

High Water Temperature Safety Shutdown on the FCX

James Romersberger 1/7/2018

There are several instances when conditions, devices, settings, faults, and combinations thereof can cause this shutdown. This is considered a critical fault if it happens frequently, and the boiler is probably running at much higher temperatures than necessary. The set point of this device is fixed at 230°F. In order to fix the problem it is necessary to find the problem.

Location: The high water temperature safety is located on the far left of the console. On the MPI branded FCX 20 it is on the right hand upper side.

Resetting: Remove the cap. It does not stick out when tripped. If it is tripped, there will be a click when pushed in.

FCX 20's: These systems are slightly different than the newer FCX 22's and FCX 30's. The primary electrical difference is that the stack sensor (not addressed here), was downsized from 250°F to 230°F. And the Aquastat is down sized from a maximum of 176°F to 158°F this latter can affect the tripping of the high water temperature safety as the higher the set point of the boiler the more it exacerbates any of the other factors that may be involved. The FCX 20 can be easily identified by in several ways:

- a. They came with the Heat Wise burner as opposed to the Riello
- b. The flame view port is in the center of the primary instead of angled to the left
- c. The temperature wells are located on the upper right side of the primary instead of the lower left
- d. The aquastat is also stamped with 50°C to 80°C (122°F to 176°F)

Tools needed: An accurately reading digital or analog thermometer with a stem sensor about 6" long or a digital thermistor with readout. The sensor needs to be no greater than 1/4" in diameter, preferably 3/16" or less. A multi-meter. The thermostat on the console reads mixed temperature. It is clipped to the output pipe. This device could be relocated to the third temperature well to read core water temperatures.

The Safety Itself

In all the boilers I have sold this device has malfunctioned once. This was determined at the startup and it had failed in the open position (the boiler would not fire). Examination of the device did not show any apparent damage. The only time I have seen any of these devices fail closed (safeties or aquastats of the bulb type) is when they get severely kinked when in the closed position. This seals the tube so the device cannot see any changes in temperature fluctuation. However it is possible for them to malfunction and become erratic.

1. To check the safety independently, remove the safety and tape the probe to a temperature gage. Slowly apply heat using a heat gun (a hair dryer will probably work). Monitor the normally closed contacts with a multi-meter. When they open (boiler shutdown) read the temperature. The safety is set to trip at 230°F.
2. You can also place the safety bulb in a pan of water. If on heating the water to a boil 212°F it does not trip, then it is probably good. If your boiler is tuned properly and everything is working properly it should never reach this temperature.

Auto Air Vent

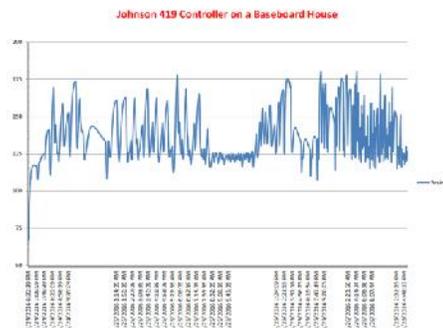
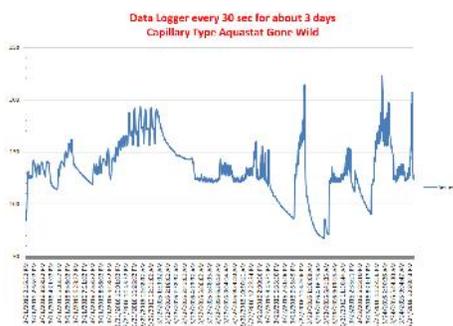
The Auto air vent at the back of boiler needs to be open and air purged from boiler. The boiler should be pressurized, usually 10 to 15 lbs. If not there may be air in top of boiler. This affects the ability to absorb a heat surge when there is no longer a call for heat (the pump stops) and the system comes up to temperature and shuts off. This surge is normal in all low mass boilers, but if there is no water to absorb the heat it can surge too high and trip the safety.

Aquastat

This is the large round black knob on the council. This device controls the boiler core temperature by starting the burner when water temperature has decreased to a certain value and then turning it off when it has increased to a certain value. As stated before the range on the newer FCX 22 and FCX 30 is 50°C to 70°C (122°F to 158°F) where as the range on the older FCX 20 is 50°C to 80°C (122°F to 176°F). You can measure these temperatures in the third temperature well.

