

DAVINCI INSTRUCTION MANUAL

QUICK START

INSTALLERS

1. If you need to assembly the kiln read the ASSEMBLY section. See hotkilns.com/assemble-davinci-kiln-video
2. If you need to hook up the kiln red the INSTALLATION section. The Wriing diagram is located in the WIRING section.
3. Read the CAUTION section for installation cautions.

USERS

1. Read and understand the CAUTIONS section
2. Read the Operation section. This is all you need to know to operate the kiln.
3. If you want to know more about how to operate the control read the CONTROL section. This is very detailed and can be overwhelming. Use it as a reference and for more sophisticated programming and configuration instructions.
4. For ongoing routine kiln maintenance read the MAINTENANCE section. This is something that the kiln operator is responsible for.
5. For more background information on Ceramics process, Cones, and a Log Sheet see the LOG, CONES, TIPS, CERAMIC PROCESS section.

MAINTAINERS

1. Read the TROUBLESHOOTING section, the WIRING section, the PARTS section and the SERVICE & WARRANTY section.

ADMINISTRATORS

1. See the Safety Data Sheet section if you have any questions about materials used in the kiln.



L&L Kiln's patented hard ceramic element holders protect your kiln.

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CAUTION INSTRUCTIONS

KILNS THESE CAUTIONS APPLIES TO CURRENT PRODUCTION KILNS

- Easy-Fire Kilns (e Series)
- School-Master Kilns (SM Series)
- Jupiter Automatic Kilns (JD Series)
- eQuad-Pro Production Kilns (eQ Series)
- JH Crystalline Kilns (JH Series)
- Easy-Load Front-Loading Kilns (EL Series)
- DaVinci Automatic Kilns (X and T Series)
- Doll/Test Kilns (DL and DLH Series)
- Fuego Kilns

OBSOLETE MODELS

- Easy-Fire XT Kilns (eXT Series)
- Liberty-Belle Kilns (LB Series)
- Jupiter Manual Kilns (J Series)
- Econo Kilns (K Series and J Series)
- Programmatic Kilns (B Series)
- Robin Kilns
- Dyna-Kilns (C & H Series)
- Dyna-Kilns (SQ Series)
- Dura-Fire Kilns (D Series)
- Enameling Kilns (E48, E49, R Series)
- Oval Kilns (OV Series)
- Genesis Kilns (G Series)
- Most other L&L kilns

RESELLERS ARE NOT AUTHORIZED TO MODIFY CAUTION INSTRUCTIONS

Distributors and installers of L&L kilns are not authorized by L&L to make modifications or contradict these Caution Instructions (or our Installation Instructions). If L&L's instructions are not followed, L&L specifically disavows responsibility for any injury or damage that may result.

DATED INFORMATION

The information in these Caution Instructions is believed to be correct to the best of our knowledge at the time of publication (see the date at the bottom of this sheet). You can view the most recent update from our web site at hotkilns.com/cautions at any time.

CAUTION INSTRUCTIONS FOR L&L KILNS

SAFETY NOTICE

1. All cautions and requirements recommended by L&L Kiln Mfg. Inc. are meant to assist users to properly and safely operate their kilns. Many of these cautions apply to kilns and ceramic processes in general. Other process and materials are outside the scope of these Cautions. If you are firing other materials than ceramics there may be issues such as outgassing or explosive hazards that you need to carefully investigate before firing in a kiln.

2. By making use of, and/or downloading from, this web site, user acknowledges that process and manufacturing systems improperly installed, maintained, or operated can pose serious and dangerous threats to worker safety, environmental integrity, and product/process quality.

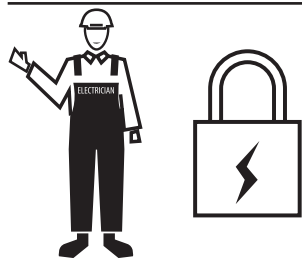
3. Kilns operate at high temperatures and make use of high voltages/amperages and if improperly installed, maintained, or used, can cause serious personal or property damages.

4. Commercial kilns are provided with various safety, performance, and operating limits, designs and devices which, if disconnected, altered, tampered with, or changed by user, user's employees, user's agents, or others acting on user's behalf or with user's knowledge, will become user's sole risk and responsibility.

5. User also has the sole responsibility for assigning properly trained persons to operate the kilns who have demonstrated common sense and a general aptitude for such work.

6. It is user's sole responsibility to understand and assure adherence to all safety notices and installation, operating, and maintenance instructions provided by L&L Kiln Mfg., Inc.

ELECTRICAL SAFETY



GENERAL

Electricity can be dangerous if not approached carefully. There are three basic hazards that cause injury or death – shock, arc-flash, and arc-blast. It is important to remember that even a small amount of current passing through the chest can cause death. Most deaths occurring for circuits

of less than 600 volts happen when people are working on “hot,” energized equipment – **PLEASE DISCONNECT AND LOCK OUT ALL ELECTRICAL POWER BEFORE ATTEMPTING KILN REPAIRS!**

ELECTRICAL HAZARDS



SHOCK

An electrical shock is a current that passes through the human body. Any electrical current flows through the path of least resistance towards ground; if an external voltage contacts a human body, e.g. by touching a live wire with the hand, the voltage will try to find a ground, and a current will develop that flows through the body's nervous system or vascular system, and exit through the closest part of the body to ground (e.g., the other hand which may be touching a metal pipe.) Nerve shock disrupts the body's normal electrical functions, and can stop the heart or the lungs, or both, causing severe injury or death.

ARC-FLASH

An arc-flash is an extremely high temperature conductive mixture of plasma and gases, which causes very serious burns when it comes into contact with the body, and can ignite flammable clothing. Arc temperatures reach up to 35,000°F – which is 4X the temperature of the sun's surface.

ARC-BLAST

Arc-blast is a pressure wave resulting from arcing, which can carry molten metal fragments and plasma gasses at very high speeds and distances. This can not only carry very hot shrapnel to injure a person, but can actually be strong enough to destroy structures or knock workers off ladders.

SAFETY PRINCIPLES

Be safe! Make sure any equipment that is being installed or serviced is disconnected from all sources of power. In industry, it is important to have 'Lockout and tagout' procedures in place to make sure that power stays disconnected while people are servicing equipment. It is just as important in residential and commercial sites – DO NOT

CAUTION INSTRUCTIONS FOR L&L KILNS

WORK ON LIVE EQUIPMENT UNLESS ABSOLUTELY NECESSARY!

Use the right tools for the job – do not improvise. For instance, use a proper fuse puller; don't use a screwdriver to pry out an open fuse.

Protect the person; use proper gloves, shoes, and clothing. In industry it is recommended to wear safety goggles or face shields to prevent arc-flash or arc-blast injuries. Wear rubber soled shoes.

Make sure the environment around the equipment being serviced is safe. For instance, when working around electricity, **it always very dangerous for the floor to be wet**. Make sure there is adequate space to work safely.

Be aware that current flow across your chest can be fatal. If possible, use only one hand to manipulate test leads when conducting any necessary measurements on live equipment. Use a clamp for one lead, and use one hand to guide the other test lead. Keep the other hand as far as possible from the live circuit components.

INSTALLATION CAUTIONS

USE A QUALIFIED ELECTRICIAN

1. Have electrical installation performed by an licensed electrician or other qualified technician.
2. There is danger of electric shock.
3. There is danger that an improperly sized or installed circuit could cause a fire.

CLEARANCES AND FLAMMABLE SURFACES



1. Make certain floor is not flammable.
2. **Install kiln so that the hot surface of the kiln is no closer than 12" (30 cm) to any wall. 18" (46 cm) is preferable.**
3. Be careful about enclosed spaces: In general, it is not a good idea to install a kiln in a small confined space (such as a closet).
4. Maintain a minimum of 36" (91 cm) between the hot surfaces of two adjacent kilns, especially if they are going to be used at the same time. (The kilns will heat each other).

5. The essential issue with kiln clearance is to keep excessive heat from flammable surfaces. Remember, even when you follow clearance and ventilation recommendations, the kiln is giving off heat. Try not to place the kiln near things that can be affected by elevated temperatures. An example would be an electrical fuse panel which you do not want to overheat.

CHECK TEMPERATURES AROUND KILN

1. Check temperatures around the kiln when it is at high fire to be sure that you are not creating an unsafe condition.
2. Combustible surfaces that stay below 71°C (160°F) are generally considered safe from the point of view of starting a fire.

LEVELING THE KILN

1. Level the kiln while you are installing it.
2. Use thin metal shims under the legs to accomplish the leveling (never wood or other combustible materials).
3. Make sure that the base will not wobble.
4. Leveling is important because the kiln sitter (in older manual kilns) is affected by gravity. If the kiln is not properly leveled the kiln sitter might be either too reactive or too sluggish.
5. You do not want your ware to be unstable in the kiln. It might fall over.
6. If kiln is not leveled this could lead to the cracking of the bottom and the top. In particular, the bottom could easily crack when you first set the weight of the kiln on the bottom while setting up the kiln for the first time.

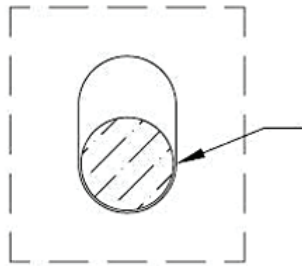
ADJUSTING THE HINGE PROPERLY

1. See the assembly instructions for your specific kiln. (Assembly instructions are available at hotkilns.com/assembly-instructions)
2. **CAUTION: DO NOT attempt to disengage the spring hinge without first reading the detailed assembly instructions.** The spring is under great pressure and could cause severe injury if it is removed under pressure. **RELIEVE ALL SPRING TENSION BEFORE REMOVING! OPEN LID COMPLETELY!**
3. The hinge of any kiln must be adjusted so that expansion caused by the heating process has room to expand up and down. (L&L includes expansion slots in the hinges.)
4. An improperly adjusted hinge can damage the top kiln rim and/or lid by compressing and breaking the brick near the hinge.

CAUTION INSTRUCTIONS FOR L&L KILNS

5. CAUTION: It is critical that the hinge bar sits in the bottom of slot. This is to allow the lid to rise and fall slightly as the kiln heats and expands without putting stress on the lids connection points and potentially damaging the lid.

IMPORTANT CAUTION:



Loosen the screws and adjust the hinge bracket so that the lid lays flat on the top ring and the middle rod rests on the bottom of the elongated holes in the bracket. (As Shown)

THERMOCOUPLES

1. Thermocouples (in automatic kilns) must be inserted into the kiln at least 1" (2.5 cm) in from the inside surface of the kiln.
2. They must protrude into the kiln itself because, if the measuring tip of the thermocouple is buried inside the insulation, the thermocouple will measure a lower temperature than the actual temperature in the kiln.
3. This could cause an overfire of the kiln.
4. Replace thermocouples once they are no longer reasonably accurate. (Note: Type K thermocouples last about the same as kiln elements so it is recommended to change thermocouples when you change elements.)

USE THE SUPPLIED KILN STAND

1. Do not use kiln without the factory supplied stand.
2. Never set a kiln on a floor without significant air space circulating under the kiln.
3. L&L stands typically raise the floor of the kiln by 8" (20 cm).
4. Using a proper stand is critical because, without a kiln stand that moves the radiant heat of the kiln away from the floor, some flooring could catch on fire. For instance, over time the radiant heat from the kiln can cause wood to lose its moisture and lower the autoignition temperature. (The autoignition temperature is the specific temperature at which a substance ignites and causes a fire.)

DON'T USE AN EXTENSION CORD

1. Never use an extension cord with your kiln. The extra length of the wire could cause the cord to overheat and catch on fire.
2. Extension cords, with their multiple connections and potentially mismatched wire gauge for the load, could cause a fire when used with a continuous resistive load like a kiln.
3. Locate the outlet close enough to the kiln to plug directly into it with the kiln's supplied power cord.
4. Kilns that pull over 48 amps and some three phase kilns generally will not have a power cord. These kilns need to be direct-wired in to the power supply.

POWER CORD MUST BE PROPERLY RATED

1. All L&L power cords are rated for 105°C (221°F).
2. Any cord temperature rating less than 105°C can cause a malfunction and possible fire where the power leads connect to the control box.
3. It is OK, and will not void the warranty, to remove the plug that comes with the kiln and direct wire the kiln. However, the connection wires must be rated for a minimum of 105°C (221°F).

USE COPPER WIRE FOR HOOK UP

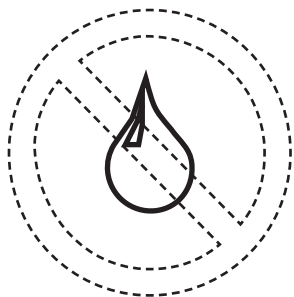
1. Do not use aluminum wire on the final connection to the kiln.
2. The specific reason particular to kilns is that the wire tends to get hotter near the kiln than it might going into some other types of appliance.
3. Being a resistive load, there is constant heat being generated by the conductors for quite a few hours. When aluminum wire gets hot it accelerates oxidation. Aluminum oxide is a resistor; copper oxide is not as much. If the connection at the terminal board gets oxidized it will really heat up - to the point where it could cause a fire.
4. Note: Depending on local codes it may be OK to use aluminum wire to your subpanel - as long as that wire is not exceeding its temperature rating while kiln is firing on full power for an extended period of time.

CAUTION INSTRUCTIONS FOR L&L KILNS

PROTECT POWER CORD FROM KILN CASE

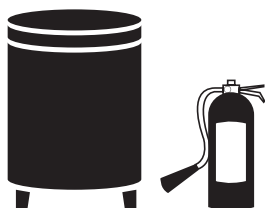
1. Route Power Cord (or electrical connection wires) away from kiln in such a way that the wires can not touch the hot case of the kiln.
2. Secure the cord so it can not move.
3. If the cord touches the hot case it could melt and cause a short circuit and/or fire.

KEEP KILN DRY & IN PROTECTED SPACE



1. The kiln must be kept dry.
2. It is best to keep it in an enclosed room away from inclement weather. See specific details in the INSTALLATION INSTRUCTION section of your instruction manual or on-line at: hotkilns.com/easy-school-install or: hotkilns.com/general-installation-instructions.
3. Note that warranty does not cover damage from corrosion and electrical damage caused by inclement weather.
4. Water in contact with a kiln can cause an electrocution hazard.
5. If you keep a kiln outside (even in a very dry environment) and cover it with a tarp to protect it from rain you could still cause corrosion from the dew that forms on the cold metal surface of the kiln in the morning.

KEEP A FIRE EXTINGUISHER NEAR KILN



1. Keep an adequate fire extinguisher near the kiln and check it on a regular basis.

2. Check with your local fire authorities to see if there are any specific requirements concerning sprinkler systems, automatic foam extinguishers, etc.

3. Use a fire extinguisher that is rated for electrical fires (ABC rating is recommended).

SPRINKLER CAUTIONS

1. If you have a sprinkler system be careful to check the temperature rating and location of the heads so that you do not inadvertently cause them to actuate under normal firing conditions.

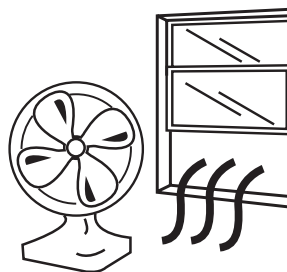


2. Be sure to monitor temperature while the kiln is at its highest firing temperature and conditions are at their worse (for instance when the door to the kiln room is closed or the ventilation fan is turned off). **Serious damage to the kiln and your premises can take place if the sprinkler system goes off when the kiln is at high temperature** - especially if no one is in the building when it happens.

3. See the following web page for guidance on how to calculate ventilation requirements for a kiln room: hotkilns.com/calculate-kiln-room-ventilation

GENERAL ENVIRONMENT CAUTIONS

VENTILATION IS ESSENTIAL



1. Kilns generate harmful fumes when firing ceramics.

CAUTION INSTRUCTIONS FOR L&L KILNS

2. Fumes include carbon monoxide, sulfur oxides, hydrogen fluoride and metal vapors (all of which can be very toxic).
3. Install kiln in well-ventilated area.
4. Never operate in an enclosed space such as a closet unless you have good ventilation in that space. See the following web page for guidance on how to calculate ventilation requirements for a kiln room: hotkilns.com/calculate-kiln-room-ventilation
5. Aside from issues of ventilating the fumes from the firing, the heat build up in an enclosed room could present a significant fire hazard. See the INSTALLATION cautions.
6. Severe corrosion can be caused by kiln fumes, salt air or other environmental conditions.
7. Good venting can minimize these problems.
8. Ventilation must be to the outside.
9. Be careful not to locate the outlet of the vent near an open window.

AMBIENT TEMPERATURES

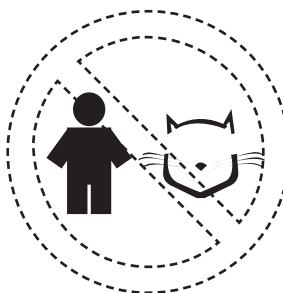
1. The kiln should operate in an environment that is between -18°C (0°F) and 38°C (100°F).
2. Note that the control, if set up for degrees centigrade, may give you an error code if room temperature drops below 0°C (32°F). The DynaTrol and most other controls do not handle negative numbers.

SURFACE IS HOT AND CAN CAUSE BURNS



1. Kiln surface can be extremely hot: up to 260°C (500°F).
2. You can be severely burned if you touch the hot surface.
3. Display a sign near the kiln that specifically warns everyone of how hot the kiln is.

KEEP CHILDREN/ANIMALS AWAY FROM KILN



1. Protect any children, animals, and unqualified adults (anyone who is not able to understand these cautions) that may be near the kiln.
2. Aside from fumes that must be ventilated, and flammability concerns, they must be protected from the heat of the kiln and the electrical dangers.
3. Ideally, the kiln should be secured in a space away from any children (especially in a schoolroom situation where children might not always follow safety precautions).

KEEP FLAMMABLES AWAY FROM KILN



1. Do not put sealed containers or combustible materials such as solvents, paper, rags, kerosene, paints, cesium, magnesium, aluminum powder, calcium, sawdust, plastic dust, coal, flour and powdered metal, in or near kiln. An explosion or fire could result.
2. The kiln elements could act as an ignitor of flammable fumes when hot.

PRACTICE GOOD HYGIENE

1. Clay contains silica dust which can be harmful (see silica caution) and some glazes contain heavy metals such as lead, cadmium and copper.
2. While this caution is outside the scope of kiln safety it is worth mentioning here.
3. Keep your room clean and your kiln clean.

PROPER USE OF KILN WASH

1. Make sure the floor of the kiln and the tops of the shelves are coated with kiln wash.

CAUTION INSTRUCTIONS FOR L&L KILNS

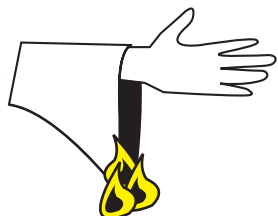
2. This will protect these surfaces from melting glaze and ceramics.
3. Do not coat the undersides or sides of the shelves.
4. Do not apply kiln wash to the brick sides or element holders. (Damage to the elements could result).
5. If you have a kiln sitter, put kiln wash on the cone supports (not the sensing rod) for accurate cone action.
6. Clean off the old wash and reapply new wash each time you fire or when it begins to chip away.
7. Be aware of any hazardous warnings on your kiln wash. Most kiln wash contains silica.

TRIPPING HAZARDS

1. Be sure to remove tripping hazards near the kiln.
2. In particular be sure to keep the kiln cord out of traffic areas.

CLOTHING TO AVOID

1. When working around a hot kiln be careful of the kinds of clothes you are wearing.
2. Some clothes could potentially catch on fire if they touch the hot surface of a kiln.
3. Also avoid loose fitting clothes that could catch on the kiln.



PREFIRING CAUTIONS

KILN WASH CONTAINS SILICA

1. Long term exposure to silica dust could cause lung damage.
2. Exercise proper caution when mixing the dry powder and when removing it from your shelves.
4. Use a NIOSH approved particulate respirator for dust and use proper ventilation. You can buy these from safety supply houses. (NIOSH_approval #TC-21C-132 is an example).
5. L&L does not sell kiln wash but you can obtain it from your ceramic distributor where you buy clay.

DO NOT USE SILICA SAND

1. Do not use silica sand in the kiln.
2. Some people like to use this as a work support medium.
3. The silica sand will attack the elements and thermocouples.
4. It can migrate in the kiln from expansion and movement due to heat.
5. If you must use sand to support or stabilize your load try alumina oxide or zirconia oxide sand.

NEVER FIRE MOIST GREENWARE

1. Never load moist greenware or pots in your kiln.
2. The expanding water vapor in the ware could cause the ware to explode, damaging your kiln interior.
3. We recommend using a dry out segment in your bisque program at 66°C (150°F). (Note that, because of the thermocouple offset programmed into our DynaTrol when we use the ceramic protection tubes, the display temperature will read 93°C (200°F) when the real temperature is 66°C (150°F)).
4. Remember that there may be water trapped in the work even if you can't always see it. If you place a piece of greenware next to your wrist and it feels cool to the touch it probably has too much moisture in it to fire.

CAUTION WITH USE OF WAX

1. When you heat wax (in wax resist and lost wax processes) it will volatilize and potentially condense in the cooler ventilation ducts.
2. Over time this can cause a fire hazard because the wax is flammable.
3. Depending on how the vent motor is mounted, the wax can also gum up the vent motor.
4. If you use these processes it is entirely up to you to engineer and monitor the safety of the installation.
5. The use of wax will void the warranty of the vent system.

DO NOT FIRE TEMPERED GLASS

1. Tempered glass can explode when fired.

STORE SHELVES IN A DRY LOCATION

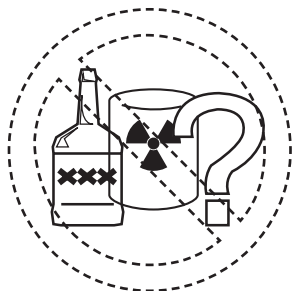
1. Shelves can absorb moisture.
2. This can cause them to explode when fired. (This is especially true of nitride bonded silicon carbide shelves).

CAUTION INSTRUCTIONS FOR L&L KILNS

DO NOT USE CRACKED SHELVES

1. Cracked shelves can fail in the middle of a firing causing the whole load in your kiln to collapse.

DO NOT FIRE TOXIC, FLAMMABLE, OR UNKNOWN MATERIALS



1. Plastics, organic materials, bakeable modeling clay, mothballs and a large variety of materials can decompose under heat causing the release of highly toxic fumes or rapid uncontrollable combustion.

2. Rocks, marbles, cement and other materials may explode under high temperatures.

3. Before firing anything but ceramics, glass and metal (obtained from a known reputable source) in a kiln carefully investigate what happens under heat.

4. This is the sole responsibility of the user.

5. The kiln is not designed to be used for firing hazardous materials. Doing so will void kiln warranty.

6. Adding propane, wood, charcoal or other materials intended to produce a reduction atmosphere can be hazardous if the volume is sufficient. Note that these materials can cause an explosion under certain conditions (just the right amount of air and flammable gasses at just the right temperature) which could cause injury or death. Moreover, a reducing atmosphere can cause premature element failure by reducing the protective oxide coating on the elements. Also note that carbonaceous materials will produce poisonous carbon monoxide and highly flammable hydrogen as they decompose at high temperatures. Also note that the "auto-ignition" temperature of flammable gasses is generally above 1400° F.

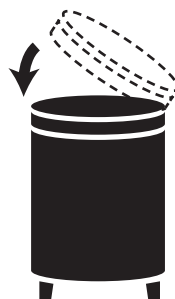
LOADING & UNLOADING CAUTIONS

TURN OFF POWER WHILE LOADING



1. Turn off power to the kiln when loading or servicing.
2. If power is on when you are loading or unloading the kiln it is possible to touch the elements and get electrocuted.
3. We recommend having the kiln attached to a fused disconnect switch with a lockout device (in any institutional or industrial installations where someone could turn on the kiln while someone else was working on it).

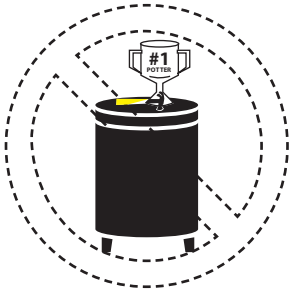
KEEP LID CLOSED WHEN KILN IS NOT IN USE



1. Keep lid closed when not operating the kiln.
2. Otherwise the weight of the lid over time may force the hinge and stainless wrap to move down.
3. This will affect the way the lid closes and may cause the lid to crack.
4. It will also keep the kiln cleaner by keeping dust out.
5. In addition, if the kiln somehow gets turned on accidentally, an open kiln could present a fire hazard.

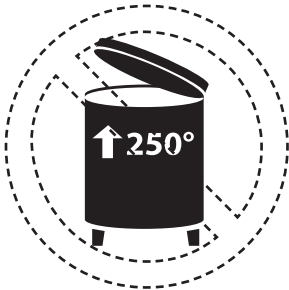
CAUTION INSTRUCTIONS FOR L&L KILNS

DO NOT STORE ANYTHING ON LID



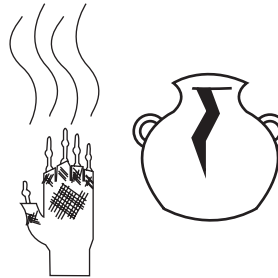
1. Do not use the lid as a storage shelf.
2. The lid could crack.
3. Also - this practice could lead to a fire if you accidentally leave combustible materials on the lid.

DO NOT OPEN THE DOOR ABOVE 250°F



1. Do not open the kiln door until the kiln has cooled down to 250°F (120°C).
2. You could burn your hand on the handle and/or the radiant heat from the kiln.
3. Be careful when you do open the door at this temperature because you can still get burned.
4. Use heat resistant gloves when opening the door. (These are available from L&L).
5. For ventilation purposes, some people fire with the lid slightly propped open 1" to 3" during the beginning phase of the firing (if they do not have a downdraft vent system). **Be aware of the potential dangers of doing this (heat, live electricity, fumes and potentially cracking the lid) and take appropriate measures to protect yourself, the kiln, and the kiln room.**

DO NOT UNLOAD KILN WHILE HOT



1. You may burn yourself
2. You may harm your work.

BE CAREFUL OF SHARP OBJECTS & GLAZE

1. Stilt marks and other sharp protrusions can cut you.
2. Remember that glaze is like glass.
3. Wear safety glasses while grinding or knocking of stilt marks.
4. Check the shelves for broken bits of glaze which may have attached to the shelves. These can be like shards of glass that can cause a serious cut.

SECURE LID WHILE LOADING OR UNLOADING IF YOU HAVE A SPRING-LOADED EASY-LIFT HINGE

1. Be sure to LOCK THE LID IN PLACE with the spring-loaded plunger pin located on the side of the hinge.

IF YOU HAVE A DAVINCI COUNTERBALANCED LID

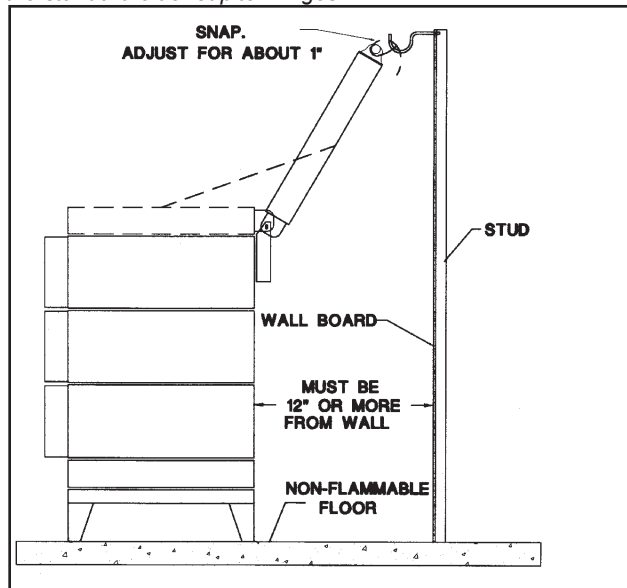
1. Be sure to LOCK THE LID IN PLACE with the safety hooks when in the up position.
2. There is one on each side of a DaVinci kiln. Use both chains.

IF YOU HAVE A BASIC HINGE WITH CHAIN SUPPORTS

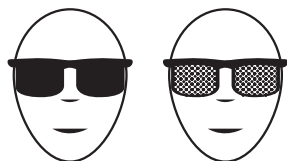
1. A special safety system is supplied with your Fuego, e18S-3, e18M-3, e18T-3, J18-3, or J18X-3 kiln (and some other older models). This is a door safety chain.
2. It secures the lid in an open position when you are loading or unloading the kiln and ensures that the lid can not accidentally come down on you. You must install and use this for your safety's sake.

CAUTION INSTRUCTIONS FOR L&L KILNS

This drawing shows the safety chain installation and use for the standard older Jupiter hinges.



VIEWING INTO THE KILN



1. Use dark glasses (shade number 1.7 to 3.0) to view inside the kiln through the peepholes when firing. These will protect you from the radiant infrared radiation and will also protect your eyes in case the ceramic ware explodes. Do not use regular sunglasses for this - they are not designed to protect your eyes from this type of radiation.
2. Use heat resistant gloves when opening peephole plugs. They are very hot and can burn you.
3. Do not open the kiln lid unless the kiln is turned off (except for carefully controlled troubleshooting tests). There is danger from electrocution. Cracks caused by propping open the lid are not covered by the warranty.
4. Use heat resistant gloves when opening a hot lid.
5. Do not open the lid when the kiln is above 121°C (250°F).

FIRING CAUTIONS

ATTEND THE FIRING

1. We recommend attending the kiln while firing.
2. **NO AUTOMATIC SAFETY DEVICE IS FOOLPROOF!** Be especially careful about attending the kiln when it is supposed to shut off. (The Delay feature in automatic kilns gives you control over this).
3. If you have a manual kiln with a Kiln Sitter PLEASE BE EXTRA CAREFUL! Kiln sitters can be very unreliable because of the moving parts, dirt or clay that can get into the tube, the way cones are placed on the tube, corrosion, etc. **DO NOT FIRE THIS KILN UNATTENDED WHEN THE KILN IS SUPPOSED TO TURN OFF AND LEARN HOW TO USE THE TIMER BACK UP.** Neither L&L Kiln Mfg., Inc. nor Edward Orton Jr. Ceramic Foundation warranty the kiln or kiln sitter against damage caused by overfiring. **We highly recommend firing all manual kilns with witness cones that you can see through the peephole and/or a pyrometer so you have some idea of what is happening inside the kiln.**
4. The controller is used to control temperature; it is not a safety device.
5. For industrial applications, or for situations where firing high value loads, we recommend the use of a high limit back up control with back up contactors. This available as an option on certain model kilns.

MAKE SURE YOUR KILN SITTER IS ADJUSTED

1. If you have a manual kiln (or the Kiln Sitter backup on an automatic kiln) be sure it is properly adjusted.
2. See the Kiln Sitter instructions.
3. Overfiring could result.
4. Note that the kiln sitter could have gone out of adjustment during shipment. Do NOT assume that it is adjusted when first firing the kiln.
5. The tube assembly should be replaced if gets overly corroded or contaminated with condensed glaze or other materials. Dawson recommended checking the pivot point for corrosion and sluggishness every 6 to 12 months.

USE KILN WASH ON THE CONE SUPPORTS

1. If you have a kiln sitter, put kiln wash on the cone support (but not the sensing rod) for accurate cone action.
2. This will keep the cones from sticking when they bend.

CAUTION INSTRUCTIONS FOR L&L KILNS

3. We recommend cleaning off the old wash and reapply new wash each time you fire.

UNDERSTAND YOUR CONTROL

1. Become familiar with either the control (if you have an automatic kiln) or the Kiln Sitter (if you have a manual control or have that as your backup control).
2. Do this before operating the kiln.

PROGRAM REVIEW ON AUTOMATIC KILNS

1. Review the current program before firing to ensure the correct profile is programmed.
2. You may pick up an important mistake and save a whole load.
3. Hit **Review Prog** after you have done your programming and the control display will scroll through the program. It only takes a minute or less.

DO NOT CONFUSE CONE NUMBERS

1. Cone ratings are not intuitive. Cones with an "0" in front of them (like cone 05) are lower in temperature rating and the higher the number the lower the temperature rating. On the other hand cones with no "0" in front (like Cone 5) raise in temperature as the number gets higher.
2. For instance, Cone 05 is a much lower temperature than Cone 5 for instance. If you fire Cone 05 clay to Cone 5 you could cause a serious overfiring of the material which could melt in your kiln and cause severe damage to the kiln interior.
3. See the Orton cone chart. (hotkilns.com/orton-cone-chart)

USE THE PROPER THERMOCOUPLE

1. Never use a different type of thermocouple with your controller unless it has been set up from the factory (or unless you carefully go through the process of changing from one type to another).
2. For instance if you used a Type S thermocouple on a control set up for Type K you would overfire your kiln.
3. On some controls (like the newer DynaTrols) it is possible to change thermocouple types. However, this involves both a programming change and a jumper change on the control. It also requires you to change out all the thermocouple lead wire to properly calibrated wire for the new thermocouple type. (See: hotkilns.com/change-thermocouple-type)

CHECK THERMOCOUPLE CALIBRATION

1. Thermocouples will drift in reading over time.

2. This could potentially lead to an overfiring before the thermocouple actually fails.

3. Although you can not easily check thermocouple calibration, the general accuracy of the entire kiln system can be checked by firing with witness cones. See the LOG, CONES & CERAMIC FIRING section or hotkilns.com/troubleshooting-cones. Also see this video: hotkilns.com/firing-kiln-witness-cones.

4. L&L recommends changing your Type K thermocouples when you change your elements.

SHUT OFF KILN AT DISCONNECT OR CIRCUIT BREAKER

1. It is possible for electrical contacts on contactor relays to fuse together.
2. If this happens power will continue to flow to the elements and your kilns could overfire even though everything on the kiln is shut off.
3. You should turn kiln off from the circuit breaker or fused disconnect switch after turning off the kiln itself.

DO NOT FIRE KILN ABOVE 2350°F (1290°C, Cone 10)

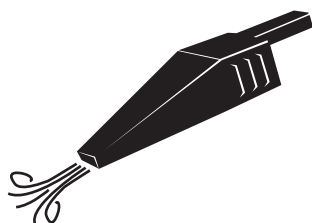
1. Most L&L kilns are rated for use to 2350°F (1290°C, Cone 10).
2. The rating of the kiln is listed on its data nameplate normally affixed to the control panel.
3. **DO NOT FIRE ANY HIGHER THAN THIS** or hold for extended periods of time at those temperatures.
4. The elements, element holders and firebrick could melt.

CAUTION INSTRUCTIONS FOR L&L KILNS

POST FIRING CAUTIONS

CHECK FOR GLAZE AND CERAMIC CHIPS

1. Check element holders and walls for glaze, clay chips or anything that could melt at a high temperature.
2. If melted clay or glaze comes in contact with an element, a rapid failure could result. The molten material traps the heat radiating from the element and subsequently raises the surface temperature of the wire. The temperature will quickly pass the maximum recommended temperature for the wire and burn it.
3. To clean holders, a good shop vacuum **with a HEPA filter** will handle dust and loose crumbs. A very gentle chisel or grinder may help with glaze contamination on element holders, but remember that the elements themselves are quite brittle when they are cool.



4. Replace the contaminated holder if you can not clean it.
5. Remove any glaze that has splattered on the firebrick or shelves. **(USE SAFETY GLASSES WHEN DOING THIS BECAUSE GLAZE CAN BE LIKE BROKEN GLASS).** Vacuum afterward. Note about vacuuming: it is possible to build up a strong static electricity charge when you are vacuuming. If this somehow manages to discharge into the control it can ruin the electronic circuit. Make sure vacuum is grounded and periodically touch some grounded metal surface away from the kiln to discharge the energy.

GENERAL MAINTENANCE CAUTIONS

ELECTRICAL SAFETY

1. Shut off kiln when servicing it. Use an approved lock out/tag out procedure to make sure that no one servicing the kiln gets injured or killed.
2. **The elements carry high voltage and can electrocute you.** Many of the tests described in the troubleshooting manual are performed under power. They should be done **ONLY** by someone who is familiar with electrical safety such as an electrician or trained maintenance person.
3. As long as the kiln is unplugged or turned off at the fused disconnect switch or circuit breaker (and checked with a reliable meter to be sure) you are safe.
4. **When checking element resistance, disconnect kiln from power by unplugging kiln or turning off at the fused disconnect switch or circuit breaker. Lock out if appropriate.**

CHECK WIRES & TERMINALS

1. Check wires for deterioration or oxidation or burns.
2. Replace any that seem brittle or where the wire insulation has deteriorated, fallen off or burned off.
3. Check terminals for oxidation (discoloration).
4. If you are near salt air or if you notice corrosion on the stainless exterior of the kiln for whatever reason (like certain fumes generated by your work) then do this far more frequently.
5. Check power connection terminals in the kiln and control box for tightness. Be sure to do this with the power disconnected (unplugged) for the kiln. If these terminal connections get loose heat can be generated (because the electrical resistance gets greater) and this can cause a fire.
6. Check thermocouple connections for corrosion, tightness and oxidation as well. A bad thermocouple connection can change the accuracy of the temperature reading which could cause an overfiring.

CHECK TEMPERATURE OF CORD

1. Occasionally check temperatures of the main power cord at the main receptacle and the main kiln breaker while the kiln is at its hottest.
2. If these are hotter than normal, it could be a sign of a loose or corroded connection, or possibly the wire gauge used in the power hook-up is the wrong size for the amount of current being drawn by the kiln.

CAUTION INSTRUCTIONS FOR L&L KILNS

3. Immediately diagnose and fix this because it could cause a fire.

4. Also check temperature of any other cords on the kilns (such as element jumper cords).

CHECK FOR CORRODED CONNECTIONS

1. When replacing infinite zone switches (and other electrical components), replace the electrical connectors.

2. At the very least check for discoloration (an indication of oxidation).

3. Electrical connectors will typically oxidize over time where there is heat and this can cause further overheating of the part at the connection point. This can in turn lead to early failure of the part, wire and connector.

4. Make certain that the new connectors are firmly crimped onto the wire.

THE WRONG PARTS CAN BE HAZARDOUS

1. Non-L&L elements can present a potential hazard to the kiln or cause a fire (by drawing too much amperage).

2. The wrong type of fuse, relay, switch or other component can cause a fire or other hazardous condition.

3. An improperly rated cord can cause a fire.

VIDEO ABOUT GENERAL MAINTENANCE

See this video for some general maintenance tips: hotkilns.com/maintaining-kiln

KILN MODIFICATIONS CAUTIONS

COATINGS

1. We can not at this time recommend any coatings for the elements.

2. Use of ceramic coatings will void the warranty on the elements and potentially the firebrick or element holders if it contaminates them.

3. Some people have reported success with ITC coating and some people seemed to have caused problems with this coating.

4. We have not adequately tested these coatings so we can only say, at this time, that any trouble that results from the use of ITC and other coatings must be at the risk of the user.

5. We do use a proprietary coating on all our firebrick that improves firebrick life and reduces dusting.

OTHER MODIFICATIONS

1. All customer modification is made solely at the risk of the customer.

2. Modifications will void the warranty.

3. L&L takes no responsibility for hazardous conditions created by unauthorized modifications.

4. Any authorization for an engineering change must be in writing from the factory.

DO NOT OVERINSULATE KILN

1. You may add insulation to the bottom, and to some extent the top.

2. If you put too much insulation on a lid it may weaken because it relies on the cooling of the lid to maintain its structural strength. This could lead to cracking or potentially a collapse of the lid.

3. See the various troubleshooting guides for information about this.

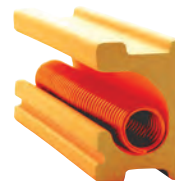
4. However, never wrap insulation around the perimeter of a typical sectional kiln.

5. You could trap heat in the wiring boxes and cause an electrical fire.

6. Also the stainless steel wrap that hold the kiln together will expand and loosen the structure of the kiln.

DAVINCI INSTRUCTION MANUAL

OPERATION



L&L Kiln's patented
hard ceramic
element holders
protect your kiln.

FIRST FIRING FOR L&L KILNS WITH A DYNATROL OR GENESIS

WHEN TO DO A FIRST TEST FIRING?

Once your kiln is set up, leveled properly (very important), control panel hooked up to the kiln correctly, and all the power wired properly, you are ready for your first firing. Read these instructions and plan your time accordingly.

VIDEO ON HOW TO PROGRAM

See this video for help in programming your DynaTrol for the first firing:

hotkilns.com/programming-first-firing

WHY DO A TEST FIRING?

The test firing is done very slowly, about 16 to 19 hours total to minimize the inner and outer surface temperature differences in the kiln while it goes through its maiden firing. Also this will slowly steam off any moisture absorbed by the firebrick during construction, shipping, and storage.

The test firing is done to cone 5 (about 2167°F) to vitrify the special coating on the inside on the firebrick and to allow an "aluminum oxide" coating to form on the element's surfaces.

The coating on the top and bottom helps to strengthen the surface of the firebrick, and helps prevent dusting in the kiln.

The oxide layer on the elements helps to protect them from the many contaminants found in many materials fired in a kiln. This aluminum oxide layer will rejuvenate itself every time there is an oxygen rich firing to a high temperature. Going to cone 5 may also point out any problems with your electrical service - like low or incorrect voltage or wrong supply line wire size.

The elements will also seat themselves in the ceramic holders - and any springiness you see when you first get your kiln will be alleviated.

NOTE: Normally bisquing is done to cone 05. Do not be confused by how the test firing uses **SLOW BISQUE** to cone 5, even though normally you would use a **SLOW BISQUE** to cone 05. The Slow Bisque program is used for the test firing BECAUSE it is a long program. We want this to be slow.

The test firing is done with the operator present as much as possible. This is to be sure the kiln is heating up safely, and that the heating kiln affects nothing else in the room or the room itself. As for the operator being present, logistically this may be difficult as the test fire is designed to take about 16 to 19 hours.

To deal with this a "Delayed Start" can be added to the test fire program, allowing you to press **START** at say 5PM, the kiln to start at say 8PM in order to turn off at 3PM the following day while you are there. More detail on this a little further on. You can also split it into two firings (see instructions at the end of this sheet).

NOTE: The test fire is done with the kiln furniture. We highly recommend putting kiln furniture in the kiln because firing an empty kiln can sometimes lead to an error code (E-D) on two or three zone kilns. Anything else in the kiln (clay) will produce contaminants to some degree, and the elements in the kiln have not yet achieved this all important aluminum oxide coating before being subjected to these contaminants.

VENTING

Leave the Vent-Sure downdraft vent system on while the kiln is heating and cooling. Keep the peephole plugs in and the lid closed. If you have no vent system then leave the top peephole plug out during the first test firing.

NOTE: it is best for the evenness and speed of the firing to keep all the peepholes closed. However, for longevity of things like the elements, and thermocouples, as well as for better colors in clays and glazes, it is best to have as much air as possible moving through the kiln, without compromising the speed and evenness of the firing (this is a trade-off). Open peepholes can be an OK way to vent, except that uneven drafts through the kiln can affect thermocouple readings, or "freeze" cones, leading to uneven or slow firings.

WHAT TO EXPECT

ELEMENT SMOKING

Brand new elements may have lubricant still on them and may smoke a little initially the first time they are heated. A fan in a window is more than adequate to deal with this. If you have the Vent-Sure vent on this should also be adequate.

NOISES IN AN AUTOMATIC KILN

A **Beep** when you press a button on the DynaTrol keypad.

FIRST FIRING FOR L&L KILNS WITH A DYNATROL OR GENESIS

Clicking noises from inside the control box as the unit heats. This will happen throughout the firing until it shuts off. Sometimes it will happen more frequently than other times. It is the result of the relays opening and closing as the control tells them to, turning the electricity on or off to the elements, working to heat the kiln evenly. (On manual kilns with contactors you will also hear contactors clicking).

Hum. Whenever kiln elements come on they are accompanied by a humming sound from electricity in the elements. This is normal. The natural properties of electricity and the dynamics of the shape of the element combine to create a slight vibration in the element.

WHAT HAPPENS AS THE KILN HEATS UP

All the materials used in the kiln's construction expand incrementally as they are heated. First the inside materials- i.e. the elements, holders, and inside surfaces of the walls, floor, and lid heat and expand slightly. Then, the heat moves slowly through the walls, lid and floor until it begins to heat the outer surface of the kiln. The greater the difference in temperature is between the inside surface vs. outside surface, the more stress there is on the material itself.

Walls, lids and floors can sometimes develop hairline-cracks on the surface or in the some cases, all the way through. Really this is normal and to be expected sooner or later to some degree. If you tighten the stainless steel bands that surround the floor, lid, and walls of the kiln every so often, the fact that the firebrick expands as it heats will mean that the cracks are actually closing up while the kiln is heating, expanding against the cooler outer shell. The geometry of the kiln and the tightness of the stainless steel bands are what holds everything together, whether the brick is in a few pieces or all one piece should not matter a whole lot, although cracked floors should be fully supported as they are with our full-support stands.

See the [***maintain.pdf***](#) and [***troubleshoot-brick.pdf***](#) for more information. See this for how to repair hairline cracks: [***hotkilns.com/repairing-hairline-cracks-firebrick-video***](http://hotkilns.com/repairing-hairline-cracks-firebrick-video)).

VISIBLE RED HEAT

Another thing to expect is to see the "red heat" through the seams, between the sections of the kiln, beginning around 1000°F. This is normal. The seam between the lid and the top section will probably appear the largest. This is partly because, when the top heats up, it becomes slightly concave and the edge lifts up.

IMPORTANT NOTE: It is important for this gap between the lid and the rest of the kiln to be even all the way around throughout the firing. If it is more open in the front when hot, then the hinge is out of adjustment and must be raised up. Your kiln's Assembly instructions detail the hinge

adjustment. The danger of this condition is that all the weight of the lid is now resting on the inner upper edge of the back firebricks on the top section. They will crack off in a firing or so and probably damage the lid too.

CAUTION: The outer metal and brick surfaces of the kiln will get very hot, as hot as 450°F - easily hot enough to burn you.

The interior of the kiln will look white hot at the highest temperatures.

CAUTION: Be sure to always use rated dark safety glasses when looking through the peepholes to protect your eyes from infrared radiation. See [***Kiln Cautions***](#) for details.

CONTROL DISPLAY ON DYNATROL

Acronyms on the DynaTrol's display screen stand for important messages, they are its way of communicating with the user. The DynaTrol display is limited to four letters or numbers at a time. So for example, **TCOS** is the acronym the DynaTrol uses for "thermocouple offset".

Once it hits its target temperature, it will shut off with a **CPLT** (complete) message. Once this message is seen the kiln is no longer running. It is safe to shut off the power to it. If no controlled cool-down was programmed, the kiln will cool quickly at first, then more and more slowly. As it is cooling it will display the **CPLT**, the **amount of time it took to complete the firing**, the **TC2**, and the **current temperature** over and over again.

The temperature will normally be displayed from **TC2**, which is thermocouple number two. Press **1** to see the temperature in the top section- **TC1**. Press **3** to see the temperature in the bottom section of a three or more section kiln. The DynaTrol is checking all three thermocouples every eight seconds even though just one thermocouple's temperature is displayed. The displayed temperature will rise as the kiln heats up, cycling from **TC2** to current temperature inside the kiln over and over again. (A kiln with just one thermocouple will just show the temperature reading, no **TC number**).

FIRST FIRING FOR L&L KILNS WITH A DYNATROL OR GENESIS

DYNATROL CONTROL: STEP BY STEP

- 1) Turn on power to the kiln with the toggle switch. Display reads **WAIT** then **IDLE**.
- 2) Press **ENTER** and wait until you see **IDLE**, **TC2**, and the current temperature cycling over and over again.
- 3) Press **SLOW BISQUE** and see **S-bC**.
- 4) Press **ENTER** and see **CONE**, and a number (which represents the cone number currently programmed in the control) flashing back and forth.
- 5) Press **5**, and see the number **5** in the display. .
- 6) Press **ENTER** and see **HOLD**, **00.00** flashing back and forth.
- 7) Press **ENTER** and see **IDLE**, **TC2**, and the current temperature cycling over and over.
- 8) Press the **Preheat** button in the **Easy-Fire Options** section.
- 9) See **HLd**, **00.00** flashing back and forth.
- 10) Press **300** so the display reads **3.00**.
- 11) Press **ENTER** and see **IDLE**.
- 12) Press **START/STOP** to begin the test firing.

You have just entered an "Easy-Fire Slow Bisque" Program to cone 5 with a three hour preheat, the combined total of which will take roughly 16-19 hours. The preheat part increases the heat in the kiln at 60°F per hour from room temperature up to 200°F where the hold time comes on, the timer appears, and it holds at 200F for the set amount of time. Once the timer runs out, the rest of the program follows.

Now you must figure out how to be around for the end of the 16-19 hour firing. This is where the Delay Start feature may come in handy. It is a digital hours and minutes timer you can add to the beginning of any program. You tell the timer how many hours and minutes to count down before the DynaTrol turns up the kiln and runs the rest of the program.

NOTE: It is critical for someone to be present for, and especially at the end of, each firing. This is particularly true for this first firing. Even if you have a high limit control - no safety device is entirely foolproof.

DO YOU NEED A DELAYED START?

Picture a clock-face and count forward 16 hours from when you planned to press **START/STOP** to begin this program. Will you be present for at least the last few hours? If "YES" then you do not need a delayed start time and you can start the firing when you planned to, skip the rest of step 6 and step 7. If "NO" then you do need a delayed start time, continue on here.

