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COURSE BROCHURE

# Advanced Process and Mechanical Engineering Training Course

14 – 25 February 2027
Manama

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Registered in the United Kingdom and Saudi Arabia

# Advanced Process and Mechanical Engineering Training Course

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Advanced Process and Mechanical Engineering is a 2-week training course for process and mechanical engineers who look after rotating and static equipment in process plants, and it ends with an equipment integrity and operating envelope review for one process unit. When process conditions drift beyond what metal, seals and bearings were built for, failures follow quickly. Jupiter Prime Training offers this course to plant engineering departments.

## Why Process and Mechanical Engineering Matters Now

Three trends push the two disciplines together. Ageing assets are run harder and longer than their original design life assumed. Process changes such as new feeds, higher temperatures or corrosive contaminants now reach equipment faster than inspection plans adapt. Experienced engineers who once bridged both views are retiring, leaving gaps between the process desk and the workshop. A plant that keeps the two apart sees seal leaks, fatigue cracks and unplanned shutdowns; one that links them sets limits each side can defend. The course rests on integrity operating windows IOW, risk-based inspection RBI principles and root cause failure analysis RCFA.

## Who Gains Most from Process and Mechanical Engineering

- Engineers who set process conditions that equipment must tolerate day to day
- Engineers who maintain pumps, compressors, turbines and their seals and bearings
- Specialists who judge pressure vessel, piping and exchanger condition
- Engineers who approve process and hardware modifications on operating units
- Specialists who investigate equipment failures and propose lasting fixes

A unit engineering group that sends its process engineer and its static and rotating equipment engineers together gains most, because each learns which limits the others hold.

## Process and Mechanical Engineering Capabilities

Participants leave able to translate process duty into mechanical limits, and mechanical condition back into process constraints.

- Specify pump and compressor operating ranges from process duty — equipment selection and rerate decisions
- Assess pressure vessel and piping condition against design and corrosion allowance — inspection planners
- Calculate thermal expansion and nozzle loads in critical piping — modifications approved by design authorities
- Design integrity operating windows for a unit — operators and shift supervisors
- Test failure hypotheses with evidence from the plant — root cause investigations
- Communicate equipment limits as process alarms and set points — the control room

## Key Process and Mechanical Engineering Terms

- Integrity operating window — a defined range of process variables within which equipment degradation stays predictable and acceptable.
- Best efficiency point — the flow at which a centrifugal pump runs with highest efficiency and lowest vibration and wear.
- Corrosion allowance — extra wall thickness added at design to absorb expected metal loss over equipment life.
- Piping flexibility — a line's ability to absorb thermal growth without overstressing pipe, supports or connected nozzles.
- Surge — unstable flow reversal in a dynamic compressor at low flow, damaging impellers, seals and bearings.
- Damage mechanism — a physical or chemical process, such as fatigue, creep or corrosion, by which equipment deteriorates in service.

## Process and Mechanical Engineering Day by Day

### Day 1: Where Process Duty Meets Hardware

- Equipment Datasheets and Process Duty Specifications — What Each Discipline Owns
- Design Margins Versus Operating Margins — Hidden Limits in Ageing Units
- Management of Change Triggers — When Process Shifts Need Mechanical Review
- Failure Cost and Production Loss Records — Prioritising Critical Equipment
- Criticality Ranking of Unit Equipment — Focus for Engineering Attention

### Day 2: Centrifugal Pumps in Process Service

- Pump Curves and Best Efficiency Point — Running Range for Reliable Operation
- Suction Conditions and Cavitation — Net Positive Suction Head Margin Decisions
- Minimum Flow Protection — Recirculation Lines Against Overheating and Vibration
- Mechanical Seal Selection and Flush Plans — Matching Fluid Hazards and Temperature
- Parallel and Series Pump Operation — Sharing Duty Without Instability

### Day 3: Compressors and Drivers

- Centrifugal Compressor Maps and Surge Control — Protecting Machines During Upsets
- Reciprocating Compressor Valves and Rod Load — Limits Under Changing Gas Composition
- Steam Turbine and Motor Driver Matching — Speed and Power Margins
- Lube and Seal Oil Systems — Supporting Systems That Trip Main Machines
- Gas Composition Effects on Head and Power — Feed Changes Reaching Machinery

### Day 4: Pressure Vessels and Columns

- Design Pressure, Temperature and Minimum Design Metal Temperature — Safe Envelope Limits
- Wall Thickness Monitoring and Remaining Life — Retirement and Repair Decisions
- Nozzle Reinforcement and Local Loads — Accepting New Connections Safely
- Vessel Internals and Support Skirts — Mechanical Limits on Process Changes
- Overpressure Protection Basis — Relief Scenarios Shared by Both Disciplines

