Web Site: www.spthermal.homestead.com

S.P. THERMAL SYSTEMS INC.

4504 Green Meadow Blvd.
Beamsville, Ontario L0R 1B5, Canada
Phone: 905 563 8651 Fax: 905 563 6234 Email spthermal@cogeco.ca

HOW TO EVALUATE VARIOUS PACKAGE BOILERS

The following report, was prepared to help potential buyers, in determining which type of boiler/s, are most suitable for their planned expansion or retrofit.

AUTHOR BACKGROUND:

H.N.C Certificate from England, in Mechanical Engineering. Ten years experience in the Caribbean as a Plant Engineer, responsible for Boilers and Water Treatment Programs. Eight years experience as a Water Treatment Consultant, for a major Water Treatment Supplier. Five years experience, working for a Boiler Manufacturer promoting Boiler sales and Water Treatment Technology. S.P. Thermal Systems Inc. was started in 1995, to provide boiler products and consulting service related to Energy, Steam production and Water Management and Chemicals for Boilers and Cooling Systems

The author has worked with many hundreds of boilers, of different designs for thirty years. In reality most people when purchasing power plant equipment have to rely on the manufacturers expertise, and try to make informed decisions related to the product they are evaluating. The purchasing decision, ***frequently*** ends up being based on boiler cost and perhaps getting referrals from other end users, that have purchased similar products.

Unfortunately this approach can have ***some*** pit falls.

(A) The type of boiler selected for one application, might ***not*** necessarily be suited for your application.

(B) Another general problem, is that most purchasers of boilers have limited experience in evaluating boiler design and determining which boiler is best suited to their needs.

This is not a reflection of the mechanical abilities of decision makers, but the reality is that Boiler Manufacturers have created a ***new wave*** of boiler technology, that has changed the parameters of understanding boiler design.

In part, these boiler design changes are in reaction to changes in regulations, by various governing Boiler Safety Boards, in Canada and USA, allowing the removal of Operating Engineers from the boiler rooms, if boilers meet certain design criteria. Boiler Manufacturers have taken advantage of these changes, by responding with new designs, which will fall under the regulations, that ***do not*** require ticketed Operating Engineers.

To help guide the new purchaser through the evaluation process, we have attempted to provide guidelines, that we believe will help in the decision making process.

It should be noted, that like every other product on the market, there is no perfect selection. We however hope that the following information, will help in providing some answers, regarding which type of boiler, the decision maker should be considering.

BOILER EVALUATION:

OPERATING ENGINEERS STATUS:

In Canada and U.S.A., each Province or State, have various regulations governing the operation of steam boilers. This would relate to boiler types, size, and operating pressure. The rules governing these regulations, should be reviewed before any purchase of boilers. Some Provinces and State have fewer restrictions on the requirements of Stationary Engineers, if certain boilers are used. By carefully investigating these requirements and making the correct boiler selection, it is quite possible to reduce the operating cost of boilers.

BOILER TYPES:
The Boiler manufacturers, have created various types of boilers to suit the new regulations for Operator Exempt units. This has resulted in reduced boiler water content and heating surfaces, and pushing engineering materials, and design to their limits. All designs have certain drawbacks, with some designs having specific advantages over others. The author has tried an unbiased approach in presenting these differences. Our intentions are to provide information that will help the decision maker evaluating the options, and have a better understanding of what unit is best suited for their application.

COIL - RECIRCULATING TYPE DESIGN
These boilers are made by various manufacturers and are designed to circulate water in coils and produce steam in the steam drum or separator. The unused portion of the boiler water, is normally recycled back to the feed tank, Hot well, or around the boiler circuit. The following are some areas that require some attention.

(A) BTU loss of heat from the boiler water during transfer in the recirculating system is possible. To prevent this from occurring, special feed water tanks are required which operate at a higher pressure. ***Vent loss*** can be significant and therefore system design is important.
(B) Improper balance of recycling water, to demand, could result in cavitation or low water failures, during load swings. System design is important.
(C) Due to the recirculating pump operates at high water temperature, maintenance cost on the pumps, is normally ***higher*** than conventional boilers.
(D) They are many safety devices on these boilers. These are necessary to protect the equipment. They require more detail troubleshooting and attention.
(E) Some designs have smaller heat transfer, than conventional units.
(F) Overall maintenance cost is normally higher.
(G) Water Treatment is more critical than conventional boilers.
(H) Steam quality can be achieved, only if proper design of system is followed.
(I) More than one pumping system, might be required.

BENEFITS:
(A) These boilers could be Operator Exempt in some Province or States
(B) Steam is produced faster than conventional units.
(C) Units are compact requiring less space
(D) Units are supplied as multiple units, which can be beneficial with varying loads.

STRAIGHT TUBE UNITS:
This design also requires attention:

(A) ***Small*** heat transfer areas. Water Treatment is very critical
(B) Limited to one or two gas pass configurations. Possible ***lower*** efficiency. Require an economizer to justify higher efficiency.
(C) Steam space is limited.
(D) Potential for poor steam quality
(E) Low water failures during load swings.
(F) Lower Total Dissolved solids (TDS) is normally recommended, to achieve good steam quality. Results are higher blowdown loss, resulting in higher fuel, chemical and water operating cost
(G) Tube replacement could be difficult, as tubes are normally welded to a header. Potential higher tube replacement cost can be expected.