CALCULATING THE DELAY START

Picture the same clock-face, and see when the firing would have ended if you had pressed **START/STOP** when you planned (i.e. 16 hours from when you want the firing to begin). Now picture how many hours later the firing would have to end, in order to have someone there for the last few hours of this 16-19-hour firing. That "number of hours later" is what to program in for the **Delay Start**.

An example

You are planning to start the program at 7 pm. Your program is going to take minimum 16 hours. 16 hours from 7 pm is 11 am the following day. You plan to get into the kiln room at 9 am. 9 am to 11 am is only two hours. You would need to get there one hour earlier to be there for the last three hours, OR start the program one hour later than 7 pm so that the program completes at 12 pm the following day. You will need to program a one hour delayed start. First you will enter the program, then the preheat, then the delayed start. You will press **START/STOP** at 7 pm, but now a timer will appear and count down the one hour before the rest of the program begins.

ADDING A DELAYED START

- 1) Press **DELAY** and see **dELA**, **0.00** flashing over and over.
- 2) Enter the number of hours and minutes to delay the start for. For example: For a two hour delay press **2, 0, 0** so it says **2.00**. For a 1 hour and thirty minute delay press **1, 3, 0** so it says **01.30**. Numbers in the display to the right of the decimal represent minutes. Numbers to the left of the decimal represent hours.
- 3) When the correct number of hours and minutes has been keyed in, press **ENTER**, see **IDLE**

START FIRING

When the correct time to begin the firing arrives, press **START/STOP**. The display will say **-ON-**, then it will cycle through a sequence showing **TC2**, and the current temperature in the kiln over and over as it heats. Here is what to expect the kiln will do based on what you have programmed, after you press **START/STOP**.

FIRST FIRING FOR L&L KILNS WITH A DYNATROL OR GENESIS

If you programmed a delayed start, there will be an hours and minutes timer displayed along with the TC2, current temperature message. It will be displayed until the timer runs out.

It will climb at about 60°F per hour until it reaches 200°F, then the timer will appear again and the three hour preheat will begin counting down on the display with the TC2, current temperature message. It will sit around 200°F until the timer runs out.

Now it will begin to climb at about 80°F per hour up to 250°F

Once the hottest thermocouple reading reaches 250°F, the kiln will begin climbing at 200°F per hour until it reaches 1000°F

Once the hottest thermocouple reading reaches 1000°F, the kiln will begin climbing at 100°F per hour until it reaches 1100°F

Once the hottest thermocouple reading reaches 1100°F, the kiln will begin climbing at 180°F per hour until it reaches 1915°F

Once the hottest thermocouple reading reaches 1915°F, the kiln will begin climbing at 80°F per hour until it reaches somewhere between 2100-2190°F

Once the hottest thermocouple reading reaches around 2165°F, the kiln display will say CPLT, a time like 17:47, the TC2, and the current temperature in the kiln as it is cooling.

Once CPLT is seen the firing is complete. We recommend shutting all power to the kiln off.

You can also leave the display on with the current messages cycling over and over, or you can press **START/STOP** to get back to IdLE, TC2, current temperature and leave it there.

NOTE: If the first firing ended in an error code please make note of which one it was; i.e. E-1 or E-d etc. See this first:

hotkilns.com/list-all-error-codes-dynatrol

GENESIS CONTROL

Refer to the instructions in the Genesis Control Manual on page 5 and 6. However instead of firing to Cone 04 fire the kiln to Cone 5 on a Slow speed.

Now you must figure out how to be around for the end of the 16-19 hour firing. This is where the Delay Start feature may come in handy. It is a digital hours and minutes timer you can add to the beginning of any program. You tell the timer how many hours and minutes to count down before the DynaTrol turns up the kiln and runs the rest of the program.

NOTE: It is critical for someone to be present for, and especially at the end of, each firing. This is particularly true for this first firing. Even if you have a High Limit Back-up - no safety device is entirely foolproof.

DO YOU NEED A DELAYED START?

Picture a clock-face and count forward 16 hours from when you planned to press **STRT** to begin this program. Will you be present for at least the last few hours? If "YES" then you do not need a delayed start time and you can start the firing when you planned to, skip the rest of step 6 and step 7. If "NO" then you do need a delayed start time, continue on here.

CALCULATING THE DELAY START

Picture the same clock-face, and see when the firing would have ended if you had pressed **START/STOP** when you planned (i.e. 16 hours from when you want the firing to begin). Now picture how many hours later the firing would have to end, in order to have someone there for the last few hours of this 16-19-hour firing. That "number of hours later" is what to program in for the **Delay Start**.

An example

You are planning to start the program at 7 pm. Your program is going to take minimum 16 hours. 16 hours from 7 pm is 11 am the following day. You plan to get into the kiln room at 9 am. 9 am to 11 am is only two hours. You would need to get there one hour earlier to be there for the last three hours, OR start the program one hour later than 7 pm so that the program completes at 12 pm the following day. You will need to program a one hour delayed start. First you will enter the program, then the preheat, then the delayed start. You will press **START/STOP** at 7 pm, but now a timer will appear and count down the one hour before the rest of the program begins.

ADDING A DELAYED START

1) Press **DELAY** and see dELA, 0.00 flashing over and over.

FIRST FIRING FOR L&L KILNS WITH A DYNATROL OR GENESIS

2) Enter the number of hours and minutes to delay the start for. For example: For a two hour delay press **2, 0, 0** so it says **2.00**. For a 1 hour and thirty minute delay press **1, 3, 0** so it says **01.30**. Numbers in the display to the right of the decimal represent minutes. Numbers to the left of the decimal represent hours.

3) When the correct number of hours and minutes has been keyed in, press **ENTER**, see **IDLE**

START FIRING

When the correct time to begin the firing arrives, press **START/STOP**. The display will say **-ON-**, then it will cycle through a sequence showing **TC2**, and the **current temperature** in the kiln over and over as it heats. Here is what to expect the kiln will do based on what you have programmed, after you press **START/STOP**.

If you programmed a delayed start, there will be an hours and minutes timer displayed along with the **TC2**, **current temperature** message. It will be displayed until the timer runs out.

It will climb at about 60°F per hour until it reaches 200°F, then the timer will appear again and the three hour preheat will begin counting down on the display with the **TC2**, **current temperature** message. It will sit around 200°F until the timer runs out.

Now it will begin to climb at about 80°F per hour up to 250°F

Once the hottest thermocouple reading reaches 250°F, the kiln will begin climbing at 200°F per hour until it reaches 1000°F

Once the hottest thermocouple reading reaches 1000°F, the kiln will begin climbing at 100°F per hour until it reaches 1100°F

Once the hottest thermocouple reading reaches 1100°F, the kiln will begin climbing at 180°F per hour until it reaches 1915°F

Once the hottest thermocouple reading reaches 1915°F, the kiln will begin climbing at 80°F per hour until it reaches somewhere between 2100-2190°F

Once the hottest thermocouple reading reaches around 2165°F, the kiln display will say **CPLT**, a time like **17.47**, the **TC2**, and the **current temperature** in the kiln as it is cooling.

Once **CPLT** is seen the firing is complete. We recommend shutting all power to the kiln off.

You can also leave the display on with the current messages cycling over and over, or you can press **START/STOP** to get back to **IDLE**, **TC2**, **current temperature** and leave it there.

SPLITTING TEST FIRING INTO TWO FIRINGS

This is done by entering in the standard program for the test fire on Day 1, first thing in the morning. Turn this on as early on Day 1 as possible and let it run all day until you go home in the afternoon. Before you go home Press **START/STOP**, then turn off the kiln.

On day 2, first thing in the morning, program in a **SLOW GLAZE** to cone 5, no hold or preheat is necessary. Regardless of how hot it still may be in the kiln, turn this program on as early as possible in the morning on Day 2. It will run up to somewhere between 2100°F and 2190°F in about 7-8 hours. If it is still not done when you go home, as long as 8 hours have passed since you turned it on, you can press **START/STOP** and turn the toggle switch off and go home. Otherwise when it is done it will give the **CPLT** message and it is then safe to Press **START/STOP**, turn the toggle switch off and go home.

FREQUENTLY ASKED QUESTIONS

There are ceramic washers in between the elements and the element holders in the corners of my kiln - what are these for?

1. This is done on some kilns - particularly DaVinci kilns. The discs are placed in the element holders to keep the elements from coming out during shipment.
2. It is a good idea to keep them in place during at least the first firing.
3. Once the elements heat up they will seat themselves in the element holders properly and they can be removed.

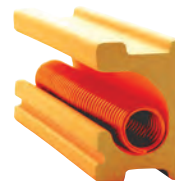
Can you fire to a higher cone than cone 5 on the first firing?

The Cone 5 temperature target is somewhat arbitrary. We want to accomplish three things with the first firing:

1. Fuse the hardening coating we apply to the surface of the tops and bottoms
2. Seat the elements in the holders
3. Put an initial oxide coating on the elements (which protects them from contaminants in the atmosphere form clay and glazes). A higher temperature is not a problem.

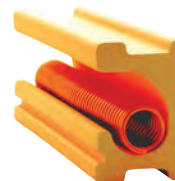
DAVINCI INSTRUCTION MANUAL

CONTROL



L&L Kiln's patented
hard ceramic
element holders
protect your kiln.

DAVINCI INSTRUCTION MANUAL



L&L Kiln's patented
hard ceramic
element holders
protect your kiln.

REGULAR MAINTENANCE OF YOUR L&L KILN

WATCH THIS VIDEO

This video shows you the basics of how to do routine maintenance on your L&L kiln:

hotkilns.com/maintaining-kiln

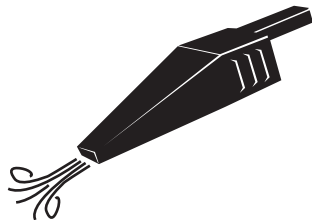
REGULAR KILN MAINTENANCE

To keep your kiln in top operating condition, we recommend the following minimum housekeeping:

AFTER EACH FIRING

1) Turn off the kiln at the circuit breaker or fused disconnect switch.

2) Check element holders and walls for glaze, clay chips or anything that could melt at a high temperature. If melted clay or glaze comes in contact with an element, a rapid failure could result. The molten material traps the heat radiating from the element and subsequently raises the surface temperature of the wire. The temperature will quickly pass the maximum recommended for the wire and burn it up. To clean holders, a good shop vacuum with a HEPA filter will handle dust and loose crumbs. A very gentle chisel or grinder may help with glaze contamination on element holders, but remember that the elements themselves are quite brittle when they are cool. Replace the contaminated holder if you can not clean it. Remove any glaze that has splattered on the firebrick or shelves. **(CAUTION: USE SAFETY GLASSES WHEN DOING THIS BECAUSE GLAZE CAN BE LIKE BROKEN GLASS).** Vacuum afterward.



VACUUMING NOTE: It is possible to build up a strong static electricity charge when you are vacuuming. If this somehow manages to discharge into the control it can ruin the electronic circuit. Make sure the vacuum is grounded and periodically touch some grounded metal surface away from the kiln to discharge the energy.

3) Make sure the tops of the shelves are coated with kiln wash as it will keep running glaze from ruining the shelf. Some people also apply the kiln wash to the kiln bottom. Because this has both its benefits and drawbacks, we recommend that it only be done based on the kiln user's individual preferences. (Do not coat the undersides or the

sides of the shelves because you do not want the kiln wash to fall off into the kiln).

4) Keep a kiln log of firings. Tracking the performance of your kiln over time may turn out to be an extremely valuable tool if you ever need to diagnose future problems. Remember that you can easily get the firing time and final temperature at the end of the firing by hitting the Prog Review button if you have a DynaTrol. On the Genesis control you will see COMPLETE with the current temperature and firing time.

CAUTION: KILN WASH AND CLAY CONTAIN SILICA

1. Long term exposure to silica dust could cause lung damage.
2. See the MSDS sheets.
3. Exercise proper caution when mixing the dry powder and when removing it from your shelves.
4. Use a NIOSH approved particulate respirator for dust and use proper ventilation. You can buy these from safety supply houses. (NIOSH_approval #TC-21C-132 is an example).

AFTER 10 FIRINGS

1) Check temperatures of the main power cord at the main receptacle and the main kiln breaker while the kiln is at its hottest. If these are hotter than normal, it could be a sign of a loose or corroded connection, or possibly the wire gauge used in the power hook-up is the wrong size for the amount of current being drawn by the kiln. Immediately diagnose and fix this because it could cause a fire.

2) If you have a plug on your kiln, unplug it from the receptacle and check for oxidation, any burn marks, discoloration, or melted spots on the plug. If you see this replace the plug (and the receptacle) before using the kiln again. Make sure the receptacle feels tight when you press the plug into the outlet. A loose receptacle indicates worn springs, which will lead to overheating.

NOTE: An oxidation inhibitor can be used on the plug's prongs.

3) Check element resistance. You will need a digital multimeter (see the Troubleshooting Guide). Keep track of this information.

4) Check tightness of case and retighten if necessary. (the case will expand and contract during each firing and may eventually become loose. Brick also shrinks slightly with

REGULAR MAINTENANCE OF YOUR L&L KILN

use - especially if used at the higher temperatures like cone 10).

5) Repair any firebrick problems.

6) If you have a manual kiln (or the Orton AutoCone backup on an automatic kiln) be sure it is properly adjusted. See the AutoCone instructions. Overfiring could result. The tube assembly should be replaced if it gets overly corroded or contaminated with condensed glaze or other materials. Orton recommends checking the pivot point for corrosion and sluggishness every 6 to 12 months.

AFTER 30 FIRINGS OR ANNUALLY

1) Check wires for deterioration or oxidation. Replace any that seem brittle or where the wire insulation has deteriorated or fallen off.

2) Check terminals for oxidation (discoloration). If you are near salt air or if you notice corrosion on the stainless exterior of the kiln for whatever reason then do this far more frequently.

3) Check power connection terminals in the kiln and control box for tightness. Be sure to do this with the power disconnected (unplugged) for the kiln. If these terminal connections get loose, heat can be generated (because the electrical resistance gets greater) and this can cause a fire.

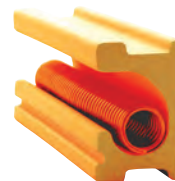
CHECK THERMOCOUPLE CALIBRATION

Thermocouples will drift in reading over time. This could potentially lead to an overfiring before the thermocouple actually fails. Although you can not easily check thermocouple calibration, the general accuracy of the entire kiln system can be checked by firing with witness cones. See *troubleshoot-cones.pdf*.

Replace thermocouples once they are no longer reasonably accurate. (Note: Type K thermocouples last about the same as kiln elements so it is recommended to change thermocouples when you change elements.)

See hotkilns.com/calibration for more complete step-by-step instructions on how to calibrate your kiln.

DAVINCI INSTRUCTION MANUAL



L&L Kiln's patented
hard ceramic
element holders
protect your kiln.

GENERAL DIMENSION DRAWING

BEFORE YOU START ASSEMBLY

An up-to-date General Dimension Drawing for your specific model can be normally be found on our website. These drawings provide important information on ventilation and installation requirements and will also help you visualize how to assembly your new kiln.

Special Models

Some special or custom models may not have a general dimension drawing but this is rare.

TO FIND YOUR DRAWINGS

1. Find your kiln model on our website (hotkilns.com)
2. Click on the General Dimension Diagram button.

L&L KILN SERIES: Easy-Fire Pottery Kilns



e23T-3 Pottery Kiln

Flagship Multi-Purpose Kiln

KEY SPECS

Polygenal Kilns
Medium (6.7 cubic feet)
DynaTrol Zone Control
Cone 10, 2350F, 1290C

\$4,275

LEAD TIME: 8 to 12 Weeks

WHERE TO BUY

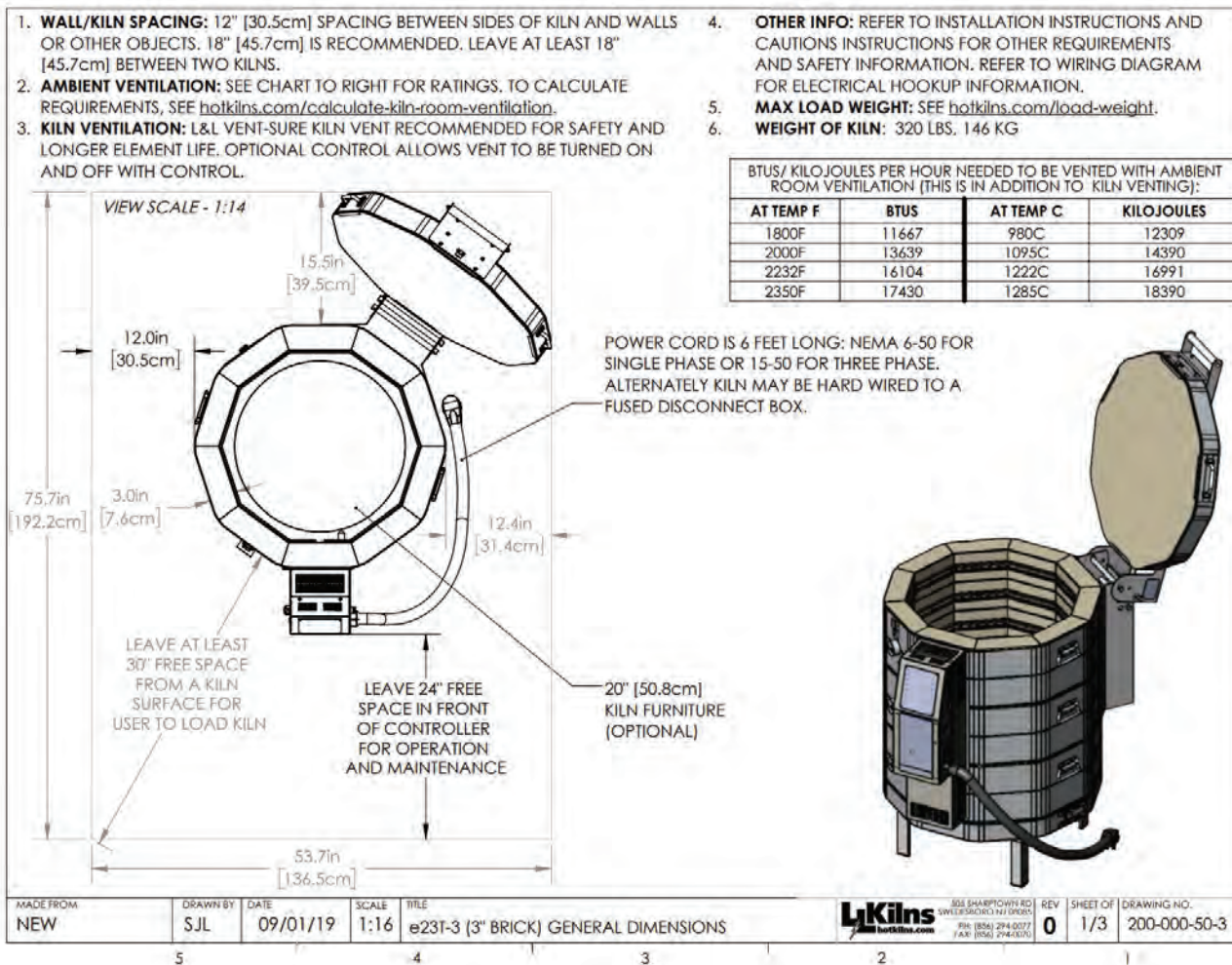
[PDF Brochure](#)

[General Dimension Diagram](#)

Model e23T-3 Easy-Fire Automatic Kiln with Multi-Program Three-Zoned DynaTrol mounted in an easy-open cool-firing piggy-back control panel that is angled for easy viewing of control. Kiln comes with hard ceramic element holders, protected thermocouples, strong solid-top stand, easy-lift spring hinge, and solid periphery plugs. 22-3/8" diameter by 27" high (6.7 cubic feet). 3" K23 brick. NEMA 6-50 single phase or 15-50 three phase 6 foot power cord included. C-MET-us listed in the USA & Canada. Cone 10 for all voltages. For export: see Crating Charges and Export Options in the Accessories Tab for crating charges.

AN EXAMPLE (of a typical e23T-3 kiln)

Each model has its own General Dimension Drawing so yours will look different. The format is generally the same as shown below.



INSTALLING YOUR L&L KILN

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CAUTIONS

See the CAUTIONS section of the Instruction Manual. (or hotkilns.com/cautions)

DATED INFORMATION

The information in these installation instructions is believed to be correct to the best of our knowledge at the time of publication (see the date at the bottom). You can download the most recent update from our web site at hotkilns.com/install.pdf at any time.

SAFETY APPROVALS & LISTINGS

LOCAL CODES

Local fire and safety codes supersede information that is provided in these installation instructions or in our caution instructions.

MET LISTING TO UL STANDARDS

Many but not all kilns are listed to UL 499 Standards for both the US and Canada by MET (An NRTL - Nationally Recognized Testing Laboratory). The Vent-Sure vent is listed in both the US and Canada for use with L&L listed kilns. UL 499, CSA C22.2, No. 122, CSA C22. Listing No E112742. If your kiln is listed it will have a listing mark on the data nameplate and on the wiring diagram. You can also check hotkilns.com/met.

NATIONAL ELECTRICAL CODE

Be sure your electrician follows the National Electric Code and any other local requirements when hooking up the kiln. **One of the requirements of this code that bears particular mentioning is the fact that you must fuse your kiln appliance for 125% of its rated maximum amperage draw.** This explains why you see fusing requirements in our electrical specifications that is in excess of the amperage draw of the kiln. The fuse for the kiln is either a circuit breaker or a fused disconnect switch.

NATIONAL FIRE PROTECTION ASSOCIATION

To the best of our knowledge, the NFPA has nothing specific about the installation of kilns. The NFPA 86 goes into considerable detail about industrial furnaces and ovens but generally with respect to internal processes and gas-fired equipment. There is one section in the NFPA 86 (Section 2-1.5 concerning Floors and Clearances) that might be construed as applicable to kilns. It requires that temperatures at combustible ceilings and floors be kept below 160°F (71°C). In general the NFPA recommends installing furnaces on noncombustible surfaces and has specific requirements if this is not possible. You can order a copy of this by going to their web site at www.nfpa.org or by calling 617-984-7249.

UNIFORM MECHANICAL CODE

Section 920.0 specifically discusses Small Ceramic Kilns and their installation. Some of the clearance information from this is given further on. However, it is best to refer to this book for complete details. This is published by the International Association of Plumbing and Mechanical Officials and can be purchased online at iapmomembership.org.

INSTALLING YOUR L&L KILN

CLEARANCES & SURFACES

GENERAL DIMENSION DRAWINGS

You should download the General Dimension Drawing for your particular kiln model from our website. There is a button on each kiln model page. This will give you all of the dimensions and clearance information you need as well as BTU ratings for HVAC design.

CLEARANCES IN KILN ROOM

L&L strongly recommends an 18" clearance to all walls.

Make certain floor is not flammable.

The Uniform Mechanical Code 2000 Edition states that "the sides and tops of kilns shall be located a minimum of eighteen (18) inches (457 mm) from any noncombustible wall surface and three (3) feet (914 mm) from any combustible wall surface."

The National Fire Protection Agency states that temperatures at combustible ceilings and floors be kept below 160 Deg F (71 Deg C) near industrial furnaces (which are like kilns).

Note that, when L&L tested kilns for UL, temperatures were measured 12" from the walls of the kiln and found to be safe from a flammability standpoint. However, locating a kiln just 12" from a wall may violate the Uniform Mechanical Code and possibly local fire codes so do this at your own risk.

WALL MATERIALS

Check with local building codes for recommended non-combustible wall materials for walls that are adjacent to the kiln. Cement board, cinder blocks, and masonry tile are possible choices.

FLOORS

The Uniform Mechanical Code 2000 Edition states that "kilns shall be installed on noncombustible flooring consisting of at least two (2) inches (51 mm) of solid masonry or concrete extending at least twelve (12) inches (305 mm) beyond the base or supporting members of the kiln."

Recommended floor surfaces are cement, ceramic tile, stone, slate, cinder blocks or brick. Do not install on a wood floor or on carpet. Vinyl flooring may be combustible. Protect linoleum flooring from discoloration with a noncombustible covering.

BE VERY CAREFUL ABOUT IMPLEMENTING THESE SUGGESTIONS. Remember that the kiln is putting out heat over a long period of time and that this could very well start a fire under certain conditions. Also, if an overfiring occurs,

materials like glass and glazes can be super-heated and electrically conductive, and they can melt right through the kiln floor. If there is a combustible floor, this could cause a fire. Also keep in mind the continued heat of the kiln can dry out combustible surfaces over time and reduce their flash point.

The NFPA 86 (Section 2-1.5 concerning Floors and Clearances) that might be construed as applicable to kilns requires that temperatures at combustible ceilings and floors be kept below 160°F (71°C). In general the NFPA recommends installing furnaces on noncombustible surfaces and has specific requirements if this is not possible.

USE THE SUPPLIED KILN STAND

Do not use kiln without the factory supplied stand.

L&L stands typically raise the floor of the kiln by 8" (20 cm).

It is CRITICAL to have air circulation under the kiln. This prevents heat from being directly conducted to the floor surface. If the floor (or subfloor) is combustible a fire could result. Even if the floor is non-combustible (like solid cement) you would create a very inefficient system by placing the kiln directly on the floor.

Using a proper stand is critical because, without a kiln stand that moves the radiant heat of the kiln away from the floor, some flooring could catch on fire. For instance, over time the radiant heat from the kiln can cause wood to lose its moisture and lower the auto ignition temperature. (The auto ignition temperature is the specific temperature at which a substance ignites and causes a fire.)

OTHER CLEARANCES

Make sure there is adequate clearance in the room for opening the kiln lid, and for periodic maintenance such as opening the element connection boxes, opening the control panel, thermocouple replacement, etc. 18" to 24" clearance around the outside wall of the kiln is usually sufficient.

Combustible surfaces that stay below 71°C (160°F) are generally considered safe from the point of view of starting a fire. However, this is a maximum and we recommend keeping surface temperatures near the kiln under 52°C (125°F).

KILN ROOM ENVIRONMENT

KEEP KILN DRY & IN PROTECTED SPACE

The kiln must be kept dry so it must be kept in an enclosed room away from inclement weather. The electrical circuits must not get wet. If for some reason they do get wet they must be thoroughly dried before operating the kiln. Kilns can corrode fairly rapidly if kept in rooms that have no

INSTALLING YOUR L&L KILN

climate control. The constant heating and cooling in an unheated shed, for instance, can cause dew to form on the cold metal and this can cause corrosion. Also exposure to salt air will accelerate corrosion dramatically. Also failure to adequately vent the kiln will allow the corrosive fumes that are generated in the firing process to corrode the metal, the wiring and even the firebrick. This sort of damage is specifically excluded from warranty coverage.

AMBIENT TEMPERATURE

The kiln should operate in an environment that is between 0°F and 100°F. Some people keep their kilns in unheated garages or sheds. This is OK as long as the room is dry. The DynaTrol and Genesis have a specification that says it can work from 32°F to 125°F. These limits can be exceeded on the low end. (The control won't deal with negative numbers so if you go below 32°F you must have the control set up for Deg F - not Deg C) On the low end it has more to do with the accuracy of the control. As the kiln reaches the point where accuracy is an issue then the control will most likely be warmed sufficiently by the kiln to insure that it is operating within specification. However, on the high end, the electronics could degrade if operated for long periods above 125°F.

SURFACE IS HOT AND CAN CAUSE BURNS

Kiln surface can be extremely hot: up to 260°C (500°F). Display a sign near the kiln that warns everyone of how hot the kiln is.

FIRE EXTINGUISHER

We recommend that an adequate fire extinguisher be kept near the kiln and checked on a regular basis. You may want to check with your local fire authorities to see if there are any specific requirements they have such as sprinkler systems, automatic foam extinguishers, etc. **Use a fire extinguisher that is rated for electrical fires. We recommend an ABC fire extinguisher.**

FIRE SPRINKLERS

If you have a sprinkler system be careful to check the temperature rating and location of the heads so that you do not inadvertently cause them to actuate under normal firing conditions.

Position the sprinkler heads in the ceiling away from the kiln(s). The rising heat from the kiln, under normal operating conditions, could set off the sprinklers which will cause water damage. Use the highest temperature rating on your sprinkler heads that is allowed by code. Or consider using a higher one that is set off by smoke.

Be sure to monitor temperature while the kiln is at its highest firing temperature and conditions are at their worse (for instance when the door to the kiln room is closed or the ventilation fan is turned off).

Serious damage to the kiln and your premises can take place if the sprinkler system goes off when the kiln is at high temperature - especially if no one is in the building when it happens.

KILN ADJUSTMENTS

LEVELING THE KILN

Level the kiln while you are installing it. Use thin metal shims under the legs to accomplish the leveling (never wood or other combustible materials). Some kilns have leveling bolts or pads. Make sure that the base will not wobble.

ADJUST THE HINGE PROPERLY

See the assembly instructions for your specific kiln. (Assembly instructions are available at hotkilns.com/assembly-instructions) The hinge of any kiln must be adjusted so that expansion caused by the heating process has room to expand up and down. (L&L includes expansion slots in the hinges.) (This only applied to top loading kilns.)

THERMOCOUPLES

Thermocouples must be inserted into the kiln at least 1" (2.5 cm) in from the inside surface of the kiln. They must protrude into the kiln itself because, if the measuring tip of the thermocouple is buried inside the insulation, the thermocouple will measure a lower temperature than the actual temperature in the kiln. This could cause an overfire of the kiln.

NOTE: Replace thermocouples once they are no longer reasonably accurate. (Note: Type K thermocouples last about the same as kiln elements so it is recommended to change thermocouples when you change elements.)

If you have taken the kiln apart carefully observe the thermocouple polarity and zone placement. See the DynaTrol instructions in your manual or hotkilns.com/tc-polarity.

VENTILATION REQUIREMENTS

VENTILATION IS ESSENTIAL

Kilns generate harmful fumes when firing ceramics. Fumes can include carbon monoxide, formaldehyde, sulfur dioxide,

INSTALLING YOUR L&L KILN

heavy metal vapors, and fluorides (all of which can be very toxic). Install kiln in well-ventilated area.

Never operate in an enclosed space such as a closet unless you have good ventilation. Aside from issues of ventilating the fumes from the firing, the heat build up in an enclosed room could present a significant fire hazard.

Severe corrosion can be caused by kiln fumes, salt air or other environmental conditions. Good venting can minimize these problems.

Ventilation must be to the outside. We recommend room ventilation of at least 25-50 times the cubic feet of the kiln per minute. For example, if a kiln has 10 cubic feet then 250 to 500 CFM should be adequate. See hotkilns.com/calculate-kiln-room-ventilation for a more precise method of calculating heat removal requirements. Our suggestion is to get a variable speed fan for ambient room ventilation and keep a thermometer on the wall. That way you can vary the ventilation to suit the needs of ambient heat conditions in the room.

VENTILATION FOR THE KILN

In addition, we recommend our VENT-SURE downdraft kiln vent system. This will take care of most of the venting of the fumes of the kiln, will improve uniformity of firing in the kiln, and will help maintain the oxygen level in the kiln (which is important for certain glaze effects as well as good element life). See the separate instructions in this book for the VENT-SURE vent system. Although you can use other kiln venting systems please note that the VENT-SURE is c-UL-us listed for use with L&L listed kilns. If UL listing is an issue then you may want to ensure that another brand of vent will be acceptable to your local authorities. Also if you use another brand of vent be sure to check with the vent manufacturer for specific installation requirements with our specific kiln model. See hotkilns.com/vent-sure for more information

CARBON MONOXIDE MONITORING

We recommend the use of a carbon monoxide monitor in your kiln room.

VENTING CODES

The following information is provided courtesy of The Edward Orton Jr. Ceramic Foundation.

OSHA has set standards for carbon monoxide exposure of 35 ppm (parts per million) for long-term exposure and 200 PPM for short-term exposure. Independent testing has shown that fumes near the kiln can exceed 200 PPM near the kiln during the firing of greenware. This can

cause headaches, fatigue, sore throats and nausea. When properly installed and operated, a downdraft vent removes all harmful fumes and provides a safer working environment.

Most states and localities have set venting requirements for firing kilns in public places. Your local and state health board should have this information. The Uniform Mechanical Code says that you must vent ceramic kilns. It says that you can use a canopy-type hood (and gives specific requirements for such use) or that "listed exhaust blowers may be used when marked as being suitable for the kiln and installed in accordance with manufacturer's instructions." Our Vent-Sure vent is UL listed and is appropriate to meet this ventilation requirement. If you decide to use a vent other than the UL listed Vent-Sure vent make sure you check with the manufacturer of the vent to be certain that it is an approved application. L&L takes no responsibility for improperly installed vents or kilns nor do we take responsibility for the use of other vents with our kilns. The manufacturer of the vent must specifically approve it for use with our kiln.

Note about canopy type vent hoods: While canopy type vent hoods can be suitable for venting a kiln from a safety point of view, they will not give you the superior advantages of a downdraft type vent like our Vent-Sure. A downdraft type vent pulls the rising hot air down to the bottom of the kiln which helps even out the firing. In addition it provides uniform distribution of oxygen in the kiln.

HVAC AND AIR CONDITIONING ISSUES

Kilns put out a lot of ambient heat. If you need to size HVAC units to handle this see the chart below. This shows the BTU output if the kiln was held at these temperatures under steady-state conditions (which is rarely the case for a ceramic kiln). Typically it would never be worse than what is shown in the this chart which makes this a safe figure to use for sizing HVAC systems.

You can download charts of BTU outputs for most L&L kilns at hotkilns.com/btu.

Voltage is not an issue with regards to BTU output.

ELECTRICAL INSTALLATION

VOLTAGE

L&L makes different configurations for 208 volts, 220 volts, 240 volts, 380 volts and 480 volts.

It is important that the kiln be hooked up to the proper voltage. 208 volt kilns hooked up to 240 volt power supplies will generate too many amps. 240 volt kilns hooked up to a

INSTALLING YOUR L&L KILN

208 volt power supply will heat up about 25% slower than they should and may not reach the higher temperatures. Although it is possible to hook a single phase kiln to two legs of a three phase supply it will cause an unbalanced load on your electrical supply. **CHECK WITH A QUALIFIED ELECTRICIAN.** It is best to get a three phase kiln for a three phase power supply.

In addition to the power wires there is, on all L&L kilns, a ground wire. The ground wire is not used as a neutral (i.e. no electricity normally flows through the ground). **BE SURE TO GROUND THE KILN PROPERLY USING THE GROUND WIRE. AN UNGROUNDED KILN IS A DANGEROUS KILN.** Also it is important for the control operation to have a good earth ground as well (to get rid of electrical noise).

HOOKING UP TO POWER

Most L&L kilns under 48 amps include either a 6-50P plug (for single phase kilns) or a 15-50P plug (for three phase kilns). See the specification sheet or wiring diagram to be sure.

Have your electrician install the proper receptacle (if you are using a plug) and safety switch at your kiln location. Be sure that your fuse ampere capacity is enough to carry the electrical load required. Also, ensure that your power lines are heavy enough to carry the required electrical load. If this is being used in an industrial or institutional setting be sure to follow lock out/tag out requirements and procedures.

DIRECT HOOK UP KILNS

All kilns over 48 amps are direct hook-up. This means an electrician needs to install a conduit (rigid or flexible) from the fused disconnect or circuit breaker panel to the kiln. Some kilns under 48 amps are also direct hook up.

CHANGING TO DIRECT HOOK-UP

All L&L power cords are rated for 105°C. Anything less than this can cause a malfunction and possible fire where the power leads connect to the control box.

It is OK, and will not void the warranty, to remove the plug that comes with the kiln and direct wire the kiln. However, the connection wires must be rated for a minimum of 105°C.

INSTALLING A PLUG RECEPTACLE

If your kiln comes with a plug, install the receptacle in such a way that the cord hangs down (not up). Do not place the outlet so close to floor that the kiln cord bends up at a sharp angle. The principle to pay attention to is make sure the plug seats securely in the receptacle. Otherwise it could overheat and corrode which could cause an electrical fire.

PROTECT POWER CORD FROM KILN CASE

If you have a flexible cord, rout cord away from kiln in such a way that it can not touch the hot case of the kiln. Secure it so it can not move. If cord touches the hot case it could melt and cause a short circuit and/or fire.

USE A FUSED DISCONNECT

We recommend having a separate fused disconnect box with a lockout provision mounted near the kiln, even if you also have a separate circuit breaker for your kiln. This way you can easily turn off power to the kiln and prevent unauthorized people from turning it on. We recommend this even for kilns with plugs because it makes it so much easier to disconnect all power to the kiln when not using it. Note that if you unplug a kiln frequently the spring tension in the outlet can weaken over time. A Fused Disconnect switch allows you to positively turn off power to the kiln without unplugging it.

LOCATE KILN WITHIN 50 FEET OF BREAKER

Try to locate the kiln within 50 feet of your breaker box. For longer runs you will probably have to increase the size of the hook up wire that we recommend in our literature. In any case, be sure to have a licensed electrician who knows the National Electrical Code hook up the kiln and size the hook up wire.

FUSING YOUR CIRCUIT

Be sure your electrician follows the National Electric Code and any other local requirements when hooking up the kiln. The full load amps is listed on the data nameplate of the kiln. **CHECK WITH A QUALIFIED ELECTRICIAN.**

USE PROPER GROUNDING

Make sure your electrician properly grounds the kiln and then tests for proper grounding after the installation. All electrical appliances should be properly grounded. This can be to either a cold water pipe or proper system ground in your building. If there is ever a short circuit (where the electricity flows through to the case or control panel and where you might touch it) you could be electrocuted if the kiln is not grounded. This is especially important with the high voltage used on kilns. The higher the voltage the more easily it could flow through your body. In addition, because of the heat generated in a kiln, wires are subject to potential deterioration over time and expansion and contraction can move insulators and cause short circuits. **BE SURE TO REPLACE ANY DETERIORATED WIRES!**

INSTALLING YOUR L&L KILN

USE THE PROPER WIRE GAUGE

Hook-up wire sizes are provided for many of our kilns in the electrical specifications. However, this can vary depending on ambient temperature conditions and length of wire run.

Running power for your kiln over a long distance will result in a drop in voltage. This chart gives some approximate idea of this:

7 volts per 100 feet with 10 awg wire

21 volts per 300 feet with 10 awg wire

6 volts per 100 feet with 6 awg wire

18 volts per 300 feet with 6 awg wire

3 volts per 100 feet with 1 awg wire

9 volts per 300 feet with 1 awg wire

These estimates are dependent on the kiln operating at 50% to 100% of its capacity, with the temperature of the wire no more than 167°F.

USE COPPER WIRE FOR HOOK UP

Don't use aluminum wire. It is cheaper to use aluminum wire and you may be tempted to do so. Many electricians will tell you that, with the new types of connectors, it is OK. However, it is of particular importance with kilns not to use aluminum wire for the hook ups. The specific reason particular to kilns is that the wire tends to get hotter near the kiln than it might going into some other types of appliance. Also, being a resistive load, there is constant heat being generated by the conductors. When aluminum wire gets hot it accelerates oxidation. Aluminum oxide is a resistor; copper oxide is not as much. If the connection at the terminal board gets oxidized it will really heat up - to the point where it could cause a fire. Braided copper wire is preferred.

DO NOT USE EXTENSION CORDS

Extension cords are only OK to use for the 120 volt vent system. Do NOT use an high power extension cord for the kiln.

OFF-PEAK ELECTRICAL USAGE

Some utilities offer special rates for running energy intensive appliances (like kilns) during off-peak hours. Check with local utility. This would require a special time-of-use electrical meter.

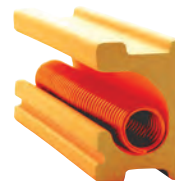
WHERE TO GET MORE INFORMATION

See hotkilns.com/volts for a complete description of electrical theory, fusing, hook-up wire sizes, etc. as they apply to kilns or, for a more basic description, at hotkilns.com/basic-electric-kilns.

ELECTRICAL SPECIFICATIONS

See your wiring diagram and data nameplate for voltage and amperage requirements.

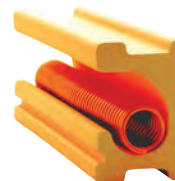
DAVINCI INSTRUCTION MANUAL



L&L Kiln's patented
hard ceramic
element holders
protect your kiln.

DAVINCI INSTRUCTION MANUAL

VENT



L&L Kiln's patented
hard ceramic
element holders
protect your kiln.

L&L VENT-SURE DOWNDRAFT KILN VENT INSTRUCTIONS

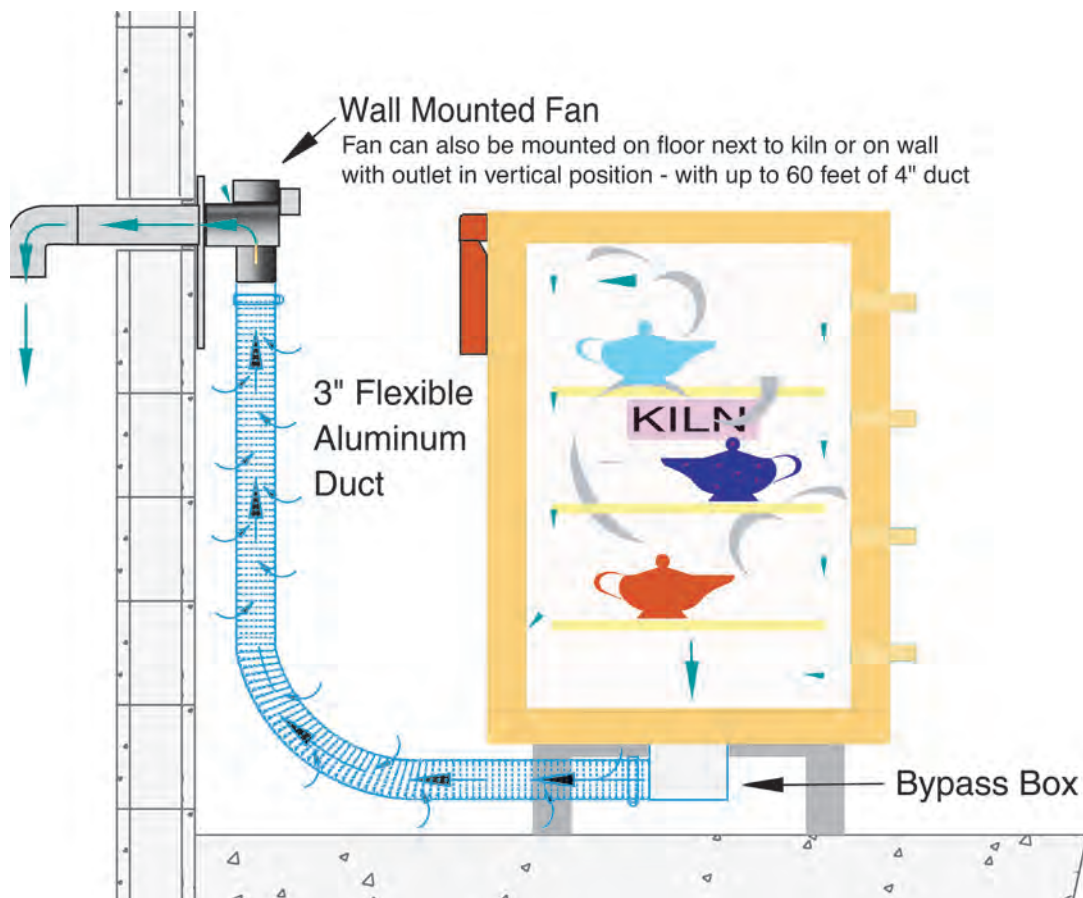


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READ THE INSTRUCTIONS

You are now the proud owner of an L&L "VENT-SURE" kiln ventilation system, engineered to give you the utmost in performance and results. This is an expensive and potentially hazardous appliance (if not used with proper caution). PLEASE TAKE THE TIME TO READ THESE INSTRUCTIONS. There is important information that you need to understand in order to operate your L&L kiln ventilation system safely and effectively.

USEFUL WEB LINKS

See this video on how to install a vent:
hotkilns.com/install-vent-sure

See this video on how to drill holes for a vent:
hotkilns.com/drilling-vent-holes

See this video on how to install a vent control:
hotkilns.com/install-vent-control

See this video on how to program a vent control:
hotkilns.com/program-vent-control

L&L VENT-SURE DOWNDRAFT KILN VENT INSTRUCTIONS

CHECKING SHIPMENT

Your ventilation system was carefully packed and inspected prior to shipment to make sure that all parts were in perfect condition.

When carrier makes delivery, you should immediately unpack your ventilation system and accessories to determine whether or not any damage has occurred in transit.

If damage has occurred, retain all of the packaging material and notify L&L at once. Retain all papers to ensure that a proper claim can be filed.

WHAT IS INCLUDED WITH VENT

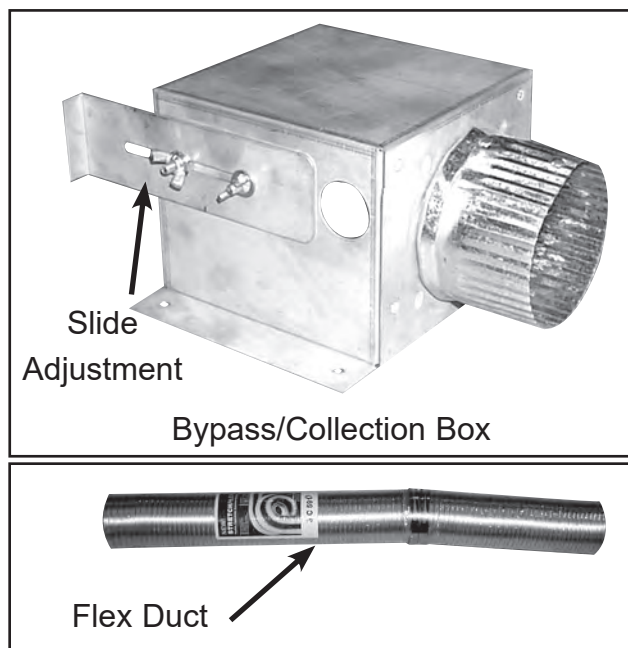
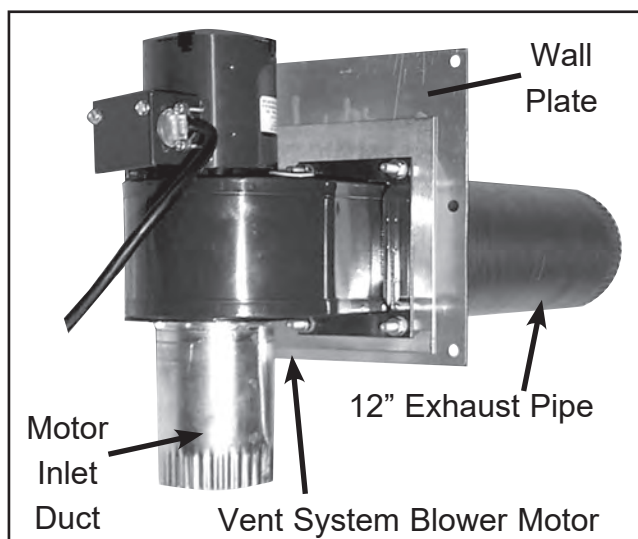
One (1) wall-mounted blower mounted on a bracket with vent pipe to go through outside wall and a Motor Inlet Duct. An 8 foot power cord with an attached On/Off switch plugs into a 120 volt standard receptacle. (Note: 220-240 volt models will have a different cord).

One (1) Bypass Collection Box to be mounted to the kiln stand, with mounting hardware.

One (1) length of flexible aluminum ducting (expands to 15 feet) with two (2) hose clamps.

One (1) 4" diameter 90 degree elbow (for outside the building).

One (1) Multi-Mount Bracket



IMPORTANT CAUTIONS

Check duct occasionally to see if there is wax or other residual build up. Wax could condense in the duct, which is a potential fire hazard. This is especially important if you are using a wax resist.

Be sure that the exhaust of the vent is not being brought back into your building. Keep exit of vent at least four feet away from any open windows or doors.

We recommend the use of a carbon monoxide monitor in your kiln room. These are available from good hardware stores for about \$50 (This is another good way to be sure you are getting proper venting).

Disconnect power cord from power source when doing any maintenance on the fan motor. Do not put your fingers inside the blower without disconnecting power. Blower may start unexpectedly because of automatic thermal shut off switch built into the motor.

DO NOT place anything in the blower/motor while powered. Serious injury and/or damage to the motor could result.

INSTALLATION TIP BEFORE STARTING

NOTE: Attach the Bypass Box to the stand and the aluminum duct to the Bypass Box before installing the kiln on the stand because it can be hard to do this when the kiln is on top of the stand.

L&L VENT-SURE DOWNDRAFT KILN VENT INSTRUCTIONS

INTRODUCTION

WHAT DOES THE VENT DO?

The Vent-Sure Kiln Ventilation System is designed to pull air contaminated with carbon monoxide and other fumes including those of volatile metals, decals, sulfur oxide, and others in a down draft fashion out of the kiln and then vent it outside or to a central vent system.

KILN VENTILATION CAUTIONS

VENTILATION IS ESSENTIAL

1. Kilns generate harmful fumes when firing ceramics including: carbon monoxide, sulfur oxides, hydrogen fluoride and metal vapors (all of which can be toxic).
2. Install kiln in a well-ventilated area and never operate in an enclosed space unless you have good airflow.
3. Severe corrosion can be caused by kiln fumes, salt air, or other environmental conditions.

