



Electric Kiln Firing Protocols

General Overview of Electric Kilns

- Our electric kilns are completely programmable and can be safely used to fire clay work from Cone 022 up through Cone 6. This can be achieved using pre-set schedules in the “Cone Fire” mode using one of three speeds (slow, medium or fast) or you can customize the schedule completely using the “Ramp Hold” mode.
- At The Potters’ Studio our electric kilns are most commonly used for bisque-firing (which we do at Cone 05) and glaze-firing at Low-Fire (Cone 05) and Mid-fire (Cone 6) temperatures.
- The goal of bisque-firing is to convert bone-dry greenware into bisqueware, making it more durable for the glazing and decorating processes. This also makes work less likely to explode from steam during the glaze firing process.
- At The Potters’ Studio all clay must be bisque-fired before it is put into a mid-fire or high-fire glaze firing. Low-fire, mid-fire, and high-fire clays all get bisque-fired in our electric kilns to Cone 05.
- Firing ceramic work in a kiln burns out various compounds from clay and glaze materials that are harmful to our physical health and detrimental to the final glaze results. For everyone’s safety, our electric kilns are outfitted with vents that should be turned on for the entirety of the firing process.
- Firing hotter than Cone 6 is not allowed because it is too hard on the kiln components and wears them out faster.

Gas Reduction Firing vs. Electric Oxidation Firing

- Reduction firing uses carbon-based fuels such as gas, wood and oil to fire the kiln. At The Potters’ Studio we use gas to fire our outdoor kilns.
- In reduction firing, the inside of the kiln is basically a big ball of fire. Fire needs oxygen to burn and if the oxygen supply (typically regulated via the damper/flue) is reduced, the fire will look elsewhere for oxygen to burn and draw it out of the clay and glaze, changing the chemical composition and look of the clay and glaze.
- Gas Kiln Reduction Firings tend to yield more subtle, earthy colors with variations and surprises depending on how the reduction phase of firing is handled. (Note that gas kilns *can* be fired without reduction.)
- Conversely, in Electric Kiln Oxidation Firing the elements heat the air like an electric oven. Electricity passes through coiled heating elements that have a certain amount of electrical resistance, generating radiant heat as a by-product. The heat rises and is absorbed by everything in the kiln. The clay and glazes keep their oxygen molecules resulting in a different look than in a gas reduction firing.
- If you are a person who loves color, firing in an electric kiln will allow you to glaze with brighter colors. Electric kiln oxidation firings tend to be very stable and consistent. Note that our studio does not stock low-fire or mid-fire glazes.

Temperatures and Cones

- In ceramics we fire kilns using a system of Pyrometric Cones, or just “Cones”, that measure “Heat Work”. Heat Work is the measurement of Temperature + Time. Traditionally, we measured these differences using 2” tall physical cones. These cones are calibrated with

different amounts of ceramic material to bend at the desired cone temperature range. Our modern electric kilns are calibrated using the same cone system but are programmable so we don't usually use physical cones.

- Cone numbers operate sort of like positive and negative numbers, 05 being cooler than 5. For ceramic people the Cone range is from Cone 022 on the low end for things like luster firing, all the way to high-fire Cone 13, which is rarely seen outside the world of wood firing.
- There is no single correct temperature for low-fire, mid-fire, and high-fire ceramics, but there are some standards that are generally adopted by the ceramics community and industry.
 - Bisque/Low-Fire = Cone 06 to Cone 04 (We bisque at Cone 05.)
 - Mid-Fire = Cone 5/6 (We fire to Cone 6.)
 - High-Fire = Cone 10
- For a better understanding of the different cone ranges take time to study the Orton Cone Chart attached to this document.

Personal Safety Issues

- Wear closed-toe shoes and natural fiber clothing when firing or unloading the kilns.
- Keep your hair tied back if it is long.
- If the kilns are very hot - wear leather gloves.
- Do not lean against kilns, they can be very hot.
- Sharp things like glaze edges and glaze on shelves will cut you - wear leather gloves when unloading.
- Wear a mask when vacuuming a kiln.

