COURSE OVERVIEW PE0146
Operations Fundamentals (E-Learning Module)

Course Title
Operations Fundamentals
(E-Learning Module)

Course Reference
PE0146

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 operations fundamentals. It covers the turbomachinery, pumps technology and machines that add and extract energy; the fluid and physics basics, the continuity equation, the first law of thermodynamics and Bernoulli's principle; the centrifugal pumps construction, casing, shaft and impeller; the wastewater pumps, immersible pumps, borehole pumps, centrifugal pumps standards and API standards; the various types of cavitation, suction cavitation, internal recirculation, discharge recirculation, air entrainment and positive displacement pumps; and the shaft sealing systems for centrifugal and rotary pumps, pumps shaft sealing device, gland packing, mechanical seals and centrifugal pumps performance curves.

Further, the course will also discuss the system performance curves, friction losses in piping, pipe fitting head loss, theory of compression, labyrinth seals and gas compression sealing system; the centrifugal compressor operation, compressor sealing system, compressor surge controls, basic antisurge control system and compressor performance control; the operator interface specification, dry gas seal system, dry gas seal arrangement and the various types of dry gas seals; and the compressors lubrication system including the major parts and types of reciprocating compressors.

During this interactive course, participants will learn the shell and tube heat exchangers, heat transfer, louvers, blades and vibration; the proper procedure to place heat exchanger in service and testing heat exchangers for leaks; the major parts of a horizontal coil furnace, vertical coil furnace housing, furnace operation, high-pressure box furnace, furnace tube life and flame impingement; the heater start-up, process control instrumentation, process variable, sensors or transducers, setpoint, control output or manipulated variable, discrete control, analog control, PI, PID and control loop; the control valve sequence methods, pressure control systems, liquid flow control loop controller action and burner management system; the purge control, oil leak test, interlock system diagram, safety logics and burner safety; the cascade control principle, process valves, relief valve and its engineering drawing symbol and control valve characteristics; and the process vessels, stabilizer and debutanizer column, overhead receiver, low pressure flash drum and high pressure separator.

Course Objectives

The course should serve the following overall learning objectives:-

- Apply and gain a good working knowledge on operations fundamentals
- Acquire basic knowledge in refinery equipment operation instruments, control loops, ESD systems and reading P&IDs, utilities systems and safe sampling procedures
- Employ operations fundamentals, petroleum refining fundamentals and equipment fundamentals covering pumps, compressor, motors, turbines valves, pipes & fittings, heat exchangers, fans & coolers, tanks cooling towers, furnaces, boilers, vessels, columns, reactors, distillation, absorption instrumentation, control valves and ESD systems. P&ID, sampling and lab analysis refinery flare and utility systems
- Recognize petroleum refining fundamentals, the petroleum industry and the purpose of petroleum refining
- Identify crude oil and synthetic crudes as well as classify crude oil and discuss crude oil assay and other non-crude refinery feedstocks
- List refinery configuration factors and illustrate refining process, desalting, distillation and refining processes involving chemical reactions
- Determine catalytic reforming, catalytic cracking, hydrotreating, alkylation and coking
- Discuss turbomachinery, pumps technology and machines that add and extract energy
- Explain fluid and physics basics, the continuity equation, the first law of thermodynamics and Bernoulli's principle
- Recognize and classify pumps, illustrate centrifugal pumps construction and identify casing, shaft and impeller
- Discuss wastewater pumps, immersible pumps, borehole pumps, centrifugal pumps standards and API standards
- Identify the various types of cavitation, suction cavitation, internal recirculation, discharge recirculation, air entrainment and positive displacement pumps

