FAQ

"Frequently Asked Questions" about *FireRight* Kiln Controls

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1. Which came first ... the chicken or the egg?

The chicken! ... and here's some information that's even more useful: *If you have a specific question or topic in mind, think of a related keyword, then use the* **"Find"** *function to locate references to it.*

2. Your temperature sensor looks like just a piece of wire. What is it?

The temperature sensor used with FireRight controls is a *"thermocouple"*. Thermocouples are made by simply connecting two different types of wire (actually, carefully controlled alloys) together. A physical phenomenon at the junction of the two dissimilar wires creates a very small amount of electrical activity in the presence of heat. The very small voltage that results (called "emf") varies predictably with the temperature of the junction, and can be measured using very sensitive electronic circuitry to provide an indication of this "thermoelectric" junction's *temperature*.

> ***NOTE***: FireRight thermocouple elements are no longer available. Please see this page for replacement elements.

3. I don't see any "junction" on my sensor. Why not?

FireRight thermocouple elements are "butt welded", meaning that the wires are welded together end-to-end, as opposed to being twisted and welded, which is more common. Butt-welding improves the response of the element, by minimizing the mass in the junction area.

In order to fit standard insulators and mounting hardware, the sensor must be bent around a fairly small radius. To protect the junction from bending stress, it is created approximately one-half inch from the middle of the element. It is therefore actually "hidden" within the first ceramic double-bore insulator.

4. How do I know if the sensor is bad?

Thermocouples ordinarily provide reliable service right up to the point of failure, so if the temperature indication appears to be reasonable, the sensor is probably ok.

When used at temperatures higher than 1800°F the "Type K" thermocouple (the type we use) comes under attack from a corrosion process generally called "green rot". When this is occurring, you will find that one of the wires is turning from metal to a carbonaceous material (like coal) which has a greenish cast.

You can scrape this material away to find out how much good metal is left within. We recommend replacing the element when the remaining good wire has been reduced to less than one-third of its original diameter. This will eliminate the possibility of the sensor's failing in the middle of a firing.

Sensors also sometimes become inaccurate, erratic and *unreliable* just prior to final failure and this can also degrade the quality of the firing.

5. I notice that replacement elements are marked differently. What does the marking signify?

Thermocouples have polarity ... positive (+) and negative (-) wires. If you reverse the connections, the temperature indication will decrease while the kiln's temperature is actually increasing.

Unlike dc electronics, where the color red usually indicates the positive side of the connection, red always signifies (-) in thermocouple circuits, and the other color (yellow in this case) is always (+). The polarity of FireRight elements is marked by grinding the (+) wire to silver it, while leaving the (-) wire in its stock oxidized (dark gray) state.

Regardless of the marking, the polarity of the wire can always be easily checked using a magnet, since the (-) wire is magnetic, and the (+) wire isn't.

When replacing thermocouple element, you should always take care to check the polarity before restoring the equipment to service. This is easily accomplished by simply holding a lighted match to tip of the sensor, and observing that the measurement *moves* upscale as the sensor heats up.

6. Why is the sensor made of such heavy wire?

As mentioned above (Item 3), these sensors are subject to "burn out" when used above 1800°F. Their useful life depends upon the operating temperature, and the time spent at high temperature. Heavy gauge wire is used to provide the longest possible life for sensors used at high temperature. This trades off good response for long life, but since kilns have very slow "thermal loops" the poor response of the heavy-gauge sensor is not ordinarily a problem.

7. I use cones in my kiln, and according to them your temperature indication is not very accurate. The controller usually shuts off before the cone bends. What's going on?

Thermocouples measure temperature, while pyrometric cones respond to heat. The melting temperature of cones is always specified with respect to the rate at which the temperature in the kiln is increasing. Cone charts usually give melting temperatures for heating rates of 60, 150 and 300°C/Hr (105, 270 and 540°F/Hr).