AMBIENT HEAT AND VENTILATION

1. The kiln should operate in an environment that is between -18°C (0°F) and 38°C (100°F).
2. Kiln vents do not take care of ambient ventilation of the kiln room to remove the heat of the kiln.
3. See the following web page for guidance on how to calculate ventilation requirements for a kiln room:
hotkilns.com/calculate-kiln-room-ventilation

INSTALLATION

IMPORTANT CAUTION

MAKE CERTAIN KILN POWER IS OFF BEFORE PROCEEDING WITH INSTALLATION.

Step 1. Turn Off Kiln Power

This is critical for safety reasons.

Step 2. Drill Holes (if needed)

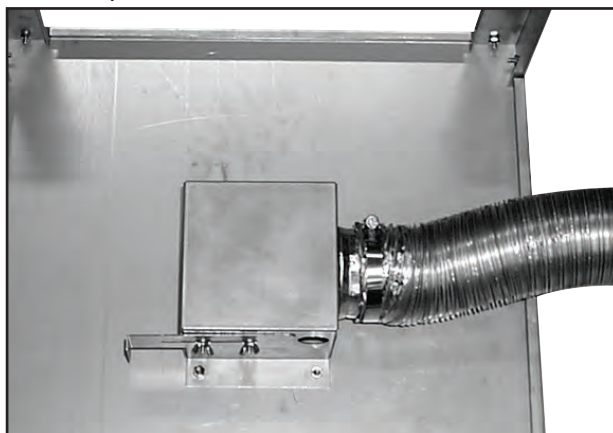
Before mounting the Bypass Box, you should drill the vent holes. (Note: if you bought the vent system with a new kiln, it may be pre-drilled) The easiest way to drill the vent holes is to place the stand upside-down on the kiln bottom, center it, and then drill your holes within the large aperture. Otherwise you can measure out the center of your kiln slab and draw a circle in the middle with a radius of 1.5" Then drill your vent holes within that circle.

Step 3. Install Bypass Collection Box

With the vent holes taken care of, you can install the Bypass Collection Box. Just simply use the studs on the bottom of the stand and secure with the provided hardware.

IMPORTANT: Remember to have the outlet pointed towards your fume exhaust location.

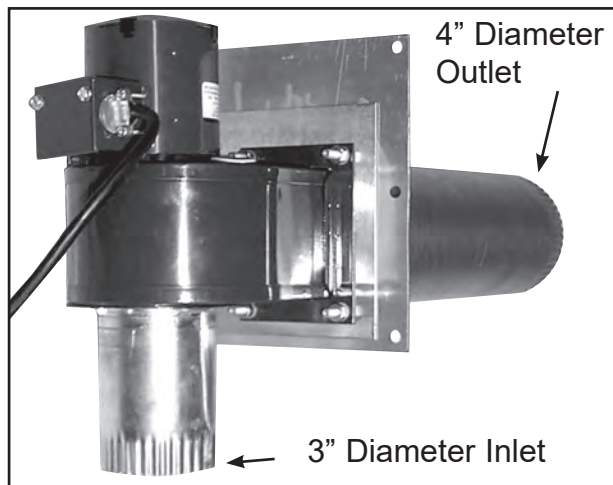
The Bypass Collection Box is mounted to the bottom of the stand with provided hardware.



Step 4. Install Blower System

Install blower system by penetrating outside wall or setting into a window with appropriate support. Attach the provided 90 degree elbow to point down on the outside of the building (this is to prevent rain water from getting into the duct). (Note: this procedure will change if you use the Multi-Mount bracket). Mount securely because motor may vibrate over time especially if it builds up any dust in the blower.

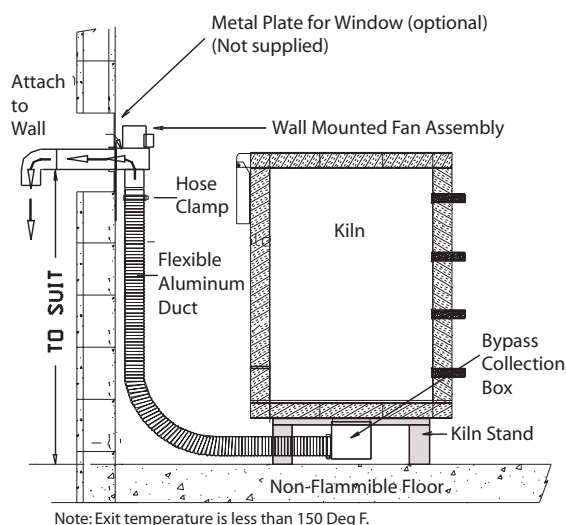
The motor assembly comes pre-mounted onto the Wall mount bracket:



L&L VENT-SURE DOWNDRAFT KILN VENT INSTRUCTIONS

CAUTION: Make sure that the vent outlet is at least four feet from any open windows or doors. This is to make sure fumes do not get back into your building. Also the fumes can be hazardous to plants within a few feet.

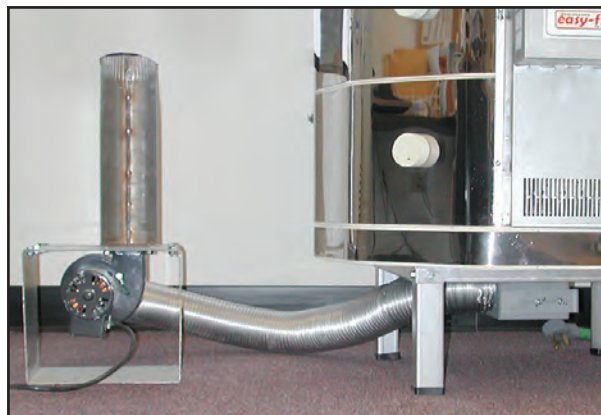
Vent-Sure Installation Diagram



A CAUTION ABOUT MOUNTING VERTICALLY

If the discharge duct of the vent is mounted pointing up (as shown on the photograph to the left), water that condenses in the duct may drop down and rust the motor. We recommend having a water trap in the bottom of a vertical duct run to drain off the water before it runs into the motor. This is not a problem when the vent has been mounted horizontally. The Multi-Mount bracket will allow you to mount the motor horizontally as well. You can then use 90 degree bends or flexible duct to go vertically. Just remember that there is water in the exhaust that will condense somewhere as it cools after it discharges from the vent motor.

A special Multi-Mount bracket is included with each vent system. This will allow you to mount the vent on the floor or wall with the outlet of the vent pointing up. This is useful when you want to use an existing penetration in a wall that won't support the vent (like a window) or when you want to have the vent go out of a roof or into a central vent system.



Step 6. Connect Flexible Duct

Attach blower system to bypass/collection box by stretching the flexible aluminum duct carefully (it can extend up to 15 feet) and securing to both the blower housing and the bypass/collection box with the provided hose clamps.

NOTE: You may want to firmly attach this to the Bypass Collection Box before installing the kiln on the stand because it can be hard to maneuver under the kiln.

Step 7. Plug In Vent

Plug in the switched cord to a standard 120 volt receptacle. **If need be you can safely use a grounded extension cord because of the small amperage required.** Be sure to secure cord away from heat of kiln. Note: On 220-240 volt models this may vary.

ROOM AIR REPLACEMENT

ROOM AIR REPLACEMENT:

The Vent-Sure system moves up to 146 cubic feet of air per minute. We suggest opening a window slightly, or bringing another fresh air source into the room, to replace this room air.

L&L VENT-SURE DOWNDRAFT KILN VENT INSTRUCTIONS

DRILL CHART

MODEL HOLE	CUBIC FEET	NO OF HOLES	DIA
FUEGO	1.5	1	1/4"
e18S, JD18, LB18	2.6	1	1/4"
e18M	3.2		1/4"
JD18X, e18T	3.9	1	1/4"
e23S, JD18, LB18	4.7	2	1/4"
e23M	5.5	2	1/4"
e23T, SM23T, eQ23T, JD230	7.0	2	1/4"
JD236	9.4	3	1/4"
JD245	11.75	3	1/4"
e28S, J2918	6.9	2	1/4"
e28M	8.6	3	1/4"
e28T, rQ2827, J2927	10.3	3	1/4"
J2936, eQ2836	13.8	4	1/4"
J2945	17.2	5	1/4"
XB2318	5.0	2	1/4"
X2327	8.1	2	1/4"
X2336	10.8	3	1/4"
X2345	13.5	4	1/4"
XB2818	7.8	2	1/4"
X2827	11.7	3	1/4"
X2836	15.6	4	1/4"
X2845	19.5	5	5/16"
XB3218	10.0	3	1/4"
X3227	15.0	4	1/4"
X3236	20.0	5	1/4"
X3245	25.0	6	1/4"
TB2318	9.7	3	1/4"
T2327	14.6	4	1/4"
T2336	19.4	5	5/16"
T2345	24.3	6	5/16"
TB3418	13.8	4	1/4"
T3427	20.7	5	1/4"
T3436 (use 2 vents)	27.6	4/vent	1/4"
T3445 (use 2 vents)	34.5	5/vent	1/4"
eFL1616	4.0	2	1/4"
eFL1626	6.6	2	1/4"
eFL2026	8.6	2	1/4"
eFL2626	10.2	3	1/4"
eFL2635	13.7	4	1/4"
EL2424	8.0	2	1/4"
EL2427	9.0	3	1/4"
EL2436	12.0	3	1/4"
EL2448	16.0	4	1/4"
EL2848	20.0	7	1/4"
EL3048	25.0	8	1/4"

OPERATION

1. Plug blower cord into 120 Volt receptacle. (Note: 220-240 volt models may be different).
2. Close all kiln apertures such as peepholes unless you very specifically want more air vented.
3. Turn on Vent with the in-line switch on the power cord.
4. Close the lid and fire. For heavy loads with lots of fumes you may want to avoid firing faster than 150°F per hour to prevent the generation of more fumes than the system can eliminate.
5. Use the flow control on the Bypass Box to modify the flow of exhaust - a larger flow control opening reduces the flow of exhaust fumes from the kiln, and a smaller flow control opening increases the exhaust.

ADJUSTING THE BYPASS SYSTEM

The sliding adjuster allows you to fine adjust the amount of venting that is done to your kiln. It is easy to adjust but hard to know just how to adjust it. The problem is that there are many factors that contribute to the amount of "pull" required. For instance, the amount of fumes that are being given off by your specific work is one factor. Some clays have a lot of carbon in them; others do not. Depending on the size of the load, and the ingredients in the clay/glaze, there will be more or less fumes generated. Another factor is the "static pressure" in your vent ducts. If you have a lot of curves, 90 degree bends, or long runs of duct this will increase the static pressure (back pressure) and hence increase the need for more venting force. One suggestion is to start with the valve in the half open position and see what happens.

The Smoke Method:

- 1) With the kiln off and with the kiln empty, turn the vent on.
- 2) Start with the bypass valve in the fully closed position. This will give it the maximum suction in the kiln.
- 3) Light a piece of paper on fire or something that will create smoke. Blow it out, and hold it near the cracks around the closed lid.
- 4) If the smoke is being pulled into the kiln around these door cracks, open the Bypass (decreasing flow from the kiln) until the smoke stops being pulled in, then back up the valve slightly, so the draw increases just slightly again. Try this again when kiln is at about 100°F.
- 5) You can do the same test directly at the bottom hole with the kiln open also to test the differential between the pull at the actual suction hole from the kiln and the pull

L&L VENT-SURE DOWNDRAFT KILN VENT INSTRUCTIONS

around the lid. *(However, if you do this make sure the kiln is disconnected from the power to avoid the risk of electrocution).*

For Gross Adjustment:

Remember that the sliding adjuster is for fine adjustment. Drilling or plugging the holes in the floor (and possibly adding or plugging holes in the top) is how you would dramatically change the amount of air vented.

VENTING CODES

OSHA has set standards for carbon monoxide exposure of 35 ppm (parts per million) for long-term exposure and 200 PPM for short-term exposure. Independent testing has shown that fumes near the kiln can exceed 200 PPM near the kiln during the firing of greenware. This can cause headaches, fatigue, sore throats and nausea. When properly installed and operated, a downdraft vent removes all harmful fumes and provides a safer working environment.

Most states and localities have set venting requirements for firing kilns in public places. Your local and state health board should have this information.

The Uniform Mechanical Code says that you must vent ceramic kilns. It says that you can use a canopy-type hood (and gives specific requirements for such use) or that "listed exhaust blowers may be used when marked as being suitable for the kiln and installed in accordance with manufacturer's instructions."

Our Vent-Sure vent is listed to UL499 standards by MET for L&L Kilns and is appropriate to meet this ventilation requirement. L&L takes no responsibility for improperly installed vents or kilns nor do we take responsibility for the use of other vents with our kilns.

REGULAR MAINTENANCE

Occasionally check for leaks in the aluminum duct. Replace if necessary. Check for corrosion especially if you are using clay with a high content of sulfur, phosphorus or fluorine. Check for wax or carbon build up if you are using a wax resist process or a high carbon content clay.

We recommend unmounting the fan and blowing out the squirrel cage with compressed air every two years or so especially if you are in a very dusty or if you have it mounted on the floor where it is more likely to pick up dust.

If the discharge duct of the vent is mounted pointing up you may get water that condenses in the duct drop down and rust out the motor. Taking it apart and spraying with WD-40

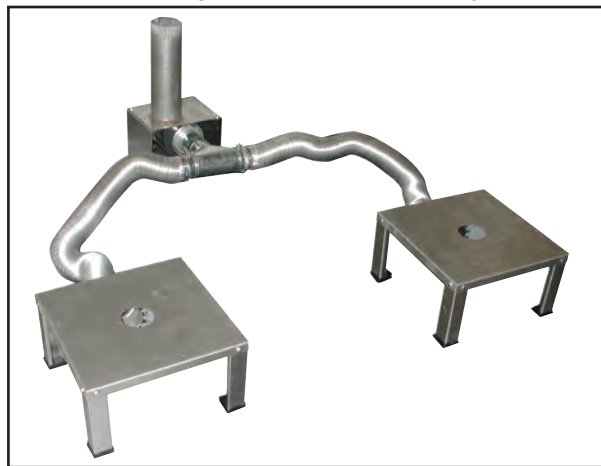
can restore the motor in some cases. We recommend having a water trap in the bottom of a long vertical duct run to drain off the water before it runs into the motor. This is not a problem when the vent has been mounted horizontally.

INSTALLATION OF MULTIPLE VENTS

For more information see:
hotkilns.com/vent-doubler-system

VENT DOUBLER SYSTEM

This shows a photograph of the Vent Doubler System:



The Vent Doubler system includes an extra Bypass Collection Box, an extra Flexible Aluminum Duct and a "T" Connector with dampers. You can vent two 10 cubic kilns with one Vent-Sure plus this Vent Doubler System.

CENTRAL VENT SYSTEMS

Multiple Vent-Sure systems may be installed individually, or each system may be connected to a central duct. The following information is provided to help the installer make decisions concerning the size and length of the central duct.

CENTRAL DUCT SIZING

QTY OF SYSTEMS SIZE OF CENTRAL DUCT

1	4"
2	6"
3	8"
4	8"
5	10"
6	10"

EXTENDING DUCT LENGTH

The duct may be 60 feet in length, and include up to four 90° bends, without a significant drop in static air flow or a reduction in kiln air pull. You may use any galvanized, stainless or aluminum duct. The outlet duct size (after the motor) is 4" diameter. The inlet duct (before the motor) is 3" diameter.

L&L VENT-SURE DOWNDRAFT KILN VENT INSTRUCTIONS

OPTIONAL VENT CONTROL

For more information see:

hotkilns.com/vent-control

The Vent Control allows you to automatically control the operation of the Vent-Sure kiln vent with one of the outputs from the DynaTrol (or Genesis).



Construction

The Vent Control consists of a relay that is controlled from output #4 on the DynaTrol (or Genesis).

There is a female 120 volt receptacle to plug the vent into and a cord to plug into a 120 volt wall outlet.

There is a 6 foot wire that connects the control box to the kiln control panel. A grommet is included for non-factory installation.

Where It Can Be Used

It is only available for kilns with DynaTrols and Genesis controls.

It may not be used with kilns with powered bottoms (because the same output on the control is used)

Operation

NOTE: These options are set in the "Hidden Menu" of the DynaTrol. (See hotkilns.com/hidden-menu for how to get into the hidden menu on the DynaTrol).

On the Genesis control go to "4-Configuration" on the Main Menu and then to "6-Output 4 Options". The code to get into Factory Configuration, if prompted, is 443.

OPTION A (OP A)

Used to control a vent. Output 4 can be programmed to be on or off during each segment of a Vary-Fire program. During an Easy-Fire program, output 4 comes on at the

beginning of the firing and turns off after the kiln has cooled to 150F.

OPTION B (OP B)

Used to control a vent. Output 4 can be programmed to be on or off during each segment of a Vary-Fire program. Output 4 comes on at the beginning of an Easy-Fire program, off at 1450°F, back on after the firing is complete and the kiln has cooled to 1000°F and finally off again when the temperature is below 150°F.

OPTION C (OP C)

Used to control a vent, an alarm, or other atmospheric control. Output 4 can be programmed to be on or off during each segment of a Vary-Fire program. Output 4 is off during Easy-Fire programs.

FREQUENTLY ASKED QUESTIONS

How do I know if the system is working?

See our comments under "Adjusting the Bypass Valve"

How hot does the duct get during the firing?

Not very, for two reasons. One is that the Vent-Sure does not draw out much heat from the kiln. The hotter the kiln gets, the less hot air that is extracted by the vent motor. The other is that the bypass box combines fresh cool air with the hot air from the kiln before passing through the ductwork.

How long can the duct be and how many bends can it have?

Up to 60 feet of ducting containing four 90 degree bends may be safely used with no drop in static air flow at the duct exhaust point or a reduction in draw at the kiln. The ducting can be run either horizontally or vertically. (The Vent-Sure should handle more static pressure than the Orton vent because of the stronger motor. This translates into longer lengths of pipe and more 90 degree bends. If you have a choice run two 45 deg bends rather than one 90 degree bend or use flexible duct which has a gentler bend).

Can I vent through a ceiling and/or roof?

Yes. You will need the multi-mounting bracket (M-V-MULT/00), so that you can position the motor output vertically. Additionally, you need to make sure that you install a water trap. At the bottom of the longest vertical run, install a u-shaped bend to catch any condensation that forms before it enters the motor. Of course if you are going through a roof, you will also need a rain cap and screen.

L&L VENT-SURE DOWNDRAFT KILN VENT INSTRUCTIONS

You do not normally need double wall ducting when going through the roof since the pipe or duct does not reach high temperature. It is always advisable to check your local building codes for their requirements.

How do I determine the size, number, and location of holes in the top and bottom of the kiln?

As a general rule, you should have one 1/4 inch hole for every 4 cubic feet of kiln volume. The holes are normally placed within a 4 inch circle in the center of the kiln floor. Please see our hole chart on page 7. L&L does not normally recommend drilling holes in the top except for certain instances where airflow needs to be increased such as for glazes which need an oxygen rich environment.

Will the fumes coming through the vent damage my plants, the neighborhood pets or disturb the local environment?

For the most part, the fumes have been diluted enough already when they are exhausted, however that depends on how you have your bypass box setup. We do not recommend placing the outlet of the vent below an open window and we have heard of plants near the vent outlet being affected by the vent fumes so keep this in mind when locating vent outlet. Once the fumes are exhausted, they will quickly be diluted by the outside air, so it is only the immediate area around the vent that you need be concerned about.

Will using the vent cause my firing to take longer?

Generally only a little bit longer. The vent system removes only a small amount of heat from the kiln due to the physics of how thin air gets at very high temperatures. (L&L NOTE: We have seen vents overpower smaller kilns - so it is important to adjust the amount of venting in some cases. On the other hand an example of an e23T 7 cubic foot kiln firing an 85 pound load on Fast Glaze program to cone 8 took 7 hours and 4 minutes with a vent on and 6 hours and 24 minutes without a vent. The vent was on the whole time).

What does it cost to operate the vent system?

The vent system should likely cost less than 1 cent/hour to operate (electricity costs). Downdraft vents are still vastly more efficient than hoods which remove tons of air from the kiln room while the Vent-Sure only removes a small amount of air from the kiln. (It does cost more to run the vent because it does take heat out of the kiln. For example an e23T 7 cubic foot kiln firing an 85 pound load on Fast Glaze program to cone 8 took 70 KW hours with a vent on

and 62 KW hours without a vent. At 8 cents per KW hour that would be a cost of \$0.64 more for the firing. The vent was on the whole time).

Will the cold air entering the kiln damage the product?

No. The amount of air coming in is too small unless you drill holes in the lid, which is not normally recommended. The air coming in is also distributed throughout the kiln evenly.

Will faster cooling crack the ware if I leave the vent on during the cooling Cycle?

No. Most kilns will cool faster with the vent system, but it is achieved at such an even rate and distribution that there would not be any damage to ware. (L&L NOTE: The vent will remove more molecules of air and hence heat as the kiln cools. This is because the density of the air increases the lower in temperature you go. This is one reason why kiln vents are so efficient - they don't remove too much heat when you don't want them too at the higher temperatures).

What should I do if I still smell fumes?

Check all ductwork for leaks and see our comments on "Adjusting the Bypass System".

If using a hood type vent (like the Vent-a-Kiln) do you need a kiln vent (like the Vent-Sure) also?

You need to vent fumes from the kiln and the room and heat from the room. You must have ambient ventilation in a small room for heat and to remove fumes that may not be fully removed by the kiln vent. If you have a very large room that can dissipate heat and trace fumes than you may not need ambient ventilation.

The Vent-Sure is designed to remove fumes that are generated in the kiln from the kiln and therefore from the room. The Vent-Sure downdraft kiln vent does not remove enough heat from a small room to be used for ambient ventilation.

If you have a good overhead vent hood you may discharge the output of the Vent-Sure into that hood.

At what temperature should you turn off the Vent-Sure kiln vent?

A customer writes: When firing glazes what is a good temp to turn off the vent so kiln can hit target temp in my case 2190 Deg F. Do glazes off-gas after say 2000 degrees? Is there a general temperature to turn off vent?

Answer: Generally speaking it is best for your kiln to leave the Vent-Sure on for the entire time the kiln is heating up. Mostly this is to get all of the corrosive fumes before they

L&L VENT-SURE DOWNDRAFT KILN VENT INSTRUCTIONS

get to your elements, wiring, and other metal parts of the kiln.

You can leave it on for the cooling as well if you need it to cool off more quickly.

Usually a slower cool-down is preferred though, so often the fan is turned off for the cool-down.

High-fire clays and glazes out-gas until the kiln begins to cool. Once the glaze has set, and the clay has vitrified no more gasses escape.

The heat in a red-hot kiln is almost all radiant heat. The hotter the kiln gets, the fewer and fewer air molecules are even present inside. Because of this- it is only helping the heating rate a tiny little bit to turn off the vent before the end of the firing.

How long does a Vent-Sure downdraft vent last?

The Vent-Sure downdraft kiln vent is pulling not only air but moisture and the products of hot moisture and the chemicals that are present in the clay. Some of these products are highly acidic (like sulfuric acid, hydrofluoric acid and others). The exact amount and composition of the effluents of your kiln, and hence in the vent, will vary with how dry your work is and what is in the clay to begin with. The Vent life seems to be totally dependent on these conditions. The more moisture and acids created by the materials in the clay and water then the shorter the vent life. If you have good conditions the vent can last for many years - if not - then you will be replacing various parts over the years.

That said - L&L's experience has been very positive. We have sold thousands of Vent-Sures for over 15 years. We sell very few replacement motors and other parts. The most vulnerable part seems to be the thin aluminum flexible duct that goes from the kiln to the vent motor. This is cheap and you can find replacements locally.

The motors hold up very well in terms of lubrication and vibration. The Vent-Sure is warranted for three years.

FEATURES AND SPECIFICATIONS

ADJUSTABLE AMOUNT OF VENTING

A sliding adjuster on the vent Bypass Collection Box adjusts the amount of venting from the system (see photo on page 3). Vent only what you need to vent - don't waste heat and energy by venting more than you need.

EXTERNAL VENTING

External venting is safer and surer than venting to the inside of your kiln room with a filter.

REMOTE MOUNTING OF MOTOR

The vent blower motor is mounted to a wall plate with a 12" length of exhaust pipe that mounts on the wall (see photo). This keeps the heat of the kiln away from the motor (for longer motor life) and keeps the motor vibration away from the kiln. (With the special "Multi-Mounting Bracket" the vent motor may be mounted on the floor or a wall with the outlet pointing up and then connected to an existing vent system or 4" wall outlet. If you decide to mount it this way see the caution on page 5).

MOUNTS ON ANY L&L KILN

The Vent-Sure vent system can be installed on almost any kiln. It requires only that you drill several small vent holes through the kiln floor (note that if mounting the bypass/collection box to the stand, that four studs are factory installed on the bottom of the stand). Mounting hardware is included.

Note: L&L Vent-Sure vent are not c-MET-us listed for use on any kiln except those made by L&L Kiln Mfg., Inc.

POWERFUL VENT MOTOR

The blower vents up to 146 CFM (cubic feet per minute at 0 static pressure and 110 CFM at 0.500-In. static Pressure). Remember - not all of this air comes from the kiln - some comes from the Bypass Collection Box.

OUTLET TEMPERATURE UNDER 150°F

The outlet temperature of the air is less than 150°F as long as you do not exceed the recommended holes in the kiln.

FLEXIBLE DUCT INCLUDED

15 feet of flexible expandable aluminum 3" diameter duct is included along with necessary hose clamps. Longer lengths or lengths of 3" stove pipe can be used as well.

LOW ELECTRICITY USAGE

The Vent-Sure vent System uses only 0.75 amps at 120 volts.

VENTS UP TO 20 CUBIC FEET OR MORE

The Vent-Sure vent System was designed to be used with all L&L model kilns. We recommend one vent system for kilns up to approximately 20 cubic feet. On larger kilns, depending on how much venting you need, you may need more than one vent system. (This really depends on how

L&L VENT-SURE DOWNDRAFT KILN VENT INSTRUCTIONS

much venting you need for your situation). Note that you can always add another vent if you find you need more venting.

MOTOR SPECIFICATIONS

120 VOLT MOTOR

PSC Blower, Type:Forward Curve, Direct Drive

Wheel Dia. (In.):3-15/16, Wheel Width (In.):2-1/2

CFM @ 0.000-In. SP:146, CFM @ 0.100-In. SP:140, CFM @ 0.200-In. SP:126, CFM @ 0.300-In. SP:124, CFM @ 0.400-In. SP:120, CFM @ 0.500-In. SP:110,

Voltage:115, Hz:50/60, Phase:1, Full Load Amps:0.75, RPM:3100

Bearing Type:Ball, Motor Type:Permanent Split Capacitor, Motor Enclosure:Open, Motor Insulation:Class B, Thermal Protection:Auto

Lead Length (In.):13, Conduit Box:Yes,

Ambient Temp. (Deg. F):104, Max. Inlet Temp. (Deg. F):104

Inlet Dia. (In.):3-1/8, Outlet Height (In.):2-3/16, Outlet Width (In.):3-1/4, Overall Height (In.):5-3/4, Overall Width (In.):6-5/16, Overall Depth (In.):5-3/8, Mounting:All Position, Housing Finish:Gray Enamel, Housing Material:Rolled Steel

Agency Compliance:UL Recognized US and Canada (E47479)

220-240 VOLT MOTOR

Item-PSC Blower, Type-Forward Curve, Direct Drive

Wheel Dia. (In.):3-3/4, Wheel Width (In.):1-7/8

CFM @ 0.000-In. SP:133, CFM @ 0.100-In. SP:128, CFM @ 0.200-In. SP:126, CFM @ 0.300-In. SP:119, CFM @ 0.400-In. SP:112, CFM @ 0.500-In. SP:105,

Voltage:230, Hz:50/60, Phase:1

Full Load Amps:0.33, RPM:2880

Bearing Type:Ball, Motor Type:Permanent Split Capacitor, Motor Enclosure:Open, Motor Insulation:Class B, Thermal Protection:Auto, Lead Length (In.):13, Conduit Box:Yes, Ambient Temp. (Deg. F):104, Max. Inlet Temp. (Deg. F):104

Inlet Dia. (In.):3-1/4, Outlet Height (In.):2-1/2, Outlet Width (In.):2-9/16, Overall Height (In.):6-9/16, Overall Width (In.):5-5/8, Overall Depth (In.):6-9/16

Mounting:All Position, Housing Finish:Gray Enamel, Housing Material:Rolled Steel

The Vent-Sure vent is c-MET-us listed in both the US and Canada for use with L&L listed kilns. UL 499, CSA C22.2, No. 122, CSA C22. Listing No E112742.

PARTS

Prices of all parts are listed at:
hotkilns.com/parts

Complete Vent-Sure Kiln Vent System

M-V-VENT/00 (see web)

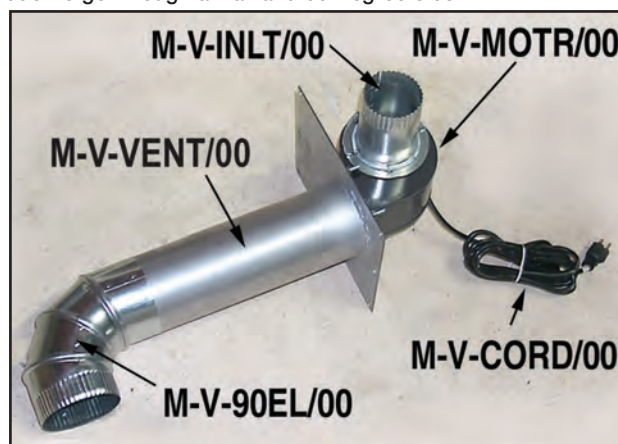
VENT-SURE Vent. 120 Volt. Complete System as described above and on our separate Vent-Sure brochure. This includes the motor, an 8 foot cord with a rocker type On/Off switch mounted in line in the cord, the inlet duct attached to the motor, the wall mounting bracket, a 90 deg elbow for mounting on the end of the outlet pipe (to keep rain water out), the Bypass Collection Box for attaching to the kiln stand or kiln side along with mounting hardware for mounting to an L&L kiln stand and one section of 15 foot flexible aluminum duct with hose clamps.

M-V-VENT/41 (see web)

VENT-SURE Vent. 220-240 Volt. Typically used in non-US installations.

You can also purchase individual parts to suit your own configuration or as replacements:

Below shows the vent system blower assembly with the motor, cord and switch set, 3" inlet duct to hold the flexible duct, 12" duct to go through a wall and 90 Degree elbow.



M-V-FANK/00 (see web)

Complete blower assembly. Pictured above ^

M-V-FAN0/00 (see web)
Fan/Blower Motor for Vent-Sure. 120 Volts. This is just the motor with no attached brackets or inlets. Cord is not included.

M-V-FAN0/41 (see web)
Fan/Blower Motor for Vent-Sure. 220-240 Volts. This is just the motor with no attached brackets or inlets. Cord is not included.

M-V-BRKT/00 (see web)
Steel plate onto which the motor mounts. Includes 4" x 12" outlet pipe and output mounting plate.

L&L VENT-SURE DOWNDRAFT KILN VENT INSTRUCTIONS

M-V-INLT/00 (see web)
Motor Inlet Duct. This is the piece of duct that attaches to the inlet of the motor. The expandable aluminum duct fits onto this.

M-V-OUTT/00 (see web)
Motor Outlet Duct. This is the piece of duct that attaches to the outlet of the motor.

M-V-90EL/00 (see web)
90 Deg 4" elbow. Used for attaching to motor mount duct to the outside to prevent water from getting into duct.

M-V-CORD/00 (see web)
Power Cord for Vent-Sure. Includes a cord mounted on/off switch. (Call factory for non-USA cords)

Power Cord with On/Off switch:



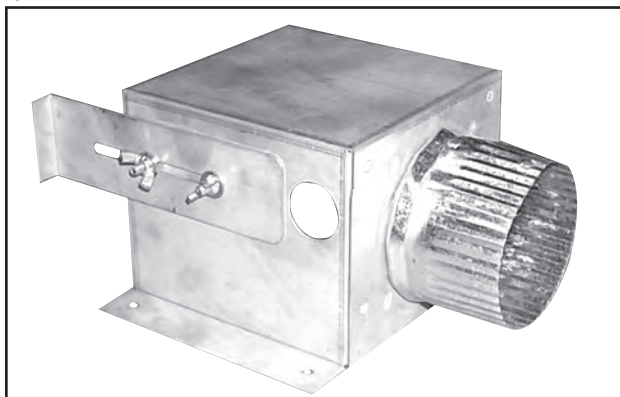
M-V-DUCT/00 (see web)
Flexible Vent Duct 2-1/2 to 15 Feet Expandable, Flexible Aluminum 3" duct with two hose clamps.

Flexible Aluminum Duct shown with hose clamps:



M-V-BBOX/00 (see web)
Bypass Collection Box. Includes hardware for mounting and slide control. Note: This has the proper mounting hole configuration to be mounted to any L&L kiln stand. It can also be mounted to the side of other kilns (typically on the bottom section).

Bypass Collection Box:



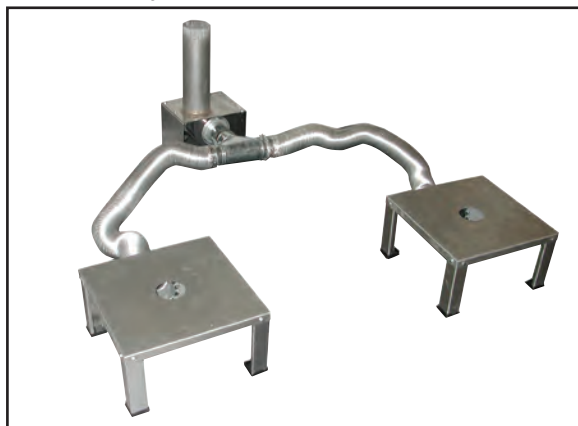
M-V-MULT/00 (see web)
Multi-Mounting Bracket. Comes with six (6) sets of 1/4-20 bolts, nuts and lock washers for mounting this to the "Wall mount bracket" (M-V-VENT/BK).

This special "Multi-Mounting Bracket" will allow you to mount the vent on the floor or wall with the outlet of the vent pointing up. There are mounting holes on the bottom (for floor mounting) and on the side as well (for wall mounting):



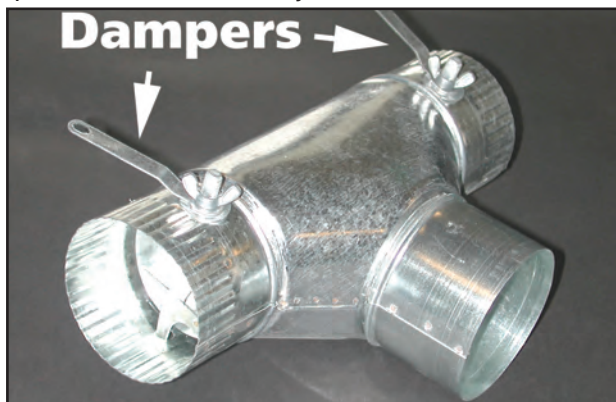
M-V-VENT/DB (see web)
Vent Doubler System for Vent-Sure. Includes a "T" duct with dampers, an extra Bypass Collection Box, Extra Flexible Duct.

Vent Doubler System:



M-V-TDUC/00 (see web)
"T" DUCT to attach two aluminum flexible ducts to. Includes dampers on the two inlets. The outlet fits onto the Motor Inlet Duct of the Vent-Sure and the Flexible Vent Duct(s) fit onto the inlets of this "T" Duct. (NOTE: The Multi-Mounting Bracket is shown in the photograph but NOT included in the system).

Special "T" duct for doubler system:



VENT CONTROL INSTRUCTIONS

VENT CONTROL

The Vent Control allows you to automatically control the operation of the Vent-Sure kiln vent with one of the outputs from the DynaTrol (or Genesis). If you have a vent this can be easily retrofitted with a little wiring into your control panel.

Construction

The Vent Control consists of a relay that is controlled from output #4 on the DynaTrol (or Genesis).

There is a female 120 volt receptacle to plug the vent into and a cord to plug into a 120 volt wall outlet.

There is a 6 foot wire that connects the control box to the kiln control panel. A grommet is included for non-factory installation.

Operation

NOTE: These options are set in the "Hidden Menu"

OPTION A (OP A)

Used to control a vent. Output 4 can be programmed to be on or off during each segment of a Vary-Fire program. During an Easy-Fire program, output 4 comes on at the beginning of the firing and turns off after the kiln has cooled to 150F.

OPTION B (OP b)

Used to control a vent. Output 4 can be programmed to be on or off during each segment of a Vary-Fire program. Output 4 comes on at the beginning of an Easy-Fire program, off at 1450°F, back on after the firing is complete and the kiln has cooled to 1000°F and finally off again when the temperature is below 150°F.

OPTION C (OP C)

Used to control a vent, an alarm, or other atmospheric control. Output 4 can be programmed to be on or off during each segment of a Vary-Fire program. Output 4 is off during Easy-Fire programs.

Where It Can Be Used

It is only available for kilns with a DynaTrol or Genesis. (Not available on the One-Touch).

It may not be used with kilns with powered bottoms (because the same output on the control is used)

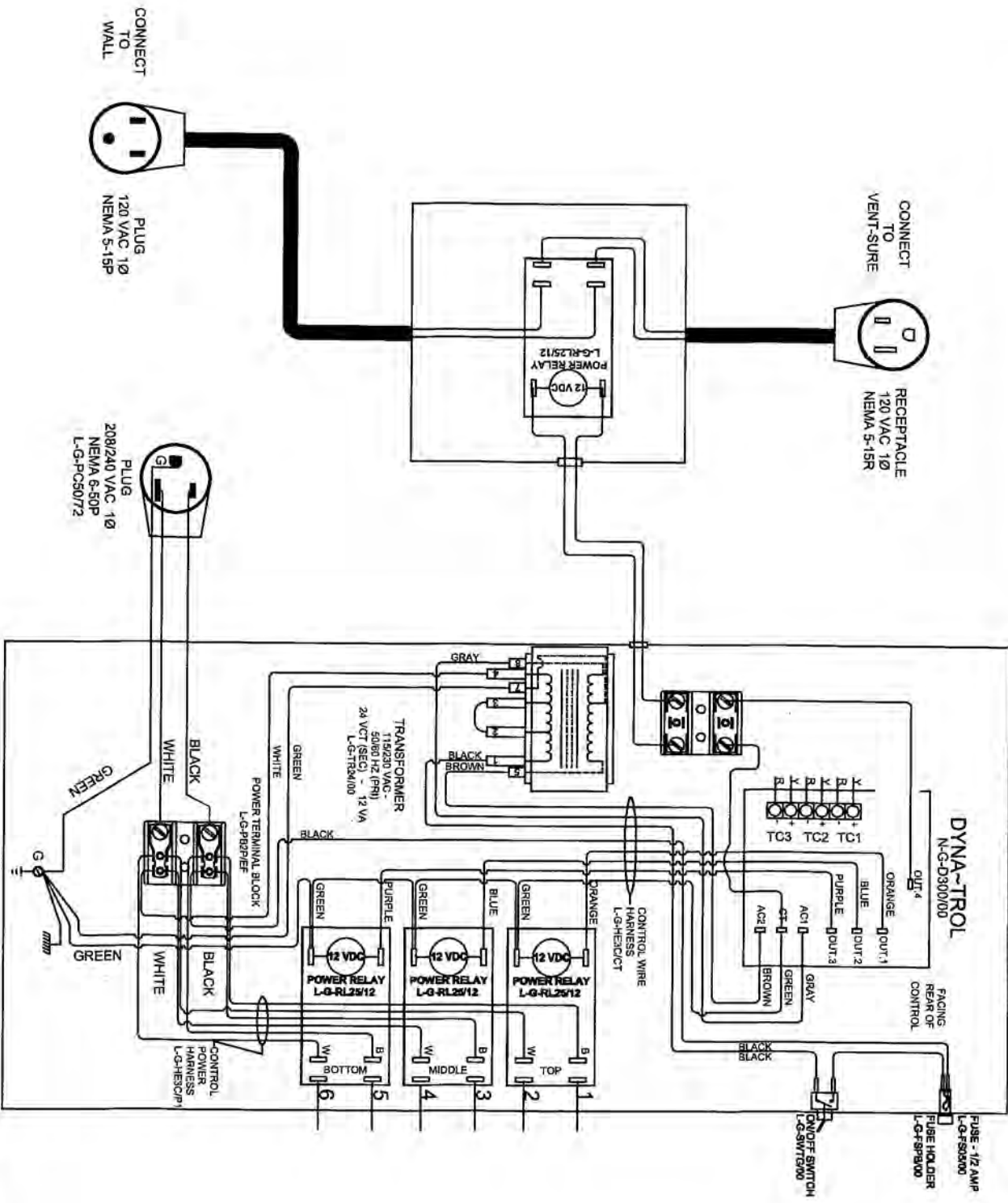


For more information:

See hotkilns.com/vent-control

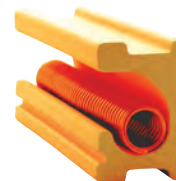


LOOKING INSIDE CONTROL PANEL



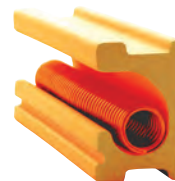
DAVINCI INSTRUCTION MANUAL

WIRING



L&L Kiln's patented
hard ceramic
element holders
protect your kiln.

DAVINCI INSTRUCTION MANUAL

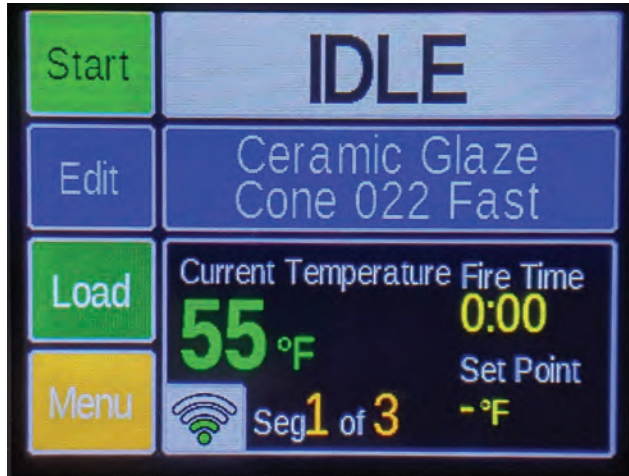


L&L Kiln's patented
hard ceramic
element holders
protect your kiln.

ACCESSORIES THAT CAN BE ADDED FOR L&L KILNS

GENESIS CONTROL

If you have a DynaTrol you can upgrade to a Genesis Touch Screen Control.



Highlights of the Genesis

1. Touch-screen technology for the user interface
2. Easy-to-follow screen descriptions
3. Different user-interface levels, which can be set to match the user's firing knowledge
4. Graphical display of the firing process right at the controller. This means you can graph the firing in real time and compare the program with actual results.
5. Glass programs included.
6. Store up to 12 custom user programs
7. Up to 32 segments per program
8. Ability to make adjustment during a firing such as add segments, add temperature, and skip segments

WiFi enabled for easy software updating. (Note KISS software is not needed for this to work). This works by connecting through a local WiFi connection to the Bartlett servers and downloading the latest software. It is very easy to do and requires no more than setting up your WiFi connection and pressing a few buttons.

For more information

See hotkilns.com/genesis

For pricing

See hotkilns.com/retrofit-genesis

ROLLING STANDS

You can add this to most polygonal kilns that is 27" or less in height.



L&L's rolling kiln stand features heavy gauge (14 ga) galvanized steel construction with multiple bends for extra strength, steel swivel locking casters with polypropylene wheels, integrated vent collection box support, and guide rails for the kiln. Each size is fitted to the kiln.

There are three sizes:

Small for an 8 sided kiln like an e18S (22.5" by 22.8")

Medium for a 10 sided kiln like an e23T (28.8" by 30")

Large for a 12 sided kiln like an e28T (34.3" by 34")

NOTE: There are the same height from the floor to the top of the stand as our normal stands.

The vent collection box is not included but, when you order a Vent-Sure vent system the longer duct is included with the system. The Rolling Stand for a 12 Sided kiln uses an 18' long duct and the Rolling Stand for the 8 Sided and 10 Sided kilns use a 12" long duct.

These ship by UPS.

For more information

See hotkilns.com/rolling-stands

Pricing for retrofit stands

hotkilns.com/kiln-parts/rolling-stand-8-sided-kiln

hotkilns.com/kiln-parts/rolling-stand-10-sided-kiln

hotkilns.com/kiln-parts/rolling-stand-12-sided-kiln

ACCESSORIES THAT CAN BE ADDED FOR L&L KILNS

PLATINUM TYPE S THERMOCOUPLES

The standard thermocouple used on the DynaTrol or Genesis control is Type K. The most common thermocouple configuration that we use is an 8 gauge exposed Type K thermocouple. This is standard on Easy-Fire, School-Master, Jupiter, eQuad-Pro, Hercules, Easy-Load, DaVinci, Fuego and Doll kilns.

The very best thermocouple for constant high fire applications is a Type S platinum thermocouple with an alumina sheath. This is standard on the JH Series kilns and is recommended for the most extreme conditions (like firing crystalline glazes). If you have a DynaTrol or Genesis control on your kiln, you can order Type S thermocouples. The control is soft and hard programmed for this (to avoid potential misfiring) and special calibrated wire connects the platinum thermocouples with the control.

Below is Type S Platinum Thermocouple:



TECHNICAL INFORMATION

Type S thermocouples are composed of a positive leg which is 90% platinum and 10% Rhodium, and a negative leg which is 100% platinum. It is usable from 32°F to 2700°F. (0°C to 1480°C). It has a different EMF output than Type K thermocouples (meaning the same temperature will produce different voltages to the control which must then be interpreted differently).

At temperatures used in pottery kilns (even the highest 2400°F) these thermocouples can last for a very long time (as long as they are not mechanically broken).

The lead wires that go from the Type S thermocouple to the control are a special grade that is not interchangeable with Type K lead wire.

On DynaTrols used before Jan 1, 2006, or on One-Touch controls, this is not a retrofittable option.

On DynaTrol 700 controls (used after Jan 1, 2006) the control can be easily converted from Type K to Type S in

the field. You will still need to change the lead wire. Contact L&L for more information.

DESCRIPTION

The Type S thermocouples that we provide have a 5/16" OD alumina sheath. They are ungrounded. There are two lengths. The short one used in the Easy-fire, Jupiter, eQuad-Pro, JH Series, DaVinci, and Doll kilns is 120 mm (4.75") long. The medium one used in the Easy-Load front-loading kilns is 160 mm long (6.3").

Polarity

Black Wire = PLUS (+)

Red Wire = MINUS (-)

RETROFITTING CAUTIONS

CHECK THE CONFIGURATION OF ANY REPLACEMENT CONTROL TO MAKE SURE YOU DON'T MELT YOUR KILN! See your control instructions for how to do this.

A replacement control, if ever needed, will typically have our standard configuration for Type K thermocouples with 3 zone control. THIS WILL NOT MATCH YOUR KILN IF YOU HAVE TYPE S THERMOCOUPLES!

This is the MOST IMPORTANT thing to do. If your kiln has Type S thermocouples and the control is set up for type K thermocouples you could overfire the kiln to the point of a complete melt-down.

Type K thermocouple extension wire (the wire that goes from the thermocouple to the control) is either yellow or brown. Type S extension wire is green (in the USA). See this for more information on thermocouple wires and hookup: hotkilns.com/tc-polarity

ORDERING

PART NUMBER: T-G-SXXX/00

Type-S Thermocouple - 120 mm (Standard Length).

Type S Platinum Thermocouple with Alumina Protection Tube and Terminal Block - Unit is 120 mm (4-3/4") Long x 1/4" Diameter. Can be used on any polygonal, square, or rectangular kilns with standard 2-1/2" or 3" brick insulation using a DynaTrol control board. Not for use on any Front-Loading kilns, or custom kilns with more than 3" of insulation.

hotkilns.com/type-s-thermocouple-standard

PART NUMBER: T-G-SXXX/06

Type-S Thermocouple - 160 mm (Medium length). Type S Platinum Thermocouple with Alumina Protection Tube

ACCESSORIES THAT CAN BE ADDED FOR L&L KILNS

and Terminal Block - Unit is 160 mm (6-5/16") Long x 1/4" Diameter. Used on Easy-Load kilns where wall thickness is 5".

hotkilns.com/type-s-thermocouple-long

NOTE: Type S thermocouples can be ordered with a kiln as part of the original equipment on all kilns that have a DynaTrol or Genesis Control.

METAL SHEATHED THERMOCOUPLES

An alternative to the standard 8 gauge thermocouple is the Type K industrial Pyrocil metal-sheathed thermocouples.

Below is metallic sheathed Pyrocil thermocouple:



APPLICATION

These thermocouples are useful where greater responsiveness is required than you will get with the 8 gauge inside of a 1/8" wall thickness ceramic protection tube. This is typically for industrial applications. Most ceramic firing does not need quick response.

We do not recommend using these above cone 6 temperatures (2232°F, 1222°C).

DESCRIPTION

Industrial Grade Pyrocil Metal Sheathed Thermocouples are made with a high temperature alloy called Pyrocil.

L&L provides these special thermocouples with a 1/4" diameter sheath. These will last longer than the smaller 1/8" diameter thermocouples that some manufactures use. We use a high quality ceramic terminal block on the end.

The standard Pyrocil thermocouple is 6-1/2" long.

Because the Pyrocil thermocouples are still Type K, no changes need to be made with the control board to use them.

