USING DATA LOGGERS TO VERIFY BOILER HOT WATER RESET

A strategy to reduce heat loss from boiler water distribution systems is to reset the supply water temperature based on heating demand. Lowering the supply water temperature reduces the energy loss from the distribution system and saves energy. The most common method is to reset hot water supply temperature based on outside air temperature. This can easily be accomplished with stand-alone boiler temperature control systems. Buildings with Building Automation Systems (BAS) can also use a combination of outside air temperature and heating valve position to determine heating demand.

In either case, how can you determine if a hot water temperature reset schedule is in use and operating properly? Here is how you can use data loggers to verify the performance of a hot water reset control.

To log the boiler water temperature and outside air temperature you need the following supplies

For Hot Water Temperature:

1. 4-Channel thermocouple data logger: Onset HOBO UX120-006M (one per boiler)
2. Surface temperature adhesive thermocouple: Onset TMCx-HE (two per logger)
3. Pipe Insulation
4. Pipe Insulation Tape

HOBO UX120 Logger

For Outside Air Temperature:

5. Temperature/Relative humidity logger: Onset HOBO U12-012 (one per building)

Also Required:

6. Personal computer with USB port
7. Hoboware® software installed on computer
8. USB to mini USB cable
9. Microsoft Excel

HOBO U12 Logger

Configuring the loggers

Install and launch the Hoboware® software on your computer. Connect the 4-channel logger to the computer via the USB cable and launch the logger. Configure the logger as follows:

1. Ensure that the logger has enough battery life for the trending period before you start the configuration process. If battery life is less than 30% replace the battery.
2. In the description box type in the site location and boiler ID
3. In the “sensors” section, select the appropriate sensor from the pull-down menu. The thermocouple ports should be named after the parameter that is being recorded. (e.g., Hot Water Supply Temperature and Hot Water Return Temperature)
4. In the deployment section, set the logging interval to 15 minutes.
5. Under “Start Logging” select “On Date/Time”. Set the loggers top start logging after the installation is complete
6. Under “Stop Logging”, select “never (wrapping)
7. By default, the LCD will always remain on while logging data. Verify that the ‘Tune LCD off” box is not checked.
8. Click “Delayed Start” to launch the logger.

9. Disconnect the logger from the USB cable when the launching window closes.

Connect the Temperature/Humidity logger to the computer via the USB cable and launch the logger. Configure the logger as follows:

1. Ensure that the logger has enough battery life for the trending period before you start the configuration process. If battery life is less than 30% replace the battery.
2. Name the logger to include the building name, system name, and parameter measured (e.g., “AnytownHS_Boiler_OAT”)
3. Set the logging interval to 15 minutes.
4. Select “On Date/Time” to schedule logging start time. Set the logger top start logging after the installation is complete. Use the same start time used for the 4-chanell logger configuration
5. Select “never” (wrap when full) in the stop logging memory options
6. Select ‘Start” to launch the logger.
7. Disconnect the logger from the USB cable when the launching windows closes.

Installation Procedure

1. Stick or attach the first temperature sensor on the hot water supply pipe, ensuring that the sensor is in good physical contact with the pipe and under insulation. Be sure that the sensor is secure. Alternately you could use a hose clamp to secure the sensor.
2. Stick or attache the second temperature sensor on the hot water return pipe, ensuring that the sensor is in good physical contact with the pipe and under insulation. Be sure that the sensor is secure. Alternately you could use a hose clamp to secure the sensor.

Note: The material and thickness of pipes vary. To ensure that the temperature sensor is measuring the temperature of the fluid inside the pipe, wrap insulation all the way around the pipe. Also, make sure the insulation traverses twelve to eighteen inches along the pipe, with the sensor centered in the insulation and the insulation secured with pipe insulation tape. This will help to minimize measurement error due to heat transfer to and/or from surroundings.

