Early Tube Leak Detection: See What You Can’t Hear

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Acoustic Monitoring

Early steam leak detection in power boilers, recovery boilers, feedwater heaters and Heat Recovery Steam Generators (HRSGs)
Benefits of Acoustic Monitoring
How Acoustic Monitoring works & Associated Hardware
Sensor Locations on the Boiler
Leak Trends and Spectrum Analysis
Acoustic Monitoring Detects

- Boiler tube leaks
- Feedwater heater tube leaks and operational anomalies
- HRSG tube leaks
- Stuck sootblowers
- Sootblower effectiveness
- Boiler pluggage and slagging
- Leaking valves and external issues
- Damaging vibration
Acoustic Monitoring is used to:

- Detect leaks earlier than traditional methods
- Reduce secondary damage
- Locate area of leak(s) before unit comes offline
- Trend the severity and progression of the leak with real time data
- Schedule a maintenance vs. a forced outage
- Pre plan jobs with correct assets
- Manage market exposure and risk
- Avoid shadow loss of generation/production
- Provides additional safety measures for high risk areas
HOW ACOUSTIC MONITORING WORKS & ASSOCIATED HARDWARE
Boiler Leak Detection

Sounding Rod Waveguide with Sensor

Weld to Tube Membrane

Boiler Wall

Acoustic Wavefront in Boiler Gas

Leak

Leak
Boiler Sounding Rod Installation

- Non invasive rods weld to boiler wall
- Sensor mounted on end
- Covered with sensor/rod box for protection
Feedwater Heater Sounding Rod Installation

- Non invasive rod welds to the shell at the tube sheet below the water level
- Sensor mounted on end
- Covered with sensor box for protection
HRSG Leak Detection

- Acoustic Wave in Boiler Gas
- Leak
- Inner Liner
- Sounding Rod Waveguide with Sensor
- Weld to Inner Liner
Non invasive rods weld to inner liner
Sensor mounted on end
Covered with sensor box for protection
Length determined based on access
SENSOR LOCATIONS ON THE BOILER
Sensor Locations on the Boiler

Each • indicates 2 sensors on opposite walls
Each • indicates 3 sensors on the same wall
Each • indicates 2 sensors on the same wall

• Sensor locations chosen based on tube configuration and plant areas of concern

• Leak noise follows the gas flow of the unit
Boiler Software Map
HRSG Software Map

<table>
<thead>
<tr>
<th>SENSOR</th>
<th>LOC.</th>
<th>DESCRIPTION</th>
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<tbody>
<tr>
<td>1</td>
<td>BTM</td>
<td>Left Side, Reheat #2</td>
</tr>
<tr>
<td>2</td>
<td>BTM</td>
<td>Right Side, Reheat #2</td>
</tr>
<tr>
<td>3</td>
<td>BTM</td>
<td>Left Side, Superheat #2</td>
</tr>
<tr>
<td>4</td>
<td>BTM</td>
<td>Right Side, Superheat #2</td>
</tr>
<tr>
<td>5</td>
<td>BTM</td>
<td>Left Side, Reheat #1</td>
</tr>
<tr>
<td>6</td>
<td>BTM</td>
<td>Right Side, Reheat #1</td>
</tr>
<tr>
<td>7</td>
<td>SIDE</td>
<td>Left Side Middle, Reheat #2</td>
</tr>
<tr>
<td>8</td>
<td>SIDE</td>
<td>Right Side Middle, Reheat #2</td>
</tr>
<tr>
<td>9</td>
<td>TOP</td>
<td>Left Side, Reheat #2</td>
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<tr>
<td>12</td>
<td>TOP</td>
<td>Right Side, Superheat #2</td>
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SIGNAL TREND
Normal Operations - baseline steady at 86dB – no tube leak
Normal Spectrum

Frequency distribution of the energy in the boiler

Reference spectrum (red trace) saved with the unit running at full load and sootblowers off
LEAK TRENDS & SPECTRUM ANALYSIS
Waterwall Leak

Step increase followed by gradual increase

Unit off-line 4 days after the leak begins

Plant plans outage and minimizes secondary damage
Waterwall Leak

At least one leak here where slope tube bends back around bottom of real division wall. Leak appears to be circumferential crack at least 180 degrees. Crack can be seen from windbox side (underside). May be more leaks will know more once seal box is removed in this area.
Pluggage & Reheat Leak

Pluggage – shift in the baseline with erratic signal

Reheat leak – signals increase with cycles in load

Note the difference between the trends for pluggage versus a leak
Reheat Leak Spectrum

- Spectrum during leak showing increased activity at 1-4 kHz
- Reference spectrum saved during normal operations at full load
Pluggage shows narrowband spikes in the 1-4kHz range

Reference spectrum
Pinhole Waterwall Leak

Gradual increase noted before shutdown for a planned outage

Plant confirms small waterwall leak during outage – repair made
Recovery Boiler Economizer Header Leak

- Mill alerted to increasing acoustic signal
- Leak confirmed and unit removed from service
- Crack in handhole cap weld
Recovery Boiler Economizer Leak

Mill alerted to increasing acoustic signal
Recovery Boiler Economizer Leak
Heat Exchanger Leak

Plant aware of tube leak and monitoring until outage

Normal after start-up
HRSG Superheat Leak

Gradual increase begins 8/18

Planned Maintenance Outage 10/1

Plant monitors acoustic leak trends until outage
HRSG Superheat Leak Spectrum

Spectrum during leak showing increased activity at 1-4 kHz

Reference spectrum
HRSG Superheat Leak

No other plant indications of a leak
Thank you!

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