# Whether for a Retrofit or a New Facility, Modular Steam Boiler Plants are a Smart Choice

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For the foreseeable future, you're not likely to hear the word boiler mentioned in regard to any design or installation meant to provide redundancy and cost savings without the words "modular" or "modular boiler plant" attached,[1] as the modular systems approach to boiler design and deployment is now in full utilization across a wide range of industries.

Fundamental to this realization, and as a first step in its discussion, is a definition of what is meant by each of these terms, provided below:

- *Modular boiler* – Boiler that is linked to other boilers in series or parallel configuration so that each can provide a percentage of the total system load and act as backup to each other in real time and/or in the event of an emergency. Usually involves substituting a large size (traditional) boiler with a proportionally greater number of smaller boilers to achieve equal HP requirements.
- *Modular boiler plant* – Fully engineered, piped, wired and tested modular boilers that are built on a common platform (skid) where they are fully integrated with all other ancillary equipment. This makes them self-contained, portable and pre-fabricated units, not unlike the new-style homes that are made from shipping containers (also called cargo container architecture). Ancillary equipment includes deaerator and surge tanks, feed water tanks, blow-down tanks, water treatment and chemical feed systems, and a system sequencing lead/lag control package.

A typical modular boiler set-up situated within a modular steam boiler plant is shown in **Fig 1**.

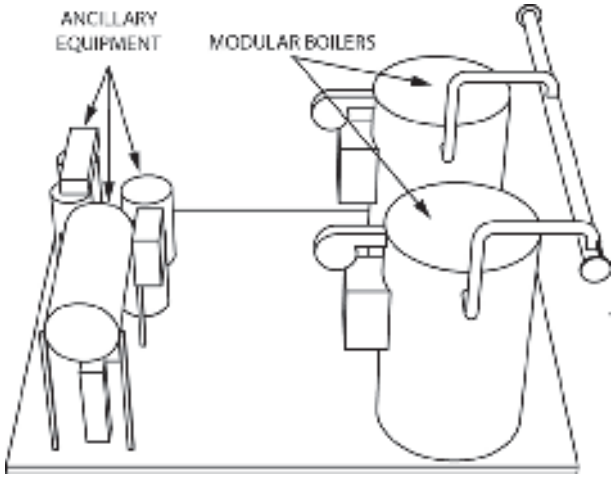


**Figure 1. Typical modular boiler set-up shown built on a skid as part of a modular steam boiler plant (simplified)**

## BACKUP CAPABLE, MORE EFFICIENT, AND SMALLER FOOTPRINT

Modular boilers and boiler plants provide several key advantages, including that they can be designed to meet backup redundancy and up-time requirements while increasing efficiency and lessening footprint at the same time.

Nowhere is this need for redundant steam greater than in healthcare facilities, whose need to sterilize surgical equipment and maintain a contamination-free environment is critical to patient care.

[1] Two new additional phrases that have emerged that describe the modularization of an entire utility plant (cooling plus heating) are Modular Central Plants and/or Central Utility Plants.

Healthcare facilities require n+1 redundancy, where "n" equals the number of modular boilers required to cover total peak load needs, and the "+1" equals the additional boiler needed for redundancy.

Traditionally, a two-boiler system has satisfied these requirements. For example, if 300 HP was needed for peak loads, a hospital would purchase two 300-HP boilers and run one full time with the second one acting as +1. But the +1 would still need to be fired to run in hot standby mode[2] even though it would sit idle (in hot standby).

However, with the new modular approach (see **Fig. 2**), three 150-HP boilers could be purchased, with two running full time at peak load and the third one at +1. The +1 unit would *not* need to be fired (i.e., it would be kept in warm standby mode) unless actually needed in an emergency to back up either of the other two boilers.

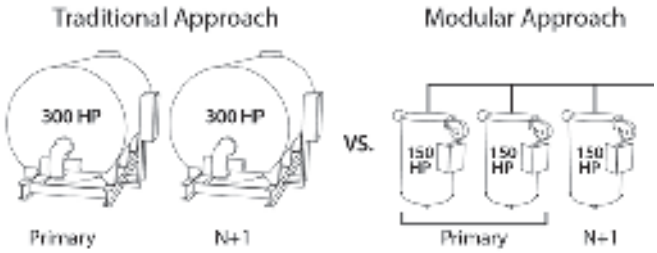


**Figure 2. N+1 modular configuration showing two 300-HP boilers versus three 150-HP boilers**

The result of this new, modular, three-boiler configuration is a substantial savings on fuel costs, as well as reduction in total HP capacity needs (600 HP versus 450 HP, as shown). Not to mention the increased lifespan for all three 150HP boilers that can be achieved by having one of them set to warm versus hot standby mode while periodically rotated in-and-out of service with the other two. (Note: Vertical boiler standby power losses are estimated to be 0.25% each, while horizontal firetube boiler losses are 1-3% each. For the system shown in **Fig. 2**, total vertical standby losses equal 0.75% of 450 HP, or 3.38 HP; while horizontal boiler system losses can be up to 3% of 600 HP, or 18 HP.)

