Optimizing Boiler System Design
According to Best Practices

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Miura New England
PRESENTATION OVERVIEW:

- U.S. energy & environmental overview
- Overview of boiler system management
- BEST PRACTICES
  - Review of current & evolving boiler efficiency metrics
  - Introduction to modular On-Demand boiler technology
  - Boiler water treatment considerations / support systems
- First Steps: Boiler performance benchmarking
- Case Studies of successful projects
WHO IS MiURA?

- Global Sales ~ 143,000 Units (~ 12,000,000 BHP)
  - Asia ~ 140,500
  - North America ~ 2,500

- ~ 500 Trillion Btu Annual Energy Savings Worldwide
- ~ 180 Million Metric Tons of Annual CO₂ Reductions Worldwide
Current North American regional offices:

- Sales and service network in the U.S. & Canada via certified local representatives
- Satellite offices established in Mexico & Brazil in 2011
WHY TALK ABOUT BOILERS? U.S. ENERGY INVENTORY:

- **U. S. Energy Flow – 2006 (Quadrillion Btu’s*)**:
- Commercial + Industrial Sectors - 50.75 Quads of Energy OR 50% of all energy use
- Fossil Fuels – 86.25 Quads or 85% of all energy consumption
- (C/I boilers account for as much as 40% of energy consumption)

![Diagram 1. Energy Flow, 2007 (Quadrillion Btu)](image)

*1 Quad Btu = 40 - 1,000 MW Power Plants*
“Boiler” is a Broad Word

While some of the concepts discussed this evening relate to many types of heat transfer equipment, we will be discussing:

- boilers with capacities greater than at least 50 Hp (2,000,000 Btu/hr), and generally greater than (100 Hp) 4,000,000 Btu/hr.
- boiler plants with capacities up to 4500 Hp (150.5 MMBtu/hr, or 155,000 lbs/hr steam)
- typically high pressure (>15 psig, 250°F), process steam and/or district energy
**Boiler Types & General Capacity Ranges**

**Modular – Point-of-Use to District Energy Capacities**

<table>
<thead>
<tr>
<th>Boiler Type</th>
<th>Max. Individual Boiler Capacity (+/- 10 MMBtu/hr or 10,350 lbs/hr)</th>
<th>Max. Multi-Unit Boiler Capacity w/ Single Controller (+/- 150 MMBtu/hr or 150,000 lbs/hr)</th>
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<tbody>
<tr>
<td>MIURA Boilers</td>
<td></td>
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<tr>
<td>Stoker Boilers</td>
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<tr>
<td>Fluidized Bed Boilers</td>
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<td>Pulverized Coal Boilers</td>
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<tr>
<td>Firetube Boilers</td>
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<td>Small Watertube Boilers</td>
<td></td>
<td></td>
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<tr>
<td>Large Watertube Boilers</td>
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</table>

*Firetube Boilers* for flexibility and efficiency.
Optimization Areas with Potential Energy Savings:

- Minimize Boiler Idling & Short-Cycling Losses (5-10%)
- Utilize Efficient Burners / Combustion Systems (2-10%)
- Maintain Clean Water-Side Heat Transfer Surfaces (0-10%)
- Minimize Radiant Losses from Boilers (1.5-5%)
- Utilize Feedwater Economizer for Waste Heat Recovery (1-4%)
- Minimize & Automate Boiler Blow-down (0.5%-1.5%)
- Utilize Boiler Blow-down Heat Recovery (0.5–2%)
- Benchmark the Fuel Costs of Thermal Energy (~1%)
U.S. Boilers – Age Distribution of Boilers > 10 MMBtu/hr (2005):

- C/I Boiler Inventory – 163,000 units w/ capacity of 2.7 Trillion Btu/hr

47% of existing inventory – 40+ yrs. old
76% of existing inventory – 30+ yrs. Old
CONVENTIONAL BOILERS: PERFORMANCE CHALLENGES

Design Limitations of Conventional Boilers:
- Physical Size / Footprint
- Excessive Warm-up Cycle
- Excessive Radiant Losses
- Lag in Response to Changing Loads
- Sub-optimal System Turn-Down Capability
- Sub-optimal Overall Operational Efficiency / Load Management Capability
- Innate Safety Issues via Explosive Energy