You will need a special ceramic bushing to fill up the hole left by the standard Type K thermocouple.

ORDERING

PART NUMBER: T-G-E23M/05

Type-K Industrial Grade Pyrocil Sheathed Thermocouples with Ceramic Terminal Block - Unit is 5" Long x 1/4" Diameter. Used on DaVinci, Jupiter, Easy-Fire and other kilns with 2-1/2" or 3" brick walls.

hotkilns.com/type-k-pyrocil-sheathed-thermocouple-5-long

PART NUMBER: T-G-E23M/06

Type-K Industrial Grade Pyrocil Sheathed Thermocouples with Ceramic Terminal Block - Unit is 6-1/2" Long x 1/4" Diameter. Used on Hercules and Easy-Load kilns where the wall has a thickness is 5" of insulation.

hotkilns.com/type-k-pyrocil-sheathed-thermocouple

ELECTRICAL NOISE FILTER AND 120V CONTROL POWER SUPPLY

Electrical Noise Problems

L&L kilns that use the DynaTrol or One-Touch™ electronic control normally get their control voltage transformed from the incoming line voltage that the kiln operates on. This is standard and proper industrial practice. However, in some cases this is not desirable.

If you have problems with short power outages, voltage spikes, voltage drops, or excessive environmental line noise (such as is caused by large 3-phase motors or phase angle fired SCRs), this can cause unpredictable behavior in the electronic control. These are conditions found on overburdened power grids, in some factories, and sometimes in rural areas. It is hard to detect without very specialized equipment (most electricians would not be able to "see" these problems).

How To Solve The Problem

When you have the above conditions we recommend having the control feed by a separate 120 volt line (with a standard 6 foot long cord) and having that voltage filtered though an EMI (Electrical Magnetic Interference) noise filter.

We then recommend plugging the 120 volt cord into a good computer surge protector or better yet a UPS (Uninterruptable Power Supply) power supply with isolation transformer. You can buy a good UPS for at a computer store for less than \$100.

For information and pricing

See hotkilns.com/noise-filter

ACCESSORIES THAT CAN BE ADDED FOR L&L KILNS

APM ELEMENTS

Technical Description

APM element wire is a very special sintered alloy that Kanthal makes. It resists grain growth at high temperatures and has a very high hot strength (which keeps the coils from flattening as easily as with Kanthal A1 or equivalent wire). You can get more technical information from the Kanthal web site at kanthal.com.

This is from Kanthal's web site:

Kanthal APM is an advanced powder metallurgical, dispersion strengthened, ferritic iron-chromium-aluminum alloy (FeCrAl alloy) which is used at wire temperatures up to 1425°C (2595°F). Kanthal APM has good hot strength, giving good form stability of the heating elements with less need for element support. It has low tendency to ageing, low resistance change and long element life. Kanthal APM has an excellent surface oxide, which gives good protection in corrosive atmospheres as well as in atmospheres with high carbon potential, and no scaling. The combination of excellent oxidation properties and form stability makes the alloy unique. Typical applications for Kanthal APM are in furnaces for firing of high temperature ceramics, in high temperature heat treatment furnaces, in high temperature laboratory furnaces, in high temperature furnaces in the electronic industries, and in diffusion furnaces.

These elements are recommended for crystalline glaze applications because the same process that causes crystal growth in glazes also causes grain growth in the standard Kanthal A-1 alloy used in electric ceramic pottery kilns.

Pricing of retrofit elements

These typically cost about three times what you would pay for regular replacement elements. For pricing of retrofit elements email service@hotkilns.com

VENT CONTROL

The Vent Control allows you to automatically control the operation of the Vent-Sure kiln vent with one of the outputs from the DynaTrol (or Genesis). If you have a vent this can be easily retrofitted with a little wiring into your control panel.

Construction

The Vent Control consists of a relay that is controlled from output #4 on the DynaTrol (or Genesis).

There is a female 120 volt receptacle to plug the vent into and a cord to plug into a 120 volt wall outlet.

There is a 6 foot wire that connects the control box to the kiln control panel. A grommet is included for non-factory installation.

Where It Can Be Used

It is only available for kilns with a DynaTrol or Genesis. (Not available on the One-Touch).

It may not be used with kilns with powered bottoms (because the same output on the control is used)



For more information and pricing

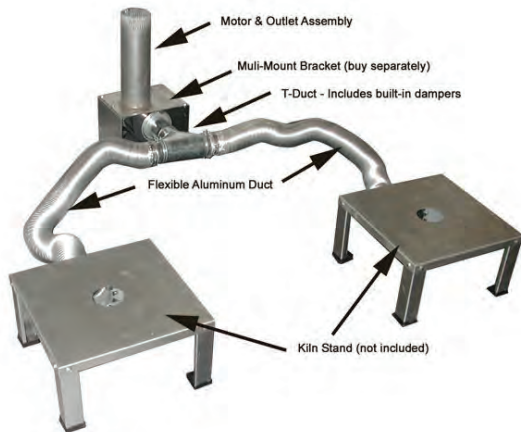
See hotkilns.com/vent-control

ACCESSORIES THAT CAN BE ADDED FOR L&L KILNS

VENT DOUBLER

Vent Doubler Allows The Use Of One Vent With Two Kilns

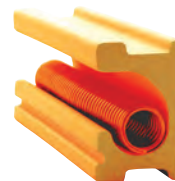
You can get a vent doubler options which allow you to vent two kilns that are each up to 10 cubic feet. This can be added to most kilns if you are adding another kiln and want to save money on the extra vent.



For more information and pricing

See hotkilns.com/vent-doubler

DAVINCI INSTRUCTION MANUAL



L&L Kiln's patented
hard ceramic
element holders
protect your kiln.

FIRING LOG FOR L&L KILNS

[illegible]

Temperature Equivalent Chart for Orton Pyrometric Cones (°F) Cone Numbers 022-14



Cone	Self Supporting Cones				Large Cones				Small
	Regular		Iron Free		Regular		Iron Free		Regular
	27	108	270	27	108	270	108	270	540
Heating Rate ° F/hour (last 180° F of firing)									
022		1087	1094				N/A	N/A	1166
021		1112	1143				N/A	N/A	1189
020		1159	1180				N/A	N/A	1231
019	1213	1252	1283				1249	1279	1333
018	1267	1319	1353				1314	1350	1386
017	1301	1360	1405				1357	1402	1443
016	1368	1422	1465				1416	1461	1517
015	1382	1456	1504				1450	1501	1549
014	1395	1485	1540				1485	1537	1598
013	1485	1539	1582				1539	1578	1616
012	1549	1582	1620				1576	1616	1652
011	1575	1607	1641				1603	1638	1679
010	1636	1657	1679	1600	1627	1639	1648	1675	1686
09	1665	1688	1706	1650	1686	1702	1683	1702	1751
08	1692	1728	1753	1695	1735	1755	1728	1749	1801
07	1764	1789	1809	1747	1780	1800	1783	1805	1846
06	1798	1828	1855	1776	1816	1828	1823	1852	1873
05½	1839	1859	1877	1814	1854	1870	1854	1873	1909
05	1870	1888	1911	1855	1899	1915	1886	1915	1944
04	1915	1945	1971	1909	1942	1956	1940	1958	2008
03	1960	1987	2019	1951	1990	1999	1987	2014	2068
02	1972	2016	2052	1983	2021	2039	2014	2048	2098
01	1999	2046	2080	2014	2053	2073	2043	2079	2152
1	2028	2079	2109	2046	2082	2098	2077	2109	2163
2	2034	2088	2127				2088	2124	2174
3	2039	2106	2138	2066	2109	2124	2106	2134	2185
4	2086	2124	2161				2120	2158	2208
5	2118	2167	2205				2163	2201	2230
5½	2133	2197	2237				2194	2233	N/A
6	2165	2232	2269				2228	2266	2291
7	2194	2262	2295				2259	2291	2307
8	2212	2280	2320				2277	2316	2372
9	2235	2300	2336				2295	2332	2403
10	2284	2345	2381				2340	2377	2426
11	2322	2361	2399				2359	2394	2437
12	2345	2383	2419				2379	2415	2471
13	2389	2428	2458				2410*	2455*	N/A
14	2464	2489	2523				2491*	2530*	N/A

Pyrometric cones have been used to monitor ceramic firings for more than 100 years. They are useful in determining when a firing is complete, if the kiln provided enough heat, if there was a temperature difference in the kiln or if a problem occurred during the firing.

Cones are made from carefully controlled compositions. They bend in a repeatable manner (over a relatively small temperature range - usually less than 40° F). The final bending position is an indication of how much heat was absorbed.

Behavior of Pyrometric Cones

Typically, it takes 15 to 25 minutes for a cone to bend once it starts. This depends on the cone number. The cone bends slowly at first but once it reaches the half way point (3 o'clock), it bends quickly. When the cone tip reaches a point level with the base, it is considered properly fired. This is the point for which temperature equivalents are determined. Differences between a cone touching the shelf and a cone at the 4 o'clock position are small, usually 1 or 2 degrees.

Temperatures shown on the charts were determined under controlled firing conditions in electric kilns and an air atmosphere. Temperatures are shown for specific heating rates. These heating rates are for the last 100° C or 180° F of the firing. Different heating rates will change the equivalent

temperature. The temperature will be higher for faster heating rates and lower for slower heating rates.

Cone bending may also be affected by reducing atmospheres or those containing sulfur oxides. Orton recommends the use of Iron-Free cones for all reduction firings (cones 010-3). If a cone is heated too fast, the cone surface fuses and binders used to make cones form gases that bloat the cone. If cones are to be fired rapidly, they should be calcined (pre-fired) before use. Cones should be calcined to about 850° F (455° C) in an air atmosphere.

If a cone is soaked at a temperature near its equivalent temperature, it will continue to mature, form glass and bend. The time for the cone to bend depends on several factors and as a general rule, a 1 to 2 hour soak is sufficient to deform the next higher cone number. A soak of 4 to 6 hours will be required to deform two higher (hotter) cones.

for more information on pyrometric cones, contact Orton or visit us at www.ortonceramic.com



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These tables provide a guide for the selection of cones. The actual bending temperature depends on firing conditions. Once the appropriate cones are selected, excellent, reproducible results can be expected. Temperatures shown are for specific mounted height above base. For Self Supporting - 1 3/4"; for Large - 2"; for Small - 1 5/16". For Large Cones mounted at 1 3/4" height, use Self Supporting temperatures. * These Large Cones have different compositions and different temperature equivalents.

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Cone	Self Supporting Cones						Large Cones			Small Regular
	Regular		Iron Free				Regular		Iron Free	
	15	60	150	15	60	150	60	150	60	150
Heating Rate °C/hour (last 100° C of firing)										
022		586	590				N/A	N/A		300
021		600	617				N/A	N/A		630
020		626	638				N/A	N/A		643
019	656	678	695				676	693		666
018	686	715	734				712	732		723
017	705	738	763				736	761		752
016	742	772	796				769	794		784
015	750	791	818				788	816		825
014	757	807	838				807	836		843
013	807	837	861				837	859		870
012	843	861	882				858	880		880
011	857	875	894				873	892		900
010	891	903	915	871	886	893	898	913	884	915
009	907	920	930	899	919	928	917	928	917	919
008	922	942	956	924	946	957	942	954	945	955
007	962	976	987	953	971	982	973	985	970	983
006	981	998	1013	969	991	998	995	1011	991	1008
05½	1004	1015	1025	990	1012	1021	1012	1023	1011	1023
005	1021	1031	1044	1013	1037	1046	1030	1046	1032	1044
004	1046	1063	1077	1043	1061	1069	1060	1070	1060	1062
003	1071	1086	1104	1066	1088	1093	1086	1101	1087	1098
002	1078	1102	1122	1084	1105	1115	1101	1120	1102	1131
001	1093	1119	1138	1101	1123	1134	1117	1137	1122	1148
1	1109	1137	1154	1119	1139	1148	1136	1154	1137	1178
2	1112	1142	1164				1142	1162	1137	1184
3	1115	1152	1170	1130	1154	1162	1152	1168	1151	1190
4	1141	1162	1183				1160	1181		1196
5	1159	1186	1207				1184	1205		1209
5½	1167	1203	1225				1201	1223		1221
6	1185	1222	1243				1220	1241		N/A
7	1201	1239	1257				1237	1255		1255
8	1211	1249	1271				1247	1269		1264
9	1224	1260	1280				1257	1278		1300
10	1251	1285	1305				1282	1303		1317
11	1272	1294	1315				1293	1312		1330
12	1285	1306	1326				1304	1324		1336
13	1310	1331	1348				1321*	1346*		1355
14	1351	1365	1384				1366*	1388*		N/A

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TROUBLESHOOTING KILN FIRING WITH CONE PACKS

BASIC CONE INFORMATION

PYROMETRIC CONES

Pyrometric cones are made of clay and other minerals and are precisely formulated to soften when fired in a kiln. They will bend over when they have absorbed a certain amount of heat. The amount of heat is related to both time and temperature. They mirror fairly accurately what goes on in a ceramic body and can be a more reliable guide to firing than a thermocouple instrument.

Differing materials in the cones result in different firing temperatures. The cones you are likely to use in an L&L kiln are numbered from Cone 022 to Cone 10 (coldest to hottest). The number is imprinted on the cone. Usually clay and glaze comes with a recommended cone to fire to. A cone is a tall (about 2-1/2") pyramid made from specific damp-pressed ceramic materials. Each cone has a slight lean to it when placed on a flat surface. Be careful not to drop cones or expose cones to moisture.

CONES MEASURE HEAT-WORK

Cones are not temperature measuring devices. They measure how much heat has been absorbed by the ware in the kiln, which is the result of the combination of time and temperature. A particular piece of clay needs a certain amount of time at a specific temperature to properly fire it, lower temperature if the time is longer, higher temperature if the time is shorter. An example of this would be if you added about a 20 minute hold to the maximum temperature of a cone 6 firing, you would be able to lower that final temperature by about 20°F. An hour hold time would mean a final temperature of about 40°F lower. A two hour hold time, about 60°F lower.

LARGE SELF SUPPORTING CONES

Although there are various types of cones available we recommend using the "self-supporting large cones". They have a built-in base that allows the cone to sit flat while always placing the pyramid part of it at the proper angle. The angle is there to ensure that the cone bends in the direction you want it to, and doesn't just slump and puddle.

CONE PACKS

The best way to use the cones, especially if they are all you have to tell how hot your kiln is getting, is to use 'cone packs', or the three cone system. The three cones are placed in a line, aimed so that when they fall, they will fall in a line. The first cone to fall should be in the front of the three cone line. This cone should be one cone number lower than the one you wish to fire to. The target cone (the cone you wish to fire to) should be the next one to fall and should be in the middle. The last

cone should be one cone number higher than the target cone. The first cone is to warn you that the firing is almost done. The target cone tells you when to turn off the kiln, and the last cone tells you if the kiln got hotter than you thought it did.



Picture of a "cone pack" (Courtesy of Orton). The ones in the back are before the firing and the ones in the front are after a perfect firing! These are Self-Supporting Large Cones.

USE CONES TO CONTROL ACCURACY IN AN AUTOMATIC KILN

We recommend checking the accuracy of your control and thermocouples every so often by placing at least one large cone (the target cone or cone number you are firing to) in the top, middle and bottom. Thermocouples will drift in their accuracy, but you can adjust the cone offset or thermocouple offset (or both) to compensate for this. You know how many degrees off the thermocouple reads at the end of the firing. Using a cone near the thermocouple and a "cone to temperature chart" will help to calibrate a thermocouple accurately. Remember though, cone temperatures are affected by their location in the kiln, the angle at which they are held, and the rate at which they are heated. Slight variations throughout the kiln should be expected. You can see a "cone to temperature" chart in the LOG, CONES, TIPS, CERAMIC PROCESS section of your manual or at hotkilns.com/orton-cone-chart.

TROUBLESHOOTING FIRING PROBLEMS

Seems like the kiln is under-firing or over-firing slightly

1) On the next firing make up "cone packs", one for each thermocouple. A cone pack is a set of three cones, standing in a line. The cone the firing should go to is called the target cone, and is in the middle. The one in front of it is one cone

TROUBLESHOOTING KILN FIRING WITH CONE PACKS

number lower, and the one behind it is one cone number higher. Pay attention to how you position the cones as they are designed to only fall in one particular direction if placed on a level surface. You do not want a lower-numbered cone stuck in the cone pack behind a higher-numbered cone because the lower-numbered one will fall first and might lean against or knock over the higher-numbered cone, which will compromise the accuracy of both cones.

2) Once the cone packs are positioned on shelves (or on a post lying on its side) and are visible through the peepholes, fire the kiln to the middle cone's number.

3) Near the end of the firing start watching the cone packs. Look for the first cone to fall over in each pack, not necessarily at the same time, but pretty close, probably in the middle zone first.

4) Now watch for the middle cone in each pack. Keep checking the DynaTrol display to be sure it does not say **CPLt**. The middle cone in each pack should start to fall at pretty much the same time in the top, middle and bottom of the kiln. When the tip of the cone touches the melted cone in front of it note the temperature readout on the display for that zone's thermocouple.

a) If the middle cones did not go down together then immediately note the differences in each thermocouple reading from the one thermocouple in the same zone as the first cone that went down. Later on, use the "thermocouple offset" feature to add or subtract degrees from each thermocouple accordingly. Use the differences between the thermocouple readings as a guide to know how much to offset each thermocouple.

b) If the three thermocouple temperatures are close enough to be reading the same thing (the middle cones did all go over at the same time), then the kiln should say **CPLt** right when the cone tips bend over and touch or just before it. If the kiln is still firing after this point, note how many degrees higher it goes before shutting itself off. Then use the "cone offset" feature to change the temperature equivalent of that cone. Subtract the same amount of degrees from the temperature equivalent that the kiln over-fired the cone by.

c) If the kiln shut itself off before bending the cones properly, you want to reprogram it and then re-start it as quickly as possible. Note the temperature at which the kiln shut down. Get from **CPLt** to **IdLE**, **tC2**, current temperature by pressing either **START/STOP** or **ENTER**. Re-program the same program to one cone number higher, then re-start the firing. Do these steps quickly. Now watch the middle cones again and note at what temperature the cones properly bend. If they bent while you were programming then just offset the temperature by 5 or 6 degrees. Shut the kiln off once you note that temperature. Using the "cone offset" feature, add

the difference of the two readings to that cone's temperature equivalent.

Note: From the factory, the settings that interpret temperature signals in the DynaTrol are hard-programmed; they will not change unless part of the microprocessor has been affected. There is a range of acceptability for the accuracy however and the cone offset feature exists to allow you to fine tune the kiln to particular sized loads. It is best to use all new thermocouples to properly tune the cone offset before individual thermocouples begin to drift. Even keeping one new thermocouple solely for calibrating the individual thermocouples will help to keep the kiln accurate.

CALIBRATING YOUR DYNATROL

This is also covered in the instruction sheet called **dynatrol-basic-operation.pdf** in the OPERATION section of your manual or at hotkilns.com/calibrating-kiln.

HELPFUL VIDEOS & LINKS

Calibration

More information on calibrating your kiln:

hotkilns.com/calibrating-kiln

Cone Offset

How to change cone offset in a DynaTrol:

hotkilns.com/change-cone-offset

How to change the thermocouple offset on a DynaTrol. This helps you calibrate the control to match your kiln:

hotkilns.com/change-thermocouple-offset

Firing with Witness Cones

This video shows you how to use witness cones to check the accuracy of the control and your kiln in an L&L Easy-Fire kiln. This video applies to any kiln:

hotkilns.com/firing-kiln-witness-cones

Orton Ceramic Institute

See ortonceramics.com for lots of very helpful information on how to use cones and for many firing tips and great information on firing kilns.

Cone Chart

You can see a "cone to temperature" chart in the LOG, CONES, TIPS, CERAMIC PROCESS section of your manual or at hotkilns.com/orton-cone-chart.

WHAT CONE NUMBERS MEAN: WHY YOU SHOULD CARE

The pyrometric cones used today by ceramic artists and industrial manufacturers were developed in the late 1800's by Edward Orton Jr. Dr. Orton recognized that ceramists needed a way to determine when their ware was fired correctly to develop the properties they required in their finished products. Thus all ceramic products were assigned a cone number to which they were to be fired to assure maturity of the ware during the firing process such as Cone 06 glazes, Cone 04 bodies, etc. Later, the development of electronic temperature controllers simplified the control of the firing process, but they could not replace the cones as a measure of the accumulative effect of time and temperature on the ceramic ware.

An interesting parallel to this principle would be the cooking of a turkey in your electric oven. You can set the oven temperature to 350 degrees Fahrenheit and place the turkey in the oven and estimate how long to cook it to attain an internal temperature of 180 degrees Fahrenheit. However if you want to be assured the turkey reaches the desired internal temperature you can place a meat thermometer into the turkey and it will tell when you have reached the desired internal temperature. Changing the oven temperature will surely effect the time required to reach the desired internal temperature. Cones serve a similar purpose in the firing of ceramics.

Both the Orton and the Bartlett electronic temperature controllers' cone-fire programs were developed based on the actual firing behavior of Orton cones and would not work without the information on cone behavior provided by the Orton Ceramic Foundation. These controllers automatically adjust the final firing temperature based on the actual heating rate of the kiln so that the kiln delivers the correct amount of heat work specified by the cone number program selected. Therefore the most efficient and reliable way to fire your kiln is to utilize the cone-fire programs built into your controller.

However, the electronic controller is not the ultimate answer for assurance that your ware has been fired correctly. The electronic controller measures the temperature inside the kiln via the thermocouple that is usually mounted in the side wall of the kiln and extending into the kiln 1 to 1½ inches. The thermocouple is great for measurement of temperature at a point in space and a point in time and provides the controller feedback needed to control the firing cycle. But heat work is a function of both temperature and time as measured by the bending of pyrometric cones.

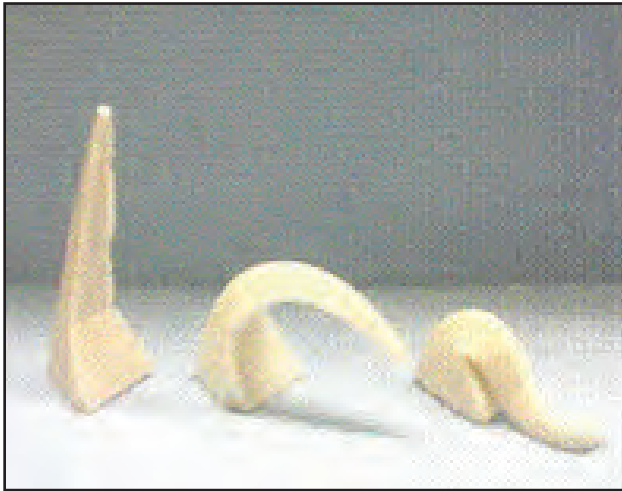
Why is it so important to know if you have attained the correct cone firing? Look at the label on your glaze jar. The

odds are that the glaze is specified as a "Cone X" glaze. The unstated instruction for firing such a glaze is to "apply heat work equal to the cone number specified and the glaze will be properly matured". The glaze manufacturer has developed the glaze formula to mature at a certain cone number. The glaze manufacturer has conducted sufficient testing to know the fired characteristics of the mature glaze as related to glaze fit to the body, color development, the chemical resistance of the glaze surface, food-safe, etc. Under-firing or over-firing can prevent the glaze from attaining the appearance and properties you expect.

Since the thermocouple and the controller do not measure heat work how do you know if you actually matured the glaze in every firing? The thermocouple measures the temperature near the wall of the kiln where the heating elements are located and unfortunately has no means of measuring the temperature within the setting of the ware in the kiln and therefore cannot confirm if the distribution of heat work was uniform throughout the kiln. Remember the turkey story? One could fire the kiln with such a long firing cycle that all areas within the kiln received the desired amount of heat work, but this practice could require additional kilns to meet firing needs and the energy consumption would be wasteful. A definite overkill approach without merit. The programmable controller, coupled with the use of pyrometric cones, allows for the development of firing profiles to meet all your firing conditions. Since most shop operators want to have their kiln fully utilized during each firing, we will consider a fully loaded kiln of glazed ware to be fired to cone 06. The load placed in the kiln has a direct bearing on the firing profile required to successfully fire your ware. Select the cone-fire program consistent with the recommendation of the glaze manufacturer, in this case cone 06. Remember that selecting a cone-fire program alone does not insure that you will obtain uniform heat distribution throughout your ware. The controller is designed to compensate if the kiln is heating slower than the expected rate, but only at the tip of the thermocouple, it has no information about what is occurring in the interior of the ware setting. Place a series of three cones, 07, 06, 05 (self-supporting cones are the most convenient to use) one series located on the outside perimeter of the ware setting, and the second series located in the center of the ware setting on each shelf in the kiln (commonly referred to as "witness cones"). Fire the kiln. Once cool, remove the cones marking their location in the kiln. If the cone 06 is bent so that the tip is at the same level as the top of the foot of the cone in all locations, congratulations, you have just achieved a successful firing to cone 06. See Figure 1.

WHAT CONE NUMBERS MEAN: WHY YOU SHOULD CARE

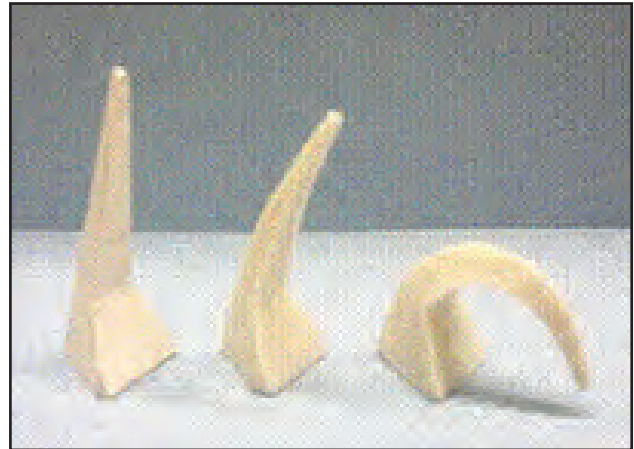
Figure 1: Cone 07 is over-fired and cone 06 indicates a successful cone 06 firing.



Cone 05 Cone 06 Cone 07

If some of the locations indicate that you did not reach cone 06, the tip of cone 06 is not bent enough, you will need to modify your firing cycle on your controller. By having cone 07 along side cone 06 you can determine by how much you failed to reach a cone 06 firing. Cone 07 measures a lesser amount of heat work than cone 06, therefore if cone 07 is bent so that the tip is at the same level as the top of the foot of the cone you are only one cone away from the desired heat work. See Figure 2. There are two simple ways to correct poor heat distribution within your kiln. First, for your cone-fire program if you selected either fast(#1) or standard(#2) heating speeds try slow(#3), which will allow more time during the firing cycle for the heat to equalize in the ware setting, or you can add additional hold time (soak) at the final cone temperature. A combination of both may be necessary depending on how heavily the kiln is loaded. Your kiln manufacturer or your controller manufacturer can be a good resource for suggestions to improve your firing program. The first question you will likely be asked is "what do your witness cones show". Repeat the procedure above once the change(s) to the firing cycle have been made.

Figure 2: Cone 06 has not reached the proper bending angle, indicating an under-fired condition.



Cone 05 Cone 06 Cone 07

Since minor under-firing may not be obvious to the eye, the use of cones in every firing will alert you if there is a potential problem with the correct amount of heat work being delivered uniformly to your ware. And, when the cones confirm a successful firing, you can sleep a little better knowing you have taken a proactive, safe approach to providing your customers a high quality firing process. Retaining the cones constitutes physical proof that the ware was fired according to the glaze manufacturer's specification.

For more information on the use of pyrometric cones and the firing of ceramics please visit the Edward Orton Jr. Ceramic Foundation on the internet at www.Ortonceramic.com.

(Text written by the Edward Orton Jr. Ceramic Foundation, reformat by L&L Kiln Mfg. Inc.)

VIDEO AVAILABLE

This video shows you how to use witness cones to check the accuracy of the control and your kiln in an L&L Easy-Fire kiln. This video applies to any kiln.

hotkilns.com/firing-kiln-witness-cones

The Ceramic Process **Firing Tips**

What happens when you fire clay

LOADING KILN WITH GREENWARE

When placing greenware in a kiln, all pieces may touch each other. To prevent possible distortion, place lids on the pieces they go with when firing to bisque. It is important to place the tallest pieces on the center of the shelf and work outward to the shortest pieces. This will give you the best heat circulation. Be sure the ware is totally dry before firing (unless you use a very long drying cycle). Moisture in the work can cause cracking or even an explosion. We suggest using either the SLOW BISQUE program for heavy loads with a Preheat time of between two to three hours or the FAST BISQUE program for lighter loads (again with a Preheat time of two to three hours). If you want to make up your own program, use the preset program as a guide (see Appendix F in the DynaTrol instructions, hotkilns.com/dynatrol-700, for a description of the segments in the preset programs). It is not a bad idea to Preheat the kiln overnight, as its only purpose is to thoroughly dry and start the expansion of the ware, so that the higher heat will not negatively affect it.

VENTING

If you are using the Vent-Sure automatic vent system, you can turn it on and leave it on during the entire firing. If you use an automatic vent, you do not normally need to prop the lid open or remove peephole plugs. If manually venting (without a powered vent), fire in the beginning with all the peepholes out. Then put bottom peephole plugs into peepholes after the low firing is over (you will know it is over when you start to see red heat through the peepholes). You typically want to leave the top peephole out during the entire firing if you do not have an automatic downdraft vent. NOTE: HEAVY GREENWARE MAY TAKE LONGER TO DRY. Be sure to use the Preheat feature in the DynaTrol for ensuring dry work. NOTE: If you have a lot of moisture in your work you may want to prop open the lid for the first hour of preheat even if you have an automatic vent system. (CAUTION: Propping open a lid in this way can cause the lid to crack if you are not careful).

LOADING KILN WITH GLAZE WARE

When placing ware into the kiln to be glaze-fired, we suggest placing the pieces ½" apart so that when they expand there is no danger of them touching each other. If pieces are placed too close together, they may touch and stick to each other, thereby ruining both pieces of ware.



Except for placing ware the proper distance from each other for good heat circulation, follow the instructions for the firing of greenware. Be certain that no piece while expanding can touch the thermocouples. Use either the FAST GLAZE or SLOW GLAZE program depending on your glaze needs (experiment if you are not sure), or make up your own program. Ask the supplier of your glaze if you use a commercial glaze. There are some good firing recipes in various glaze books such as **Mastering Cone 6 Glazes**. Your clay and glaze supplier will know the cone number to which you should fire your work.

OVERGLAZE FIRING

When firing overglazes such as Gold, Palladium, Mother of Pearl, China Paints, etc., the kiln must be vented during the firing up to 1,100°F. If you are manually venting, leave the peepholes open. (NOTE: This is if you are not using a vent system such as an L&L Vent-Sure which automates the venting process). Check with your clay and glaze supplier for recommended cycles.

SPEED OF FIRING

Although the kiln may be capable of firing relatively fast, this does not mean you should fire it as fast as it is capable of firing. The speed of firing will depend on what you are trying to accomplish. Check with the glaze or clay manufacturer or supplier for a recommended firing cycle.



Robert Shenfeld's studio in Syracuse NY where he produces production quantities of hand-crafted tiles.



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KILNS BUILT TO LAST

Bulletin No: CP-3-15

The Ceramic Process **Firing Tips**

SOAKING

Soaking is holding the kiln at any given temperature for a set amount of time. One purpose is to achieve uniform temperatures on the inside and outside of your pieces. Other benefits include the smoothing out of glazed surfaces to get rid of pin holes or craters in the glazed surface. During the bisque firing, people often hold at different temperatures to allow the clay body to out-gas more of its organic material. Holding is also useful at a low temperature like 150°F to 180°F to dry out pottery or kiln wash on shelves.

The downside to holding only happens at high temperatures. There is almost no downside to holding at low temperatures except increased firing time and slight element and thermocouple degradation from the extra firing time. At high temperatures the amount of degradation to the elements and thermocouples is exponentially greater. As a result, holding the kiln at a high temperature will affect the element and thermocouple life.

Try soak times in the range of 5 or 10 minutes at the most. If longer, exercise care as the kiln may over-fire your work. Compensate by reducing the cone's temperature in the cone offset setting, or raise the thermocouple offset. Use witness cones that you can see through your peephole (and be sure to use dark safety glasses when doing so). If you see the cones bending (which would indicate proper heat-work achieved), then you can always turn off the control at that point manually. The Orton website has a great program available for free which helps you calculate how different temperature ramps and hold times will affect the "heat-work" and cone bending in a kiln.

FIRING LOG

Keep a firing log. Keep track of firing times, approximate load weight, firing temperatures and notes on results of the firing. There is a sample log in our instruction manuals (hotkilns.com/firing-log).

APPLYING KILN WASH

Kiln wash the floor of the kiln and the upper sides of the shelves only. Apply the kiln wash to the thickness of a postcard. The purpose of kiln wash is to prevent any glaze that drips from ware from sticking to the floor or shelves. If dripping should occur, remove dripping and cover the

spot with new kiln wash. Kiln wash is a powder mixed with water to a light creamy consistency.

For best results, apply three separate coats. If you brush one coat on, let it dry and then brush on another; you can brush off the first in the process, so ideally each coat should be fired on. The shelf can be used while firing the kiln wash, so theoretically you would put one coat on, load the shelves and do your test-firing of the kiln. The second coat would be fired on in the first bisque and the third coat in the second bisque or first glaze (whichever comes next). Fire at least to cone 018—hot enough to give the kiln wash enough adherence to the shelf to prevent it from coming off in the second coating. Note that some people make do without three firings of the kiln wash. However, we include this recommendation as a "best practice".

WHAT HAPPENS WHEN YOU BISQUE AND GLAZE IN YOUR KILN

When you fire a kiln, you chemically and physically alter clay and glaze compounds in a way that, to some degree, can be anticipated and accounted for. There is quite a bit more going on during firing than meets the eye. It is useful to divide the processing cycle into separate distinct stages or segments. The stages that clay and glaze go through in a typical firing can be divided as follows:



COMPLETE DRYING

Even after you room-dry your work there will be some moisture left in the seemingly dry ware. Your ware will pick up moisture from the air, even if it is left for weeks on a warm, dry shelf. Bisque ware can also absorb moisture during glazing, and the newly applied glaze is really a very fine-grained clay coating at this point; it will retain the water it was mixed with and the water in the air until it is completely dry.

When you put this piece in the kiln it will first go through a complete drying stage. This is where any water that was in your ware evaporates and expands to 1,170 times its original volume. This moisture must escape from your ware before the kiln temperature gets to 212°F. It is important that the kiln temperature climb very slowly at first, and that the lid be propped 1" with several soft pieces of firebrick or ceramic posts and the peepholes opened if there is no forced venting system. (CAUTION: Keep in mind that propping open a lid in this way can cause the lid to crack if you are not careful). If you have a lot of moisture in your work you may want to prop open the lid for the first hour of preheat even if you have an automatic vent system. The amount of drying needed depends on factors such as how much mass is in the kiln and how wet the ware is. Factors that lead to a longer drying time include fine-grained clay and thick-walled ware. Be sure to use the Preheat feature in the DynaTrol which automatically sets the kiln temperature at the right drying temperature. Preheating overnight is recommended. It is best to be conservative to prevent the ware from exploding in the kiln. After a while you will get a feel for how long is necessary. Remember to carefully vacuum out your kiln if a piece that is not fully dried explodes.

THE "CERAMIC CHANGE"

This happens to each crystal and mineral particle in the clay body. Even though water between the crystals and minerals has already evaporated (hopefully during the slow preheat time), there is still water in these crystals and minerals that is venting off. This can occur all the way until the kiln reaches red heat. Slow firing is not as critical as there are pathways for the steam to travel through where the water molecules between the particles used to be. Venting, however, is critical to remove the water vapor.

The Ceramic Process **Firing Tips**

QUARTZ INVERSION

This is a generic name for the 20 or so changes quartz goes through as the temperature increases and the molecules/particles/atoms become increasingly mobile. Most phases that a particle of quartz goes through as the kiln is heating will reverse during cooling. One of the largest and quickest changes the quartz goes through is roughly at 1,060°F with about a 2% increase in the size of the particles during heating. The process is reversed during cooling. Also, during cooling another 2% contraction takes place at about 439°F. This is caused by the formation of “cristobalite” in some clay bodies. There is a lot of other material in your clay besides quartz, so it is not always that important to account for the quartz while the kiln is heating up. The structure of unfired clay is full of pores and non-glass bound particles, so it can withstand the expansion of a few of its quartz particles. Once the clay is fired, though, the particles become part of a solid mass of glass. This mass is extremely intolerant of the expanding quartz particles. This is especially true in the glaze firing (even more so if the bisque was even slightly under-fired). In under-fired ware the quartz never has a chance to react with the fluxes and remains intact during a second firing, ready to expand and contract as your kiln heats and cools. This is one cause of dunting (fine cooling cracks). The glass mass simply has no room for the expanding quartz crystals.

BURNOUT

This is the burning off of any trapped organic matter in the clay. Burnout generally takes place at and above red heat. Sufficient airflow and time are necessary to burn off all the organic matter. If a bisque piece is under-fired, or fired too quickly, any unburned organic matter will bubble up through the glaze during the second firing. Even if the bisque is properly fired, there will still be some organic matter in the clay that will burn out once you pass the bisque's firing temperature. A glaze that fluxes too early will block off the exits for the gasses in the clay body and cause bloating or pitting.

SINTERING

This is the point at which powdered clay particles will begin to form chemical bonds with each other. Although the clay is not melting yet, it is forming a lump from the powdered clay. The point at which this begins to happen is called the ‘sintering point’. This, like burnout, happens right around red heat.

DECOMPOSITION

This is where fluxes really start to react and clay and glaze ingredients are deconstructed into their basic building blocks. This process can emit gasses such as sulfur and carbon dioxide which must travel out of the clay body. Once the firing is finished and the kiln cools, reconstruction takes place and the glaze and clay body recombine into a glass.

VITRIFICATION

This is a process that develops in the clay body during firing. At one point a piece of clay might be under-fired and at a higher point it may have good strength, but not good color; at another point it may be perfect and at another, even hotter point, the piece may warp, or melt. What is important to understand is that as the firing progresses, more and more activity is taking place on a molecular level. This is good only to a certain point, after which you are left with a warped blob, or puddle. You want to achieve the “glassification” of the clay. This occurs right before the clay body begins to slump. At this point the molecular bond between fluxes, quartz, silica and other materials makes the “glass”. However, it is the formation of the long mullite crystals (which only occurs above 2,000°F) from the decomposing clay crystals that gives the ware its strength.

GLAZE SET, COOL & FREEZE

Unlike the clay body, the glaze melts completely, and the bond between it and the clay becomes more complete as the temperature rises; eventually, the glaze starts to run. Things like fluidity and surface tension are determined first by the chemistry of the glaze, then by the layer formed by the heightened interaction between the glaze and clay molecules. When the ingredients of the clay and glaze have been properly matched, the nature of the molten layer between the two is such that when the kiln is at maximum temperature during firing, things like pinholes and bubbles can rise through this layer and reach the surface from the clay body within, and not remain trapped in the surface when the glaze sets and begins to cool. Once maximum temperature is reached and the kiln begins to cool, the glaze and clay body will follow. The glaze will not solidify until some time after the kiln begins to cool. When this happens depends on the rate of cooling and the chemistry of the glaze. Right before the glaze solidifies, however, crystals can form. Depending on its chemistry, the glaze can solidify quickly and form crystals. Or,



Bill Campbell at work.

“I make a living out of my five L&L kilns. I really beat them up firing them at least three times a week to Cone ten. They take a real beating and keep on going” -Bill Campbell

with some glazes, crystal formation can take place throughout the initial cooling until the glaze finally solidifies several hundred degrees lower than the highest temperature. By adjusting the glaze recipe slightly, one can maximize or minimize the forming of crystals in the glaze during cooling. Once the glaze solidifies it is still important for the kiln to cool slowly. Crazing (fine cracking) can occur if cooling is too rapid. Heat shock, which is usually catastrophic, is something that can happen in the kiln or may occur gradually over time.

In truth, simply test-firing the kiln and the ware to be fired is usually enough to deal with the complexity of the process. Every kiln and kiln-load fires differently, and a new kiln is no exception. The use of a vent system is recommended simply because it will exhaust any detrimental particles and fumes from the kiln, circulate air in the kiln and provide an oxygen-rich atmosphere. See ortonceramics.com for helpful information on how to use cones, firing tips and great information on firing kilns. They have an excellent program available for free which helps you calculate how different temperature ramps and hold times will affect the “heat-work” and cone bending in a kiln.



Firing Glass in a Ceramic Kiln

How to use an L&L Ceramic Kiln with a DynaTrol to Fire Glass

BASIC IDEAS

Glass is not as forgiving as clay when fired in a kiln. Temperatures and firing times must be more precise; as such firing glass requires special considerations when fusing and slumping in a pottery kiln.

Using a kiln sitter with cones is a difficult process when fusing and slumping glass and will not be discussed here. The following instructions address how to use a DynaTrol digital controlled pottery kiln when fusing and slumping glass. Glass casting is a special process and is not covered by the following information.

Pottery kilns heat from the side elements where as glass kilns heat from the lid element and side element. In most glass kilns the lid element provides 70% of the heat and the side elements provide 30% of the heat. The lid element throws heat down in a uniform manner across the kiln shelf. The side element is only there to adjust for the height of the kiln.

A pottery kiln heats from the sides toward the center. Using a standard glass firing sequence in a pottery kiln will cause the glass pieces on the outer edges of the kiln shelf to fuse long before the glass pieces in the center of the kiln shelf. If firing a large piece of glass the outer edges will fuse quickly and trap air bubbles in the glass and by the time the center of the piece reaches fusing temperature the outer edges will be over fired and may become distorted and thin.

The number of stacked shelves (amount of furniture) will impact the firing of the kiln. Kiln furniture absorbs heat before the glass absorbs heat causing what is referred to a heat steal. Also impacting glass firing in a pottery kiln is the size of the kiln plus if the kiln is made of 3 inch brick will also affect the firing. Glass kilns tend to be shorter in height than potter kilns and are usually made of 2 ½ inch brick or refractory fiber board or blanket.

With side elements, kiln furniture, size of the kiln and brick thickness you must fire slow in a pottery kiln when firing glass. If you fire too fast you will have an over fire plus you may also thermoshock the glass causing it to break. If you cool too fast you

will thermoshock the glass causing it to break.

The following fusing sequences are to be used as a starting point from which you will develop your own firing sequence for successful firing of your projects. The sized of your kiln and how you load the furniture may require refining the sequence below.

You would use the same firing sequence for small jewelry pieces as well as large platters and bowls.



On the left of the DynaTrol digital controller is a yellow section labeled "VARY-FIRE". This feature has 6 user programs each user program has 8 segments. A segment permits the artist to input firing sequences with a specified ramp rate in degrees per hour, a soak temperature, and a soak time. These three items comprise a segment. You select the number of segments needed for your firing sequence.

Simple firings like jewelry and small plates and bowls you should be able to obtain good results with the use of 2 segments.

If you are loading the kiln with multiple shelf levels or a single shelf you would use the 3 zone feature of your kiln to obtain uniform heating.

The assumption is made that you already know how to safely and correctly operate your DynaTrol digital controlled kiln. The following information is provides a guide line for adjusting your firing from pottery to glass.

The following information is not to replace the instructions provided in your kiln owner's manual. Refer to the owner's

manual for complete information on the operation and features of the DynaTrol digital controller.

After loading your kiln you would set the DynaTrol digital controller in the following manner.

NOTE: All degrees listed below are degrees F. If you want to use degrees C you will need to set the controller for degrees C and convert the degrees F below to degrees C for you firing.

The firing schedule below is for use with Bullseye, Uroboros, or Spectrum Glass. It is not for use with float or borosilicate glass.

FUSING GLASS

1. If the kiln has an off/on switch, turn the kiln on.
2. The kiln should indicate it is in the idle mode by flashing "Idle", the number of zones and the temperature inside the kiln.
3. Press the "Enter Prog" key in the VARY-FIRE section. You will see the display flashing between "USER" and a number between 1 and 6. At this point you want to choose which USER program you want to use. You can set USER 1 for a fusing project and you can set USER 2 for a slumping project, as an example.
4. Press the number 1 on the key pad, then press the ENTER button in the number key pad area. You have chosen to use "USER 1"
5. The display will now flash SEGS and a number. It is asking how many segments you want to use for your firing.
6. Press the number 2 on the key pad, then press the ENTER button in the number key pad area. You have chosen to use 2 segments for your firing.
7. The display will now flash RA 1 and a number. It is asking for the ramp rate in degrees per hour for the first segment.
8. Pressing the number keys enter 150, then press the ENTER button in the number key pad area. You have instructed the controller to heat at 150 degrees per hour. This means that after 1 hour the kiln will be at room temperature plus 150

Firing Glass in a Ceramic Kiln

degrees, after 2 hours it will be at room temperature plus 300 degrees, and so forth.

9. The display will now flash °F 1 and a number. It is asking for the soak temperature for the first segment.

10. Pressing the number keys enter 1450, then press the ENTER button in the number key pad area. You have instructed the controller to heat to 1450 °F. This means that the kiln will heat at a rate of 150 degrees per hour and go to 1450 degrees, taking roughly 9.66 hours to do so.

11. The display will now flash HLd 1 and a number with a decimal point 2 digits to the left, You may have a number which looks like 12.30 or 1.20 or 0.20. The decimal point separates minutes from hours. Hours to the left of the decimal point and minutes to the right of the decimal point. It is asking for the soak time period for the first segment.

12 - Pressing the number keys enter 15, then press the ENTER button in the number key pad area. You have instructed the controller to soak for 15 minutes. On review of the program you would see: 0.15. You have entered the first segment.

13. The display will now flash RA 2 and a number. It is asking for the ramp rate in degrees per hour for the second segment.

14. Pressing the number keys enter 150, then press the ENTER button in the number key pad area. You have instructed the controller to cool at 150 degrees per hour.

15. The display will now flash °F 2 and a number. It is asking for the soak temperature for the second segment.

16. Pressing the number keys enter 100, then press the ENTER button in the number key pad area. You have instructed the controller to cool to 100 °F. This means that the kiln will cool at a rate no faster than 150 degrees per hour and go to 100 degrees, taking roughly 14.5 hours to do so.

17. The display will now flash HLd 2 and a number with a decimal point 2 digits to the left, You may have a number which looks like 12.30 or 1.20 or 0.20. The decimal point separates minutes from hours. Hours to the left of the decimal point and minutes to the right of the decimal point. It is asking for the soak time period for the second segment.

18. Pressing the number keys enter 30, then press the ENTER button in the number key pad area. You have instructed the controller to soak for 30 minutes. On review of the program you would see: 0.30

19. The display will now flash ALRM and 9999. It is asking if you want to have an alarm sound when the kiln reaches a particular temperature. The number 9999 instructs the controller NOT to sound any alarm.

20. Press the ENTER button in the number key pad area, with the 9999 number in the display, if you do NOT want an alarm. If you want the controller to sound an alarm notifying you that it has reached a particular temperature enter that temperature number on the key pad and then press the ENTER button in the number key pad area.

21. The display will now display CPL for a few seconds then switch to the IdLE mode. You have entered the second and final segment. The digital controller has the above firing sequence in its memory as USER 1. It will remember this firing sequence even after the kiln is turned off. You can edit and change the firing sequence any time.

22. When the display is in the IdLE mode press the "Recall Prog" button in the VARY FIRE section of the key pad. The display will flash USER and a number. Press the number 1 and then press the "START /STOP" button. The display will briefly show STOP then switch to the IdLE mode. Press the START/STOP button again. The display will show -- ON -- and the controller will start the firing the USER 1 program.

Note: The digital controller does not understand heating or cooling. It only understands what temperature it is at and what temperature it is to go to. Thus it will adjust the firing to go to the destination temperature.

The above glass firing sequence has instructed the kiln to do the following.

Heat at 150 degrees per hour, go to 1450 degrees, stay at that temperature for 15 minutes then cool at 150 degrees per hour, go to 100 degrees and stay at that temperature for 30 minutes then stop firing.

SLUMPING GLASS

To slump glass you will use the same sequence however you must change the

soak temperature from 1450 degrees to 1250 degrees, all other values remain the same.

HOW TO CORRECT FOR OVER OR UNDER FIRING WITH THE ABOVE FIRING SEQUENCE

Only change one variable at a time.

1. I suggest that you adjust the soak time not the temperature.
2. If the glass is over fired reduce the soak time by 5 minutes.
3. If the glass is under fired add 5 minutes to the soak time



ANNEALING GLASS

The above firing sequence passes through the annealing temperature so slowly that the glass is annealed. If you want to use a formal annealing cycle you would use 3 segments with the second segment having the annealing soak temperature and soak time in it. The heating and cooling rate would remain the same.

Marty Dailey - Sept 2006

Firing Tips

LOADING A KILN FOR BEST RESULTS

Loading a kiln for firing is not a simple matter of placing shelves and stacking ware. The more thought and planning that is put into loading, the better the results. Ware and shelf placement, the size of the load, the firing characteristics of the kiln and the type of ware being firing are all important factors.

First the Furniture

Kiln shelves come in all shapes and sizes. For economy of space, it is best to choose shelves similar in shape and size to your kiln chamber. For instance, use a round or multi-sided shelf in a round or multi-sided kiln. Keep the size small enough so there is at least 1" of space between the shelf edge and the side of the kiln or the Kiln-Sitter®. Also allow some room between the top of your ware and the lid of the kiln and leave space for witness cones amongst your ware.

