## COURSE OVERVIEW PE0147

# Operational Upsets and Root Cause Analysis for Process Engineers (E-Learning Module)

### Course Title
Operational Upsets and Root Cause Analysis for Process Engineers (E-Learning Module)

### Course Reference
PE0147

### 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 is designed to provide participants with a detailed and up-to-date overview of operational upsets and root cause analysis. It covers the incident development, operational upset, outcomes of incidents and the contributing factors; the various types of incidents, environmentally damaging escapes, toxic liquid or gas release causing damage to the environment and the major equipment breakdown; the incidents in chemical processing plants, domino effect, incidents arising from hazardous materials and environmental damage; the analysis of causes of incidents using fault trees; the purpose and scope of legislation; the reporting procedure, incident reporting, writing a good report and incident investigation preparations; the aim of the investigation; and the benefits of incident investigation.

Further, the course will also discuss the investigation strategy, incident investigation and recommend system improvements; the root cause analysis; the fishbone diagram; the use of root cause analysis to understand failures and accidents; the different RCA techniques; the five P's of root cause failure analysis; the 5 why's of RCA, fault tree analysis (FTA), pareto analysis, 80/20 rule and the steps to calculate the "significant few" failure list; the hazard identification/risk assessment, hazard classification and control and risk management; and the ALARP, risk concepts, risk significance and risk assessment process.

During this interactive course, participants will learn the frequency analysis, risk significance (measure), the basic steps of a PHA, risk analysis, risk assessment and HIRA procedure; the hazard effects management process (HEMP), bow tie and safety management cycle; the chemical engineering problem solving; the continuous improvement and total quality management; the benchmarking and best practices for performance measures and profitability; the equivalent distillation capacity, complexity factors and samples of troubleshooting -potential sources; the successful plant problem solving, daily monitoring system guidelines, disciplined learned problem-solving approach and directionally correct hypothesis; the performance analysis software; and the process optimization and classification of mathematical modelling.

**Course Objectives**

The course should serve the following overall learning objectives:-

- Apply and gain a comprehensive knowledge on operational upsets and root cause analysis
- Identify the problem, propose solution and avoid recurrence
- Discuss the terms and definitions as well as incident development and common reasons, operational upset, outcomes of incidents and the contributing factors
- Recognize the various types of incidents, typical types of incidents, types of process plant incidents, environmentally damaging escapes, toxic liquid or gas release causing damage to the environment and the major equipment breakdown
- Explain the incidents in chemical processing plants, domino effect, incidents arising from hazardous materials and environmental damage
- Identify emergency incidents and carryout analysis of causes of incidents using fault trees, fault tree construction, fault tree analysis limitations and fault tree analysis advantages
- Discuss the purpose and scope of legislation as well as implement reporting procedure, incident reporting, writing a good report and incident investigation preparations
- Explain the aim of the investigation and the benefits of incident investigation
- Secure incident site, ensure no escalation potential exists and apply investigation strategy, incident investigation and recommend system improvements
- Deal with immediate risks, select the level of investigation, investigate the event, determine causes, record and analyze the results and review the process
- Employ root cause analysis and discuss the layers and layers of latent causes and philosophy of root cause analysis
- Verify the complaint, use fishbone diagram, perform brainstorming and review the questions to ask when performing RCA
- Use root cause analysis to understand failures and accidents, investigate causes of failures, upsets and mishaps and apply the various steps of root cause analysis
- Carryout different RCA techniques including some techniques that are commonly used within RCA

- Identify the five P's of root cause failure analysis and the parts and position of failure mode inventory
- Discuss the 5 why's of RCA, fish-bone diagram (ishikawa) and the seven cause and effect steps
- Illustrate fault tree analysis (FTA), fault tree construction and fault tree symbols
- Create a simplified fault tree for root cause analysis and assess the frequency of likelihood of potential hazardous incidents or losses
- Quantify fault tree and incident frequency on fault trees as well as employ pareto analysis, the 80/20 rule and the steps to calculate the "significant few" failure list
- Establish incident severity classification, classify the events, perform costing of accidents and near misses and calculate man-hours worked
- Carryout hazard identification/risk assessment, hazard classification and control and risk management
- Identify ALARP, risk concepts, risk significance, risk assessment process and the basic steps of a PRA
- Employ frequency analysis, risk significance (measure), the basic steps of a PHA, risk analysis, risk assessment and HIRA procedure
- Discuss risk matrix, risk significance, hazard effects management process (HEMP), bow tie and safety management cycle
- Perform chemical engineering problem solving as well as identify the components and limitations of plant problem solving
- Apply daily monitoring system guideline, develop equipment related hypotheses, bridge training gaps and perform compressor problem solving approaches
- Illustrate fractionation tray stability diagrams, guidelines for problem solving and apply data verification via technical resources and manual computation techniques
- Carryout continuous improvement and total quality management as well as review comments on continuous improvement, some inconsistencies and contradictions
- Implement benchmarking and best practices for performance measures and profitability
- Identify equivalent distillation capacity, complexity factors and samples of troubleshooting -potential sources
- Apply successful plant problem solving, daily monitoring system guidelines, disciplined learned problem-solving approach and directionally correct hypothesis
- Recognize performance analysis software and carryout process optimization and classification of mathematical modelling

**Who Should Attend**

This course provides an overview of all significant aspects and considerations of operational upsets and root cause analysis for senior process engineers and process engineers.