Though it’s being addressed, there remains:
- Lack of Integrated NOx Emissions Control
- Lack of Integrated Heat Recovery
- Lack of Integrated Controls / Automation
- Lack of Integrated 24/7 Online Monitoring
ENERGY OPTIMIZATION APPROACH: PROCESS

- Assess & benchmark current system performance relative to actual loads
- “Right-size” system relative to optimized heat recovery
- Optimize system load matching / management capability for actual demand
- Look for opportunities to maximize heat recovery within system
- Configure system to reduce potential for future secondary / infrastructure energy losses
- Implement long-term system & infrastructure BEST PRACTICES management program
- Implement continuous system monitoring & management for 24/7 commissioning capability
- Implement recurring optimization “gap analysis”
MANAGING ENERGY LOAD VARIABILITY: “RIGHT-SIZING” OPTIMIZATION

- Understand load profile for typical steam generation cycle
- Quantify disparities between utility output & process needs
  - Utility Design Safety Factor (1.33 – 1.5 ~2% EE Potential)
  - Avg. Load Factor over typical production cycle (LF<60% = EE Potential)
  - Aggregate over-shoot + part-load intervals to identify potential ECM’s
- Investigate opportunities to mitigate sub-optimal LF via scheduling

![Diagram showing load profile and utility output over time](image)

- **Max. Capacity** (100% LF)
- **Max. Output** (50-66% LF)
- **Avg. Output** (~33% LF)

**DSF**
OPTIMIZATION FIRST STEPS: ENERGY ASSESSMENT & BENCHMARKING

You are not managing what you do not measure...

- Select assessment method based on targeted objectives
- Select assessment period to capture standard operating cycle characteristic of process
- Plan on sampling one full additional operating cycle as a back-check to primary data
- Utilize measurement interval synergized with production profile (process start/stop intervals)
- Review past 24 months utilities statements to account for seasonal, etc. load characteristics not captured during assessment period

Courtesy of ENERGY STAR Program Guide
BENCHMARKING TO SAVE ENERGY: *In-Service Efficiency (ISE) Study*

You are not managing what you do not measure...

- Meter existing equipment & collect data on current consumption, including:
  - Gas & water consumption rates
  - Gas pressure at the meter
  - Gas temperature at the meter
  - Feedwater temperature
  - Steam pressure
  - Blow-down rate
- Review utilities statements for historical data
- Size loads and determine load “profile” (i.e., high-low load swings) over test period
- Determine In-Service Efficiency to “benchmark” existing energy performance

Courtesy of ENERGY STAR Program Guide
Miura’s Data Logger records metered usage to benchmark existing efficiency:

- Existing Boiler
- Gas
- Water
- Radiant Losses
- Tank
- Blow-down
- Steam
- Steam Demand
BENCHMARKING TO SAVE ENERGY: IN-SERVICE EFFICIENCY (ISE) STUDY

- Metered ISE study provides detailed load profile illustrating process usage impact on steam demand
- Graphing load profile allows for high level of precision in “right sizing” of boiler system optimized for highest efficiency
- Executive summary provides estimated energy / cost savings, O&M savings & reduced CO₂

Summary

I. In-Service Efficiency 66.5 %
II. Expected Gas Saving Rate 18.9 %
III. Average HP 51.8 HP 34.5 %
* Under operation
IV. Max. HP 97.9 HP
V. Min. HP 20 HP
VI. Measurement period 2011/6/28 ~ 2011/7/14
VII. Gas Cost Saving 25,032 $/year
VIII. Steam Cost Saving 31,290 $/year
   Estimate (Gas, Water, Sewer, Electricity, Chemical,..)
IX. CO₂ Saving 220.6 ton/year
   365 days/year
Benchmarked energy efficiency of 25 boilers via ISE data:

- Average In-Service Efficiency = 66% at 33% average load factor

Example Steam Load Profile

### Results from ISE Studies - Competitor's Boilers

<table>
<thead>
<tr>
<th>Company</th>
<th>Industry</th>
<th>Manufacture</th>
<th>HP</th>
<th>Year</th>
<th>Ave. Load</th>
<th>ISE</th>
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<tr>
<td>1</td>
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<td></td>
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<tr>
<td>2</td>
<td>Foods</td>
<td>CB</td>
<td>1500</td>
<td>1978</td>
<td>17%</td>
<td>73.9%</td>
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</table>

