# COURSE OVERVIEW PE0007

# Plant & Equipment Integrity - Fundamental (E-Learning Module)

## Course Title

Plant & Equipment Integrity – Fundamental (E-Learning Module)

## Course Reference

PE0007

## 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 E-Learning course is designed to provide participants with a detailed and up-to-date overview of the fundamental of plant and equipment integrity. It covers the technical integrity, some performance-based standards and regulations and the elements of integrated process safety management; the industrial failures & prevention, industry statistics and the oil and gas exploration and production; the event escalation, near misses, failures in rotating equipment and typical failures for major turbocompressors in process plants; the failure prevention; and the categories of functional failures, failure consequences and failure effect analysis logic.

Further, the course will also discuss the resistance of failure, enhancing knowledge of failures and the 6 failure patterns; the causation model, design codes, standards, specifications and best practices; the United States agencies and legislation, industry standards and frequently used codes; the engineering materials, the nature of material failures, failure mechanisms and fracture mechanics; the stress corrosion cracking (SCC), pitting corrosion, defects, pressure vessel design loads, operating design condition, pressure vessel design and design of piping systems; and the pumps, piping systems, valves, safeguarding systems, safety integrity level (SIL), pressure relieving devices and pressure relief valves.

During this interactive course, participants will learn to test and monitor technical integrity audit; apply general inspection guidelines; assess facilities and practices; employ audit planning, periodic auditing, hazard identification, risk analysis, assessment and management; apply risk assessment, reliability engineering, cause and effect diagram, the bow-tie process and pareto analysis; identify the levels of risk and ALARP; deal with risk; review hazard and operability (HAZOP); apply fitness-for-service/engineering critical assessments and KOC integrity management standards for plant and equipment performance and operating conditions; carryout condition assessment and fitness for service (FFS) assessment procedures; interpret remaining useful life (RUL), the standardization process at KOC including the ISO 19345-1:2019 and ISO 19345-2:2019; apply pipeline integrity management at KOC and asset integrity management system implementation at KOC; perform maintenance process, reactive maintenance, breakdown maintenance, preventive maintenance (PM) and reliability centered maintenance (RCM); identify the failure process, maintenance tasks, the analytical decision logic and the modern maintenance terminology; recognize the ten essential requirements for design and RAM; report abnormal conditions and take appropriate actions under instruction of panel operator; describe the operating area, site organisational structure, maintenance information management systems, identification information and labeling in the field; review the information needed to initially verify integrity; apply the methods of documentation, availability of documents and written procedures for MI; perform proper procedures for identical equipment; identify the sources of information for procedures and other documents to include; and record plant and equipment performance data in KOC database system.

## Course Objectives

At the end of this course, the Trainee will be able to:-

- Apply and gain a fundamental knowledge on plant and equipment integrity
- Explain the basic principles related to plant and equipment integrity
- Describe the main purpose of the plant and equipment Integrity management process
- Describe the requirements of KOC integrity management standards in area of responsibility
- Follow KOC integrity management standards related to the daily activities while monitoring and controlling plant and equipment performance and operating conditions
- Report abnormal conditions and take appropriate actions under instruction of Panel Operator (OP-1)
- Record plant and equipment performance data in KOC database system
- Perform routine activities related to plant and equipment performance testing, monitoring and controlling process parameters such as flow line pressure, performance of pumps, valves, filters etc.
- Discuss the technical integrity, some performance-based standards and regulations and the elements of integrated process safety management

