocabulary
- Materials, Repair, Operations Store Management
- Course Perspective & Approach
- Manager's View of MRO Storerooms
- Typical Look of MRO Stores

- Typical Look of MRO Storeroom
- MRO to be
- RMO to be
- Lubrication Storage & Handling – Best Practice
- Indoor Storage
- How Do We Go from Pictures A to B
- Organization Chart of MRO's
- Organization Chart of MRO Storeroom
- Storekeeper Attributes
- Procurement
- Cutting Inventory Costs
- Ways to Reduce Inventory Waste/Costs
- Supplier Partnering
- Co-Operation Between Plants
- Apply World Class Manufacturing (WCM) Principles
- Stock Control
- Stock Depreciation
- Stock Availability & Ease of Retrieval
- Work Planning
- New Plant, Modifications & Redundant Plant Procedures
- Supplier Partnering Programme (SPP)
- The SPP “Win-Win” Alliance
- Definitions
- Lead Time
- Economic Order Quantity (EOQ)
- Open or Closed Storeroom?
- Physical Storage
- Environment
- Housekeeping
- Receiving, Inspection & Shipping
- Servicing of Stored Items
- Racks & Bins
- Satellite Storage

- Free-Issue Stores
- Vendor-Managed Storage
- Rolling Element Bearing Failure Analysis
- Ball & Roller Bearing
- What is a Bearing?
- Why are they Used?
- Types of Ball Bearing
- Double Deep Groove
- Thrust Bearings
- Needle Bearings
- Types of Roller Bearing
- Spherical Roller Bearings
- Tapered Roller Bearing
- Thrust Roller Bearings
- Failure Modes
- Frequent Causes
- Infrequent Causes
- Three General Causes for Premature Failures
- Eight Specific Causes
- Excessive Load
- Normal Fatigue Failure
- Contamination
- Corrosion
- Misalignment
- Tight Fits
- Bearing Failure Modes & their Causes
- Seals
- Seal Classification
- Mechanical Seals
- All Mechanical Seals Leak
- Balanced versus Non-Balanced
- Typical Failure Modes for Mechanical Seals
- Determining the Cause of Mechanical Seal Distress

- Cause Categories
- Examination Strategy
- Troubleshooting Mechanical Seals
- Look at the Faces
- Check Springs or Bellows
- Final Note
- Failure Modes - Mechanical Seals
- Seal Classification
- O-Rings
- Failure Modes
- Method of Operation
- Applications
- Advantages
- Lubrication
- Failure Modes – Extrusion
- Failure Analysis
- Prevention/Correction
- Failure Modes – Compression Set
- Failure Modes – Explosive Decompression
- Failure Modes – Heat Hardening & Oxidation
- Failure Modes – Installation Damage
- Machinery Lubrication
- Principles of Lubrication
- The Importance of Lubricating: Why Do We Lubricate?
- Basic Lubricant Requirements
- Types of Friction
- Types of Wear
- Abrasive Wear
- Fatigue Wear
- Lubricant Film
- Plain Bearing Lubrication
- Hydrodynamic Lubrication
- Methods of Supply

- Advantages
- Disadvantages
- Applications
- Hydrostatic Lubrication
- Methods of Supply
- Components of Hydrostatic System
- Advantages of Hydrostatic Lubrication
- Methods of Supply
- Disadvantages of Hydrostatic Lubrication
- Applications of Hydrostatic Lubrication
- Hybrid Lubrication
- Components of a Hybrid System
- Advantages
- Disadvantages
- Applications
- Lubricant Storage
- Lubrication Storage & Handling
- Indoor Storage
- Advantages of Synthetic Oils
- Properties of Mineral & Synthetic Oils
- Properties of Lube Oils
- Viscosity
- Effect of Temperature on Viscosity
- Thermal Stability
- Oxidation Stability
- Pour Point
- Demulsibility
- Flash Point
- Fire Point
- What Is Grease?
- Lubricating Greases versus Oils
- Putting it All Together - Roadmap to a World Class PPM Programme
- Tasks & Procedures

- Check Sheets
- Total Quality Management
- Process Quality Management
- Measuring the Results
- Benchmarking
- Key Performance Indicators (KPI's)
- Performance Indicators
- Characteristics & Requirements
- Performance Parameter Hierarchy
- Performance Measures
- Benchmarking
- Typically Solomon Indicators
- Refining Business Results Indicators Solomon – Maintenance
- Refining Business Results Indicators Solomon – Reliability
- Maintenance Effectiveness Metrics
- Pump MTBF Targets
- Discussion
- Measuring of Results
- Key Success Factors - The Eight Major Losses
- Downtime
- Speed Losses
- Defects
- Overall Equipment Effectiveness (OEE)
- Role of the Maintenance Organization
- Guidelines for Good Maintenance Leadership
- Bad Actors
- PPM Implementation: 12 Steps
- Six Sigma
- What is Sigma ?
- What is Six Sigma?
- Sigma Levels
- Companies Using Six Sigma
- Six Sigma Methodology



- Business Process Management System
- What is DMAIC?
- Phases
- What is DMADV?
- When Should Six Sigma be Used
- Benefits of Six Sigma
- Usage of Six Sigma
- Six Sigma Management
- Key Roles for Six Sigma
- Tools & Techniques
- Trainings & Certifications
- Conclusion
- Kepner-Tregoe
- Think of a Problem
- The Kepner-Tregoe Tool
- Situation Appraisal
- Planning the Next Steps
- Decision Analysis
- Planning the Next Steps
- Potential Problem (Opportunity) Analysis
- Problem Analysis Describe the Problem
- Problem Analysis – What
- Problem Analysis – Where
- Problem Analysis – When
- Problem Analysis Identify Possible Causes
- Problem Analysis Evaluate Possible Causes
- Problem Analysis Confirm True Cause
- Let's Look at Some Problems!

