Steam Systems and Boiler Reliability

Tube Failure, Steam Distribution and Condensate Management

FORMAT	DATES	CPD POINTS	
Online – MS Teams	17 – 18 September 2026	2 Points	R 8 999 per delegate

Overview

Steam systems are among the most critical energy and process systems in industrial facilities. Boiler tube failures, poor steam distribution, failed steam traps, waterhammer, contaminated condensate, inadequate drainage and poor boiler-water chemistry can result in production losses, equipment damage, excessive energy consumption and serious safety risks.

This intensive programme provides an integrated understanding of boiler tube integrity, steam distribution, steam traps, condensate management and boiler/feedwater chemistry — rather than treating boiler reliability and steam-system performance as separate disciplines, it examines the complete steam cycle:

Boiler → Steam Generation → Steam Distribution → Process Equipment → Condensate Recovery → Feedwater → Boiler

Participants learn how failures and inefficiencies at one point in this cycle create problems elsewhere in the system. The programme combines engineering principles with failure investigation, root cause analysis, steam trap assessment, waterhammer prevention, system auditing, condensate management and reliability planning.

Who Should Attend

- Boiler Operators & Supervisors
- Mechanical / Plant / Utilities Engineers
- Maintenance & Reliability Engineers
- Steam-System & Process Engineers
- Energy Managers
- Condition-Monitoring & Inspection Personnel
- Engineering Consultants & Facilities Managers

What You Will Learn

- ✓ Explain the operating principles of industrial boiler and steam systems
- ✓ Identify common boiler tube failure mechanisms and their likely causes
- ✓ Distinguish between corrosion, overheating, erosion, fatigue and mechanical failure
- ✓ Apply a structured approach to boiler tube failure investigation
- ✓ Interpret evidence from tube appearance, deposits, operating history and inspection results
- ✓ Understand the relationship between boiler-water chemistry and tube integrity
- ✓ Select appropriate steam traps for different applications
- ✓ Evaluate steam distribution systems for drainage, sizing and air removal
- ✓ Identify the causes and consequences of waterhammer
- ✓ Diagnose common steam trap and condensate-system failures
- ✓ Conduct a structured steam trap and steam-system audit
- ✓ Evaluate condensate recovery opportunities
- ✓ Understand the relationship between condensate quality and boiler reliability
- ✓ Develop integrated boiler and steam-system monitoring programmes
- ✓ Identify opportunities to reduce steam, water, chemical and energy losses
- ✓ Apply reliability principles to improve steam-system performance

1 Boiler Systems and Tube Integrity Fundamentals

- Industrial boiler types and applications
- Boiler pressure parts and tube arrangements
- Economizers and heat-transfer surfaces
- Tube materials and basic metallurgy
- Factors affecting boiler tube service life
- Fire-tube and water-tube boilers
- Waterwalls, generating banks, superheaters, reheaters
- Boiler operating pressure and temperature
- Thermal stresses and operating conditions
- Operating conditions vs. tube integrity

2 Boiler Tube Failure Mechanisms

- Corrosion-related tube failures
- Under-deposit corrosion
- Hydrogen damage
- Scale formation and overheating
- Fireside corrosion and erosion
- Welding and fabrication defects
- Oxygen pitting and corrosion
- Caustic corrosion and gouging
- Acid/phosphate-related corrosion
- Short-term and long-term overheating / creep
- Thermal / mechanical fatigue, vibration failures

3 Boiler Tube Failure Investigation

- Establishing the failure history
- Visual and macroscopic examination
- Deposit and metallurgical assessment
- Assessing deformation and cracking
- Developing an evidence-based failure hypothesis
- Documenting failure location and orientation
- Tube-wall thickness measurement
- Recognising overheating and corrosion patterns
- Reviewing operating history: trips, startups, low-water events

4 Root Cause Analysis & Corrective Action

- Structured root cause analysis methodology
- 5-Why and cause-and-effect analysis
- Linking operating conditions to failure mechanisms
- Preventive actions vs. corrective repairs
- Failure mode identification
- Distinguishing symptoms from root causes
- Identifying contributing factors
- Developing a tube integrity management strategy