## Day 5: Piping Systems and Stress

- Thermal Expansion and Flexibility Analysis — Line Routing and Loop Decisions
- Pipe Supports, Hangers and Guides — Load Paths Under Operating Temperature
- Nozzle Loads on Pumps and Compressors — Protecting Machinery Alignment
- Vibration and Fatigue in Small-Bore Connections — Bracing and Redesign Choices
- Water Hammer and Slug Flow Loads — Transient Effects on Piping Integrity

## Day 6: Heat Exchangers and Fired Equipment

- Tube Vibration and Baffle Spacing — Flow Rate Limits for Exchanger Bundles
- Tube-to-Tubesheet Joints and Leak Paths — Repair or Retube Decisions
- Thermal Stresses in Fixed Tubesheet Designs — Start-Up and Shutdown Rates
- Fired Heater Tube Creep and Coking — Firing Limits and Decoking Intervals
- Air Cooler Fan and Header Integrity — Mechanical Limits on Cooling Duty

## Day 7: Damage Mechanisms and Materials

- Corrosion Loops and Damage Mechanism Identification — Linking Chemistry to Metal Loss
- Stress Corrosion Cracking and Hydrogen Damage — Material Choice and Limits
- High-Temperature Creep and Embrittlement — Life Assessment for Hot Equipment
- Erosion and Erosion-Corrosion — Velocity Limits in Lines and Bends
- Material Selection Diagrams — Upgrading Metallurgy for New Duties

## Day 8: Integrity Operating Windows and Inspection

- Integrity Operating Window Development — Critical, Standard and Informational Limits
- Risk-Based Inspection Principles — Inspection Interval and Method Selection
- Condition Monitoring for Rotating Equipment — Vibration, Temperature and Oil Analysis
- Non-Destructive Testing Method Choice — Detecting the Expected Damage
- Operator Rounds and Alarm Set Points — Turning Limits into Daily Practice

## Day 9: Failure Investigation and Modifications

- Root Cause Failure Analysis Method — Evidence Collection After a Breakdown
- Fracture Surface and Wear Pattern Reading — Distinguishing Fatigue, Overload and Corrosion
- Bad Actor Equipment Lists — Targeting Repeat Failures
- Rerate and Modification Engineering — Checking Mechanical Limits Before Process Changes
- Fitness-for-Service Assessment Concepts — Continued Operation with Known Flaws

## Day 10: Practising the Equipment Integrity and Operating Envelope Review

- Unit Equipment Criticality Register — Selecting Items for the Review
- Rotating Equipment Operating Range Check — Pumps and Compressors Against Duty
- Static Equipment Damage Mechanism Summary — Vessels, Piping and Exchangers
- Draft Integrity Operating Windows — Limits Agreed by Process and Mechanical
- Equipment Integrity and Operating Envelope Review — Findings and Limit Changes

## Applying Process and Mechanical Engineering After the Course

- Lead a joint walkdown of one pump and one exchanger, comparing actual operating points with their datasheet ranges.
- Draft integrity operating windows for a corrosion loop and agree alarm set points with operations.

## Process and Mechanical Engineering Questions FAQ

### What is process and mechanical engineering, and why does it matter now?

Process and mechanical engineering is the joint discipline of matching process conditions to the limits of plant equipment. It matters now because ageing units run harder while feed changes and staff turnover widen the gap between process settings and mechanical reality.

### Which roles gain most from advanced process and mechanical engineering training?

Process engineers, rotating and static equipment engineers, inspection specialists and modification approvers gain most. Each sees how decisions on flow, temperature and composition reach seals, bearings, welds and tube bundles.

### How does advanced process and mechanical engineering differ from a mechanical engineering essentials course?

It assumes the basics and works at the interface. Instead of introducing machine elements, it ties pump curves, compressor maps, piping stress and damage mechanisms to the process limits operators control, ending in integrity operating windows.

### What do you bring back from process and mechanical engineering training?

You bring back a review of one unit's equipment. It ranks critical items, checks rotating machines against duty, summarises damage mechanisms for static equipment and proposes integrity operating windows that process and mechanical staff both accept.

## Process and Mechanical Engineering: The Way Forward

The equipment integrity and operating envelope review first informs which process limits need tightening or relaxing on a unit. Process engineers, equipment engineers and inspection planners use it to align set points with hardware condition. After its first use, revisit the damage mechanism assumptions, because new feeds or longer run lengths can change how equipment degrades.