**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 Fee**

As per proposal

## 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 Contents

- Definitions
- Incident Development and Common Reasons
- The Operational Upset
- The incident
- Outcomes of incidents
- Contributing Factors
- Types of Incidents
- Typical Types of Incidents
- Types of Process Plant Incidents
- Fires
- Vapour Cloud Explosion
- Dust Explosions
- Other Explosions
- Toxic Gas Escapes
- Acute Exposure
- Toxic Fumes from Fires
- Environmentally Damaging Escapes
- Toxic Liquid or Gas Release Causing Damage to the Environment
- Major Equipment Breakdown

- Incidents in Chemical Processing Plants
- Introduction
- Why do incidents Happen?
- Incident Theory
- Energy Theory
- Multiple Factor Theory
- Domino Effect
- Incidents Arising from Hazardous Materials
- Environmental Damage
- Interruption to Supply of Goods or Services
- Examples of Incidents
- Buncefield Fuel Depot - 2005
- Total Liability – 2009
- Emergency Incidents
- Analysis of Causes of Incidents
- Analysis of Causes of Incidents Using Fault Trees
- Fault Tree Construction
- Fault Tree Analysis Limitations
- Fault Tree Analysis Advantages
- Fault Tree for Simple Example
- Case Study
- Legislation
- Purpose and Scope
- Reporting Procedure
- Incident Reporting
- Writing a Good Report
- Incident Investigation Preparations
- Leading Causes of Workplace Deaths
- The Aim of the Investigation
- Benefits of Incident Investigation
- Who Should Investigate?
- Securing Incident Site & Ensuring No Escalation Potential Exists
- Investigation Strategy

- Incident Investigation OSHA (USA)
- Objectives
- Incidents and incidents
- The Basics
- The Process
- Step 1:  Secure the Scene
- Step 2:  Collect Facts About What Happened
- Interviewing
- Cooperate, Don't Intimidate
- Team Exercise: Cooperation is the Key
- Step 3: Develop the Sequence of Events
- Step 4:  Determine the Causes
- Team Exercise: "Getting to the Roots by Asking Why? Why? Why? Why?"
- Exercise: Digging up the Roots
- Step 5:  Recommend Corrective Actions and Improvements
- Team Exercise: Recommending Corrective Actions
- Recommend System Improvements
- Making System Improvements Might Include Some of the Following
- Team Exercise: "Fix the System Not the Blame"
- Step 6: Write the Report
- The Report is an Open Document Until All Actions are Complete!
- Incident Investigation HSE (UK)
- incident Investigation
- What to Investigate?
- incident Studies
- Stages in an incident/Incident Investigation
- Dealing with Immediate Risks
- Selecting the Level of Investigation
- Investigating the Event
- A few Sources Should Give the Investigator All that is Needed to Know
- Interviews
- Observation
- Documents

- Determining Causes
- Determine what Changes are Needed
- Recording & Analysing the Results
- Reviewing the Process
- Course Recap
- Introduction to Root Cause Analysis
- Root Cause Analysis
- What is Root Cause?
- Go Deeper than Blame
- The Domino Theory
- Layers and Layers of Latent Causes
- Philosophy of Root Cause Analysis
- We Perform Root Cause Analysis to Prevent Turnbacks and Customer Escapes from Recurring
- Symptom Approach vs. Root Cause
- How do we do Root Cause Analysis?
- Example: The Washing Machine
- Verify the Complaint
- Fishbone Diagram - A Useful Tool
- Investigate Why
- Root Cause of our Example?
- Tools Used in Root Cause Analysis
- Brainstorming
- Fishbone Diagram
- Questions to Ask When Performing RCA
- Fishbone Diagram Exercise
- Asking Why: Sometimes Simple, Sometimes Complex
- Summary
- Using Root Cause Analysis to Understand Failures & Accidents
- Agenda
- What's an Upset?
- Types of Upsets
- Purpose of Company Upset Investigation
- Investigating Causes of Failures & Upsets