Select posts in heights to accommodate the ware you are firing. Leave some room between the kiln shelves for air to flow, for heat transfer and for removal of fumes.

Half shelves are very useful to improve

air movement in the kiln. Use two side by side with a 1/2" space between them and you don't lose much stacking space.

Some kiln manufacturers recommend placing shelves directly on the floor of the kiln. Most suggest using 1" posts to put the bottom up from the cooler floor. This creates an insulating layer much like a storm door.

Setters and Stilts

Air movement in the kiln is clearly a big consideration - one of the most important when loading a kiln. Ceramics need to heat uniformly to prevent warping and stresses in the ware. Air needs to move around shelves and around individual pieces.

Plates and tiles benefit from the use of tile and plate setters or stackers. Shelf-style setters allow air to move under the large flat objects so they heat more evenly. Avoid heating large flat objects directly on the cooler shelf. If you are firing decorated tiles or plates, vertical setters economize on space, and sets can be stacked to fit even more.



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FIRING TIPS is a series of firing problem solvers. New TIPS are available every month. Contact your Orton supplier for your copy.

Glazed ware needs to be stilted or dry footed or the melting glaze will stick the ware to the kiln shelf, ruining both. Stilts also provide space for air to move around all sides of the ware. Porcelain and stoneware can not be stilted. The stilts embed into the ware during firing. Instead, use high fire kiln wash or silica sand on the shelf. Use prop to prevent sagging of porcelain.

Consider Heat Distribution

It is important to evaluate heat flow in your kiln and to make this a consideration in loading. Use pyrometric cones to determine the heating characteristics of your kiln so you know where the hot and cooler places are. Arrange your ware with different sized pieces on the same shelf to allow better heat flow.

Don't Overfill

Perhaps one of the most important factors in good fired results is enough air to mature the ware - to burn out organics in bisque and develop best colors in glazes. Shelf and ware placement and the use of setters and stilts can all help this, but here are a couple more tips:

1. When stacking bisque, invert bowls and mugs opening to opening instead of nesting - this helps air move around all sides of a piece and prevents black rings and spots in the bottom of ware.
2. Fire bisque lids and bottoms together. To get the best fit for lids, fire them on the piece they match.

This will let the two pieces shrink together so you get a good tight fit. Fire all glaze pieces separately.

3. Leave space between ware - don't overfill. There is a temptation to cram as much as possible into the kiln to economize on firing costs. Ware fired too closely together creates firing problems. If you must overfill, fire very slowly and vent adequately.
4. Mix thin and thick-walled pieces together throughout the load - don't concentrate them in one area where they are competing for air and heat.
5. Use downdraft venting to move air through the kiln and to remove fumes created during firing.

Want to learn more?

Read more about Loading A Kiln in the Orton Firing Line and Technical Tips publications. Each issue is packed full of articles to help you learn more about firing. Members of the Orton Firing Institute receive these publications at no charge. Single copies are available to non-members at a per issue rate. Orton's 80 minute video, *Key Principles of Successful Firing*, is also an excellent resource on firing.

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Firing Tips

UNDERSTANDING HEAT TRANSFER

How Heat is Transferred

Heat moves through the kiln from hotter to cooler zones by:

1. convection
2. conduction
3. radiation

Convection

Convection is the first step in the heating process in the kiln. Air is heated as it passes across the warming kiln elements. As the hot air rises and cool air falls, air currents are created which circulate hot air to cooler places in kiln. This heat is transferred to the ware, shelves, etc.

The kiln will not be uniform in temperature at this early stage of firing unless the hot air is pushed through the kiln by mechanical means. Low cone firings such as 022 and 021 depend more heavily on convection for heat transfer.

The most common type of convection we are familiar with is wind chill. The cool air passes across the face and pulls heat from our warmer body, which lowers our skin temperature.

Conduction

When heat moves through a solid, it is conducted. An example would be heat moving through the handle of a saucepan. This is a slow way to heat, but the handle will eventually get hot.

In a kiln, conduction moves heat from the inside to the outside of the kiln and from the outside to the inside of the ware. Conduction is the main way we get uniform heating in the kiln. This is a slow process and if we fire too fast, the inside of our ware will receive too little heat and not fire properly.

Radiation

At the beginning of the firing, the elements are the hottest part of the kiln. The heat from the elements radiates out - like the sun warming us on a cool day. Eventually the firebrick and the ware will also get hot and will radiate heat as well.

As the temperature increases, more and more of the heat is transferred by radiation from the heating elements. For uniform heating, is important that all surfaces of the ware be exposed to heating elements, even partially.

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4. Time and temperature profile during the burn out period

Both time and temperature are important for proper burn out of the carbon. Some carbons require much higher temperatures than others. Oxidation should be completed below red heat (1400°F).

Carbon burns out from the surface first. As more oxygen penetrates the body, then more carbon is reacted to form the CO or CO₂ gas and the burn out process continues. If there is sufficient time, temperature and oxygen, then complete burn out occurs. If these conditions do not exist, the resulting incomplete burn out is referred to as black coring (where the center of the piece has a black or gray cast).

Incomplete Burn Out

Incomplete burn out can result in several firing problems including:

1. Bloating of the ware
If the temperature is hot enough, the outside of the piece will seal up before all the gases can escape. As the body becomes plastic due to glass forming, gases trapped inside the body expand with heat and cause bloating and sometimes cracking of the ware.
2. Glaze defects, such as pinholes
The escaping gases will push through the glaze surface and cause bubbles which pop. If these do not heal, then pinholes will result.
3. Appearance of fired bisque

Where carbon burn out is incomplete, the piece will have a grayish cast (white bodies) or may have a greenish cast (red bodies). The body will also be more porous and weak.

Preventing Incomplete Burnout

1. Slow down the firing.
2. Be sure the kiln is vented adequately so there is sufficient oxygen.
3. Load the kiln with burn out requirements in mind.

Leave plenty of space between ware and shelves. Do not stack ware. Use tile and plate stackers and invert pieces on top of one another to help conserve space and insure proper burnout.

Want to learn more?

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Firing Tips

CRACKING AND THERMAL SHOCK

Cracks that appear in fired ware which were not caused by casting or drying problems may be the result of thermal shock.

Thermal shock occurs when too much stress is created in a piece of ware during the heating and cooling process. It comes from temperature differences in the ware and can cause small to large cracks in the piece, or the piece may actually break.

Why Does Cracking Occur?

The tendency of a piece of be susceptible to thermal shock is related to:

- the strength of the piece
- the thermal expansion of the material

Thermal shock can result when changes in temperature occur in the kiln during heating and cooling. As temperature changes rapidly, the outside of the ware and kiln furniture becomes much hotter or cooler than the inside. This causes stresses which may result in cracking or breaking.

The following can effect thermal shock

- a fast heating rate or rapid cooling
- a sudden influx of cool air such as opening the kiln lid when the kiln has not finished cooling
- in a gas kiln - turning off the gas and allowing cool air from the burners to enter the kiln

Thermal shock can also occur when ware is stressed in use such as a casserole or dish that is taken from the freezer or refrigerator and put into a hot oven.

The stronger ware is, the better able it is to resist cracks due to thermal shocking. Weak ware will be more likely to break when stressed.

A piece that is porous will also be weaker, making it easier to crack. Water or condensation that enters pores in the ware can turn into steam and expand and this can cause cracking when heated. The harder (hotter) ware is fired, the less porous it will be.

Ware that expands and shrinks a great deal during heating and cooling is also more likely to be affected by thermal shock. Most kiln shelves contain



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cordierite because this material has a lower expansion than most of our ware and so less affected by thermal shock.

What Happens to Ware During Firing?

During heating and cooling, the body and glaze undergo many physical and chemical changes. Some of these include:

- moisture is driven out of the ware - if this occurs too rapidly, cracking can occur
- organic material is oxidized and released from the material
- the glaze softens, melts and flows during heating and may trap gas
- the body expands as it is heated and contracts during cooling
- the glaze solidifies and contracts during cooling

If the body or glaze contains silica, it will expand rapidly at 1063°F on heating and contract during cooling. If the heating or cooling is rapid near this temperature, this change can lead to cracking of the piece.

Control of heating and cooling is especially critical when firing thick-walled pieces or pieces with an irregular wall thickness.

Reducing Thermal Shock

There are several easy ways to minimize the potential for thermal shock:

- use a smooth, moderate heating rate
- let the kiln cool naturally with the lid closed

- use a controller to slow down the cooling time
- avoid sudden temperature changes

A programmable controller such as the Orton AutoFire™ is the best solution to control the heating and cooling rates and to get a smooth temperature rise.

If instrumentation is not available, heat loss during cooling can be controlled to some extent by keeping the kiln closed until well below red heat (900°F).

To be sure that ware is properly matured, be sure to use witness cones. Underfired bisque will continue to shrink during the glaze firing and this can result in a poor glaze fit.

Want to learn more?

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Firing Tips

CRACKING AND WARPING CAUSED BY DRYING AND CASTING

In some instances cracking and warping problems share a common source: the casting and drying of the piece. In other cases, cracking may be related to how the piece is fired. This Tip looks at problems related to casting and drying

DRYING CERAMICS

Ceramics contain clay which can absorb and hold water. Before firing, it is important to remove all of the physical water so that the piece will not crack or explode when heated. This is often accomplished in steps with firing being the final stage. During firing, the chemical water is removed from the piece and it gains strength while developing physical surface characteristics.

UNDERSTANDING DRYING

Simplified, drying is the removal of water from body by evaporation. As the ware is dried, the film of water separating the clay particles gets thinner and thinner, the solid particles get closer together and the piece shrinks. Shrinkage stops when the particles finally contact each other.

DRYING FAULTS

Cracking, distorting and warping are problems that may not become evident until after firing. They are usually caused by drying too fast or unevenly.

If ware is heated too fast, the pressure from water vapor inside the piece can cause cracking. Ware dried only on one side, can shrink more on that side causing warping or bending of the somewhat plastic (flexible) piece. When one surface finishes drying, the piece is now too stiff to recover and the warping becomes permanent. This can lead to cracking.

Bodies made of very plastic clays or compositions having a high clay content require attention to uniform, slow drying.

Thicker walled pieces will often have a greater tendency to warp or distort.

Care needs to be taken to allow for uniform air movement around all sides of a piece to avoid drying problems. Sometimes drying must be slowed down to avoid cracking.



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Handles on cups can have a tendency to pull away from the mug. Doll heads and chest cavities may deform inward.

REDUCING WARPING AND CRACKING

To reduce warping and cracking, take steps to dry more slowly and more evenly from all sides.

Don't dry a flat object on a wet or cool surface like a formica or plastic table top or damp newspaper. The piece can only dry on one side. Instead, dry objects on something porous like wood or plaster or set them so air can circulate around them. If necessary, turn pieces over during drying for more even result.

Slow the drying of thick walled pieces and hand built ware.

Support areas during drying that might cause stresses to build up.

DRYING TECHNIQUES

slip cast ware - may warp or crack if stressed (deformed) when removed from the mold. Even if the ware is gently returned to the original shape, the created stress will ultimately cause the piece to warp or crack.

wheel thrown ware - should not distort during drying unless subjected to further mechanical forces - let the ware dry naturally on a bat or shelf and it should be fine.

thick handbuilt ware - needs to be

dried for a very long time before it can fired or it may explode during firing. Several days may be required or a low heat drying in an oven may be necessary to remove all the water.

plates - even drying is particularly important with plates. Warping can cause the center of plate to fall or arch up. Rims and centers must dry evenly to prevent warps, humps and cracks.

drying tiles - drying tiles can present a particular challenge because it can be difficult for the piece to dry evenly. Usually air is passed over the top of the tile. This results in warping because the bottom of the tile remains wet. Drying tiles in tile racks can help air movement for more even drying.

Want to learn more?

Read more about Solving Cracking and Warping Problems in the Orton Firing Line and Technical Tips publications. Each issue is packed full of articles to help you learn more about firing. Members of the Orton Firing Institute receive these publications at no charge. Single copies are available to non-members at a per issue rate. Orton's 80 minute video, *Key Principles of Successful Firing*, is also an excellent resource on firing.

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Firing Tips

USING THE THREE CONE SYSTEM

All ceramic products fire within a range to develop best fired properties. Some products such as stoneware have a wide firing range. Other products such as porcelain slip and leadless glazes have a narrow firing range (less than 2 cone numbers).

To be sure ware is properly fired, it is important to understand how your kiln is firing. The Three Cone System is an excellent way to do this.

What is the Three Cone System

The Three Cone System consists of three consecutively numbered cones:

Firing Cone - cone number recommended by manufacturer

Guide Cone - one cone number cooler

Guard Cone - one cone number hotter

For example: Cones 017 (guide cone), 018 (firing cone), 016 (guard cone)

Uses for the Three Cone System

- determine temperature uniformity in the kiln
- check the performance of the Kiln-Sitter® or electronic controller
- manually shut off the kiln by direct observation of the cones bending

- evaluate heatwork that ware receives during firing

How Witness Cones Work

Pyrometric cones indicate how much heat has been absorbed. Witness cones set on the shelf near the ware are true indicators of whether the ware received the proper amount of heat. Products are expected to be fired to a cone number or within a range of numbers. For some products, good results can be obtained at a cone lower or higher. Other products have to be fired very precisely.

Using the Three Cone System for Manual Shut-off

By observing the witness cones during firing, the end of the firing can be determined for manual kiln shut off.

To use the Three Cone System for manual shut-off, place cones on a kiln shelf near the center of the load, but out of a draft and where they can be observed through the peephole

When the kiln is near its firing point, the Guide cone will begin to bend. The ware is approaching maturity and soon the kiln can be shut off.



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It takes about 15 to 20 minutes for the Firing Cone to reach it's end point. The cone bends slowly at first, and more quickly after the half way point. When the cone tip is even with the top of the cone base, it is time to shut off the kiln. If the Guard Cone bends, the desired heatwork has been exceeded.

Using the Three Cone system to Evaluating Kiln Performance

Most kilns have temperature differences from top to bottom. The amount of difference depends on

- design of the kiln
- age of the heating elements
- load distribution in the kiln
- cone number being used

Usually, there will be a greater temperature difference at lower cone numbers than at higher ones. Placing a set of cones on each shelf during various firings allows you to determine the heating uniformity of your kiln for the materials you fire.

After firing, observe the cones and evaluate the heat distribution in the kiln. If only the guide cone is bent, there is less heat on that shelf. If the guard cone is bent, there is more heat on that shelf.

If you do find a difference, the heating uniformity can be improved by changing the kiln loading, adjusting switching or adding a downdraft vent system.

Checking Kiln-Sitter® Performance

The Kiln-Sitter® is designed to shut off the kiln as a Small Cone or Bar deforms. Here's how it works:

- Small Cone/Bar is placed under sensing rod
- firing begins, cone/bar receives heat, begins to soften
- sensing rod presses down, cone bends with weight
- movement of rod activates shut-off

Because the cone or bar in the Kiln-Sitter® is near the kiln wall (closer to the heating elements), it may receive more heat than witness cones on the shelf. If the kiln shuts off before the witness cones have properly deformed, you may need to use the next hotter cone number in the Sitter®.

Witness Cones Are Like Insurance

Cones are considered an inexpensive way to monitor your kiln and detect problems before a crisis occurs. Use Self-Supporting Cones for the Three Cone System because they are the easiest to use and most consistent cones available.

Want to learn more?

Read more about The Three Cone System in the Orton Firing Line and Technical Tips publications. Published 8 times a year, each issue is packed full of articles to help you learn more about firing. Members of the Orton Firing Institute receive these publications at no charge. Single copies are available to non-members at a per issue rate.

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Firing Tips

CONES AND CONTROLLERS

Automatic controllers and shut-off devices are a convenient way to heat and turn off a kiln. But for consistent results it is still important to know how much heat the ware received. Only cones provide this information.

Witness cones set near the ware tell if the firing reached the cone value necessary to properly mature the ware. Cones also help in diagnosing firing problems.

Advantages of Controllers

Electronic controllers have many advantages. They:

- allow heating rate control - heat up/cool down of the kiln
- permit slow down of the firing below red heat to burn out carbon and organic materials
- permit elimination of a kiln shut-off device, although some use this as a safety backup
- allow soaking of kiln at the firing temperature to get more uniformity of fired pieces or for special results
- provide more consistency from firing to firing

So with all of these advantages, why

are cones still needed?

Firing Ceramics

Firing ceramics is much like baking food, except ceramics go to higher temperatures. When we bake, we leave food in the oven at a temperature for a certain time. A thermometer may help measure the temperature of our food or we may stick a fork in to test whether it seems right.

It is the same with firing - a combination of temperature and time "cooks" the ware. However, unlike baking we can't put our ware into a preheated kiln and poke a fork in our pot to test doneness. The next best thing is to place Pyrometric Cones near the ware to measure whether it has received enough heat.

Firing With Cones

The bodies, glazes and decoration products we use are all formulated to be correctly fired when they have received enough heat to properly bend a cone. The companies and individuals who make and test these supplies use Orton Cones. Cones deform when they have received the



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right amount of heat, not just when the kiln reaches a certain temperature. In other words, cones behave just like your ware. This is why they are such good indicators of whether the ware was properly fired.

How Controllers Work

Electronic controllers regulate power to the heating elements. They do this by comparing the temperature measured by a thermocouple with the expected temperature programmed into the controller. If the temperature is low, heat is added.

Controllers fire a kiln to a temperature. If this temperature is not measured accurately, the controller will fire the kiln improperly. Most controllers use a Type K thermocouple, which is less expensive, or a platinum thermocouple (Type S), which costs more but is more accurate and has a longer life.

Measuring Temperature

Even brand new, a Type K thermocouple can vary from a true reading, as shown below. On the other hand, a Self-Supporting witness Cone will vary no more than 4°F.

Variation in New Thermocouples		Max. Cone Variation	
Cone	Type K	Type S	Cones
020	8.5°F	2.9°F	4°F
06	13.5°F	4.5°F	4°F
6	16.6°F	5.6°F	4°F

This variation in the temperature measured by a thermocouple becomes even larger after the thermocouple has been used for awhile. It is not unusual for a Type K thermocouple to have an error of more than 25°F when fired to Cone 6 repeatedly. This means that more than a full cone error can be introduced.

Using Controllers and Cones

Controllers do a good job at what they do - controlling the heating and cooling rate and providing consistency from firing to firing. However, if witness cones are not used with the controller, there is no way of determining what the actual firing conditions were, except by how the ware looks. By then, it may be too late.

Want to learn more?

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Firing Tips

AVOIDING CARBON BURNOUT PROBLEMS

Materials used in ceramics contain naturally occurring impurities that can affect the color, appearance and maturing temperature of the product.

Carbon, found in most clays, is normally considered one of these impurities. Carbon can also be present in the additives and binders which make up clay bodies, slips, decals and lusters.

How Carbon Burns Out

During heating (firing) the carbon reacts with oxygen to form carbon dioxide and carbon monoxide gases. The carbon leaves the body as a gas.

Binders are burned off at a relative low temperature: 300°F to 500°F.

Naturally occurring carbon in clay burns off (become gases) at higher temperatures: up to 1200°F-1400°F.

The rate at which this carbon burns out is related to:

1. The amount of carbon present (that is, the amount of natural contaminants in the body)

Some bodies have more contaminants than others, such as red clays. This needs to be considered when planning the firing.

2. Amount of air available (air provides oxygen for burnout)
Air needs to get to the carbon inside the body.

This is impacted by several factors. A load that is fired very quickly will not allow enough time for the oxygen to react with the carbon, form gases and leave the ware.

If ware is stacked during bisque firing, oxygen may not be able to penetrate all surfaces of or inside all the pieces.

Also, if gases are not removed from the kiln and replaced with fresh air, then there may not be sufficient oxygen to burn out the carbon.

3. Thickness of the piece

Air has to penetrate through the entire thickness of the piece and the gases have to escape the same way. It takes longer for carbon to burn out of a thicker piece of ware.



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4. Time and temperature profile during the burn out period

Both time and temperature are important for proper burn out of the carbon. Some carbons require much higher temperatures than others. Oxidation should be completed below red heat (1400°F).

Carbon burns out from the surface first. As more oxygen penetrates the body, then more carbon is reacted to form the CO or CO₂ gas and the burn out process continues. If there is sufficient time, temperature and oxygen, then complete burn out occurs. If these conditions do not exist, the resulting incomplete burn out is referred to as black coring (where the center of the piece has a black or gray cast).

Incomplete Burn Out

Incomplete burn out can result in several firing problems including:

1. Bloating of the ware
If the temperature is hot enough, the outside of the piece will seal up before all the gases can escape. As the body becomes plastic due to glass forming, gases trapped inside the body expand with heat and cause bloating and sometimes cracking of the ware.
2. Glaze defects, such as pinholes
The escaping gases will push through the glaze surface and cause bubbles which pop. If these do not heal, then pinholes will result.
3. Appearance of fired bisque

Where carbon burn out is incomplete, the piece will have a grayish cast (white bodies) or may have a greenish cast (red bodies). The body will also be more porous and weak.

Preventing Incomplete Burnout

1. Slow down the firing.
2. Be sure the kiln is vented adequately so there is sufficient oxygen.
3. Load the kiln with burn out requirements in mind.

Leave plenty of space between ware and shelves. Do not stack ware. Use tile and plate stackers and invert pieces on top of one another to help conserve space and insure proper burnout.

Want to learn more?

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Firing Tips

FIRING HANDBUILT OR THICK CAST WARE

Most pinch pots, coiled or slab built ware generally have thicker walls than their slip cast cousins, although molded pieces may be cast heavily as well. With these types of pieces, the thicker walls create some unique challenges for firing.

Basic problems that can occur when firing handbuilt or thick cast ware include cracking (or exploding) and carbon burnout. Because of the thicker walls it is important to fire slower and control heating and cooling during firing. Preparation of the piece is important as well.

During forming, stresses within the piece may result in hairline cracks that appear during firing. It takes longer to fully dry a thick piece. Uneven drying can result in warping or cracking.

For pieces properly prepared, handled and dried, the next critical step is firing.

Firing issues

- Is the ware fully dry?

Ware that is not adequately dried will crack or explode during the early stages of firing. Water inside the pores of the ware turns to steam, exerting pressure inside the ware. To fully dry a thick walled piece, the ware needs to be warm for more than 12 hours.

- Am I firing too fast?

All bodies expand when heated and shrink when cooled. If the outside wall expands more than the inner wall, stresses occur. If these stresses are large enough, they pull the body apart and cause cracking. A 1" thick wall can have more than a 10°F difference in temperature between the hotter and cooler surfaces. Firings need to be slowed down for thicker wall pieces. Likewise, it is important not to cool too fast.

- Have I allowed enough time for carbon burnout?

It is important to burn out all carbon from the ware before higher temperatures are reached (1200°F or 650°C). It takes time for oxygen to move into the porous body, react with the carbon and then leave. If carbon remains, many problems can occur. These include problems with color, glaze fit, strength, blistering and discoloration. Use of a downdraft vent system, combined with slower heating, virtually eliminates carbon-related problems.

Heating & cooling control

The best way to control cracking problems during firing is by controlling the rate of heating and cooling for the kiln.



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During firing, materials that make up the body undergo many changes. Special care must be taken at temperatures below 1500°F (815°C) to heat the body uniformly.

Remember, the thicker the wall, the slower the heating should be done. Above 1500°F, temperatures can be increased more rapidly because the changes are less likely to cause stress cracks within the ware.

- What kind of changes occur?

All clays and many minerals contain water which does not leave the body until above 700°F. Organic (carbon) materials need to be oxidized (burned out). Other minerals, such as calcite, break down and give off a carbon dioxide gas. Minerals such as flint (silica) undergo a sudden expansion on heating to 1060°F and contraction during cooling.

- How can I control my heating?

This depends on the controls for the kiln. With switches, leave them on medium settings longer. It should take more than 3 hours to reach red heat and even longer for thick pieces or a heavily loaded kiln.

Make sure the kiln is well vented below red heat and closed up completely above red heat. Keep the kiln closed during cooling for 8 hours or until well below red heat.

- When did cracking occur?

Often the crack itself can be examined to determine when it occurred. If the edges are sharp, then it probably occurred during cooling. If the edges are rounded or if glaze has flowed into the crack, then it occurred during heating.

- What else can cause cracking?

1. Uneven heating is a primary culprit that causes cracking during firing.

Hot and cold spots in the kiln can cause uneven heating of pieces.

Use witness cones to diagnose hot and cold spots and then adjust the switching or use a downdraft vent to help even out the heating.

Careful loading of the ware in setters and on stilts can also help heat circulate around the piece.

2. Underfired bisque is not as strong and may crack more easily during the glaze firing.

Use witness cone to assure a proper firing and prevent underfired bisque.

3. Gas expanding in air pockets which developed in the ware during forming can cause large cracks during firing.

Want to learn more?

Read more about firing handbuilt and thickcast ware in the Orton Firing Line and Technical Tips publications. Published 8 times a year, each issue is packed full of articles to help you learn more about firing. Members of the Orton Firing Institute receive these publications at no charge. Single copies are available to non-members at a per issue rate.

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Firing Tips

FIRING CERAMIC BODIES

Most bodies and glazes contain clay. These fine clay particles give the body and glaze many desired properties and bonds other materials together.

When the body is fired:

- clay and other minerals in the body start to change
- clay/minerals break down and react with other materials to produce gases
- at 900 F (red heat), tightly held water molecules begin to break free and leave
- gases such as sulfur oxides and some fluorine may be released
- as the temperature increases, clay and other minerals continue to change and react with each other to form new compounds that will be part of the final product
- some products form glass which will bond everything together

Gases

The gases which form need to be removed from the body. For example, carbon is in the clay and organics are added to the body, glaze or decoration to improve strength during handling or application. These must be removed during firing to avoid defects.

Firing Conditions

Firing conditions can also determine many properties of the fired product. Firing too fast at lower temperatures may not allow sufficient time for materials to react and gases to leave the body or glaze.

Firing too fast can result in

- weaker bodies
- pinholing
- bubbling of the glaze
- color changes in the body
- color changes in the decoration
- mildewing of porcelain
- crazing or peeling of glazes if body is not properly mature

TYPES OF BODIES

Earthenware

- typically fired from Cone 07 - 03
- made with talc, less expensive clays
- clays contain many impurities, need fired longer at lower temperatures
- low shrinkage
- porous after firing
- usually tan or red in color
- frequently glazed or stained
- sometimes used as-fired.



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Often, problems arise because bodies are underfired. The piece may look okay, but is porous and weak. Also, underfired bodies may not match the expansion of the glaze used in a later firing. This can result in glaze fit problems or cracking of the body in use.

The high iron and carbon content of these clays requires plenty of air during firing to maintain good color and to burn out all of the carbon. If this is not done, many problems can occur when the product is glazed and refired.

Stoneware

- typically fired between Cone 6 -10
- large number of compositions
- contain clays and other minerals with many impurities, including sand, feldspar and grog
- additives are used to provide plasticity, workability, strength, color and to reduce shrinkage
- colors depend on raw materials

Because of the additives and impurities, care needs to be given to how stoneware is fired and to proper ventilation of the kiln early in the firing to burn out organics.

Stoneware is vitreous and contains a high percentage of glass in the fired product. For color variations, mature the ware under reducing conditions.

Porcelain

- typically fired from Cone 3 - 10
- compositions vary, but contain high quality materials
- colorants may be added.
- bodies are hard, white, translucent
- very high glass content

- narrow firing range - need to be fired close to slump or sag point for best fired properties.

Because color is very important, these bodies need to be fired with plenty of air below red heat to be sure all the carbon is removed. Shrinkage is high and special care must be given to supporting porcelain during firing or it will warp and distort.

CRITICAL FIRING PERIODS

For all clay containing bodies and for most glazes and decorations:

- be sure ware is dry before firing
- fire slowly below red heat (1100 F) where many changes occur in the clay and other materials
- provide plenty of air below red heat for oxidation and to burn out organics and carbon
- do not to force cool the kiln while it shows red heat.

Want to learn more?

Read more about successfully firing ceramic bodies in the Orton Firing Line and Technical Tips publications. Published 8 times a year, each issue is packed full of articles to help you learn more about firing. Members of the Orton Firing Institute receive these publications at no charge. Single copies are available to non-members at a per issue rate.

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Firing Tips

FIRING LEAD FREE GLAZES

Changes in glazes

Lead free glazes are becoming the standard for commercial use. This is due to government regulation and health concerns by the manufacturers.

As the name implies, lead free glazes are made from compositions or materials where lead has not been added.

To eliminate lead, glazes are reformulated. This can change some of their properties. Some of the differences you may notice include:

- does not flow or run as much in firing as lead containing glazes
- brush marks may show after firing
- not as wide a firing range
- may not be compatible with as many bodies (improper fit). This leads to shivering or crazing of the glaze.
- color does not match lead glazes
- more surface defects

For problem-free results with lead free glazes, firings must be more closely controlled and kilns well vented. Bodies may have to be bisqued to a higher or lower cone number to solve a problem.

Why do problems occur?

Lead softens a glaze and allows it to be fired over several cone numbers. Glazes made without lead have a narrower firing range. Typically, lead glazes are able to be fired over a four cone number range (example 08 to 05).

Lead free glazes typically need to be fired within two cone numbers (example 06-05) - less than half of that for lead glazes.

Glaze and body fit

Since the glaze and the body on which it is fired (bisque) are made from different materials, it is important that they expand and shrink a like amount when heated and cooled. If they don't, then the fired glaze can be stretched to the point where it can crack (crazing), or it can be pushed together on to itself to a point where shivering or crawling occurs.

When using lead free glazes:

1. Make test firings of the body and glaze to their recommended cone number, first the unglazed body and then the glazed bisque.



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2. Use witness cones placed near the ware to be sure the proper cone number was reached. Differences may exist between the Kiln-Sitter® and a witness cone or from the top to the bottom of the kiln. Firing with a controller to a cone number or a temperature may not be adequate.
3. If crazing occurs and the witness cone indicates the glaze and bisque firings are properly fired, make some tests by firing the bisque progressively hotter (e.g. if you fire bisque to 05, test to 04, then 03).

When you fire hotter, the expansion of the bisque is changed and glaze on the bisque may fit better.

4. If shivering occurs, fire one cone cooler. You may need to select another body for your bisque. Firing too cool is not a good idea since the strength is reduced and porosity increased, both of which may cause problems during use of the final piece.

Is Your Kiln Uniform in Temperature?

If temperature in your kiln varies by more than 1 to 2 cones, then glazed ware in one part of your kiln may fire okay, while ware fired in another part of your kiln will have a problem.

Most kilns vary in temperature from top to bottom. To determine how much your kiln varies, place witness cones on each shelf when making firings. Usually, there is less difference top to bottom for hotter firings.

Each kiln has its own personality and the solution for improving temperature uniformity may vary.

If you have glaze firing problems because

of too much variation, then we recommend the following:

1. Make sure cracks and holes are repaired to keep heat in your kiln.
2. Fire slower during the early part of your firing, before red heat (below 1200°F). This allows heat to soak into the refractory and even out temperatures in the kiln.
3. Consider changing the switching pattern to even out top and bottom temperatures. Switch the bottom to a higher setting before the top or vice versa. Higher settings add more heat.
4. Consider adding an Orton KilnVent. These pull hot gases from the top to the bottom of the kiln and cut temperature variations in half. Hoods above the kiln will not help temperature uniformity problems.

Want to learn more?

Read more about glaze and body fit, heat distribution and measuring heatwork in the Orton Firing Line and Technical Tips publications. Published 8 times a year, each issue is packed full of articles to help you learn more about firing. Members of the Orton Firing Institute receive these publications at no charge. Single copies are available to non-members at a per issue rate.

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Firing Tips

FIRING RED GLAZES

Red glazes are among the liveliest, brightest colors we can use, but unfortunately, red glaze problems are legendary. Many of us simply give up using reds or accept whatever results we can get, including the problems.

Common Red Glaze Problems

improper color development - dark bluish or purple cast to the glaze

color loss - glaze looks gray, white

poor surface texture - a rough matte finish and/or visible surface defects

"The Strawberry Effect" - tiny black dots or spots in the fired glaze

crazing - a crackled or cracked appearance in the fired glaze

Some of these problems relate to the preparation of the piece and application of glaze, but many defects are the result of improper firing practices.

Preparation and Application

1. ware must be clean and free of dust
2. do not apply red glaze to greenware
3. apply only to properly fired bisque (use witness cones to verify firing) -
4. work area and tools should be kept clean and free of contaminants
5. no eating/smoking in glazing area
6. glaze away from cleaning areas
7. apply adequate coats of glaze - four coats is often recommended

8. allow each coat to dry

How Colors Develop

Many ceramic glazes need to be fired in an oxidizing (air) atmosphere for best results. Red, orange and yellow glazes in particular are very oxygen sensitive. This means they require sufficient air during the firing to bring out the colors to their fullest and to prevent surface/finish defects.

Firing reds requires us to control the firing rate and properly vent the kiln.

Controlling the Firing Rate

Nearly all ceramics fire better when fired slowly below red heat. Slow firings have the advantage of allowing the necessary physical and chemical changes to occur in the ware. Slower firings also permit time for sufficient air to enter the kiln and displace the carbon monoxide. This is true for both bisque and glaze firings.

Firing rate can be controlled using the settings on an automatic kiln, programming an electronic controller or by adjusting the switching. Control or slowing of the firing rate is most important in the early stages of the firing when most of the reactions are occurring and when air is needed to

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burn out the organics in ceramic materials. Near vitrification (the end of the firing) a faster rate is desirable and can usually be applied.

Venting for Proper Air

It is most important that enough air gets into the kiln in the early stages of firing. This is when the organic materials are burning out of the ware and air reacts with carbon to form carbon monoxide. Kilns can be vented manually or with an automatic venting system.

Manual Venting

Manual venting lets the fumes out of the kiln, but is only somewhat successful at letting air into the kiln. For manual venting, the top lid should be propped and the peephole plugs out for at least the first hour and a half. Slower firings require additional time. When the kiln reaches red heat, the lid can be closed and peephole plugs replaced. Leaving the peephole plugs out for the whole firing is not recommended since it can cause cold spots in the kiln.

Manual venting works better with a smaller load. Also, using split shelves allows air circulation and helps ventilation.

Manual venting is recommended whenever a downdraft vent is not available. When venting manually, it may be desirable to locate red glazes on the top shelf to assure sufficient air.

Automatic Downdraft Venting

A downdraft automatic venting system like the Orton KilnVent efficiently brings the proper amount of air into the

kiln and removes the fumes for exhausting. The kiln lid and peepholes remain closed the entire firing. Using the Orton Vent, tests have shown reds can even be fired with other colors with good results.

Firing to Proper Cone Number

Using witness cones on the kiln shelf to verify results is important to good results. Many problems occur when red glazes are not fired to the proper cone number. Blistering can occur if underfired and loss of color if overfired. Glaze on underfired bisque may craze. Firing lead free glazes to the proper cone number is especially important.

Firing reds can be a challenge, but by following good preparation, application, firing and venting practices, and by firing to the proper cone number, most problems can be eliminated.

Want to learn more?

Read more about Firing Reds in the Orton Firing Line and Technical Tips publications. Each issue is packed full of articles to help you learn more about firing. Members of the Orton Firing Institute receive these publications at no charge. Single copies are available to non-members at a per issue rate. Orton's 80 minute video, *Key Principles of Successful Firing*, is also an excellent resource on firing.

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Firing Tips

UNDERSTANDING CRAZING

What is Crazing

Crazing is one of the most common problems related to glaze defects. It appears in the glazed surface of fired ware as a network of fine hairline cracks. The initial cracks are thicker and spiral upward. These are filled in horizontally with finer cracks.

Crazing is caused by the glaze being under too much tension. This tension occurs when the glaze contracts more than the body during cooling. Because glazes are a very thin coating, most will pull apart or craze under very little tension.

Crazing can make foodsafe glazes unsafe and ruin the look of a piece.

There are two types of crazing, each with a different cause:

immediate crazing

- appears when piece removed from kiln or shortly thereafter
- caused by glaze body fit (glaze fits too tightly to body)

delayed crazing

- shows up weeks/months later
- caused by moisture getting into ware

Immediate Crazing

Size Changes During Firing

All ceramic bodies change in size during heating (firing) and cooling. What is desired is for the glaze to shrink a little more than the body during cooling. If it doesn't then glaze problems may occur.

It is important for ware and glaze expansion and shrinkage to match or crazing can occur.

Glazes During Firing

1. during firing, glaze undergoes physical and chemical changes
2. as heating progresses, glaze melts
3. with further heating more liquid forms until viscous or thick fluid
4. more heating, more fluid glaze
5. at this point, viscous (thick flowing) glaze still conforms to size of the bisque.
6. any gas evolving from body will form blisters which can heal if glaze is still fluid
7. when kiln shuts off, glaze and body cool together
8. during cooling, both the body and glaze shrink
9. eventually glaze becomes a hard glass that will no longer flow



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Thermal expansion/shrinkage properties of both the body and the glaze determine if the glaze crazes.

Glazes are designed to shrink less than the body which puts them in compression, makes them stronger, and makes them less susceptible to crazing.

Solution to Glaze and Body Fit

1. test samples for a good fit
2. bisque to 1-2 cone numbers hotter than glaze to insure body is mature
3. use Self-Supporting Witness Cones to verify heatwork
4. recognize that bodies and glazes will have different fits for different heatwork. A glaze might fit bisque fired to 03, but craze on 07 bisque

DELAYED CRAZING

This type of crazing shows up weeks or months later and is practically always caused by underfiring.

If ware is underfired (does not reach maturity), it can, in time, expand when moisture fills the pores causing the body to expand. Sudden changes in temperature can cause crazing if the body and glaze do not expand or contract uniformly.

Either the body expanding or the glaze shrinking can cause fine hairline cracking (crazing) to occur. Refiring to the proper cone will sometimes solve the problem.

Proper Firing

Firing to the proper cone number is critical to help eliminate crazing problems. Witness cones must be used

to verify the heatwork the ware receives.

If the Kiln-Sitter® turns the kiln off and a witness cone is not properly deformed, then the ware is not fired to maturity.

Underfiring can occur because of:

- variations in kiln heating uniformity
- Kiln-Sitter® out of adjustment and shutting kiln off early
- controller thermocouple inaccurate
- differences in heatwork between kiln shelf and Kiln-Sitter® location

Crazing can also be reduced by slower cooling and slower firing.

LEAD FREE GLAZES

Lead-free glaze formulations today have less of firing range. They develop their fired properties more quickly and this makes proper firing more critical.

Want to learn more?

Read more about crazing in the Orton Firing Line and Technical Tips publications. Published 8 times a year, each issue is packed full of articles to help you learn more about firing. Members of the Orton Firing Institute receive these publications at no charge. Single copies are available to non-members at a per issue rate.

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Firing Tips

SOLVING GLAZE DEFECTS BLISTERS, CRATERS and PINHOLES

Blisters, craters and pinholes are related glaze surface defects. They show up as a rough, grainy or bubbled surface on the ware and appear after the glaze firing or decorating firing.

What Causes These Defects?

This family of problems can be caused by many different factors including:

- dust and contamination in the glaze
- air bubbles in the glaze
- air trapped in the slip
- improperly mixed slip
- a dirty kiln

Most commonly, however, the problems are related to gases coming from the body, glaze or kiln atmosphere.

What Happens During Firing?

Clays and glazes contain organic materials. When heated, these burn out of the body, forming gases such as carbon, sulfur and water.

If the carbon in materials is not fully removed from the body, then gas will form during the glaze or decorating firing, forming bubbles or blisters. These may pop to become craters or pinholes.

These defects can occur because:

1. There was not enough air in the kiln during firing for the carbon to properly burn out.

Any combustion process requires air. Without air, oxidation cannot occur.

2. Carbon monoxide formed by oxidation of carbon has not been adequately removed from kiln.

If the gases produced during firing are not removed from the kiln, they may deposit onto the glaze surface or affect the glaze color.

3. The kiln was heated so quickly that there was not enough time for the carbon to burn out.

Carbon which is only partially burned will continue to oxidize during the glaze or decorating firing causing defects.

4. The ware was underfired. That is, there was not enough heatwork.

When the body is underfired, it is weaker and its expansion may no longer fit the glaze.



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How Do I Solve Glaze Defects?

To make sure that glaze defects do not occur, it is important to properly mix glazes and slips and to use good pouring (slip) and application (glaze) techniques. Proper housekeeping for the kiln and workplace should be observed. Straining glaze through nylon often helps remove any lumps.

Most critical for good results are proper firing practices. We recommend the following:

1. Bring air into the kiln and make sure it circulates around the ware especially during bisque firings:
 - use setters and stilts to improve air flow around the ware
 - use half shelves to improve air flow through the kiln
 - adequately vent the kiln
 - position ware to take best advantage of air flow in the kiln

Use a downdraft vent like the Orton KilnVent to bring a controlled amount of air into the kiln and circulate it throughout the kiln. This helps remove fumes and even out the temperatures in the kiln.

2. Control the firing.

Fire slower, especially below 1200°F (650°C). Slow down the firing by adjusting switches to lower settings or soak/hold at a temperature to allow carbon to burn out.

Use an automatic controller to set heating rates and hold times.

3. Use witness cones to verify heat-work.

Underfiring can occur due to burned out heating elements, an improperly adjusted Kiln-Sitter®, a controller thermocouple which has changed or differences in heating within the kiln. Witness cones give a true reading of the heatwork the ware received.

Witness cones placed throughout the kiln show differences in heat distribution.

4. Vent the kiln to remove gases and prevent them from redepositing on ware. Only downdraft venting removes the gases from the kiln.

If good firing and venting practices are observed during firing, problems with glaze surface defects can be controlled.

Want to learn more?

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Firing Tips

SUCCESSFUL GLASS FUSING

Probably the most common problem encountered when fusing glass is that it breaks during firing. There are several causes, including:

1. glass incompatibility
2. glass sticking to shelves
3. glass heated too rapidly
4. glass annealed too quickly

Glass Compatibility

To be compatible, glasses must expand and contract at the same rate when heated and cooled. When this does not occur, they are considered incompatible.

If incompatible glass is fused together and then cooled, stresses will occur in the piece. If the stress is excessive, the fused glass will break either immediately upon cooling or months or even years later.

Glasses are rated using a coefficient of thermal expansion scale. This is based on the linear size change or expansion during heating.

What this means is that the amount the glass expands during heating is

measured and compared to a scale. The larger the number, the greater the expansion. Glass with low expansions will have greater resistance to thermal shock and breaking or cracking.

When you purchase glass, be sure all of the materials you are planning to use in a piece have similar expansion (coefficient) numbers.

Glass Sticking

If kiln wash (shelf primer) is applied unevenly or bare patches are left, the glass may stick as it moves (expands) during the firing process. When this happens, the glass can pull itself apart and break.

Kiln wash should be cleaned off and reapplied in a thin even coating to prevent sticking problems. Take care not to use too much shelf primer as it may require sandblasting to remove it from the bottom of the fired piece.

Glass Heating Too Rapidly

Thermal shocking of glass during



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heat up can lead to uneven heating and cracking of the piece. Thermal shocking means that the surface of the glass changes temperature rapidly.

When fusing glass, it is important to control the heating rate between about 150°F and 500°F. For larger or thicker pieces more time is needed. Glass fired in a mold is more susceptible to uneven heating since contacts with the cooler refractory (mold) can lead to uneven heating.

Direct radiant heat from heating elements needs to fall uniformly on the glass or it can cause uneven heating. Most glass firing is done in electric kilns, often with elements above the glass.

Glass Annealed Too Quickly

Annealing is done to reduce stresses in the glass that can result in cracks or breaks. Typically annealing is accomplished by soaking during the cooling cycle (at about 900°F) and then slow cooling between 900°F and 500°F. The amount of time the glass is annealed depends on its thickness. Annealing permits all the glass to equalize in temperature.

When glass is annealed too quickly, stresses can remain that can cause cracking.

When thick sheets or pieces of glass are being annealed, a process called firing down may be necessary. Firing down is done during the slow cooling phase of annealing. Firing down is

used if the kiln is unable to maintain the slow cooling rate required for the piece. The process of firing down involves adding a small amount of heat to the kiln as it cools.

The best way to control cooling during annealing is to use an automatic controller. The desired anneal temperature, soak time and cooling rate are set and the kiln operates automatically. Temperature is displayed. However, even with a controller, the cooling rate set by the operator may be too fast for the kiln to achieve. It is necessary to monitor the temperature change to insure the proper annealing and cooling down occurs.

The thickness of the glass being fired

Want to learn more?

Read more about annealing and firing glass in the Orton Firing Line and Technical Tips publications. Each issue is packed full of articles to help you learn more about firing. Members of the Orton Firing Institute receive these publications at no charge. Single copies are available to non-members at a per issue rate. Orton's 80 minute video, *Key Principles of Successful Firing*, is also an excellent resource on firing.

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Firing Tips

SUCCESS WITH GOLDS

Gold overglazes are known as liquid precious metals. They are expensive and because of this they are traditionally used only for decoration.

Golds are typically used to add detail or distinction to plates, cups and china blanks.

There are several types of gold available in different forms, including bright golds and burnished golds.

Bright Golds

These are gold overglazes. They are not solid gold; instead they contain some percentage of gold, usually about 5 to 15%.

They come as a liquid solution and are usually applied with a brush to reduce waste. A thin coat is preferred to prevent the decoration from running, or failing to adhere.

If the liquid gold becomes too thick, it can be thinned with gold essence. Both of these products are very expensive and come in small vials or bottles.

Burnished Gold

Burnished golds are also gold overglazes. They differ from bright golds in that they require finishing (burnishing) to develop a lustrous finish and bright sheen.

Burnished golds are more durable and have a higher resistance to scratching than other golds. Their appearance is very rich and dense and slightly more matte. The brightness or matte quality can be controlled by application. A thinner application makes for a brighter gold.

Burnished golds contain 16-32% gold, including gold powder. Burnished golds are available in several forms: liquid, paste, dry powder or concentrated pats. The dry powder is extremely expensive.

There are some burnished golds that do not require polishing. These contain between 12 and 20% gold.

Firing Golds

Golds generally fire in the 022 to 018



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cone range. This can vary greatly depending on the gold itself and the ware it is being used on. For typical glassware, an 022-021 firing is the most common. For china blanks, the gold can fire as high as 011. Follow the instructions of the manufacturer when firing golds.

Gold will adhere best with a slow firing and a soak. This helps them to develop the proper color and finish. A faster firing increases the risk of surface defects which can be magnified through washing or use.

Golds contain heavy solvents which make kiln ventilation a must for both health and safety reasons and to bring air into the kiln. Usually gold is fired alone to reduce contamination problems.

Typical Gold Faults

Most gold faults are surface defects. These include:

cloudy appearance

caused by inadequate ventilation or too heavy application, firing too fast or overfiring

gold not adhering

caused by underfiring or too heavy application

gold is running

caused if application is too heavy

burnished gold is dull

caused by insufficient burnishing or possible underfiring

dull or scummy appearance

caused by inadequate ventilation or possible overfiring

cracking in finish

caused by firing too fast

pinholes and blemishes

caused by poor quality of gold or contamination of gold

blisters

caused by heavy application

Application and proper firing are the key to great gold results. Gold should be applied in moderation using a very light coating. Be sure to vent the kiln until it glows red hot. Use witness cones to verify the proper heatwork was achieved.

Want to learn more?

Read more about using golds in the Orton Firing Line and Technical Tips publications. Each issue is packed full of articles to help you learn more about firing. Members of the Orton Firing Institute receive these publications at no charge. Single copies are available to non-members at a per issue rate. Orton's 80 minute video, *Key Principles of Successful Firing*, is also an excellent resource on firing.

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Firing Tips

SUCCESS WITH DECALS

Decals offer an opportunity to add decoration to ceramic and glass ware without the time and skill required for hand painting. When properly applied and fired, decals can add color, texture, design and personalization to a piece.

To achieve professional results with decals, it's important to understand how to select, apply and fire the decals.

- type of decals
 - different decals are made for glass and ceramics
 - ceramic decals often fire hotter than those for glass
- application
 - decals must have good contact with the surface of the ware
 - all wrinkles and bubbles need to be smoothed away
 - avoid tearing the decal
- firing
 - decals are generally low firing - from cone 022 to 016
 - check the package for the proper firing range
- venting
 - decals contain lots of organics which need to be burned off

- often smelly fumes result during decal firings

Firing Decals

A decal isn't fired that much differently than any other piece of ware, although there are some special considerations.

1. Venting is very important to good results with decals - especially to get true colors.

Problems related to venting include:

- poor color development
- a cloudy or hazy appearance

2. Proper heatwork is also an important factor. Decals that are under or overfired may exhibit the following:

- faded colors (overfired)
- color shift (underfired)
- decals rub off (underfired)
- dull appearing metallics (underfired)

Determining Firing Range

Because the colors on decals can so easily be affected by the amount of heatwork they receive, we recommend test firings to determine the best firing range.



The Edward Orton Jr. Ceramic Foundation
6991 Old 30 Highway
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FIRING TIPS is a series of firing problem solvers. New TIPS are available every month. Contact your Orton supplier for your copy.

Use a series of witness cones to fire samples of the decals on tiles or blanks. Make several firings and then select the fired appearance which looks the best.

Color development

Cloudy looking decals or decals where the color is not bright need to have additional air to develop properly. Organics need to be burned out and carbon monoxide fumes have to be removed from the kiln.

