

## Miura Design Advantage

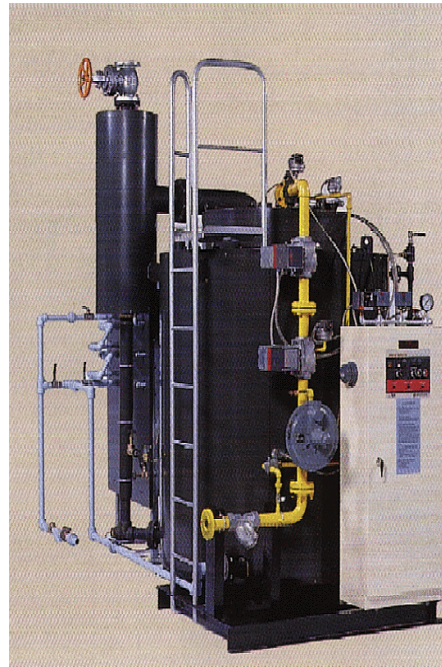
A boiler purchase is one of the most important investments for a process steam or hot water plant. A low efficiency boiler purchased for \$75,000 can easily waste its purchase price within one year compared to a high efficiency design.

Savings can be broken down into three general categories: initial cost, maintenance and boiler efficiency savings. While capital expenditure and maintenance costs should be carefully analyzed, the smallest part of an overall boiler investment is initial cost. Running costs will determine the survival of your company. By far the best method to maximize your investment year in and year out is to understand the costs of your boiler operation.

Miura's specialty is developing superior boiler technology, which will help the customer's bottom line so they can be as competitive as possible in domestic and international markets. The result is the revolutionary LX (Low Nox gas fired boiler) and the EX (gas/oil fired boiler) models. They were designed to **greatly decrease physical size, reduce maintenance and capital costs, and minimize energy consumption.**



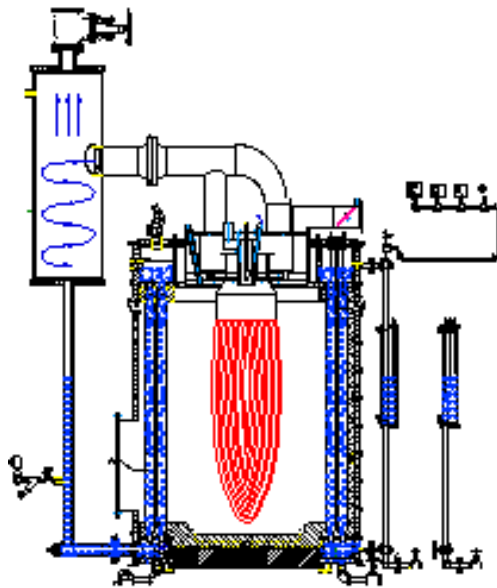
**LX MODEL**



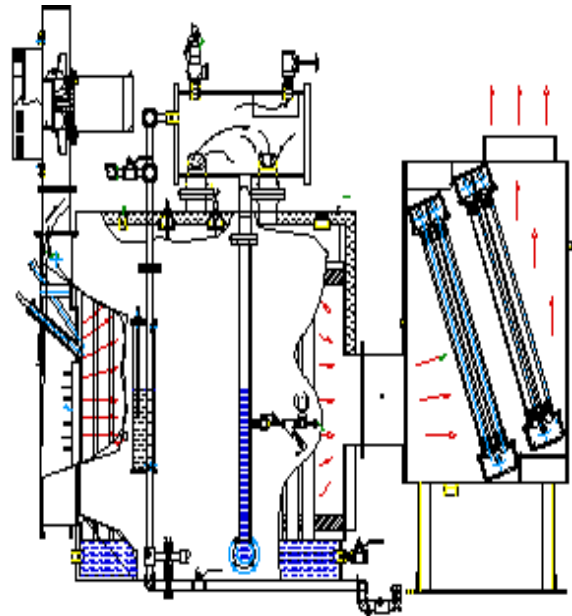
**EX MODEL**

It is easy to forget how much something cost you, but you will always remember the problems! Get the right system and invest your time solving other, more important problems.