- Investigating Causes of Failures & Mishaps
- Definitions
- Root Cause Analysis – Steps
- What is Root Cause Analysis? (RCA)
- Where Did it Come From?
- RCA Goals
- Why involve residents in RCA?
- ACGME “Procedure Log”
- RCA Model
- When is an RCA Done?
- A Decision Making Tool (SAC)
- Why is an RCA Important?
- Why Use a Particular Method?
- When not to do an RCA?
- How RCAs Work
- Key RCA Roles
- Overview of Steps
- Triage Cards
- RCA Team in Action
- RCA Role Play
- Case Summary
- Definitions of RCA & Related Terms
- Company Upset Classification Levels
- Generic RCA Steps
- STEP 1: Register Equipment Incidents
- STEP 2: Trigger Mechanism for RCA
- STEP 3: Appoint the RCA Team
- STEP 4: The Root Cause Analysis
- Root Cause Summary Table
- Course Recap
- Different RCA Techniques
- Some Techniques that are Commonly Used Within RCA
- Comparison of Some Tools Commonly Used within RCA

- Most Used Methods for RCA
- Which one to use?
- The 5 P's of RCA
- The Five P's of Root Cause Failure Analysis
- Preserve Failure Information
- Parts and Position — Failure Mode Inventory
- Failure Mode Inventory: Another View
- People
- Paradigms
- Paper
- Collection Form
- The 5 Why's of RCA
- Five Why's Preparation
- For all the Five Why's
- Five Why's – The First Why
- Five Why's – The Second Why
- Five Why's – The Third Why
- Five Why's – The Fourth Why
- Five Why's – The Fifth Why
- Five Why's – Conclusion
- The Fish-Bone Diagram (Ishikawa)
- Fish-Bone Diagram
- Example: Fish-Bone Diagram
- Fishbone Steps
- The Seven Cause and Effect Steps
- Fault Tree Analysis (FTA)
- What is Fault Tree Analysis?
- History
- FTA Main Steps
- Preparation for FTA
- Boundary Conditions
- Fault Tree Construction
- Fault Tree Symbols

- Example: Redundant Fire Pumps
- Event and Fault Trees
- The 5 Whys
- Creating a Simplified Fault Tree for Root Cause Analysis
- Assessment of the Frequency of Likelihood of Potential Hazardous Incidents or Losses
- Fault Trees
- Fault Tree Analysis
- Fault Tree Construction
- Fault Tree Example
- Fault Tree Analysis Limitations
- Fault Tree Analysis Advantages
- Simple Example
- Fault Tree for Simple Example
- Quantification of a Fault Tree
- Quantifying Incident Frequency on Fault Trees
- RCA Methods - Pareto Analysis
- Pareto Analysis
- Pareto Principle
- The “Significant Few”
- The 80/20 Rule
- Steps to Calculate the “Significant Few” Failure List
- Let’s Talk Data Analysis: Pareto Curve
- Pareto Curve
- Pareto Chart
- Establishing Incident Severity Classification
- Classification of Events
- Incidents
- Accidents
- Industrial Fatality
- Lost Workday Case - LWDC
- Restricted Workday Case - RWDC
- Medical Treatment Case - MTC
- First Aid Case – FA

- Occupational Illness
- Property Damage (Accidental)
- Damage to the Environment
- Near Misses
- Costing of Accidents & Near Misses
- Introduction
- Purpose and Objectives
- Responsibilities
- Estimation of Events Losses
- Calculations of Man-hours Worked
- Introduction
- Purpose
- Responsibilities
- Procedures
- Hazard Identification/Risk Assessment
- Hazard Classification & Control
- PSM Summary
- Risk Management
- What do we mean by "Risk"?
- ALARP - As Low as Reasonably Practicable
- Risk Concepts
- Risk Significance
- 100% Safe?
- Risk Assessment Process
- When/Why do Risk Assessment?
- The Basic Steps of a PRA
- Frequency Analysis
- The Fault Tree, The Event, and the Event Tree
- Fault Tree Analysis
- Sample Event Tree
- Sources of Data
- Risk Significance (Measure)
- Relative vs. Absolute

- The Basic Steps of a PHA
- Risk Measure
- Fatal Accident Rate
- Common FAR Figures (UK)
- Safety Layer of Protection Analysis Express Risk Target Quantitatively
- Risk Acceptability Template
- Safety Integrity Level (SIL)
- Risk Analysis
- Risk Assessment
- Fault and Event Trees
- Examples of Risk Measures
- A Multimedia, Multiple Pathway Exposure Model
- HIRA Procedure
- Risk Management Without or With Numbers
- "As Low as Reasonably Practicable"
- Meaning of ALARP
- Definition of ALARP
- Levels of Risk and ALARP
- Risk Matrix
- Risk Significance
- Risk Calculator-Easy Program
- Risk Acceptance Graph
- Risk Matrix
- Risk Assessment
- Hazard Effects Management Process (HEMP)
- Bow Tie
- The Swiss Cheese Model of Accident Causation (Reason)
- Safety Management Based on the Reason Model
- Safety Management Cycle
- The Basic Steps of a QRA
- Acceptability of Risk
- ALARP
- Risk Mitigation

