COURSE OVERVIEW PE0066
Troubleshooting Oil & Gas Processing Facilities for Engineers - Intermediate (E-Learning Module)

Course Title
Troubleshooting Oil & Gas Processing Facilities for Engineers - Intermediate (E-Learning Module)

Course Reference
PE0066

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 oil & gas processing facilities troubleshooting. It covers the crude oil constituents, hydrocarbons, sulfur compounds, nitrogen compounds, oxygen compounds and samples of troubleshooting potential sources; the potential sources in plant operations; the daily monitoring system guidelines; the problem-solving approach, 5 whys technique and the six-step problem solving method; the Carryout data gathering skills, critical thinking process and how to select a diagnostic action; and the failure analysis and the benefits and types of RCFA.

Further, the course will also discuss the RCFA techniques, problem solving and corrective/preventive action; the components of process, the process factors and types of troubleshooting problems; the process used to solve troubleshooting problems; the five key elements common to the troubleshooting process; the Murphy's law, problem solving process, brainstorming possible causes and collecting data; the start-up troubleshooting guidelines and pressure drop data; and the system thinking & problem-solving technique, fish-bone diagram, lateral thinking, critical thinking, the six thinking hats and creative thinking.

During this interactive course, participants will learn the mental problem-solving process used in troubleshooting and some considerations when applying the strategy to solve troubleshooting problems; using data collection and analysis to test hypotheses; getting organized; the seven steps to identify the important causes using pareto analysis; the relief & flare system, source isolation, vessel overpressure protection, flare system and key components; the fired heaters troubleshooting, fabrication, shut-down trip systems, lube oil systems, field inspection and compressor configuration; the calculation of distance between the surge limit line and the compressor operating point; the surge limit line, centrifugal compressor, mechanical seal and bearings; the mechanical design; the stages of the centrifugal pump; and the system head calculation.

Course Objectives

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

- Apply systematic techniques on oil & gas processing facilities troubleshooting
- Define troubleshooting as relevant to oil and gas facilities
- Explain difference between troubleshooting, optimization and debottlenecking
- List common issues in oil and gas process and equipment
- Recognize troubles in oil and gas processes and equipment
- Define troubles using standard method like fishbone chart
- Identify root causes for process deviations, abnormal conditions and various troubles using a standard methodology
- Propose solution to identified process deviations, abnormal conditions and various troubles
- Perform troubleshooting for oil and gas separators, 3-phase separators, reciprocating and centrifugal compressors, glycol dehydration units, centrifugal pumps, oil treatment systems, produced water treating systems, heat exchangers, pipeline network, flow line erosion and chemical injection as applicable to their area of responsibility
- Discuss crude oil constituents, hydrocarbons, sulfur compounds, nitrogen compounds, oxygen compounds and samples of troubleshooting potential sources
- Identify the potential sources in plant operations and apply daily monitoring system guidelines
- Employ problem-solving approach, 5 whys technique and the six-step problem solving method
- Carryout data gathering skills, critical thinking process and how to select a diagnostic action
- Perform failure analysis and identify the benefits and types of RCFA
- Apply RCFA techniques, problem solving and corrective/preventive action
- Identify the components of process, the process factors and types of troubleshooting problems

- Characterize the process used to solve troubleshooting problems and recognize the five key elements common to the troubleshooting process
- Discuss Murphy's law, apply problem solving process, identify the problem, brainstorm possible causes and collect data
- Implement start-up troubleshooting guidelines and interpret pressure drop data
- Illustrate system thinking & problem-solving technique, fish-bone diagram, lateral thinking, critical thinking, the six thinking hats and creative thinking
- Apply the mental problem-solving process used in troubleshooting and some considerations when applying the strategy to solve troubleshooting problems
- Use data collection and analysis to test hypotheses, get organized and apply problem solving
- Implement the seven steps to identify the important causes using pareto analysis
- Recognize relief & flare system, source isolation, vessel overpressure protection, flare system and key components
- Apply fired heaters troubleshooting, fabrication, shut-down trip systems, lube oil systems, field inspection and compressor configuration
- Calculate the distance between the surge limit line and the compressor operating point
- Build the surge limit line, operate centrifugal compressor, arrange mechanical seal and bearings and illustrate mechanical design
- Troubleshoot and operate centrifugal pump, identify the stages of the centrifugal pump and apply system head calculations

