The New Standard for Steam Trap Management

According to the Alliance to Save Energy, facilities have saved as much as 17% of fuel use when implementing energy-saving processes. Establishing a consistent, long-term steam trap management process is one way to achieve savings.

Historical Approach to Steam Trap Program*
Trap inspections are typically performed one time per year. The problem with this approach is that steam traps fail every day. These undetected failures lead to system irregularities, which, when left undetected long enough, can result in severe problems and equate to many dollars lost.

Proactive Approach to Best Practice Steam Trap Management*
Early detection means being able to act on a trap failure before the associated problem becomes severe. Therefore, immediate evaluation of the situation and measurement of the results are critical for continued best practice process improvement, yearly steam loss reductions and sustained monetary savings.

Wireless, Labor-free, Instant Notification of Steam Trap Failure!

If you were to describe your vision for steam trap best practice, what would it look like?

Awareness
• The ability to constantly monitor the steam trap population without labor allocation
• Instant notification of steam trap failure

Action
• Quick diagnosis and action on best trap replacement based on return on investment (ROI)

Accountability
• A reporting system that provides tracking, measurement, ROI analysis and easy company-wide communication

SteamEye® and SteamStar® bring steam savings through instant notification of steam trap failure.
SteamEye® is the tool to reduce labor and energy costs by constantly monitoring the steam trap population. SteamStar® is the measurement software that will create company-wide awareness for a whole new level of steam savings. When working together, SteamEye® will feed the moment-to-moment steam trap data into SteamStar®. SteamStar® will instantly report this information through Web-based software that allows easy access for company personnel to make timely, money-saving decisions.


 Abramson Steam and Condensate Group, 811 Maple St., Three Rivers, MI 49093 – USA Phone: (269) 273-1415 Fax: (269) 278-6555
SteamStar®
Easy-to-use and Very Affordable Steam Trap Database

SteamStar® is the first Web-based software for recording, monitoring and managing steam trap information.

Improve steam system efficiency.
Steam system efficiency can be directly linked to how well the system is managed. SteamStar® provides diagnostic reporting at various levels of organizational responsibility. The reports permit the evaluation of current conditions and provide the knowledge necessary to make money-saving decisions.

Achieve best practice energy management goals.
History has shown that companies maximize sustainable cost savings when energy goals are measured, monitored, and managed on a consistent basis. SteamStar® is the Web-based tool that will bring data together by site, by region and by company to help achieve best practice energy management goals.

Save valuable time.
Typically steam trap data are presented from multiple sites in different software formats and with different qualifying terminology. These variables make managing steam system information difficult and time-consuming. SteamStar® offers a platform for company-wide steam data to be viewed and analyzed without wasted time.

Eliminate costs associated with software licensing agreements. Licensing agreements can cost tens of thousands of dollars for initial software purchase. For the software to facilitate multiple users, additional capital outlay is required. The Web-based platform of SteamStar® eliminates licensing fees and dramatically reduces the required investment. A one month return on investment!

Improve company-wide communication.
Users at the plant level can perform evaluations to determine root causes of steam system issues. Using the same platform, the global energy manager has the ability to analyze data for sites around the world. This level of communication promotes understanding of steam system efficiency.

Screen shot of SteamStar® home page.
SteamStar® Web-based software will evaluate steam system data.
Continuous Steam Trap Monitoring captures real time steam trap operation from SteamEye®. SteamEye® is the automated steam trap monitoring tool that provides accurate and constant information from each steam trap. This information is translated by SteamStar® into actionable reports. All of the reports available in SteamStar® are designed for best practice measurement.

- Executive Summary
- Steam and Monetary Loss
- Defective Trap Report
- Manufacturer Summary
- Trap Evaluation by Application

Company Benchmarking
This premium report establishes a comparison to sister sites and industry peer best practices. The user has a choice of which sites to benchmark and which factors to compare. Steam losses and monetary losses can be compared by site, by type of application, by type of trap, and more. This report will offer management a wide analysis of which sites are working to reduce steam losses and which lag behind. It will also highlight any areas of concern in terms of high steam trap failure rate compared to total monetary losses. This report is a valuable tool for facility managers and global energy managers alike.

Prioritized Work Orders
The work order report is a premium report that was designed for optimum facility payback on labor and material while keeping energy losses to a minimum. This report is available at the site or unit level and will create a work order for steam trap repairs based on payback.