- Example Steam Load Profile
STEAM COST CALCULATOR: TCO (TOTAL COST OF OPERATION) ANALYSIS

- Fuel Cost
- Water Cost
- Sewer Cost
- Electricity Costs
- Chemical Costs
- Service Contract
- O&M Costs
- Future CO₂ Costs
- Projected Lifecycle Costs
MANAGING ENERGY LOAD VARIABILITY: CONVENTIONAL SYSTEMS

- Conventional boiler systems expend large amounts of energy to meet variable load conditions
- Design limitations of conventional boilers prevent them from efficiently responding to every-changing load demands
- Result: Significant wasted energy & emissions at load swings
FEMP GUIDELINES: BOILER SELECTION CRITERIA

- **FEMP =** Energy Star for larger energy-using equipment
- **Minimum boiler efficiency guidelines**
- **Boiler system selection & sizing guidelines**

“If building loads are highly variable, as is common in commercial buildings, designers should consider installing multiple small (modular) boilers.”

“Modular systems are more efficient because they allow each boiler to operate at or close to full rated load most of the time, with reduced standby losses.”
MANAGING ENERGY LOAD VARIABILITY: MODULAR ON-DEMAND SYSTEMS

- Modular on-demand boiler systems reduce energy consumption required to meet variable loads by dividing the output capacity among multiple small units (like gears in a transmission).
- Modular systems are designed specifically to meet varying load demands.
- Result: Significantly reduced energy & emissions at load swings.
Optimized Energy Management via Modularity

- Modular design concept:

- 200HP TDR=1:3 Step(H,L)
- 200HP TDR=1:3 Step(H,L)
- 200HP TDR=1:3 Step(H,L)
- 200HP TDR=1:3 Step(H,L)
- 200HP TDR=1:3 Step(H,L)
Optimized Energy Management via Modularity

- Modular design concept:
- Each boiler unit acts like a single piston in the overall boiler system

1000HP boiler system
TDR=1:15
(15 steps of modulation)
**Space Savings – Addition by Subtraction:**

- Small boiler footprint (good for point-of-use applications)
- No tube-pull space required
- **Double** the boiler output of a typical boiler room (existing facilities)
- Reduce required boiler room area by over **50%** (new construction)

*Without Tube-Pull & Door-Swing Space*

*Modular Systems Offer Substantial Space Savings*
Conventional Approach: Primary + Back-up

Modular Approach: Integrated Back-up

Reduce purchased capacity by ~ 30% while also complying with N+1 requirements
SPACE SAVINGS – ADDITION BY SUBTRACTION:

The 21st century boiler plant…

Take advantage of freed-up space to:

- Increase capacity
- Incorporate other functions (in lieu of costly new construction)
- Miura has received UL certification for zero side-clearance modular configuration
UNDERSTANDING BOILER EFFICIENCY: \textit{In-Service Efficiency}

Boiler Efficiency = \frac{\text{Steam / Hot Water}}{\text{Input Energy}} = \frac{\text{Output Energy}}{\text{Input Energy}}
UNDERSTANDING BOILER EFFICIENCY:

“Combustion Efficiency” (Ec)
- The effectiveness of the burner to ignite the fuel
- Per ANSI Z21.13 test protocol

“Thermal Efficiency” (Et)
- The effectiveness of heat transfer from the flame to the water
- Per the Hydronics Institute BTS-2000 test protocol
- Recognized by ASHRAE 90.1 standard

“Boiler Efficiency”
- Often substituted for combustion or thermal efficiency

“Fuel-to-Steam Efficiency” (A.K.A. Catalog Efficiency)
- The effectiveness of a boiler operating at maximum capacity and a steady state, with flue losses and radiation losses taken into account.
UNDERSTANDING BOILER EFFICIENCY: ASHRAE STANDARD 155-P

- A more meaningful measure of boiler performance
- Applicable to steam & hot-water boilers with $\geq 300,000$ Btu/hr capacity
- Applicable to individual, modular and/or multiple boilers

