



MIURA

Optimizing Energy Management with Modular On-Demand Systems

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Innovative Design – Summary:

Key Benefits



▪ **Modularity**

- Highly efficient load management with back-up capability & flexibility for changing steam demands

▪ **Size**

- New Construction - Cut boiler room size up to 50%
- Existing Applications - 1) Double your steam capacity in the same space 2) Free up space for other uses

▪ **Efficiency**

- Startup-to-steam in 5 minutes
- Save 15%-20% in Fuel Costs on Average

▪ **Reduced Environmental Impact**

- Reduced emissions
- Reduced water consumption

▪ **Safety**

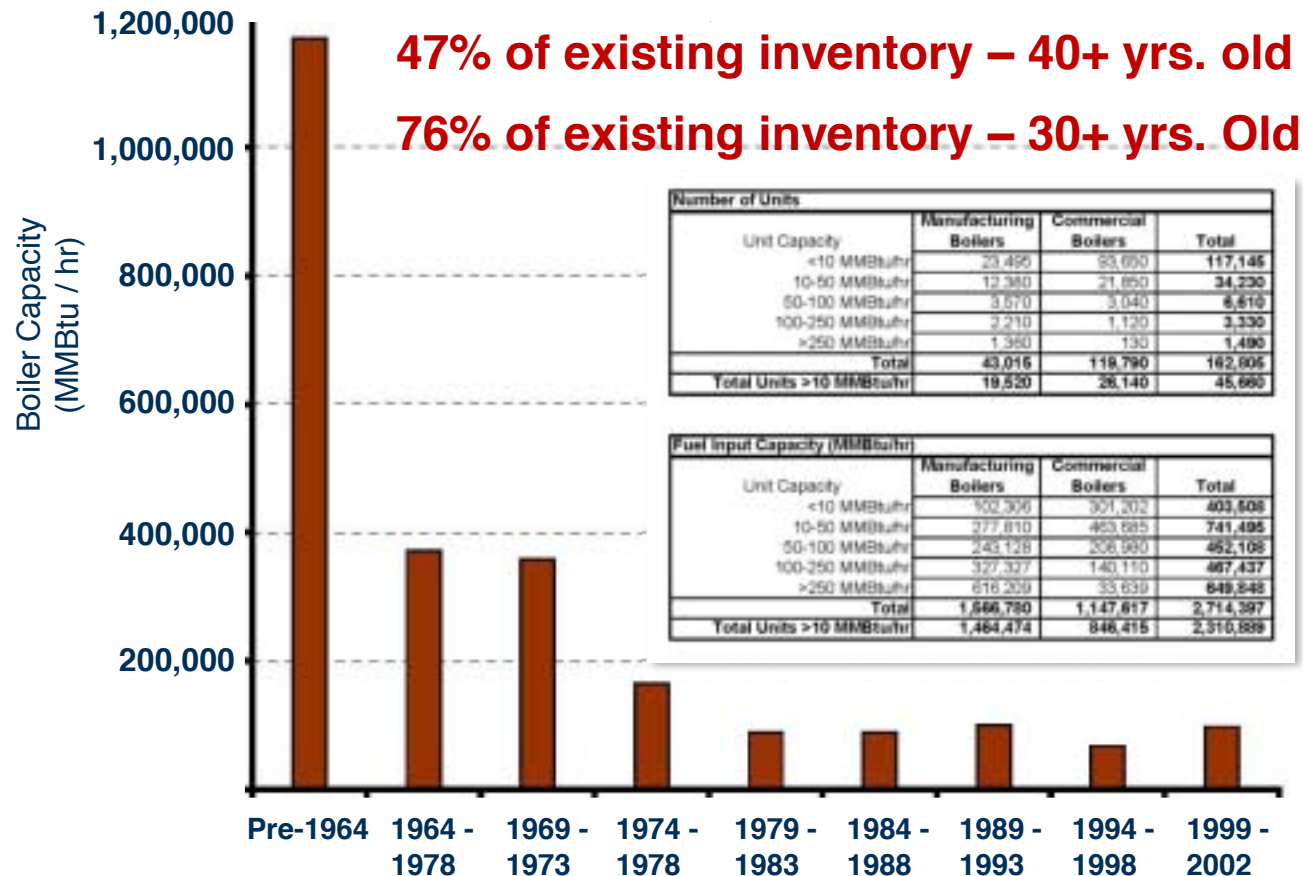
- Safest Boiler Design on the Market Today

▪ **Low Maintenance / Durable Design**

- “Floating Header” design eliminates damage caused by thermal stress

U. S. Boiler Market Survey: Age Distribution

- 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
- **Just 10% in reduced efficiency ~ 270 Billion Btu/hr in wasted energy**



- **What are the roots of the boiler technology currently operating in the U.S.?**



- **The U.S. can benefit from emerging technologies to become more competitive & move our economy onto a sustainable path**

Environmental Impact – Understanding the Role of Technology:

- Conventional role of technology:

$$I = P \times A \times T1$$

I - Environmental Impact

P - Population

A – Affluence (consumption per capita)

T1 – **Technology**

UNSUSTAINABLE

The role of technology must be re-defined to reduce environmental impact ...

Environmental Impact – Understanding the Role of Technology:

- “Restorative” role of technology:

$$I = \frac{P \times A}{T_2}$$

I - Environmental Impact

P - Population

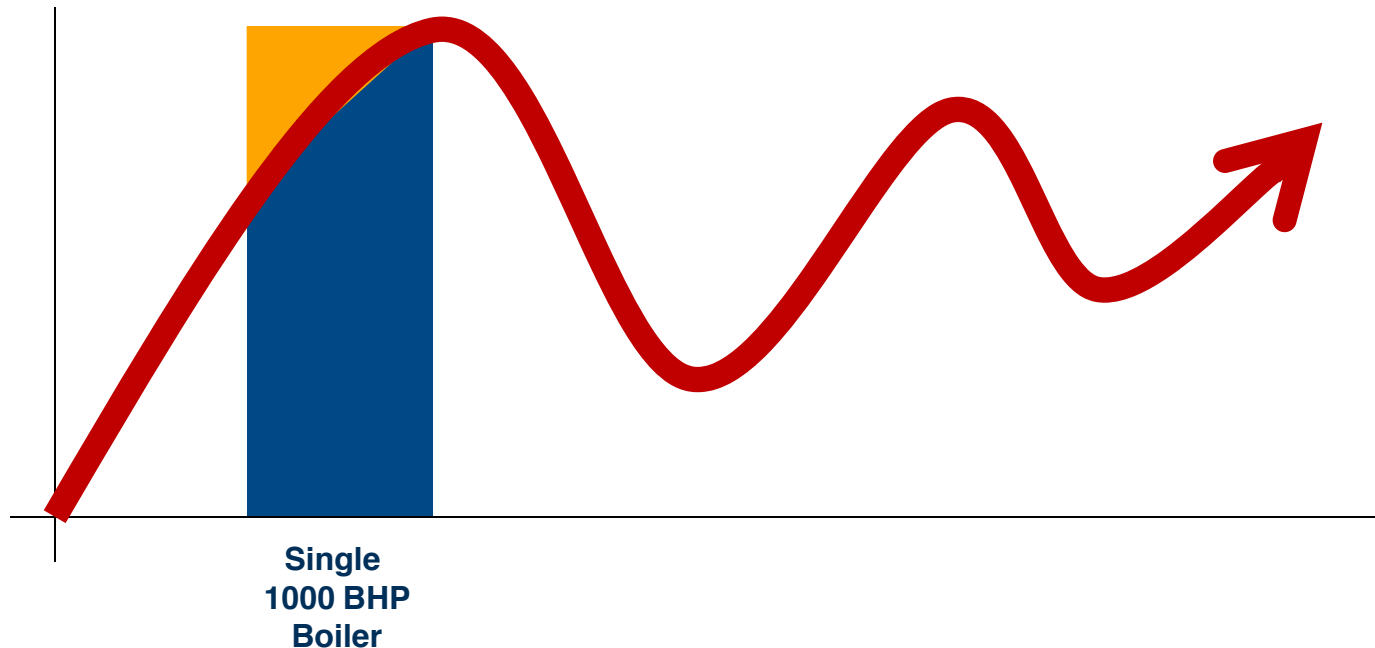
A – Affluence (consumption per capita)

T₂ – **Technology** (“green” technology)

SUSTAINABLE / RESTORATIVE

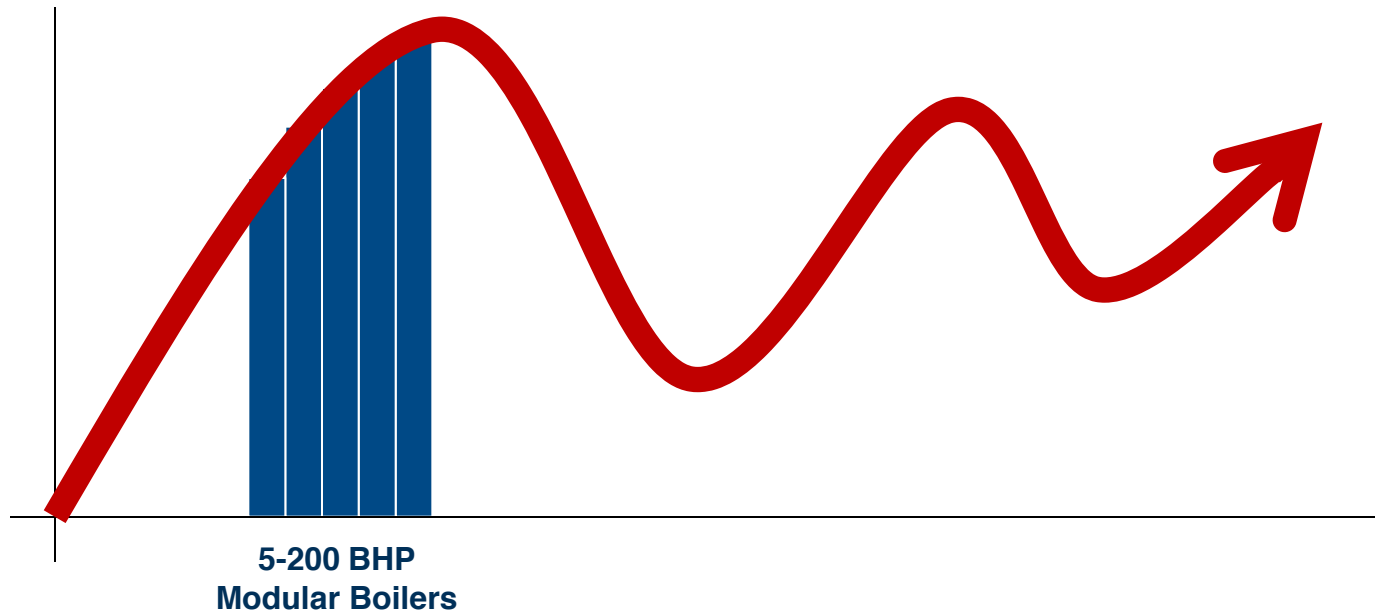
Managing Energy Load Variability: *Conventional Systems*