Kiln Safety Issues

- Always press "STOP" before loading the electric kilns to cancel previous kiln programs and avoid shocks.
- Don't leave anything flammable on, against, or under a kiln.
- Never fire our electric kilns beyond Cone 6.

Whose Work Can You Fire?

- You can only fire your own work.
- Do not fire work for other members without asking a staff-person first.
- Do not fill empty space in your kiln with contract firing work without asking a staff-person first.

Choosing a Kiln

- Choose the kiln based on the sizes of work you want to fire. This takes into account the size of your work and the kiln posts and shelves you will need to use.
- An electric kiln can be fired partially full, BUT it is a waste of energy and drives up the cost to make your work. Depending on the type of clay you are using, not filling a kiln can actually cause a kiln to cool too quickly causing cracking or dunting in your work.
- Maximizing space usage allows for more mass in the kiln to radiate heat in a tighter proximity, causing the kiln to cool more slowly which is safer for your work.

Kiln Loading

- For bisque firing, make sure your greenware is dry.
- How to test if greenware is dry.
 - Feel for temperature difference, bottom compared to top.
 - Compare temperature to a pot you *know* is dry
 - Lick test, cheek test

- Electric kilns are lined with a very soft brick that can easily be damaged, especially when loading shelves onto posts. Be careful and try not to touch and damage these bricks.
- The thermocouple is also very delicate and easily damaged, especially when loading shelves onto posts! Be careful and do not put any wares close to the thermocouple.
- Using the “tripod rule”, all shelves in the kiln should be placed on (3) posts for maximum shelf stability.
- Three 1” posts should be placed on the kiln floor and the first shelves loaded onto those posts. This will allow adequate heat circulation at the bottom of the kiln.
- The next shelf should be at least 4” above the bottom shelf or the work on the bottom shelf may be under-fired.
- Stack posts directly above one another as you add more shelves so the posts all the way down to the floor of the kiln support the load weight, instead of the shelves. This means all posts above the bottom shelf should line up vertically with the 1” short posts under the bottom kiln shelves.
- Don't put wide flat things on the bottom shelf because there's no heat underneath and the temperature differential can lead to cracks.
- Fire big heavy sculptures on a thin bed of sand or grog (acts like mini ball bearings, allowing clay to expand and contract without cracking). The studio has sand in a container near Kiln C.
- Check shelf height clearance with a ruler or stick held horizontally.

Kiln Programming and Firing

- The Skutt Kilns we use have two firing modes.
 - “Cone Fire” Mode: A set of easy-to-use preset schedules (slow, medium, and fast) for any cone temperature. “Cone Fire” Mode is easy and suitable for most firing needs.
 - “Ramp Hold” Mode: This mode can be utilized to fully customize every part of your kiln schedule. For example, Crystalline Firing needs a much slower cooling cycle than a normal ceramic firing. This mode of firing can be handy for specialty glaze firings or for thick sculpture.
- Standard studio bisque firings are fired using the “Cone Fire” mode medium fast with a three-hour pre-heat added. See “How to Program the Electric Kiln” section at the end of this document for more thorough instructions.
- Consider extending the pre-heating phase of firing if your work is super thick or possibly damp.
- Pre-heating is not necessary for work that is already bisqued.
- Keep the kiln lid closed during firing. Put peeps in from the start.
- The kiln ventilation fans should be ON during firing.
- Make sure you are familiar with the kiln’s digital error messages. See “Skutt Kiln Error Messages” at the end of this document.

Kiln Log Sheet

- A Kiln Log Sheet must be filled out every time a member fires a kiln.
- The Kiln Log Sheet must contain the date, your full name, kiln name, the Cone # you are firing to, loading time, unloading time and any notes about your firing (did you do an extra-long pre-heat?)

Kiln Un-Loading and Post-Firing Clean-Up

- Ideally, you should be able to pick up a piece with your bare hands before unloading it.
- Peeps can be removed and the lid can be propped open with a soft brick or horizontal kiln post at 250 degrees (not before!).