- Recognize industrial failures & prevention, industry statistics and the oil and gas exploration and production
- Determine event escalation, near misses, failures in rotating equipment and typical failures for major turbocompressors in process plants
- Apply failure prevention and identify the categories of functional failures, failure consequences and failure effect analysis logic
- Prevent failure, resist failure, enhanced knowledge of failures and identify the 6 failure patterns
- Illustrate causation model, design codes, standards, specifications and best practices
- Discuss United States agencies and legislation, industry standards and frequently used codes
- Recognize engineering materials, the nature of material failures, failure mechanisms and fracture mechanics
- Determine stress corrosion cracking (SCC), pitting corrosion, defects, pressure vessel design loads, operating design condition, pressure vessel design and design of piping systems
- Discuss pumps, piping systems, valves, safeguarding systems, safety integrity level (SIL), pressure relieving devices and pressure relief valves
- Test and monitor technical integrity audit, apply general inspection guidelines and assess facilities and practices
- Employ audit planning, periodic auditing, hazard identification, risk analysis, assessment and management
- Apply risk assessment, reliability engineering, cause and effect diagram, the bow-tie process and pareto analysis
- Discuss the levels of risk and ALARP, deal with risk and review hazard and operability (HAZOP)
- Apply fitness-for-service/engineering critical assessments and KOC integrity management standards for plant and equipment performance and operating conditions
- Carryout condition assessment and fitness for service (FFS) assessment procedures
- Discuss remaining useful life (RUL), the standardization process at KOC including the ISO 19345-1:2019 and ISO 19345-2:2019
- Apply pipeline integrity management at KOC and asset integrity management system implementation at KOC
- Perform maintenance process, reactive maintenance, breakdown maintenance, preventive maintenance (PM) and reliability centered maintenance (RCM)

- Identify the failure process, maintenance tasks, the analytical decision logic and the modern maintenance terminology
- Recognize the ten essential requirements for design and RAM and report abnormal conditions and take appropriate actions under instruction of panel operator
- Describe the operating area, site organisational structure, maintenance information management systems, identification information and labeling in the field
- Review the information needed to initially verify integrity and apply the methods of documentation, availability of documents and written procedures for MI
- Perform proper procedures for identical equipment as well as identify the sources of information for procedures and other documents to include
- Record plant and equipment performance data in KOC database system

## Who Should Attend

This course provides a basic overview of plant and equipment integrity for refinery and petrochemical plant technical professionals, engineers, inspectors, maintenance personnel as well as for project and consulting engineers and engineering and technical personnel involved in plant mechanical integrity and reliability.

## 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: -

- 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.

- 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

- Overview of Technical Integrity
- Introduction
- Some Performance-based Standards and Regulations
- Seveso II

- Process Safety Management (PSM)
- Elements of Integrated Process Safety Management
- Technical Integrity
- Mechanical Integrity (MI)
- Key Elements of a Mechanical Integrity Programme
- Assessing Technical Integrity
- The “Three Legged Stool”
- Key Elements
- Case study #1
- Quiz #1
- Industrial Failures & Prevention
- Industry Statistics
- The Oil Industry: Oil and Gas Exploration and Production
- Sources of Failure Statistics
- Flixborough Disaster
- Bhopal Disaster
- Seveso
- Piper Alpha Disaster
- BP Fined by US Government
- BP Pays Compensation
- Some Other Major Incidents
- Event Escalation
- Near Misses
- Failures in Rotating Equipment
- Introduction
- Typical Failures for Major Turbocompressors in Process Plants
- Failure Prevention
- The Failure Process
- Evident Failures
- Hidden Failures
- Categories of Functional Failures
- Failure Consequences
- Failure Effect Analysis Logic

- Preventing Failure
- Resistance to Failure
- Enhanced Knowledge of Failures
- 6 Failure Patterns
- Age vs. Reliability Patterns
- Equipment Failure Countermeasures
- Causation Model
- Case study #2
- Quiz #2
- Design Codes, Standards, Specifications and Best Practices
- United States Agencies and Legislation
- Industry Standards
- Standard Producers
- International Organization for Standardization (ISO)
- Industry Standards
- Frequently Used Codes
- Case study #3
- Quiz #3
- Engineering Materials
- Overview of Engineering Materials
- The Nature of Material Failures
- Failure Mechanisms
- Elastic and Plastic Behaviour
- Ductile vs. Brittle Behaviour
- Failure
- Fracture Mechanics
- Fracture Mechanics: Hydrogen Embrittlement
- Fracture Mechanics: LME
- Fatigue Damage
- Crack Growth
- Distortion Failures
- Wear Failure
- Wear Failure: Galling