- 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**



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)

Modular System: *Flexibility & Back-up (N+1)*

- Miura's modular boiler system optimizes energy efficiency by quickly responding to changing load demands

➔ Initial Installation



➔ Demand Increases



➔ Demand Decreases



Relocated or turned off to maintain high efficiency

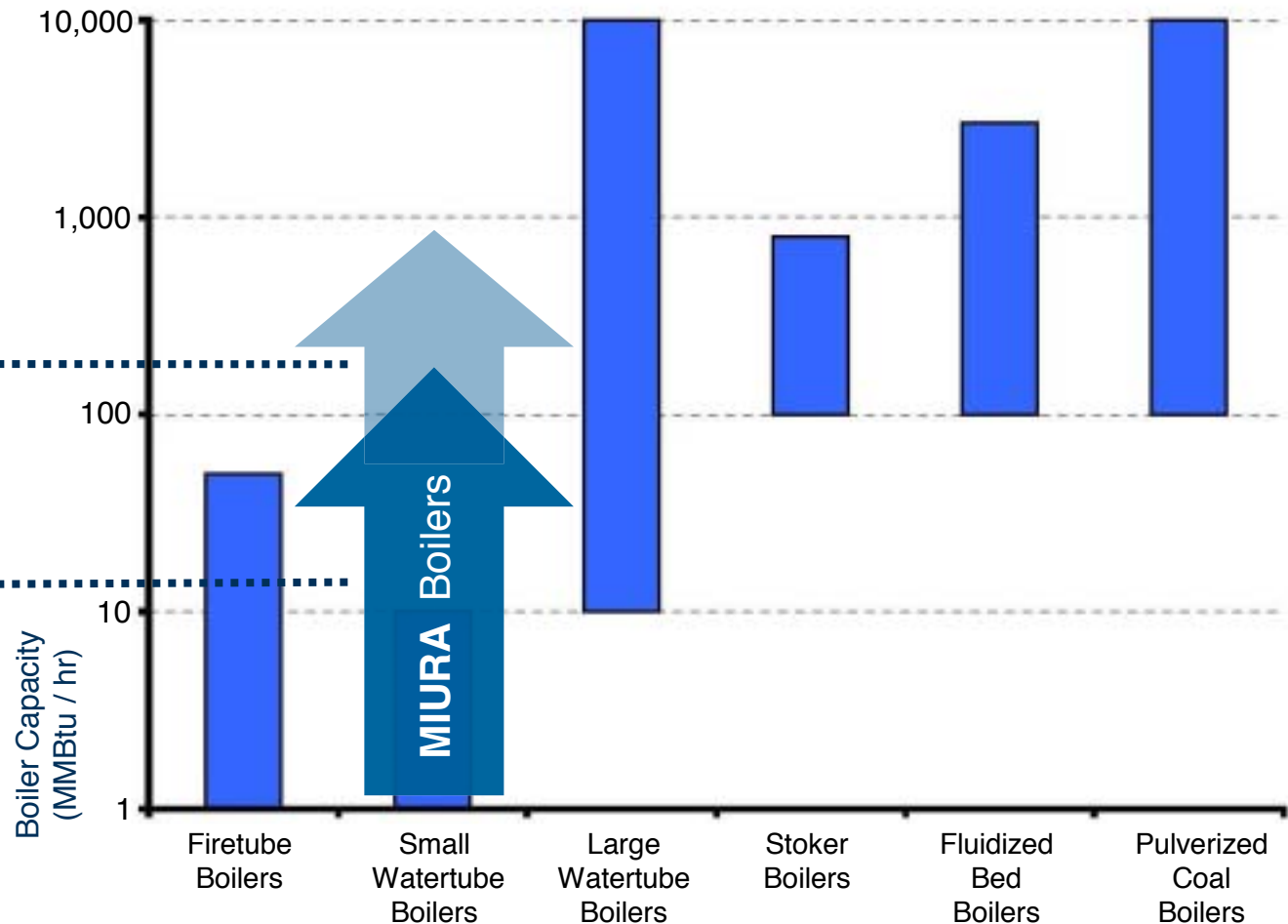
Modular Capacity Range: *Flexibility + Efficiency*

- **Boiler Types & General Capacity Ranges**
- **Modular – Point-of-Use to District Energy Capacities**

Multiple Boiler Installation to Meet Specific Demand
(Multiple Boilers & Controllers)

Max. Multi-Unit Boiler Capacity w/ Single Controller
(+/- 150 MMBtu/hr)

Max. Individual Boiler Capacity
(+/- 10 MMBtu/hr)



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.”

FEMP Federal Energy Management Program

FEMP Designated Product:
Commercial Boilers

Leading by example, saving energy and taxpayer dollars in federal facilities

Purchasing Specifications for Energy-Efficient Products

Legal Authority
Federal agencies are required by the Energy Policy Act of 2005 (PL 109-58) and Federal Acquisition Regulations (FAR) Subject 23.2 to specify and buy ENERGY STAR-qualified products or, in categories with no ENERGY STAR label, FEMP-designated products which are among the highest 25 percent of equivalent products for energy efficiency.

Performance Requirement for Federal Purchases		
Type	Rated Capacity (Btu/h)	Thermal Efficiency*
Gas / Water	300,000 - 10,000,000	83% E
Gas / Steam	300,000 - 10,000,000	79% E
#2 Oil / Water	300,000 - 10,000,000	83% E
#2 Oil / Steam	300,000 - 10,000,000	83% E

* Thermal efficiency (E), also known as "boiler efficiency" or "overall efficiency," is the boiler's energy output divided by energy input, as defined by DOE 23.13. In contrast to combustion efficiency (E_c), thermal efficiency accounts for boilers and conversion losses through the boiler's shell.

Buying Energy-Efficient Boilers
This purchasing specification applies to low- and medium-pressure boilers used primarily in commercial space heating applications. It does not apply to high-pressure boilers used in industrial processing and cogeneration applications. Specify boilers that meet the thermal efficiency levels shown in the Performance Requirement table. Select only boilers listed under the certification program run by the Hydronics Institute of the Gas Appliance Manufacturers Association (HAMA), see <http://www.hama.org> for more information. The Hydronics Institute publishes a directory listing the construction and thermal efficiencies for all commercial boilers.

Agencies must use ENERGY STAR-qualified and FEMP-designated performance requirements for all procurements of energy-consuming products and systems including guide and project specifications, and construction, renovation and service contracts. They should also be used in evaluating responses to solicitations. In contracts and solicitations, agencies must specify that commercial boilers must at least meet the thermal efficiencies shown above. Model language to assist agencies with incorporating these performance requirements into their procurement documents is available at <http://www.eere.energy.gov/femp/purchasing/specifications.asp>.

Agencies can claim an exception to these requirements through a written finding that no ENERGY STAR-qualified or FEMP-designated product is available to meet the functional requirements, or that no such product is life-cycle cost-effective for the specific application.

Sizing and Part Load Performance
A boiler system should be capable of meeting the building's peak heating demand and also operating efficiently at part-load conditions. Selecting the right system and properly using a boiler requires knowledge of both the peak demand and load profile. 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. Other efficient options for handling variable loads are condensing boilers and modulating boilers (which can run at partial capacity instead of cycling on and off).

U.S. Department of Energy
Energy Efficiency and Renewable Energy
Helping you do it better. Smarter. Greener.

