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June 27, 2013 via e-mail

Charles Aspinwall, Town Administrator
Town Hall
900 Main Street
Millis, MA 02054

Dear Charles:

Apparently, one of the four modular boilers serving the Town Hall has failed catastrophically. While the Slant Fin Caravan boilers are still manufactured, our concern is that because their serial numbers are likely consecutive, they were all assembled by the same person and the controls rotate the firing order of the burners at each burn cycle to ensure equal wear, the failure of one unit will be followed closely by the sequential failure of the others.

While replacement in kind of the Caravan boiler will restore the system to operation, we have an opportunity to replace the boiler string with two condensing boilers each sized to accommodate two-thirds of the design heat load of the building. At this latitude, comfort conditions can be maintained 95 percent of the time by supplying only 65 percent of the design heating requirement. The proposed configuration will provide 100 percent redundancy 95 percent of the time.

As with virtually all conventional multiple boiler systems, the existing modules are piped in parallel: all the water is pumped through both boilers during the entire heating season. This configuration contributes to a significant loss mechanism. The heat exchange surfaces that transfer the thermal energy from the fireside to the waterside when the burners are firing, work just as well in reverse. During the time that the burners are off (i.e., most of the time), the natural draft of the chimney constantly ingests relatively cool air from the boiler room, passing it over the fireside surfaces. The water that we just expended energy to heat is cooled by this air flow, warming the air before it is discharged out the chimney. Not exactly a recipe for efficiency.

Alternatively, we propose to install two high-efficiency condensing boilers, each piped as a subloop off the primary building loop. Currently, there are 44 brands of high-efficiency (condensing) boilers marketed in the United States. Condensing (gas) boilers and furnaces, as their name implies, take advantage of the physics of the combustion of natural gas. Principally methane (CH_4), each molecule of natural gas comprises one atom of carbon (C) and four atoms of hydrogen (H). When combined with oxygen during combustion, the carbon forms carbon dioxide (CO_2) and the hydrogen oxidizes to water (H_2O). Because the temperature of the products of combustion is above the boiling point, however, the water leaves the chimney as a vapor: steam. This is why, on a cold day in winter, a plume of white "smoke" exits a chimney serving a gas appliance: the steam is condensing into visible water vapor.

The so-called "heat of vaporization" of water is 970.3 Btus per pound. Simply stated, to convert (by boiling) a pound of water (approximately a pint) at 212 degrees F into steam at 212 degrees

requires nearly 1,000 Btus (British Thermal Units). To put this into perspective, the quantity of heat released by a wooden kitchen match from the moment it is struck until it threatens to burn your fingers is on the order of one Btu.

A condensing boiler includes a secondary heat exchanger to reduce the temperature of the products of combustion to below the dew point, condensing the water vapor into liquid water, and recovering most of the heat of vaporization. The corrosive nature of the condensed vapor [the sulfur in the natural gas forms sulfuric acid when mixed with condensate (water)] is such that exotic materials are required for construction.

Significantly, the efficiency of a condensing boiler is a function only of the return water temperature. If the return water is above 130 degrees, it operates much like a conventional boiler. In a typical heating application, the baseboard is designed for a 180 degree supply and 160 degree return. Simply installing a condensing boiler to replace a conventional unit buys the owner bragging rights, not economical operation. The higher water temperatures are necessary because the return water to a cast iron boiler must be greater than 145 degrees to prevent cracking the rear section, attributable to thermal stress.

Because it was formerly a school, the Town Hall has more than 50 unit ventilators, or fancoil units, which function satisfactorily on low temperature supply water (and, therefore, low return water temperatures). Fortunately, the terminal radiation is a good "fit" to a condensing boiler. A minimum savings of 15 to 20 percent can be anticipated; in all likelihood, the actual savings will be greater.

Utility companies are mandated by the Department of Public Utilities to provide cash incentives to their customers to use less of their product by purchasing and installing high efficiency equipment. America is a great country! Based upon the current published schedule by Columbis Gas, the Town would be eligible for an $8,000.00 rebate.

Replacing the boilers now would eliminate the worry of successive boiler failures while providing substantial energy cost savings in the decades to come. Further, we do not know how long the generous rebate program will be in effect.

I trust that the foregoing will serve to be sufficiently descriptive to convince the Town meeting to appropriate funding for the project. Please call if further clarification or amplification is required.

Very truly yours,

Bruce D. Norian

Bruce D. Norian, P.E.

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