Manual venting by propping the lid and removal of peephole plugs will improve the firing, but may not help bring enough air to the bottom of the kiln or to distribute it evenly throughout the load.

A downdraft vent system will ensure sufficient air is brought into the kiln and circulated throughout.

Measuring heatwork

Heatwork is another critical factor in the color development of decals.

Fading, shifting and dullness are signs of too much or too little heatwork. This is also true when decals rub off after firing. (White or blank spots or burned off areas are generally related to application, not firing.)

Use witness cones to measure heatwork and to check the heat distribution in the kiln. Firing to a temperature or firing to a Kiln-Sitter® cone may not give the same results as found with a witness cone next to the ware.

Measuring heat distribution

Differences in heat distribution from top to bottom in the kiln are usually far more noticeable for cooler firings like decals. A 2 or 3 cone difference at 022 may only be a 1 cone difference at cone 6. This is because at higher temperatures radiation heats the kiln more effectively.

Slowing the first half of the firing can help heat distribution problems. This also helps by allowing more time for air to enter the kiln and burn out organics and for carbon monoxide to leave the kiln.

Use a controller to set heating rates and soaks for more precise firings.

Want to learn more?

Read more about successfully firing decals in the Orton Firing Line and Technical Tips publications. Published 8 times a year, each issue is packed full of articles to help you learn more about firing. Members of the Orton Firing Institute receive these publications at no charge. Single copies are available to non-members at a per issue rate.

For information on Orton products, see your Orton dealer or distributor.

For information on the Firing Institute or publications, contact

Orton Firing Institute, 6991 old 3C Hwy.,
Westerville OH 43082, 614-895-2663.

**Orton pyrometric cones and bars • KilnVent systems
kiln accessories and firing supplies • Orton Firing Institute**

Firing Tips

MAKING FOODSAFE WARE

When making ware to contain food and beverages, it is very important to be sure it is foodsafe. Some of important considerations for mugs, serving pieces and dinnerware include:

- body composition
- design of the ware
- glaze selection
- decoration
- firing to maturity
- testing for lead safety
- government regulations

What Type of Ware?

The design of some pieces of ware have inherent problems which make them unsuitable to contain food and beverages.

Design-related cracks, rough areas, crevices and nooks and crannies are difficult to clean and might trap bacteria. They can also be difficult to thoroughly glaze. Pitchers with hollow handles can have the same problems.

Ware also needs to be serviceable - that is, it should be strong so it won't fail or break during service.

Making Smart Glaze Choices

While glazes are extremely durable, most are not completely insoluble. If attacked by acids in foods such as orange juice, vinegar and tomatoes, small amounts of the glaze may dissolve and pose a health hazard.

Acid resistant glazes have passed rigorous tests and are labeled as foodsafe. These should be selected for glazing food ware. Lead-free glazes may not be acid-resistant and should not be used unless labeled as foodsafe.

Homemade, altered, crackle, matte or specialty glazes also should be avoided for surfaces of containers that will contact food and beverages.

How to Decorate

When glazing, be sure to completely glaze the ware to ensure the entire body is sealed. Properly bisqued porcelain may be dry footed, but only if the porcelain has been fired to vitrification. Label the ware as foodsafe for future users.

China paints, decals and rim designs



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FIRING TIPS is a series of firing problem solvers. New TIPS are available every month. Contact your Orton supplier for your copy.

are a popular way to decorate plates and mugs, but may not be safe for food surfaces. Specific regulations exist for the location of rim decorations which must be followed.

Decals should be used on the outside of a piece where they will not be in contact with food or beverages. Use china paints on decorative items only.

Safe Firing

Proper glaze firing and the bisque firing are very important to insure ware is foodsafe. If the bisque is underfired, it may create problems with glaze and body fit that result in crazing of the glaze, or glaze surface defects such as pinholes. These would not be acceptable for ware used to contain food and beverages.

If the glaze is not properly matured, it will not meet the foodsafe standards under which it was tested and may craze while in service.

Using pyrometric witness cones on the kiln shelf is the only way to insure that a proper firing has occurred. For foodsafe ware, many prefer to fire their bisque to an 03 witness cone just to be sure it is fully mature. Read and follow the manufacturer's instructions for glazes for the best and safest results.

Regulations

There are several very specific regulations for ware which will contain or contact food and beverages. California has the most stringent rules for dinnerware and new standards have been set

by the FDA for rim decorations. These rules are available from state and federal agencies. If you are selling your dinnerware you may be subject to additional regulation.

How to Test for Lead Release

Several easy to use products are available on the market to test for lead release. These are primarily quantitative tests - that is, they tell you yes or no if the surface has lead above a certain level. The most commonly used kit is a thick cotton swab which turns pink if lead levels are exceeded. This test does not harm ware so if it tests too high in lead, the piece can still be used as decoration. These tests are a simple, economical way to feel confident that your ware is safe.

Want to learn more?

Read more about Making Foodsafe Ware in the Orton Firing Line and Technical Tips publications. Each issue is packed full of articles to help you learn more about firing. Members of the Orton Firing Institute receive these publications at no charge. Single copies are available to non-members at a per issue rate. Orton's 80 minute video, *Key Principles of Successful Firing*, is also an excellent resource on firing.

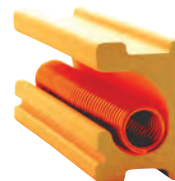
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DAVINCI INSTRUCTION MANUAL

TROUBLE
SHOOTING



L&L Kiln's patented
hard ceramic
element holders
protect your kiln.

TROUBLESHOOTING AND REPAIR INSTRUCTIONS FOR L&L KILNS

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TROUBLESHOOTING AND REPAIR INSTRUCTIONS FOR L&L KILNS

CAUTION - ELECTRICITY CAN KILL

Many of the tests described in here are performed under power. They should be done **ONLY** by someone who is familiar with electrical safety such as an electrician or trained maintenance person. We identify any test that is live with a CAUTION statement. We describe these tests in detail so that an electrically trained person who doesn't specifically understand kilns can do the troubleshooting - the level of simplicity described is not meant as an invitation to harm the untrained. **AS LONG AS THE KILN IS UNPLUGGED YOU ARE SAFE.**

GET A DIGITAL MULTIMETER!

If you want to do much of the troubleshooting described here and not be dependent on a kiln service person then get this tool. It is not hard to use! Without it you are only guessing at the origin and severity of an electrical problem based on how the kiln is acting. A slow-firing kiln may just have old elements, or the elements could be fine but the incoming voltage from your power supply could be low, or fluctuating. Unless you test with a multimeter, you could purchase new elements and run the risk that you might be wasting money and time without solving the problem. Be forewarned however: Testing electrical circuits is very dangerous and potentially deadly if you do it incorrectly. It could result in electrocution! If you don't feel comfortable doing this hire an electrician or get someone to do it who is qualified. That being said - many of the tests described in here just require testing for resistance - which is done with the kiln unplugged. **AS LONG AS THE KILN IS UNPLUGGED YOU ARE SAFE.**

You can buy an inexpensive digital multimeters for around \$40-\$50. The meter you buy should be digital simply because the analog type is not very accurate. **You must be able to see ohm (resistance) readings to the first decimal place.**



TROUBLESHOOTING GUIDE

This manual is meant to assist and educate kiln owners and service technicians. Our basic philosophy at L&L is to make kilns that last. No small part of having a reliable well-firing kiln is good maintenance. This information is provided as a service and is believed to be accurate. However, it is the reader's sole responsibility to interpret and use this information correctly. Please visit our web site to download the latest versions of all our instructional and technical information.

VIDEOS

ALSO WE ENCOURAGE YOU TO USE THE VIDEOS ON OUR WEB SITE (hotkilns.com/videos).

TROUBLESHOOTING WEB TOOLS

The latest troubleshooting information is on the web. This is constantly updated. See hotkilns.com/knowledgebase

RELATED L&L GUIDES

CAUTION INSTRUCTIONS

See CAUTION INSTRUCTIONS FOR L&L KILNS in the CAUTIONS section of your Instruction Manual. **THIS IS SOMETHING YOU MUST READ.** (Also hotkilns.com/cautions)

REGULAR KILN MAINTENANCE

See REGULAR MAINTENANCE OF YOUR L&L KILN in the MAINTENANCE section of your Instruction Manual. **THIS IS SOMETHING YOU MUST READ.**

BASIC ELECTRICITY FOR TROUBLESHOOTING

See BASIC ELECTRICITY FOR TROUBLESHOOTING KILNS in the TROUBLESHOOTING section. Also see hotkilns.com/volts for more in-depth information about electricity for kilns.

TROUBLESHOOTING BRICK PROBLEMS

See TROUBLESHOOTING AND FIXING BRICK PROBLEMS in the TROUBLESHOOTING section for information on firebrick problems and instructions on how to repair firebrick problems.

TROUBLESHOOTING AND REPAIR INSTRUCTIONS FOR L&L KILNS

TROUBLESHOOTING ELEMENT PROBLEMS

See ELEMENT TROUBLESHOOTING & INSTALLATION INSTRUCTIONS in the TROUBLESHOOTING section for information on elements problems and instructions on how to install elements and element holders.

TROUBLESHOOTING FIRING PROBLEMS WITH CONE PACKS

See TROUBLESHOOTING KILN FIRING WITH CONE PACKS in the LOG, CONES, TIPS section.

THE CERAMIC PROCESS

See THE CERAMIC PROCESS in the LOG, CONES, TIPS section.

REPLACEMENT PARTS

See the PARTS section.

SERVICE

See SERVICE section.

GENERAL TROUBLESHOOTING TOOLS AND METHODS

BASIC TOOLS REQUIRED

The minimal toolkit necessary for effective troubleshooting and fixing of electric kilns contains a digital multi-meter to measure ohms and AC voltage, and an assortment of screwdrivers, nutdrivers, wrenches, pliers, cutters, wire strippers and wire terminal crimpers. As you work on your kiln you will see what types of tools you need, like a 3/8" nut-driver, needle-nose pliers without the cutting part so the tips will close all the way. wire cutters heavy enough to cut the element terminals, wire strippers and wire terminal crimpers. No special tools are required for maintenance on L&L kilns.

KEYS TO GOOD TROUBLESHOOTING

SAFETY FIRST

Pay attention to electrical safety. Don't get electrocuted and don't guess.

DEFINE THE VARIABLES

Define all variables of the situation, and how they could potentially interact with and affect each other in each unique case you come across.

ELIMINATE VARIABLES ONE AT A TIME

Eliminate variables one by one to expose the problem variable(s). Asking questions can do this to some degree. Electrical testing, examining shards of ware or cone, or examining the interior of the kiln usually can supply the rest of the story. Good troubleshooting is based on logic.

Err1 (ERROR 1) - THE MOST COMMON ERROR

This is the most common troubleshooting problem we see. It generally means one of two things. 1) The elements have aged with increased resistance and therefore lower power. 2) A relay is not working. See The section in these instructions on Error Codes, CHECKING ELEMENT OHMS, and various paragraph on checking the relays. There are several good videos (hotkilns.com/videos) about how to check relays and ohms.

CONTROL DISPLAY DOESN'T SHOW ANYTHING

On/Off Switch

1) Make sure the On/Off Switch is turned on. Turn it on and off.

Fuse

1) Check control fuse in side of control box. Twist open the fuse holder and physically check the fuse. If the metal element inside is melted if it is blown. You can also use your digital multi-meter to check continuity across the fuse. Replace if faulty: hotkilns.com/control-panel-fuse

TROUBLESHOOTING AND REPAIR INSTRUCTIONS FOR L&L KILNS

Picture of the on/off switch and fuse holder opened.



Fuse Holder

If you notice that the fuse holder itself is damaged replace it. See: hotkilns.com/change-fuse-holder

On/Off Switch

The on/off switch rarely needs replacing but if you have to replace that see this video: hotkilns.com/replace-on-off-switch

Plug & Cord (if you have one)

1) Make sure the power cord is plugged into the receptacle. Reseat plug. Make sure it is held firmly and that the springs inside the receptacle seem to be working.

2) With power off examine the electrical cord. Look for burned or melted areas and breaks or pinched sections. Look closely at the head of the plug. If there is an internal problem with the wires and the plug parts you won't be able to see it but you may detect a softening or melting of the plastic at the plug head. Look for oxidation or substantial discoloration or even burnt spots on the prongs. Replace plug and cord if this is questionable.

3) With power turned on and panel open check voltage at the Power Terminal Block. If you see no voltage there then you know something is wrong with the power source.

CAUTION: This test should only be done by an experienced person familiar with electricity and its dangers.

If you have to replace the power cord see this video. It includes video of changing a power cord. hotkilns.com/change-phase-easy-fire

Checking voltage at the power terminal block.



Circuit Breaker / Power Source

1) Check voltage at the receptacle. **CAUTION:** This test should only be done by an experienced person familiar with electricity and its dangers.

A fused disconnect switch.



2) Check circuit breaker or fused disconnect switch to make sure they are turned on. Sometimes circuit breakers need to be turned on and off to reset them.

3) If you have a fused disconnect check the fuses with your voltmeter for continuity. **CAUTION:** This test should only be done by an experienced person familiar with electricity and its dangers.

4) Make sure fuses or circuit breaker are the proper amperage and type. See wiring diagram for details.

5) Test for voltage at the main power supply as close to the kiln as possible. **CAUTION:** This test should only be done by an experienced person familiar with electricity and its dangers.

TROUBLESHOOTING AND REPAIR INSTRUCTIONS FOR L&L KILNS

Control Transformer

See this video: [hotkilns.com/check-control-transformer](https://www.hotkilns.com/check-control-transformer) and [hotkilns.com/change-transformer](https://www.hotkilns.com/change-transformer).

1) If none of these solve the problem then you could have a bad control transformer. To check the transformer operation test with your digital multimeter. It should read 240 (or 208) volts across terminals 1 & 4 (black and white wires) and 24 volts across terminals 5 & 8 (where the gray and brown wires come out). This is a live test so be very careful not to touch any of the wires - remember there is 240 volts in the panel and this can electrocute you. See photo below. If you are receiving 240/208 Volts in, but not getting the proper approximate 24 Volts out, then you need to replace the control transformer. See: [hotkilns.com/control-transformer-12-va](https://www.hotkilns.com/control-transformer-12-va)

2) If there is no voltage coming into terminals 1 & 4, white & black, then test for it at the Power Terminal Block where the power cord comes in. If there is power there then look for a bad connection or wire between the power connection block and the transformer, i.e. a bad toggle switch, wire, or ½ amp fuse holder. If power is not there then go further back on the line and measure the voltage. Keep going until you find voltage, then look for the problem between that point with the voltage and the last point checked that had no voltage.

Control Board

1) If the transformer is OK and you know you have voltage going to the control board but the control still shows no display then the control board needs to be replaced.

DynaTrol: [hotkilns.com/dynatrol-control-board](https://www.hotkilns.com/dynatrol-control-board)

Genesis: [hotkilns.com/genesis-control-board](https://www.hotkilns.com/genesis-control-board)

One-Touch for School-Master kilns: [hotkilns.com/one-touch-control-board-cone-6](https://www.hotkilns.com/one-touch-control-board-cone-6)

One-Touch for Doll, Liberty-Belle and Fuego kilns: [hotkilns.com/one-touch-control-board-cone-10](https://www.hotkilns.com/one-touch-control-board-cone-10)

See this for how to replace: [hotkilns.com/replace-dynatrol](https://www.hotkilns.com/replace-dynatrol)

Internal Wiring

1) Unplug kiln or turn off at circuit breaker or fused disconnect and open up panel. CHECK VOLTAGE TO BE SURE. Make sure that all the wires inside the control panel are connected. See photograph on page 2 or page 3 and also the Wiring Diagram. Specifically look at the wires that go from the power connection block to the on/off switch, then to the control fuse and then to the control transformer.

Short Circuits

Do all the following with the kiln unplugged.

1) Check for short circuits. Look for any signs of burnt wires. This might indicate a short circuit. A way this might happen, as an example, is that frayed wires at the end of a wire connector might touch each other.

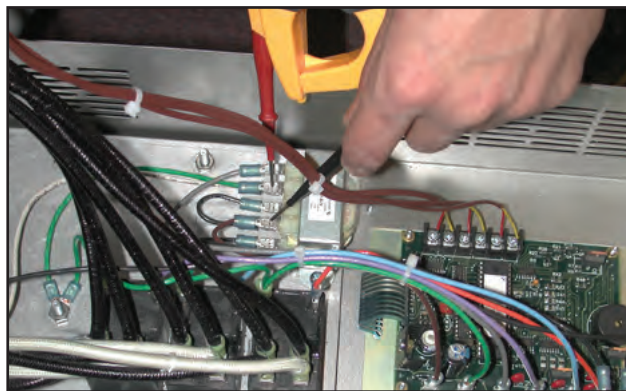
2) Check for worn wires that may have shorted against the case. Examine wire insulation. If the wire insulation has become frayed the wires could short to the metal casing which is electrically grounded.

3) Look for dirt. Some dirt (such as carbon compounds) are electrically conductive. This is generally not the case with ceramic materials but some can be. Vacuum out if you see dirt.

NOTE: Usually a short circuit will trip either the circuit breaker for the kiln or the fuses in the fused disconnect switch, if you have one. You will then not see any display on the DynaTrol. Turn your circuit breaker on and off, and check fuses on the fused disconnect and control fuse.

CAUTION: These tests should only be done by an experienced person familiar with electricity and its dangers.

Checking output of the Control Transformer (DANGER-live test).



EASY-FIRE DISPLAY READS FAIL

Usually **FAIL** will be seen flashing along with a **tC1**, **tC2** or **tC3** indicating which thermocouple circuit has failed.

Typically this will just mean that your thermocouple(s) need replacing. Overtime the thermocouple tip will corrode and cause a circuit to **FAIL**. We recommend replacing all thermocouples simultaneously rather than as they fail.

See this to replace thermocouple: [hotkilns.com/change-thermocouple](https://www.hotkilns.com/change-thermocouple)

1) Unplug the kiln. Open the Control Panel. Remove

TROUBLESHOOTING AND REPAIR INSTRUCTIONS FOR L&L KILNS

the offending thermocouples connection wires from the Thermocouple Terminal Strip and bind the red and yellow wires together with electrical tape. Close up the panel and plug in the kiln. The control should read room temperature for that thermocouple (approximately 90 Deg F because of the thermocouple offsets).

2) If it does read room temperature then the thermocouple is probably bad and needs to be replaced. If the control does not read room temperature then there is either a bad thermocouple wire in the Control Thermocouple Harness or the control is bad.

3) Redo the test by putting a small jumper like a paperclip across the thermocouple terminals directly on the DynaTrol board. If the control now will read room temperature then you have a bad thermocouple wire. If it does not read room temperature then the control is definitely bad and needs to be replaced. See this: hotkilns.com/replace-dynatrol

EASY-FIRE DISPLAY READS 2400 or CPLt WHEN IT STARTS UP

Even though you know the kiln is not that hot. This indicates thermocouple circuit failure.

TECHNICAL NOTE: This is called thermocouple upscale protection. If the control senses a lack of millivoltage (an open circuit) it interprets this as the highest temperature the control could reach. This automatically ensures that the control will not call for power.

1) Check thermocouple end. Examine end carefully. Sometimes there can be a crack that opens up while the kiln is hot but appears to be normal when the kiln is cold. If the end of the thermocouple looks severely corroded and you are getting Error codes then it is best to replace the thermocouple. NOTE: You have to open up the Element Cover Box and remove the thermocouples to check the ends.

A thermocouple end that will still work but is getting close to creating a problem.



2) Check thermocouple circuit. For instance check to

make sure that all the thermocouple lead wires are firmly connected to the Thermocouple Terminal Strip. Check where the thermocouple lead wires go into the ends of the thermocouples. Are the wires loose? Tighten the screws on the ends of the thermocouples to be sure you have a tight connection. Check for corrosion. Check where the thermocouples connect to the DynaTrol. Try pulling off each connection and reseating it. This can scrape away corrosion that may have built up. Check for melted wires inside the Element Cover Box.

3) A very easy check is to check resistance (ohms) right on the Thermocouple Terminal Strip. Unplug kiln or disconnect from live power by turning off circuit breaker or fused disconnect switch. Open panel. You don't even have to remove the thermocouple wires. Just touch the terminal strip itself with your probes (terminals #1 & #2 for TC1, terminals #3 & #4 for TC2 and terminals #5 & #6 for TC3). If the thermocouples and circuit is normal then you will see a resistance of about .9 or 1.0. If you see an **OL** in your meter then you have an open circuit somewhere which is probably a bad thermocouple.

4) If you have a bad thermocouple replace it with a new one. Although you may be able to "make it work" by twisting the ends of the wire together this could easily fail during an important load and could also be extremely inaccurate.

ONE-TOUCH CONTROL DISPLAY READS FAIL

Usually **FAIL** will be seen flashing along with a **tC** indicating the thermocouple has failed.

1) Check thermocouple end. Examine end carefully. Sometimes there can be a crack that opens up while the kiln is hot but appears to be normal when the kiln is cold. If the end of the thermocouple looks severely corroded and you are getting Error codes then it is best to replace the thermocouple. NOTE: You have to open up the Element Cover Box and remove the thermocouple to check the end.

See this to replace thermocouple: hotkilns.com/change-thermocouple

2) Check thermocouple circuit. For instance check to make sure that all the thermocouple lead wires are firmly connected to the Thermocouple Terminal Strip. Check where the thermocouple lead wires go into the ends of the thermocouples. Are the wires loose? Tighten the screws on the ends of the thermocouples to be sure you have a tight connection. Check for corrosion. Check where the thermocouples connect to the DynaTrol. Try pulling off each

TROUBLESHOOTING AND REPAIR INSTRUCTIONS FOR L&L KILNS

connection and reseating it. This can scrape away corrosion that may have built up. Check for melted wires inside the Element Cover Box.

3) A very easy check is to check resistance (ohms) right on the Thermocouple Terminal Strip. Unplug kiln or disconnect from live power by turning off circuit breaker or fused disconnect switch. Open panel. You don't even have to remove the thermocouple wires. Just touch the terminal strip itself with your probes (terminals #1 & #2 for TC1, terminals #3 & #4 for TC2 and terminals #5 & #6 for TC3). If the thermocouples and circuit is normal then you will see a resistance of about .9 or 1.0. If you see an **OL** in your meter then you have an open circuit somewhere which is probably a bad thermocouple.

4) If you have a bad thermocouple replace it with a new one. Although you may be able to "make it work" by twisting the ends of the wire together this could easily fail during an important load and could also be extremely inaccurate.

DISPLAY IS NORMAL BUT KILN WON'T HEAT UP

Programming

1) Make sure you have programmed the kiln properly and it is supposed to be firing. Do you have a **Delay Time** or a **Preheat Time** in your program? (Hit the **Review Prog** button on the Easy-Fire or hold down the **Custom/Review** button on the School-Master to find out).

Wiring

1) Unplug kiln or disconnect from live power by turning off circuit breaker or fused disconnect switch. Open panel. Check all power wires for firm connections. Using your multimeter set on resistance you can check continuity of each element circuit by placing the probes on each set of outputs on each Power Relay or right at the Power Terminal Strip (as shown below).

Picture showing a Multimeter testing for continuity in an element circuit.



2) Visually inspect the power wires coming from the Power Terminal Block to the inputs of the Power Relays. Reseat all the spade connectors to rub off any oxides and to ensure a good connection.

EASY-FIRE Control Board Outputs

1) It is possible that the internal switches on the DynaTrol or Genesis control board could be bad. You can test that by checking to see if you find voltage (12 volts DC) between any of the output contacts on the control board (where the orange, blue and purple wires come out) to ground (any green wire). CAUTION: This test should only be done by an experienced person familiar with electricity and its dangers. See this video: [hotkilns.com/check-switches-dynatrol](https://www.hotkilns.com/check-switches-dynatrol)

ONE-TOUCH Control Board Outputs

1) It is possible that the internal switches on the One-Touch™ control board could be bad. You can test that by checking to see if you find voltage (12 volts DC) between the output contacts (AC1 & AC2 marked on the control board) to ground (any green wire). CAUTION: This test should only be done by an experienced person familiar with electricity and its dangers.

Bad Power Relays

See this video: [hotkilns.com/checking-relay](https://www.hotkilns.com/checking-relay) and [hotkilns.com/change-relay](https://www.hotkilns.com/change-relay)

1) You should be able to hear contactors going on and off with a soft clicking noise when you first turn on the kiln and it is supposed to be heating up. If not try turning the kiln off and then back on again and restarting the program. Of course if you don't hear the relays it only tells you that they aren't firing. The problem could be in the control for instance not telling the relays to fire. If you do hear relays and the kiln is not heating then you know the problem is in the power circuit AFTER the relays.

2) With power on and panel open check voltage before and after each of the contactors while the kiln is firing. CAUTION: This test should only be done by an experienced person familiar with electricity and its dangers.

Bad Elements

See next section.

Run a Simple Paper Test

This will tell you if all kiln sections are firing. If they are not it could be a bad relay or maybe a bad internal switch on the control. See this: [hotkilns.com/paper-test](https://www.hotkilns.com/paper-test)

1. Place a little piece of paper in each element.

TROUBLESHOOTING AND REPAIR INSTRUCTIONS FOR L&L KILNS

2. Then run a Fast Glaze (or turn the manual switches to Hi on a manual kiln) while you watch the papers.
3. They begin to smolder in about 2 minutes. After 3 or 4 minutes shut the kiln off.
4. This shows you if the elements are operating (or which ones are and which ones are not).

KILN FIRES UNEVENLY

Peepholes

- 1) Plug up Peephole holes in the kiln to prevent drafts.

Lid Seal

1) Check to make sure that door/lid is sealing properly. If door/lid is not sealing against top brick correctly a bright red glow will be visible around the door/lid seal when kiln is operating. (A little of this is OK). Also excessive heat loss can be felt around seal. Rub seal high points down with sandpaper until no more than 1/16 of an inch gap is found at any point along seal. Note that the gap at the top will definitely appear larger than any gap you see between the kiln sections. This is partly because the lid actually bows down in the center of the lid when it heats up and the edges consequently rise slightly. Just check for an UNEVENNESS in this gap which will cause an excessive heat loss.

2) If door/lid is excessively cracked or worn or has holes in it this may cause drafts in the kiln. Replace lid.

See the TROUBLESHOOTING AND FIXING BRICK PROBLEMS section in the TROUBLESHOOTING tab of your instruction manual or hotkilns.com/brick-troubleshooting

Elements

1) Elements may have differentially changed in resistance which will also have an effect on uniformity. The three zone control mostly compensates for this but there are limits. Check element resistance (see section at end of this Troubleshooting Guide called "CHECKING ELEMENT OHMS").

2) Empty the kiln. Then turn kiln on using a fast program like FAST GLAZE until elements are red. Open the door carefully and observe the elements to see if they all seem to be glowing about the same amount. CAUTION: The power does not turn off when you open the lid. Be careful not to put your hand inside the kiln while it is on. Dangerous electric shock could result if you touch an element.

RUN AN EASY-FIRE DIAGNOSTIC

There is a useful diagnostic program within the DynaTrol on Easy-Fire Kilns. This is handy to use when your kiln is first delivered and set up to make sure it was done properly. It can also be useful in seeing if an element has burned out. To use this diagnostic program enter the following sequence when the display says Idle.

1) Press **OTHER, 4, 4, 3**.

2) Keep pressing **OTHER** to cycle through the menu options until you get to **diag** and then press **ENTER**.

3) Open the lid of your kiln. You will see each zone of the kiln turn on for one minute each, starting with zone #1, the top zone. The control will display **Out1**, then **Out2**, then **Out3** as it cycles through this sequence. **CAUTION: The power does not turn off when you open the lid. Be careful not to put your hand inside the kiln while it is on. Dangerous electric shock could result.** This will tell you if the kiln sections are in the wrong order or if the wires are somehow crossed in the control panel. If this is the case the zones will not turn on in the proper 1, 2, 3, order.

Loading

The Dynamic Zone Control of the EASY-FIRE kilns can compensate for many uneven loading situations. The SCHOOL-MASTER kilns, however, do not employ Zone Control so pay particularly close attention to the following steps.

1) If you are having a problem with uneven firing try to vary the way you load it to match the firing characteristics of the kiln. For instance if it typically fires hot at the top then put more weight in the top to absorb that heat. You can discern how your kiln fires in each section by using cones.

2) Be sure to put posts under the bottom shelf. The bottom shelf should be at least 1/2" to 1-1/2" above the floor of the kiln.

Firing with Cones

1) Run an empty kiln with three cone packs top- middle - bottom. This will tell you if the load contributes to the problem.

2) Try using cone packs in all sections (top, center, bottom) of the kiln during loaded firings and keep records of what happens. See the TROUBLESHOOTING KILN FIRING WITH CONE PACKS in the LOG, CONES, TIPS, CERAMIC PROCESS tab or hotkilns.com/troubleshooting-cones.

TROUBLESHOOTING AND REPAIR INSTRUCTIONS FOR L&L KILNS

EASY-FIRE Thermocouple Offsets

Thermocouples can drift in their accuracy over time and this can happen at different rates for each thermocouple. If one thermocouple reads at a different temperature than another thermocouple this can cause unevenness in the kiln. You may need to adjust the offsets to trick the kiln into firing hotter or cooler in certain zones. Read about Thermocouple Offset in section 9.9 of the DYNATROL 700 INSTRUCTIONS FOR L&L KILNS in the CONTROL section of the Instruction Manual and the and the CALIBRATING THE CONTROL section in the BASIC OPERATION OF L&L KILNS WITH A DYNATROL 700 in the OPERATION section of the manual. Also see this: hotkilns.com/calibrating-kiln.

ONE-TOUCH Thermocouple Offsets

Thermocouples can drift in their accuracy over time and this can cause inaccurate firings in the kiln. You may need to adjust the offset to trick the kiln into firing hotter or cooler. Read about THERMOCOUPLE OFFSET in the OPTIONS Section of the OPERATION OF L&L KILNS WITH A ONE-TOUCH™ (Deg F) in the OPERATION tab in your instruction manual. Also see this: hotkilns.com/calibrating-kiln.

Vent System

1) Is your vent system on and pulling air? You can check this with a source of smoke in a cold kiln. (If you burn a small piece of paper near the holes on the bottom of the kiln with the vent on and THE KILN OFF you can see if the smoke is being drawn into the holes. You can also check this by feeling the output of the vent when the kiln is at high temperatures. The air coming out should be quite warm to the touch (about 110°F to 140°F). The Vent-Sure will aid in keeping your kiln uniform by drawing hot air from the top of the kiln towards the bottom. It counteracts the natural rising of the heat.

2) If you want to increase draw first close the Bypass valve on the Bypass Collection Box under the kiln. You can also increase the size of the vent holes in the bottom of the kiln. You can also try taking out the top peephole plug. See the L&L VENT-SURE DOWNDRAFT KILN VENT INSTRUCTIONS in the VENT section of your instruction manual or hotkilns.com/vent-sure-instructions.

KILN FIRES TOO HOT OR COLD

Firing with Cones

Try using cone packs in all sections (top, center, bottom) of the kiln and keep records of what happens. See the TROUBLESHOOTING KILN FIRING WITH CONE PACKS in the LOG, CONES, TIPS, CERAMIC PROCESS tab or hotkilns.com/troubleshooting-cones.

Easy-Fire vs Vary-Fire (on DynaTrol)

Keep in mind that the Easy-Fire programs feature Orton software that adjusts the final temperature based on the speed of firing. This in effect adjusts the heat-work and hence the actual cone that the kiln fires to. This applies to Easy-Fire and cone-fire Vary-Fire programs.

Be Careful with Hold Times

Be very careful with hold times. Even a fairly short hold time of 10 minutes can dramatically increase the amount of heat work and hence the cone that the kiln fires to. On the other hand you can use the hold time to increase the heat-work to compensate for underfired work. Just test this in small increments.

Control Settings and Calibration

You may need to calibrate your kiln with thermocouple offsets. See hotkilns.com/calibrate for the most up-to-date information on this process.

Thermocouple Drift

Thermocouples drift in their accuracy with time. You may have to make further adjustments in the Thermocouple Offset or Cone Offset settings over time. **You should change all thermocouples when you change elements because they age at approximately the same rate.**

KILN STALLS

1) The kiln may refuse to increase in temperature, and the kiln will just run on and on. If it is re-started it may work fine for a while. The most likely cause is old or failing elements or relays. An issue in one circuit/section/zone can cause the whole kiln to stall as it waits for the problem section to "catch up". Check the temperatures in all zones to see if one zone is lagging behind and test elements and relays.

2) Thermocouples close to end of their useful life can cause some of these same problems.

3) Sometimes excessive ambient temperatures (over 125°F) around the control can cause stalling too.

TROUBLESHOOTING AND REPAIR INSTRUCTIONS FOR L&L KILNS

- 4) Corroded connection points can also cause stalling.
- 5) Generally you will see the error message **Err1** when this happens.

KILN FIRES SLOWLY - BOTH SERIES

Run a Simple Paper Test

See page 7.

Bad or Wrong Voltage

1) Check your voltage. Do this at the kiln at the Power Terminal Block with the control panel open or check it at your fused disconnect box. **CAUTION: This test should only be done by an experienced person familiar with electricity and its dangers.** You need to see what the voltage is when the kiln is firing. Low voltage will make the kiln fire considerably slower. For instance a kiln designed for 240 volts will have 25% less power when operated on 208 volts. Check voltage at your panel and where the kiln is connected. Check the voltage when the kiln is firing and when it is not firing. Sometimes the high amperage draw of the kiln will cause a voltage drop at the kiln. A voltage drop of 5 to 10 volts is not uncommon and is to be expected. If your voltage drop is more than that then you may have a problem with your electrical supply.

2) Make sure no other large electrical appliances such as a clothes dryer or electric oven are on when you are operating your kiln. This may cause a voltage drop which would slow the kiln down.

3) Voltage may vary in your area depending on season and time of day. Frequently there are "brown outs" during the summer months in some areas. This is when the electric utility reduces the voltage. Try firing at night after peak electrical use hours. You can use your Delay feature to do this easily. Find out from your local utility company when the end of the peak period of electrical use is. Some utilities offer preferential rates for using electricity at night because it is cheaper for them.

4) Check to see what the wire size of your circuit is. If it is very long (more than 50 feet) from your main circuit box then the wire size might need to be higher (e.g. #8 instead of #10 wire).

Element Aging

1) Elements both age and increase in resistance when fired. When they increase in resistance the amount of power they develop decreases. See the section on "CHECKING

ELEMENT RESISTANCE" at the end of this guide.

2) Replacing only one element per section or zone may cause an unbalance in firing. In Easy-Fire kilns the multi-zone control will compensate for much of this imbalance automatically, however, this will not be the case in School-Master kilns.

3) Use original L&L parts for satisfactory maintenance. (Elements, in particular, provided by other vendors may not work well in your L&L kiln. Some of our customers have found this out the hard way and thought it was an L&L problem. Only L&L has the design information to make our elements properly).

4) Empty the kiln. Then turn kiln on until elements are red. Open the door carefully and observe the elements to see if they all seem to be glowing about the same amount. **CAUTION:** The power does not turn off when you open the lid. Be careful not to put your hand inside the kiln while it is on. Dangerous electric shock could result. See the diagnostic program described in the earlier section called KILN FIRES UNEVENLY.

5) Elements expand and grow with age. If you fire low-fire clay and glazes and never get above cone 05 or so, your elements will last a long time, especially if you are only bisque firing. This is good, to a point. If you only low-fire, the problem you are most likely to encounter over many years is that the elements will expand as they age. The length and the coil diameter increase. Meanwhile the atmosphere in the kiln slowly eats away at the metal of the element. Although the total resistance usually increases as the elements age, sometimes it decreases, or reverses itself. This usually only happens when the elements are very old but have not yet failed completely. As the element expands, it binds up in the corners. This can make the individual coils push together and touch each other in the corners, making a short cut for the electricity, reducing the amount of element material the electricity must pass through, and therefore reducing the resistance in the whole element. This may make it hotter in the kiln, but if there is a lot of element material jammed in the corners there will not be enough material left in the coiled form to radiate the heat generated by the increased amperage and decreased resistance. Only the parts of the wire not touching the coils on either side of them will emit heat. More amperage through the electrical components in the control could cause damage if the situation continues or the resistance drops far enough. In addition, the expanding diameter of an element can make it difficult to get it out of the holder. Usually this will not happen to those firing to higher temperatures because the maximum temperature of the kiln is quickly compromised by increases in the resistance,

TROUBLESHOOTING AND REPAIR INSTRUCTIONS FOR L&L KILNS

requiring the elements to be changed long before they can jam up in the corners. Also, high temperatures and glaze firings are more prone to eating through the element, causing it to fail, before the element can expand enough to cause the problems mentioned above. Visually inspect your elements for the above conditions and do a resistance check. If you see this it may be time to change elements.

Power Relays

As mechanical switches, power relays will fail over time. In particular, the coil which actuates the switch closure increases in resistance to the point where it no longer has the power to close, especially as it gets hot. This means that a relay can work at low temps but fail at elevated ones, making it more difficult to diagnose.

WIRES WILL GET HOT

Unlike many other appliances that use electricity (like motors) kilns are called a "resistive load." This means that there will be a continuous pull of steady electrical power for many hours. Even with properly sized wire this will generate SOME heat in the wires. This is one reason we recommend against using aluminum wire for a power feed. If you look carefully you will see that we have OVERSIZED our internal power wires far in excess of their rated capacity. In addition all our power wire is rated for very high temperatures. The larger the wires the less resistance in the wires and the cooler they will operate.

Bad Wiring

1) Have an electrician check your wiring. We have seen aluminum wire cause intermittent problems with allowing enough voltage through. We do not recommend aluminum wiring although some electricians will swear by it. The problem with it is that aluminum oxide, which is formed from heat, is a resistor while copper oxide is not a resistor. With kilns you will often develop some heat in the electrical lines. If all connections are perfect and the wire is oversized you probably will not have a problem - but why take that chance? Make sure your wires are of the proper size and that all connections are good.

2) Check your circuit breaker for proper operation. These sometimes go bad over time.

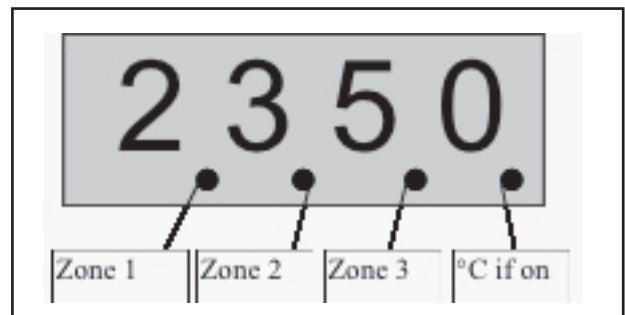
3) If all the elements are firing and the kiln is still firing too slow check the amperage draw of the kiln under a full load. CAUTION: This test should only be done by an experienced person familiar with electricity and its dangers. You need to see what the voltage is when the kiln is firing.

Check amperage under load with an amp-probe.



3) To check to see if all zones are firing on an Easy-Fire kiln, press the number 8 on the control numeric pad. You will see one little light per zone under the numbers on the control display. If you see two dots on an e18S, e23S, or e28S then you are firing at full load. If you see three dots on an e18T, e23T, or e28T then you are firing at full load. See if the amperage drawn is the same as what the kiln is rated for. See the product literature and/or data nameplate on the kiln for the rated amperage draw. There is also a complete table of this information in the Installation Instructions part of this manual. For instance, a model e23T rated for 240 volts, Single Phase should draw 48.0 amps. If it is substantially less than the rated amperage draw and your voltage is within 5% of the rated voltage (for instance 230 volts for a 240 volt unit), then chances are the elements have changed in resistance. This will require element replacement.

Pressing the number "8" will turn on 2 or 3 small LEDs that indicate whether the various zones are firing.



Wiring in the Kiln

- 1) Unplug kiln.
- 2) Trace wiring for missing or bad connections.
- 3) Check wiring against wiring diagram.
- 4) Check for corroded connectors or connectors that have

TROUBLESHOOTING AND REPAIR INSTRUCTIONS FOR L&L KILNS

frayed wires. Replace if you see this.

Element Connections

1) The holes where the elements go through the firebrick walls are too large. This could cause too much heat to escape from the kiln thereby overheating the element terminals. This can be remedied by lightly stuffing non-RCF ceramic fiber in the element holes. (See hotkilns.com/non-rcf-fiber-blanket for non-RCF fiber). You can stuff this in from the inside of the kiln using a sharp tool like a very small screw driver.

2) Check to see if the element ends are twisted properly. They should be twisted clockwise around the terminal screw. If the twist is too loose this could generate extra heat at the element ends. Check for corrosion on the terminal. If there is corrosion sometimes you can remove it with a wire brush.

3) The element connection hardware may not be tight enough. A loose connection can generate heat and cause oxidation of the hardware which in turn will cause a worse electrical connection (because of resistance) and more heat. Replace with new terminal hardware. See hotkilns.com/parts and filter for **Model Series** and **Elements (Terminals)**

Heat Leakage & Vents

- 1) Make sure peephole plugs are in.
- 2) Make sure hole for vent is proper. Check Vent-Sure instructions for proper hole sizes.
- 3) If you are using a different brand of vent make sure it is the appropriate size for your kiln. Check with the vent manufacturer and tell them how many cubic feet are in your kiln.
- 4) If your lid or bottom is cracked check to see if it seems to be leaking much heat at high temperatures. Patch or replace if extreme. (SOME IS OK).

Adding More Insulation

- 1) In L&L's top loading kilns an additional bottom may be placed under the original bottom. This will improve the insulation in the kiln, thereby slowing heat loss and speeding the firing time. You can also put a 2" layer of calcium silicate on top of the stand beneath the bottom of the kiln.
- 2) Also try raising the height of the kiln from the floor or putting a reflective stainless steel or aluminum sheet under the kiln. All these things keep the floor from absorbing the radiant energy from the kiln and will improve heat up times (as well as bottom of the kiln uniformity).
- 3) Put a 1" layer of non-RCF ceramic fiber on the lid. This

is completely non-hazardous which is important in this application because you will be releasing fibers into the air when you move it while loading. While this is a somewhat extreme measure we have found that a disproportionate amount of the heat loss from a kiln is through the top. Non-RCF ceramic fiber is soluble in the body and is considered totally safe.

4) Whatever you do be sure NOT to put the kiln directly on the floor. If the floor is cement or other hard non-flammable material it will absorb the heat from the kiln. If the floor is wood or other flammable material you will create a very DANGEROUS situation which could cause a serious fire.

KILN FIRES SLOWLY - EASY-FIRE

Single vs Three Zone Control

1) Three zone control will slow a kiln down. It helps even out the temperatures in a kiln by shutting off one or more zones while firing. In addition zone control introduces other issues like LAG that sometimes complicate a firing. The first thing to try if you are getting a slow firing is to switch the kiln to single zone operation. That may get you back into operation quickly. Then, if that makes the problem go away you can fine tune the specific issue within the zone system that is causing the problem.

2) Normally models e23S and e28S are programmed to have two zones and models e23T and e28T are programmed to have three zone control. You can easily change this to be single zone operation.

3) Press **OTHER, 4, 4, 3**

4) The display says **notC** This stands for "number of thermocouples".

5) To run the kiln using only one thermocouple press **ENTER** at the **notC** prompt. You will then see **0003** or **0002** (depending on whether it is currently programmed for three zones or two zones). Then press **1**, then **ENTER**. The display will then say **StOP**. All the zones of the kiln will turn on and off simultaneously when you program the DynaTrol to use only one thermocouple.

ShtO (SHUT-OFF) SETTING

1) This option is used to shut off the automatic feature in the DynaTrol that holds the hottest part of the kiln at each segment's set point until the average of the three (or two) thermocouples reaches that set point. This can have a dramatic effect on speed of firing and is worth trying to see if it helps you if you are having a problem.

TROUBLESHOOTING AND REPAIR INSTRUCTIONS FOR L&L KILNS

- 2) When you press **OTHER, 4, 4, 3**.
- 3) Press **OTHER** until **Sht0** is displayed.
- 4) Pressing **ENTER** here allows you to toggle, using any number key, between **0n** and **0FF**.
- 5) On means that as soon as the hottest zone gets to the segment's set point the entire kiln switches to either the "hold time" or the next segment. This will result in a quicker firing.
- 6) **0FF** means that the DynaTrol will not let the hottest zone's temperature rise until the average temperature of the three zones reaches that segment's set point. Then the kiln can begin the "hold time" or the next segment. This will result in more even firing.
- 7) When you have the setting you want shown in the display (On or **0FF**) press **ENTER**. **CPL** will display for a few seconds and then **IdLE**, **tC2** and current temperature.

PId SETTING

- 1) This setting generally should be left at its factory default because it is hard to predict the changes that it will create in your firing. However, a full explanation is given for more advanced users who want to experiment with this.
- 2) This setting comes pre-programmed at the factory for 65%. Basically this setting determines how much help the middle zone of the kiln gives the bottom zone of the kiln when the bottom zone is lagging behind during heating. This comes into play when the bottom zone is on 100% of the time. With this feature, the middle zone of the kiln will come on the programmed percent (**PId**) of the time that the TOP zone comes on, if the bottom zone is on all the time. Tests showed that if the bottom was on 100% of the time, the top zone was generally on 90% of the time, but the middle zone was on only about 40% of the time. By programming a higher percent you can greatly speed up your firings. (you will have to experiment, try the factory setting 65% then try maybe 100% and compare your results). Basically the higher the **PId** setting the faster the firing at the potential price of unevenness.
- 3) As your elements age firing by firing, this setting will activate earlier and earlier in the firing because the bottom will be working at 100% earlier and earlier. This will allow the artificial inflation of the center's temperature sooner and sooner. Because this center is heating based on mathematics now and not it's own thermocouple's reading, it will have a longer and longer period of time to get hotter than the top and the bottom. In some cases this can lead to gross unevenness. You may find yourself dialing down the **PId** to something like 50% or 60%. Remember that if it is

set around 40% (it's normal operating percentage) or below, the thermocouple's reading then will be the control for that section, not the mathematics of the **PId** feature.

- 4) When display flashes **IdLE, tC2** press **OTHER** see **rSEt**. Press **4, 4, 3**. See **notC**
- 5) Keep pressing **OTHER** to cycle through the menu options until you get to **PId**.
- 6) Press **ENTER**. See **Pct, 0085** cycling.
- 7) Press any number from **0** to **150**, see the number you have entered preceded by a zero like **0120** if you entered **120**. Press **ENTER**, see **CPL** or **St0P** for a few seconds, then **IdLE**, etc.
- 8) Pressing **ENTER** here allows you set another percent setting that can help a slow, heavily loaded kiln fire faster.

Change elements to graded elements.

This is an extreme solution for Easy-fire kilns but can be effective. Contact factory.

KILN HEATS TOO FAST

Relays

- 1) A stuck relay, meaning that the power relay is stuck closed, delivering constant power to the elements, can cause the kiln to heat uncontrolled. If the kiln is still heating even when no program is firing or even the toggle switch is off, then you have a stuck relay. Whichever section is still heating, that is the relay that needs replacing.

Voltage

- 1) Check your voltage. Some people may have high voltage like 245 volts where you should nominally have 240 volts.
- 2) Make sure you don't have a 208 volt kiln hooked up to a 240 volt circuit. This is dangerous because the kiln will draw more amps than it is rated for which will overload the power wires and other components and could cause a fire.

Elements

- 1) Check element ohms and compare with factory values. (See CHECKING ELEMENT OHMS later in this section).
- 2.) Make sure the elements are wired properly. Check the wiring diagram.

EASY-FIRE ERROR MESSAGES

See this for a complete description on the web: hotkilns.com/error-codes. You can also see more information in

TROUBLESHOOTING AND REPAIR INSTRUCTIONS FOR L&L KILNS

the instruction manual in the CONTROL section: Appendix E in DYNATROL 700 INSTRUCTIONS FOR L&L KILNS.

Error codes can appear at any time during the firing. They always refer to a problem that, if allowed to continue, could end with unknown or even disastrous results. **Errd**, **Err1**, **ErrP** and the **FAIL** message make the most frequent appearances. **Errd** means there is a temperature difference of more than 50 degrees between the zones. **Err1** indicates that the kiln is climbing too slowly in an Easy-Fire program. **ErrP** indicates that there was either a very quick power outage (**ErrP** will flash along with the temperature and the kiln will still be heating), or there was a longer power outage (**PF** will be the only thing in the display and the kiln will not be heating). **FAIL** refers to a specific thermocouple failure. It will appear after displaying a 'tC' (thermocouple) number **1**, **2** or **3**.

Errd

1) If the kiln was just re-assembled and **Errd** is the error code, then double-check that the element connection wires go to their proper power relays and that the thermocouple wires are connected to the proper zones.

2) If you are sure the kiln is set up properly, nothing is out of place and none of the thermocouples are partially out of the kiln, then one of the following situations may apply:

3) You were firing with the lid open and you got **Errd** either while the lid was open or right after you closed it. For drying with the lid open, only about two inches is needed to adequately vent off water vapor. This is plenty if all the peep holes are open. The DynaTrol will attempt to compensate for the heat loss, and it usually can. The trouble may happen when you close the lid. The elements in the top of the kiln are already much hotter than the ones nearer the bottom due to their need to compensate for the heat loss from the top. When you close the lid it can take as long as eight seconds for the DynaTrol to respond to the rise in temperature in the top of the kiln, and shut off those elements. This can quickly cause an uneven temperature in the kiln, which will usually result in **Errd** (possibly an **Err2** in a smaller kiln -**Err2** is when the entire kiln temperature is more than 50°F over the hold time's temperature for longer than 18 seconds).