**Purpose of the standard:**

1. Provide a comprehensive measure of boiler system operating efficiency, including:
   - Steady-state thermal efficiency
   - Part-load efficiency
   - Through-flow loss rate
   - Idling-energy input rate of individual boilers

1. Provide a calculation to determine application-specific seasonal efficiency ratings for boilers
Application Seasonal Efficiency (ASE):

Seasonal “bin-based” calculation whereby hourly building loads are divided into 101 bins, 0-100

Each “bin” is a snapshot of the boiler system load factor percentage based on heating demand

In any bin, various boilers may be:

- Off and isolated (via modular, on-demand system)
- Off, but with through-flow from active boilers
- Operating at steady-state high fire
- Modulating
- Operating at steady-state low fire
- Cycling
- Idling
UNDERSTANDING BOILER EFFICIENCY:

- Fuel-to-Steam vs. In-Service Efficiency
- Understanding operating efficiency = tracking energy losses
In-Service Efficiency by Boiler Type:

Miura’s modular systems provide increased energy efficiency at around 85% consistently from low to high load factors.
Increasing Efficiency = Reducing Losses: Radiant Losses

- With energy efficiency, size matters...
- Increase efficiency via reduced boiler thermal footprint

Smaller Boiler Surface Area = Significant Reduction in Radiant Losses
INCREASING EFFICIENCY = REDUCING LOSSES: RADIANT LOSSES

- Radiant Losses: 12 MMBtu/hr input at 100% output
- Option A – Conventional System:
  - Single 12 MMBtu/hr unit input
  - Rated at 2% radiant loss
  - 240,000 Btu/hr energy loss
- Option B – Modular System:
  - 3 x 4 MMBtu/hr unit input
  - Rated at 0.5% radiant loss
  - 3 x 20,000 Btu/hr losses = 60,000 Btu/hr energy loss
Increasing Efficiency = Reducing Losses: Radiant Losses

- Radiant Losses: 12 MMBtu/hr input at 33% output

- Option A – Conventional System:
  - Single 12 MMBtu/hr unit at 33% = 4 MMBtu/hr input
  - 240,000 Btu/hr energy loss
  - Results in 6% total radiant loss

- Option B – Modular System:
  - 3 x 4 MMBtu/hr units (only 1 operating)
  - 1 x 20,000 Btu/hr losses = 20,000 Btu/hr energy loss
  - Only 0.5% total radiant loss
Increasing Efficiency = Reducing Losses:

▪ Utilize feed-water economizer for built-in waste heat recovery
▪ Feed-water economizers increase efficiency by capturing waste exhaust gases to preheat feed-water entering the boiler
▪ Boiler efficiency can be increased by 1% for every 40°F decrease in stack gas temperature

<table>
<thead>
<tr>
<th>Initial Stack Gas Temperature, °F</th>
<th>Recoverable Heat, MMBtu/hr</th>
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<tbody>
<tr>
<td></td>
<td>Boiler Thermal Output, MMBtu/hr</td>
</tr>
<tr>
<td>25</td>
<td>50</td>
</tr>
<tr>
<td>400</td>
<td>1.3</td>
</tr>
<tr>
<td>500</td>
<td>2.3</td>
</tr>
<tr>
<td>600</td>
<td>3.3</td>
</tr>
</tbody>
</table>

Based on natural gas fuel, 15% excess air, and a final stack temperature of 250°F.
Increasing Efficiency = Reducing Losses: Start-up Losses

- Thermal shock - primary constraint on boiler performance
- Conventional boiler performance is limited by thermal stress resulting in inefficiency by requiring slow start-up & perpetual idling
- Firetube boilers: 60-90 min warm-up cycle & must remain idling in stand-by mode
Increasing Efficiency = Reducing Losses: Start-up Losses

- Innovative “Floating Header” pressure vessel design eliminates thermal shock
- All welded tube to tube-sheet construction
- X-ray & dye-penetrant quality control with heat treatment for stress relief of steel
- Single-pass design for even temperature distribution
- No more “re-rolling tubes” or “tube popping”...
- Allows for steam production in 5 minutes from cold start
INCREASING EFFICIENCY = REDUCING LOSSES: BLOW-DOWN LOSSES

- U.S. DOE steam systems BEST PRACTICES recommendation:

  “Improve boiler efficiency and reduce water consumption by utilizing automatic surface blow-down in lieu of continuous and/or manual blow-down.”