Trend History
The premium trend analysis report will assist a manager with the comparison of multiple years of data. The data available for comparison are steam loss, monetary loss, fuel consumed, and emissions created. Like the other premium reports, the trend analysis report can be compared by site and/or region. It will also track emissions—CO₂, SOx, NOx—and highlight the progress made toward steam system efficiency and dollars saved.

Emissions Summary
The premium emissions report is valuable for its ability to focus on the quantifiable emissions of CO₂, SOx, and NOx in one summarized view. Steam system efficiency is not only viewed as important in terms of energy losses but also in terms of environmental impact. The emissions report is especially beneficial to users that are penalized by world governments for high emission factors.
SteamEye®—The Only 24/7, Wireless, Labor-free Steam Trap Monitoring System!

“IT'S LIKE HAVING A MAN SITTING THERE WATCHING TRAPS ALL DAY.”
That’s how a maintenance supervisor at an installation summed up the benefits of SteamEye®.

But exactly how does SteamEye® do what it does? And how does it use radio waves to signal a real beginning in steam system optimization? What is wireless steam trap monitoring anyway?

Wireless monitoring of steam traps gives you an instantaneous insight into trap performance that is the most accurate measure of steam trap status available. The system consists of a transmitter, a repeater (if necessary), and a receiver. Building automation system integration is also an option. Consult your Armstrong Representative or Armstrong’s Application Engineering Department.

SteamEye® saves energy and money
Whoever first observed “Little things mean a lot” perhaps had failed steam traps in mind. Show us a steam trap blowing through (losing steam), and we’ll show you potential for huge savings in the dollars you spend for energy to generate steam in the first place. Besides, less energy consumed means less waste, fewer emissions and a healthier environment. As you see from the table below, a little steam leak can truly be the start of something big. A single trap with an 1/8-inch orifice can squander more than $4,000 per year. Multiply that by the number of traps represented in a typical 20% failure rate, and you begin to get the idea. Failed steam traps waste energy and cost you money. Big money. But that was then. Now there’s SteamEye®.

What does an undetected failed steam trap cost?
At today’s energy prices, steam trap blow-thru can no longer be tolerated. Energy lost means dollars lost. In addition to energy losses, do not forget the other costs associated with undetected steam trap failure.

• Critical processes, possible loss of product
• Pressurized return lines
• Failure to other equipment such as electric condensate pumps, PRVs and control valves
• Unexpected downtime
• Emergency labor requirements

Cost of Various Sized Steam Leaks (assuming steam costs of $10.00/1,000 lb)

<table>
<thead>
<tr>
<th>Pressure (psig)</th>
<th>Orifice</th>
<th>Steam Loss</th>
<th>Dollar Loss Per Year</th>
<th>500 Traps 20% Failure Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>3/16&quot;</td>
<td>241,741</td>
<td>$2,417</td>
<td>$241,700</td>
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<tr>
<td>50</td>
<td>5/32&quot;</td>
<td>365,991</td>
<td>$3,660</td>
<td>$366,000</td>
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<tr>
<td>125</td>
<td>1/8&quot;</td>
<td>497,563</td>
<td>$4,976</td>
<td>$497,600</td>
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<tr>
<td>250</td>
<td>#38</td>
<td>610,027</td>
<td>$6,100</td>
<td>$610,000</td>
</tr>
<tr>
<td>450</td>
<td>1/8&quot;</td>
<td>1,655,099</td>
<td>$16,551</td>
<td>$1,655,100</td>
</tr>
<tr>
<td>600</td>
<td>7/64&quot;</td>
<td>1,674,206</td>
<td>$16,742</td>
<td>$1,674,200</td>
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</tbody>
</table>

NOTE: Steam loss based on bi-phase flow through an orifice using Armstrong’s steam loss formula, approved by the United Nations Technical Committee.
The SteamEye® System

Wireless technology has been around for decades. Armstrong International has taken this technology, combined it with our 100 years of steam trap experience and developed a product to accurately determine the operational condition of any type, make and model of steam trap without a labor requirement.