- Recognize shaft sealing systems for centrifugal and rotary pumps, pumps shaft sealing device, gland packing, mechanical seals and centrifugal pumps performance curves
- Interpret system performance curves, friction losses in piping, pipe fitting head loss, theory of compression, labyrinth seals and gas compression sealing system
- Carryout centrifugal compressor operation, compressor sealing system, compressor surge controls, basic antisurge control system and compressor performance control
- Discuss operator interface specification, dry gas seal system, dry gas seal arrangement and the various types of dry gas seals
- Recognize compressors lubrication system including the major parts and types of reciprocating compressors
- Identify shell and tube heat exchangers, heat transfer, louvers, blades and vibration
- Apply proper procedure to place heat exchanger in service and testing heat exchangers for leaks
- Employ air cooler heat exchanger operation and maintenance and explain the major parts of a horizontal coil furnace, vertical coil furnace housing, furnace operation, high-pressure box furnace, furnace tube life and flame impingement
- Describe cooling tower, flare systems, absorption and stripping
- Perform heater start-up and discuss process control instrumentation, process variable, sensors or transducers, setpoint, control output or manipulated variable, discrete control, analog control, PI, PID and control loop
- Discuss process control instrumentation and process valves
- Employ control valve sequence methods, pressure control systems, liquid flow control loop controller action and burner management system
- Apply purge control, oil leak test, interlock system diagram, safety logics and burner safety
- Discuss cascade control principle, process valves, relief valve and its engineering drawing symbol and control valve characteristics
- Identify process vessels, stabilizer and debutanizer column, overhead receiver, low pressure flash drum and high-pressure separator
- Carryout process safety through automation and steam generation boilers operations
- Employ ESD safety system, safe sampling procedures, P& ID and utilities

Who Should Attend

This course provides a basic overview of operations for process engineers, maintenance engineers, maintenance superintendents, maintenance supervisors, maintenance foremen, plant managers, team leaders, section heads, production managers, production engineers, operations managers, operations engineers, field managers, field engineers, superintendents, supervisors, shift foremen, plant supervisors, plant foremen, plant technicians, plant operators and technical staff.

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

- Petroleum Refining Fundamentals
- The Petroleum Industry
- Exploration
- Production & Supply
- Refining
- Distribution & Marketing
- Purpose of Petroleum Refining
- Crude Oil
- What is Crude Oil?
- What are Synthetic Crudes?
- Classifying Crude Oil
- Are Crude Oils All Pretty much the Same?
- Crude Oil Assay Program
- Analytical Testing
- Crude Assay Laboratory
- Converting Information to Intelligence
- Typical Crude Assay
- Other Non-Crude Refinery Feedstocks
- Refinery Configuration Factors
- A Very Simple Refinery

- Simplified Refinery Processes
- Refining Process
- Refining Crude into Useful Products
- Desalting
- Distillation
- Refining Processes Involving Chemical Reactions
- Catalytic Reforming
- Catalytic Reforming – Primary Process Chemistry
- Catalytic Cracking
- Hydrotreating
- Alkylation
- Alkylate Product - An Ideal “Green” Gasoline Blendstock
- Coking
- What Products do We make?
- Petroleum Refinery Products
- Gasoline Blending (at the Refinery
- Typical Gasoline Specification
- HTSUS Overview
- Refining Resources
- Introduction to Turbomachinery & Pumps Technology
- Feet to PSI
- Head Pressure Under Static Conditions
- Density
- What is Meant by Turbomachinery?
- Machines that Add Energy
- Machines that Extract Energy
- Fluid & Physics Basics
- The Continuity Equation (Conservation of Mass)
- First Law of Thermodynamics
- Bernoulli’s Principle
- Introduction to Pumps
- Definition
- Classification of Pumps

- Centrifugal Pumps
- How do Centrifugal Pumps Work?
- Conversion of Kinetic Energy to Pressure Energy
- Summary
- Centrifugal Pumps Construction
- Centrifugal Pumps - Casing
- Volute Type
- Diffuser Type
- Centrifugal Pumps - Shaft
- Centrifugal Pumps - Impeller
- Impeller – Open Type
- Impeller – Semi Open Type
- Impeller – Closed Type
- Effect of Impeller Geometry
- Effect of Impeller Vane Number
- Effect of Blade Shape
- Hydraulic Thrusts
- Radial Thrusts
- Axial Thrust
- Axial Thrust – Balancing Holes
- Axial Thrust – Radial Back Vanes
- Axial Thrust – Double Suction Impeller
- Single Suction Vs. Double Suction
- Classification of Centrifugal Pumps
- Number of Impellers
- Single Stage Pumps
- Multistage Pumps
- Multiple Impellers – Axial Thrust
- Seals – Wear Rings
- Wastewater Pumps
- Immersible Pumps
- Borehole Pumps
- Centrifugal Pumps Standards