- Miura’s BL Controller boiler control system includes automatic blow-down for optimization of blow-down for highest efficiency operation.

- Automatic blow-down is managed by the BL Controller via a proportional flow system & back-up conductivity probe that monitor TDS to maximize boiler performance and efficiency.
Increasing Efficiency = Reducing Losses:

Post-Purge Losses

- Utilize a control system that includes an intelligent purge system to optimize boiler performance
- “Purge Cancel” function interrupts post purge when fast restart is required, eliminating energy loss & improving response time
- Optimized response time (w/in 10 seconds) = increased efficiency + reduced emissions
Increasing Efficiency = Reducing Losses: Losses at High Turn-Down

- Modular boiler system:
- Sequential boiler staging via “master” & “slave” controllers for precise load matching capability
Boiler Scale Detection & Prevention: Heat Transfer Losses - Scale

- An eggshell thickness of scale can reduce boiler efficiency as much as 10%* (25% for 1/8” thickness, 40% for 1/4” thickness)

*Just 1/32” of scale thickness multiplied times each industrial boiler in the U.S. inventory ~

- Over $7 billion in wasted energy / yr (@ $1.00/therm)
- Over 50 million metric tons of CO₂ emissions / yr
BOILER SCALE DETECTION & PREVENTION: WATER HARDNESS MONITORING

- Installed between water softener & feed water tank
- Colormetry “sips” feed water every 30 minutes
- Detects water hardness below 1 ppm
- Automatically increases surface blow-down when water hardness is detected
- Interfaces with BL Controller & M.O.M. System
- Easily replaceable cartridges
**BOILER SCALE DETECTION & PREVENTION: INTEGRATED WATER SOFTENER SYSTEM**

- “Smart” water softener system
- Enhanced performance via *split-flow regeneration*
- Automatically alternates between primary / regeneration tanks for optimized performance
- Monitors brine tank level & alarms thru BL Controller
- Interfaces with Colormetry, BL Controller & Online Monitoring Systems

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**Diagram:**
- Boilers
- ML2 Panel
- MW
- CMU-H
- Online Interface
Integrated Water Softener System

Online Interface:

- Raw Water Hardness / Pressure
- Treated Water Hardness / Flow
- Primary / Regen Tank Operating Status
- Automatic Primary / Regen Tank Switching
- Brine Flow / Concentration
- Brine Concentration Alarm
BOILER TUBE PROTECTION: **BOILERMATE WATER TREATMENT SYSTEM**

- Eco-friendly Silicate-based water treatment
- Eliminates need for high temperature feed-water (i.e., DA tank) to activate chemical treatment
- Provides increased boiler efficiency by +1-2% via reduced blow-down & low temperature feed-water
- Reduces boiler chemical treatment costs due to more effective tube protection & computer controlled chemical feed system
- Reduces maintenance issues related to constant monitoring & adjustment of boiler water chemistry
- Reduces boiler performance issues such as feed-water pump cavitation, increasing pump efficiency by +10-20%
**BOILER TUBE PROTECTION: BOILERMATE WATER TREATMENT SYSTEM**

- Silicate filmer water treatment feed is modulated via an interface with the MI Controller.
- Chemical feed is based on steam demand measured by the steam pressure sensor.
- Scale dispersant also available to address scale formation without down-time.

Diagram showing the system with labeled components such as MI Chemical Controller, Water Treatment Tank, Chemical Pump, Feed Water Tank, and control signals.
ONLINE MONITORING / MANAGEMENT: **Online “Energy Dashboard” Systems**

- Stand-alone online monitoring system that interfaces with boiler control system as thermal energy management “dashboard”
- Provides 24/7 online M&T/ M&V online maintenance system
- Real-time 24/7 operation, fuel/water consumption, efficiency & emissions tracking capabilities
- Communicates with operations staff via workstation interface, PDA, email alerts
- Provides monthly reports
Online Monitoring / Management: ER System “Energy Dashboard”

- 24/7 Real-time Operational Parameters: LX Series Interface
  - Firing Rate
  - Steam Pressure
  - Scale Monitor
  - High Limit
  - Flue Gas Temp
  - Feedwater Temp
  - Flame Voltage
  - Next Blow-down
  - Surface B/down
  - Conductivity
  - Date / Time
COMPLETE FULLY INTEGRATED BOILER PLANT