## THE DESIGN



**EX-Series cut-away view**



**LX-Series cut-away view**

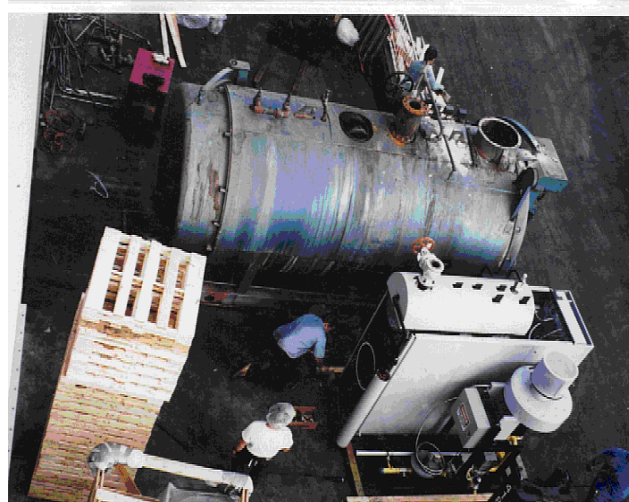
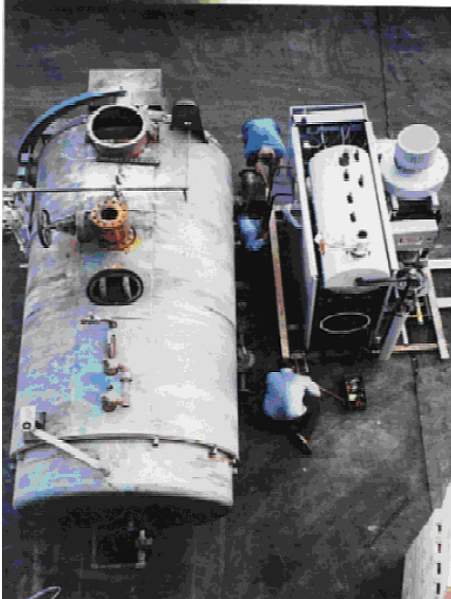
The *MIURA* design consists of rows of vertical tubes sandwiched between two annular or rectangular headers (see the above cutaway). Both headers are encased in a castable refractory with only the tubes exposed to flame and/or combustion gasses. The upper header is attached to the lower header only by the tubes. Therefore, as the tubes expand and contract, the headers float up and down accordingly. This "floating header" concept, aided by forced flow greatly reduces stress and allows for the use of cold water without the fear of significant thermal shock.

Feed water is fed into the bottom header and forced into the tubes where boiling occurs, creating a two-phase steam/water mixture rising in each tube. This can be envisioned as a "steam gradient" with more steam at the top of the tubes than at the bottom. Steam from each tube is then collected in the upper header, which is designed with baffles to help further separate water from steam; and then a final separation in an external separator before leaving the pressure vessel to do work. This, along with the patented *MIURA* two-way water control system, helps to ensure safety and steam quality above 99%.

- ✓ **Miura Boilers are made in North America and incorporates commonly available, non-proprietary parts. You can use your local warehouse supplier.**

## Why Does Miura Save Fuel Over Other Boiler Designs?

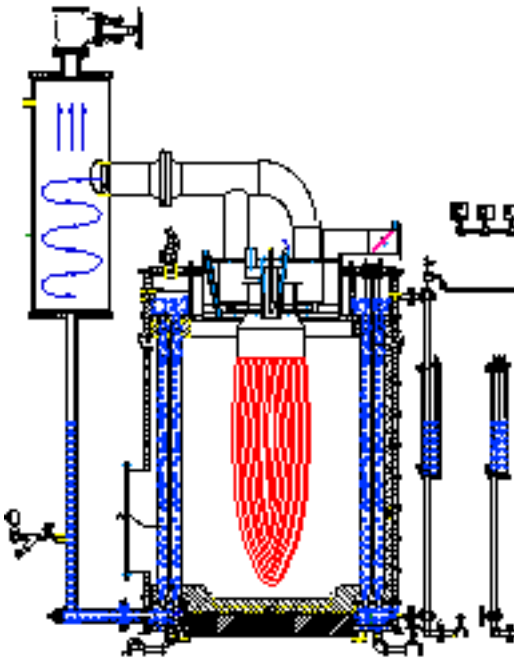
**First reason is size.** The Miura design is a low mass, water tube boiler. The LX model, for example, has approximately 1/3 the radiation surface area of a fire tube the same size. That means 2/3 less radiation loss per boiler. The fuel savings is magnified in a multiple installation.



