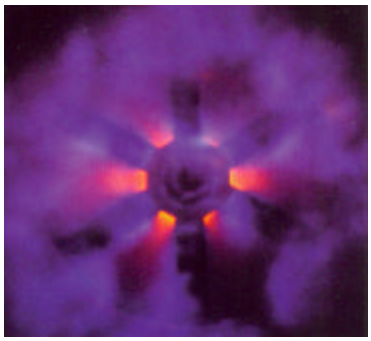

Two Case Studies

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Case Studies Based on Union Gas Boiler Efficiency Program:

- **Will look at two different applications:**
  1 - **Case study 1 deals with a major boiler control tuning/Steam Plant Operation.**
  2 - **Case study 2 deals with major boiler repairs and tuning.**
- **Will discuss the way we found the boilers when we first looked at them.**
- **Will discuss the problem and the solution.**
- **Will discuss the boiler performance following the upgrade/repair.**
- **Will touch on the energy saving issues.**
- **Will discuss similar experiences if any.**

Case Study #1

Original Conditions:

- **Steam plant with two boilers operating using natural gas only.**
- **Boilers operating with high excess oxygen all the time.** 12-18%
- **Steam plant unable to handle large steam load changes automatically.**
- **Unreliable boiler operation. – Too many unexpected boiler trips.**
- **Needed two boilers on line because of unreliability.**
- **DA vent was set too high.**
- **Boiler feedwater pumps oversized for current needs.**
- **Major concern: High fuel and electric power consumption.**

Work Done:

- **Install accurate mass flow metering systems for gas and steam flows.**
- **Install oxygen analyzers & implement O_2 trim control system.**
- **Up-grade the airflow characterization curves to meet requirements.**
- **Establish the combustion airflow control from the FD fan inlet vanes.**
- **Implement all four burners firing all the time, from min. to MCR.**
- **Fix the DA vent issue by using an orifice plate.**
- **Replace the feedwater pumps and reduce horsepower from 250 to 100.**

Conditions After the Upgrade:

- **Boilers operating with excess oxygen at 2.5% most of the time.**
- **All four burners firing all the time deliver a uniform heat input and distribution, optimize heat transfer and boiler circulation.**
- **One boiler can take the load swings automatically.**
- **Proven-reliable operation convinced management to use one boiler only.**
- **One boiler on line instead of two saves energy.**
- **One boiler operates at its most efficient firing rate on a continuous basis.**
- **Boiler feedwater pumps running smoothly at about 70% load.**
- **Significant energy saving was obtained.**

Energy Savings per Year:

• Natural gas savings attributed to improved control	$790,000.00
• Electric power saving due to boiler tuning and resized feedwater pumps.	$203,000.00
Total savings per year	$993,000.00
Payback time	3.6 months

Case Study #2

Original Conditions:

- **This is a steam plant with three boilers.** The case study applies to one of them.
- **Oxygen trim control mechanism did not deliver performance.**
- **Boiler operating with very low excess oxygen all the time.**
- **Boiler operating with very high and visible CO.**
- **Boiler exhaust flue gas temperature was very high at >850/600°F.**
- **Flue gas path restrictions limited the use of more combustion air.**
- **The total steam generation capacity was limited to 73.4%.**
- **Average efficiency was around 72%.**
- **Major concern: Safety + poor boiler performance at high energy cost.**

Work Done:

- **Install the oxygen analyzer in the middle of the duct before the air heater.**
- **Reconfigure airflow characterization curve to meet requirements.**
- **Clean boiler tubes, remove all hardened deposits, repair baffles and refractory.**
- **Install new soot blowers (steam type).**
- **Install new access doors to the generating bank area.**
- **Perform other boiler maintenance tasks. Windbox, burners, igniters, other.**
- **Check all control system components.**

Boiler Conditions After the Repair:

- **Boiler at normal firing rate with an excess oxygen of about 2.5%.**
- **Boiler operating with a CO at zero ppm under all loads condition.**
- **Boiler flue gas temperature returned to design value - 627/360°F.**
- **Steam generation capacity very comfortable at MCR - 225,000#/hr.**
- **Flue gas path restrictions cleared.**
- **Efficiency improved by 5.09%, from about 78.6% to 83.7%.**
- **Fuel saving improved by 11.72%** (details next slide)

Energy Savings Results per "Quarter":

	Before	***After***
• **Flue gas temperature**	**580°F**	**360°F**
• **Cost of fuel**	**$5.20/GJ**	**$5.20/GJ**
• **Fuel flow per hour** (at 75%)	**175,000scf/hr**	**175,000scf/h**
• **Total fuel used**	**383,249,984cf**	**338,334,560cf**
• **Total fuel cost**	**$2,134,702**	**$1,884,523**
• **Efficiency**	**78.6%**	**83.7%**
• **Efficiency improvement**		**5.09%**
• **Savings in fuel**		**11.72%**
• **Savings in fuel used**		**44,915,428cf**
• **Dollar savings per quarter**		**$250,178.00**
• **Estimated payback time**		**1.5 months**

Easy Steps to Energy Savings:

- **Review the steam plant performance and think about the problem(s).**
- **Prepare study, take lots of data and think about the solution(s).**
- **Prioritize all options and focus on the payback time.** Do with what you have.
- **Implement and manage the solution for minimum cost.**
- **Evaluate results and provide documentation for future reference.**
- **Train the operating engineers to maintain high efficiency.**
- **Implement adequate maintenance programs to ensure continuous energy saving and optimized operating performance.**
- **Manage the energy saving program…on going.**

In general terms, two parts compose the efficient operation of a boiler:

The first part is the deals with enabling the boiler to perform efficiently.

During this part we look at all the items that interfere with providing a safe and efficient boiler operation.

The second part deals with operating the boiler efficiently on a continuous basis.

Here is where the "Operating Engineers and Maintenance Teams" play a key role every day.

However, if the boilers are not conditioned and tuned to run efficiently, the expected energy savings will not be realized.

The End