Unlocking Energy Efficiency

Boiler BEST PRACTICES

- **Benchmark the fuel costs of steam generation**
- **Maintain Clean Boiler Water-side Heat Transfer Surfaces**
- **Minimize Radiant Losses from Boilers**
- **Utilize DA System to Protect / Optimize Boiler Operation**
- **Minimize Boiler Blow-down**
- **Minimize Boiler Short-Cycling Losses**
- **Reduce Steam System Operating Pressure**
- **Utilize Automatic Blow-down Control Systems**
- **Utilize Energy-Efficient Burners / Combustion Systems**
- **Utilize Waste Heat Recovery via Stack Economizers & Blow-down Heat Recovery System**



Understanding Boiler Efficiency: *In-Service Efficiency*

Boiler Efficiency

=

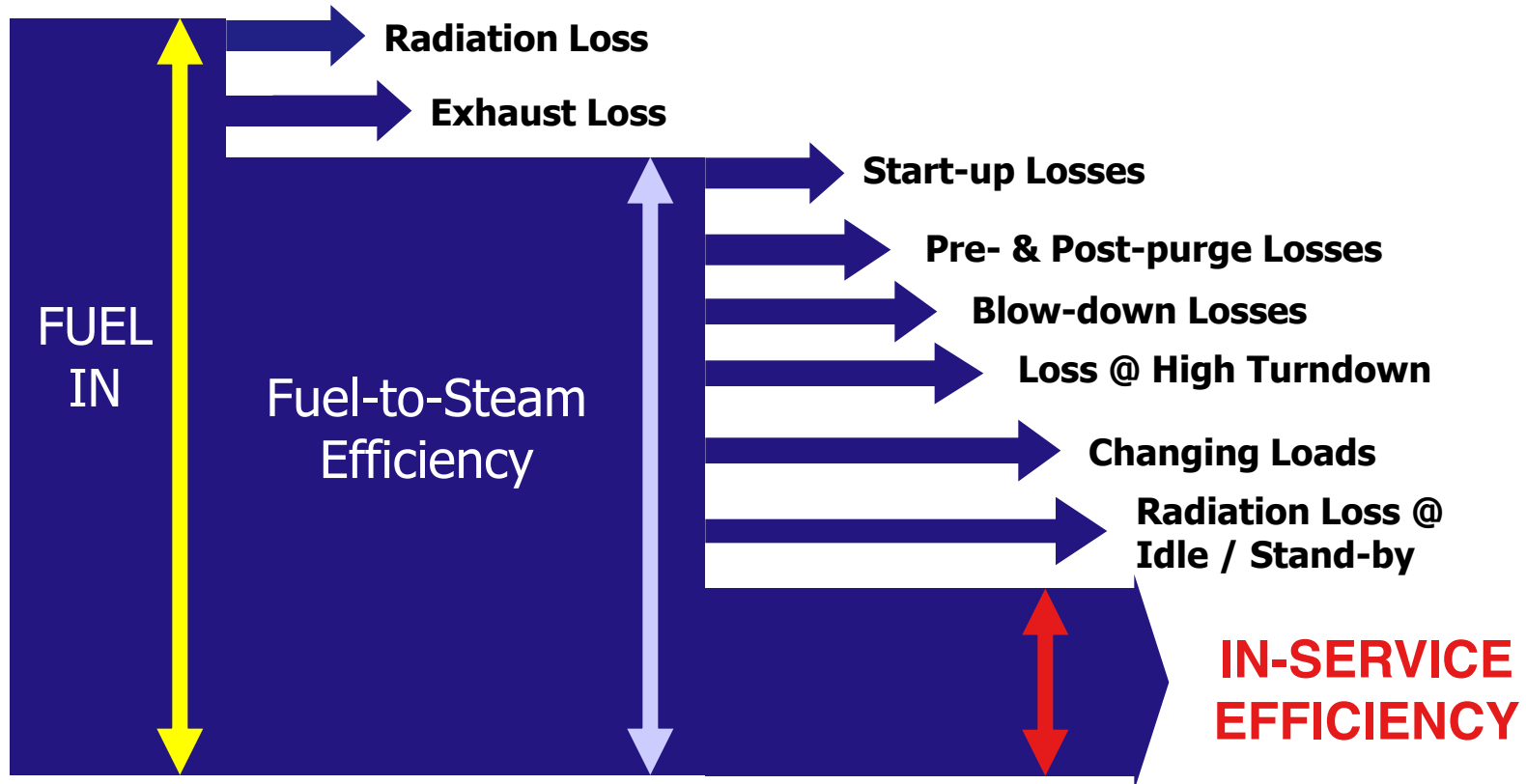
Output Energy

—————

Input Energy

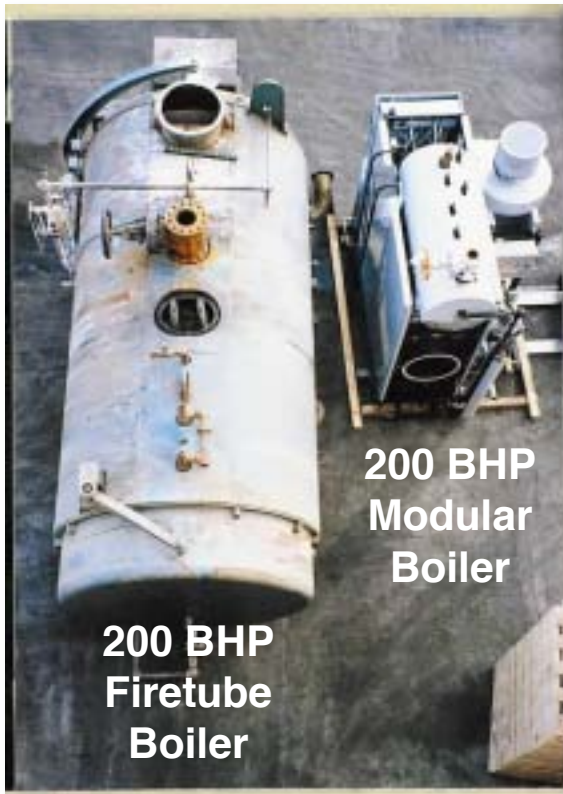
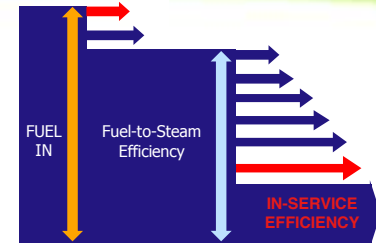


- **Fuel-to-Steam vs. In-Service Efficiency**
- **Understanding operating efficiency = tracking energy losses**



Increasing Efficiency = Reducing Losses: *Radiant Losses*

- With energy efficiency, size matters...
- Increase efficiency by reducing boiler thermal footprint

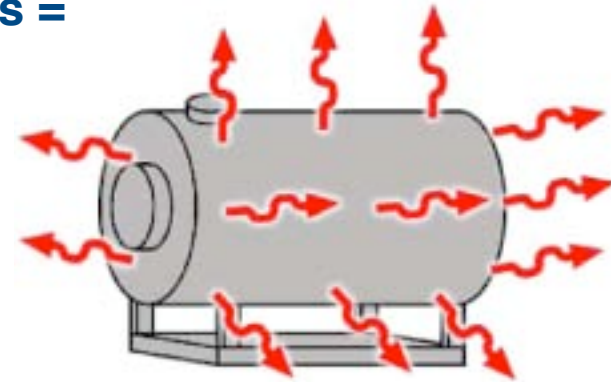


200 BHP
Firetube
Boiler

200 BHP
Modular
Boiler

1,000+ Gallons VS 65+ Gallons

Rate of Radiant Losses =
~300 Btu/hr-ft²

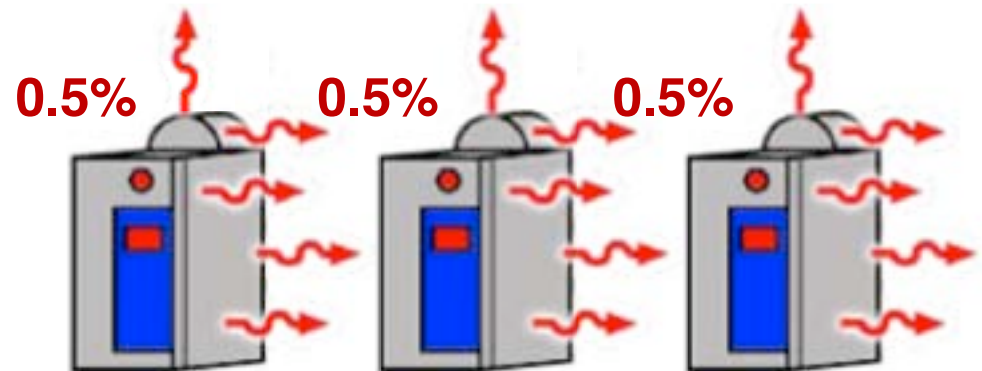
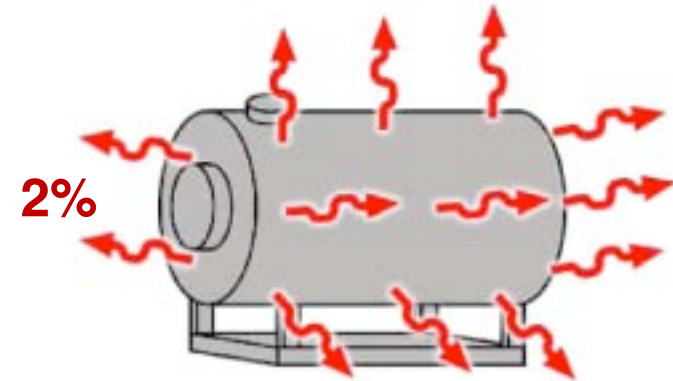
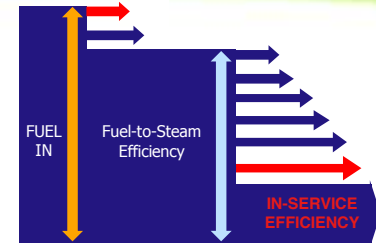