- API Standards
- Cavitation
- Cavitation - Introduction
- Cavitation - Types
- Suction Cavitation
- Internal Recirculation
- Suction Recirculation
- Discharge Recirculation
- Air Entrainment
- Cavitation – Identify Which Type
- Minimum Flow
- Low Flow Recirculation
- Suction Specific Speed
- BEP
- Positive Displacement Pumps
- PD Pumps – Theory of Operation
- PD Pumps Vs. Centrifugal Pumps
- PD Pumps – Classifications
- Reciprocating Pumps – Piston Pumps
- Rotary PD Pumps – External Gear Pumps
- Shaft Sealing Systems for Centrifugal & Rotary Pumps
- Pumps Shaft Sealing Device
- Gland Packing
- Mechanical Seals
- Mechanical Seal Components
- Basic Principles of Mechanical Seals
- Mechanical Seal Components – Primary Seals
- Mechanical Seal Components – Secondary Seals
- Mechanical Seal Components – Spring
- Basic Principles of Mechanical Seal
- Pressure Drop & Vaporization
- Mechanical Seals
- Mechanical Seals Classification by Arrangement

- Mechanical Seals – The Configurations
- Double Seals
- Double Seals – Tandem
- Double Seals – Back to Back
- Double Seals – Face to Face
- Multiple Seals
- Centrifugal Pumps Performance Curves
- Pump Characteristic Curves
- Performance of Centrifugal Pumps
- Best Efficiency Point (BEP)
- System Curve
- System Performance Curves
- Static Losses – Example
- Friction (Dynamic) Losses
- Friction Losses in Piping
- Pipe Fitting Head Loss
- Centrifugal Compressors - A Basic Overview
- Theory of Compression
- Purpose of Compression
- Understanding of Key Terms
- Kinetic Theory of Gases
- Law of Conservation of Energy
- Methods of Compression
- Types of Compressors
- Continuous & Intermittent
- Applications of Compressors
- Labyrinth Seal into Two Halves
- Labyrinth Seal
- Radial Tilting Pad Bearing
- Oil Wedge
- Gas Compressors Sealing System
- Centrifugal Compressor Operation
- General Aspects

- Compressor Sealing System
- Wet Seal System
- Dry Gas Seal System
- History of Dry Gas Seals
- Spiral Groove Sealing Surface
- Principle of Operation
- Spiral Groove Operation
- How Dry Seal Works
- Dry Nitrogen Circuit
- Mechanical Seal and Bearings Arrangement
- Why to Use Dry Seal Instead of Wet Seal
- Forces Acting on the Seal
- Centrifugal Compressors - Construction and Working Principle
- Disadvantages
- Advantages
- Construction
- Radial Magnetic Bearing
- Thrust Magnetic Bearing
- Compressor Arrangements
- Compressor Drivers
- Centrifugal Compressor Rotor Assembly
- Understanding Compressor Curves
- Basic Operation
- 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 Ss

- 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 Ss
- What i 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
- Basic Operation
- Trend of Major Process Parameters During Surge
- Developing the Surge Cycle on the Compressor Curve
- Some Surge Consequences
- Surge
- Anti-Surge Control
- Discharge Pressure Discharge Temperature Suction Flow
- Dry Gas Seal Systems for Centrifugal Compressors
- Dry Gas Seal Arrangement
- Typical Dry Gas Seal
- Seal Face of Dry Gas
- Theory of Non-Contact

- Dry Gas Seal Arrangement in K-2115/K-4115
- Understanding Seal Gas Supplies to Dry Gas Seal
- Primary Seal
- Secondary Seal (Containment Seal)
- Separation Seal (Barrier Seal)
- Operational Guide Lines –Dry Gas Seals
- Seal Gas Supply Quality
- Seal Gas Supply Flow
- Seal Gas Leakage Trends
- Reverse Rotation
- Reverse Pressure
- Slow Roll
- Description
- Dry Gas Seal Faces
- Slow Speed Operation of Seal Faces (Slow Roll)
- Types of Dry Gas Seals
- Single Seal
- Double Seal
- Tandem Seal
- Flow Through Tandem Dry Gas Seal with Intermediate Labyrinth
- Separation (Barrier) Seal
- Segmented Dual Carbon Ring Barrier Seal
- Separation Gas
- Seal Gas Control Methods
- Explosive Limits for Hydrocarbons-Plus Air Mixtures — Upper (UEL), Lower (LEL)
- Seal Gas Control Methods
- Seal Gas Conditioning
- Seal Gas Heater
- Seal Gas Coalescing Prefilter Assembly
- A Seal Gas Booster Scheme
- Dry Gas Seal Vent System
- Dry Gas Seal in Cryogenic Applications
- Sulfur Contamination