Each transmitter is equipped with an electronic board. This board houses the engineered “thought process” that gives SteamEye® its reliability and accuracy. The conductivity transmitter uses a conductive probe to detect a blow-thru steam trap. The Ultrasonic transmitter uses a unique Armstrong designed Waveguide that concentrates the operational sound of any steam trap to the electronic board of the transmitter. The “thought process” of the electronic board “listens” to the trap operation and determines precisely whether a trap is operating normally or is in a blow-thru state. In addition to the blow-thru condition, both transmitters have the ability to sense when a trap is cold. To eliminate false readings on modulating steam applications, the Ultrasonic and Conductivity transmitters will check to see if pressure exists before sending a cold alarm.

SteamEye® How It Works

Using wireless technology, the transmitters (SteamEye® monitors) send information about the operating condition of the steam trap, or other monitored device, to the receiver (Gateway). The Gateway is connected to your company’s network where the information can be viewed through a web browser as though you are surfing the intranet (see screenshot of SteamEye® on page TM-6).

SteamEye® can be integrated into your existing Building Automation System (BAS) or Digital Control System (DCS) using MODBUS RS-232 or RS-485 communication platform. This allows you to view and alarm your SteamEye® monitored devices seamlessly throughout your existing control systems.

Furthermore, SteamEye® can be linked to SteamStar® through the Internet for real time steam loss information using the Energy Tracker feature. This will calculate and quantify accumulated steam and dollar losses until action is taken. All this is important information to help prioritize busy work schedules in today’s “do more with less” workplace.

In applications where the transmitter has line of sight to the receiver, the range is approximately 1,500 feet. In facilities where the signal must travel through walls, floors and other obstructions the range is 300 to 500 feet. If the receiver is out of the range of a transmitter, devices called repeaters can be placed between the transmitter and the receiver to “repeat” the signal from one device to the next. A radio frequency signal strength survey is required to determine if repeaters are needed, where they will be located and how many will be required.

Steameye® will...

- Monitor traps 24 hours a day, 365 days a year using wireless technology
- Alert immediately when a steam trap has failed, mitigating steam loss
- Protect critical process from steam trap failure
- Mitigate frozen coils caused by plugged traps
- Hasten problem solving in areas where incorrect size or type of trap is used in specific applications
- Eliminate labor associated with testing traps
- Work in conjunction with a building automation system (BAS)
SteamEye® Transmitter Choices

The Ultrasonic 4700 Series transmitter is used for applications 15 psig and above. The Conductivity 4300 Series transmitter is designed for steam pressures below 15 psig. In addition, each series transmitter has two operating designs, constant pressure and on/off. The constant pressure transmitter is used on steam traps where steam is "on" at all times. The on/off transmitter should be used in applications where steam pressure is not constant. An example of an on/off application would be a batch process: steam pressure is required when the process is running, and steam is valved off when there is no batch being run. The purpose of the on/off transmitter is to eliminate a false cold signal due to no steam pressure. The on/off transmitter provides a connection allowing the unit to be tied to a pressure or position switch that indicates whether the system is pressurized.

Got Tunnels or Confined Spaces?
Testing steam traps in hard-to-reach locations such as tunnels, confined spaces or ceilings is labor intensive, costly and unsafe! SteamEye® allows traps to be monitored remotely, eliminating unnecessary access to these areas. A remote probe is available for areas like steam vaults, which can be challenging for an RF signal. A radio frequency survey would be performed to determine the most cost effective manner of providing labor-free monitoring of steam traps in areas where worker safety is a concern.

With SteamEye® and SteamStar®, Energy Management Is Right at Your Desk

As we have seen, the SteamEye® system is your window into the inner workings of your steam trap population. You can also use the SteamStar® platform for data management. As a result, you can build a remarkably versatile database of trap operating history.
### SteamEye® Series 4000