**Actual picture of a Miura 200 HP boiler along side a 200 HP Fire tube.**

- In general, the Miura boiler can double the capacity of your existing boiler room or, cut in half the space requirements of a new boiler room!
- The Miura design can help eliminate the need for costly annual factory shutdowns. The Miura boiler can be drained, inspected, and back on line within two hours.
- The Miura Multiple Installation System can assure constant steam without waste. How much does it cost each hour if your process line goes down?

**Second reason is superior design.** Miura can give full steam output from a cold start within five minutes without fear of thermal shock. This means no concern about feed water temperature, no fear of bringing the boiler on or off line too quickly. The “leaky tube” problem common with other designs is eliminated - no more re-rolling of the tubes to the tube sheet and no more cracked tubes sheets. In fact, our vessel is 100% welded, heat treated and X-rayed.



**Water content of only 48 gallons vs. over 2,000 gals for a typical fire tube. We truly achieve full steam output within 5 minutes from a cold start up.**

**EX-Series cut-away view**

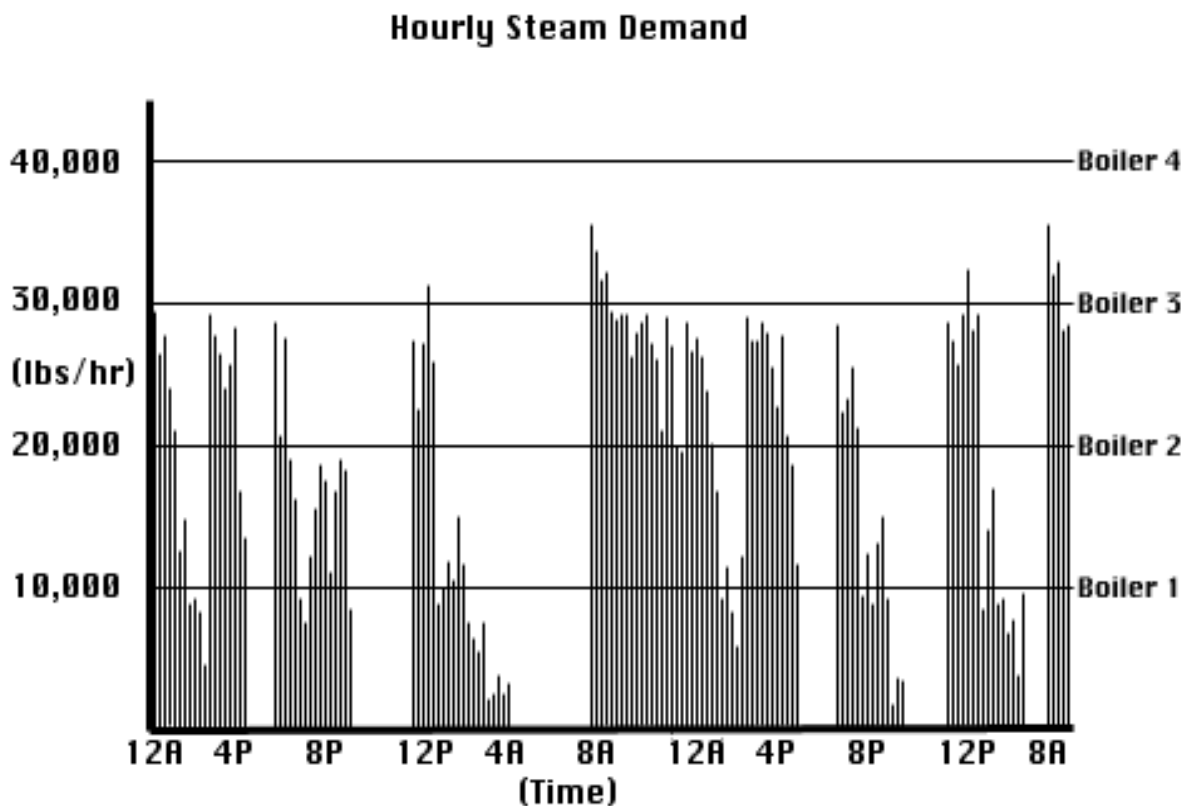
Thermal shock for a boiler is when the stresses created from repeated warm up and cool down periods in a boiler manifests itself in metal fatigue, resulting in cracks or “leaky tube” - tubes which lose their seal with the tube sheet. All boilers suffer from thermal shock to some degree. However the patented *MIURA* design can guarantee all its models (steam as well as hot water) from any thermal shock effects, regardless of the feed water temperature - for twenty-five years.