BENT / FLEX TUBE DESIGN BOILERS:
This design has more of the looks of a conventional boiler and function similar to conventional water tube boilers. The heat transfer areas and the steam space are normally ***larger***. The number of gas passes is also ***greater***. These types of units can be adapted more readily to different burner technologies and controls. This design functions similarly to a conventional boiler and in the author's opinion has some benefits, that are lacking in other high heat transfer designs.

VERTICAL TUBELESS BOILERS

These boilers are probably the most forgiving, when it comes to Water Treatment. They are also reliable and simple to operate. They are usually manufactured in the smaller BHP range. (6 - 100 BHP)
They are compact and come in various burner configurations. They are usually supplied as step fired units. Certain manufacturers supply them with modulating burners. Modulating burners will provide better efficiency, due to higher turndown and less cycling.
Units can be supplied with 2 or 4 gas pass designs. The ***more*** gas passes, the ***higher*** the combustion efficiency

FIRE TUBE BOILER:

These boilers have a large water content and a sizable steam drum space. They require a larger foot print space than Coil type boilers.
The fire is in the tube itself, with the water on the outside.

DISADVANTAGES:

(A) Units take longer from a cold start, to produce steam, than Coil Type boilers
(B) Units are prone to thermal shock, if design is not considered.
(C) Refractory maintenance, depending on design, can be every 2 - 10 years.
(D) Might require Operators in some Provinces or States

BENEFITS:

(A) Reliable and proven to be a work horse.
(B) Produce good quality steam
(C) Can handle load swings easily

BURNER COMBUSTION CHAMBER:

Every boiler requires a burner, that can mix the fuel with air, to provide combustion and a chamber in which this burning takes place. Normally, combustion efficiency ***increases,*** with boilers which have a ***larger*** combustion chamber.

NO_x EMISSIONS:

This is becoming an issue everywhere, but most currently, where proposed regulations have indicated, that tighter emissions control will be enforced in the future. All indications are that the regulations and values enforced in California, will be enacted in some Provinces or States in North America.
Some boiler manufacturers are currently marketing " Low NO_x Boilers"
and claim values of less than 50 PPM NO_x. We believe this is achievable, but in some cases, at ***significant*** cost to the end user. To achieve this low NO_x value, the burners on some of these types of boilers, have to be set at ***high*** excess Oxygen values.
This results in excessively ***high*** CO (Carbon Monoxide) emissions and ***poor*** combustion efficiency. As a rule, the ***lower*** the excess Oxygen, the ***higher*** the boiler combustion efficiency.
Generally NO_x below 50 PPM is achieved, by having ***cooler*** combustion chambers. Some boiler manufacturers have created this by making modifications to the combustion chamber and by ***cooling*** this area with flame quenching techniques, or returning flue gas to re -burn, to reduce Thermal NO_x being produced. The most effective and efficient way to reduce $No_{x,}$ would be to design boilers having ***larger*** heating surfaces and combustion areas, to release the heat and maintain combustion temperatures below 1800 C. Above 1800 C the Thermal NO_x threshold becomes critical.
Flue Gas Recirculation, (FGR) techniques are common. However, the ***disadvantage*** of this system, is ***reduced*** boiler output. This can result in losses as high as ***10 - 15%*** of the expected output of the boiler, with FGR. Critical combustion control is required, to reduce the potential of combustion hazards.

HEATING SURFACE AREA

Heating surface area on boilers, have changed drastically in recent years, to adapt to the ***newer*** boiler designs.

In general, the ***higher*** heating surface area of a boiler, will provide many advantages such as:

(A) Possible less NO_x

(B) Fewer problems associated with Water Treatment. This is because boilers with ***small*** heating surfaces, require ***higher*** rates of heat to be transferred per unit of area, resulting in ***higher*** temperature differentials. This allows any hardness leakage in the water, to precipitate much ***faster.*** Also it can be assumed that if the heating surface is smaller, then either the tube diameter or furnace area is smaller. This permits any calcium and magnesium hardness present in the water, to have ***faster*** fouling possibilities, with ***smaller*** heating surfaces, than boilers with ***larger*** heat area.

(C) ***Longer*** life expectancy of boiler tubes, can be expected to occur with ***higher*** heating surfaces**,** due to less heating stress. Smaller heating surface boilers have to accomplish the same job, as higher heating surface units, at same rating.

NUMBER OF GAS PASSES:

Normally a boiler with ***more*** gas passes is ***more*** efficient, than a boiler with ***fewer*** gas passes. Boiler manufacturers have come up with various methods of capturing heat before the boiler flue gases exist the stack. These methods may be in the way of deflectors, or baffles, to hold back the gas or create more turbulence. Another option is to use an economizer on the boiler, to capture the heat before it exits the stack. The most effective method is by having a boiler with ***multiple*** gas passes, in the combustion area. Also important is having the tube surface ***exposed*** as much as possible to the fire that is passing across the boiler furnace.