- Storage and Protection of Dry Gas Seals
- Schematic Illustration of Magnetic Bearings and Auxiliary Rolling Element Bearings
- Gas Compressors Sealing System
- Centrifugal Compressor Operation
- General Aspects
- Compressor Sealing System
- Wet Seal System
- Typical Seal Oil Trap (Drain Pot)
- Dry Gas Seal System
- How Dry Seal Works
- Alarm and Trip
- Dry Nitrogen Circuit
- Compressors Lubrication System
- Centrifugal Compressors Lubrication Systems
- Generic Lube Oil System Diagram for a Centrifugal Compressor
- API 614 Compliant Lubricating Oil System
- Reciprocating Compressors
- Major Parts
- Cylinder
- Piston
- Suction Valve
- Discharge Valve
- Crankshaft
- Suction Valve Unloaders
- Types of Reciprocating Compressors
- Single-Stage Compressor
- Two-Stage Compressor
- Cooling System
- Double-Action Compressor
- Reciprocating Compressor Control Device
- Gas Pulsation Control
- Heat Exchangers
- Heat Transfer

- Heat Transfer Basic Equations for Design
- Shell and Tube Heat Exchangers
- Optimum Layout for Heat Exchangers
- Heat Transfer Basic Equations for Design
- Types of Heat Exchangers Shell and Tube - Fixed Tubesheet
- Types of Heat Exchangers Shell and Tube - Return Bend (U Tube)
- Types of Heat Exchangers Shell and Tube - Floating Tube Sheet
- Shell Side
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- Principles
- Heat Exchanger Type
- Heat Exchanger Design Considerations
- Fluid Allocation
- Corrosion
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- Heat Exchanger Design Considerations Fluid Allocation
- Temperature
- Pressure
- Pressure Drop
- Viscosity
- Flow Rate
- Mean Temperature Difference
- Recommendations
- Types Of Exchangers
- Single Pass
- Two Pass
- Multi Pass
- Hairpin Exchangers
- Aerial Coolers
- Draft
- Louvers
- Blades
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- Heat Transfer and Equipment Factors Affecting Heat Transfer
- Procedure to Take a Heat Exchanger Out of Service
- Testing Heat Exchangers for Leaks
- Course Recap
- Air Cooler Heat Exchanger Operation & Maintenance
- General Assembly View
- Tube Bundle Details
- Tube Assembly & Plug Detail
- Maintenance Activity Case Summary
- Safety Plan First
- Leakage from Header Plugs
- Leakage from Tubes
- On Line Leak Elimination from broken Tube
- Device Installation Method
- Handover & Final House Keeping
- Direct Fired Heaters
- Hydrocracking Reactor Charge Heater (End View)
- Major Parts of a Horizontal Coil Furnace
- Housing
- Firebox
- Tubes
- Shock Tubes
- Radiant Tubes
- Burners
- Fuel Gas Burner
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- Radiating Cone
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- Furnace Operation
- Product Flow
- Combustion Control
- Draft
- Coking
- Ignition
- High-Pressure Box Furnace
- Furnace Tube Life
- Flame Impingement
- Heater Start-Up
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- Cooling Tower
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- Where Cooling Tower Used
- How Does it Work?
- Parts of Cooling Tower
- Cooling Tower Material
- Cooling Tower Types
- Categorization by Air-to-Water Flow
- Cross Flow
- Counter Flow
- Natural Draft Towers
- Types of Natural Draft Cooling Tower
- Electrical Equipment Cooling Towers
- Mechanical Draft Cooling Towers
- Forced Draft Cooling Towers
- Induced Draft Cooling Towers
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- Effectiveness
- Cooling Capacity
- Evaporation Loss
- The Main Areas for Improving the Energy Efficiency of Cooling Towers
- Factors Affecting Cooling Tower Performance
- Wet Bulb Temperature
- Fill Media Effects
- Facts
- Energy Saving Opportunities in Cooling Towers
- Flare Systems
- Overview of Flare Types
- Steam-Assisted Flares
- Air-Assisted Flares
- Non-Assisted Flares
- Pressure-Assisted Flares
- Enclosed Ground Flares
- Flare Systems
- Location and Regulations of Flare
- Pilots and Ignition
- Flare Burner Head
- Seal Drum – Liquid Seal
- Seal Drum – Gas Seal
- Burner Tip
- Pilot Burners
- Pilots and Ignition
- Steam Jets
- Controls
- Flame Detectors
- Flame Ionization Principle