The fact is that cones will eventually melt at much lower temperatures than those indicated on cone charts, if they are held at the lower temperature long enough. For example, cone charts indicate the "cone 6" should melt at 2232°F when the temperature in the kiln is rising at a rate of 270°/Hr, but this cone will most certainly melt even at 2032°F *after* being held for several hours at that temperature.

8. I've always had pretty good firing results using cones. After switching to your controller and choosing a limit temperature corresponding to the same cone I've always used, my ware seems to be somewhat over-fired. I like the convenience, but should I question the accuracy of your controller?

Practical electric kilns are not able to maintain a heating rate of even 108°F/Hr (the slowest rate shown on cone charts) once their temperature rises above about 1750°F, so it’s necessary to "guesstimate" what the appropriate temperature limit setting should be if attempting to duplicate firing results achieved when using cones as the gauge. Since the heating rate is much slower than the rates indicated on standard cone charts, the cone you've been using will have been bending at temperatures much lower than those indicated on the chart. The controller's limit setting should *therefore* also be set to a lower temperature than the cone charts indicate.

9. My kiln over-fired and just ruined everything ... your controller never shut off and from the looks of things the temperature must have been over 3000°F! Now what?

The heating elements used in electric kilns are usually calibrated to run at a maximum "skin temperature" of about 2505°F, so your kiln isn't physically capable of producing temperatures exceeding that limit. Excess time spent a high temperature, however, often produces the same result.

Controllers sometimes fail in the "ON" condition, and over-firings therefore result. If you can't be on hand to assure that the kiln has been shut off after the maximum expected firing time, consider installing a timer ... or use a KilnSitter as a safety device.

More frequently, over-firings result when the controller's limit setting is adjusted to a temperature higher than the kiln is able to produce. If you fire to temperatures in excess of 2100°F you need to keep your kiln in top condition to assure that your high limit setting temperatures can actually be achieved.

When your kiln has reached the point where it "needs work", compensate for its diminished heating capacity by lowering the limit setting, taking into account the fact that the kiln will be very slow on the top end. Within limits, you can *achieve* the same results firing more slowly to a lower limit temperature.

10. OK ... assuming the problem is my kiln, what can I do to get it up to snuff again?

As kilns age, heating elements become brittle and more highly resistive, which reduces their heating ability. Elements that are broken are, of course, easy to diagnose since they don't "light up". The only real way to determine that worn elements need to be replaced is to measure the total current drawn by the kiln with all the heaters running at 100%. Measure the voltage and current, at the kiln (not, for example, at the electrical service's source), and compare the values to those shown on the kiln's name plate. The current will be proportional to the voltage, so if your line voltage is different from that shown on the name plate, adjust the name plate current value accordingly. Then, if the measured current is much lower than this adjusted name plate value, it's probably time to consider replacing the elements.

Loose connections are also frequently the cause of reduced heating capacity. Electrical current causes wiring to heat up slightly, and the resulting expansion and contraction can eventually loosen up connections at screw terminals, box clamps, etc. Its good maintenance practice to periodically remove all power from the kiln, and then get out your big screwdriver and make sure that all connections are still as tight as you can make them. Loose connections often result in damage to the wiring due to overheating (it can actually become red-hot), so while you're at it, look for signs of such damage and replace any wiring and hardware that's no longer serviceable.

"Infinite switches" also degrade with age, losing their calibration and throttling power to the heaters even when set on "HIGH" (you can usually detect this by listening for the tell-tail clicking sound that these switches make as they turn on and off).

Sometimes problems arise when other loads are added to shared electrical services in commercial or institutional settings. Residential electrical services can also become more highly taxed, especially during periods when hot weather promotes increased use of air conditioners, etc. In such cases, the reduced line voltage will degrade the kiln's heating capacity. As mentioned above (Item 8) you can "fudge" the controller's limit settings to compensate for this. But since overloaded circuits usually become a continuing nuisance, and can present a serious fire hazard, its usually a better strategy to upgrade the service, rather than to depend on "fudge factors".

