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Protocol for Evaluating the Layout of a Hot Water Distribution System

The purpose of this protocol is to understand the layout of the trunks, branches and twigs (sometimes called fixtures branches) within the hot water distribution system. This information can be used to determine the applicability of the installation of one or more demand activated pumping systems, and if so, where to locate the pump(s).

The layout of plumbing lines and hot water pathways can be assessed visually if the pipes are exposed. Even if horizontal piping is visible, it may be necessary to estimate what is happening when the piping goes vertically or horizontally within the walls. However, this protocol was developed so that the evaluation can be done even when the piping is not visible.

While the protocol is written assuming the evaluation will be conducted in a home, it can be used in almost any occupancy. We would observe that the piping did not read the building code and cannot tell if it has been installed in a house or an office building!

The following tests can be completed to better understand the layout of the trunks, branches and twigs in the hot water distribution system.

1. Measure the full-on flow rate of the hot water outlets. One way to do this is to measure the volume of water that comes out of the outlet within given period of time. (The volume is a function of flow rate multiplied by time.) This can be done one outlet after the other, with the focus on sinks and showers.

A simple way to measure flow rate is to turn the tap on full and capture the water for 15 seconds. Pour this water into a measuring container and determine the volume. Convert the result to gallons. Multiply the result times 4 to get gallons per minute. There are 16 cups in one gallon.

Pick any easy multiple of 60 (5, 6, 10, 12, 15, 20 or 30 seconds) to determine how long you want to capture the water. Longer is better than shorter but volume and weight become an issue (10, 12 or 15 seconds are good compromises)! Be sure to use the correct multiplier to get gallons per minute.

- a. When the flow rates of the hot water outlets are significantly different or they are unknown, it is necessary to measure the volume. When they flow rates can be assumed to be very similar (such as the water coming out of the lavatory sinks looks and feels the same (plus or minus 10%)), time may be used as a proxy for flow rate.
2. Measure the time-to-tap of hot water at each hot water outlet. This test can take several days (or at least long enough between tests for the temperature of the water in the pipes to cool down (it can take several hours). It may be best to ask the occupants to conduct this portion of the test.

- a. First thing in the morning, at one sink, turn the hot tap on full and measure the time it takes for hot water to arrive. Write down the time.
 - b. Do this on successive mornings for the remaining sinks and showers. If there is a tub/shower combination valve, measure the time using the shower.
 - c. Now multiply the time-to-tap values by the flow rate to get the volume-to-hot.
 - d. After completing these timed tests on all the sinks and showers, on the next morning go back to the sink with the largest volume-to-hot and turn the hot water on full hot and measure the time again. It should be similar to when you measured it the first time, but it may not be identical. This is normal.
 - e. Immediately after you have hot water at this sink, go back to each previously measured hot water outlet, turn the hot water on full hot, measure the time again and write it down. Do this for the showers too, even if you haven't measured them before.
 - f. Compare the measured time (or volume) from the first morning (cold start) and the last morning (hot start for all but the furthest sink). If there is a 50% or more decrease in the time from first morning (cold start) to the last morning then the hot water outlet is on the same trunk line as the furthest sink. The higher the percentage reduction, the closer the plumbing fixture is to the trunk line.
 - g. You may find that the volume and time did not change much from the cold starts to the day with the hot start at one or more plumbing fixtures. If so, you could repeat steps d, e, and f the next day and see if there is another trunk line (or main branch).
3. A demand activated pumping system makes sense to install if the wait and waste is large in a given hot water location (kitchen, bathroom, laundry), and if that location is regularly used, say a kitchen or master bathroom. There is additional benefit to be obtained if there are two or more hot water locations on the same trunk line with the furthest hot water location. An activation mechanism can be installed in each location that tells the pump to turn on when hot water is desired. Wired and wireless buttons are the most common mechanisms used to activate the pump when these systems are installed in retrofit applications.
4. If step g indicates there are two or more main branches and these are used regularly, it would then be effective to install a demand activated pumping system at the end of each main branch. Each main branch gets its own set of activation mechanisms.
5. The pump is generally placed on each under the sink furthest from the water heater on the trunk line or at the end of each main branch. Activating the pump shortly before hot water is needed can significantly reduce the time-to-tap at each commonly used hot water plumbing fixture.