5 Steam Distribution System Fundamentals

- Steam generation and distribution fundamentals
- Steam quality and its importance
- Pressure and temperature relationships
- Pressure-drop principles and pipe sizing
- Pipe supports and system flexibility
- Saturated and superheated steam
- Steam mains and branch connections
- Steam velocity considerations
- Expansion and thermal movement
- Insulation and heat-loss considerations

6 Steam System Drainage & Condensate Formation

- Why condensate forms (operation, startup/warm-up)
- Drip legs and drainage points
- Drainage at control valves, risers and drops
- Air removal and venting
- Pressure-reducing station drainage
- Steam-main drainage philosophy
- Low-point drainage
- Condensate removal from process equipment
- Strainer installation
- Consequences of inadequate drainage

7 Steam Traps: Selection, Operation & Failure

- Purpose and operating principles of steam traps
- Mechanical traps: float & thermostatic, inverted bucket
- Trap operating characteristics
- Capacity, operating conditions, differential pressure
- Oversized and undersized traps
- Strainer and isolation arrangements
- Thermostatic steam traps
- Thermodynamic disc traps
- Selecting the correct trap for an application
- Failed-open / failed-closed traps
- Trap installation errors
- Steam trap maintenance requirements

8 Waterhammer, Steam-System Failures & Troubleshooting

- What is waterhammer? Condensate- vs. steam-induced
- Incorrect pipe gradients
- Startup-related waterhammer
- Detecting waterhammer conditions
- Diagnosing steam-system pressure and flow problems
- Poor drainage and excessive condensate
- Improper valve operation
- Consequences for piping and equipment
- Prevention and mitigation strategies

9 Condensate Recovery & Management

- Importance of condensate recovery
- Return systems: open and closed
- Condensate pumping arrangements
- Backpressure and drainage problems
- Condensate temperature and energy recovery
- Water and chemical savings via recovery
- Condensate quality requirements
- Flash steam formation and recovery
- Condensate return-line sizing
- Condensate contamination: sources and detection
- Makeup-water requirements

10 Feedwater & Boiler-Water Chemistry

- Water chemistry vs. boiler reliability
- pH and conductivity control
- Oxygen corrosion and pitting
- Phosphate treatment principles
- Silica and contaminant control
- Chemistry monitoring and trending
- Feedwater quality fundamentals
- Dissolved oxygen and deaeration principles
- Scale and deposit formation
- Blowdown management
- Iron and copper transport
- Linking chemistry deviations to tube failure

11 Steam Trap & Steam-System Auditing

- Developing a steam-system audit strategy
- Ultrasonic trap testing
- Visual inspection
- Prioritising defective traps
- Condensate recovery opportunities
- Audit reporting and corrective-action tracking
- Steam trap population assessment and tagging
- Thermal / infrared inspection
- Identifying failed-open vs. failed-closed traps
- Estimating steam losses; high-loss systems
- Maintenance prioritisation

12 Integrated Boiler & Steam-System Reliability

- Connecting boiler reliability with system performance
- Developing a boiler tube monitoring programme
- Steam trap inspection schedules
- Reliability KPIs and failure-frequency tracking
- Developing an integrated reliability calendar
- Integrating chemistry, inspection and maintenance data
- Integrating NDT and condition monitoring
- Condensate-quality monitoring
- Risk-based intervention planning
- Roles of operations, maintenance, engineering, chemistry

Registration Form

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R 8 999
per delegate

BOOKING CONTACT (APPROVING OFFICIAL)

FULL NAME (MR / MRS / MS)

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VAT NUMBER

TELEPHONE

EMAIL

ADDRESS

SIGNATURE

DATE

FINANCE & PAYMENT

PERSON RESPONSIBLE FOR FINANCE

DIRECT TEL NO.

DATE OF PAYMENT

PURCHASE ORDER / REFERENCE NO.

ACCOUNT HOLDER	BANK	BRANCH	ACCOUNT NO.
Independent Training Management (Pty) Ltd	FNB South Africa	Randburg (251650)	62685879276

DELEGATES ATTENDING THIS WORKSHOP

#	FULL NAME	POSITION	EMAIL
1			
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5			

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