Note: Conventional boilers must be either “bank” fired, or take a long time (about one hour) to heat up from a cold start in order to avoid thermal shock. The Miura design can give full output within five minutes from cold start-up without thermal shock. Therefore boilers can be nested together to act like one large boiler, yet individual boilers can also be taken off line **and forced to stay cold** during normal operation until brought on quickly for periodic spikes in load. This maximizes fuel savings.

**How much do you spend on re-rolling tubes and/or repair of castable?**

**The result is Efficient Operation for high In-Service Efficiency** - The “Hourly Steam Demand” graph below is typical for a larger food processing plant. With this type of load fluctuation, a conventional fire tube will modulate its fire rate up and down to meet the load swings - however the radiation losses from the boiler remains constant. At full fire, the in-service efficiency is high, but at zero percent load, the in-service efficiency is zero.

With a Miura Multiple Installation (MI) system, boilers can give full output within five minutes from cold start-up without thermal shock. Therefore boilers can be nested together to act like one large boiler yet boilers can be taken off line **and forced to stay cold** during normal operation and brought on quickly for periodic spikes in load. This maximizes fuel savings.



**This design also lends itself well to protecting other boilers in large steam systems. For example, say there is a base load requirement of 900 BHP with a peak load of 1,800 BHP. A fire tube or water tube can handle the base load at a steady firing rate while three Miura boilers will run only when steam is required and shut down and stay cold on standby until needed again - minimizing radiation losses. This protects the base load boilers from thermal shock and preserves total steam plant efficiency.**

## What is Efficiency?

If the Miura boiler design is placed side by side with a conventional fire tube, with the exact same fuel-to-steam efficiency criteria (such as fuel specification, excess air levels, ambient air temperature and relative humidity) and the exact same operating load requirements - Miura boiler will save, on the average, anywhere from 10 to 25% of the **total** boiler fuel bill. How is this achieved?

First, what is efficiency?

**COMBUSTION EFFICIENCY** - This is the effectiveness of the burner only and relates to its ability to completely burn the fuel. The boiler or heat exchanger has little influence on combustion efficiency.

**THERMAL EFFICIENCY** - This is the effectiveness of the heat transfer in a heat exchanger. It does not take into account boiler radiation and convection losses.

**BOILER EFFICIENCY** - Be careful when a salesperson mentions this term. This can mean almost anything and must be clearly defined by the manufacturer.

**FUEL-TO-STEAM EFFICIENCY** - This is the ratio of BTU output divided by BTU input on a particular boiler. This includes all the heat loss (e.g. radiation and convection losses) from a boiler. Fuel-to-steam efficiency is the most commonly used efficiency in boiler comparisons. It is a readily verifiable number and is often used in efficiency guarantees by various manufacturers. However this efficiency is blind to actual load requirements of your system and does not give the actual efficiency of your boiler under actual operating conditions.

**IN-SERVICE EFFICIENCY** - This is the resulting efficiency of a boiler when the total operation cycles are taken into account such as day, night, weekends, high loads, low loads, standby loads and reflects how well a particular boiler design handles a particular operating model. It is a comprehensive efficiency, which is based upon an operating model and is the “bottom line” efficiency, which should be used in any boiler comparison.

The basic difference between Fuel-to-Steam verses In-Service efficiencies is that the Fuel-to-Steam efficiency of a particular boiler design is a fixed fire-rate efficiency (i.e. 100%, 75%, 50% or 25%) which includes radiation and convection losses; while In-Service efficiency factors in how the fuel-to-steam efficiency of the particular boiler design responds to the full firing range - from bank firing (idling) to full fire - under a projected operating schedule.

**For example** - A 100% fire rate - which includes convection and radiation losses (fuel-to-steam) - efficiency of a typical fire tube boiler for natural gas at operating steam pressure of 125 PSIG is about 81%. Drop the fire-rate with convection and radiation losses included to 25% for the same boiler and the efficiency becomes about 78.5%. Likewise an In-Service efficiency of a boiler at 100% load (meaning full fire 24 hours per day, 365 days per year) will be about 81%. However drop the steam load to 25%, (i.e. full fire for six hours and idling for 18 hours - or half fire for 12 hours and idling for 12 hours) and the In-Service efficiency will be much lower than 78.5% efficiency. Idle the boiler to keep it warm and ready to deliver steam upon demand and the In-Service efficiency becomes zero. In-Service efficiency is the most conservative approach to efficiencies and should be considered in order to project what the bottom line fuel consumption of a boiler should be.