- Typical integrated modular, on-demand boiler plant
Available Models:

- LX Series
- EX Series
BL BOILER CONTROL SYSTEM: LX / EX SERIES

- Easy push-button start-up / controller interface
- 47 alarm messages
- 38 caution messages
- Color-coded visual alarm interface coupled with caution / alarm messages
- Probable cause and/or solution given for each alarm or caution
- Allows for short 10 second pre-purge and minimized post-purge via “purge cancel” feature
- Stores last 7 fault incidents
- On-line “dashboard” system interface
- Boiler control system driven by dry-contact probes
- Utilizes exterior LVC to capture average water level in tubes across combustion chamber
- M-Probe - locates “strike zone” where optimized heat transfer will occur for best performance
- L-Probe – manages against overheating via low water level
- S-Probe – manages against carry-over via high water level
- Provides high precision for optimizing heat transfer & quick response time for variable load demands
BOILER MODEL SUMMARY: *LX SERIES*

- Gas Only – Natural Gas / Propane
- 50, 100, 150, 200, 300 BHP Models
- Steam in 5 min. from Cold Start
- Low NOx Design (as low as 9ppm)
- Horizontal Flame Path
- 70-150 PSI Standard Operating Pressure (low and high pressure options available)
- Also Available in Hot Water Version
• Patented Self-Quenching / Cooling Burner Design: Flame Temp ~ 2,200 °F
• Flame in Direct Contact w/ Water Tubes (No Furnace)
• Low NOx Leader: 20 ppm standard (12 & 9 ppm models available)
**BOILER MODEL SUMMARY:**

**LX SERIES – SYSTEM SPECS**

<table>
<thead>
<tr>
<th>Model</th>
<th>A1</th>
<th>A2</th>
<th>A3</th>
<th>B1</th>
<th>B2</th>
<th>B3</th>
<th>H1</th>
<th>H2</th>
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<tr>
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<td>39 1/2</td>
<td>16 1/2</td>
<td>21 1/2</td>
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<td>57</td>
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<td>121</td>
<td>116 1/2</td>
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<td>84 1/2</td>
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**Minimum height for Boiler Knock Down**

**Drawing not applicable for LX-300 SG**

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**NO. NAME OF PART**

1. BOILER VESSEL
2. STEAM SEPARATOR
3. LIQUID VOLUME CONTROLLER
4. WIND BOX
5. BLOWER
6. CONTROL BOX
7. MANUAL BLOWDOWN VALVE
8. MANUAL BLOWDOWN VALVE
9. STEAM OUTLET VALVE (OPTIONAL)
10. MAIN SAFETY VALVE
11. AUTOMATIC BLOWDOWN
12. MAIN GAS TRAIN
13. FEEDWATER PIPING
14. ECONOMIZER
BOILER MODEL SUMMARY: **EX SERIES**

- Duel Fuel – Natural Gas/Propane & Oil
- 100, 150, 200, 250, 300 BHP Models
- Steam in 5mins From Cold Start
- Vertical Flame Path (top down)
- 70-150 PSI Standard Operating Pressure (high pressure option available)
- Also Available in Hot Water version
**Vertical Flame Path:**

Unlike other watertube boilers constructed inside an insulated box, the Miura boiler is constructed entirely of boiler tubes. The tubes form the inner and outer walls of the flue gas path.

**Floating Header Design – Side View**

**Combustion Path – Top View**

- Upper Header connected to Lower header only by schedule 40 water tubes. No external shell holds the headers together because the entire body of the boiler is constructed of boiler tubes.
- Heat Transfer Zone: Only this middle section of the tubes receives heat. This is the area of thermal expansion. As the tubes expand and contract, the upper header moves independently of the lower header, relieving stress without tube bends.
- External Level Control
- Lower Header
- Castable Refractory Protects the tube sheet welds
REDUCING BOILER “FOOTPRINT”

▪ Physical Footprint:
  • Reduced space requirements
  • Reduced energy plant construction costs
  • Reduced boiler “hardware”

▪ Energy Footprint:
  • Reduced energy consumption / wasted energy
  • Reduced explosive energy
  • Reduced embodied energy