- Course Recap
- Chemical Engineering Problem Solving
- What You Can Expect
- Seminar Approach
- Teaching Mode
- Seminar Outline
- Components of Plant Problem Solving
- Limitations to Plant Problem Solving
- An example of improper problem solving
- Plant Problem Solving Considerations
- Real World Applications
- Successful Plant Problem Solving
- Daily Monitoring System Guidelines
- Table 2-1 Sources of Historical Data
- Figure 2-1 Essential Variable % of Theory vs Time
- Daily Monitoring System Guidelines
- Setting Trigger Points
- Disciplined Learned Problem Solving Approach
- Considerations for Step 2
- Problem Specification Example
- Considerations for Step 3
- Considerations for Step 4
- Optimum Technical Depth
- Figure 2-2 Confidence Level vs Solution Cost
- Optimum Technical Depth
- Directionally Correct Hypothesis
- Application to Common  Household Problem
- Examples of Plant Problem Solving
- Reactor Temperature Runaway
- Rotary Filter Screen Tear
- Figure 3-3 Hypothetical Baffle Deformation
- The Green Elastomer Case
- Developing Equipment Related Hypotheses

- Bridging Training Gaps
- Application to Prime Movers
- Kinetic Systems
- Displacement Systems
- Dynamic Systems “Head Curve” Considerations
- Important Definitions
- Calculation Considerations
- Compressor Problem Solving Approaches
- Example Problems
- Application to Plate Processes
- Fractionation as an Example
- Fractionation tray Stability Diagrams
- Areas of Unacceptable Operation
- Fractionation Problem Solving Considerations
- Development of a Theoretically Correct Working Hypothesis
- Table 5-1 Evaluation of Trays By Sampling/Data Analysis
- Application to Kinetically Limited Processes
- Approach Considerations
- Guidelines for Problem Solving
- Application to Unsteady State
- Challenges of Unsteady State Problem Solving
- Optimum Technical Depth
- Guidelines for Approaching Unsteady State Problems
- Verification of Data
- Data Verification via Technical Resources
- Verification by Process Analysis
- Verification of Temperature Measurements
- Verification of Pressure Measurement
- Verification of Level Measurement
- Data Verification via Human Resources
- Manual Computation Techniques
- Vapor-Liquid Equilibrium for Binary System
- Equilibrium Constant of Water Dissolved in a Hydrocarbon

- Water Dissolved in a Hydrocarbon
- Vapor Phase Composition with 2 Immiscible Liquids
- Condensation into two Liquid Phases
- Short Cut Fractionation Calculations
- Review of Concepts
- Additional Problems
- Continuous Improvement
- Total Quality Management
- Deming Cycle for TQM
- Continuous Improvement Technology
- Kaizen
- Lean Manufacturing
- Just in Time
- Six Sigma
- Statistical Six Sigma Definition
- The Balanced Scorecard
- Comments on Continuous Improvement
- Some Inconsistencies & Contradictions
- Improvement Slows Down
- Continuous Improvement
- Benchmarking & Best Practices for Performance Measures & Profitability
- Definitions
- Bench Mark
- Equivalent Distillation Capacity
- Complexity Factors
- Performance Measures & Profitability
- Relative Energy Intensity Index – Example
- Relative Maintenance Index US$/EDC – Example
- Bench Mark Margin & Margin Capture
- Key Performance Indicators: Refinery Example
- Key Performance Indicators
- Best Practices
- Model Validation

- Back-Casting
- Model Validation & Back-Casting
- Other Considerations
- Troubleshooting
- Definition of Troubleshooting
- Troubleshooting Sources
- Samples of Troubleshooting -Potential Sources
- Engineering Problem Solving
- Components of Plant Problem Solving
- Limitations to Plant Problem Solving
- Plant Problem Solving Considerations
- Real World Applications/1
- Proposed Problem-Solving Steps
- Successful Plant Problem Solving
- Daily Monitoring System Guidelines
- Sources of Historical Data
- Daily Monitoring System Guidelines
- Setting Trigger Points
- Disciplined Learned Problem-Solving Approach
- Optimum Technical Depth
- Confidence Level Versus Solution Cost
- Directionally Correct Hypothesis
- Performance Analysis Software
- Process Optimization
- Process Modelling for Optimization
- Classification of Mathematical Modelling
- References for Process Optimization
- Software Simulation Used
- Software: Process Simulation & Modeling
- Course Recap