Smaller Boiler Surface Area =
Significant Reduction
in Radiant Losses



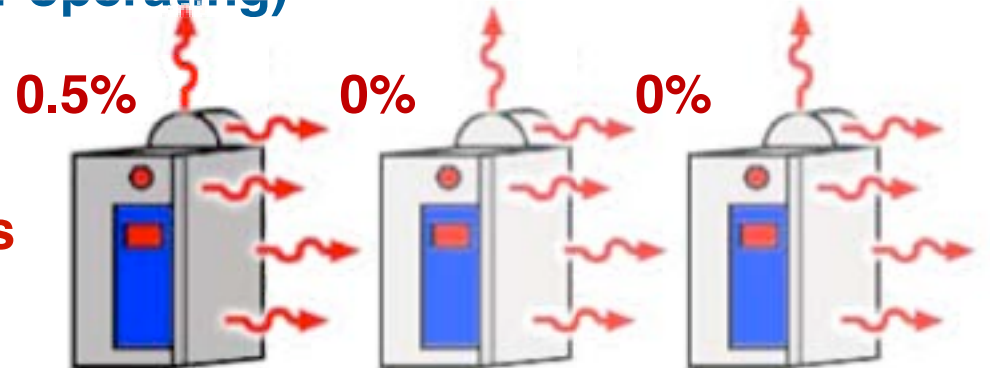
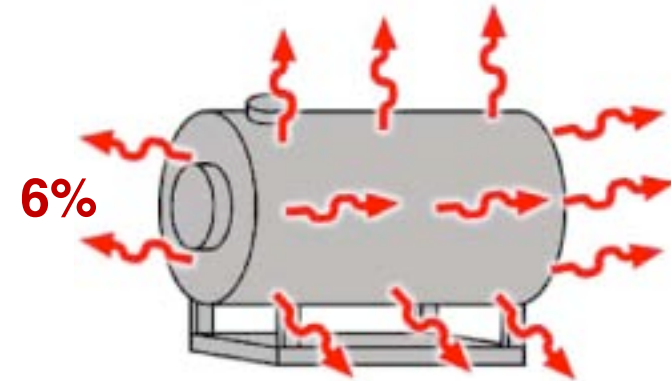
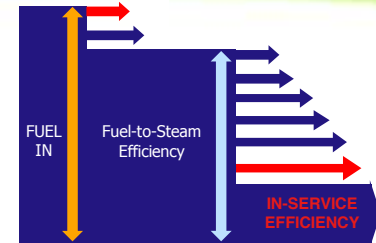
Increasing Efficiency = Reducing Losses: *Radiant Losses*

- 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**

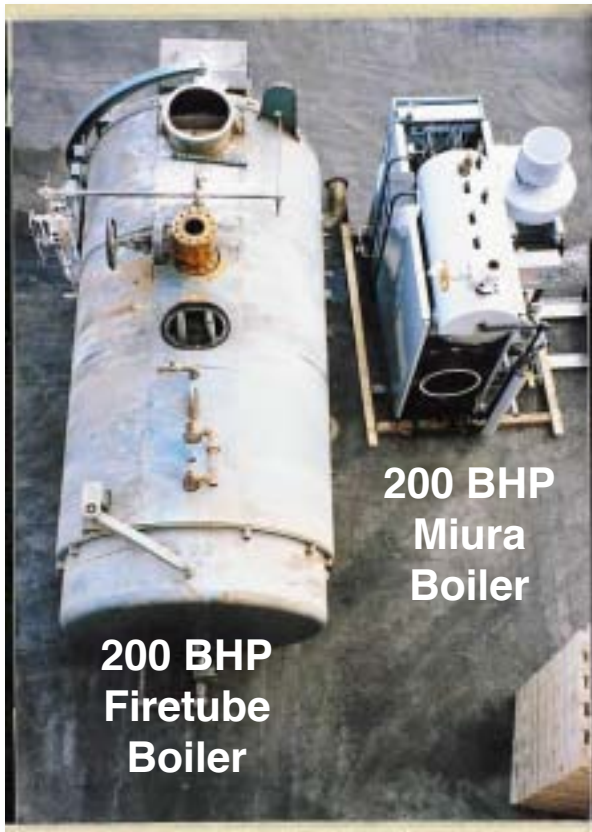


Increasing Efficiency = Reducing Losses: *Radiant Losses*

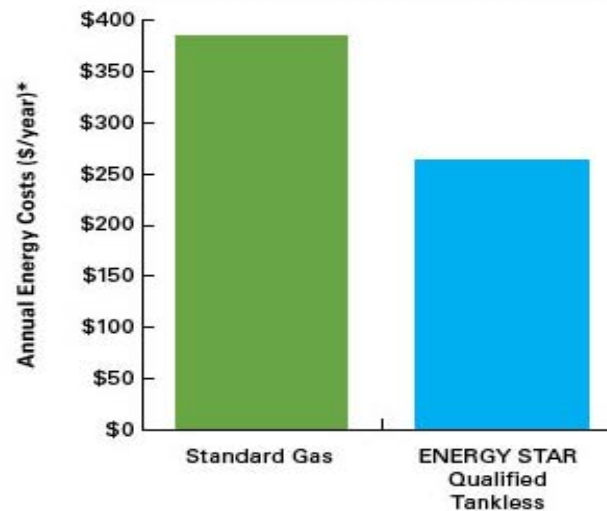


- Large scale *on-demand* thermal energy systems

Commercial / Industrial

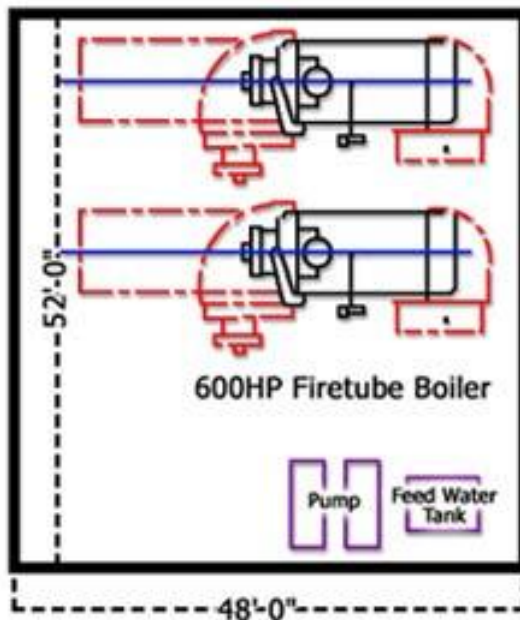


Residential

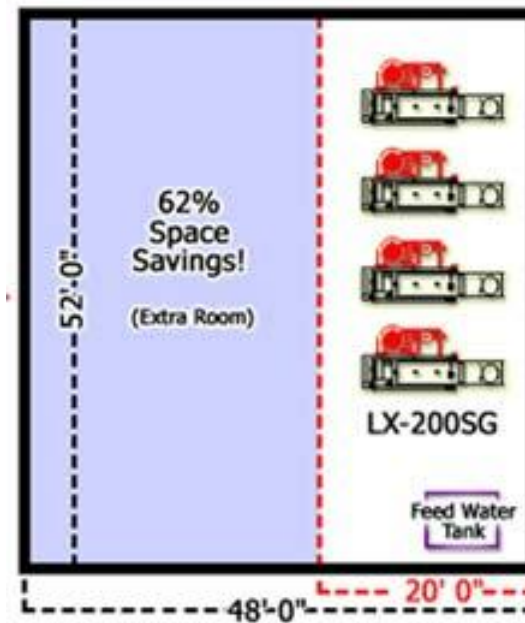


- Small boiler footprint (good for point-of-use applications)
- No tube-pull space required
- **Double the boiler output of a typical boiler room (existing facilities)**
- **Reduce required boiler room area by over 50% (new construction)**

Without Tube-Pull & Door-Swing Space



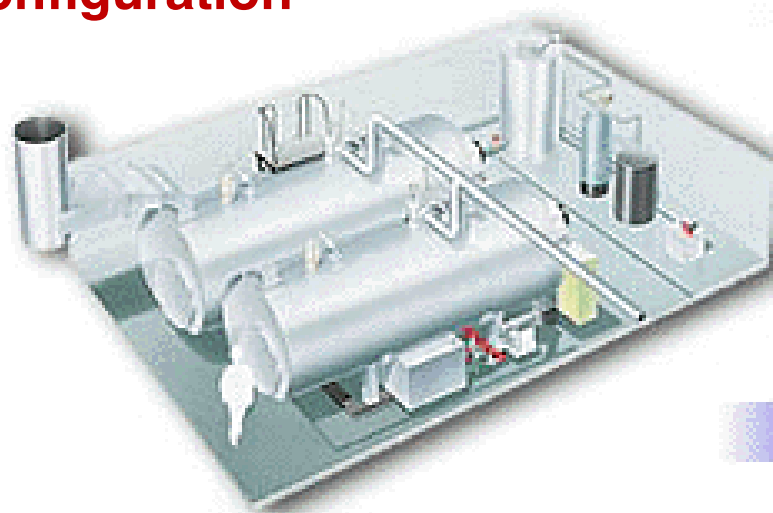
Modular Systems Offer Substantial Space Savings



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**

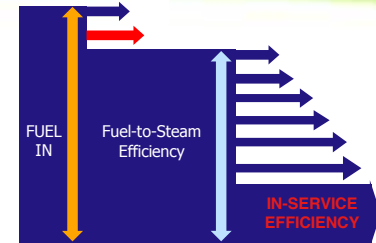


- Low Water Content:
stores less potentially harmful energy
(Miura 200 BHP only 65 gallons)
- Unique water tube design -
eliminates catastrophic failures



Increasing Efficiency = Reducing Losses: *Radiant 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**

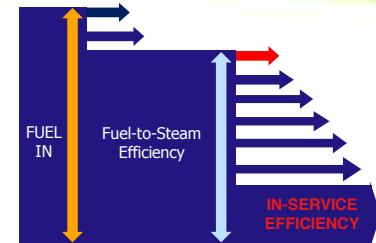


Recoverable Heat from Boiler Flue Gases				
Initial Stack Gas Temperature, °F	Recoverable Heat, MMBtu/hr			
	Boiler Thermal Output, MMBtu/hr			
	25	50	100	200
400	1.3	2.6	5.3	10.6
500	2.3	4.6	9.2	18.4
600	3.3	6.5	13.0	26.1

Based on natural gas fuel, 15% excess air, and a final stack temperature of 250°F.