- Corrosion
- Stress Corrosion Cracking (SCC)
- Pitting Corrosion
- Intergranular Corrosion
- Galvanic Corrosion
- Manufacturing Defects
- Fabrication Defects
- Example of Material Selection - The Motor Car
- Case study #4
- Quiz #4
- Design
- Design of Major Plant
- Pressure Vessel Design Loads
- Combinations of Pressure Vessel Design Loads
- Erection (empty) design condition
- Operating design condition
- Test design condition for a shop hydrotest
- Short-time (overload) design condition
- General Design Criteria – ASME Pressure Vessel Code, Section VIII, Division 1
- Subsection A
- Subsection B Methods of Fabrication
- Subsection C Materials
- Mandatory Appendices (Indicated by numbers)
- Non-mandatory Appendices (Indicated by letters)
- General Design Criteria – ASME Pressure Vessel Code, Section VIII, Division 2
- Fatigue Design
- Pressure Vessel Design
- Material
- Design
- Fabrication
- Service
- Design of Piping Systems
- Codes of Practice and Standards

- Hangers and Supports
- Joints and Flanges
- Gasket Failures
- Expansion Joints
- Anchoring and guiding
- Pumps
- Piping System Design Concerns
- Piping Systems
- Valves
- Case study #5
- Quiz #5
- Safeguarding Systems
- Some Types of Safety Systems
- Safety System Maintenance Testing
- Safety and Control and Instrument Systems
- Safety Integrity Level (SIL)
- ANSI/ISA S84.01, Application of Safety Instrumented Systems in the Process Industries
- Self Assessment Guide
- Pressure Relieving Devices
- Pressure Relief Valves
- Safety valve
- Relief Valve
- Pressure and/or vacuum vent valves
- Rupture Disc Device
- Case study #6
- Quiz #6
- Testing and Monitoring & Technical Integrity Audit
- Testing and Monitoring
- Regulatory Requirements
- General Inspection Guidelines
- On-Line Inspection
- Off-Line Testing and Inspections
- Bypassing Equipment for Inspection

- Inspecting and Testing New Equipment
- Determining Inspection Priorities
- What a Standard Record Needs to Contain
- Inspection of Piping
- Attributes of the Record System
- Technical Integrity Audits
- Assessment of Facilities and Practices
- Purpose of Assessments of Inspection Programmes
- Audit Planning
- Auditors Preparation
- MI Audit Checklist
- Safety Audits
- Periodic Auditing: Parts and Materials
- Case study #7
- Quiz #7
- Hazard Identification, Risk Analysis, Assessment and Management
- People: The Newest Measure in Risk
- Terminology
- Exposure
- Probability
- Frequency/Probability
- Terminology
- Hazard
- Consequence
- Consequence Categories
- What are Risks?
- Risks Quantification Example
- Risk Assessment
- Systematic Identification Principles
- Checklist Examples
- Reliability Engineering
- Sources of Probability Statistics
- Example Data

- Number of Failures Recorded per Cycle
- Probability Density Function (PDF)
- Gathering FCA (Failure Characteristic Data)
- OSHA CFR 29. 1910.119 – Process Safety Management of Highly Hazardous Chemicals
- Fault Tree (compare with FMEA)
- Cause and Effect Diagram
- The Bow-Tie Process
- What is a Bow-Tie Diagram?
- The Bow-Tie Process
- Ranking and Short–Listing of Risks
- Pareto Analysis
- Two Classes of Risks for Attention
- Risk Management
- Why Bother with Risk Management Anyway?
- Legal Requirements
- Commercial Requirements
- Why Bother with Risk Management Anyway?
- Moral or Ethical Requirements
- Steps in Risk Management of a Process Plant
- Risk Matrix
- ALARP
- Levels of Risk and ALARP
- Dealing with Risk
- Example of a Risk Register (simplified)
- Hazard and Operability (HAZOP) Review
- Applicability
- HAZOP Process
- HAZOP Guide Words
- HAZOP Checklist
- Case Study #8
- Quiz #8