- Flame Rod Detector
- Flame Radiation Properties
- Ultra-violet Flame Detection
- Detectors in Visible & Infra-red Range
- Low Temperature Flaring
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- Absorption and Absorbers
- Gas Absorption
- Equipment
- Absorption in Chemical Reaction
- Advantage
- Absorption in Packed Tower
- Absorption for Counter Current
- The Packing Either be Regular or Random based on Industrial Requirement
- Choice of Solvent
- Material Balance
- Continuous Contact Equipment
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- Absorption and Stripping in Packed Column
- Absorption and Stripping
- Comparison Between Plate and Packed Columns
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- Selection of Solvent
- Mass Balance (Single Component)
- Mass Balance
- Packed Column Height
- Applications
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- Process Control Instrumentation

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- Industrial Burner
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- Components
- Gate Valve
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- Swing Check Valve
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- Relief Valve and its Engineering Drawing Symbol
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- Angle Valve
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- Liquid Level Control Using Flow Loop
- Level Control Using Flow
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- Control Room Design Guidelines
- Control Room Structure
- Human Factors/Ergonomics
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- Safety Control System
- System Integrity
- Performance and Availability Depend on
- Integrity Levels
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- Safety Integrity Levels
- What is DCS? (Distributed Control System)
- Distributed Control Systems (DCS)
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- DCS Workstation
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- Equal Percentage Characteristic (or Logarithmic Characteristic)
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- Course Recap
- Process Safety Through Automation
- Safety Hierarchy Essential for Every Plant and Engineered Device
- Let's Consider a Flash Drum
- Safety Through Automation
- Safety Involves Many Layers to Provide High Reliability
- Key Concept in Process Safety - Redundancy!
- Categories of Process Control Objectives
- Basic Process Control System (BPCS)
- Pneumatic Control Valves can be Designed to Fail Open or Fail Closed
- Alarms that Require Analysis by a Person
- Alarm Trend in Response to a Process Measurement
- Safety Instrumented (Interlock) System (SIS)
- Three-way Solenoid Valve
- Risk Matrix for Selecting SIS Design
- Safety Relief System
- Two General Classes of Devices
- Good Practices in Control for Safety
- Safety Automation Systems, What have We Learned?
- Safety Through Automation
- Safety Through Automation Workshop 1
- Safety Through Automation Workshop 2
- Functional Safety Demystified
- What is Functional Safety?
- Some Terms: SIS, SIF and SIL
- Why Functional Safety?
- Standards: IEC61508 or IEC61511?
- IEC61511 Safety Lifecycle
- Complying with AS IEC 61508 & AS IEC 61511
- Comply Throughout Lifecycle
- Hazard and Risk Analysis
- Case Study: 1 A Hazard
- Case Study: 2 HazOp

- Allocation of Safety Functions
- Case Study: 3 Design after HazOp
- Risk: The Product of Severity and Likelihood
- Case Study: 4a Risk Reduction
- Risk Analysis - Layers of Protection 1
- Case Study: 4b Risk Reduction
- Case Study: 5 Add a SIF
- SIL Determination 1 - Layers of Protection
- Safety Integrity Level vs. Risk Reduction
- SIL is more than just PFD
- Safety Requirements Specification – SRS
- Cause-and-Effect Diagram
- Design and Engineering
- Standards Compliance
- Case Study: 6 PFD Calculation
- Safety Integrity Level vs. PFD_{ave}
- Approximation to PFD_{ave}
- Case Study: 6 PFD Calculation
- Effect of Test Interval on PFD_{ave}
- Case Study: 7a Adjust Test Interval
- Case Study: 7b Duplicate Block Valves
- Architectural Constraints
- Safe Failure Fraction
- Architectural Constraints – IEC61508.2
- Case Study: 8 Architectural Constraints
- Architectural Constraints for Logic Solver
- Case Study: 9 – Transmitter Selection
- Installation, Commissioning, Validation
- Case Study: 10 Verification and Validation
- Operations, Maintenance and Modification
- Operations and Maintenance Obligations
- Case Study: 11 Operation and Maintenance
- Case Study: 12 – Modification