## Single Boiler Example (11% savings)

### Three Hundred BHP Peak Demand

#### 1. Capital costs

A. One three hundred BHP firebox fire tube with all the trim lists for about \$72,500. One three hundred BHP *MIURA* EX unit lists for about \$82,500.

B. Boiler room size requirement for the three hundred BHP fire tube versus the three hundred BHP *MIURA* unit with the allowance considered for same ancillary equipment is 810 SQ.FT. vs. 380 SQ. FT. respectively. Assume a cost of \$35/SQ.FT. for construction costs and *MIURA* saves about \$15,000.

Total capital cost savings on boiler equipment is a net \$5,000 in favor of a Miura Boiler.

#### 2. Fuel Savings

Fire tube - (at an average of 35% peak load conditions)

In-Service Efficiency: 72%

Steam Demand:  $3.175 \times 10^7$  lbs/year (at 1 PSIG)

Nat. Gas Cost: 0.0032 \$/FT<sup>3</sup>

Nat. Gas HHV: 1004 BTU/FT<sup>3</sup>

Steam Enthalpy: 1150 BTU/lb (at 1 PSIG)

Feed Water Enthalpy - 212 BTU/lb

$$3.175 \times 10^7 \times 0.0032 \times (1150-212)/(0.72 \times 1004) = \$132,250/\text{year}$$

*MIURA* - with same conditions, in-service efficiency is 83%.

$$3.175 \times 10^7 \times 0.0032 \times (1150-212)/(0.83 \times 1004) = \$114,365/\text{year}$$

**Fuel savings** in favor of *MIURA* - \$17,885/year.

**Total Savings** with the *MIURA* system is about \$94,425 in five years!

**NOTE:** If we run the same scenario at 100% load, raising the fire tubes efficiency to 82%, the fuel savings works out as follows:

Fire tube - (at an average of 100% peak load conditions)

In-Service Efficiency: 82%

Steam Demand:  $9.05 \times 10^7$  lbs/year (at 1 PSIG)

Nat. Gas Cost: 0.0032 \$/FT<sup>3</sup>

Nat. Gas HHV: 1004 BTU/FT<sup>3</sup>

Steam Enthalpy: 1150 BTU/lb (at 1 PSIG)

Feed Water Enthalpy - 212 BTU/lb

$$9.05 \times 10^7 \times 0.0032 \times (1150-212)/(0.82 \times 1004) = \$329,950/\text{year}$$

*MIURA* - with same conditions, in-service efficiency is 85%.

$$9.05 \times 10^7 \times 0.0032 \times (1150-212)/(0.85 \times 1004) = \$318,300/\text{year}$$

**Fuel savings** in favor of *MIURA* - \$11,650/year.

**Total Savings** with the *MIURA* boiler is about \$63,250 in five years!

## Multiple Boiler Example (11% Savings)

### Six Hundred BHP Peak Demand

#### 1. Capital costs

A. Two, six hundred BHP fire tubes with all the trim lists for about \$190,000. An equivalent system with four, two hundred BHP *MIURA* EX units with an MI controller lists for about \$248,000.

B. Boiler room size requirement for the same six hundred BHP fire tubes versus four, two hundred BHP *MIURA* units with the same space considered for ancillary equipment is 1,599 SQ.FT. vs. 1065 SQ. FT. respectively. Assume a cost of \$35/SQ.FT. for construction costs and *MIURA* saves about \$18,690.

Total capital cost savings on boiler equipment is a net \$39,310 in favor of a fire tube system.