**Physical Data and Material Specification**

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Image" /></td>
<td>URFC 4700</td>
<td>Constant</td>
<td>123 Duracell Li-ion</td>
<td>902-928 MHz</td>
<td>200 kHz</td>
<td>60 mW</td>
<td>-40°F to 140°F (-40°C to 60°C)</td>
<td>—</td>
<td>—</td>
<td>Class I, Groups C, D, Class II, Groups F, G, Class III, Div. 1, 2</td>
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<tr>
<td><img src="image2.png" alt="Image" /></td>
<td>URFM 4700</td>
<td>Modulating</td>
<td>123 Duracell Li-ion</td>
<td>902-928 MHz</td>
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<td>60 mW</td>
<td>-40°F to 140°F (-40°C to 60°C)</td>
<td>6.5 ft. (2 m)</td>
<td>7” x 3” dia. (17.8 x 7.6 cm) dia.</td>
<td>Class I, Groups C, D, Class II, Groups F, G, Class III, Div. 1, 2</td>
</tr>
<tr>
<td><img src="image3.png" alt="Image" /></td>
<td>URFC 4700R</td>
<td>Remote</td>
<td>123 Duracell Li-ion</td>
<td>902-928 MHz</td>
<td>200 kHz</td>
<td>60 mW</td>
<td>-40°F to 140°F (-40°C to 60°C)</td>
<td>16.4 ft. (5 m)</td>
<td>Transmitter 3.5” x 4.5” x 2.25” (8.9 x 11.4 x 5.7 cm) Probe 7” x 3” dia. (17.8 x 7.6 cm) dia.</td>
<td>—</td>
</tr>
<tr>
<td><img src="image4.png" alt="Image" /></td>
<td>RFC 4300</td>
<td>Constant</td>
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<td>902-928 MHz</td>
<td>200 kHz</td>
<td>60 mW</td>
<td>-40°F to 140°F (-40°C to 60°C)</td>
<td>6.5 ft. (2 m)</td>
<td>5.5” x 4.5” x 2.6” (14.1 x 11.4 x 6.6 cm)</td>
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<td>60 mW</td>
<td>-40°F to 140°F (-40°C to 60°C)</td>
<td>—</td>
<td>7” x 3” dia. (17.8 x 7.6 cm) dia.</td>
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<tr>
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<td>123 Duracell Li-ion</td>
<td>902-928 MHz</td>
<td>200 kHz</td>
<td>60 mW</td>
<td>-40°F to 140°F (-40°C to 60°C)</td>
<td>50 ft. (15.24 m)</td>
<td>Transmitter 6.3” x 3.2” x 2.2” (16 x 8 x 5.6 cm) Probe 5” x 1.9” dia. (12.7 x 4.8 cm) dia.</td>
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</tr>
<tr>
<td><img src="image7.png" alt="Image" /></td>
<td>RFM 4300R</td>
<td>Modulating</td>
<td>123 Duracell Li-ion</td>
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<td>200 kHz</td>
<td>60 mW</td>
<td>-40°F to 140°F (-40°C to 60°C)</td>
<td>50 ft. (15.24 m)</td>
<td>Transmitter 6.3” x 3.2” x 2.2” (16 x 8 x 5.6 cm) Probe 5” x 1.9” dia. (12.7 x 4.8 cm) dia.</td>
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**Gateway / Repeater Data**

<table>
<thead>
<tr>
<th>Gateway</th>
<th>4000</th>
<th>4000M</th>
<th>4008 Series</th>
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<tbody>
<tr>
<td>Power Requirements</td>
<td>120 VAC</td>
<td>120 VAC</td>
<td>120 VAC or 12 VDC</td>
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<td>Power Consumption</td>
<td>300 mA at 12 VDC</td>
<td>1.2 A at 5 VDC &amp; 0.27 A at 12 VDC</td>
<td>40 mA at 12 VDC</td>
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<tr>
<td>Frequency</td>
<td>902 - 928 MHz</td>
<td>902 - 928 MHz</td>
<td>902 - 928 MHz</td>
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<tr>
<td>Bandwidth</td>
<td>200 kHz</td>
<td>200 kHz</td>
<td>200 kHz</td>
</tr>
<tr>
<td>Operating Temperature Range</td>
<td>32°F to 158°F (0°C to 70°C)</td>
<td>-32°F to 140°F (0°C to 60°C)</td>
<td>32°F to 140°F (0°C to 60°C)</td>
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<tr>
<td>Connections</td>
<td>Ethernet 1 x 10/100 mbps</td>
<td>Ethernet 1 x 10/100 mbps Modbus</td>
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<tr>
<td>Transmission Power</td>
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<td>250 mW</td>
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<tr>
<td>Dimensions</td>
<td>6.5” x 4.5” x 1.6” (16.5 x 11.4 x 4 cm)</td>
<td>6.5” x 4.5” x 3.25” (16.5 x 11.4 x 8.3 cm)</td>
<td>6.5” x 3.5” x 1” (16.5 x 8.9 x 2.5 cm)</td>
</tr>
<tr>
<td>Max. number of hops</td>
<td>—</td>
<td>—</td>
<td>11</td>
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</table>

