# Boiler Steam Audit Helps Customers Lower Operating Costs

## *Learn How the Process Can Help Reduce Energy Use, Save Money*

*By Steve Connor of Cleaver-Brooks*

With today's economic challenges, many of your customers are looking for ways to reduce operating costs. Increasing the efficiency of a boiler or steam system can offer a fast and high return on investment.

Finding these inefficiencies starts with a steam audit, a comprehensive analysis of energy used within a facility, process or equipment, including recommendations for energy conservation measures.

Reducing fuel cost is the number-one reason for a steam audit. Money saved on fuel can be reinvested in the business or, if needed, provide liquidity when cash flow is tight.

### Types of Audits

There are two types of steam audits: a *simple boiler room audit* and a *complete facility audit*. In a simple audit, a professional evaluates the boiler room, including the boiler and accessory support equipment. In a complete site audit, auditors evaluate the boiler room, the steam system, and all the components throughout a facility, including steam traps, piping, valves and steam users.

Audit customers will be provided with:

- Data – Where and how a facility, process or equipment uses energy, along with costs and utility data affecting energy consumption.
- Analysis – Potential measures to make energy use more efficient, less expensive and more environmentally friendly.
- Final Report – A detailed list of areas for improvement and recommended actions, usually accompanied by some type of economic justification.

A simple boiler system audit costs approximately $2,500, whereas a complete site audit—depending on the complexity and the size of the plant—can cost several thousand dollars.

### Steam Audit Process

During a simple boiler room audit, facilities should operate as normal so the auditor can spot visual indications of energy loss and possible operational and safety issues.

The boiler, its controls, fuel delivery, blowdown (continuous and bottom), safety valves, safety valve piping, feedwater conditioning and delivery will be inspected to identify inefficiencies and possible hazards. This includes an inventory of key equipment, looking for energy-saving methods, areas to improve engineering practices, and health and safety concerns.

Once this is completed, the auditor conducts a boiler efficiency analysis, sampling the products of combustion as the burner ramps from low to high fire. During this process the auditor is looking for a typical boiler load and how much time the unit stays at certain firing rates. This, along with the flue gas analysis showing percent oxygen, carbon dioxide and carbon monoxide will then determine the overall efficiency of the boiler. This is very important because a typical boiler will consume four times its initial cost in fuel, annually, nad in many industrial applications this means a fuel spend in excess of $1,000,000 per year.

In a complete facility audit, auditors will also focus on the boiler room, but then extend beyond into the overall steam system looking for potential energy and safety improvements throughout the facility. They'll gather data regarding steam flow, pressures, temperatures, supply and return piping and support, steam trapping, steam venting, piping ancillaries including valving and insulation, remote condensate pumping and heat recovery; seeking energy savings by identifying where the losses or infractions are occurring, then documenting the data for incorporation into the final report.

**Important Steam Audit Findings**

A simple boiler room or complete system audit will determine the condition of the current boiler system, looking beyond age at issues such as:

- Pressure vessel condition
- Evidence of overheating and poor combustion (soot)
- Outdated burners and controls
- The boiler room log(s) including boiler operations and water chemistry
- If it makes good economic sense to invest in improvements
- If it makes better sense to replace with new or used equipment
- What the boiler load is, and what the boiler capacity (size) should be to avoid wasteful cycling.

Many times what is found is a well-maintained boiler, fit for investment, only requiring an updated burner and/or combustion control system for improving the fuel/air mix and repeatability. Retrofits are significantly cheaper than boiler replacement, but still provide a great opportunity for significant fuel savings. The audit will delineate the detail, providing the basis for an informed decision.

It's also important to investigate whether the boiler has been overheating. If so, there might be problems with either the boiler's insulation or gasketing, which could lead to damaged and unsafe equipment. Repairs are relatively nominal to correct these issues. On the other hand, it may indicate the boiler is seriously scaled on the waterside, telling us it may have to be acid cleaned at a fairly significant cost or, it is now time to replace the boiler rather than investing good money after bad.

During the efficiency analysis mentioned previously, the auditor is checking for specific elements in the flue gas which indicate the effectiveness of the burner to efficiently oxidize the fuel. Additionally, the auditor is looking for the level of nitrogen oxides (a precursor to smog formation) and the stack temperature above the saturated steam temperature within the pressure

vessel. Results could lead to recommending an oxygen sensor/transmitter in the exhaust gas, which continuously senses oxygen content and provides a signal to the controller to trim the air damper and/or fuel valve to maintain consistent oxygen concentration as atmospheric conditions vary, improving combustion efficiency. If the nitrogen oxide level is high and the boiler is in a non attainment area for ozone (smog), a flue gas recirculation (FGR) system may be recommended and retrofitted to bring the boiler package into air quality compliance.