- At 200 degrees, the lid can be opened (not before!). The bisque-ware might still be too hot to handle. It's ok to wear gloves to handle hot work, but you are less likely to drop things if you wait until you don't need gloves.
- Put everything away after unloading (shelves, posts, etc.) When stacking kiln shelves behind the kilns, put the kiln-washed sides face-to-face.
- Vacuum the inside of the kiln after firing. If anything explodes in the kiln, vacuum the kiln elements as well. If you use sand or grog under your work, vacuum it out.
- If a shelf has been damaged (glaze runs, shelf breaks, etc.) you **MUST** notify staff. You may be asked to clean up the shelf (scrape and kiln wash) or pay for a new shelf (\$20-50). Failure to report shelf damage may result in a suspension of your firing privileges.

How To Reserve an Electric Kiln

- Reserve an electric kiln by making an appointment on our website under the Services Tab > Electric Kiln Reservations.
- Members can fire the electric kilns in the Flexspace three times per month, but no one kiln can be fired more than twice a month. Test kilns can be fired as often as you want.
- Generally speaking, members only have access to the electric kilns in our Flexspace.
- Talk to a staff-person if you think you need to use one of the studio's larger electric kilns located in the Main Studio.

Cancellations

- Cancellations for firing the electric kilns must be done 24 hours in advance (either online or by calling the studio.) If you cancel less than 24 hours in advance of your scheduled firing, you will be charged as if you had fired the kiln.
- If you forget to cancel and you do not fire a kiln during your reserved slot, you will be charged as if you had fired the kiln.
- If a kiln has not been unloaded at the designated time, staff will unload the kiln and the member will be charged a \$25 kiln service fee.
- You can email Darcy Delgado at glazes@berkeleypottersstudio.com if you have questions about invoice charges for firing the electric kilns.

Kiln	Make /Model	Capacity-Cu/ft	Capacity-Cu/in	Cone 05	Cone 6
I	Skutt Kilnmaster LT	.22	384	\$4.00	\$5.00
J	Skutt KM-714	1.53	2646	\$9.02	X
K	Skutt KM-818	4.6	7949	\$16.74	\$23.92
L	Skutt KM-1018	7	12,096	\$29.62	\$42.32

Kiln Models, Capacities, and Fees for Members Doing Their Own Firing

Orton Cone Chart (when heated at 302F an hour)

Cone #	Temperature
022	1112
021	1137
020	1175
019	1261
018	1322
017	1376
016	1457

015	1479
014	1540
013	1565
012	1623
011	1641
010	1652
09	1693

Low-Fire Earthenware

Mid-Fire Stoneware

Cone #	Temperature
4	2167
5	2185
6	2232
7	2264
Cone #	Temperature
08	1751
07	1803
06	1830
05	1914
04	1940
03.5	1976
03	2014
02	2048
01	2070
1	2109
2	2124
3	2134

Cone #	Temperature
8	2305
9	2336
10	2381
11	2399
12	2419

High-Fire Stoneware

Cone #	Temperature
12	2419
13	2455

Some Porcelain

How to Program the Electric Kiln

Steps to Program a Skutt Electric Kiln to Cone 05 (Bisque-Fire)

- 1) Press STOP.
- 2) Press Cone Fire.
- 3) The panel should read PrHT (Pre-Heat). Press 3.00, Enter.
- 4) The panel should read "CONE". Press 05, Enter.
- 5) The panel should read SPd (Speed). Choose Medium, Enter.
- 6) The panel should read HLd (Hold) 00.00. Press Enter.
- 7) The panel should read IdLE. Press START.
- 8) You will hear a click when the kiln program starts!

Steps to Program a Skutt Electric Kiln to Cone 6 (Mid-Fire)

- 1) Press STOP.
- 2) Press Cone Fire.
- 3) The panel should read PrHT (Pre-Heat). Press 1.00, Enter.
- 4) The panel should read "CONE". Press 6, Enter.
- 5) The panel should read SPd (Speed). Choose Medium, Enter.
- 6) The panel should read HLd (Hold) 00.00. Press Enter.
- 7) The panel should read IdLE. Press START.
- 8) You will hear a click when the kiln program starts!

Most Common Skutt Kiln Error Codes

All Skutt kilns with "KilnMaster Controllers" are programmed to generate Error Codes when something goes wrong during a firing. These not only give you an indication of what the problem may be, they also often will shut down the firing to protect your ceramic ware and /or the kiln itself. When an Error Code is generated it will appear red letters in the display.