- Summary 1 – The SIS Lifecycle
- Summary 2 – Requirements
- Need more?
- Steam Generation: Boilers Operations
- Introduction: Boiler
- Boiler Component
- Steam Piping
- Boiler Systems
- Fuels Used in Boiler
- Types of Boilers
- Fire Tube Boiler
- Water Tube Boiler
- Packaged Boiler
- Stoker Fired Boiler
- Pulverized Fuel Boiler
- Waste Heat Boiler
- Fluidized Bed (FBC) Boiler
- Mechanism of Fluidized Bed Combustion
- Types of Fluidized Bed Combustion Boilers
- AFBC / Bubbling Bed
- Bubbling Bed Boilers
- Features of Bubbling Bed Boiler
- Bubbling Bed Boiler-1
- Bubbling Bed Boiler-2
- BFB Bottom Supported
- Top Supported BFB
- Coal-fired Power Plant
- Pressurized Fluidized Bed Combustion System (PFBC)
- PFBC Boiler for Cogeneration
- Circulating (Fast) Fluidized Bed Combustion System (CFBC)
- Circulating Fluidized Bed (CFB) Boiler
- Circulating Bed Boiler (At a Glance)
- Advantages of Fluidized Bed Combustion Boilers

- Fig. 1 Process Flow of Circulating Fluidized-bed Boiler
- Fig. 2 Schematic drawing of CFBC
- General Arrangements of FBC Boiler
- General Features of our Project (3nos)
- General Features of our Project (1nos)
- Future of CFBC Boiler
- Air CFB Technology – Current State of the Art
- Foster Wheeler Awarded Contract for World's Largest 100% Biomass Boiler
- Performance of a Boiler
- Boiler Performance
- Heat Balance
- Boiler Efficiency
- Boiler Efficiency: Direct Method
- Boiler Efficiency: Indirect Method
- Boiler Blow Down
- Boiler Feed Water Treatment
- External Water Treatment
- Energy Efficiency Opportunities
- Stack Temperature Control
- Feed Water Preheating Economizers
- Combustion Air Preheating
- Minimize Incomplete Combustion
- Excess Air Control
- Radiation and Convection Heat Loss Minimization
- Automatic Blow Down Control
- Scaling and Soot Loss Reduction
- Reduced Boiler Steam Pressure
- Variable Speed Control for Fans, Blowers and Pumps
- Control Boiler Loading
- Proper Boiler Scheduling
- Boiler Replacement
- Boiler Auxiliaries
- Boiler Mountings

- Water Level Indicator
- Blow Off Cock
- Fusible Plug
- Pressure Gauge
- Safety Valves
- Steam Stop Valve
- Feed Checked Valve
- Boiler Accessories
- Feed Pump
- Economizer
- Super Heater
- Air Pre-Heater
- Another Boiler Equipment
- Boiler Drum
- Furnace Chamber
- FD Fan
- ID Fan
- Chimney
- Operation
- Boiler Starting System
- Control Panel Board
- Switching on Boiler
- Boiler Shut Downing System
- Maintenance
- Operation and Maintenance at Running Condition
- Scheduled Maintenance
- Daily Maintenance
- Weekly Maintenance
- Monthly Maintenance
- Yearly Maintenance
- Boiler Blowdown
- Boiler Blowdown Benefits
- Problem & Solution