TUBE REPLACEMENT

One of the most important aspects that the end user must face, when purchasing a boiler, is that the possibility does exist, for tube repair during the life time of the boiler,

This is mainly due to one of the following problems.

(A) Poor Water Treatment control, resulting in corrosion due to pitting of the tubes

(B) Poor Water Treatment control, resulting in scale deposits, causing tube failure

(C) Stress failure, resulting from over heating of the tubes. This failure can be a result of boiler design. Not enough heat transfer.

(D) Over firing of the boiler

(E) Thermal shock

(F) Water starvation, due to carry over resulting in material stress

(G) Steam Blanketing

(H) Tube material failure

To reduce the cost, the potential owner needs to evaluate many areas, to decide his best option. To help in this evaluation the following table has been developed

PROBLEM	CAN IT BE REPAIRED	DOWNTIME	COST
Can the tubes be replaced or repaired?			
Can the tubes be welded?			
Can the tubes be patched?			
Is Welding required, to replace tubes.			

ELECTRIC POWER CONSUMPTION

The power consumption of a boiler, can vary dramatically. This is because some boilers require ***large*** blower fans on their combustion air. This is normally seen on the boilers that have the ***lowest*** heating surface. Larger HP blowers are found on boilers with ***low*** heating surfaces, which rely on forced circulation, having tube velocities around
11 Feet per second, accounts for the low amount of heat transfer surface used. A **larger** blower motor is required to help in the heat transfer of heat to water, on **low** heating surface boilers.
However the cost for having to run ***larger*** than ***normal*** fan blower, need to be taken into review, if energy and operating factors are to be considered. A known fact is the cost to purchase capital equipment is expensive, but the operating cost of the equipment, normally has a much ***larger*** impact on operating profits.

EXAMPLE: *This example shows the potential significant savings that can be achieved when evaluating equipment.*

The Approximately Electric Operating costs are as follows:

BOILER	**TOTAL ELECTRIC HP (Blower motor + pump + cabinet)**	**HRS / YEAR BOILER WORKS**	**ELECTRIC COST / KWH (approximate)**	**TOTAL COST FOR ELECTRIC (approximate)**
EXAMPLE / HP/hr of operation	1 HP	1 Hour	**$ 0.067**	**$ 0. 054 / HP / hour of operation**

Minimum Combustion Oxygen Levels Various Boiler Burners Can Maintain:
This is an issue that is often over looked, but the impact can be extremely ***costly,*** when reviewing boiler efficiency and determining Fuel to Steam efficiency.
Most boiler manufacturers, do not discuss, with their clients what expected oxygen value that their burner can function effectively, during various loads. This topic should be reviewed with all the Boiler Manufacturers and values should be confirmed in writing. The ***lower*** the excess oxygen in combustion, the ***higher*** the efficiency, the boiler will operate. This value should be supplied for all the firing ranges. See Fuel to Steam Efficiency.

FUEL TO STEAM EFFICIENCY

When evaluating Fuel to Steam Efficiency of boilers, this requires a good understanding of the manufacturer's interpretations.
To determine Fuel to Steam Efficiency, the following factors need to be requested from the manufacturer, to arrive at a true number. Beware manufacturers' use various Thermal sayings, that are very confusing and do not necessary mean the same.

Request data and carry-out the following exercise:

1. What is the minimum Oxygen level can the boiler manufacturer guarantee his burner will operate at 100% load:, 80% load; 50% load; 30% load; 20% load
2. The purchaser should then calculate efficiency and operating cost at various loads and times, in which the boiler will be operating. The lower the O_2 values, at loads and time the more efficient will be the boiler.
3. Ask the manufacturer to provide calculations on the Radiation loss at 100% load
4. Request that all the values above, are provided at the proposed ***operating feed water temperature and boiler pressure.***
5. Determine the boiler burner intake air ambient temperature.
6. Request from the boiler manufacturer a complete Fuel to Steam calculations based on the above. Do not accept Fuel to Steam efficiency without a detailed set of operating data.
7. Before purchase, request a field performance report on the boiler.
8. Some manufacturers offer a factory performance test. If this is not carried out under an ASME performance method, this report is normally not providing a true value. Request an ASME short form test,

for Thermal Efficiency.
9. When requesting the above, the manufacturer should also provide the NO_x and CO values expected at the ***various*** loads, at the ***% oxygen*** combustion value.

RADIATION LOSS

Some boilers have higher radiation loss due to poor insulation design or because of furnace design. Water tube boilers usually have less radiation loss, than coil type boilers. Always request from the manufacturer, that the radiation loss be given at 100% load. The actual BTU input loss calculated is the same at 100% load, as it will be at 10% load. The main difference is the radiation loss increases dramatically at the lower loads. Therefore, the ***sizing*** of your boiler to your load demand, is very important for maximizing Fuel to Steam efficiency

EXAMPLE :

A boiler with a radiation loss of 2 % at 100% load, will result in a radiation loss of 20 % at 10 % load.
FUEL TO STEAM EFFICIENCY: of a boiler operating at ***80% combustion*** efficiency at **10% load** will be (80 - 20) = ***60% Fuel to Steam efficiency less other losses such as Purge Loss, Blowdown loss and Scale loss.***
Therefore buying an ***over sized*** boiler, can be a ***major*** excessive operating expense
Smaller boilers, sized for the Summer / Winter loads, are usually more efficient to operate

IS AN ECONOMIZERS FEASIBLE?