11. The circuit breaker for my kiln trips every now and then. I've inspected my kiln and its wiring, and I don't really see any sign of problems there. Could there be something wrong with the controller?

Probably not. If the kiln is the only load serviced by the circuit breaker in question, there might be an intermittent problem of some kind that's causing the load current to exceed the breaker's limit, but such problems rarely involve the control system, and most often cause other kinds of damage which is usually readily apparent.

It's more likely that there's a problem with the circuit breaker itself. Either it lost its "calibration", it has a loose connection (that's heating it up) or the temperature in the breaker box itself is too high (possibly due to loose connections, a bad location, etc.)

If the electrical box is not excessively warm, try tightening up the wire connections on the circuit breaker. If these appear to be tight, remove the breaker and make sure that the clips that connect it to the box's buss bars are tight and have not lost their resiliency due to overheating.

If you still have problems, you might be able to "fudge" your way through a firing by opening the front panel of the breaker box and training a fan on it during the firing. If this successfully eliminates the problem, its probably time to replace the *circuit* breaker.

12. My controller makes strange noises ... like a high pitched whine ... whenever the heat comes on.

Your control system uses a mechanical relay, or "Definite Purpose Contactor" (DPC), to switch the high levels of current required for your heating elements. The funny noises are a characteristic of this type of relay. Humming sounds sometimes result when the pole pieces of its solenoid don't seal exactly when the contacts close. High pitched whines, often varying in pitch, result from resonances in the contact elements resulting from the current passing through them.

Although perhaps a nuisance in some settings, these noises are natural and are not indicative of any sort of *problem*.

13. The power relay on my kiln bothers me with all its clicking and clacking. Why not use a quieter relay? And doesn't all this racket indicate a lot of wear?

Mechanical contactors are noisy; no doubt about it. The alternative is the mercury displacement relay, which is virtually silent, and has much higher "contact life" ratings.

While the prices of mercury relays have become more competitive with mechanicals in recent years, failure modes and disposal problems have also become an issue. Since these devices contain appreciable amounts of liquid mercury, it's no longer legal to simply pitch them into the nearest trash can. Given the choice as a manufacturer, we would prefer not to assume the responsibility for the disposal of these devices forever, and therefore prefer to use mechanical relays instead, even if they are noisy.

The long contact life ratings for mercury relays are not necessarily significant because contact failure is not the predominant failure mode for this device. In practice, these relays die either because of loose connections, which result in the destruction of their terminals, or because of coil failures. Coil failures occasionally generate enough heat to pressurize the capsule containing the mercury, causing it to rupture and spill its contents. Whether or not this is hazardous is open to debate, but it is certainly messy.

Mercury relays achieve their high contact life ratings by eliminating arcing as the contacts open an close. Some suggest that this also makes them "RFI free" (Radio Frequency Interference). Here again ... the solenoid systems of mercury relays tend to be much more highly inductive than their mechanical counterparts, which leads to problems in other areas ... either switching difficulties when driven by solid state devices, or arcing problems when operated by *small* control relays. Some sort of suppression is often required to compensate for this high coil inductance.

14. Why not use solid state power controllers? They're quiet, and don't introduce any environmental concerns.

Except in the very small sizes (up to 10-amps) the cost of solid state power switching is about $1 per amp. For safety's sake, both lines in a kiln's 220-volt circuit need be switched, so for a 48-amp kiln, solid state switching would cost about $100 for the device itself. Then, to dissipate its heat, a "heat sink" is also required. Since kilns are apt to be operated in a very warm "kiln room", the size and cost of the required heat dissipater can become quite significant.

On the other hand, we are able to sell a small 48-amp relay, which requires no heat sink, for only $32 ...

15. My kiln makes a racket like a machine gun ... ratta-tat-tat ... whenever the controller turns the heat on or off. Is this normal?

No, this is not normal. What's more, contact chattering can rapidly degrade the contacts of your power contactor, and even damage its solenoid coil. An occasional sputter probably does no harm, but the cause of consistent chattering needs to be diagnosed and corrected.