#### 2. Fuel Savings

Fire tube - (at an average of 35% peak load conditions)

In-Service Efficiency: 72%

Steam Demand:  $6.35 \times 10^7$  lbs/year (at 1 PSIG)

Nat. Gas Cost: 0.0032 \$/FT<sup>3</sup>

Nat. Gas HHV: 1004 BTU/FT<sup>3</sup>

Steam Enthalpy: 1150 BTU/lb (at 1 PSIG)

Feed Water Enthalpy - 212 BTU/lb

$$6.35 \times 10^7 \times 0.0032 \times (1150-212)/(0.72 \times 1004) = \$263,670/\text{year}$$

*MIURA* - with same conditions, in-service efficiency is 83%.

$$6.35 \times 10^7 \times 0.0032 \times (1150-212)/(0.83 \times 1004) = \$228,730/\text{year}$$

**Fuel savings** in favor of *MIURA* - \$34,940/year.

**Total costs** with the *MIURA* system is recovered in about 15 months with five-year savings of \$135,390!

**Note:** If we run the same scenario at 100% load, raising the fire tubes efficiency to 82%, the fuel savings works out as follows:

Fire tube - (at an average of 100% peak load conditions)

In-Service Efficiency: 82%

Steam Demand:  $1.81 \times 10^8$  lbs/year (at 1 PSIG)

Nat. Gas Cost: 0.0032 \$/FT<sup>3</sup>

Nat. Gas HHV: 1004 BTU/FT<sup>3</sup>

Steam Enthalpy: 1150 BTU/lb (at 1 PSIG)

Feed Water Enthalpy - 212 BTU/lb

$$1.81 \times 10^8 \times 0.0032 \times (1150-212)/(0.82 \times 1004) = \$661,200/\text{year}$$

*MIURA* - with same conditions, in-service efficiency is 85%.

$$1.81 \times 10^8 \times 0.0032 \times (1150-212)/(0.85 \times 1004) = \$636,620/\text{year}$$

**Fuel savings** in favor of *MIURA* - \$24,580/year.

**Total costs** with the *MIURA* system is recovered in about 19 months with five year savings of \$83,590!

# Scale

Daily water Treatment is important to every boiler just as oil changes are to a car for good engine operation.

Pertaining to scale, the fundamental difference between the Miura design and a fire tube design is that the fire tube will allow build up of scale without causing much trouble. On the other hand, the Miura boiler is DESIGNED to quickly give trouble with the presence of scale. How and Why?

**How** - Miura incorporates thermal-couples measuring the temperature of the tubes. Should scale begin to form, the Miura boiler will shut down and ring an alarm. Then the source of the hardness can be traced (water softener, condensate return lines, operator error, etc.), fixed with an acid rinse, and return the boilers to their original efficiencies.

**Why** - The whole purpose of the Miura design is efficiency. It was designed in Japan where fuel is roughly five times the cost of fuel in the U.S. and one square foot of land can cost about \$50,000! Consequently, customers want only the most compact and efficient boiler designs if they are serious about their domestic and international markets. If you allow scale to build up on your boilers, look at the waste.

## Scale

BTU Loss from scale

1/64 inch	4.0%
1/32 inch	8.5%
1/16 inch	13%
1/8 inch	22%
1/4 inch	38%
3/8 inch	50%

Look at the above numbers. Think about them. Scale buildup of an eggshell thickness means energy loss of about 9% on top of normal boiler operation.

How much does this cost? Look at the following example.

For a 600 BHP fire tube boiler at 35% fire with an In-Service efficiency of 72% and an eggshell thickness of scale.

Fire tube - (at an average of 100% peak load conditions)

In-Service Efficiency: 72%

Efficiency loss from scale buildup: 9%

Steam Demand:  $6.35 \times 10^7$  lbs/year (at 1 PSIG)

Nat. Gas Cost: 0.0032 \$/FT<sup>3</sup>

Nat. Gas HHV: 1004 BTU/FT<sup>3</sup>

Steam Enthalpy: 1150 BTU/lb (at 1 PSIG)

Feed Water Enthalpy - 212 BTU/lb

No Scale:  $6.35 \times 10^7 \times 0.0032 \times (1150-212)/(0.72 \times 1004) = \$263,700/\text{year}$

Scale:  $6.35 \times 10^7 \times 0.0032 \times (1150-212)/(0.63 \times 1004) = \$301,340/\text{year}$

This means an eggshell thickness of scale on the boiler tubes translates to about \$37,000/year in wasted fuel!

The choice is simple. Do you want a boiler that will ignore scale build up and not cause any trouble? Or do you want a boiler to tell you when there is a scale problem? It is your call.



Be sure to take care of your boiler water treatment. Boilers do not create scale, they simply “find” it if allowed into the boiler.



A flooded 300 BHP Miura boiler has only about 100 gallons of water in it verses about 2000 gallons for a 300 BHP fire tube. Acid rinses are much less expensive on a Miura boiler.