Some Boiler Manufacturers recommend that an economizer be installed on each boiler they sell. Attractive claims of savings, of 3 - 5% are normally mentioned, without justification. Any economizer should ***only*** be purchased only after reviewing the savings calculation. Efficiency claims will vary with feed water temperature to the boiler.
Another caution is that some boiler manufacturers are having to install economizers on their units, to ***obtain*** efficiencies and be ***competitive.*** This is the result of boiler design, number of gas passes and the small heating surface of the boiler.
We recommend that when considering economizers review the following.

* Request outlet flue gas temperature from the boiler, at the various operating loads ***before*** the economizer.
* Determine feed water or process water inlet temperature into the economizer
* Fuel cost, and total hours / year the boiler is working.
* Hours of operation at the various operating loads

From the above data, the cost savings can be calculated for the justification of the economizer. This will satisfy the end user and not the manufacturer, who might be trying to hide his own design limitations, which requires an economizer.
The economizer if determined to be cost effective, should have some **special features incorporated into the design.**

(A) The unit should have a bypass damper to divert the flue gases if the stack temperatures run ***below*** 300 F. This is a requirement under certain Provinces or States code. Some variations exist.
(B) The unit must be easily accessible for cleaning
(C) The unit must be designed with the correct fin clearance for the type of fuel being used. When firing on dual fuel, consideration of the fins must be reviewed, to determine if fouling will not be a problem. Consider a smooth tube economizer with dirty fuels.
(D) The unit should be designed so that Water Treatment will not be a problem. Some users have ignored this and the result is the economizers last a few years. The replacement is normally supplied at a higher cost than which it was originally sold. Reviewed this, with a competent Water Treatment Consultant.

MODULATING BURNER VERSUS STEP FIRED BURNER:
The type of burner that is on the boiler, can have a major determination on how your boiler responds to your steam requirements.

STEP FIRED BURNERS:
These types of burners have probably one significant advantage in that it can respond to steam demand ***faster*** than modulating type burners. Some manufacturers also claim that step fired boilers can be more efficient, as it reduces hunting loss. Hunting loss is a result of poor combustion that can occur when modulating type burners are constantly adjusting air to fuel ratios, due to constant fluctuation in steam loads.
Normally ***Step Fired burners*** have ***many disadvantages***. These are as follows:

(A) Larger steam pressure, and steam temperature variances, occurs.
(B) Higher maintenance on relays with variable loads. Alternating between high and low fire.
(C) More potential for carryover as water in the boiler is subjected to more drastic changes, due to sudden change in firing rates. (50% fuel to instant 100% fuel)
(D) Reduced turn down ratios with Step fired units. Normally minimum 50% or 2:1
(E) Step Fired boilers normally have higher purge loss, due to stop and start occurs more frequently. Every boiler on startup, requires a set amount of air changes, before combustion can occur. This purging, creates a cooling of the combustion area resulting in a BTU loss through the stack.

On the other hand modulating type burners have the following features

(A) Output Steam pressure and temperature control of the boiler can be controlled at closer bands. With some boiler burners this can be as little as +/- 1.5 PSI. This eliminates process temperature variances.
(B) Less chance of carryover causing wet steam.
(C) Higher turn down ratios, reducing purge loss. (Can be as high as 10:1)
(D) Purge loss is kept at a minimum, due to higher turndown ratios.

DUAL FUEL CAPABILITIES:
If the needs for dual fuel exist, then the following should be considered.

(A) Is the boiler burner capable of operating on more than one fuel?
(B) What is the steam output capacity of the boiler, when it is operating on the secondary fuel? Some package boilers can ***lose 10 - 15%*** of its actual output when firing on another fuel.
(c) Is compressed air required for atomizing of oil, when firing on that type of fuel?
(D) What change over procedures is required, when switching fuels. Example: Do the burner or burner nozzles need changing? Does the combustion control need adjusting, to maintain good combustion control and to achieve boiler maximum output?

STEAM DRUM SPACE:
Generally the ***larger*** the steam drum, the better the boiler steam quality. Better steam quality will ***reduce*** system maintenance and provide ***better*** production temperature control.
Boilers with poor steam quality, will result in failure of any yellow metals in your condensate system. This is the result of high PH will ***attack*** brass and copper fittings in traps etc.
Poor steam quality will also result in ***carryover*** of boiler chemicals, that will contaminate and ***foul*** steam pipes, heat exchanger and traps resulting in a thermal efficiency loss.