Who Should Attend

This course provides an overview of all significant aspects and considerations of oil & gas processing facilities troubleshooting for production operations, production personnel, junior staff and other staff who want to increase their understanding of the oil & gas production operation.

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 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

Course Contents

- Crude Oil Constituents
- Characterization of Crude Oils
- Hydrocarbons
- Sulfur Compounds
- Nitrogen Compounds
- Oxygen Compounds
- Data Sources, Daily Monitoring, Six Steps
- Sources of Historical Data
- Samples of Troubleshooting Potential Sources
- Potential Sources in Plant Operations
- Problem Sources on Startup of a Plant
- Daily Monitoring System Guidelines
- Disciplined Learned Problem-Solving Approach
- 5 Whys Technique
- Six-step Problem Solving Method
- Considerations for Step 2
- Problem Specification Example
- Considerations for Step 3
- Considerations for Step 4
- Considerations for Step 5
- Considerations for Step 6
- Troubleshooting Exercise
- Data Gathering Skills
- Critical Thinking Process
- How to Select a Diagnostic Action
- Select among a Range of Diagnostic Actions
- Personal biases and style in collecting evidence and reaching conclusions
- Consistent Use of Definitions
- Introduction to Root Cause Analysis
- What is Root Cause Analysis?
- Root Cause Analysis

- RCA vs RCFA
- Why Root Cause Analysis
- Why perform failure analysis?
- We Perform Root Cause Analysis to Prevent Turnbacks and Customer Escapes from Recurring
- Benefits of RCFA
- Types of RCA
- RCFA 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 “Machinery Failure”?
- Failure Definition
- How Failures Appear?
- Chronic Failure
- Sporadic Failure
- How Failures Appear?
- What is Root Cause?
- The Root Cause
- Components of Process
- What are the Process Factors?
- Troubleshooting and Problem Correction

- What is Troubleshooting?
- Types of Troubleshooting Problems
- Characteristics of the Process Used to Solve Troubleshooting Problems
- How the Type of Problem Guides the TS Process or Strategy
- Five Key Elements Common to the TS Process
- Summary
- Troubleshooting
- Murphy's Law
- Problem Solving Process
- Identify the problem
- Brainstorm Possible Causes
- Collect Data
- Identify Most Likely Causes
- Brainstorm Possible Solutions
- Identify Preferred Solution
- Implement
- Check that it Worked
- Re-assess
- Start-up Troubleshooting Guidelines
- Case Studies 7.2
- Case Study 1. Crude Distillation Problem
- Crude Distillation
- Interpreting Pressure Drop Data
- The Solution is an Aspect of The Problem
- Eliminating The Black Gas Oil
- Case Study 2. Vibration Failure of the Heat Exchanger Tube
- Vibration Failure of the Heat Exchanger Tube
- Case Study 3. Ethylene Glycol Plant
- The Ethylene Glycol Plant Schematic
- Ethylene Glycol Plant
- Further Analysis
- Case Study 4. Removal of Isolations
- Group Discussion Question