All dimensions and weights are approximate. Use certified print for exact dimensions. Design and materials are subject to change without notice.
# SteamEye® Series 3000

**Physical Data and Material Specification**

<table>
<thead>
<tr>
<th>Illustration</th>
<th>Transmitter</th>
<th>Application</th>
<th>Battery</th>
<th>Operating Frequency</th>
<th>Transmission Bandwidth</th>
<th>Transmission Power</th>
<th>Operating Temperature Range (Ambient)</th>
<th>Cable</th>
<th>Approximate Dimensions</th>
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<td>Constant</td>
<td>123 Duracell</td>
<td>902-928 MHz</td>
<td>200 kHz</td>
<td>10 mW</td>
<td>-40°F to 140°F (-40°C to 60°C)</td>
<td>—</td>
<td>7&quot; x 3&quot; dia. (17.8 x 7.6 cm) dia.</td>
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<tr>
<td><img src="image" alt="URFM 3700" /></td>
<td>URFM 3700</td>
<td>Modulating</td>
<td>123 Duracell</td>
<td>902-928 MHz</td>
<td>200 kHz</td>
<td>10 mW</td>
<td>-40°F to 140°F (-40°C to 60°C)</td>
<td>6.5 ft. (2 m)</td>
<td>7&quot; x 3&quot; dia. (17.8 x 7.6 cm) dia.</td>
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<td><img src="image" alt="URFC 3700R" /></td>
<td>URFC 3700R Remote</td>
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<td>902-928 MHz</td>
<td>200 kHz</td>
<td>10 mW</td>
<td>-40°F to 140°F (-40°C to 60°C)</td>
<td>Transmitter: 3.5&quot; x 4.5&quot; x 2.25&quot; (8.9 x 11.4 x 5.7 cm)</td>
<td>Probe: 7&quot; x 3&quot; dia. (17.8 x 7.6 cm) dia.</td>
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<tr>
<td><img src="image" alt="RFC 3300" /></td>
<td>RFC 3300</td>
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<td>5.5&quot; x 4.5&quot; x 2.6&quot; (14 x 11.4 x 6.6 cm)</td>
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<td><img src="image" alt="RFM 3300" /></td>
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<td>200 kHz</td>
<td>10 mW</td>
<td>-40°F to 140°F (-40°C to 60°C)</td>
<td>6.5 ft. (2 m)</td>
<td>5.5&quot; x 4.5&quot; x 2.6&quot; (14 x 11.4 x 6.6 cm)</td>
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<td><img src="image" alt="RFC 3300R" /></td>
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<td>902-928 MHz</td>
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<td>Transmitter: 6.3&quot; x 3.2&quot; x 2.2&quot; (16 x 8 x 5.5 cm)</td>
<td>Probe: 5&quot; x 1.9&quot; dia. (12.7 x 4.8 cm) dia.</td>
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<td><img src="image" alt="RFM 3300R" /></td>
<td>RFM 3300R Remote</td>
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<td>Probe: 50 ft (15.24 m)</td>
<td>Switch: 6.5 ft. (2 m)</td>
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## Gateway / Repeater Data

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<thead>
<tr>
<th>Gateway</th>
<th>Repeater</th>
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<tr>
<td><strong>3000</strong></td>
<td><strong>3000M</strong></td>
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<td>Power Requirements</td>
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<td>Power Consumption</td>
<td>300 mA at 12 VDC</td>
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<tr>
<td>Frequency</td>
<td>902 - 928 MHz</td>
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<tr>
<td>Bandwidth</td>
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<td>Operating Temperature Range</td>
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<td>Connections</td>
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<td>Transmission Power</td>
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<tr>
<td>Dimensions</td>
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</tr>
<tr>
<td>Max. number of hops</td>
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</tr>
</tbody>
</table>

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SteamEye® Monitoring Capabilities

4700 Ultrasonic type steam trap monitors
  Steam trap monitor for constant pressure
  Steam trap monitor for on/off steam systems*
  Steam trap remote monitoring

4300 Conductivity monitors
  Steam trap monitor for constant pressure
  Steam trap monitor for on/off steam systems*
  Steam trap remote monitoring

Safety Relief Valve Monitor
Coil Monitor
Liquid Level Monitor
Pump Trap Monitor
Universal Switch
Pressure Switch

*Pressure switch to be used on systems where steam may be shut off. This will prevent false “Cold” alarms.