▪ Environmental Footprint
  • Reduced consumption of natural resources
  • Reduced harmful emissions
  • Reduced carbon footprint
CASE STUDIES: SUNTORY BREWERIES (KYOTO, JAPAN)

- Total Boiler Units in Operation: (22) LX-160
- Total Boiler Capacity: 3,520 BHP
- Total System Turn-Down: 1:66
- Placed into Service: 2005
- Process applications: pasteurization, heating water, C.I.P.
CASE STUDIES: SPOETZL BREWERY (TEXAS)

- **Boiler Upgrade:**
  - (2) 200 BHP Units - 1 Natural Gas (LX) + 1 Dual-Fuel (EX)
  - Replaced (1) 400 BHP Firetube Boiler

- **Placed into service:** 2010

- **Process applications:** pasteurization & process heating for brewing

- **Estimated Annual Fuel Savings:** ~ $55,000 / yr (~19%)

- **Estimated Annual CO₂ Savings:** 275 mtCO₂ / yr

- **Biogas Adaptation:** Biogas fueling boilers (via iron sponge biogas conditioning system)
CASE STUDY: FOOD INDUSTRY FRITO-LAY (CALIFORNIA)

- Boiler Upgrade – (6) 50 BHP units
- Application: Process Steam
- Emissions Compliance: Utilizing multiple 50 BHP units allowed boiler plant to stay below NOx regulation output limit
- Placed into Service: September 2010
- Estimated annual fuel cost savings: $150,000 / yr (220,000 therms / yr)
- Estimated annual reduced CO2 emissions: 1,100 metric tons CO2 / yr
CASE STUDY: ELECTRONICS INDUSTRY SAMSUNG SEMICONDUCTOR (TEXAS)

- Boiler Upgrade – (7) 200 BHP 9ppm-NOx units replacing (2) existing 1600 BHP + (3) 800 BHP Cleaver Brooks firetube boilers
- Application: Steam Plant for FAB2 Process Expansion
- Placed into Service: October 2010
- Estimated annual fuel cost savings: $215,000 / yr (615,000 therms / yr)
- Estimated annual reduced CO2 emissions: 3,000 metric tons CO2 / yr
CASE STUDIES: FOOD INDUSTRY

Quaker Oats (Iowa)

- Boiler Upgrade – (10) LX-300 BHP units
- Replacement of coal-fired utility’s district steam sold to site
- Placed into service: 2010
- Estimated annual fuel cost savings: $295,000 / yr (410,000 therms / yr)
- Estimated annual reduced CO2 emissions: 3,600 metric tons
**CASE STUDIES: HEALTHCARE**

**MERCY MEDICAL CENTER (IOWA)**

- **Boiler Upgrade –** (6) 300 BHP dual-fuel units
- **Placed into service –** 2009
- **Estimated avg. fuel cost savings =** $295,000 / yr (454,000 therms / yr)
- **Estimated avg. reduced CO2 emissions =** 2,270 metric tons of CO2 / yr

- “Miura boilers take up less space than typical fire-tube boilers do. We didn’t need as much space as other boiler designs would have required, which is good because we’re right up against our property line. Thanks to the Miura boilers we have a very nice facility that’s not cramped.” – Bob Olberding, Director of Facilities

- “Miura’s “green” technology is essential for complying with emissions standards mandated by Iowa’s DNR. In addition to their low-NOx emissions, our 6 EX-300 boilers also have exhaust-gas recirculation to reduce emissions even further, so it’s a plus for us when surveys are done. “I believe the emissions produced by Miura boilers are about as low as you can get.” – Olberding
CASE STUDIES: CHEMICAL INDUSTRY

FUJI-HUNT CHEMICALS (TENNESSEE)

- Boiler Upgrade – (2) EX-200 BHP units
- Placed into service: 2011
- Actual System Efficiency Improvement: +24%
- Estimated annual fuel cost savings: $165,000 / yr (370,000 therms / yr)
- Estimated annual O&M cost savings: $107,000 / yr
- Project Simple Pay-back: 1.85 yrs
- Estimated annual reduced CO2 emissions: 1,850 metric tons CO₂ / yr
Case Study: College / University