- Safety for Boiler Room
- Safety System/Emergency Shutdown System (ESD)
- Emergency Shutdown System Philosophy
- Usually there are Several Levels of Shutdown
- Setting Sequence of the ESD is as Follows
- Resetting Philosophy
- Field Equipment Reset
- Start-up and Maintenance Inhibit/ Override
- ESDV: How it Works?
- Full Open Position – Normal Operation
- Full Closed Position – Emergency Situation
- Unlocking Assured by Position Indicator
- There are 2 Types of Testing Methods Available Being
- Shutdown Valve (SDV) Vs Emergency
- Shutdown Valve (ESDV)
- Burner Management System (BMS)
- The Burner Management System can have the following functions
- BMS Functions
- Types of BMS
- An Integrated System Offers
- Advantages
- Disadvantages
- The Need for Safety Instrumentation
- Risk and Risk Reduction Methods
- Other Terms Used for Safety Systems
- Objectives of a Shutdown Control System
- Safety, Reliability, and Availability
- The Safe State
- Safety
- Reliability
- Availability
- What is Hazard and What is Risk?
- Hazards Analysis

- Risk
- Risk Reduction
- Emergency Shutdown (ESD)
- Process Shutdown (PSD)
- Fire and Gas Control (F&G)
- Typical Actions from FDP Systems
- Typical Actions from PSD Systems
- Fire / Gas Detection and Protection (FDP)
- Safety Process General Overview
- Five-Step Safety Process Model
- The Process for Managing Risk
- Risk Evaluation
- Key Questions to Ask
- Risk Assessment
- Alternatively
- Risk Matrix Example 1
- Risk Matrix Example 2
- Scales of Consequence
- Risk Classification of Accidents
- Concepts of ALARP and Tolerable Risk
- ALARP Diagram
- Step 1
- Step 2
- Establishing Tolerable Risk Criteria
- Fatal Accident Rate
- Tolerable Risk Conclusion
- Practical Exercise
- Hazard Analysis Techniques
- Summary of Hazard-Identification Methods
- Deductive Method
- Inductive Method
- Rating for Safety
- Safety Integrity Levels and Different Safety Standards

- AK Class & SIL
- Linking Risks to SIL
- Safety Integrity Level (SIL)
- A Determination of the Target Safety Integrity Level Requires
- Safety Architectures
- The Conventional PLC Architecture Provides Only a Single Electric Path. Sensors Send Process
- Typical Applications
- Emergency Shutdown
- Boiler Flame Safety
- Turbine Control Systems
- Offshore Fire and Gas Protection
- Safe Sampling Procedures
- Gas and Liquid Sampling Applications
- Applications Review
- Refinery Applications
- Refining
- Refinery Process
- Common Process Terms
- Refinery Process Simplified
- CDU – Crude Distillation Unit
- VDU – Vacuum Distillation Unit
- VBC – Visbreaking Unit
- HTU – Hydrotreater Unit
- CRU – Catalytic Unit
- SRU – Sulfur Recovery Unit
- FCCU – Fluid Catalytic Cracking Unit
- Polymerization Unit
- Alkylation Unit
- Other Processing Units
- Typical Sampling Points and Samples
- VDU - Visbreaker
- LPG – Liquid Petroleum Gas Unit
- Amine Units

- Simplified Refinery Process
- Other Processing Units
- Reasons Refineries Sample
- Keys to Refinery Sampling
- Typical Materials Sampled
- Keys to Refinery Samples
- Chemicals/Petrochemicals
- Why Use Sentry Samplers?
- MVD Sampler with Box and Heater
- MVD Sampler with Sample Cooler
- MFV Sampler
- MCL Sampler
- MCG Sampler for Gases
- Wastewater Applications
- Wastewater – Process flow
- Typical Sampling Points
- Why Sample in a Wastewater Plant?
- Challenges with Sampling in a Wastewater Plant
- Why the *ISOLOK*®?
- Mining Slurry
- *ISOLOK*® in Shell Oil Sands
- Reactor Vessel Sampling
- Pipe / Tank Sampling
- Solvent Recovery
- Why Sentry Samplers?
- Typical Sample Point
- Techniques for Natural Gas Sampling
- Purpose
- Introduction
- Gas Sampling
- Components of a Gas Sampling System
- Hydrocarbon Dew Point
- Spot Sampling