STEAM SEPARATOR:
Some boiler manufacturers try to overcome steam quality problems, by adding a separator onto the boiler. This will enhance the quality, but the reality overall, is that the ***larger*** the steam drum, the ***better*** the chance of achieving good steam quality.
The design of the steam separator and type of steam separator being offered, will also determine the type of success one can have in achieving results. Mechanical spray separators are usually more successful, than straight baffle type units. However, in general terms, a ***small*** steam space is basically the limiting

factor. The smaller the steam drum space, the larger the size of a steam separator is required.

STEAM QUALITY: - How to improve it

The following are some guide lines, to help the end user achieve good quality steam.

* Select a boiler that has the ***largest*** steam drum space as possible.
* Determine steam demand fluctuation, frequency and swings. Discuss this with the various Boiler Manufacturers and get their feed back.
* Determine if the boiler capacities selected are border line or approximately ***80%*** of the boiler load requirements. When selecting boilers, it is important that the boiler capacity match the load requirement. It is also important to know that the Boiler Manufacturers state boiler outputs at 212 F (Zero Pressure) and at a specific Feed Water temperature. This is called ***Equivalent Output***. As the boiler will probably be running at higher pressures than "zero" and the Feed water temperature will be different, the output will be ***much less***. It is important to request or have someone ***calculate*** the output at your operating parameters, to make sure boiler ***capacities*** are in order**.**
* If the boilers being reviewed are of the Low Water Content, or Coil Tube Design, water content in the boiler is very ***small,*** compared with conventional boiler units. This will result in the boiler water quality changing ***rapidly,*** as the boiler makes steam. Good control of TDS in the boiler is essential for good quality steam
* Having automatic continuous blowdown controllers installed on the boilers, is therefore essential. Some boilers on the market, do not have surface water lines to ***remove*** these high solids effectively and therefore implement various methods that are not necessary effective in removing boiler solids. On these types of boilers, ***over*** compensation of blowdown is normally necessary, to get good quality steam. The result to the end user on this type of boiler, is ***excessive*** energy, water and chemical waste. This could easily be as ***high*** as ***5 - 10%,*** of your total fuel bill.
* Select a boiler that removes water solids at the line of separation of water and steam. (Not from in a coil or tube)
* The use of a back pressure valve in the system, after the boiler, will help in controlling carryover with some boilers, that are prone to poor steam quality. The draw back to this idea is ***extra*** capital cost and the possibility of ***steam starvation*** at the process. It however is a good option, if this is the last resort to stop carryover.
* In line steam separators after the boiler main steam valve, is another option that can be considered. These can be purchased separately from various Steam equipment suppliers.
* Some boiler manufacturers try to overcome steam quality, by throttling the main steam valve. This is cheap fix method, that results in the end users having to constantly replace the main steam valve and the Boiler Manufacturer having an opportunity to sell after market parts.

WATER TREATMENT CONCERNS:

The most ***important*** factors to remember in any boiler Water Treatment program are ***feed water quality*** and ***steam quality*****.** Maintaining both areas, is the utmost important when it comes to treating these coils or Low Volume types of boilers.

The ***higher*** the heating surface area, the **less** prone to failure. Whichever way you review this, if Operator Exempt Boilers are the units being considered, then caution and reviewing your Water Treatment program with a ***competent*** supplier is essential. The need for good quality soft water, the possibility of soft water polishing, and the type of treatment program need to be reviewed.

BOILER MANUFACTURERS SPECIAL WATER TREATMENT REQUEST:

Some boiler manufacturers require special Water Treatment guidelines be maintained. These guidelines can be good or bad. In general terms they are designed to protect the ***interest*** of the manufacturer. Some manufacturer stipulates that the boiler must be ***completely*** blowdown ***once / day***. This can be ***costly*** and result in other related problems, such as potential corrosion. Some boiler manufacturers also request the installation of ***timed*** bottom blowdown controllers. This is a sound idea, but unfortunately this could result in the over blowing down of boilers. The manufacturer usually pre sets the timers on the units, to blowdown frequently. This will result in ***higher*** operating cost and poor chemical control, if the frequency is not

controlled. An automatic TDS controller is preferred to control the TDS level. TDS level can be increased in a boiler, until the level in which carryover becomes noticeable, then reduced. This value becomes the maximum value for carrying the TDS.
This factor will affect the operating cost. It is known that certain manufacturers put excessive pressure on the purchaser when the boilers are in operation to excessive blowdown the boilers, to protect their interest and limit the chances of tube failure. Part of the problem, is that some boilers on the market, with their small heating surface area, ***cannot*** tolerate ***any*** deposits on the tubes. The slightest deposit of even 1/32" could result in a tube failure. This problem can be compounded even further, if the boiler is working **close** to its **maximum** output capacity.

REFRACTORY MAINTENANCE:
The next ***highest*** expense after ***tube failure*** , would be ***refractory*** repair, or replacement. The type of refractory used and the procedure used for curing, is of vital importance. Curing is normally done on start up, or test firing of the boiler.
All boilers will require refractory repair during its life expectancy. The ***ease*** of repair will be the governing factor of cost. Some boiler manufacturers offer warranties on their refractory. This could be one year or higher. The end user should take the time to review the refractory, before the warranty finishes. The ***fine print*** of the warranty needs to be ***inspected carefully*** and do not rely on just the talk of ***"X"*** years, coming from the manufacturer. Most of the warranties reviewed, stipulate out of town expense and labour as extra. The material is of minimum expense and it might turn out, that a local supplier or trade person, can carry out the repair much cheaper, than what the manufacturers will request, the boiler owner to pay.