- Fitness-for-Service/Engineering Critical Assessments & KOC Integrity Management Standards for Plant and Equipment Performance and Operating Conditions
- Introduction
- Condition Assessment
- Fitness for Service (FFS)
- General Fitness-For-Service (FFS) Assessment Procedure
- Remaining Useful Life (RUL)
- KOC Integrity Management Standards for Plant and Equipment Performance and Operating Conditions
- The Standardization Process at KOC
- Major Activities of the Standards Team
- Need for KOC Standards
- Standards Technical Committee
- Online Access Provided by Standards Team
- Abbreviation Booklet
- Technical Library
- Formation of Permanent Task Force for Standardization Process
- Participation in International & Regional Standardization Bodies
- ISO 19345-1:2019 - Petroleum and Natural Gas Industry — Pipeline Transportation Systems — Pipeline Integrity Management Specification — Part 1: Full-Life Cycle Integrity Management for Onshore Pipeline
- ISO 19345-1:2019 - Pipeline Integrity Management Specification — Part 1: Full-Life Cycle Integrity Management for Onshore Pipeline
- ISO 19345-2:2019 - Petroleum and Natural Gas Industry — Pipeline Transportation Systems — Pipeline Integrity Management Specification — Part 2: Full-Life Cycle Integrity Management for Offshore Pipeline
- ISO 19345-2:2019— Pipeline Integrity Management Specification — Part 2: Full-Life Cycle Integrity Management for Offshore Pipeline
- Pipeline Integrity Management at KOC
- Asset Integrity Management System Implementation at KOC
- Case Study #9
- Quiz #9
- Maintenance Strategies and Programs & Report Abnormal Conditions and Take Appropriate Actions Under Instruction of Panel Operator
- What is Reliability?
- Maintenance Process

- Types of Maintenance
- Reactive Maintenance
- The Vicious Cycle of Breakdown Maintenance
- Breakdown Maintenance
- The “Waddington Effect”
- Preventive Maintenance (PM)
- Which Maintenance is the Most Effective?
- A New Maintenance Strategy
- Reliability Centered Maintenance (RCM)
- The Failure Process
- Maintenance Tasks
- RCM – The Analytical Decision Logic
- Appendix
- Modern Maintenance Terminology
- Age
- Age Reliability Curve
- Autonomous Work Group (AWG)
- Availability
- Backlog
- Benchmarking
- Best Operating Practice (BOP)
- Burn-in
- Common Cause Failure Group
- Condition
- Condition Based Maintenance
- Condition Monitoring
- Conditional Probability of Failure
- Corrective Maintenance
- Cost of Failure
- Critical Failure
- Critical Effects
- Criticality
- Criticality Matrix

- Decision Logic Diagram
- Dominant Failure Cause
- Duty Cycle
- Failure Cause
- Failure Evidence
- Functional Failure
- Failure Mechanism
- Failure Mode and Effect Analysis (FMEA)
- Failure Rate
- Hidden Failure
- Key Performance Indicators (KPI's)
- Life Cycle Cost (LCC)
- Maintainability
- Mean Time Between Failures (MTBF)
- Mean Time to Failure (MTTF)
- Mean Time to Repair (MTTR)
- Redundancy
- Reliability
- Reliability Centered Maintenance (RCM)
- Resistance to Failure
- Safe Life Limit
- Small Business Unit (SBU)
- Total Productive Maintenance (TPM)
- Design & RAM
- Improve Accessibility
- Use Standardized Components
- Use as Few Components as Possible
- Improve the Ease of Replacing
- Minimize Consequential Damage
- Neutralize Human Errors
- Increase In-Situ Condition Monitoring
- Include "Self Help"
- Maintenance Manuals

- Modular Construction
- Report Abnormal Conditions and Take Appropriate Actions Under Instruction of Panel Operator
- Site Introduction
- Operating Area Introduction (Batch)
- Site Organisational Structure
- Individuals Involved in Case Study
- Actions Required
- Case study #10
- Quiz #10
- Engineering Information and Systems Management & Record Plant and Equipment Performance Data in KOC Database System
- Introduction
- Maintenance Information Management Systems
- Identification Information
- Labeling in the Field
- Information Needed to Initially Verify Integrity
- Methods of Documentation
- Availability of Documents
- Written Procedures for MI
- Procedures for Identical Equipment
- Sources of Information for Procedures
- Other Documents to Include
- Record Plant and Equipment Performance Data in KOC Database System
- KOC Builds New System with IBM's Asset Management Tool
- IBM's Maximo
- Case study #11
- Quiz #11