If the stack temperature is high it may mean that the boiler is scaled or sooted inhibiting proper heat transfer. A cleaning and re-tuning of the burner will in most cases alleviate this problem, bringing the boiler/burner package back to an acceptable fuel to steam efficiency.

The stack temperature may also indicate the boiler to be an excellent candidate for a feedwater economizer, reducing the stack temperature, adding to the boilers efficiency by transferring Btu's in the stack to usable energy in the boiler's feedwater makeup. For every forty (40) degree temperature drop in the stack, you gain one (1) percent in efficiency.

***Reducing Operating Pressure***

An audit will also observe and determine if it's possible to reduce the boiler's operating pressure.

Auditors look at the heating process and the existing piping layout to determine if the diameter of the piping, controls, steam traps and control valves can tolerate lower pressure. If the pressure can be reduced, fewer BTUs per hour will be used, cutting the customer's energy costs.

***Piping Conditions***

A complete facility audit will review steam piping for energy loss through radiation and steam leaks. Steam loss through radiation can be reduced by insulating the pipes and associated valving.

Steam leaks are especially wasteful and should be addressed as soon as practically possible. Depending on the pressure in the pipe, and the size of the leak, the losses can be staggering; thereby warranting the time effort and expense required to rectify. See table 1 for details.

| Dollars/Year at 100 Psig | | Table 1 | | |
|---|---|---|---|---|
| Equivalent Orifice Diameter | Lbs./Yr. Steam Loss | Steam Cost Per 1,000 Lbs. | | |
| | | $5.00 | $7.50 | $10.00 |
| 1/16” | 115,630 | $578 | $867 | $1,156 |
| 1/8” | 462,545 | $2,313 | $3,469 | $4,625 |
| 1/4” | 1,848,389 | $9,242 | $13,863 | $18,484 |
| 1/2” | 7,393,432 | $36,967 | $55,451 | $73,934 |

**Cost Multipliers For Other Steam Pressures:**

| | | |
|---|---|---|
| 16 Psig -. 26 | 50 Psig - .56 | 150 Psig - 1.43 |
| 200 Psig - 1.87 | 300 Psig - 2.74 | 600 Psig - 5.35 |

***Feedwater System***
An auditor will investigate the feedwater supply to the boiler and condensate returns.

The object is to determine if water sent directly into the boiler is free of dissolved gases such as oxygen and carbon dioxide, which can cause destructive corrosion to the boiler and condensate lines. If such gases are present, the auditor may recommend installing a deaerator. Deaerators are an option if the boiler operates at 75 psig or greater, has limited standby capacity and is using 25 percent or more cold water make-up. It will greatly reduce the need for chemical treatment which not only adds operational cost because of the cost of the chemical, but fuel cost as well because of the need to increase the amount of continuous blowdown; Btu filled effluent, ejected into the sewer unless it is reclaimed….. .

Auditors will also examine the condensate return system, and how much (hot) condensate is being returned to the boiler’s feed tank. It takes less heat to turn condensate back into steam because it returns with much of its sensible energy. Returning more condensate back to the boiler can; therefore, lead to hundreds of thousands of dollars in annual savings because the burner does not have to add as much (fuel) energy to bring the boiler water back to the boiling point. For every eleven (1) degree rise in the feedwater temperature there is a one (1) percent rise in boiler efficiency.

***Steam Trap Audits***
Steam trap audits are typically performed during a complete facility site audit. Besides finding, documenting and testing the individual traps, the examiners primarily look for traps that are “blowing through”—pressurizing the condensate line(s) causing possible water logging of the heat user, cutting down on its efficiency and performance. This situation can also result in excessive venting and energy loss through the condensate receiver/boiler feedwater tank.

The other critical issue auditors look for is water hammer, which occurs when steam condenses in a horizontal section of the steam piping—usually caused by a poor condensate drainage and

trapping strategy. Steam picks up the water as it travels approximately 10 times faster above the fluid, forming a wave or "slug" which hurls it at high velocity into a pipe elbow or other restrictive device (valve, tee, etc), creating a loud hammering noise while severely stressing the pipe. In some cases this is of sufficient force to fracture the pipe causing the condensate to flash into steam, expanding over 1600 times its volume, resulting in major damage for anything in its destructive path.

***The Return on Your Investments***

The last key component of a steam audit is what can be expected for return on investment, ROI.

The boiler room or full facility audit documents where the key energy losses are occurring and what can be done to rectify the problem, returning thousands of dollars to the customer in the form of fuel burning savings.

Then, given the cost of the "fix," the installation costs, and the possible (cost) loss due to downtime, the auditor and/or installing contractor can evaluate and document the ROI, fitting those retrofits which make good economic sense into the customer's budget or time span for return of the investment.

*Steve Connor is Director of Marketing/Communications for Cleaver-Brooks Company, the world's largest producer of steam and hot water boilers. His background includes over 40 years of experience in the steam generating field spanning a broad scope of disciplines including engineering, service training, and field application sales.*