WARRANTIES PROVIDED AND THE FINE PRINT:
Most Boiler Manufacturer warranties are for ***one year parts*** and possible labour, FOB the nearest maintenance shop. Some warranties can be misleading. Warranties are normally offered on manufacture defects on ***the pressure vessel***. Some warranties cover ***thermal shock and refractory***. The fine prints of these warranties are very important. Usually the manufacturer will stipulate exceptions, such as Water Treatment deposits or corrosion are not covered. Water failures due to pump or water control equipment, will make the warranty invalid.
In determining one manufacturer warranty against the other, the warranties need to be examined carefully.

PRICE TO INSTALL THE BOILERS AND OTHER FINAL POINTS TO REVIEW:
Most Boiler Manufacturer claims that their boiler is cheaper to install than the other Boiler Manufacturer. This is sometimes the result of not comparing what you are getting with what you require or expect.

Guidelines to help in comparing installation, boiler cost and needs:
* Is the main steam valve included in the quotation? Multiple boilers require a check and stop valve. Make sure an installation quotation includes for this.
* Are the blowdown valves included in the quotation, or is it extra, to be supplied by the installing contractor?
* Is the boiler design pressure satisfactory for your plant requirements?
* Are the safety valves included in the quotation? Will it satisfy operating needs?
* Are the feed water pumps, motor starter, strainer etc .included?
* Is the feed tank included? Is the present tank big enough, or in good condition?
* Are the feed tank water controls included? Determine if the valve suits your specifications. Some valves operate better than others.
* Does the tank have a heater to preheat the water? Is it required?
* Does the pre heater come with the necessary steam trap and regulator?
* Is the feed water pump piped and wired to the boiler? Sometimes the manufacturer stipulates this as a complete package. However when the boiler arrives it has been taken apart, to allow for shipping and fitting into the room.
* Does the boiler require a hot well instead of a feed tank? What is the extra cost compared with a feed tank? Review payback calculations.
* Does the boiler require a booster pump and a feed water pump? What are the extra cost and operating

cost of the booster pump?
* Is the economizer packaged as part of the boiler or separate to be installed? Some manufacturers claim the economizer is prepackaged, but again on shipping it is separated and requires installing by the contractor in the field.
* ***Is an economizer required?*** Is it feasible based on boiler / system design. Feed water temperature?
* Does the boiler come with a shut off valve to prevent flooding of the boiler on shutdown? This can occur, with boilers that do not have sufficient head pressure to overcome water slipping through the feed pump, on a shutdown. If this is a problem, special motorized, ball valves have to be installed to prevent this from occurring.
* Do the boiler/ s come with automatic blowdown controllers. The various models should be reviewed to determine the best available units to suit your needs.
* Is the blowdown controller includes the solenoid or motorized valve, strainer and the needle valve? When selecting solenoid valves, make sure the valve can withstand the boiler water temperature and pH. of water. The preferred choice is using the motorized ball valve, or air solenoid. If using air solenoid make sure the air supply pressure is correct.
* Does the boiler come with a chemical water sample cooler? Is it required?
* Is a back pressure valve required for the design boiler chosen?
* Is an external steam separator required for the boiler being selected?
* Is a stack temperature gauge included or required?
* Is a feed water temperature gauge supplied on the feed tank?
* Does the economizer have inlet and outlet temperature gauges, to determine efficiencies? Is the economizer designed to meet code?
* What is the noise level of the boiler? Normally the larger the blower motor HP, the more noise can be expected.
* Does the boiler require a silencer to reduce the noise created by the blower fan?
* Is the cost of the silencer included, if required?
* What is the electric cost to operate the various boilers? (Based on motor HP)
* On large HP motors the payback using ***high efficiency*** motors should be considered. Is this included in the price?
* What are the electric requirements in your plant? Do the boiler and equipment correspond to your requirements? Review electric requirements for Max. Effy.
* What is the input gas pressure to your plant? Does it match the boiler you have selected? Is there a requirement to purchase additional gas regulators or to modify your present system?
* Is the gas or fuel piping large enough to accommodate your proposed new boiler size?
* What type of stack/s are being recommended. Stainless steel or carbon steel. Does the stack/s meet local code for the type of boiler/s?
* What are the NOx regulations? What is the NOx values on all fuels at various loads? What will be the CO and O2 values at the NOx values? Carry out efficiency calculations at NOx values. Does the boiler meet present / future regulation for the area of operation?
* Has the chemical treatment program been reviewed? What is the cost to modify the controls to achieve good results to protect the new boiler/s?
* Is a lead lag control required to operate the boilers? How does it function?
* Will a boiler with the capabilities of larger turndown be more feasible?
* Would remote monitoring, and control be advantageous?
* Is combustion trimming of Oxygen available? Is it economical to install? .
* Would fuel monitoring be required?
* What is the procedure for fuel change over on dual fuel units? Can combustion set up be done ahead of change over? What is the output of the boiler at various fuels?
* Are the steam piping, valves and system present design sized sufficiently for the new retrofit?
* Is the boiler and equipment shipping cost included to your plant?
* Is commissioning included of all boilers? Is it extra, if boilers are commissioned separately at different times?
* Is the cost of training of your operators included in your purchase?