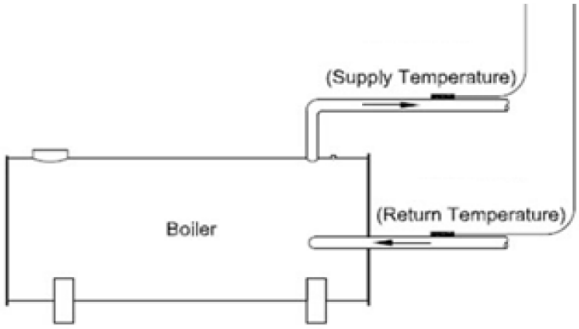


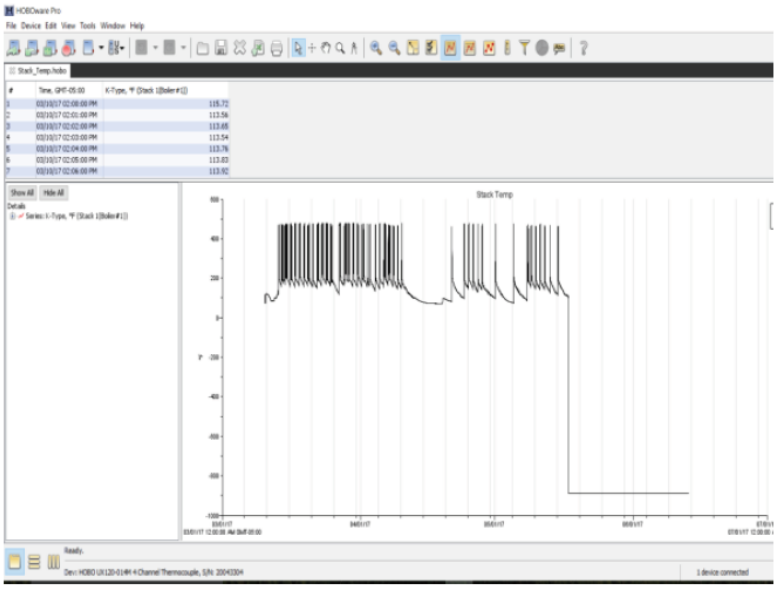
Diagram and note courtesy of the Building Performance Lab (BPL) noBAS Building Re-tuning User Guide

3. Deploy the UX120-006 4-channel logger within reach of the thermocouple(s). Use the mounting magnets on the back of the logger or use mounting tape and cable ties to secure the logger.
4. Plug the thermocouple cables into the correct mounting port. Verify temperature readings on the LCD dsplay.
5. Using cable ties or tape mount the Temperature/Humidity logger in a location outside the building where it is protected from rain and direct sunlight. It is important that the logger be placed where it will not be influenced by any sources of heat or other factors that could add

error to the measurements; this includes but is not limited to exhaust vents, dampers, and chilled or hot water pipes.

Data Acquisition

1. Retrieve the loggers after a minimum 2-week logging period. Repair/replace any disturbed piping insulation.
2. Launch the Hoboware® software on your computer and connect the loggers using the USB cable.
3. Select “Readout” from the device menu.
4. Wait for the data to be read out. Once the readout is complete, choose a location and /or a new filename, or accept the default filename and location. Click “Save”
5. The plot window will appear after you save. Select the data series you want to plot and click “Plot” to view the data.



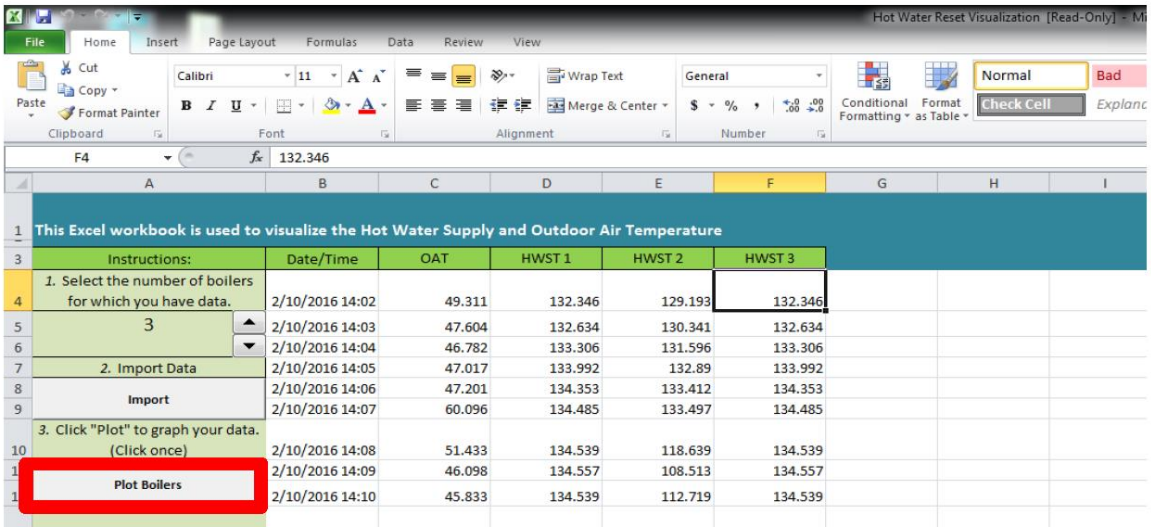
Screen capture courtesy of the Building Performance Lab

6. Export the raw data file to Excel for further analysis. Click on “Export Table Data” under the File menu. Save the document to a new folder designated for this project.
7. Repeat these steps for the Temperature/Humidity data logger and export the table data to the same folder for further analysis.
8. You can use the “Merge Data Files” under the File menu to combine the Temperature/Humidity data with the 4-Channell logger data and plot the data for analysis.

Data Visualization using Excel

Microsoft Excel can be used to combine the raw data from the data loggers and provide a graphical visualization of the data to determine if hot water reset is being used. Excel is also a handy method to determine min/max and average temperature during the logging period. Alternately, there are free Excel based Macro tools that can be downloaded and installed with built-in data visualization tools. Examples include Energy Charting & Metrics (ECAM), OpenEIS, and the noBAS Building Retuning Guide from the Building Performance Lab at CUNY. Regardless of what tool you use you want to plot hot water supply temperature verses outdoor air temperature.