4) There was a lot of air being exhausted from your kiln when **Errd** appeared. If a vent system pulls too much air from just one point in the kiln, say, to down-ramp the load very quickly to a lower hold time for crystal formation, an uneven temperature can result. The firing will go slowly as it will be difficult to compensate for the heat loss; eventually, however, the **Errd** (or **Err1**) can appear.

5) Something is too close to, or is touching, **TC#** in the kiln. Allow almost an inch between everything for thermal expansion. Fix and re-fire the kiln.

6) A thermocouple wire has melted against the kiln case. The wire must be replaced.

7) A thermocouple is about to fail. Perform a physical inspection if possible, or just re-start the kiln and monitor it carefully.

8) Element(s) just burned out. Perform an ohms test for more information.

9) A relay has just failed. Perform a voltage test.

10) There is a bad connection point somewhere. This will become more of a possibility as the kiln ages. Examine all points carefully for melting, corrosion, and discoloration.

Err1

1) If **Err1** is the error code on the screen when you check on the firing, then for some reason the kiln could not generate enough heat to counter the heat loss. If the kiln can get no hotter (even though all the elements appear to be on and the program is not holding), then **Err1** is what you will see. If one of the elements or one of the circuits in the control fails while the kiln is at a high enough temperature then it will probably display an **ErrB** code (which means temperature is falling when it should be rising) **Err1** or **ErrB** can mean either you need new elements or a new component in one of the circuits. An ohms test and a voltage test can tell you which it is. If you recently changed locations, power supplies, elements, or did any repairs, then closely examine what changed between your last successful firing and this one. There may be some other issue besides bad elements or a bad component.

2) A new location can mean a 208 volt power supply rather than a 240 volt supply (about 25% less power).

3) In re-wiring the power supply you may not have used thick enough copper wire (line, conduit and connection points will be very hot).

4) The elements are the wrong resistance. Check new elements with your multimeter just to be safe. Mistakes can happen.

5) If you rewire anything improperly or incorrectly the potential for anything from a blown breaker to just no power at all is possible. (Using wire with a temperature rating of less than 150°C for the power wiring can seriously limit the life of the circuitry and can be dangerous as well, especially when the wires are close to the kiln.) Use a wire diagram and trace every wire to check yourself. You can buy high

TROUBLESHOOTING AND REPAIR INSTRUCTIONS FOR L&L KILNS

temperature wire from L&L (see the Parts List).

Err2

During a hold segment the temperature rises to greater than 50 degrees above the hold temperature which was set. The temperature must stay 50 degrees above this set temperature for 18 seconds before the error is displayed.

Err3

During a hold segment the temperature is more than 50 degrees below the hold temperature which was set. The temperature must stay 50 degrees below this set temperature for 18 seconds before the error is displayed.

Err4

The temperature is more than 50 degrees above the previous hold temperature during a ramp segment where the temperature is programmed to decrease. The temperature must stay 50 degrees above this set temperature for 18 seconds before the error is displayed.

Err5

The temperature is more than 50 degrees below the local setpoint temperature during a ramp segment where the temperature is programmed to decrease. The temperature must stay 50 degrees below this set temperature for 18 seconds before the error is displayed.

Err6

A Negative temperature is displayed. This generally indicates the thermocouple is connected incorrectly. To correct this situation, ensure the red and yellow wires are connected correctly to the controller and at all junctions. You can identify the red lead on an unmarked thermocouple with a magnet because a magnet will be attracted to the red lead.

Err7

The temperature is more than 50 degrees above the local setpoint temperature during a ramp segment where the temperature is programmed to increase. The temperature must stay 50 degrees above this set temperature for 18 seconds before the error is displayed.

Err8

When using the Easy Fire Mode, the temperature is decreasing during the last ramp segment. This could indicate that the lid was up or the peepholes open or some other physical thing is causing the kiln to decrease in temperature.

ErrP + PF

Continuous **PF** in display. Indicates a long term power outage. The kiln has been shut down. Press **1** to clear the display.

ErrP and the current temperature are alternately flashing. To clear the display, press the **1** key. If a firing was in progress, the kiln will continue to fire even though this message is flashing. This error can also happen as a result of RF (radio frequency) noise that resets the microprocessor. If this is suspected, the control panel should be returned to L&L for testing and possible modification. Also see hotkilns.com/noise

Err-

The **Err** with a dash indicates there was a power loss to the controller while writing a program to the non-volatile memory chip. Recheck the selected program, and reprogram if necessary.

FAIL

1) If, upon inspection, the error code **FAIL** turns out to be a burned out thermocouple then replace it. You typically will not need to replace the mullite protection tube - just the internal thermocouple "element" (see hotkilns.com/thermocouple-k-standard). You should not mix unsheathed thermocouples with sheathed ones. (because their response rates are slightly different). A spare on hand is a good idea as well.

2) If the TCs are not bad (you just replaced them and they worked fine for at least one complete firing) but the **FAIL** message still appears, it may be that the TC wire is bad (melted or broken at a point) or the electronics have partially failed.

A) Turn OFF the power at the Disconnect Switch or Circuit Breaker and/or unplug the kiln.

B) Open the cover of the control.

C) Remove the Thermocouple wires from the DynaTrol and the Thermocouple Terminal Strip. Take out of the Control Box and set aside.

D) Make tiny "U" shaped jumper wires from paperclips and jumper between each of the + and - connections on the DynaTrol board.

E) You are simply completing each TC circuit without using the TC wire or the TC. Do not let the 'U's touch anything other than the TC connection points. Note: the fact that a paperclip is not the proper type of metal to use in a Type K TC circuit is not an issue for a test like this.

TROUBLESHOOTING AND REPAIR INSTRUCTIONS FOR L&L KILNS

F) Close up the Control Box and turn the unit on. If it still says **FAIL** then the electronic board has failed. If it reads room temperature then the TC wire or the TC has failed.

G) If it reads room temperature with these jumpers in, and you are not sure if it is the TC or the TC wire, just re-attach TC2's wire to TC3 and re-attach TC3's wire to TC2. If the **FAIL** message is still on **TC2** then it is the wire, not the TC. If it says that the **FAIL** is now at **TC3**, then you know it is the TC, not the wire (there are many other ways to determine this as well).

Turning Error Codes On or Off

1) When you receive your DynaTrol the error codes are turned on. In most cases, you will want the error codes on. They can be turned off if you are doing special firings, such as jewelry or glass firing where the kiln is opened while hot. Turning the error codes off turns off the dynamic zone control feature that keeps the temperature in the kiln even top to bottom. It eliminates nuisance shut downs but side steps built in fail-safe measures.

2) The only Error codes that this can not turn off are **ErrB**, **FAIL**, and **ErrP** in both the "Easy Fire" and "Vary Fire" modes. In addition **Err1** and **Err8** are not turned off in the last segment of an "Easy Fire" program. This is because the built in calculations would make no sense if the kiln were firing too slowly.

3) To turn Error Codes off do the following:

4) Press the **OTHER** button several times until you see **ErrCd**.

5) Press **ENTER**

6) Display will say **On** (which indicates that the error codes are turned on) or **OFF** (which indicates that the Error Codes are Off). You can toggle back and forth between on and off by pressing the **1** key.

7) Hit **ENTER** when you see **On** or **OFF** and you want to keep that setting

8) **CPL** will display for a few seconds. **Idle**, **tC2**, and the current temperature then cycle in the display.

Can you restart the kiln after it stops because of Error Codes?

You can try to restart the kiln after getting an error code. Some messages, like flashing **ErrP** and **FAIL**, will not necessarily turn off the kiln. Depending on the problem though, re-starting it may or may not let it finish the firing, or even start up again. An **Errd** will usually not re-start easily because the temperature top to bottom is drastically

different. An **Err1** at the end of the firing will re-start but will probably re-occur in about 22 minutes. A **FAIL** message will not go away even if the problem is fixed during the firing. The kiln can still be firing with the **FAIL** message flashing along with the number of the TC that failed. Stopping and then re-starting the kiln after fixing the problem with the TC circuit is the only way to erase the **FAIL** message. **ErrP** flashing with the temperature means that the kiln is still firing, after just a short power outage or interference. Just press any number to clear the **ErrP**. An **ErrP** which is not flashing must be re-started.

Worst Case Scenario for Restarting After an Error Code

Keep in mind that you run the risk of over-firing if you re-start while the kiln is very close to the final temperature. A pyrometric cone melts with the proper combination of time and temperature. Add more time and you don't need as high a temperature, go to a higher temperature and you don't need as much time. When an error code shuts down the kiln near your final temperature (within about 50 degrees) and you do not know exactly how long it has been cooling, or what temperature it reached before the error code appeared, you run the risk of having too much unaccounted for time in your time-temperature equation. The DynaTrol calculates this equation automatically after determining how many degrees per hour the kiln is climbing (time) and to what temperature it is climbing to (temperature). However, it cannot do this accurately after a high temperature re-start.

If you have cones in the kiln that you can see through the peepholes, then use these after you re-start and turn off the kiln manually when the target cone bends over.

If you do not have cones visible then you can gamble and estimate a final temperature based on how many degrees per hour the kiln has risen, including the time it was off.

For example, you come in and the control says **tC2, 2200** (degrees F) and everything seems fine in your slow glaze to cone 6 firing. But twenty-five minutes later you come back and see **Err1**.

The first thing you want to do is press 1 to clear the error code. Look for tC2's temperature and write it down. It might be **2175**. You have no cones in the kiln but you really need these pieces fired.

Wait a few seconds until you see "**Idle, tC2, 2175**". Press **START** to re-start the program and note the time on your watch. Note the 25 minutes the kiln was "holding" from the last time you saw it at 2200°F until this time, where it says **2175**. It must have continued to climb somewhat, but

TROUBLESHOOTING AND REPAIR INSTRUCTIONS FOR L&L KILNS

because the **Err1** will appear after 22.5 minutes of holding when the kiln is programmed to be climbing, it probably never got over 2210°F. So the kiln has held at an average of about 2195°F for about 25 minutes, instead of continuing on to 2232°F (cone 6) to finish the firing.

The relationship between time and temperature allows you to estimate how much hold time to add to get the same amount of heat work as the kiln would have achieved by climbing to 2232°F. Assuming a 108°F per hour temperature rise, a good rule of thumb is to add about a 20 minute hold to the maximum temperature; this will allow you to lower the final temperature by about 20°F. An hour hold time would mean a final temperature of about 40°F lower. A two hour hold time would be about 60°F lower.

In this example, the kiln has already held at about 35 degrees lower than the final temperature for 25 minutes. It would need another 25 minutes of holding to give the ware the same amount of heat work that 2232°F (cone 6) would have.

In reality, however, an Err1 that close to the end of a firing probably means you need new elements. So re-starting the kiln will probably not enable it to climb much higher in temperature. Keeping track of the time, let it run, and when it shows Err1 again just keep re-starting it until the firing finishes. Meanwhile call and order new elements.

Be very careful if you try this method. On loads that are very important always use cones you can see through the peepholes in case of a failure of some kind. If you have to use this method without the cones, remember that almost all your calculations are based on estimates and the results could be disastrous to your ware and/or the kiln if you are not accurate enough. The further away the temperature that the kiln is holding at is from the cone that the firing was trying to get to, the less accurate an estimated amount of time will be to achieve the amount of heat work necessary. If you can wait and re-fire from room temperature, you should. If you depend in any way on your kiln you should keep spare parts around for it. You could replace the elements easily yourself after the kiln cools and then re-load it and re-fire it to the proper cone without losing much time at all. Or consider that most glazes have an entire cone's temperature range that they can mature within. Weigh your options and decide.

In general though, Error Codes mostly appear after the kiln has been disassembled and set back up improperly, has had its power supply altered (like moving to a new studio with different voltage), or has had an element, a relay, or a thermocouple burn out.

ONE-TOUCH ERROR MESSAGES

Error codes can appear at any time during the firing. They always refer to a problem that, if allowed to continue, could end with unknown or even disastrous results. **Errd**, **Err1**, **ErrP** and the **FAIL** message make the most frequent appearances.

Errd

Error d indicates that the kiln temperature is 100°F above the traveling set-point, which is the current desired temperature in the kiln. The traveling set-point will increase or decrease according to the programmed rate.

- 1) Something is too close to, or is touching the thermocouple. Allow almost an inch between everything for thermal expansion. Fix and re-fire the kiln.
- 2) The Thermocouple Lead Wire has melted against the kiln case. The wire must be replaced.
- 3) The thermocouple is about to fail. Perform a physical inspection, or just re-start the kiln and monitor it carefully.
- 4) Element(s) just burned out. Perform an ohms test for more information.
- 5) The relay has just failed.
- 6) There is a bad connection point somewhere. This will become more of a possibility as the kiln ages. Examine all points carefully for melting, corrosion, and/or discoloration.

Err1

Error 1 indicates the temperature in the kiln is rising during an up ramp slower than 15°F/hr. If this rate continues for 8 minutes the firing will be stopped. **Err1** may be an indication that the elements are worn or that a relay has stopped working.

- 1) If **Err1** is the error code on the screen when you check on the firing, then for some reason the kiln could not generate enough heat to counter the heat loss. If the kiln can get no hotter (even though all the elements appear to be on and the program is not holding), then **Err1** is what you will see. **Err1** can mean either you need new elements or a new relay. An ohms test and a voltage test can tell you which it is. If you recently changed locations, power supplies, elements, or did any repairs, then closely examine what changed between your last successful firing and this one. There may be some other issue besides bad elements or a bad component.

- 2) A new location can mean a 208 volt power supply rather than a 240 volt supply (about 25% less power).

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3) In re-wiring the power supply you may not have used thick enough copper wire (line, conduit and connection points will be very hot).

4) The elements are the wrong resistance. Check new elements with your multimeter just to be safe. Mistakes can happen.

5) If you rewire anything improperly or incorrectly the potential for anything from a blown breaker to just no power at all is possible. (Using wire with a temperature rating of less than 150°C for the power wiring can seriously limit the life of the circuitry and can be dangerous as well, especially when the wires are close to the kiln. Use a wire diagram and trace every wire to check yourself). You can buy high temperature wire from L&L (see the Parts List).

ErrP

ErrP is displayed whenever there is a power interruption that is long enough to stop the firing. If the power interruption is brief the kiln will continue to fire when power is restored; in this case there will no indication of a power failure. To clear the error, press any key.

This error can also happen as a result of RF (radio frequency) noise that resets the microprocessor. See hotkilns.com/noise

ErrF

ErrF indicates the temperature in the kiln is decreasing during a down ramp less than 15°F/hr. If this rate continues for 8 minutes the firing will be stopped. **ErrF** may be an indication that a relay has stuck in the on position.

tC-

tC- indicates that the red and yellow thermocouple wires are reversed. Make sure they are right all the way through the circuit.

FAIL

See the section in these Troubleshooting Instructions called DISPLAY READS **FAIL** and **tC**.

Can you restart the kiln after it stops because of Error Codes?

You can try to restart the kiln after getting an error code. Some messages, like flashing **ErrP** and **FAIL**, will not necessarily turn off the kiln. Depending on the problem though, re-starting it may or may not let it finish the firing, or even start up again. An **Err1** at the end of the firing will re-start but will probably re-occur in about 22 minutes.

Worst Case Scenario for Restarting After an Error Code

Keep in mind that you run the risk of over-firing if you re-start while the kiln is very close to the final temperature. A pyrometric cone melts with the proper combination of time and temperature. Add more time and you don't need as high a temperature, go to a higher temperature and you don't need as much time. When an error code shuts down the kiln near your final temperature (within about 50 degrees) and you do not know exactly how long it has been cooling, or what temperature it reached before the error code appeared, you run the risk of having too much unaccounted for time in your time-temperature equation.

If you have cones in the kiln that you can see through the peepholes, then use these after you re-start and turn off the kiln manually when the target cone bends over.

If you do not have cones visible then you can gamble and estimate a final temperature based on how many degrees per hour the kiln has risen, including the time it was off.

For example, you come in and the control says **2200** (degrees F) and everything seems fine in your slow glaze to cone 6 firing. But twenty-five minutes later you come back and see **Err1**.

The first thing you want to do is press **1** to clear the error code. Look for the temperature and write it down. It might be **2175**. You have no cones in the kiln but you really need these pieces fired.

Wait a few seconds until you see "**IdLE, 2175**". Press **START** to re-start the program and note the time on your watch. Note the 25 minutes the kiln was "holding" from the last time you saw it at 2200°F until this time, where it says **2175**. It must have continued to climb somewhat, but because the **Err1** will appear after 22.5 minutes of holding when the kiln is programmed to be climbing, it probably never got over 2210°F. So the kiln has held at an average of about 2195°F for about 25 minutes, instead of continuing on to 2232°F (cone 6) to finish the firing.

The relationship between time and temperature allows you to estimate how much hold time to add to get the same amount of heat work as the kiln would have achieved by climbing to 2232°F. Assuming a 108°F per hour temperature rise, a good rule of thumb is to add about a 20 minute hold to the maximum temperature; this will allow you to lower the final temperature by about 20°F. An hour hold time would mean a final temperature of about 40°F lower. A two hour hold time would be about 60°F lower.

In this example, the kiln has already held at about 35

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degrees lower than the final temperature for 25 minutes. It would need another 25 minutes of holding to give the ware the same amount of heat work that 2232°F (cone 6) would have.

In reality, however, an **Err1** that close to the end of a firing probably means you need new elements. So re-starting the kiln will probably not enable it to climb much higher in temperature. Keeping track of the time, let it run, and when it shows **Err1** again just keep re-starting it until the firing finishes. Meanwhile call and order new elements.

Be very careful if you try this method. On loads that are very important always use cones you can see through the peepholes in case of a failure of some kind. If you have to use this method without the cones, remember that almost all your calculations are based on estimates and the results could be disastrous to your ware and/or the kiln if you are not accurate enough. The further away the temperature that the kiln is holding at is from the cone that the firing was trying to get to, the less accurate an estimated amount of time will be to achieve the amount of heat work necessary. If you can wait and re-fire from room temperature, you should. If you depend in any way on your kiln you should keep spare parts around for it. You could replace the elements easily yourself after the kiln cools and then re-load it and re-fire it to the proper cone without losing much time at all. Or consider that most glazes have an entire cone's temperature range that they can mature within. Weigh your options and decide.

In general though, Error Codes mostly appear after the kiln has been disassembled and set back up improperly, has had its power supply altered (like moving to a new studio with different voltage), or has had an element or a thermocouple burn out.

SERVICE FOR YOUR KILN

WHERE TO GET SERVICE

See the SERVICE Section of your Instruction manual or see hotkilns.com/technical-support

WHERE TO BUY PARTS

You can order parts for your L&L Kiln through L&L or your local distributor. See the Parts List that pertains to your particular kiln model. Our on-line parts list is easy to navigate. See hotkilns.com/parts. Standard Parts are typically shipped the day after an order is placed. Rush service is available.

REPLACEMENT ELEMENTS

Replacement Elements made by L&L Kiln Mfg., Inc. are designed for each individual model for long life and superior performance. Good element design is a complex balance of watt density, design voltage, stretch ratio, wire gauge, element length and material. It takes many hours and years of experience to design a good element for each model. Do not expect an outside supplier with no interest in your kiln performance or long experience with L&L kilns to spend the necessary time to do this right. In the end you will not save

NOTE: Many of these procedures have accompanying instructional videos. Look out for the video links in each section or go to hotkilns.com/videos for more.

REMOVING PANEL FOR SERVICE

- 1) It is easy to access the inside of the control panel for troubleshooting. In addition it is easy to remove this panel and send it back to the factory for inspection and/or repair.
- 2) Disconnect power and unplug the kiln.
- 3) Follow the instructions in ASSEMBLY INSTRUCTIONS FOR in the ASSEMBLY tab of your instruction manual or see hotkilns.com/assemble-easy-school in order to remove the Control Box for Easy-Fire and School-Master kilns.
- 4) Pack the control panel with cushioning material such as bubble wrap, balled-up newspaper or foam in a cardboard box and follow instructions from the factory or your local distributor about where to send it. **DO NOT SEND A CONTROL PANEL WITHOUT CALLING FIRST.**

CAUTION: The controller contains electronic components which are sensitive to static electricity. Before handling the controller dissipate any static charge you may have by touching metal or a screw on the controller panel, the electrical box, the kiln lid, or some other grounded object.

REPLACING DYNATROL

See this video: hotkilns.com/replace-dynatrol

- 1) Unplug kiln or turn off the kiln at the fused disconnect switch.
- 2) Remove the four #6 screws that hold the DynaTrol in place from the front face of the control panel.
- 3) Open up the control box and hinge down for access (as shown on page 2)

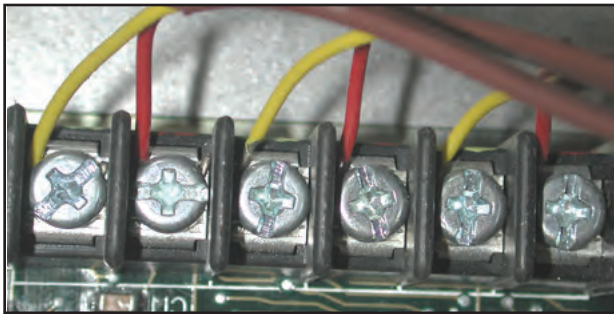
TROUBLESHOOTING AND REPAIR INSTRUCTIONS FOR L&L KILNS

4) Pull off the spade connectors from all the connection points on the back of the control. Loosen the screws that hold down the thermocouple wires and pull out the wires from under the screw heads. It is OK to remove the screws if this is easier for you. First note where all the wires go. These are all clearly marked with color coding on the Wiring Diagram.

5) Pull old control out. Put new control in and screw in place with the #6 mounting screws. Replace wires on proper connectors.

6) Be careful to get the Red or Yellow of the thermocouple wires to match the colors painted on the DynaTrol board.

Picture showing thermocouple wires installed on DynaTrol. There is no need to wrap the thermocouple wire around the screw head- although it is OK to do so. However, do make sure the wire is tight and secure UNDER the screw head.



7) Double check that the proper color coded wire goes to the proper terminal.

Orange = OUT 1

Blue = OUT 2

Purple = OUT 3 (not on e18S, e23S, and e28S)

Gray = AC1

Green = CT

Brown = AC2

TC1 = TC1

TC2 = TC2

TC3 = TC3 (not on e18S, e23S, and e28S)

REPLACING ONE-TOUCH™

See this video: [hotkilns.com/replace-dynatrol](https://www.hotkilns.com/replace-dynatrol) (Note the process of changing a DynaTrol is very similar)

1) Unplug kiln or turn off the kiln at the fused disconnect switch.

2) Remove the four #6 screws that hold the One-Touch™ in place from the front face of the control panel.

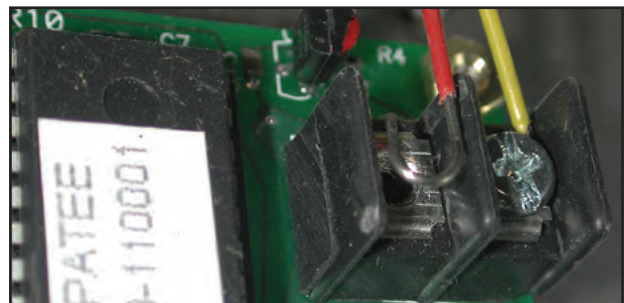
3) Open up the control box and hinge down for access (as shown on page 3)

4) Pull off the spade connectors from all the connection points on the back of the control. Loosen the screws that hold down the thermocouple wires and pull out the wires from under the screw heads. It is OK to remove the screws if this is easier for you. First note where all the wires go. These are all clearly marked with color coding on the Wiring Diagram.

5) Pull old control out. Put new control in and screw in place with the #6 mounting screws. Replace wires on proper connectors.

6) Be careful to get the Red or Yellow of the thermocouple wires to match the colors painted on the control board.

Picture showing thermocouple wires installed on Control. One screw is removed to show how the TC wire should be prepared with a "U" shape.



7) Double check that the proper color coded wire goes to the proper terminal.

Orange = J5

Gray = J2

Green/Yellow = J4

Brown = J3

REPLACING TRANSFORMER

See this video: [hotkilns.com/change-transformer](https://www.hotkilns.com/change-transformer)

1) Unplug kiln or turn off the kiln at the fused disconnect switch.

2) Open up the control box and hinge down for access (as shown on page 2).

3) Using needle nose pliers pull off the wires from the transformer. THIS CAN BE TRICKY. It can take a good bit of force sometimes to remove these little spade connectors. You will probably not be able to do it with just your hands.

TROUBLESHOOTING AND REPAIR INSTRUCTIONS FOR L&L KILNS

Also the spade connectors on the transformer are not very strong. Take your time. Of course, if you are replacing a bad transformer it doesn't matter if you damage it.

Shows wires being pulled off the control transformer.



4) Unscrew the two #8 screws that hold the control transformer onto the Contactor Panel and remove the transformer.

5) Before installing the new transformer put the small jumper wire onto terminals #2 and #3 on the bottom row of terminals. Note the little numbers by the contacts.

REPLACING POWER RELAYS

See this video: hotkilns.com/change-relay

1) Unplug kiln or turn off the kiln at the fused disconnect switch.

2) Open up the control box and hinge down for access (as shown on page 2).

3) Pull off the wires to the relay(s) that you are replacing. Everything is color coded and marked so you can refer to the wiring diagram when replacing if you forget where the wires go. The wire lengths also don't give you much choice and will help keep you from making a mistake.

4) Unscrew the #8 screws that hold the relays in place. Remove old relay and replace with new one.

5) Visually inspect the wire connectors. Do they look corroded or "cooked"? Are the wires frayed? Any corrosion on the wire itself? If any of this is questionable you may need to replace the appropriate wire harness.

6) Reconnect all wires. Visually inspect to make sure the spade connectors are down as far as they can go and feel to see that they are tight (a gentle tug should not remove one). If they are loose for some reason remove the wire and slightly squeeze the spade connector with pliers to tighten it.

REPLACING FUSE HOLDER

See this video: hotkilns.com/change-fuse-holder

1) Unplug kiln or turn off the kiln at the fused disconnect switch.

2) Open up the control box and hinge down for access (as shown on page 2).

3) Remove the wire connectors from the end of the fuse holder on the inside of the panel.

4) Unscrew the nut that holds the fuse holder in place.

5) Remove and replace with a new fuse holder. Reconnect wires.

REPLACING THERMOCOUPLES

See this video: hotkilns.com/change-thermocouple

1) Unplug kiln or turn off the kiln at the fused disconnect switch.

2) Remove the Control Box and Element Terminal Box as shown in the Assembly Instructions.

3) Remove the Thermocouple Lead Wires.

4) Unscrew the Thermocouple from the kiln (these are #6 x 1-1/2" screws)

5) Remove Thermocouple.

6) Remove Thermocouple Protection Tube. Shake it and dump out the oxide powder that has accumulated inside the tube. Then reinsert the tube into the hole in the kiln.

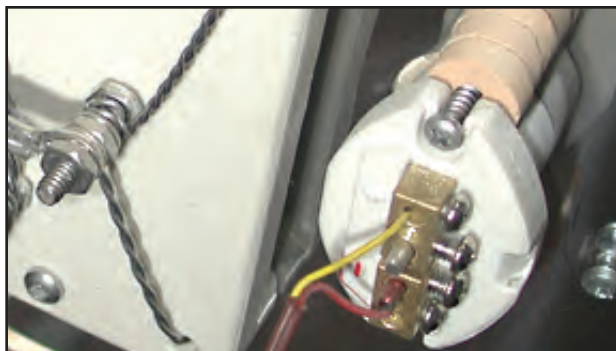
7) Install a new Thermocouple and screw in place.

8) Replace Thermocouple Lead Wires and tighten. Be sure to get Red matched to the Minus (-) sign and the Yellow matched to the Plus (+) sign.

IMPORTANT: The slip on wire connectors can not be loose or corroded. If there is a bad connection then heat will be generated and the component that they slip onto (relay, terminal strip, etc) may overheat and fail. If you squeeze the slip on terminal to make it tighter - be sure to squeeze it evenly so that one side is not tight and the other

TROUBLESHOOTING AND REPAIR INSTRUCTIONS FOR L&L KILNS

Picture showing end of thermocouple.



CHECKING ELEMENT OHMS

See this video: hotkilns.com/test-resistance-ez

See the instructions in the TROUBLESHOOTING Section of your instruction Manual (ELEMENT TROUBLESHOOTING & INSTALLATION INSTRUCTIONS) or here: hotkilns.com/element-troubleshooting

Element Ohm Charts

Check your wiring diagram for resistance values for your kiln.

CHANGING ELEMENTS

SEE THESE VIDEOS FIRST

For most top loading kilns:

hotkilns.com/change-elements-ez

For kilns with Quad elements:

hotkilns.com/change-element-quad

See the instructions in the TROUBLESHOOTING Section of your instruction Manual (ELEMENT TROUBLESHOOTING & INSTALLATION INSTRUCTIONS) or here: hotkilns.com/element-troubleshooting

REPLACING ELEMENT HOLDERS

See this video: hotkilns.com/change-element-holder

1) When ordering a new holder provide model number of kiln and length of the element holder. See the Parts List for this information.

2) Note that if the holder has melted badly you may need to either replace the brick that holds it or at least patch the brick with our Brick Repair Kit.

See the extensive instructions in the TROUBLESHOOTING Section of your instruction Manual or here: hotkilns.com/element-troubleshooting

CRACKS IN THE LID & BOTTOM

See these videos for bad cracks:

hotkilns.com/fix-cracks-front-load

and hotkilns.com/repair-cracked-top

See this video for hairline cracks:

hotkilns.com/repair-hairline-cracks

See the instructions in the TROUBLESHOOTING Section of your instruction Manual (TROUBLESHOOTING & FIXING BRICK PROBLEMS) or here: hotkilns.com/brick-troubleshooting

TIGHTENING STAINLESS BANDS

See these videos:

hotkilns.com/replace-side-brick-kiln

hotkilns.com/replace-side-brick-davinci

See the instructions in the TROUBLESHOOTING Section of your instruction Manual (TROUBLESHOOTING & FIXING BRICK PROBLEMS) or here: hotkilns.com/brick-troubleshooting

REPLACING FIREBRICK IN SIDES

See these videos:

hotkilns.com/replace-side-brick-kiln

hotkilns.com/replace-side-brick-davinci

See the instructions in the TROUBLESHOOTING Section of your instruction Manual (TROUBLESHOOTING & FIXING BRICK PROBLEMS) or here: hotkilns.com/brick-troubleshooting

DRILLING OUT HOLES FOR PEEPHOLES

See the instructions in the TROUBLESHOOTING Section of your instruction Manual (TROUBLESHOOTING & FIXING BRICK PROBLEMS) or here: hotkilns.com/brick-troubleshooting

DRILLING OUT FOR ELEMENT CONNECTIONS

See the instructions in the TROUBLESHOOTING Section

TROUBLESHOOTING AND REPAIR INSTRUCTIONS FOR L&L KILNS

of your instruction Manual (TROUBLESHOOTING & FIXING BRICK PROBLEMS) or here: hotkilns.com/brick-troubleshooting

REPLACING BOTTOMS

See the instructions in the TROUBLESHOOTING Section of your instruction Manual (TROUBLESHOOTING & FIXING BRICK PROBLEMS) or here: hotkilns.com/brick-troubleshooting

REPLACING LIDS

See the instructions in the TROUBLESHOOTING Section of your instruction Manual (TROUBLESHOOTING & FIXING BRICK PROBLEMS) or here: hotkilns.com/brick-troubleshooting

MORE ABOUT TROUBLESHOOTING CERAMIC PROBLEMS

1) We provide many firing tip brochures from Orton in the pdf library on our website. For a more in depth explanation Orton has a great booklet called Successful Firing Practices. They also have a number of other booklets available such as Cones and Firing (20 pages), Using Orton Cones/Temperature Charts, Kiln Safety Booklet, Kiln-Sitter Maintenance & Repair and Porcelain Firing Guide. Contact Orton at 614-895-2663 for more information. See ortonceramic.com for lots of very helpful information on how to use cones and for many firing tips and great information on firing kilns.

2) Check out a book called Electric Kiln Ceramics written by Richard Zakin, a book called What Every Potter Should Know by Jeff Zamek and Mastering Cone 6 Glazes by Ron Roy and John Hesselberth. Check out a book called "Ceramic Faults and their remedies" by Harry Fraser, A&C Black, London.

4) The magazines Ceramics Monthly (ceramicsmonthly.org) and Clay Times (claytimes.com) have many good articles and resources.

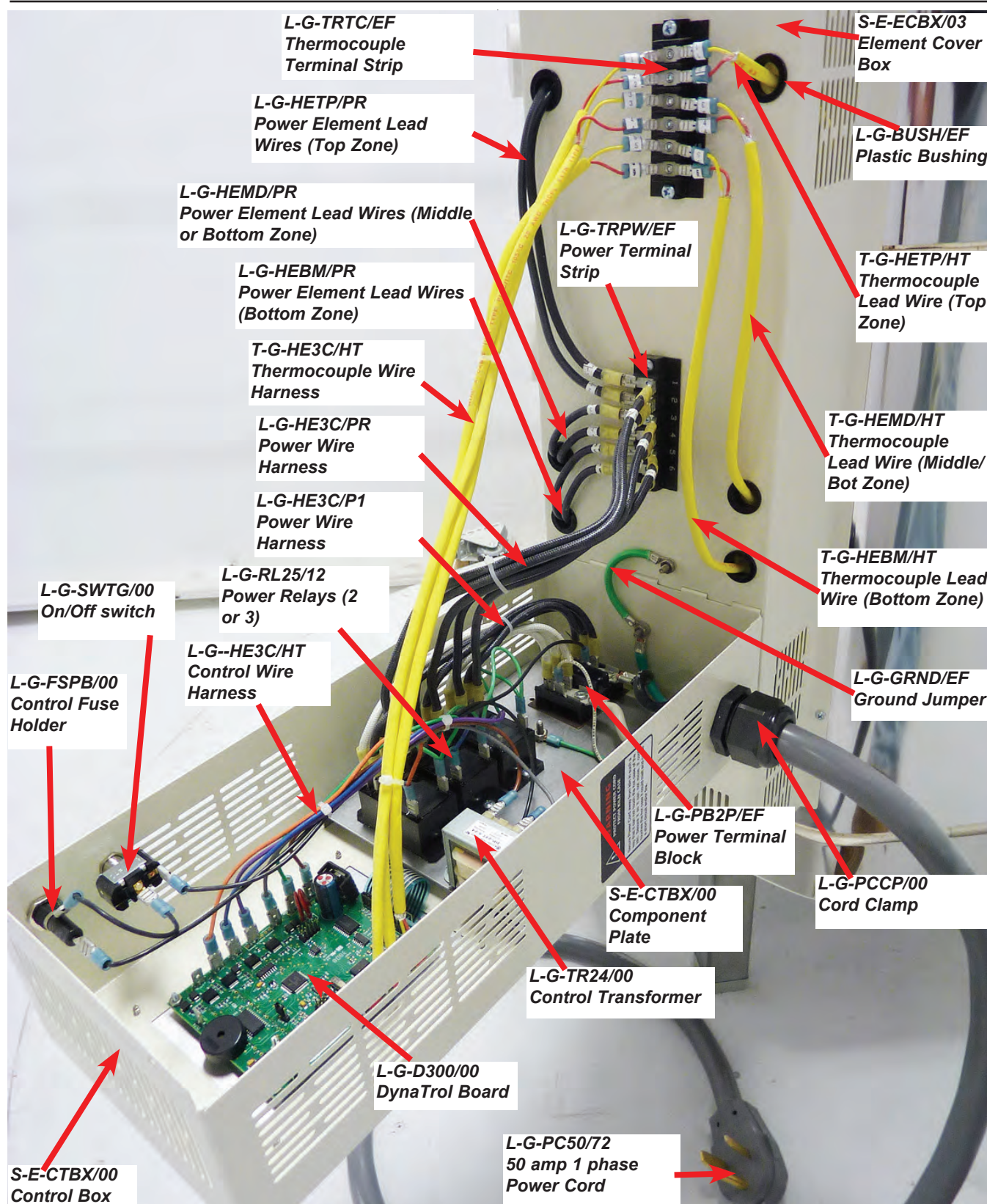
5) Also check out the great web resource, the Clayart discussion group at potters.org.

6) Check the links page on our web site.

7) Your ceramic supplier is a good source of knowledge and will have a wide variety of helpful books and videos as well

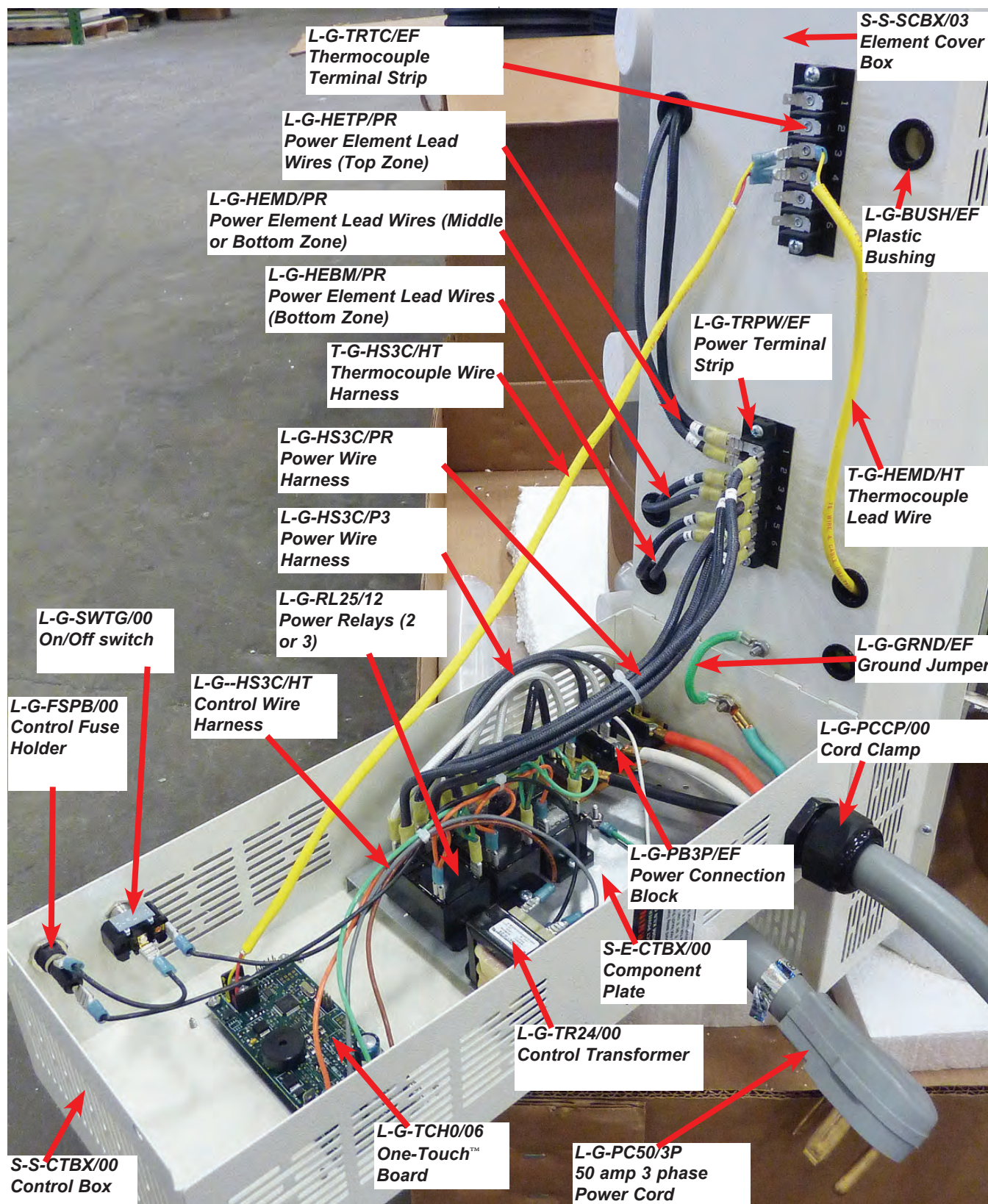
TROUBLESHOOTING AND REPAIR INSTRUCTIONS FOR L&L KILNS

Photo of a 1-phase control panel for a three section Easy-Fire kiln



TROUBLESHOOTING AND REPAIR INSTRUCTIONS FOR L&L KILNS

Photo of a 3-phase control panel for a three section School-Master kiln



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TROUBLESHOOTING KILN FIRING WITH CONE PACKS

BASIC CONE INFORMATION

PYROMETRIC CONES

Pyrometric cones are made of clay and other minerals and are precisely formulated to soften when fired in a kiln. They will bend over when they have absorbed a certain amount of heat. The amount of heat is related to both time and temperature. They mirror fairly accurately what goes on in a ceramic body and can be a more reliable guide to firing than a thermocouple instrument.

Differing materials in the cones result in different firing temperatures. The cones you are likely to use in an L&L kiln are numbered from Cone 022 to Cone 10 (coldest to hottest). The number is imprinted on the cone. Usually clay and glaze comes with a recommended cone to fire to. A cone is a tall (about 2-1/2") pyramid made from specific damp-pressed ceramic materials. Each cone has a slight lean to it when placed on a flat surface. Be careful not to drop cones or expose cones to moisture.

CONES MEASURE HEAT-WORK

Cones are not temperature measuring devices. They measure how much heat has been absorbed by the ware in the kiln, which is the result of the combination of time and temperature. A particular piece of clay needs a certain amount of time at a specific temperature to properly fire it, lower temperature if the time is longer, higher temperature if the time is shorter. An example of this would be if you added about a 20 minute hold to the maximum temperature of a cone 6 firing, you would be able to lower that final temperature by about 20°F. An hour hold time would mean a final temperature of about 40°F lower. A two hour hold time, about 60°F lower.

LARGE SELF SUPPORTING CONES

Although there are various types of cones available we recommend using the "self-supporting large cones". They have a built-in base that allows the cone to sit flat while always placing the pyramid part of it at the proper angle. The angle is there to ensure that the cone bends in the direction you want it to, and doesn't just slump and puddle.

CONE PACKS

The best way to use the cones, especially if they are all you have to tell how hot your kiln is getting, is to use 'cone packs', or the three cone system. The three cones are placed in a line, aimed so that when they fall, they will fall in a line. The first cone to fall should be in the front of the three cone line. This cone should be one cone number lower than the one you wish to fire to. The target cone (the cone you wish to fire to) should be the next one to fall and should be in the middle. The last

cone should be one cone number higher than the target cone. The first cone is to warn you that the firing is almost done. The target cone tells you when to turn off the kiln, and the last cone tells you if the kiln got hotter than you thought it did.



Picture of a "cone pack" (Courtesy of Orton). The ones in the back are before the firing and the ones in the front are after a perfect firing/ These are Self-Supporting Large Cones.

USE CONES TO CONTROL ACCURACY IN AN AUTOMATIC KILN

We recommend checking the accuracy of your control and thermocouples every so often by placing at least one large cone (the target cone or cone number you are firing to) in the top, middle and bottom. Thermocouples will drift in their accuracy, but you can adjust the cone offset or thermocouple offset (or both) to compensate for this. You know how many degrees off the thermocouple reads at the end of the firing. Using a cone near the thermocouple and a "cone to temperature chart" will help to calibrate a thermocouple accurately. Remember though, cone temperatures are affected by their location in the kiln, the angle at which they are held, and the rate at which they are heated. Slight variations throughout the kiln should be expected. You can see a "cone to temperature" chart in the LOG, CONES, TIPS, CERAMIC PROCESS section of your manual or at hotkilns.com/orton-cone-chart.

TROUBLESHOOTING FIRING PROBLEMS

Seems like the kiln is under-firing or over-firing slightly

1) On the next firing make up "cone packs", one for each thermocouple. A cone pack is a set of three cones, standing in a line. The cone the firing should go to is called the target cone, and is in the middle. The one in front of it is one cone

TROUBLESHOOTING KILN FIRING WITH CONE PACKS

number lower, and the one behind it is one cone number higher. Pay attention to how you position the cones as they are designed to only fall in one particular direction if placed on a level surface. You do not want a lower-numbered cone stuck in the cone pack behind a higher-numbered cone because the lower-numbered one will fall first and might lean against or knock over the higher-numbered cone, which will compromise the accuracy of both cones.

2) Once the cone packs are positioned on shelves (or on a post lying on its side) and are visible through the peepholes, fire the kiln to the middle cone's number.

3) Near the end of the firing start watching the cone packs. Look for the first cone to fall over in each pack, not necessarily at the same time, but pretty close, probably in the middle zone first.

4) Now watch for the middle cone in each pack. Keep checking the DynaTrol display to be sure it does not say **CPLt**. The middle cone in each pack should start to fall at pretty much the same time in the top, middle and bottom of the kiln. When the tip of the cone touches the melted cone in front of it note the temperature readout on the display for that zone's thermocouple.

a) If the middle cones did not go down together then immediately note the differences in each thermocouple reading from the one thermocouple in the same zone as the first cone that went down. Later on, use the "thermocouple offset" feature to add or subtract degrees from each thermocouple accordingly. Use the differences between the thermocouple readings as a guide to know how much to offset each thermocouple.

b) If the three thermocouple temperatures are close enough to be reading the same thing (the middle cones did all go over at the same time), then the kiln should say **CPLt** right when the cone tips bend over and touch or just before it. If the kiln is still firing after this point, note how many degrees higher it goes before shutting itself off. Then use the "cone offset" feature to change the temperature equivalent of that cone. Subtract the same amount of degrees from the temperature equivalent that the kiln over-fired the cone by.

c) If the kiln shut itself off before bending the cones properly, you want to reprogram it and then re-start it as quickly as possible. Note the temperature at which the kiln shut down. Get from **CPLt** to **IdLE**, **tC2**, current temperature by pressing either **START/STOP** or **ENTER**. Re-program the same program to one cone number higher, then re-start the firing. Do these steps quickly. Now watch the middle cones again and note at what temperature the cones properly bend. If they bent while you were programming then just offset the temperature by 5 or 6 degrees. Shut the kiln off once you note that temperature. Using the "cone offset" feature, add

the difference of the two readings to that cone's temperature equivalent.

Note: From the factory, the settings that interpret temperature signals in the DynaTrol are hard-programmed; they will not change unless part of the microprocessor has been affected. There is a range of acceptability for the accuracy however and the cone offset feature exists to allow you to fine tune the kiln to particular sized loads. It is best to use all new thermocouples to properly tune the cone offset before individual thermocouples begin to drift. Even keeping one new thermocouple solely for calibrating the individual thermocouples will help to keep the kiln accurate.

CALIBRATING YOUR DYNATROL

This is also covered in the instruction sheet called BASIC OPERATION OF L&L KILNS WITH A DYNATROL 700 in the OPERATION section of your manual or at hotkilns.com/calibrating-kiln.

HELPFUL VIDEOS & LINKS

Calibration

More information on calibrating your kiln:
hotkilns.com/calibrating-kiln

Cone Offset

How to change cone offset in a DynaTrol:
hotkilns.com/change-cone-offset

How to change the thermocouple offset on a DynaTrol. This helps you calibrate the control to match your kiln:
hotkilns.com/change-thermocouple-offset

Firing with Witness Cones

This video shows you how to use witness cones to check the accuracy of the control and your kiln in an L&L Easy-Fire kiln. This video applies to any kiln:
hotkilns.com/firing-kiln-witness-cones

Orton Ceramic Institute

See ortonceramics.com for lots of very helpful information on how to use cones and for many firing tips and great information on firing kilns. See this: ortonceramic.com/Resources/Pyrometric_Cones

Cone Chart

You can see a "cone to temperature" chart in the LOG, CONES, TIPS, CERAMIC PROCESS section of your manual or at hotkilns.com/orton-cone-chart.

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BASIC ELECTRICITY TROUBLESHOOTING FOR L&L KILNS

SAFETY CHECKLIST

When repairing a kiln or working around any electrical equipment, always remember...

1. Wear appropriate PPE (personal protective equipment): rubber-soled/closed-toed shoes, safety goggles, or face shield if possible, work gloves, long pants and short sleeves, and remove all jewelry.
2. Do not work on live equipment unless absolutely necessary: unplug power cable and lock out electrical power.
3. If working with live equipment: use only one hand near the equipment; when touching the leads of a multimeter to your circuit, clamp one of them in place and operate the other lead with one hand, keeping your free hand away from the equipment.
4. Clean the area around the kiln and make sure it's free of water.
5. Use the proper tools and don't improvise: for example, use a fuse puller to remove blown fuses; don't use a screwdriver for this.

BASIC ELECTRICITY FOR KILNS

Electricity can be measured in four different ways: amps (current), volts (energy or potential energy), ohms (resistance), and watts (power). You will likely recognize a few of these as in your 15 amp, 120 volt outlet or your 60 watt light bulb. Let's go into a little more detail on each component of electricity.

Volts:

Volts can be thought of as the force or pressure pushing the electricity through the circuit. The higher the voltage the higher the force. (This is why high voltage can be dangerous). Voltage will likely be predetermined in your location, but it varies from place to place. In the United States, we typically have 240V available in most homes with 208V or 480V available in industrial or commercial settings and many schools. Some of your major household appliances (like ovens and house-sized air conditioners) will use 240V while your typical household outlets will use 120V for your small electronics.

Amps:

Amp(ere) is the unit of measurement for electrical current or flow. The higher the amperage the greater the total volume of electricity. Current is important because it represents the strain that will be placed on your electrical system. Your

house for example will only have a set amount of amps (very typically 200 amps) that it can handle and every wire and component must be sized to handle the appropriate amps.

