ROOT CAUSE ANALYSIS FOR BOILER & STEAM CYCLE FAILURES

28 – 29 JUNE 2018, MANILA, PHILIPPINES

TOPICS COVERED

Review of Steam Cycle Damage Mechanisms

Steam Cycle Components and Failure Modes

Collecting Evidence and Identifying the Failure Mechanism

Root Cause Analysis Methods

Sample Case Histories and Discussion

Expert Course Faculty Leader
James W. Malloy
About This Training Course

This training course is primarily intended for experienced O&M staff working in thermal power and process plants as well engineering and management staff at the corporate level. The objective is to give attendees all the essentials for effective determination of the root cause of failures that can occur in the boiler or associated steam balance-of-plant. The principal failure modes are reviewed, with focus on those occurring in the boiler, critical piping and other key components such as pressure vessels and condensers.

Major emphasis is placed on analyzing how upstream events in the steam cycle process can lead to failures in downstream components. Several actual failure case histories treated by Tetra Engineering staff at plants around the world are presented, providing attendees with practical application of the presented concepts.

Course Learning Outcome

- Gain an overview of the most common damage mechanisms, either on the waterside or fire/gas/air-side, that can affect components in the steam cycle
- Understand how to define the problem, collect the evidence and then identify the component failure mechanism, which is not the same as the failure root cause.
- Acquire insight into the various root cause analysis methods, their respective merits and how several were applied in some actual case studies

Who Should Attend

Engineers of all disciplines, managers, technicians, design, maintenance and operations personnel, and other technical individuals who need a comprehensive introduction to practical optimization, operation and design considerations of a major combined cycle power plant.

Unique Features with powerEDGE Training

- Pre-Course Questionnaire to help us focus on your learning objectives
- Detailed Course & Reference Manual for Continuous Learning and Sharing
- Practical Exercises & Case Examples to better understand the principles
- Limited class size to ensure One-to-One Interactivity
- Assessment at the end of the course to help you develop a Personal Action Plan
2 Day Course Outline

Review of Steam Cycle Damage Mechanisms
Gain an overview of the most common damage mechanisms, either on the waterside or fire/gas/air-side, that can affect components in the steam cycle
- General Surface Corrosion
- Pitting Corrosion
- Flow Accelerated Corrosion, Cavitation and Fluid Erosion
- Underdeposit Attack
- Fatigue and Corrosion Fatigue
- Creep, Creep Fatigue and other Heat Damage
- Fire or Gas Side Erosion or Attack
- Gas and Waterside Fouling
- Hydrogen Embrittlement
- Stress-Corrosion Cracking

Steam Cycle Components and Failure Modes
A summary of failure modes and mechanisms most frequently observed in various steam cycle components
- Boiler Tubes and Internal Pressure Parts
- Boiler Gas Path and Exterior
- Power Piping (Condensate, Feedwater and Steam)
- Valves and Pumps a (Summary with Focus on Major Items)
- Condensers and Other Heat Exchangers
- Pressure Vessels

Collecting Evidence and Identifying the Failure Mechanism
The key first step is to define the problem, collect the evidence and then identify the component failure mechanism. It’s important to remember that this is usually not the same as the failure root cause.

Root Cause Analysis Methods
There are several methods or approaches to determining the root cause, these are presented in summary fashion here as background. Despite their differences, all follow a similar overall strategy and aim to achieve the same goal. Whatever the method chosen, it is important to remember that the ultimate objective is to find a solution that prevents further failures.
- Defining the Investigation Scope
- Collecting the Field Evidence: Visual, NDE and Destructive Samples
- Process Data Collection
- Overview of Laboratory Analytical Techniques
- Getting the Most Out of Metallurgy
- Effective Reporting

Sample Case Histories and Discussion
Examples from recent projects performed by Tetra staff are presented, covering failure analyses on a variety of steam cycle pressure part components
- Steam Turbine Corrosion
- HRSG Casing Vibration
- Superheater Tube Cracking Failure 1
- Superheater Tube Burst Failure
- HRSG LP Evaporator Tube Burst Failure
- Boiler Tube Fouling
- Others......
Your Expert Faculty — James W. Malloy

James is currently Director of European Operations of a leading engineering and inspection consultancy in the power generation sector. Activities are now concentrated on the steam cycle in combined cycle plants, but included projects for coal, oil, diesel and nuclear plants in the past. Areas of specialization are instrumentation and controls (I&C) as well as materials science.


Lead Engineer, worked on the design and development of real-time systems for controlling diesel generators and turbines. One application involved the development of a complete monitoring system under subcontract to a major European diesel manufacturer, which was subsequently installed on a new black start diesel at a US nuclear plant.

Raytheon Company, Development Laboratory, Sudbury, MA. USA 1983-1987

Engineering and analyses to improve resistance of defense electronic systems to spatial environments and effects of nuclear radiation. This involved designing custom test circuitry and carrying out the tests at both Raytheon and US government facilities.

Combustion Engineering Inc., Nuclear Division, Windsor CT. USA 1980-1982

Worked in the design group responsible for the nuclear fuel reloading (enriched uranium) for the St Lucie 1 and BG&E Calvert Cliffs plants. Used radiation transport programs for simulating the physics of the reactor during a cycle.

Recent Project Experience

- HRSG Inspections (more than 50 in last six years)
- Computer Simulation of Boiler and Steam Plant Performance
- API/ASME FFS-1 Fitness for Service Analysis on HRSG Components
- Coal Boiler Inspection and Life Assessments
- HRSG and Radiant Boiler Failure Analyses
- HRSG Training (annual public courses and closed session at client sites)

Publications:

- "Computer Simulation of HRSGs Can Improve O&M", J.W. Malloy, C. Daublebsky, M.
- Taylor, Power Magazine, Jun 1, 2009

Patents:

US Patent 5,044,992, Sept 3, 1991, "Printed circuit injection molded connector with removable bifurcated contacts capable of high temperature exposure" (assigned to Raytheon Co.)
## ROOT CAUSE ANALYSIS FOR BOILER & STEAM CYCLE FAILURES

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<tr>
<th>Programme</th>
<th>PER PARTICIPANT</th>
<th>2 PARTICIPANTS OR MORE</th>
<th>IN-HOUSE TRAINING</th>
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<tr>
<td>2 Day</td>
<td>SGD 2,737 Per Participant</td>
<td>SGD 2,537 Per Participant</td>
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### ATTENDEE DETAILS

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### COMPANY DETAILS

Organisation name ................................................ Industry .................................................................
Address .................................................................
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