- Troubleshooting Techniques
- Murphy's Law
- Problem Solving Techniques
- The RCFA Paradox (Root Cause Failure Analysis)
- Problem Sources In Plant Operations
- Trouble-shooting & "corrective" Action Required
- Skill Areas for Good Troubleshooter
- People Skills
- Thinking Process & Definition
- System Thinking
- System Thinking & Problem Solving Technique
- Fish-bone Diagram
- Example: Fish-bone Diagram
- Lateral Thinking
- Critical thinking
- Critical thinking- Six Serving Men
- The Six Thinking Hats
- Creative Thinking
- To be a Creative Thinker
- Problem Solving Process
- Identify the Problem
- Brainstorm Possible Causes
- Collect Data
- Identify Most Likely Causes
- Brainstorm Possible Solutions
- Identify Preferred Solution
- Implement
- Check that it Worked, Re-assess
- How To Collect Data & Select Diagnostic Action
- What Common Faults Causing Problems
- Corrosion can be Problem Cause
- Practical Exercises
- Course Recap

- The Mental Problem-Solving Process Used in Troubleshooting
- Problem Solving
- Considerations when Applying the Strategy to Solve Troubleshooting Problems
- Problem-Solving Processes Used by Skilled Troubleshooters
- Data Collection and Analysis: Approaches Used to Test Hypotheses
- Getting Organized: The Use of a Troubleshooter's Worksheet
- Troubleshooter's Worksheet
- Feedback about your Troubleshooting
- Example Use of the Troubleshooter's Worksheet
- Problem Solving
- Summary
- Course Recap
- Root Cause Failure Analysis "RCFA"
- Root Cause Failure Analysis (RCFA) The Philosophy
- Primary Causes of Engineering Disasters
- Symptom Approach vs. Root Cause
- Levels of Causes
- The Three Levels of Cause (Physical, Human and Latent Causes)
- The Benefits
- 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
- Major Steps
- Seven Steps to Identifying the Important Causes Using Pareto Analysis
- Diagram Analysis
- Creating Fishbone Diagrams
- Most Appropriate Categories
- Course Recap
- Relief & Flare System

- Source Isolation
- Vessel Overpressure Protection Standards
- HIPPS Design Intent
- Overpressure Protection – Target # 1 (Boiler & Pressure Vessel)
- Overpressure Scenarios
- HIPPS to Prevent Runaway Chemical Reaction
- Key Issues per ASME BPV Code - Code Case 2211
- Pressure Relief Design Philosophy
- Overpressure Protection per –Target #2 (API Recommended Practice 521)
- RP-521 HIPPS to Safeguard Against Overloading Relief Header
- RP 521 HIPPS Analysis “Complicating Factors”
- Active Relief Devices on Global Plant Power Failure
- Safeguarding Against – Target # 2 (Liquid Relief)
- Flashing Liquid Relief
- “As Safe or Safer”
- Relief Device Design
- Blocked Discharge
- Fire Exposure
- Tube Rupture
- Control Valve Failure
- Thermal Expansion
- Utility Failure
- Purposes of Flares
- Flare System & Key Components
- Combustion Process
- Typical Relief System & Purpose
- Course Recap
- Fired Heaters Troubleshooting
- Heater
- Where We Go Wrong in Compressors
- Introduction
- Compressors Costs FS LHC#1
- Compressor Problems

- Complex Comp Systems Can Be Found In An Ethylene Plant
- Mass Balance Problems
- Typical Steam Balance
- Pressure / Temperature
- Interstage Conditions
- NCOMP Results
- Discharge Conditions
- Composition
- Physical Properties
- Vendor Offering
- Follow-up
- Prototypes
- Spare Parts
- Shop Tests
- Fabrication
- Interstage Seals
- Vibrations
- Bearings
- Anti-surge Control
- Shut-down Trip Systems
- Lube Oil Systems
- Field Inspection
- Compressor Gears
- Compressor Configuration
- Typical Configuration
- 3 Case C3H6 Compressor
- Foundations
- Inlet Piping
- Driver Selection
- Compressor Surge Controls
- Developing the compressor curve
- Developing the surge cycle on the compressor curve
- Major process parameters during surge

