Proper Steam Boiler Replacement Etiquette

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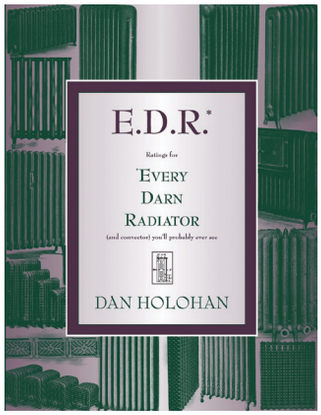
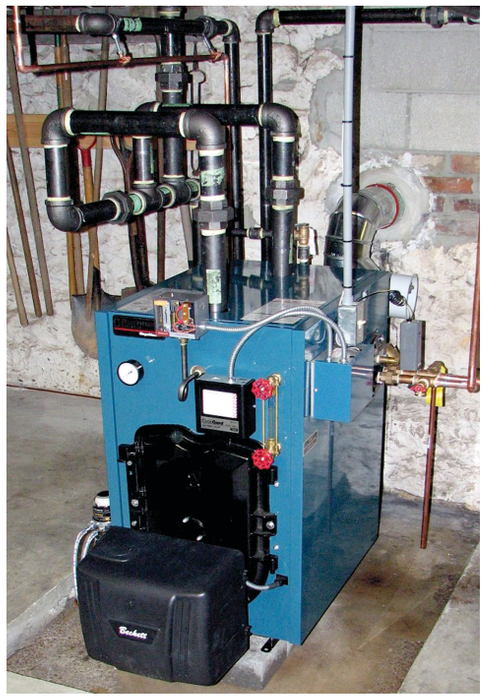
Recently, a contractor asked me what the correct way to size a replacement steam boiler was; he said he had heard conflicting ideas from different people within the industry. The proper way to size a replacement steam boiler is to go around and add up all of the radiation in the house. Back in the day, the expression used to indicate a radiator's heating capacity was referred to as a "square foot of steam," that came from the original flat steel radiators used back in the mid 1800s. They would measure how many actual square feet of surface area the panel radiator had to determine its heating capacity.

One square foot of surface area from the radiator would put out 240 British Thermal Units (BTUs) when the air temperature around the radiator was 70°F and the steam temperature inside the radiator was 215°F. If a radiator had 20 square feet of surface area, it could emit 4,800 BTUs an hour. Also important to note, 1psig steam has a temperature rating of 216°F, so every radiator that has been installed in a steam system can offset the heat loss of that room with less than 1psig steam pressure at the radiator. If you try to solve a heating problem by raising the steam pressure, you'll overheat the rooms and consume more fuel in the process. Almost from the beginning of installing residential steam heating systems, homeowners complained about the size and look of those flat, steel-plated radiators and so the industry responded. Radiator manufacturers started making tubular style radiators that took up less space and aesthetically were more pleasing to the homeowners. They were able to provide increased output in a smaller footprint by adding surface area to the tubes. This created a new term in the radiator industry: EDR which stands for Equivalent Direct Radiation. Because these radiators were not shaped like a panel radiator, it was challenging at the beginning to establish a square foot rating but eventually they figured it out and the term a Square Foot of EDR was born.



Back to sizing the replacement boiler–there are sizing capacity charts provided by various boiler manufacturers in the industry that will list a radiator's heating capacity in Square Foot of EDR based upon the height of the radiator, the number of columns per section and the number of sections. Dan Holohan offers an excellent book that contains virtually every piece of radiation ever manufactured titled *EDR…Every Darn Radiator*. If you are in the business of replacing steam boilers, you should have this book. When you are asked to size a replacement steam boiler, the last thing you should be concerned with is the heat loss of the house. I know it sounds crazy, but it's true. If you were replacing a hot water boiler, you would calculate the current heat loss and then select the correct boiler. In a hot water system, you are using a liquid to transport the heat from the boiler out to the radiation and this liquid is going to stay a liquid…cooler on its way back but still a liquid. However, with steam it is different. Steam is a gas that carries the heat from the boiler out to the radiators where it is needed. If you don't produce enough gas (steam), the heat won't reach all the radiators and you end up with cold rooms and unhappy customers. You have to produce enough steam to fill the piping and all the radiators. This is because steam wants to turn back into water as quickly as it can. When steam enters cold pipes and radiators, the cold metal robs the steam of its latent heat. With no more latent heat the steam turns back to a liquid (condensate). The idea is to have a boiler produce enough steam to overcome the system's ability to condense it.



Steam is made up of two types of BTUs. The first type is called sensible heat. This is the amount of heat required to bring water to its boiling point. It can be "sensed" by a thermometer. At every pressure, there is a corresponding requirement of sensible heat to boil water (the higher the pressure, the greater the amount required of sensible heat).The second type of heat is known as latent heat (the heat of evaporation). This is the amount of energy required to take the boiling water

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and change it into steam. A thermometer can't sense this energy, although it is very real. In fact, in a low pressure system (0-15psig), the amount of latent heat is usually five times as much as the sensible heat per pound of steam. Steam can hold a tremendous amount of energy while requiring no assistance to travel throughout the system.

When steam is manufactured in the boiler, it races out of the boiler into the piping system and towards the radiators. As it does, it encounters the cold pipes that cause the steam to condense back into water. During this condensing process, the steam gives back the latent heat it received in the boiler. In a steam heating system, this is what heats the rooms. It is not high pressure that heats the house, so there is no sense in turning up the pressuretrol. In fact, the lower the pressure, the greater the quantity of latent heat per pound of steam.

The problem arises when the boiler can't produce enough steam to offset the system's ability to condense it. The steam condenses in the near-boiler piping, supply mains and maybe in some of the closer radiators. The thermostat never lets the burner shut off. No matter how high you turn the pressure up, you can't produce enough steam. One symptom I have consistently noticed is that the pressure gauge never registers any pressure when the boiler is undersized or underfired. The boiler can't build any pressure because as soon as any steam is produced, the system condenses it.

When you install a replacement steam boiler, it is important that it be sized to the connected load. Once you have picked the correct size and have installed it according to the manufacturer's specifications, make sure you also fire the burner to the connected load. If you don't, the results can be the same as an undersized boiler.

You have to realize that just because the boiler manufacturer says it's a steam boiler and supplies all the necessary trim, it doesn't make steam by magic. You have to input enough energy so that the boiler can offset the connected load's condensing ability. That means when the boiler is rated to a certain gallons per hour (GPH), you have to use that firing rate. If you don't the boiler won't be able to produce enough steam. The steam won't be able to reach the furthest radiators because it's condensing in the pipes. **ICM**

If you have any questions or comments, e-mail me at gcarey@fiainc.com, call me at (800) 423-7187 or follow me on Twitter at @Ask_Gcarey.