- **E-1:** Error 1 (E-1) is the most common Error Code that your kiln will display. It is telling you that the kiln does not have the power to rise in temperature at a minimum rate. The most common causes of E-1 errors are failed relays, worn out elements, broken elements or voltage issues. **If this happens, talk to a Staff-Person.**
- **FAIL:** A steady display indicates that all thermocouples have failed. If the word FAIL is flashing, a single thermocouple in the kiln has failed. **If this happens, talk to a Staff-Person.**

Glossary of Terms Related to Firing

- **Bone-dry:** The state of clay when all physical water has dried from the clay. At this stage clay becomes chalky and when held up to your face, does not feel cold.
This is the last stage of greenware and is ready for the first kiln firing.
- **Bisque-ware:** The state of the work when it comes out of the kiln after the first firing. All chemical water bonded to the clay particles is gone leaving it in a permanent ceramic state (cannot be turned back into workable clay by adding water) making it strong and suitable to apply glaze and other decoration. Firing transforms fragile greenware into more durable bisque-ware! From Clay into Ceramic!

- Cone: Cones are tall, skinny ceramic pyramids that are inserted into the kiln, designed to melt at a certain temperature to let the potter know when a certain temperature has been reached. Cones measure 'heat-work', which is a combination of the temperature reached, and the time it took to become that hot. The cone will melt and bend over indicating when a piece in the kiln has absorbed the necessary amount of energy needed to transform green-ware to bisque-ware, or bisqueware into vitrified ceramic.
- Crazing: A network of very fine cracks in the glaze is called crazing. It is caused by a mis-match between the clay and glaze. It often will not show up until the pot is cooled, or sometimes even until it has been heated and cooled a few times. Some people believe slow cooling will prevent crazing, but the stresses still exist and eventually the crazing would occur.
- Dunting: Dunting is a special type of crack which occurs from stresses caused during firing and cooling. These stresses primarily occur during two critical points of firing called silica inversions which occur at 1063 degrees F (573 degrees C), and 439 degrees F (226 degrees C). At these inversion points, the structure of the silica molecules rearranges. It is important to fire slowly through these two temperatures, and electronic kiln profiles often do this for you automatically while they are heating.
- Firing: The process of heating clay work in a kiln to at least a glowing or white heat. Firing permanently transforms the clay to a rock-like state and melts glazes.
- Glaze: A mixture of ground minerals and water that is applied to bisque-ware and results in a glassy coating and forms a water-tight surface when fired.
- Glaze-ware: Ceramic works after the glaze has been applied and the piece has been fired for a second time.
- Glazing: Applying liquid glazes to the ceramic pieces, usually bisque-ware.
- Glaze-Firing: Firing done after glaze has been applied to bisque-ware or (occasionally) greenware to produce a finished surface.
- Kiln: A piece of equipment used in ceramics to fire (bake) our ceramic work. At our studio, kilns are fueled by either electricity or gas.
- Kiln Wash: A mixture painted on the top surfaces of kiln shelves to protect them against glaze drips and runs. Projects with runs are easily pulled up from the surface.
- Maturation: The ideal condition of fired clay, when it has been fired as high as possible, stopping short of sagging or slumping or other form of excessive melting. The clay is as hard as it can be and still hold its form.
- S-Cracks: One of the most common cracks found in pots is the "s" crack, which occurs at the bottom of a pot, in the shape of an s, usually on thrown pieces. You should keep the bottom of the pot as dry as possible while throwing and compress the bottom during throwing and trimming to prevent S-Cracks.
- Shivering: Sometimes a piece of glaze will crack off, normally near a rim or at edges. Some clay may be attached to the glaze piece that cracks off. This occurs because stress has built up between the clay and glaze that can't be absorbed. It is often caused by over-sponging which

takes away the fine clay particles and leaves behind the groggier clay particles which are not elastic enough to absorb the stress.

- Vitrified: When clay has been fired to the point where it is no longer porous (without glaze). It is glass-like and can hold water.

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