1. At the lowest temperature (knob fully counter-clockwise) the system should turn on at about 120°F and off at about 135°F - boiler may surge to 150°F on the up cycle and drop below 120°F during the down cycle.
2. At the highest temperature (knob fully clockwise), the boiler should turn off at about 158°F.
 - a. To simulate a satisfied call for heat close the output valves (assuming they were installed).
 - b. If there are no valves then just turn the mixing valve to the fully recirculation position.
 - c. The boiler should come up to temperature and shut off normally. If it surges to over 200°F there most likely a problem with it.

This aquastat has been shown to vary in its temperature ranges of more than 10°F. It also has been documented to become erratic after a year's operation. The following charts demonstrate the difference between an erratic aquastat and a digitally controlled aquastat. If the aquastat is malfunctioning it can be replaced, but that may not solve the problem totally.



Now that all the players involved have been identified, know the operational criteria, the problem should be identifiable by measuring temperatures and testing devices. This is where to start.

1. What is the setting of the main aquastat on the control panel?
2. At what boiler water temperature is the boiler turning on?
3. At what boiler water temperature is the boiler turning off?
4. What is the heating temperature supply and return? (they can be different because of the mixing valve)

Computer Monitoring

The preceding charts were compiled because intermittent shutdowns were occurring on the system in question and on restarting the system it performed properly for a few days, so the fault was not readily apparent. The data was collected in a CSV file was then imported into Excel. The following link will take you to where the item used to record the preceding charts was purchased. However, knowing what we know now, we can diagnose the problem from its symptoms, so this information is given for reference for anyone who wants to track and record their boilers temperatures.

https://www.amazon.com/Thermometer-Hygrometer-Temperature-Recorder-Windows/dp/B00QES0UXO/ref=sr_1_cc_6?s=aps&ie=UTF8&qid=1509909905&sr=1-6-catcorr&keywords=USB+Thermometer%3FData+Logger+Recorder

Going Forward

Understanding Normal Operation

The FCX is an oil fired condensing boiler. In order to condense, return water temperatures need to be below 115°F. This means that if the output temperatures are high and the return temperatures are high the boiler will not be condensing and efficiency will be down. This boiler is simply not designed to operate continuously in non-condensing mode. There are solutions to this that will vastly increase efficiencies.

The first thing is to determine the needs of the system. Unless you are in a super insulated home with radiant floor heating, or have other low temperature heating devices, you will probably need to vary the temperature of the heating water over the year. Simply running at the highest temperature needed on the coldest day is self-defeating, and horribly inefficient. The solution is to run the boiler and the mix at the lowest temperatures possible and still maintain comfort. Excepting this the core temperature of the boiler needs to be above 115°F in order to not condense in the primary.

There are temperature controls that do this. See the **Technical** page on my website. In the meantime, turn the boiler temperature and mixing valve down starting at aquastat fully counter clock wise and mixing valve at 50%. Increase or decrease the mixing valve as necessary to maintain heat needed, If you need more heat than **then** increase boiler temperature as needed.

Digital Temperature Controllers

Since it is not uncommon to have 10+ degrees difference between operation temperatures in bulb type aquastats, and while the FCX is a plug and play boiler, these inherent inaccuracies of analog controllers of the bulb type warrant further discussions. Adding to this uncertainty there is no way to actually monitor core boiler temperature without a separate device. So it would seem to me that if one is willing to buy the most efficient oil-fired boiler in the United States (the FCX), they would want to put some enhanced controls on it. It is unlikely that a reasonably insulated and properly plumbed home in Fairbanks and elsewhere in more moderate regions need even 160°F water to heat its baseboard.

A digital temperature control is a "must" for any system. It takes the guess work out of the analog device and provides a continuous readout of boiler temperature. To accurately set and monitor boiler temperatures the Johnson 421 digital controller is perfect. To utilize Outdoor Reset with Indoor Feedback to modulate boiler and mixed supply temperatures, I have found none to compare with the Tekmar 400 series of controllers. Here is a link to my website showing how to wire these devices. <http://www.fcxalaska.com/HTMLs/Technical.html>