#### HIGHER SEASONAL EFFICIENCIES

Modular boilers provide the highest seasonal efficiencies, as well. For example, if you need only 150 HP of heat in the summer versus 300 HP in the winter (see **Fig. 3**), you can run one 150 HP boiler in the summer and two in the winter with high efficiencies (the modular example). Whereas, with the 300 HP boiler you would need to run the 300 HP all year, yielding comparatively low efficiency.

These smaller boilers could also be installed as space-saving vertical, rather than horizontal units. Given the same HP requirements, vertical boilers have up to 50%+ reduced footprint compared to horizontal boilers.

[2] Hot standby mode, in this case, means a boiler that is close to or at full load steam capacity (i.e., full operating temperature and pressure) due to having fired its burner.

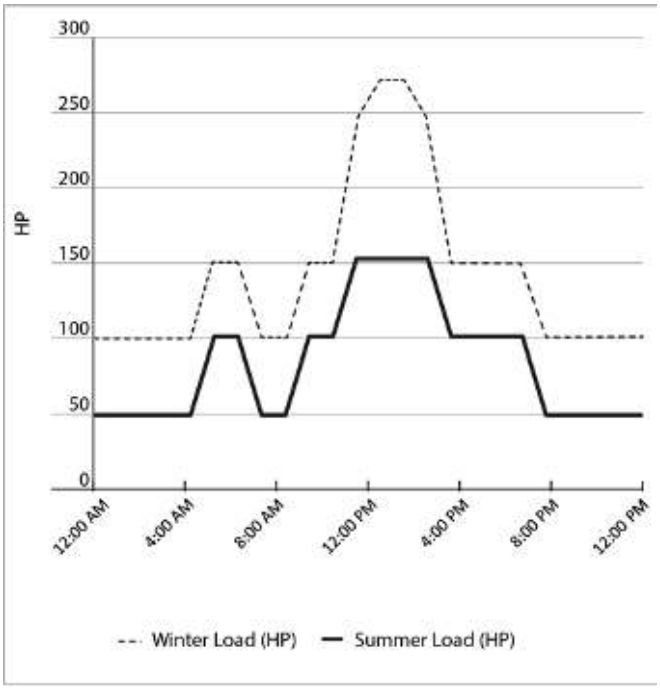


**Figure 3. Typical seasonal load efficiency swings from winter to summer**

A vertical boiler, having vertical heat transfer surfaces, can also provide energy savings and greater durability by means of superior circulation within the boiler itself – i.e., no stratification or extended warm-up time. The vertical design greatly diminishes corrosion of the heat transfer surfaces, as the steam bubbles that are generated lift away vertically from the heat exchanger surface without impinging on other (horizontal) tubes.[3]

Smaller, vertical boilers are also easier to install and service, with some, such as Fulton's VSRT, even fitting though a single doorway.

#### BETTER LOAD BALANCING, HIGHER TURNDOWN

Modular boiler set-ups – using more, smaller boilers versus less, larger boilers – can also enable a boiler to run at peak efficiency. This is achieved by being better able to match a given current load with the capacity that the boilers in use are designed for.

In other words, modular boilers enable better overall load balancing than traditional, larger boilers that generally run at much lesser loads. This is because a modular setup enables boilers to operate at around 50-60 percent of load, or close to full rated load, where greatest efficiencies occur.

Better balanced loads also reduce standby losses[4] as well as the amount of time a boiler cycles on and off. Thus,

[3] An even greater low-maintenance design is provided by vertical boilers which are tubeless (i.e., have no need to ever be re-tubed or to allow plant space for tube pull) such as Fulton's vertical tubeless boilers, a design that Fulton pioneered in 1949.

[4] Standby losses are also reduced by use of vertical boilers, which have 0.25% standby losses as compared to horizontal firetube boilers that have 1-3% losses.

the additional wear on components is lessened, decreasing the chances of thermal shock, and extending service life.