Chattering is sometimes caused by nearby equipment which produces stray electromagnetic energy referred to as "RFI/EMI" (Radio Frequency Interference/Electromagnetic Interference). A mobile radio transmitter, arc welder, etc operating nearby can cause problems of this type.

More often, chattering results from loose connections at the kiln or in its control circuit, especially within the "Power Controller" box or the kiln's switch box. FireRight control systems use a small transformer that reduces the the high-level input power to 24-volts for the control system, and chattering sometimes results when one of the pins that connect the transformer to the power controller circuit board cracks. Since arcing results where the pin is cracked, a small, dark carbon deposit usually develops around pin, which is the key to quickly diagnosing this problem.

Feedback can sometime result when the sensor cable or control cable is routed in close proximity with the kiln's main power cord. Switching the high kiln current creates changes in the electromagnetic field around the main power cord, which can induce stray signals into the sensor and control cables. These spurious signals can result in "glitches" in the controller's sensitive circuitry, which can result in erratic operation. The sensor and control cables should be kept well away from the kiln's power cord or, at least, should not run parallel to the kiln cord.

In cases where chattering seems to become a problem only after the system warms up, the optical isolator on the power controller circuit board is often the cause. This small 6-pin "chip" (usually marked MOC-3040 or MOC-3041) is used to isolate the low-level output of the controller from the high-voltage coil circuit of the contactor, using a light beam to communicate the switching signals. When these little devices fail, their output usually breaks down, feeding power randomly to the contactor coil, which causes it to chatter and buzz.

16. Your controllers aren't adjustable enough! It's too hard to set the temperature ... I can hardly ever get it exact.

The resolution of the adjustment mechanism is technically infinite. However, their "setability" has practical limitations which makes it difficult to easily achieve exact settings. If you have enough patience, you will usually be able to "tweak" the adjustment until you get the number you want.

Please also keep in mind that the range of the adjustment spans 2500°F, so a variation of one-degree amounts to only a four hundred "parts per million" (or 0.04%) ... which generally falls within the definition of "precision" for controls of this type. Further, since firing is a "heat treating" process that involves (1) time and (2) temperature, exact *temperature* settings do not, by themselves, guarantee perfect results anyway.

17. Why don't professional artists and potters use electric kilns?

Some do. The choice of kiln type is a matter of personal preferences and firing requirements. In some artistic communities there's an affinity for creating beauty using only the basic elements of "earth, fire and water" ... which is often the *source* of this "debate".

18. Will your controls work on gas kilns?

Yes. They behave in about the same manner as a common On-Off thermostat. Use control systems equipped with an "Interface Panel" and connect it to a gas solenoid valve rather than to an electrical power contactor. Of course, pilot safety valves are also required for these applications. FireRight cannot provide either gas solenoid valves or *pilot* safeties, however these components are commonly available from commercial distributors.

18. I set my controller to take the kiln up to 2381°F, but it stalls at 1800°F. I think there's something wrong with your controller, because it says the temperature is 2250°F, but my kiln pyrometer says its only 1800.

You have two problems working together to confuse the situation.

First, the average "Cone 10" kiln really has to struggle to reach Cone 10 after a little wear and tear. In your case, your kiln is apparently "peaking out" at about 2250°F. This is typical, and 2250° is respectable for a kiln that's not brand new. If you must work at Cone 10, you'll have to keep your kiln in tip-top working condition ... no heat leaks, new heaters, clean electrical connections, no other significant loads on the power line serving the kiln, etc.

The second part of the problem is your pyrometer. Inexpensive "Kiln Pyrometers" have been sold over the years ***for use in gauging the rate of temperature change***. Since the "measuring uncertainties" associated with these inexpensive instruments become extremely wide with expanded ranges and high temperatures, they aren't very useful in measuring the absolute temperature of the kiln. The controller's temperature indicator is infinitely more accurate. If you need a pyrometer in order to read the temperature more closely, or for a "second opinion", purchase a digital type. These are no longer any more expensive than the old analog type kiln pyrometers, and are quite accurate.