- Surge description
- Some surge consequences
- Factors leading to onset of surge
- Calculating the distance between the Surge Limit Line and the compressor operating point
- Building the Surge Limit Line
- The surge parameter S_s
- Introducing the distance between the operating point and the Surge Control Line
- The approach to surge is fast
- The approach to surge is fast - another example
- Basic antisurge control system
- Antisurge controller operation Protection #1: The Surge Control Line (SCL)
- Adaptive Gain Enhancing the effectiveness of the PI controller
- Antisurge controller operation Protection #2: The *Recycle Trip*® Line (RTL)
- Improving the accuracy of *Recycle Trip* open loop control
- *Recycle Trip* based on derivative of S_s
- What if one *Recycle Trip*® step response is not enough?
- Antisurge controller operation Protection #3: The Safety On® Line (SOL)
- Built in surge detector
- Fall-back strategies for the antisurge and performance controller
- Compressor performance control
- Performance control by speed variation
- Power limiting in the performance controller an example
- Limiting Ps or Pd using the antisurge controller
- Operator Interface Specs.
- Alphanumeric Displays
- Operator Keys
- Status LEDs
- Compressor Dry Gas Sealing Systems
- Dry gas seal systems
- Principle of operation
- Seal gas
- Labyrinth Seals
- Pressure balancing

- Boil off gas compressor
- End Flash Compressor
- Seal gas
- Seal gas vent
- Seal gas filters
- Dry gas seal systems
- Labyrinth Seal
- Radial Tilting Pad Bearing
- Centrifugal Compressor Operation
- Compressor Sealing System
- Typical Seal Oil Trap (Drain pot)
- Dry gas seal system
- History of Dry Gas Seals
- How Dry Seal Works
- Dry Nitrogen Circuit
- Mechanical seal and bearings arrangement
- Dry Gas seal is a self adjusting Seal
- Course Recap
- Where We Go Wrong
- Where We Go Wrong In Heat Exchangers
- Introduction
- Exchanger Problems
- Poor Mass Balances
- Fouling
- Pressure Drop
- Selection
- Heat Transfer
- Temperature Profiles
- Mechanical Design
- Maldistribution
- Acoustics
- Entrainment
- Expansion Joints

- Recirculation Problems
- Thermosiphon Layout
- Previous Exam Problem
- Other Possible Exam Questions
- Summary
- Where We Go Wrong In Centrifugal Pump
- Centrifugal Pump Troubleshooting
- The Centrifugal Pump
- Structure of the Centrifugal Pump
- Operation of the Centrifugal Pump
- Stages of the Centrifugal Pump
- Theoretical Considerations
- Pump Performance Characteristics
- Net Positive Suction Head
- System Characteristics and Pump Selection
- Pumps in Series or Parallel
- Hydraulic Facts Pump Operations ‘Advanced’
- Absolute and Gage Pressure
- Weight of Water
- Specific Gravity
- Vapor Pressure (PSIA)
- Viscosity
- Pump Operation
- Centrifugal Pump Curve
- Velocity / Pressure /Head
- Suction Pressure (P1/ PSIG or barg)
- Discharge Pressure (P2/ PSIG or barg)
- Differential Pressure (PSIG or barg) Δ P = P2 – P1
- Head and Pressure
- Specific Gravity
- Differential Head (ft. or m)
- Differential Pressure (bar)
- Brake Horsepower (BHP)

- Net Positive Suction Head (NPSH)
- Pressure Profile
- Pump Cavitation
- Suction Piping
- Affinity Laws
- Effects Caused by Viscosity
- Pump Temperature Rise
- Shaft Stiffness Ratio L3/D4
- Impeller Radial Force At Any Flow
- Radial Load
- Radial Forces On Impeller
- Specific Speed and Suction Specific Speed
- System Head Calculations
- System Curve
- Pump Problem Areas
- Causes of Pump Problems
- Focus on matching the pump & system
- Why is the system curve important?
- Pump and system
- Develop system curve from field measurements
- System static head
- System friction head
- System Curve
- Ways to reduce flow
- Ways to increase flow
- Alternative Three Gage Method
- Three gage method