*As the Federal Energy Management Program (FEMP) states, "If building loads are highly variable, as is common in commercial buildings, designers should consider installing multiple small (modular) boilers [since they] 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."*

Also, in the example given of the three boilers chosen over the two-boiler setup, we could add the feature of *modulating burners*[5] to this arrangement. This would improve the system turndown over the turndown of the two-boiler plant.

For example, instead of having one boiler with 10:1 turndown, you can have two boilers with 8:1 turndown for a total of 16:1 system turndown – the idea being that, for equal HP requirements, more boilers in a plant generally equals higher turndown.

Modular boilers usually also have some type of integrated system control installed so that each boiler fires only as needed (modulates) with every other boiler to match the load. This helps maintain an even number of operating cycles and run hours across all of the boilers in the system (so-called lead/lag capability).

Better still, they can be fitted with a dedicated *sequencing controller* (usually a panel-mounted, stand-alone device) installed similar to Fulton's *ModSync* (see **Fig. 4**). The sequencing controller can achieve even greater efficiency gains by matching optimal boiler operation with system load requirements.

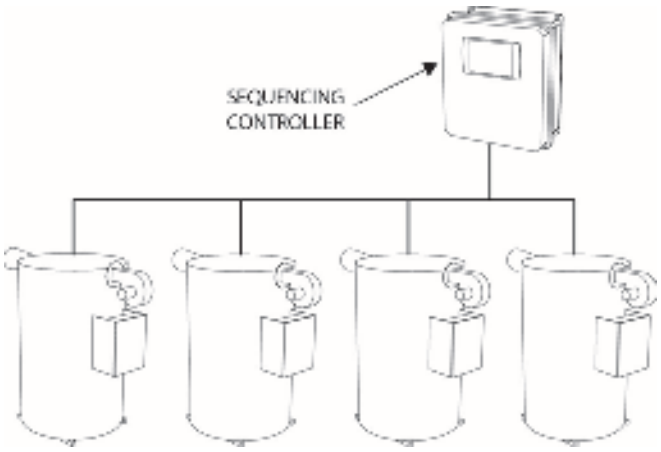


**Figure 4: Sequencing controller used to regulate boilers for greater efficiencies**

#### BENEFITS FROM SINGLE SOURCING

Because modular boiler systems are fully constructed, assembled, and operationally tested as a complete system before being shipped, many of the potential delays in getting the system working properly can be discovered and eliminated ahead of time.

This greatly reduces the risk of failure during startup/commissioning, which is especially important when performing equipment safety checks and operational sequencing testing.

Single-source supplier/manufacturer responsibility also lowers risk to the owner in terms of needing to purchase separate components and perform separate onsite installations. It also saves time in selecting, assembling and installing individual components and in choosing suppliers, as well as in repair and parts replacement.

In addition, single-source, modular boiler systems provide a single point of customer contact, which makes it easier to design for customer- and site-specific needs and customizations. These include decorative enclosures, as well as designs that have scalability in mind so that custom expansion modules can be added as needed in a phased approach or when budget allows.

But the gains don't stop there.

Modular boiler systems of this kind can be less expensive to build. For new construction, they can reduce the required boiler room area by over 50%, as already stated.

Implicit in the space-savings aspect of a well-thought out modular boiler strategy is, of course, the vertical design of the boiler itself.

#### CONCLUSION

Full integration of modular boilers into modular plants can create substantial gains in time to market, commissioning, maintainability, serviceability, footprint, thermal efficiency, heat recovery, emissions control and online monitoring, which includes system load matching – all of which can result in significant cost savings.

But because of the added complexity, or the many added parts and systems within systems that are required of modular boiler plants, it is critical that manufacturers of these systems – also called skidded, engineered or turn-key systems – have a proven track record in providing them to customers.

Fulton Steam Solutions has been building modular plants for decades – longer than just about anyone else. Fulton provides all of the equipment as well as all of the piping and connections needed – a one stop shop, as it were – as well as customer service and engineering design expertise that is backed by decades of successful experience.

Their modular plants are low-maintenance, rugged, robust, reliable, long-lasting designs that also come with an industry-leading, 10-year warranty on the boiler pressure vessel.

They include ultra-low emission burner options and solid state boiler sequencing controls that monitor load demands and optimize modular boiler plant performance.

[5] Ability of burner (and thus boiler) to operate at less than its highest rated output while maintaining thermal efficiencies.