* In most Provinces or States it is the owner' s responsibility to register the boiler with the various environmental bodies. Request the various documentation.
* All boilers and pressure vessels operating in Canada must be registered for the Province and have a CRN registration number. If operating in Canada, does the boiler have a CRN # and registered for the Province of operation?
* It is the responsibility of the owner of the boiler, to register the boiler with the Technical Standards and Safety Authority (TSSA) in Canada on arrival of the pressure vessel at their plant.
* It is the responsibility of the owner of the equipment to notify their Insurance Company of the new equipment.

STANDARD PARTS AND AVAILABILITY:
The problem in today boiler market is the competitive pricing of each manufactured boiler, has resulted in very small profit margins to get the sale. Therefore, all boiler manufacturers try to market their products as much as possible after. This happens in some instances by altering off the shelf components, or using components that are specially imported from other countries.
Another area of concern is the type of burners, pumps and speciality parts that are part of the boiler manufacturer design.
Overall the least components required to be purchased from the boiler manufacturer, will lower your future operating maintenance cost.
Be wary of manufacturers that try to control all the maintenance on the boiler. The downfall is that these types of manufacturers might be quite a distance from your operation. In the case where the local contractor could come in and fix your boiler in a few minutes, the end user might be waiting in line for hours or days for a simple repair. ***Downtime*** can be a ***costly*** experience for any business.

PRICE OF BOILER:
If the evaluation is followed carefully, then the final exercise will be to determine price justification for each boiler being reviewed.
In doing this, the end user might require some help. The only way to end up with the correct selection, would be to review capital cost, operating cost, maintenance cost, installation cost, downtime cost, special equipment cost and review the ***features and benefits*** of the final evaluation.

NOTE TO THE READER:
We hope this article will help the end user of the proposed new boiler/s, in arriving at the type of boiler and the equipment, to suit his future needs. The opinions and evaluation supplied in this report, are the author' s personal overviews of the boiler market. It is not intended to discourage the end users from purchasing certain equipment, but to help in his purchase decision.
The author cannot be held liable, or responsible for the accuracy of this document. The Information provided, is based on experience and gathering information from various sources in the boiler industry. This article is being distributed on this basis. The boilers discussed are not to be interpreted as a particular make. The report is based on a general review of the total boiler market in North America.
We strongly suggest that purchasers of Boilers, consider hiring a competent Thermal person or Company that can make the correct selection. If the selection is made based on any other bases, it is a good possibility that you may run the risk of selecting the equipment that will cost you heavily in maintenance and higher operating cost

STEPHEN FOSTER ***President***

PURCHASER BOILER EVALUATION SHEETS: **To determine the best Boiler for application.**

EVALUATION SUMMARY: ----- **BHP** — **Fuel** --- **Opp. Press** ---- **F** **Feed Water Temp.**

COMMENTS UNDER REVIEW	**Evaluation Data Determined from Boiler supplier**	**PURCHASER Evaluation Guidelines**	**Purchaser Evaluation comments**	**Comments to check & Review**
Furnace Volume (CU FT)		Higher the value is better		
Heat release in furnace (Btu/ sq. Ft)		Lowest value is better		
Square feet of heat transfer / BHP		Higher the value is better		
Water Operating content in boiler tubes		Check operator exempt requirements		.IMP Gall
Steam Drum space in (Sq. Ft)		Higher value is better		
Total Elect. Motor HP		Lower HP is better. Less opp. Cost		Burner Fan Motor Feed water Pump
NOx values at various loads & at excess O2 in ppm		Lower Nox is better. Lower O2 is better. If O2 is high Effy. Will be less.		Load 100% Nox O2 Load 80% Load 50% Load 30%
Min excess oxygen at various loads of combustion		Lower the O2 is better. Lower O2 the unit is more efficient		Load 100% O2 Load 80% Load 50% Load 30%
Expected CO at various operating loads and excess oxygen		Lower CO is better. Lower O2 is better. If O2 is higher Effy. Will be lower		Load 100% CO O2 Load 80% Load 50% Load 30%
Min. Burner turn down		Lower is better		Ratio:
Can the tubes/ coils be easily repaired		Easier will reduce maintenance cost		Explain briefly
Can **all** the tubes/ coils be repaired		If no check replacement cost		Explain briefly procedure etc.
Where is the refractory located in the boiler? Can it be repaired easily		Review repair cost		Show Location Briefly explain procedure.
Who manufacturers the boiler burner. Show turndown ratio.		Lower turndown is better		Full Mod T/ D High / Low Other