University of Arkansas

- Boiler Upgrade – (6) 300 BHP units replaced (3) existing 600 BHP Kewanee firetube boilers
- Summer “Peaking” Plant
- Placed into service – March 2008
- Reported energy savings = $210,000 / yr
- Reported reduced CO2 emissions = ~1,400 metric tons of CO2 / yr

- “On-Demand Steam is a great asset as it allows us to be able to spool the boiler up very quickly, and then take it back down offline when the load dies down is really helpful. Another advantage of the Miura boilers is that if, by chance, we lose a boiler for some reason, we only lose a sixth of our production capacity. If you lose a large boiler, you can lose it all. That additional reliability factor of a multiple installation of Miura boilers is also something we liked.”

- With the installation of the six Miura LX-300 steam boilers, the University of Arkansas has not only upgraded its physical plant with the advantages of On-Demand Steam and a reduced
**CASE STUDY: COLLEGE / UNIVERSITY**

**BAYLOR COLLEGE OF MEDICINE (TEXAS)**

- **Boiler Upgrade** – (7) 300 BHP units
- **Mezzanine Installation** - serving 1.4 million sq ft of campus process / heating demand
- **Placed into service** – 2001
- **Estimated avg. fuel cost savings** = $270,000 / yr (360,000 therms / yr)
- **Estimated avg. reduced CO2 emissions** = 1,800 metric tons of CO2 / yr

- Baylor’s decision to switch to the newer watertube technology evolved over time. Over the years, as Baylor expanded, it increased its firetube boiler capacity to 2,100 BHP. The 21st-century physical plant that Baylor is striving to complete had to confront redundancy, capacity, regulatory, & space issues.

- To meet its on-demand steam needs, Baylor decided to switch to watertube boilers. Regini explained, “They only hold about 78 gallons of water, each. So instead of heating a firetube boiler that holds thousands of gallons of water that have to keep bubbling and hot all the time, I’m heating a smaller surface area and I’m directly changing the water into steam at a much more efficient rate.”
CASE STUDY: TEXAS SOUTHERN UNIVERSITY (TEXAS)

- Boiler Upgrade – (4) 200 BHP units
- Replaced (3) c.1986 era Firetube boilers
- Serving 150-acres / 40 buildings with campus steam heating
- Placed into service – 2010
- Estimated avg. fuel cost savings = ~$400,000 / yr (~ 30% energy savings)
- Estimated avg. reduced CO2 emissions = ~1,200 metric tons of CO2 / yr

“We were spending around $1.2 million annually on natural gas consumption with our old fire-tube boilers, but that has dropped to about $600,000 since the Miura boilers were installed. “Installation of the Miura boilers provides a 33% reduction in natural gas usage and it has also increased our overall steam production. We no longer have problems getting steam to any of the buildings on campus.”  - Tim Rychlec, Executive Director of Facilities and Maintenance Services
CASE STUDIES: Duke University (North Carolina)

- Boiler Upgrade – (15) 300 BHP units
- Replacement of Coal-burning Plant
- LEED-Gold Historic Building Restoration
- Placed into service – February 2010
- Estimated avg. reduced CO2 emissions = over 50,000 metric tons of CO2 / yr.

Miura’s technology provides a significant reduction in the energy losses associated with a typical start-up, purge, and warm-up cycle of a boiler.”

- Russell Thompson, Duke University’s Director of Utilities and Engineering for Facilities Management

(referencing the on-demand steam capabilities of the university’s 15 new Miura LX-series natural-gas fired boilers, any one of which can be turned on or off as needed to meet the campus’ ever-changing steam-generation demands while optimizing performance for increased efficiency and reduced environmental impact.)
SUMMARY:

- Optimized energy management of process heating applications with sharp load swings (via centralized or point-of-use configuration)
- On-demand peaking capacity for “gaps” (cogen, residual heating loads, etc.) and/or low-load periods
- On-demand N+1 back-up capacity to eliminate perpetual idling conventional back-up system
- On-demand back-up of solar thermal systems (peaking intermittency of renewable energy source)
- Combined biogas / natural gas powered utility
- Optimized utility asset management flexibility (via mezzanine installation, modular expansion, mobility)
- Optimized modular district heating system for year-round heating with maximum turn-down & efficiency
Questions:

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