Here is an example of the raw logger data that has been imported into the Building Performance Lab's Hot Water Reset Visualization Tool for Excel. The data is recorded at 1-minute intervals which is not necessary but will give you more a more detailed visualization of reset performance. This example compares the outside air temperature to the hot water supply temperature for three boilers.

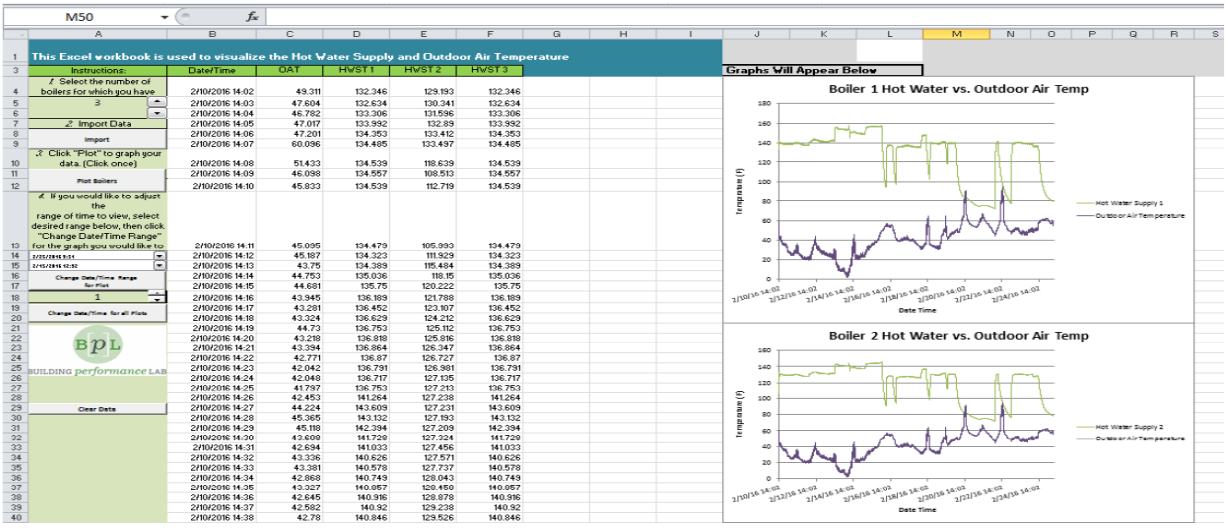


This Excel workbook is used to visualize the Hot Water Supply and Outdoor Air Temperature

Instructions:	Date/Time	OAT	HWST 1	HWST 2	HWST 3
1. Select the number of boilers for which you have data.	2/10/2016 14:02	49.311	132.346	129.193	132.346
3	2/10/2016 14:03	47.604	132.634	130.341	132.634
	2/10/2016 14:04	46.782	133.306	131.596	133.306
2. Import Data	2/10/2016 14:05	47.017	133.992	132.89	133.992
Import	2/10/2016 14:06	47.201	134.353	133.412	134.353
	2/10/2016 14:07	60.096	134.485	133.497	134.485
3. Click "Plot" to graph your data. (Click once)	2/10/2016 14:08	51.433	134.539	118.639	134.539
Plot Boilers	2/10/2016 14:09	46.098	134.557	108.513	134.557
	2/10/2016 14:10	45.833	134.539	112.719	134.539

Screen capture courtesy of the Building Performance Lab

The BPL visualization tool can plot the relationship between hot water supply temperature and outside temperature for each boiler. An example is below. Note that during occupied periods when the boiler is enabled the hot water supply temperature stays at a relatively fixed temperature setpoint. There is no reset strategy functioning or in place. If there was a functioning reset strategy we would see a clear correlation between hot water supply temperature and outside air temperature. Building operators can further check the sequence of operation of the boiler and verify that the hot water reset strategy setpoints are correct.



Screen capture courtesy of the Building Performance Lab

Hot water supply temperature (HWST) can be reset based on outdoor air temperature (OAT) or heating demand to reduce heating energy consumption. High HWST is appropriate when OAT is low, but energy savings can be achieved when a low HWST is used when OAT is high when only modest heating is required. If the data shows that hot water reset is not being used or is not operating correctly enable (or repair a reset capability so that HWST is reduced when OAT increases. A typical controller might have HWST vary from 160-180°F when OAT temperature varies from 20-50°F. Condensing type boilers allow much more aggressive reset schedules reducing energy consumption further.

This article was written by Duane Lewellen- Senior Project Manager of the Tool Lending Library at the Smart Buildings Center. The data loggers and accessory sensors mentioned in this article are available for loan to building operators and service providers in the states of Washington and Oregon free of charge. Visit our website for more information http://www.smartbuildingscenter.org/tool-library/