Increasing Efficiency = Reducing Losses: *Start-up Losses*

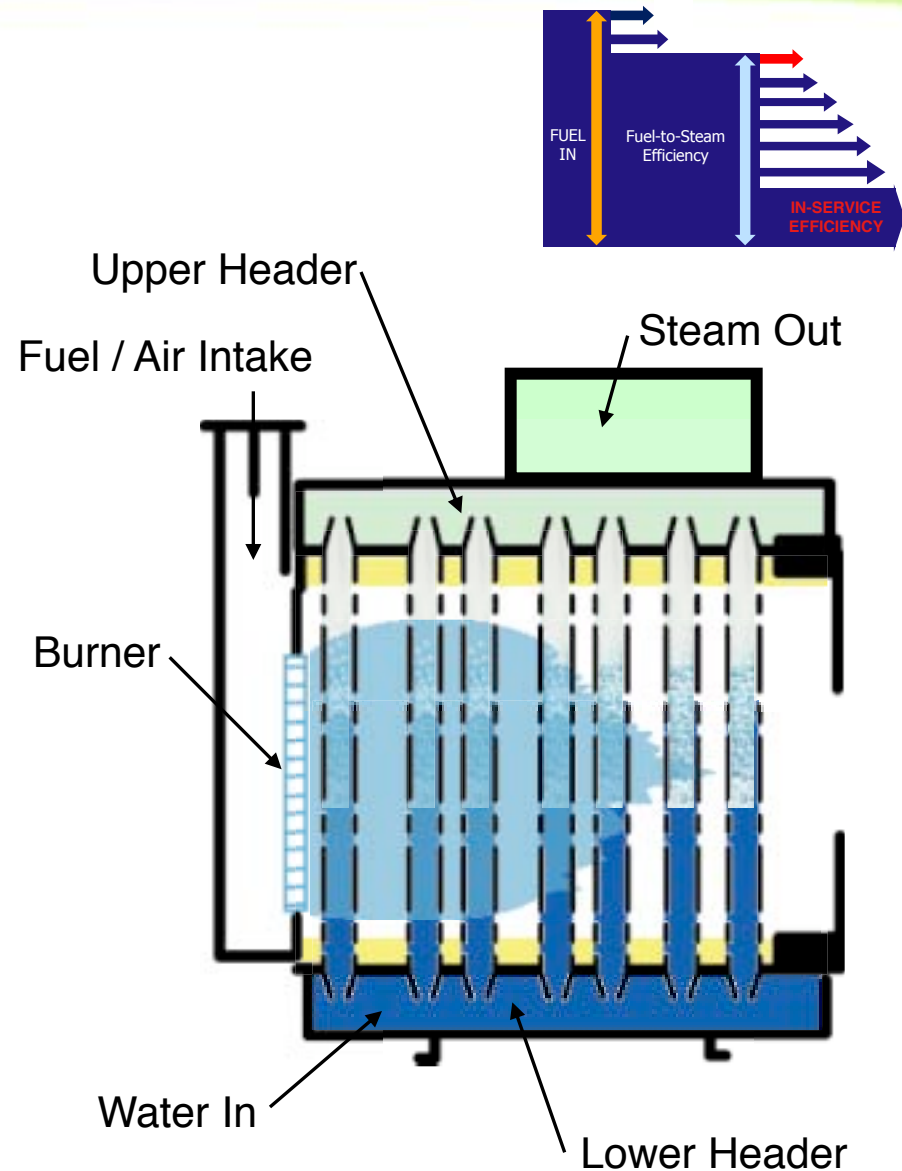
- Thermal shock/stress is the **#1 cause** of fire-tube boiler damage & repair
- Conventional boiler performance is limited by thermal stress resulting in inefficiency by requiring slow boiler start-up & perpetually idling operation
- Firetube boilers typically require as much as 90 minutes for cold start-up & must remain idling when in stand-by mode resulting in significant wasted energy & emissions



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**



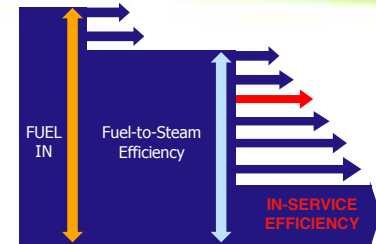
Increasing Efficiency = Reducing Losses: *Blow-down Losses*



- 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.



BL Boiler Control System: *LX / EX Series*

Miura

- **47 alarms in plain English**
- **38 caution messages in plain English**
- **Probable cause and/or solution given for each alarm or caution**
- **Allows for short 10 second pre-purge and minimized post-purge**
- **Stores last 7 fault incidents**
- **On-Line maintenance system interface**



BL Boiler Control System: *LX / EX Series*

- **User-friendly controller interface**



Green (normal)



Yellow (caution)



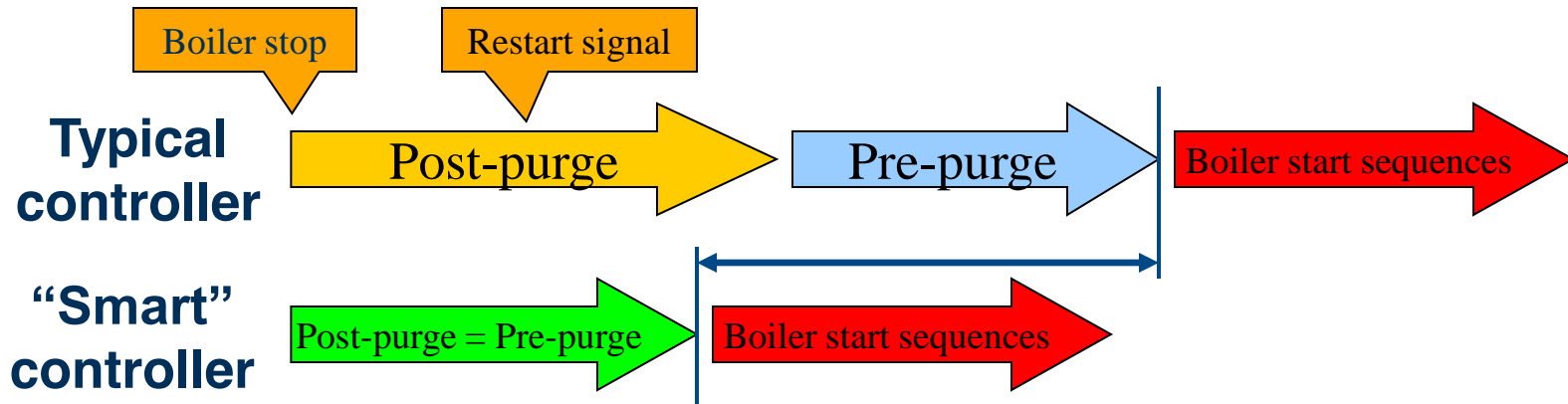
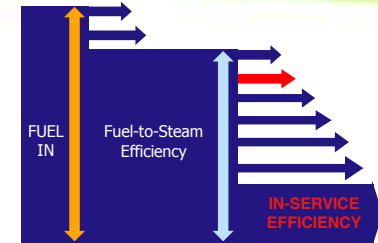
Red (alarm)

- **Alarm example with probable cause:**



Increasing Efficiency = Reducing Losses: *Pre- & Post-Purge Losses*

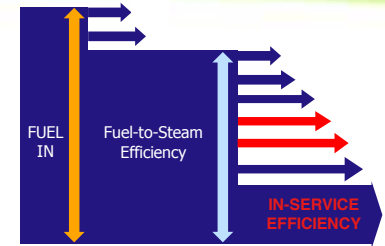
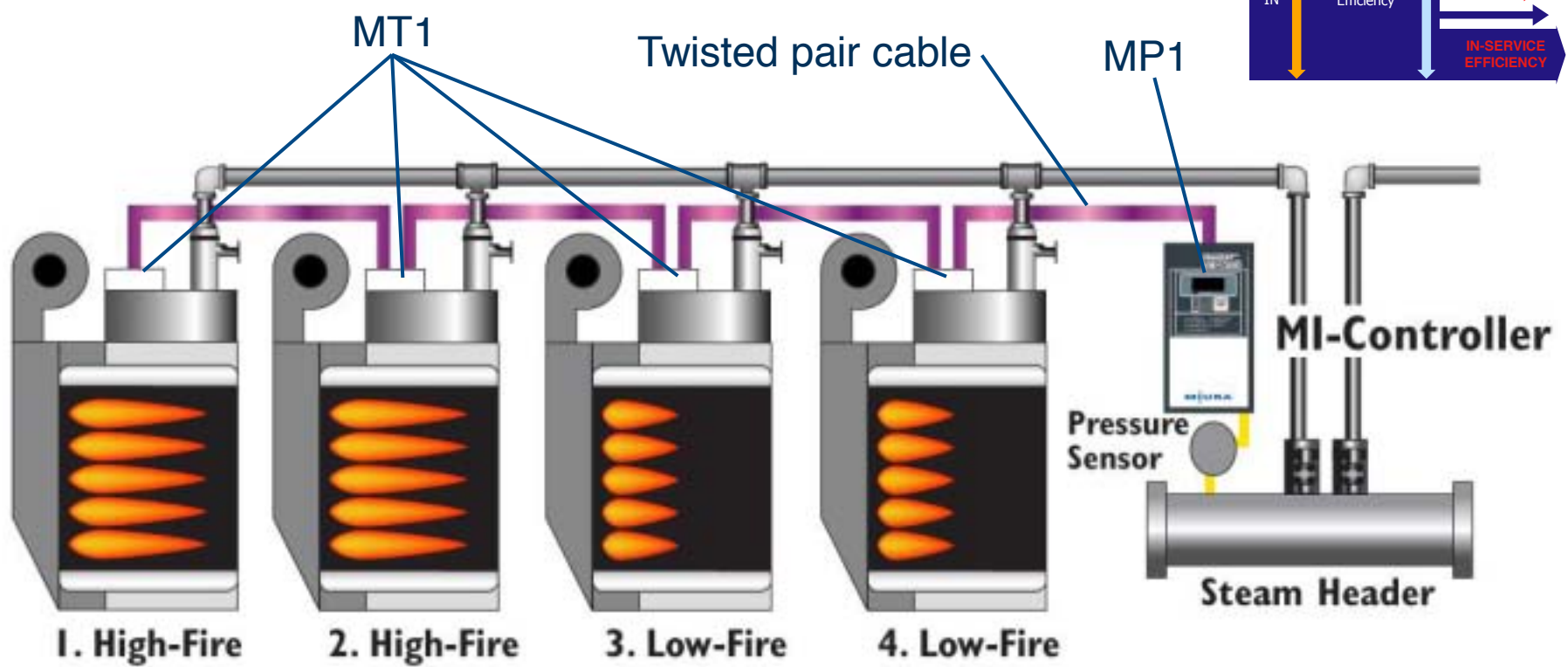
- Utilize a control system that includes an intelligent purge system to optimize boiler performance
- “Purge Cancel” function interrupts post purge when fast restart is required, eliminating heat loss and improving response time
- **Optimized response time (w/in 10 seconds) = increased efficiency + reduced emissions**