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All dimensions and weights are approximate. Use certified print for exact dimensions. Design and materials are subject to change without notice.
Steam System Survey

History
Industries use approximately 42% of the total energy consumed annually in the United States. Of this, about half (or 21% of total U.S. energy consumption) is used to generate steam in more than 54,000 large industrial-sized boilers.

Unfortunately, much of that steam is lost through leaks in the distribution system, including piping, valves and steam traps. Lost steam must be replaced, which can only be done in a boiler that consumes fuel.

The cost of replacing wasted steam can be enormous in terms of system efficiency, lost production, fuel consumption, makeup water treatment cost, and maintenance. These additional costs must be factored into the bottom line of every organization.

Environmental Considerations
Inadequate trapping on steam mains not only results in economic losses, it also creates environmental concerns as additional fuel is burned to replace lost steam. For example, assume the steam-main pressure is 150 psig and the leak size is 5/64”—about the thickness of a penny. In this instance, approximately 27 lb of steam will be wasted per hour—escaping from the system or blowing through a trap and into the return line.

Twenty-seven pounds per hour may not sound significant, but over one year (8,400 hours), that small leak will waste the following equivalent amounts for fuel:

- 1.9 tons of bituminous coal at a value of $679 (coal cost $57/ton)
- 2,385 gal of residual oil at a value of $978 (oil cost $0.41/gal)
- 3,141 ccf of natural gas at a value of $1,272 (gas cost $4.05/mcf)

Pulverized bituminous coal in a dry bottom-firing boiler will generate the following pollutants per year:

- 727 lb of particulate matter
- 465 lb of sulfur oxides
- 250 lb of nitrogen oxides
- 7.2 lb of carbon monoxide
- 9.7 tons of total carbon

These figures represent a case in which just one trap has blown through—typical failure mode of many steam traps. Compound the figures by the number of potential failed traps and you can begin to understand the value of trap maintenance, both in terms of energy and the extra load placed on your environmental cleanup systems.

Evaluation = Efficiency = Dividend
Reliable evaluation of steam trap operation is necessary for traps to work at peak efficiency. Trap testing is a key element in a complete energy management program, and an essential skill for protecting your investment.

Accurately evaluating steam trap operation can pay dividends in energy conservation, save countless maintenance hours, and reduce unscheduled downtime caused by trap failure.

Steam-Trap Survey
To ensure that your steam traps are maximizing the return on your product investment, your first steps should be to conduct a steam-trap audit or trap survey, then implement a comprehensive trap-maintenance program. Proper trap maintenance requires someone who knows how each type of trap functions and can determine if each trap is operating as required.

Armstrong has the ability and trained personnel to conduct steam system energy audits for any facilities in the world. Our factory-trained technicians have decades of experience and have tested tens of millions of steam traps worldwide.

Test and Replace Just the Failed Traps
The sooner a trap is identified as an energy waster, the sooner it can be replaced. Since newer testing methods require minimal labor, traps can be tested more frequently and failed traps can quickly be identified. In addition, perfectly good traps that may be misdiagnosed as failed by less reliable testing techniques will no longer be routinely replaced, thus saving the expense of a new trap and related labor costs.

Armstrong continues to lead the industry with innovative testing and tracking tools such as SteamStar®, SteamEye® and TrapAlert™.

By using SteamEye® technology, you can better spend your maintenance time repairing only defective traps and not evaluating traps that have been misdiagnosed as failed. In conjunction with SteamStar®, the system becomes the premier steam trap management package for maintaining a healthy steam system.

Maintaining the Boiler Plant
Boiler plant reliability and efficiency depend on the stability and success of each component of the steam generation, distribution and condensate return system. Maintaining a boiler plant means paying close attention to components including flanges, elbows, valves, unions and steam traps, since each component has the potential to waste steam.

We can help with proper system evaluations, as well as piping recommendations, replacement-trap sizing and troubleshooting.