- Types of Spot Sampling
- Example Procedure for Fill and Empty Method
- Fill and Empty Purge Cycles
- Transportation and Analysis
- Conclusion
- Guidelines for the Collection of Oil Samples
- General Considerations
- Oil Samples for Organic Analysis
- Sample Containers
- Sample Labeling
- Sample Transportation
- Packing Considerations
- Guide for Estimating the Size of an Oil Slick on Water
- Reservoir Fluids Sampling
- Outlines
- Objectives
- Planning the Sampling Program
- Preparing the Well for Sampling
- Conducting the Sampling Operation
- PVT Laboratory Tests
- Compositional Analysis
- Pressure Depletion Tests
- Viscosity Test
- Density Test
- Separator Test
- Know, Read & Understand Your Piping & Instrumentation Diagrams (P&ID's)
- Introduction
- What is a P&ID?
- Instruments Line
- The "Tag Numbers"
- Instrument Identification
- What is Piping and Instrumentation Diagram (P&ID)?
- Contents and Function

- List of P&ID Items
- Piping and Instrumentation Diagram Example
- Anatomy of a Drawing
- The Title Block
- First Area of the Title Block
- Second Area of the Title Block
- Third Area of the Title Block
- Drawing Scale
- Revision Block
- Changes
- Notes and Legend
- Categories of Drawings
- Piping and Instrument Drawings (P&IDs)
- Electrical Single Lines and Schematics
- Valve Symbols
- Valve Actuators
- Control Valve Designations
- Piping Systems
- Instrumentation
- Sensing Devices and Detectors
- Modifiers and Transmitters
- Indicators and Recorders
- Controllers
- Examples of Simple Instrument Loops
- Components
- Miscellaneous P&ID Symbols
- Reading Engineering P&IDs
- Standards and Conventions for Valve Status
- P&ID Document Reading Example
- Identify Instruments in Piping and instrumentation Diagram
- Piping and instrumentation Diagram
- Solution
- Identify Process Variables in P&ID

- Solution
- Instrumentation Diagrams Multiple Choice Questions
- Architecture of Instrumentation & Automation System
- Architecture of Instrumentation
- Junction Box Connections
- Signal Layout
- Typical Instrumentation Layout
- P&ID Guidelines for Control Valves
- P&ID Guidelines for Pumps
- P&ID Guidelines for Storage Tanks
- P&ID Guidelines for Centrifugal Compressor Systems
- Typical P&ID for a Centrifugal Compressor System
- Liquid Level Control Using Flow Loop
- Level Control Using Flow
- Motor Controllers
- Manual Controllers
- Magnetic Controller
- Electronic Diagrams and Schematics
- Logic Diagrams and Prints
- Fabrication, Construction, and Architectural Drawings
- Drawing Format
- Single Line P&ID Drawings
- Pictorial or Double Line Drawings
- Assembly Drawings
- Cutaway Drawings
- Views and Perspectives
- Orthographic Projections
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- Piping and Instrumentation Diagram (P&ID)
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- Outlines
- Process Diagrams
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- Example 2
- Example 3
- Process Flow Diagram (PFD)
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- Example 4
- Example 5
- A/B Letter
- Stream Numbering and Drawing
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- Stream Information - Full Stream Data
- Basic Loop
- Sensors (Sensing Element)
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- Thermocouple
- Resistance Temperature Detector (RTD)
- Flow Sensor
- Turbine Meter
- Magnetic Flow Meter
- Orifice Meter
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- Final Control Element
- Instrumentation Symbology
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- Instrumentation Numbering
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- Utilities - Power Management System
- Business Drivers for PMS
- Operational Drivers for PMS
- Architecture
- Typical Electrical Network of Industries
- Electrical Distribution Equipment
- Industrial^{IT} System 800xA Architecture for PMS
- PMS Functionality
- Power Management Functionality
- Load Shedding: The Types
- Load Shedding: Keywords
- ABB's Starting-point for Load Shedding
- Contingency Load Shedding
- Technical Data Load Shedding
- Power Management Functionality
- Display Generator Capability Diagram
- Active and Reactive Power Control

- Power Control Example Displays
- Generator Dialogue Faceplates
- Power Management Functionality
- Mode Control
- Supervision, Control and Data Acquisition
- Integration with Supervisory Systems
- Integrated Protection & Control Units
- Re-Acceleration / Re-Starting
- Synchronisation
- Utilities Air Separation, Oxygen and Nitrogen
- Uses
- Introduction
- Liquefaction
- Liquefaction of air by Joule - Thomson Effect
- Manufacture
- Manufacture - Linde's Process
- Linde's Process
- Manufacture - Claude Process
- Linde's Process
- Claude's Process
- Operation of a Rectification Column
- Adsorptive Separation
- Membrane Separation