Increasing Efficiency = Reducing Losses: *Losses at High Turn-down*

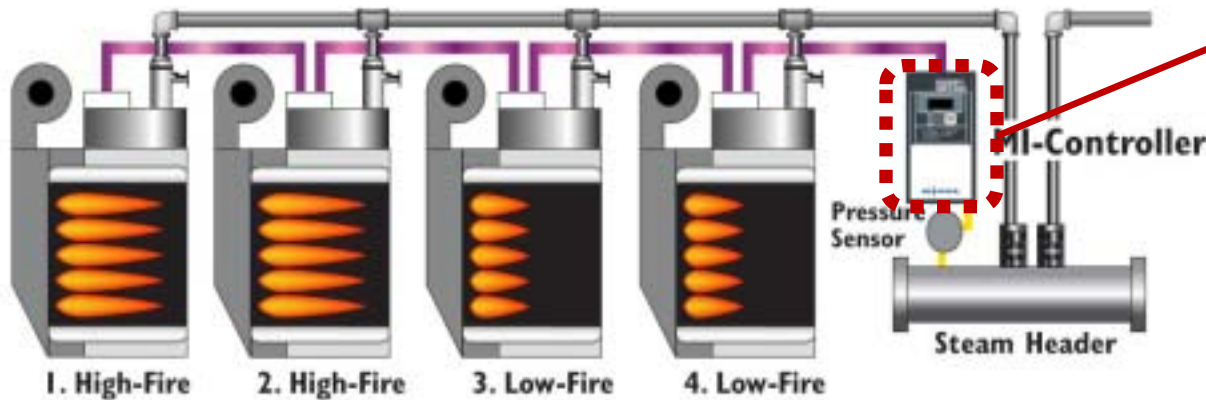


▪ Modular boiler system:

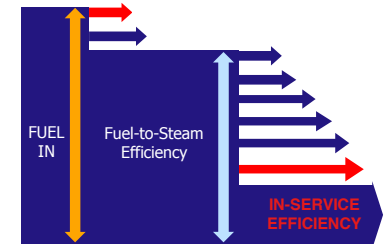
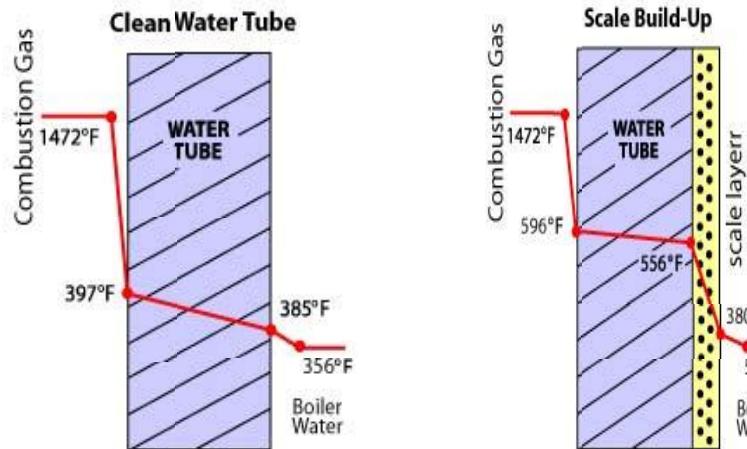


Optimized Energy Management with *Modularity*

- Multiple modular boilers act as one large, high efficiency, high turndown boiler
- Boilers react in 30 seconds or less.
- Shut off boilers in low load conditions
- In the event of a fault, backup boilers come online in 30 seconds



- 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 ~

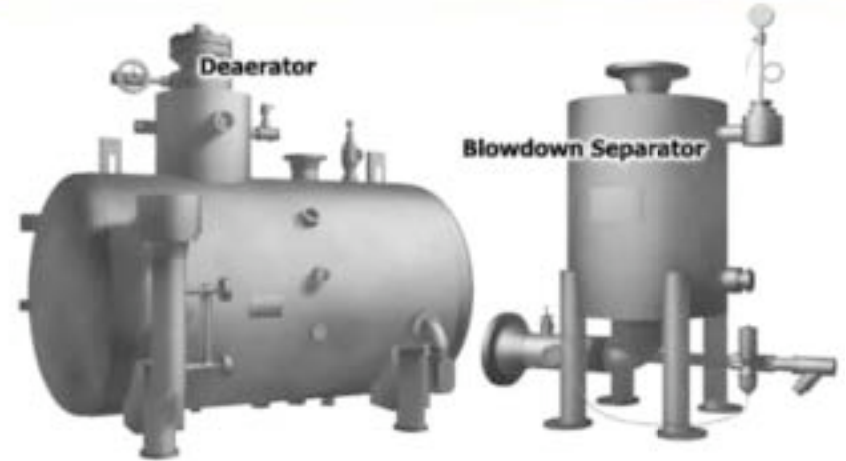
- Over \$7 billion in wasted energy / yr (@ \$1.00/therm)
- Over 50 million metric tons of CO₂ emissions / yr

Boiler Model Summary: *Ancillary System Components*

- Deaerators, Blow-down Separators, Pumps, Feed-water Tanks & Check Valves



- Water Hardness Monitor



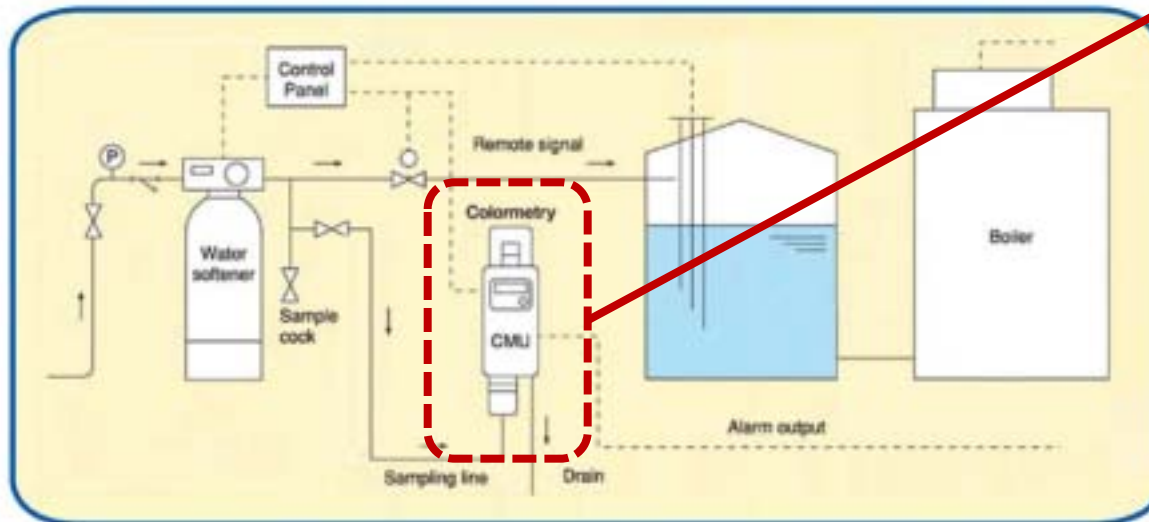
- Water Treatment



The ancillary equipment complete the boiler system & are crucial to its long-term performance / efficiency.

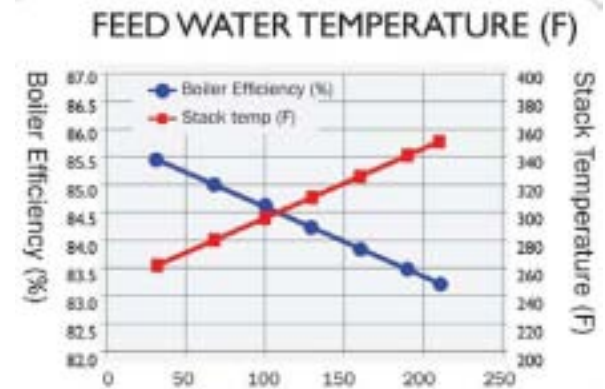
Boiler Scale Detection & Prevention: *Water Hardness Monitoring*

- 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 Tube Protection: *Enhanced Chemical Water Treatment*