20. How can I set up the AutoMate II Automatic Kiln Switch to provide a soak time at the end of the firing?

That is an AutoMate II. It is basically just a turn-up controller, designed to throttle the kiln’s heating system such that the heat (not necessarily the temperature) increases at a linear rate during the time period selected ... 0 to 10 hours. Moving the control to the HOLD position at any time during that turn-up process will stop the kiln at that heating rate, and hold it there indefinitely. Hence, to “smoke out” ware prior to proceeding with a bisque firing, users may run the output up to about 20% “on”, and hold that setting for a while, prior to continuing with the firing.

Once the AutoMate II has turned the kiln up to 100% on, it is essentially then out of the picture. The kiln will continue to fire at its maximum rate until the cone in the KilnSitter bends, or the KilnSitter’s timer times out, either event causing it to trip off, thus shutting the kiln down. This assumes that there is a KilnSitter, which is usually the case. The other option, of course, is to shut the kiln down manually, using sight cones as a guide.

In firing ceramics, there is actually no such thing as “soaking”, since firing is a heat-treating process, which is not strictly temperature-related. As long as you have ware in a hot kiln, the chemical process will be on-going, being a matter of time and temperature, not just temperature, per se. For example, cone charts relate maturity points to temperature, but at specified rates of temperature increase ... typically 270°F/Hr (150°C/Hr.). In fact, cones will bend at much lower temperatures if the rate of temperature change is much slower, or even zero ("soaking").

After the AutoMate II has reached it's "100% On" condition, the temperature in the kiln will continue to increase until it is shut down. The only way to automatically ramp up to some temperature and hold at that point for a while and then shut-off, would be to replace the AutoMate II/KilnSitter setup with a programmable electronic temperature/rate controller ... usually an expensive proposition.

For what it's worth, most practical kilns, even when new, have problems getting much higher than 2350°F (1290°C), and the rate of temperature change slows down exponentially as the temperature in the kiln approaches the skin temperature of the heating elements themselves (usually around 2505°F (1375°C at best). This maximum-achievable temperature decreases as the heating elements age, the kiln develops cracks which leak heat, etc. So, if you were to have an elaborate temperature/rate controller and programmed it to do a "perfect" Cone 8 firing ... ramping up to 2308°F at 270°F/Hr, if the shut-off was contingent on the temperature reaching 2308°F, an over-firing would be the likely result, since at elevated temperatures the kiln would never be able to maintain the 270°F/Hr heat-up rate and, in fact, might also not even be capable of reaching the shut-off temperature. When over-firings do occur, it's usually because the kiln failed to shut off for some reason, and therefore heated up to whatever its peak maximum temperature was, and remaining in that hung-up situation until manually shut off, or until some catastrophic sort of failure (melt down) cased its circuit breaker to trip. On surveying the sorry results ... which often includes damage to the kiln itself ... people often assume that the temperature must have reached drastically high levels. But, as explained here, that isn't possible; it was too much time at that high temperature, not the temperature itself.

So, what all this boils down to is that the practical kiln-firing of ceramics remains an art, rather than a science. Your best option is probably still sight cones ... watching the progress of the firing carefully towards the end of the process, and then keeping the kiln on for as long as you think you should, see how things work out, and tweak future firings accordingly to get exactly the results you want. If there's a KilnSitter, you'll probably need to keep that from interfering by using a high-rated cone in order to ensure that it wont interrupt the process, and you can use its timer (if there is one) as a back-up safety device, setting it an hour or two longer than you expect the firing to be.

***FireRight* Controls/Warner Instruments**
1320 Fulton Ave
Grand Haven MI 49417-1534 USA
Phone: 616-843-5342
Internet: www.fireright.com

([1])*KilnSitter* is a Registered Trademark of W.P. Dawson Inc., 399 Thor Place, Brea, CA 92812. *KilnSitter* is a *UL* Listed device.

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