What fuels can the boiler burner run on?		Natural gas Oil or other
Is compressed air needed for atomization of oil firing if applicable	If air is required a air compressor is needed	
What is the input gas pressure required	Check if it matches your operation.	Natural gas Oil if applicable
What are the warranties offered in months / years	Review fine print.	Pressure Vessel Refractory Parts Labour
What is the boiler price, Show Shipping + Commissioning	Look for hidden cost	Boiler Shipping Commissioning
Can any boiler service Company do the service work. What about warranties?	If any burner contractor can do it the operating cost will be less	
What control package is being offered. Example lead lag, remote etc.	Review capabilities to see if it meets your needs.	
What are the Boiler Manufacturer Water Treatment requirements?	Review with a competent W.T supplier	Boiler TDS Other
Radiation Loss at 100% load	Lower value is better	
Provide total Installation cost?	Look for hidden cost	
Provide Max Output at FD water Temp and Min Output of boiler in lbs / hr	Check to see if it meets your requirements.	Feed water Temp F Opp. Pressure PSI Max Output Min Output
What are the Max / Min temp. / pressure will the boilers maintain?	Less swings will be better	+ /- PSI Response time

What are the **Combustion** Efficiency at various loads? What is the O2 value and stack temperature **before** economizer if any. Stipulate feed water temperature	Review with a competent Thermal Consultant.	Feed water temp F Effy O2 F 100% Ld 80% Ld 60% Ld 50% Ld 30% Ld
Please provide CRN # for the boiler for location of install	In Canada this is required to operate the unit.	
Please provide data and documentation if your boiler is Exempt from Operators for the area of install	Please consult the local TSSA office to verify or request a letter from the manufacturer	TSSA approval Classification: Coil / Low water content Max single unit BHP Total BHP
Please provide 3 referrals. Contact / Company / Ph. No	Ask many questions.	1. 2. 3.
Does the boiler come with a blowdown TDS controller. Please provide a price separate for **package** if not included	Review controller with your Water Treatment consultant.	Controller Probe Solenoid Strainer Needle valve Installation
If an economizer is recommended, please provide a detail cost justification/ savings.	Review data with a Thermal Consultant	
If the economizer is **not included** in boiler price , please provide price if recommended	Check other quotations	
Please provide quality of steam expected at various load and at operating pressure	Higher the % of Saturated dry steam is better	Load 100% Load 80% Load 50% Load 30%
Is a steam separator recommended	Review unit and installation cost.	
Please provide the noise level at your standard location	Check if acceptable.	Noise level Location

Is the feed water pump starter included in boiler price	Compare costing	Show price if extra
Does the pump come complete with check valves / strainers etc.	Compare costing	Show extra if applicable
is the main steam/ hot water valve included	Compare costing	If extra show price
If their is more than one boiler quoted does the price include for a steam check valve. If not show extra price.	Compare costing	Show extra cost if applicable
What are the electrical requirements of your equipment	Check if suitable and state on purchase order	Feed pump Control panel Others
Is training of our operators included in the boiler price	Compare cost	Show cost if extra
What is the stack dia of your unit	Larger the stack dia. the higher install cost	
What is the cost of a blower silencer if required	Compare costing	
Is a back pressure valve required and if so please provide a cost. What are the limitations of the back pressure valve based on our loads?	Compare costing. Note: Back pressure valve can choke off steam supply.	

OTHER FACTORS TO CONSIDER WHEN REVIEWING ENERGY SAVINGS OF THERMAL SYSTEMS

REDUCING OPERATING PRESSURE:
Normally boiler operating pressure is determined by process heat requirements, piping system design, plant layout and the boiler design capabilities.
Sometimes the operating pressure is preset based on past experience and without carrying out a total system evaluation.
A review of your Steam pressure to determine savings should be considered as part of your Energy Evaluation.
When reviewing this exercise and when changes are made, the steam quality should be checked to determine if this has not changed. This is recommended as some boilers when operating at lower pressure have a tendency to carryover. Carryover or wet steam can cause significant heat loss and damage to a steam system.

ENERGY LOSS FROM SYSTEM LEAKS
Many steam systems have leaks that are ignored due too shutting either the plant down is not possible or the user is not aware of the cost associated with the leak.
These leaks can be from steam traps that are not functioning properly, holes in steam gaskets, or in pipes.
The cost below should justify early attention when leaks are found.
One of the most difficult leaks that are neglected, comes from steam traps. It is worth noting that a proper preventive maintenance program on traps could save considerable money.

THERMAL LOSS FROM CONDENSATE NOT RETURNED:
Many plants operate, returning all the possible condensate from the steam system. Some times due to condensate pump failure or breaks in the condensate system, condensate is lost. This situation if not rectified, can cause significant extra cost to an operation.

FLASHED STEAM RECOVERY*:* Heat recovery from Flashed steam is worth considering on Large boiler Systems over 10,000 lbs / hr

Flashed steam is resulted from hot condensate or boiler water under pressure, being released to a lower pressure. Part of the water is re evaporated, becoming what is known as flashed steam.

In some cases the boiler blowdown water can be used to pre heat process streams, such as make up water using a heat exchanger and or for low pressure steam for deaeration.
To determine the justification, calculation should be done to decide if this project is feasible