- **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%**



CORROSION PREVENTION WITH SILICATE



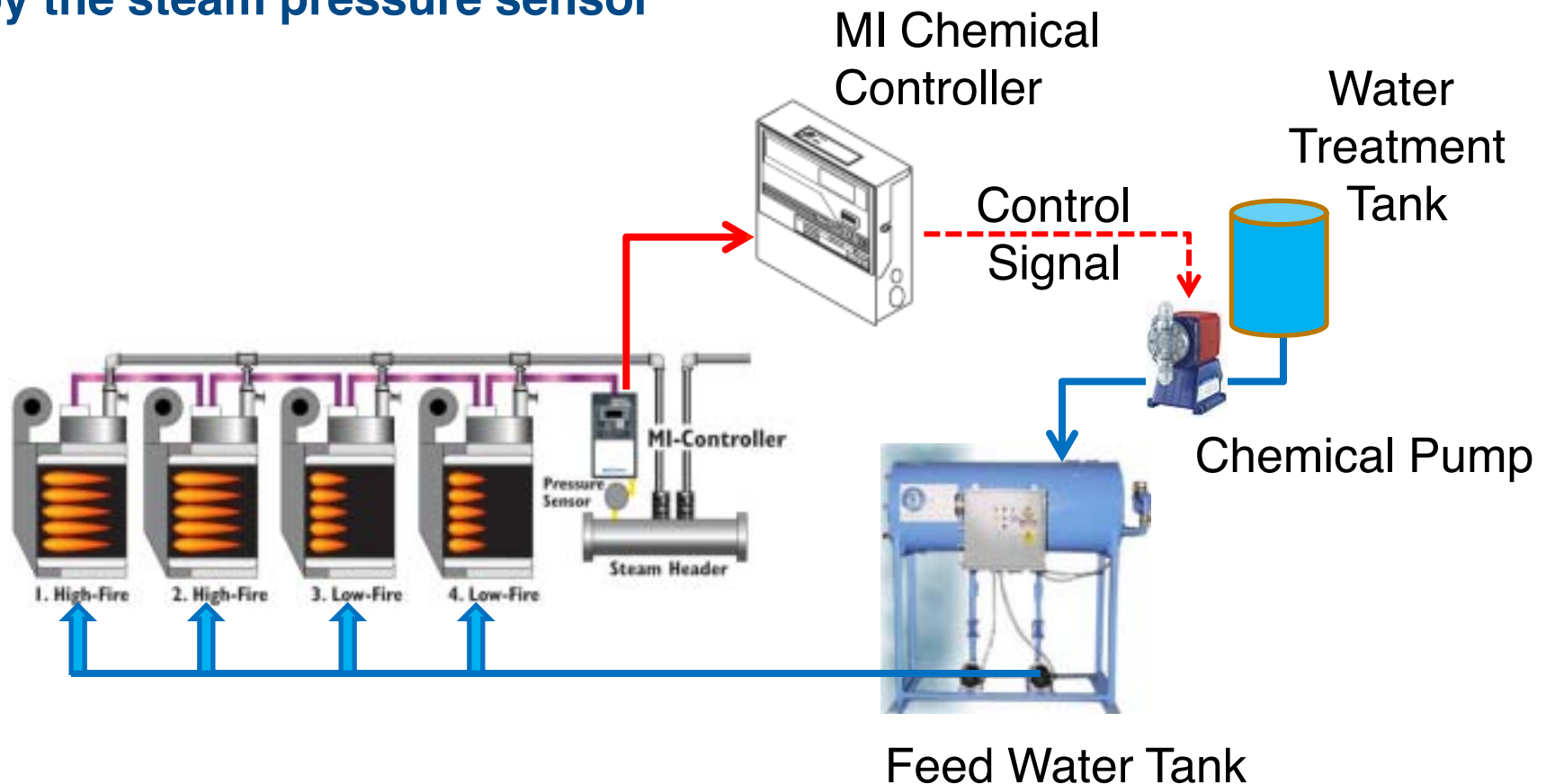
No Chemical



BOILERMATE®

Boiler Tube Protection: *Enhanced Chemical Water Treatment*

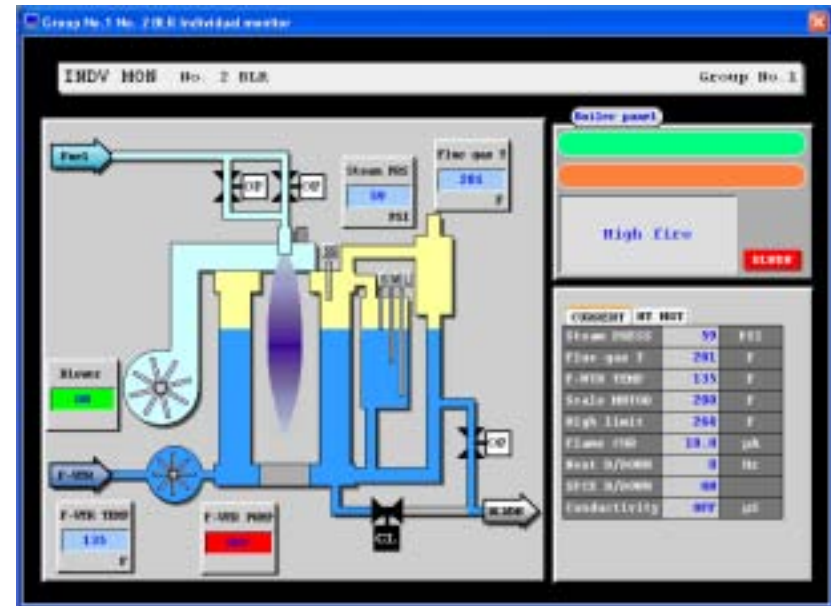
- Silicate filmer water treatment feed is modulated via an interface with the MI Controller
- Chemical feed is based on steam demand measured by the steam pressure sensor



Miura Online Maintenance: “M.O.M.” System

MIURA

- Utilize online maintenance system that interfaces with boiler control system as thermal energy management “dashboard”
- Speeds maintenance by diagnosing fault conditions
- Alerts maintenance staff to warnings before they become problems
- Provides monthly reports
- Standard with every boiler shipped
- **6 months monitoring with monthly reports free with boiler system purchase**



Miura Online Maintenance: "M.O.M." System



Available Operational Settings:

SETTING DATA			
CONDUCTIVITY SET	25 00 uS	START UP DATE	052500
HI CONDUCTIVITY	40 00 uS	CHANGE DATA DATE	051000
B/DOWN SCHEDULE	030 Hour	SUPPLY GAS TEMP.	070
AUTO BLOW RATE	05 %	SUPPLY GAS PRESS.	138
STEAM SET LOW	135 PSI	GAS METER PULSE	000
STEAM DIFFER LOW	05 PSI	S PROBE TIME SET	20
STEAM SET HIGH	145 PSI	M PROBE TIME SET	10
STEAM DIFFER HI.	05 PSI	SPARE	000
SCALE MONITOR L	426 F	TRANSMIT FAILURE MESSEGES	ENABLE
SCALE MONITER H	460 F	MIURA BRANCH PHONE	T9_18475418034
OVERHEAT TEMP.	660 F	SERIAL No.	####8968
EQUIV. OUTPUT	0690 0 LB/Hr	PASSWORD	****
BRIGHTNESS ADJ	4		

SAVE as MAINT. DATA CANCEL

Miura Online Maintenance: "M.O.M." System



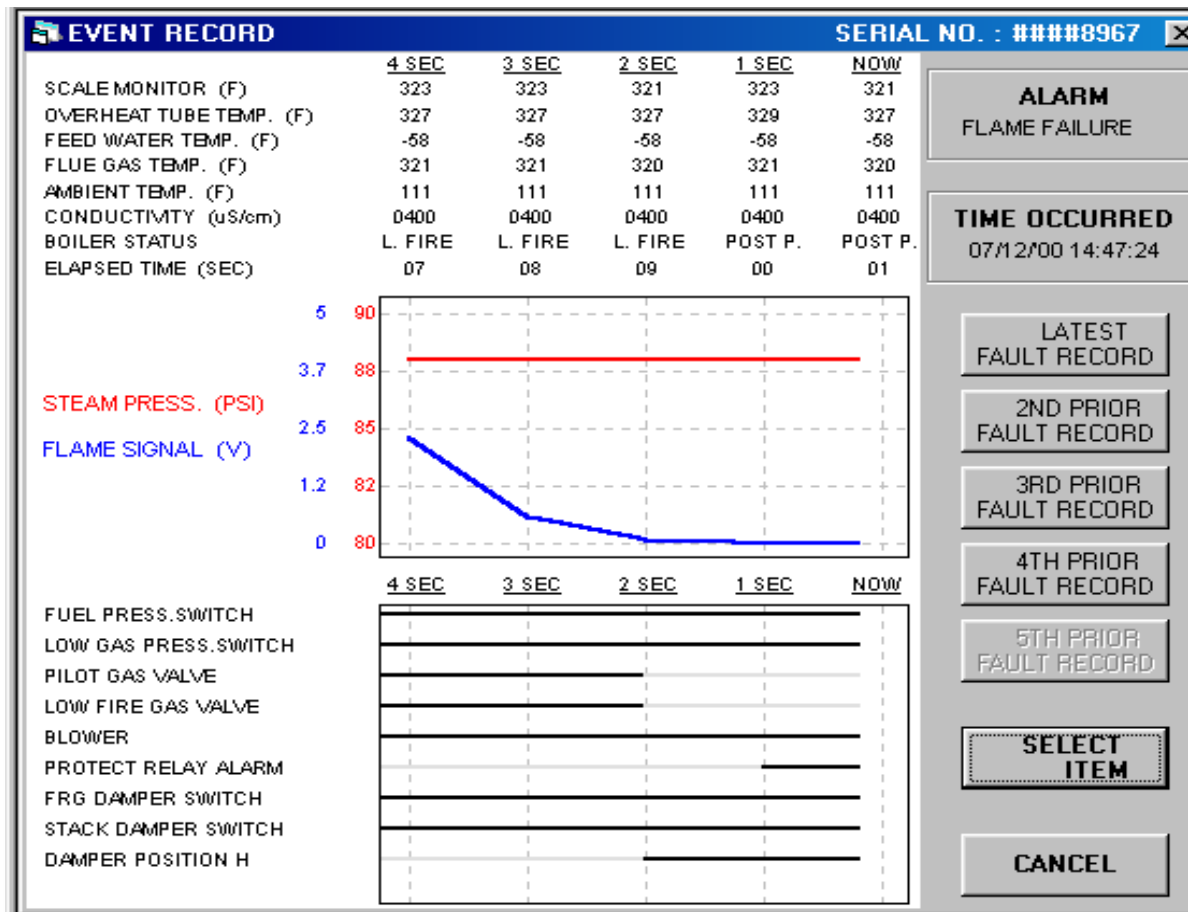
Alarm History:

ALARM HISTORY	
SERIAL NO.	#####8967
EMERGENCY STOP	0000
FLAME FAILURE	0002
FLAME DETECTED	0000
AIR PRESS FAULT	0001
LOW WATER LEVEL	0009
HIGH WATER LEVEL	0000
HIGH W TUBE TEMP	0000
O. HEAT T.C. FAULT	0000
POWER FAILURE	0000
FGR DAMPER FAULT	0000
HIGH GAS PRESS	0000
SCALE WARNING	0000
ECO DIFF PRESS	0000
LOW GAS PRESS	0000
SCALE T.C. FAULT	0000
CHIMNEY DAMPER	0000
LOW OIL PRESS	0000
SPARE	0000

CANCEL

Miura Online Maintenance: "M.O.M." System

- Alarm Record: "Sliding Window" feature allows view of real time operation + 4 seconds into the past for enhanced troubleshooting



Boiler Systems - Introduction:

Available Models:



Boiler Model Summary:

LX Series

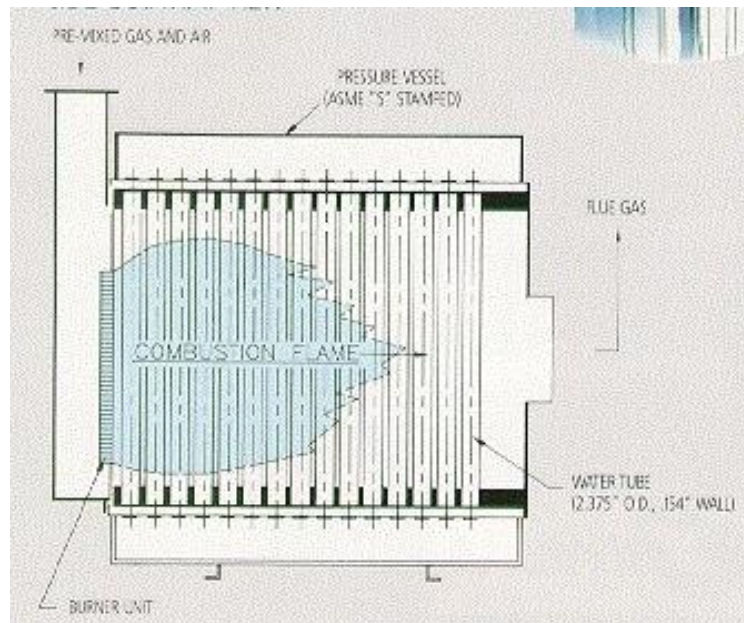
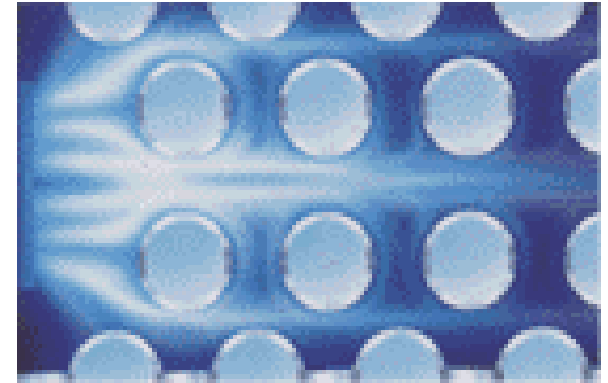
Miura

- **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**

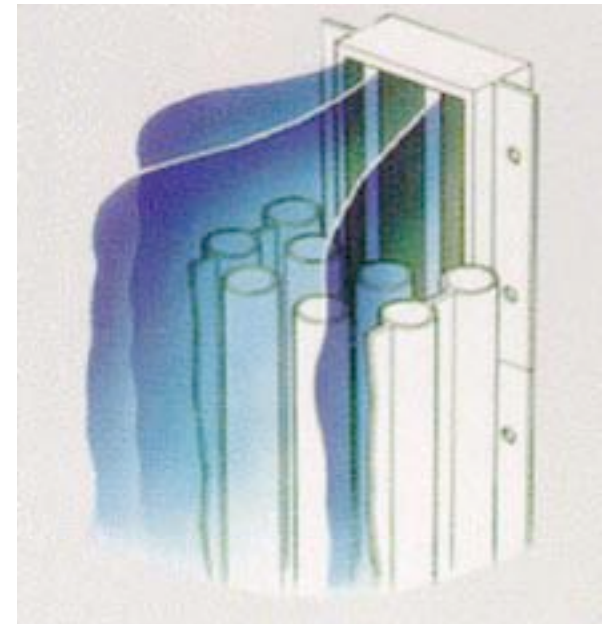


Boiler Model Summary: Combustion *LX Series*

- **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 Vessel – Side View



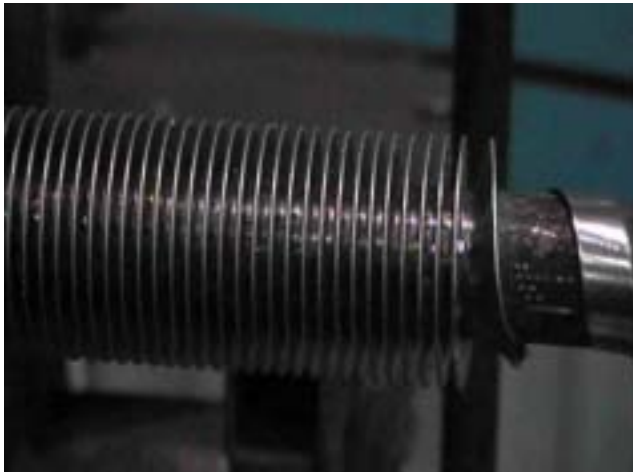
Combustion – Detail View

Boiler Model Summary: *LX Series*

**Pressure Vessel w/
Steam Separator**



Upper Header w/ Baffle Plate



Fins on LX Series Tube

Boiler Model Summary: *EX Series*



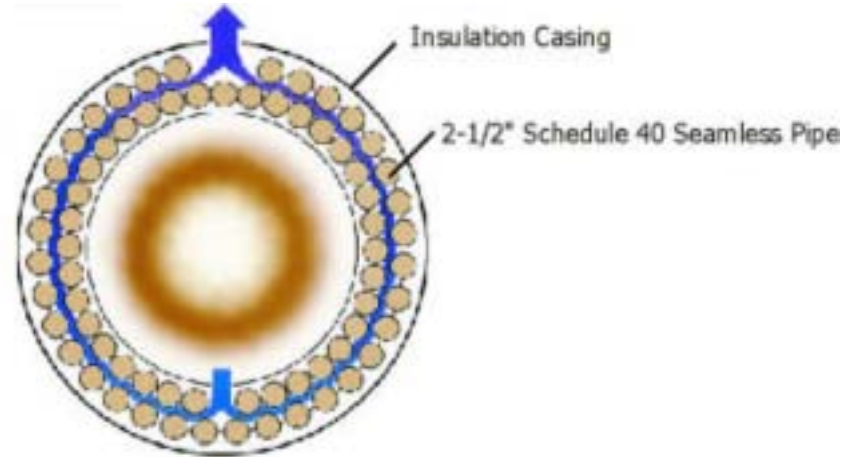
- **Duel Fuel – Natural Gas/Propane & Oil**
- **100, 150, 200, 250, 300 BHP Models**
- **Steam in 5mins From Cold Start**
- **Vertical Flame Path (top down)**
- **70-150 PSI Standard Operating Pressure (high pressure option available)**
- **Also Available in Hot Water version**



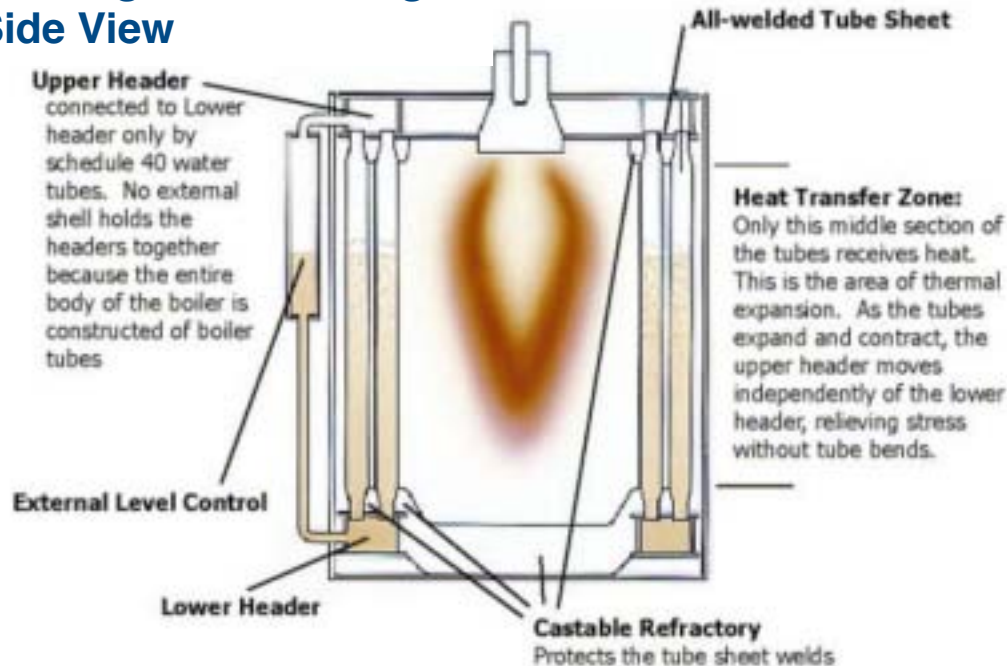
Boiler Model Summary: Combustion EX Series

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

Boiler Model Summary: Steam Quality *EX Series*

- Innovative boiler tube design optimizes energy efficiency by maximizing heat transfer
- Design, placement & location of fins are precisely reverse engineered to maximize energy efficiency





MIURA

Questions:

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