Ohms:

Ohms are the measure of resistance to flow in an electrical circuit. Certain materials are more conductive than others (think copper vs. rubber). Copper has a very low resistance, which allows electricity to freely flow. Our elements are made of a metal alloy that is somewhat resistive, which is good because where there is resistance, heat builds up. Otherwise the kiln would never get hot!

Watts:

Finally, watts are the measure of power. This is important because the more power you have, the faster your kiln will heat up and the higher temperature it can get to. Larger kilns will need more watts than smaller ones, as they need more power to heat up the space in them.

Ohm's Law:

All four of these measurements are related to each other in what is called Ohm's Law. Using this, we can use two measurements to find a third. For example, we can find a kiln circuits amperage by dividing volts by ohms.

Mathematical Relationships (formulas)

For use with single phase only: The electrical industry has designated letters to stand for amps, volts, ohms, and watts.

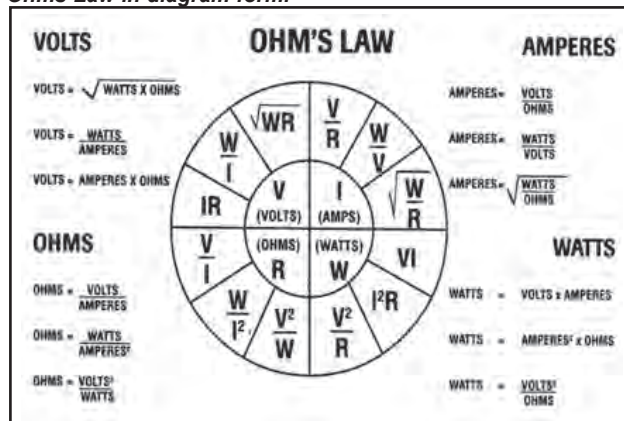
Amps = "I" (think "intensity of amperage")

Volts = "E" (think "energy")

Ohms = "R" (think "resistance") (Ω is the symbol used to indicate ohms)

Watts = "P" (think "power")

Ohms Law in diagram form.



BASIC ELECTRICITY TROUBLESHOOTING FOR L&L KILNS

Single vs. Three Phase:

Electricity can also be delivered in two ways: single or three phase. Single phase means that electricity is moved along two “hot” wires. Think of it as flowing in one wire and out the other. Three phase meanwhile utilizes three “hot” wires to distribute electricity. The advantage here is that current is more spread out meaning that your kiln will draw fewer amps. Fewer amps means smaller wire and circuit breaker are needed.

THE WATER ANALOGY FOR UNDERSTANDING ELECTRICITY IN KILNS

Electricity is analogous to water

Electricity is easiest to understand when compared to water flow and pressure. As far as your kiln is concerned, its supply of electricity is like a huge reservoir of water. Imagine that a kiln is like a bucket with small holes for the water to leak out of (which would represent the heat loss of the kiln). Imagine that the water flowing into the bucket is like electricity. To fill two different sized buckets with the same porosity (i.e. same number of small holes per square inch which would be like the standard heat loss in firebrick) you will need different flow rates of water. If you turn on the small 2.6 cubic foot model e18S, electricity will flow into the kiln at one particular rate, measurable in “watts” per hour (actually Kilowatts per hour, or kWh, 1000 watts = 1 kWh). If you turn on a T3445 which has 34.5 cubic feet, electricity will flow into it at a much greater rate, still measurable in watts per hour. Likewise the larger bucket needs more gallons per hour than the smaller bucket not only to get filled at the same speed but to get filled up at all (because of the porosity). This analogy can help you to understand why it takes longer or might even be impossible for some kilns to heat up to very high temperatures. Note that the heat loss gets greater as the kiln gets hotter so it takes more and more electricity to heat a kiln the hotter it gets. It is like the porosity increasing over time as you fill up the bucket in the above analogy.

Amps (amperes) = flow

If the volume of water can be measured in gallons per second, then the volume of electricity flowing is measured in “amps”, a particular amount of electrons flowing through a wire in one second.

Volts (voltage) = pressure

Water is forced through the pipes by water pressure. A water tank at the top of a hill will provide you with more water pressure than a water tank only half-way up the hill. Electricity is forced through the wires by electrical pressure, called volts. A 12 volt battery is like the lower water tank: there is not much voltage to push the electrons along the wire. A 120 volt house power source is like the higher water tank, pushing a much greater volume of electricity (many more amps) down the same diameter wire than the 12 volt source.

Ohms (resistance) = resistance to flow

Say your house in the valley is somehow fed by both of these two water tanks. Sink number one has water from the top-of-the-hill water tank flowing to it. Sink number two, which is right next to sink number one, has water from the half-way-up-the-hill water tank flowing to it. Sink number one will have much greater water pressure and much more water coming from it than sink number two (assuming the same size orifice in the faucet). To get them to flow at the same rate, you must use a smaller diameter pipe to connect the water to sink number one than the pipe connecting the water to sink number two. By restricting the heavier flow of water with a smaller pipe, you can make the same amount of water come out of each sink. Electricity can be restricted (or “resisted”) as well. A small diameter wire can resist electricity like the smaller pipe resisted the water. In the same way that a large pipe will let more water through than a small pipe, a thick wire will have less resistance and will allow more electricity through than a thin wire. A short wire will have less resistance and let more electricity through than a long wire. This amount of electrical resistance can be measured in terms of “ohms”. The higher the number of ohms, the higher the resistance of the circuit.

Watts (power) = work

In the same way that the combination of water pressure and the actual water itself (measured in gallons per second) comes together to perform “work”, the combination of voltage (pressure) and amps (volume) comes together to perform “work” as well. This electrical work is measured by multiplying the values of the volts and the amps together. The result is called “watts”. Watts are a measurement of the work done by electricity.

Single Phase Power

Like voltage, the phase is specific to each location. The huge electrical lines you see across the country use three “hot” lines, what is termed “three phase”, with 1000’s of volts

BASIC ELECTRICITY TROUBLESHOOTING FOR L&L KILNS

running through them. From these three “hot” lines any two can be tapped (eventually, after stepping down the voltage through transformers) to provide power for any single phase circuit. To use a small electrical appliance as an example, if you trace the two wires that make up the cord for the appliance back through the lines you will eventually end up at two of the three wires from some main power line, and from there back to the generating plant. Often the power for a residential area is all single phase, from a junction station to a single house in the neighborhood. There may be no way for three phase power to be obtained without the equipment (mainly the extra line) in place. Industrial areas, large facilities, and schools usually have access to three phase power. Even then, sometimes the three phase ends at the main junction box in the building and the single phase power supplies branch out from there.

Three Phase Power

Three phase power uses three “hot” wires to supply electricity to the circuit. From the main power supply, the three lines remain three lines all the way through to the circuit. The same amount of electricity is simply split over three wires instead of two. The benefit of three phase is not a lower electric bill, since the kilowatts used are still the same. The benefit is in the cost of setting up the supply line itself. For example, a model T3427 208 volt in single phase draws 119.88 amps. It will need two “2/0” awg wires to supply it with power. The circuit breaker would need to be a two pole, 150 amp breaker, and any safety switches would need to be rated for at least 150 amps, if not more. That same kiln in three phase will draw 69.21 amps. It would only need three 2 awg wires to supply it with power. The circuit breaker would only need to be a three pole, 90 amp breaker, and any safety switches would only need a 90 or more amp rating. The cost of material and components for creating electrical lines are expensive. This cost increases exponentially with the size of the service. A 2/0 awg wire costs considerably more per foot than a 2 awg wire. The size of the conduit that houses the wires costs more as the diameter increases. A 150 amp circuit breaker is large and has a heavy protective housing. It has mechanical arms to provide leverage and physically move the electrical contacts together or apart. A 90 amp breaker is more familiar looking, with its plastic switching arm and the way it sits side-by-side with the other breakers in the box. The total cost (especially if power needs to be run for some distance) is much less for three phase than for single phase. The cost for another wire in the three phase is almost always offset by the potentially vast difference in total cost between installing single and three phase.

SERIES CIRCUITS

A circuit that only has one path over which current can flow is a series circuit.

A break in any part of a series circuit stops current flow.

All components in a series circuit see the same amount of current; therefore, each component must be capable of carrying that number of amperes.

RULES FOR SERIES CIRCUITS

- 1) The value of a current (amperage) flowing in a series circuit is the same through all parts of the circuit.
- 2) The total voltage of a series circuit is equal to the sum of the voltages across each part of the circuit.
- 3) The total resistance (ohms) of a series circuit is equal to the sum of the resistances across each part of the circuit.
- 4) Line voltage is divided across each component in a series circuit in proportion to the component resistance values. Referring to the schematic below, the total resistance is ($25\Omega + 30\Omega = 55\Omega$). Voltage measured between points A and B is:

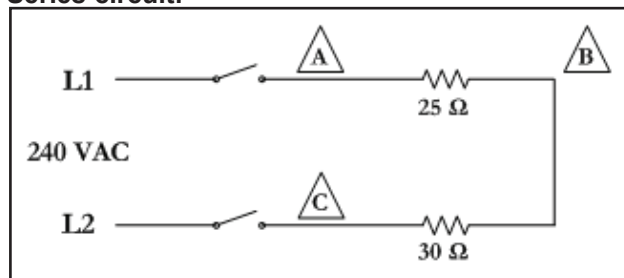
$$240 \times (25\Omega/55\Omega) = 109 \text{ Volts.}$$

Voltage measured between points B and C is:

$$240 \times (30\Omega/55\Omega) = 131 \text{ Volts.}$$

Note that $109 + 131 = 240$ volts

Series circuit:



If there were (2) resistances whose values were equal, the voltage would be divided equally in half, and would measure 120 Volts.

Measuring Resistance in Series Circuits

The total resistance of a series circuit is the sum of all the individual resistances.

BASIC ELECTRICITY TROUBLESHOOTING FOR L&L KILNS

PARALLEL CIRCUITS

A circuit that has two or more current paths is a parallel circuit.

Each component is connected to line voltage, and current still flows through part of the circuit if one component fails.

Each component must be capable of withstanding the full line voltage.

The amount of current (amperes) varies according to the resistance of each separate part of the circuit.

The more circuit paths, the less opposition to the flow of electrons. Total circuit resistance decreases when more paths are added.

RULES FOR PARALLEL CIRCUITS

- 1) The total current (amperage) supplied to a parallel circuit is equal to the sum of the currents through the branches.
- 2) The voltage across any branch of a parallel circuit is equal to the supply voltage.
- 3) The total resistance of a parallel circuit is always less than the resistance of any of the branches.

Example of a Parallel Circuit in an L&L kiln

The following parallel circuit is typical of the DaVinci, Doll and J2900 kiln rings; there are (3) elements per ring, connected in parallel.

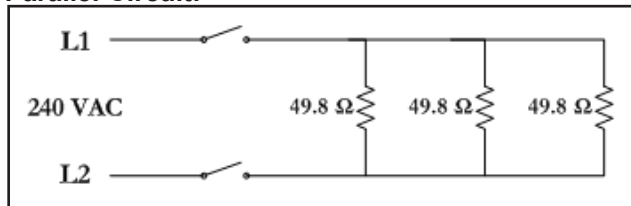
In this example, each element has a resistance of 49.8Ω. At 240 VAC, each element develops

$$(240 \text{ VAC} / 49.8\Omega) = 4.82 \text{ Amperes}$$

The total circuit amperes, then, is

$$4.82 + 4.82 + 4.82 = 14.46 \text{ Amperes.}$$

Parallel Circuit:



Measuring Resistance in Parallel Circuits

The total resistance is always less than the lowest reading of a single element. Often this is difficult to measure if all the elements in the circuit are connected to two points with no way to isolate them.

If all elements are known to all have the same resistance then you can multiply the number of elements by

the resistance value of the entire circuit to get one element's approximate resistance. In the above example The resistance of the entire circuit is $49.8\Omega / 3 = 16.6\Omega$.

$$\text{Total Resistance} = 1 / ((1 / R1) + (1 / R2) + (1 / R3))$$

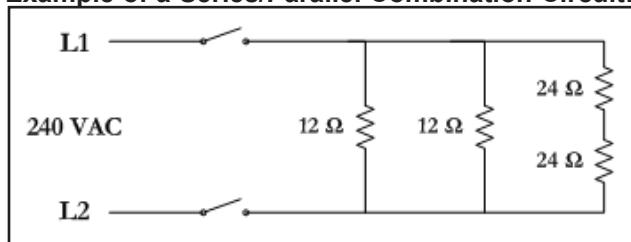
If the elements in the circuit have different resistances, like in School-Master kilns, there is no easy way to determine the individual resistances of the elements. The best way to solve an element problem with these kilns is to replace all the elements in the troublesome circuit. You can also measure the resistance on each element.

BASIC ELECTRICITY TROUBLESHOOTING FOR L&L KILNS

SERIES/PARALLEL or COMBINATION CIRCUITS

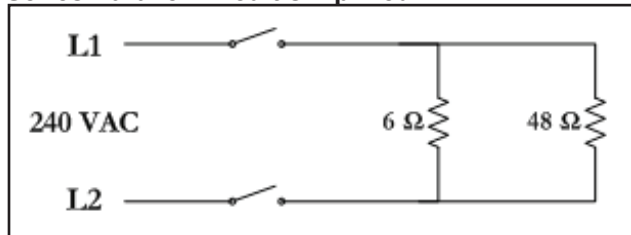
Certain circumstances require the use of Series/Parallel, or Combination circuits (in which series and parallel circuits are combined). In some front-loading kilns these circuits are used to combine, for instance, sidewall heating elements and backwall heating elements (often shorter than sidewall) in a combination circuit that is controlled by one power relay.

Example of a Series/Parallel Combination Circuit:



In the above example, the total resistance can be found by first dealing with each branch circuit individually. Starting from the right, this circuit is a series circuit; add the ($24\Omega + 24\Omega = 48\Omega$). The other two circuits are parallel and are equal in value (12Ω each); therefore, the resistance value of these two circuits is equal to ($12\Omega / 2 = 6\Omega$). Drawing an equivalent circuit with (2) parallel circuits, one of 6Ω and one of 48Ω , looks like the following:

Series/Parallel Circuit simplified:



Solving for this circuit:

$$\text{Total Resistance} = 1 / ((1 / R1) + (1 / R2) + (1 / R3))$$

$$\text{Total Resistance} = 1 / ((1 / 6\Omega) + (1 / 48\Omega)) =$$

$$1 / (.1666 + .02083) = 5.33\Omega$$

WHERE TO GET MORE INFORMATION ABOUT ELECTRICITY

hotkilns.com/volts.pdf

www.elec-toolbox.com

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ELEMENT TROUBLESHOOTING & INSTALLATION INSTRUCTIONS

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ELEMENT TROUBLESHOOTING

Getting E-1 Error

If you get an E1 or E-1 or Err1 error code on your DynaTrol or On-Touch control it means that your kiln no longer can get to temperature. It is slowing down. There are three main causes of this in order of likelihood:

- 1) Your elements have aged and need to be replaced. This is most likely when you notice the kiln gradually slowing down.
- 2) One or more contactors or relays have failed. This is most likely if you notice a sudden change.
- 3) You have a low voltage problem. This is most likely if you find this happening in the summer.

Why does an older kiln slow down?

Old elements generally increase in their resistance. Mathematically this increase in resistance will decrease the amount of amperage and, ultimately, the amount of heat given off by the elements. This is why older kilns sometimes go so slowly and may not reach their maximum temperature. Periodic element resistance readings using the multimeter will allow you to check the "health" of your elements. Of course, a slow firing kiln is the first indication that you have an element problem.

Elements expand and grow with age

If you fire low-fire clay and glazes and never get above cone 4 or so, your elements will last a long time, especially if you are only bisque firing. This is good, to a point. If you only low-fire, the problem you are most likely to encounter over time is that the elements expand as they age. The length and the coil diameter increase. Meanwhile the atmosphere in the kiln slowly eats away at the metal of the element. Although the total resistance usually increases as the elements age, sometimes it decreases, or reverses itself. This usually only happens when the elements are very old but have not yet failed completely. As the element expands, it binds up in the corners. This can make the individual coils push together and touch each other in the corners, making a short cut for the electricity, reducing the amount of element material the electricity must pass through, and therefore reducing the resistance in the whole element. This may make it hotter in the kiln, but if there is a lot of element material jammed in the corners there will not be enough material left in the coiled form to radiate the heat generated by the increased amperage and decreased resistance. Only the parts of the wire not touching the coils on either side of them will emit heat. More amperage through the electrical components in the control could cause damage if the situation continues or the resistance drops far enough.

In addition, the expanding diameter of an element can make it difficult to get it out of the holder. Usually this will not happen to those firing to higher temperatures because the maximum temperature of the kiln is quickly compromised by increases in the resistance, requiring the elements to be changed long before they can jam up in the corners. Also, high temperatures and glaze firings are more prone to eating through the element, causing it to fail, before the element can expand enough to cause the problems mentioned above. Use the multi-meter. Visually inspect your elements.

ELEMENT TROUBLESHOOTING & INSTALLATION INSTRUCTIONS

What if I see charred and blackened corners?

The coils that sometimes get squashed together in the corners do not always touch each other, but they may be close enough to allow the electricity to 'arc' across the gap. An electrical arc can generate extreme temperatures for the millisecond it arcs. Charred and blackened corners of the kiln are warning signs for this problem.

Do not confuse this with what can be observed even with new elements; which is randomly sized sections of the coils glowing more quickly than other sections of the same coil. The annealing process of the wire causes this, and does not adversely affect the elements' operation in the kiln.

Factors shortening element life

1) Contamination (such as glaze or kiln wash). Silica, a main ingredient of both of these, attacks the element wire.

2) Tightly wound areas on element coils resulting from improper stretch. Have the elements been stretched evenly? This is important. If the element coils are bunched up along the length of the element the element will overheat where the coils are too close. Some replacement elements are shipped unstretched. Even prestretched elements may need some stretching. See section below on stretching elements.

3) Glaze accidentally rubbing off into holder and on element in loading kiln. If this occurs immediately vacuum the kiln and element holders thoroughly. Glaze will cause very rapid element failure.

4) Blow ups or explosion of bisque ware cause small pieces of clay to be blown into holder and element. If not immediately removed clay may melt, contaminating the element and element holder. Keep in mind that temperatures are considerably higher right next to the element so that you may very well exceed the clay melting temperature next to the element even if the kiln temperature is correct for the clay body.

To avoid explosions make certain clay is very dry before firing and, in the case of heavy handmade pieces, fire on low for a long period until you are sure ware is dried out thoroughly. If you hear a "pop" when firing such pieces, stop firing, cool the kiln. If blow-up has occurred, vacuum all element grooves very thoroughly. If you have the DynaTrol use the PreHeat feature for this final forced drying.

5) Firing pieces too close to elements. We recommend at least 1-1/2" from piece to element. Further if large flat surfaces are parallel to kiln wall.

6) Reducing atmospheres will destroy elements. Do not use wood chips, oils and other materials to generate a

reducing atmosphere. A very rapid element failure may result. NOTE: Reducing atmospheres are the opposite of oxidizing atmospheres (plain air is an oxidizing atmosphere). The word reducing comes from the ability of a reducing atmosphere to "reduce" oxides.

7) Are any waxes, oils, carbon, fluorine, fumes present? Are you using any lead glazes? Iron-Chrome-Aluminum elements require an oxidizing atmosphere to give dependable service. The aluminum in the element forms a protective aluminum oxide. Oil from tools or carbon from wax burnout will attack the element coating. Halogens such as chlorine or fluorine will attack the elements. Molten metals, for instance, zinc, aluminum and copper, react with iron-chrome-aluminum elements. Moreover, these metals oxidize easily and their oxides have an unfavorable effect on iron-chrome-aluminum. The salts of the alkali metals, halogen salts, nitrates, silicates, and compounds of borax, disturb the formation of oxide and are, therefore, harmful to these elements. This is also true of the oxides of such metals as copper, lead and iron. Do not use with free carbon. Lead oxide attacks the protective alumina oxide coating on the element. If you are using lead glaze (or are creating any of these other problems) be sure to use a kiln vent. Also try firing every other load or as often as you can with a non corrosive load (such as a bisque firing). This will help the element restore its protective alumina oxide coating. Note that clay almost always has organics (which will create a slightly reducing atmosphere, sulfur (which will also attack elements) and fluorine which is also corrosive. This is one reason why proper venting is critical for long trouble-free operation of your kiln.

8) Excessive soaking time will accelerate increase in element resistance. The higher the temperature, the longer the soak, the sooner the element will decrease in life. Usually short soaks work fine.

9) Are they genuine L&L elements? There are a number of people selling "replacement elements" for kilns. These people do not have access to the proper design information for L&L elements. Designing an element is a complicated process which balances such things as voltage, wire diameter, watt density, stretch ratio, etc. It is very easy to make an element that has the same watts as an L&L element and have nowhere near the other design qualities that result in long element life.

10) If the failure is taking place at the element end it may be twisted too tightly, causing stress at terminal through holes. This causes local overheating at the "through hole", and element failure. (Contact factory).

ELEMENT TROUBLESHOOTING & INSTALLATION INSTRUCTIONS

11) Make sure all elements are heating. If all elements are not doing their share of the work then the other elements will not last as long.

Element Terminal Burn-out

Sometimes the ends of the elements can burn out at the element terminals (connections). This can be due to any or all of the following causes:

- 1) The element ends are not twisted properly. If the twist is too loose this could generate extra heat at the element ends.
- 2) The holes where the elements go through the firebrick walls are too large. This could cause too much heat to escape from the kiln thereby overheating the element terminals. This can be remedied by lightly stuffing ceramic fiber (we have non-RCF ceramic fiber available in our parts list) in the element holes.
- 3) The element connection hardware may not be tight enough. A loose connection can generate heat and cause oxidation of the hardware which in turn will cause a worse electrical connection (because of resistance) and more heat. Replace with new hardware.
- 4) The hardware should be stainless steel or at least nickel plated. Check to see if the hardware is in good shape. If not replace at least the hardware with stainless steel hardware or better yet replace the whole terminal board assembly with one of our new ones.

CHECKING ELEMENT OHMS

The most common cause of kiln slowdown, E-1 messages, and failure to reach temperature is element wear. As your elements age they generally increase in electrical resistance. According to Ohm's Law, when resistance, measured in Ohms, increases, both Watts and Amperes will decrease, assuming Voltage remains constant. Since Amps and Watts are the measures of current and power respectively, they can be thought of as the amount of juice that your kiln has to generate heat. Obviously if you don't have enough power, your kiln will fire slowly and might not even reach the desired temperature.

Using resistance, we can tell exactly how much power your kiln has lost over the course of your element's life. For example on an e23T that uses 240V, a brand new kiln section would read about 14.5 ohms. If you measured this same kiln section after several months of cone 6 firings let's say and the reading was 16.5 Ohms, you would know that this section of elements has lost approximately 14% of

it's power ($16.5/14.5=1.138$, or close to a 14% increase). Again, an increase in resistance means decrease in power. A very general rule of thumb is that most people will typically begin to notice some slowdown once you've lost more than 10% of your power. It will certainly vary based on the kiln you have, your voltage, as the types of firing you do. People only doing low fire work will continue to get by on lower power than those needing to go to higher temperatures (cone 6+). As you can see, measuring your element Ohms is the best way to identify when elements need replacing.

Keep in mind that the ohms on the wiring diagram are per ELEMENT while your reading will be per SECTION. How you figure out the section ohms depends on whether the elements are wired in Parallel or Series. Most kilns are wired in Parallel except for JD230V and most 18" kilns like the e18T. For a parallel kiln you take the per element ohms listed and divide by the number of elements per section. Ex. e23T 240V 1 Phase is 28.9 Ω per element with two elements per ring = 14.5 Ω per section. Ex. 2. JD2927 240V is 36.5 Ω per element with three elements per ring = 12.2 Ω per section. See this link for more info on Series vs. Parallel

Here we will show how to best measure your element resistance for two groups of L&L Kilns, into which most models fall.

Easy-Fire, eQuad-Pro, Liberty Belle, Doll, School Master, e23S-JH

See this video: [hotkilns.com/test-resistance-ez](https://www.hotkilns.com/test-resistance-ez)

In these series' of kilns a piggy-backed control panel covers up the element terminals.

1. Turn the power to the kiln completely OFF and unplug it if possible. If it is direct wired, then you should at least turn off all power at the disconnect switch or circuit breaker.
2. Open the outermost control panel by unscrewing it either from the element cover box in the case of Easy-Fire, eQuad Pro, School Master and Liberty Belle kilns or from the kiln body in the case of Doll kilns.
3. Once you open up that control panel you will see the element power wire terminal strip. See the picture. It will have numbered wires coming from the element terminal blocks and wires connecting to the power relays. There are two wires per kiln section/ring, so numbers 1 & 2 are for the top section, 3 & 4 for the middle, and 5 & 6 for the bottom section on a three ring kiln.
4. Set your multimeter to Ohms (Omega symbol Ω) and using your testing leads, place one in between the two tabs/terminals w/ #1 wires connected. There is a small circular

ELEMENT TROUBLESHOOTING & INSTALLATION INSTRUCTIONS

divot that the lead fits into (see picture). Put the other lead on terminal #2 and make note of the reading. Repeat the process for 3 & 4 and then for 5 & 6. Remember that each pair of wires represents one section.

5. Compare your readings to those on the wiring diagram in your instruction manual. Keep in mind that the ohms on the wiring diagram are per ELEMENT while your reading will be per SECTION. See above for more info on understanding the readings.

Jupiter, Davinci

See this video: [hotkilns.com/test-resistance-jupiter](https://www.hotkilns.com/test-resistance-jupiter)

In these series' of kilns, the control panel is separated from the kiln body and the element terminals are connected to the controls via external jumper cords or plugs.

1. Turn the power to the kiln completely OFF and unplug it if possible. If it is direct wired, then you should at least turn off all power at the disconnect switch or circuit breaker.
2. Unplug the first jumper cord from the control panel.
3. Set your multimeter to Ohms (Omega symbol Ω) and using your testing leads, place one lead on each of the "hot" prongs. They will be the flat ones.
4. Make note of the reading and move on to the next one.
5. Compare your readings to those on the wiring diagram in your instruction manual. Keep in mind that the ohms on the wiring diagram are per ELEMENT while your reading will be per SECTION. See above for more info on understanding the readings.

How to check ohms of an entire L&L kiln section. Put the test leads of the multi-meter on the two "hot" plug terminals:



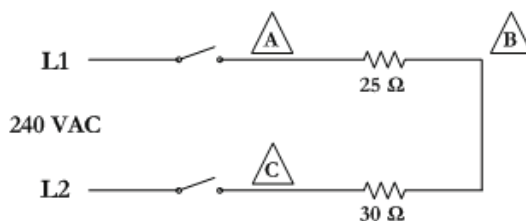
HOW ELEMENTS ARE WIRED

Why is this important?

The way the elements in a particular kiln are wired is important. Different wiring schemes with the same resistance elements will yield drastically different results. For example, if a kiln section or group of elements is out, and the kiln is made up of series circuits, you would first look at the elements because even one element out in a series circuit can make all the elements in that circuit appear to be burned out. If this same kiln had parallel circuits you would first look at the switch or relay. This is because in a parallel circuit, if one element is out the others will still light, so for all the elements in the parallel circuit to be out would mean that whatever controls the circuit (i.e. the switch or the switch by way of a relay) or the wires in-between would be suspect. CAUTION: Accidentally wiring a kiln with parallel element circuits will make it heat up incredibly fast, until the breaker trips. For instance, An e18S-3 kiln wired properly, in series, draws 23 amps at 240 volts. Wired in parallel it would draw around 90 amps at 240 volts, which would be disastrous.

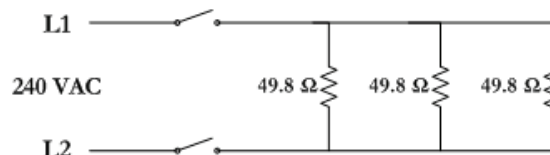
Series Circuits

In a series circuit, power flows through one element and then another. We can see this in how it is wired. Think again of power coming in one wire and out the other.



Parallel Circuits

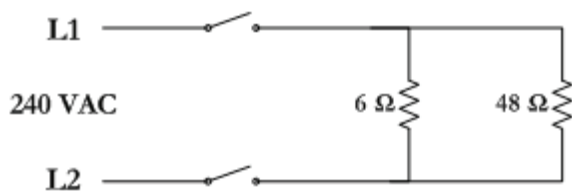
Parallel circuits meanwhile allow power to flow through both elements simultaneously in no order. The power is applied to the beginning and end of ALL the elements at once. Thus the resistance of the entire circuit is the number of elements in the circuit divided into the factory resistance value for one element.



ELEMENT TROUBLESHOOTING & INSTALLATION INSTRUCTIONS

Series-Parallel

Sometimes element wiring can be termed series-parallel.



Both series circuits get power at the same time, making them series-parallel circuits.

Specific to non-sectional kilns:

In non-sectional kilns it can be difficult to tell the element circuits apart since the element connection board runs the entire length of the kiln and covers all the circuits. Trace the connecting wires to discover the beginning and end of each element circuit on the element connection board. Ideally, you would draw a picture of each element circuit before dismantling it. If you are just replacing the elements it is not necessary to know if they are wired series or parallel; it is imperative, though, that they go back together exactly how they came apart.

For a more in-depth description of Series, Parallel and Series-Parallel circuits, along with descriptive diagrams see **BASIC ELECTRICITY TROUBLESHOOTING FOR L&L KILNS** in the **TROUBLESHOOTING** Section for more information on circuit wiring. If you want even more information about electricity for kilns see hotkilns.com/volts.

POWERED BOTTOMS

The elements on the powered bottoms are typically the same as those in the kiln with some exceptions. Series elements cannot be used by themselves in a power bottom, so a parallel element must be used in smaller, series-wired kilns like the JD230V-PB.

OTHER TYPES OF ELEMENTS

Heavy-Duty elements

If your kiln was made after January of 1996 (the year and month are coded into the serial number) it has larger cross-section element holders. These new holders are capable of holding a larger diameter, heavy gauge element. These high grade heavy duty elements feature lower watt density than the standard elements and that, coupled with the heavier gauge wire, results in longer element life. If you

are experiencing short element life because of your duty cycle (frequent firing, high temperature firing, long soak times) you should try these heavy duty elements. They have the same ohm rating (resistance) as the standard elements. This means that the power rating of the kiln does not change. It also means that you can use them with the standard elements. One consideration with mixing the standard and heavy duty elements is that the heavy duty elements will age more slowly than the standard elements and may have an effect on uniformity in the kiln. This is really no different than what you would experience when you change just one element and so have a new element (unaged) with older elements. Dynamic Zone Control will automatically balance your system and compensate for this problem. We do suggest, however, that you put any newer elements in the bottom ring where temperatures tend to be cooler and hence need as much power as they can get. Keep in mind that L&L can not keep track of which elements you have and that you must specify heavy duty elements when ordering. If you don't specify heavy duty elements you will get standard elements.

APM Elements

APM is a special version of the Kanthal A-1 alloy used on kilns. It is sintered and resists the crystallization that normal Kanthal type alloy experiences. As a result it makes sense to use this when you are doing processes that require long holds at high temperatures (like crystalline glaze for instance). On the other hand these elements are very expensive and a subject to the same problems like glaze contamination that any elements can experience. See hotkilns.com/apm for more information.

Quad Elements

The quad element option gives you four rows of heavy duty elements to maximize element life and heating power. Double the element surface area means that quad elements will degrade at a slower rate than ordinary elements which is great for those firing to high temperatures. More surface area also means more radiated heat for faster and more even firings. Quad elements are also typically made from thick gauge element wire further increasing their durability. Note: Quad element designs use extra long elements to wrap around the kiln twice each meaning that the electrical specs are kept the same. Because of the need to have more element holders in the brick, quad elements are not interchangeable with regular elements. See hotkilns.com/quad-elements for more information.

ELEMENT TROUBLESHOOTING & INSTALLATION INSTRUCTIONS

Increasing Power in Your Kilns

If you have a JD230 you can retrofit the new Easy-Fire e23T elements in that specific model and increase the power rating of the kiln. That will give you about 10% more power to start with and therefore, as elements age, the lowering power will have less impact on your firings. See hotkilns.com/jd230-ez as an example. These elements can be retrofitted into older kilns.

CHANGING ELEMENTS

SEE THESE VIDEOS FIRST

For most top loading kilns:

hotkilns.com/change-elements-ez

For kilns with Quad elements:

hotkilns.com/change-element-quad

REMOVING OLD ELEMENTS

- 1) Unplug kiln or turn off the kiln at the fused disconnect switch.
2. First remove the control box or element boxes and their wire connections from the kiln. Before undoing any wires, however, label how the wires and the elements are configured inside the element boxes (take pictures if needed). After you are certain you have documented the wiring then you can carefully remove the wires.
- 3) Using a 3/8" nut driver remove the nuts that hold the element end onto the Element Terminal Bolt. If you don't have this tool you can use an adjustable wrench - it will just take longer.

A 3/8" nut driver:



- 4) Untwist the element end from around the Element Terminal Bolt. Straighten it out as much as possible.

Untightening the element terminal:



- 5) Cut the old elements off as close to the "through hole" on the outside of the kiln as possible. You want a straight element tail to pull through the through hole, not a crooked one.

FOR OLDER NON-CERAMIC TERMINAL BOARDS:
Remove all the old tails from the element connection bolts and re-tighten these bolts to the element connection board. You may have to remove the element connection board from the kiln to do this. If the bolts are corroded, replace with new stainless steel terminal bolts, nuts, and washers. If the terminal board itself is burnt or broken replace that as a complete unit with new hardware.

- 6) In most cases you can just lift the element out of the holder at this point. Sometimes, if the element has really disintegrated, you need to remove it in pieces with needle nose pliers.

Using a sharp tool like a screw driver lift the elements out of the ceramic grooves at the corners. You can slide the holder over to make enough of a gap to get the tool under the element:



ELEMENT TROUBLESHOOTING & INSTALLATION INSTRUCTIONS

Lift Elements out of the groove of the ceramic holders:



Sometimes very old elements can become wedged in the element holders, making it necessary to carefully pry/twist/break them out. A propane torch or just turning the kiln on for a few minutes (if it will come on) will soften the wire of the elements and make them easier to get out. Use heat protecting gloves such as welding gloves or heat treating gloves (you can buy these from L&L) and a pair of needle nose pliers to pull out the softened element. **DANGER:** You could burn or electrocute yourself if you get the elements too hot or forget to unplug the kiln after warming them up. **IF YOU DECIDE TO USE THIS METHOD BE VERY CAREFUL OF THE POTENTIAL FOR BURNING YOURSELF.**

7) Be sure to check for failure points for evidence of contamination on the element and the element holder. If the element holder is contaminated it will cause rapid failure of the new element. Replace contaminated holders with new ones (See later in this sheet how to do this).

8) From the inside of the kiln, using needle nose pliers, grab the element as close to where it goes through the brick wall to the Terminal Block. Pull the element end through the hole. Be careful not to enlarge the hole in the firebrick. The brick is quite soft and will not take much abrasion.

Removing element from inside the kiln:



9) **FOR OLDER MODELS WITHOUT CERAMIC TERMINAL BOARDS:** There are normally ceramic insulator bushings on the outsides of the through holes that the elements pass through. On some models (particularly older J2900 kilns and DaVinci kilns) there are spacers to keep these insulators in

place. These may fall out (and chip or break) if you are not careful. Be sure not to lose these spacers when replacing elements. Note carefully how they are positioned so you can replace in the same way. Note that on the new all ceramic terminal boards used on the J2900 and DaVinci kilns there are no bushings or spacers - it is all one integrated piece.

10) Once the old elements are out, carefully vacuum all the element holders. Watch for any glaze or material contamination. Anything that will melt (i.e. glaze, slip, porcelain, etc.) will cause rapid failure of the new element. Chip or scrape carefully to remove the contaminant, or replace the affected element holders. **DO NOT** replace the element if there is foreign material stuck in the element holders. You must fix that problem first by either cleaning or replacing the contaminated element holder.

CHECKING ELEMENTS

Examine your new elements. Look to see the wire thickness is similar to that of the old ones. Look to see that the coils per inch and the diameter of the coils are also similar. Using your multimeter check the resistance of your new element. Compare to the factory resistance value(s) for your kiln's elements. Your reading should be no more than one ohm off (less for elements with ohm readings of less than 10 ohms). If you have received the wrong element in error call the factory to get it exchanged. This is the time to deal with the problem. **DO NOT WAIT UNTIL YOU HAVE STARTED THE JOB, STRETCHED THE ELEMENT OR EVEN INSTALLED IT BECAUSE AT THAT POINT YOU WOULD NOT BE ABLE TO RETURN IT.**

ELEMENT TROUBLESHOOTING & INSTALLATION INSTRUCTIONS

Checking resistance of the elements before you put them in. This is a good double-check and can save you a lot of trouble if there is a mistake. Put the probes on the twisted element ends about 3" from the beginning of the coil:



STRETCHING ELEMENTS

NOTE: Most replacement elements come prestretched. All elements are slightly understretched and will have to be adjusted for final fit. The following are instructions for how to stretch unstretched elements:

To determine total length to stretch an element measure total length of element grooves.

IF ELEMENTS NEED TO BE STRETCHED

- 1) Mark floor with two marks for stretched length. Have a helper stand on the tail of one element, and pull the other tail until the element is the proper length. The assistant must stand very firmly because a flying element could cause severe injuries. **WEAR SAFETY GLASSES WHEN YOU DO THIS.** Alternately clamp the end to something with vice-grips.
- 2) Examine for evenness of stretch. Selectively stretch close wound sections to provide uniformity of stretch.
- 3) Repeat this procedure several times.
- 4) You will have to pull element beyond last mark in order to obtain full stretch.
- 5) If overstretch occurs insert a metal rod or small diameter dowel into the element coil and compress with needle nose pliers.
- 6) Stretch uniformity is necessary for satisfactory element life.

INSTALLING NEW ELEMENTS

NOTE: We highly recommend you get all new element terminal hardware when you replace your elements. In fact we offer a 50% discount on element terminal hardware when buying elements.

- 1) Replace one element at a time so that you do not make a mistake with the wiring.
- 2) Insert the tails through the through holes from the inside out. Element ends should be straight at this point.
- 3) Pull them up tight up to the wall of the kiln by pulling from outside the kiln.
- 4) Lay the element into the groove. Note that the unfired element is going to have some springiness to it before it is fired for the first time. You may need to use a screw drive to press the element into the holder. **YOU DO NOT NEED PINS.**
- 5) FOR KILNS WITH NON-CERAMIC TERMINAL BLOCK OR ON RETROFITTED KILNS WHERE YOU HAVE ADDED A CERAMIC TERMINAL BLOCK BUT STILL NEED BUSHINGS: Be sure to replace the insulators and spacers over the element tails.
- 6) Consulting your picture or labeling, wrap the appropriate element tails around the appropriate element connection bolt, clockwise, once around, and cut off the excess tail. If you have the newer large washer system you just need to make a "U" around the bolt and let the large washer do the clamping.

Detail showing the terminal set:



ELEMENT TROUBLESHOOTING & INSTALLATION INSTRUCTIONS

Detail showing all the parts:



Detail showing how all the hardware gets assembled on the Terminal Bolt:



7) Install the elements and hardware:

- a) A washer goes under the first element
- b) Twist the first element end **CLOCKWISE** around the Terminal Bolt.
- c) The next element gets twisted around the Terminal Bolt on top of the first element.
- d) Then another washer goes over the Terminal Bolt.
- e) Then the nut goes over it and get tightened.
- f) Then a washer goes on.
- g) Then the Ring Terminal of the Power Lead Wire goes on.
- h) Then a washer goes on.
- i) Then another nut goes on and gets tightened. How tight you can make this is dependent on how tight you got the element connection bolt onto the element connection board.

A tight connection is very important, but if you tighten too much and twist the element on the bolt too far you could break the element, the bolt, or the insulator.

Detail showing how all the parts for an older style "red board" terminal system for a J2900 kiln:



8) Place the wires from the jumper cord or connecting wires onto the appropriate bolts and tighten with stainless steel nuts.

9). Reattach the ground wires and the element box if the kiln has them. **DO NOT FORGET TO ATTACH GROUND WIRES. IF EACH KILN SECTION IS NOT GROUNDED THIS CAN BE VERY DANGEROUS.**

10) Test the ohms at the jumper cord's plug head or at the other end of the connecting wires.

11) Reattach the control box, turn the kiln on and make sure all the elements come on.

FIRST FIRING WITH NEW ELEMENTS

NOTE: You may experience some smoking from the kiln on its first firing with new elements. This, if it occurs, is due to residual oil left on the element wire when the wire was made. We recommend firing the kiln empty to cone 5 once to oxidize the new elements (no particular speed is necessary) and to seat the new elements in the holders.

REPLACING ELEMENT HOLDERS

See this video: [hotkilns.com/change-element-holder](https://www.hotkilns.com/change-element-holder)

1) When ordering a new holder provide model number of kiln and length of the element holder. See the Parts List for this information.

ELEMENT TROUBLESHOOTING & INSTALLATION INSTRUCTIONS

2) Note that if the holder has melted badly you may need to either replace the brick that holds it or at least patch the brick with our Brick Repair Kit.

Method #1

1) This method leaves the kiln in tact. You break up the holder and remove it in pieces and then modify the new holder to snap into the groove.

2) Using a chisel or large screw driver and a hammer carefully crack the holder that needs to be removed.

Just take your time with this. You can break the holder into little pieces so that it comes out:



The holder shown with about half the job done:



The groove is shown with the holder removed:



Using Linemen's Pliers snap off the BOTTOM edge of the holder



A normal holder compared to one with edge removed:



ELEMENT TROUBLESHOOTING & INSTALLATION INSTRUCTIONS

You can now just snap the new holder into the slot in the firebrick. It will hold in place with no cement:



Method #2

This method requires you to take the kiln sections apart.

- 1) Take the section with the bad holder off the kiln and put it on a flat surface like a flat floor or table.
- 2) Carefully pull the elements out of the element holders of the brick section involved and allow them to hang loose. Take great care not to “break” the element as they are very brittle after firing.
- 4) Loosen up the adjustable clamps that hold the stainless steel wrapping. Loosen them just enough to allow the brick to slide out with slight hand pressure (so that the other bricks stay in place). NOTE: If you don't have the section on a flat surface then the bricks will all come out of proper alignment at this point.
- 5) Pull up the brick with the bad element holder just enough to allow removal of the defective element holder and replace with new one. Slide the bad brick(s) out and put in new brick(s). Be sure the element holders line up with the other holders on either side. Note there is a top and a bottom in the element holder so be sure to get the orientation correct.
- 6) Retighten the clamps on the wrap. Alternately tighten the bottom and top clamp so that you don't cock the stainless casing.

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TROUBLESHOOTING AND FIXING BRICK PROBLEMS

BRICK PROBLEMS

EXCESSIVE BRICK WEAR

1) Excessive brick wear can be the result of various conditions. Most common is improper curing of the brick when first fired. **FOLLOW THE INSTRUCTIONS FOR THE FIRST FIRING AND CURING CYCLE in the OPERATION Section of the instruction manual).**

2) All insulating firebrick expands and contracts when heated and cooled. Over time this will lead to cracking and spalling. Spalling is the continued cracking of the brick which eventually results in large pieces of the brick falling out from the brick section. This is a normal condition as long as the emphasis is on eventually. Factors such as how close the kiln is operated at or near maximum temperature, how often and how fast the kiln is cycled up to heat and then cooled, how heavy the loads are, all figure into the brick wear equation. There is no set rule as to how long a brick lining will last. There are some L&L kilns which are 25 to 40 years old with the original lining still in usable shape.

3) Frequent door openings when the kiln is at high temperatures can cause thermal shock, leading to excessive cracking and spalling.

INSTRUCTIONS FOR USING BRICK REPAIR KIT

To order see: hotkilns.com/brick-repair-kit

GENERAL NOTE: Firebrick is a very fragile material and subject to breakage, spalling and heat shock. The good news is that it is very easy to repair and maintain with the proper materials and techniques. Our Brick Repair Kit has all the materials you will need to do a first class job.

LIST OF BRICK REPAIR KIT MATERIALS

- (1) 3" X 4.5" x 9" K23 Firebrick piece
- (1) 1/2 pint of Brick Cement (in a 1/2 pint container)
- (1) One Quart container of Brick Dust

MIXING A BATCH OF GROUT

The grout should be mixed up JUST prior to use. (Otherwise it will dry out). Mix the ingredients with a small spatula in a container (like a glass jar or plastic cup). Mix in the following:

1/2 cup firebrick dust

1/4 cup water

1 tablespoon Brick Cement

NOTE ABOUT GROUT

The special grout material is firebrick dust mixed with water and a small amount of cement. The cement makes a matrix of the firebrick dust. This compound dries into a material almost exactly like the original firebrick with the same color, consistency, texture and insulating properties.

BRICK REPAIRS

APPLICATION OF BRICK FACING/HARDENER

- 1) Mix water and high temperature cement in a 50/50 mix.
- 2) First brush and vacuum the surface of the brick clean to remove any loose material or crumbling firebrick.
- 3) Next wet the brick surface lightly. Use a paint brush or spray bottle (make sure there is no soap residue in the bottle).
- 4) Then apply a thin coat of this mixture with a soft clean sponge or brush over the surface of the firebrick. Do not make too thick a coat of the hardener or it will spall off. One or two light brushings on wet brick is enough.
- 4) Let the coating dry for 24 hours.
- 5) Run the First Firing Cycle (See the OPERATION Section in your manual).

REPAIRING SMALL HOLES & CHIPS IN BRICK

- 1) Mix water and high temperature cement in a 50/50 mix.
- 2) Brush and vacuum the surface of the brick clean to remove any loose material or crumbling firebrick.
- 3) Next wet the brick surface lightly. Use a paint brush or spray bottle (make sure there is no soap residue in the bottle).
- 4) Apply a very thin coat of brick cement mix (no more than 1/3" to 1/6") all over the hole. Do this with your finger or a small brush.
- 5) Fill hole with the special grout material. Apply grout with a spatula (like plaster.) You can also use your finger. Push it into the hole. It is OK to let it be a rough surface or slightly larger than the hole it is filling.
- 5) Let dry for 24 hours.
- 6) Take some rough sandpaper and sand surface to even it out with the rest of the firebrick.
- 7) Run the First Firing Cycle (See the OPERATION Section in your manual).
- 8) You can brush on hardener or facing afterward if you desire.

TROUBLESHOOTING AND FIXING BRICK PROBLEMS

REPAIRING VERY LARGE HOLES IN BRICK

See this video: [hotkilns.com/repair-brick-front-load](https://www.hotkilns.com/repair-brick-front-load)

- 1) Cut out an area around the brick chip with a small knife, saw or router. The hole that you make should have 90° angles so that a square or rectangular block will fit in the hole.
- 2) Cut a piece of firebrick to fit into this cut out hole. The piece should be slightly smaller than the hole (by about 1/16" to 1/8").
- 3) Both the hole and the brick piece should be brushed and vacuumed clean.
- 4) Wet the brick surface lightly. (Both the hole and the surface of the block that you are going to insert in the hole). Use a paint brush or spray bottle (make sure there is no soap residue in the bottle).
- 5) Apply the High Temp Kiln Cement to the surface of the piece that you are going to put in the hole as well as the hole itself. Use only about 1/32" to 1/16" of an inch of cement. Push the brick plug in hard and move slightly for a second or two to make sure the cement adheres to all surfaces.
- 6) Let dry for 24 hours.
- 7) Sand off excess brick and cement.
- 8) Cover with Brick Facing and allow to dry for another 24 hours.
- 9) Run the First Firing Cycle (See the OPERATION Section in your manual).

FIRST FIRING AFTER REPAIR

(See FIRST FIRING INSTRUCTIONS in the Operation Section). The only difference is that you can fire to a lower temperature because you do not need to reseat the elements. Firing to cone 05 instead of 5 is OK.

The kiln needn't be empty either.

If you have the DYNA-TROL program control fire the following program: Using the "Easy-Fire" mode fire on Slow Bisque to Cone 05 with a PreHeat setting of 3 hours and a hold of 1 hour.

For kilns with the manual control fire the kiln on low (setting #2) for two hours to bake out any moisture. Then set to medium (setting #5) for two hours and then increase enough to reach final temperature. Fire it to cone 05 (1888°F).

CRACKS IN THE LID & BOTTOM

See these videos for bad cracks:

[hotkilns.com/fix-cracks-front-load](https://www.hotkilns.com/fix-cracks-front-load)
and [hotkilns.com/repair-cracked-top](https://www.hotkilns.com/repair-cracked-top)

See this video for hairline cracks:

[hotkilns.com/repair-hairline-cracks](https://www.hotkilns.com/repair-hairline-cracks)

- 1) It is quite normal to get hairline cracks in both the lid and the bottom firebricks.
- 2) They are caused by the expansion and contraction of the firebrick as it heats and cools.
- 3) As long as the bottom is fully supported by the stand the cracks in the bottom will not adversely affect the operation of the kiln.
- 4) The stainless steel clips we use in our lids also help keep these natural cracks from normally becoming a problem in the lids.
- 5) Note that it is possible to put another bottom under the original bottom as a second layer (this can also improve performance and heat up rate of the kiln).
- 8) You can tighten the stainless steel band.

This crack is OK:



TIGHTENING STAINLESS BANDS

See these videos:

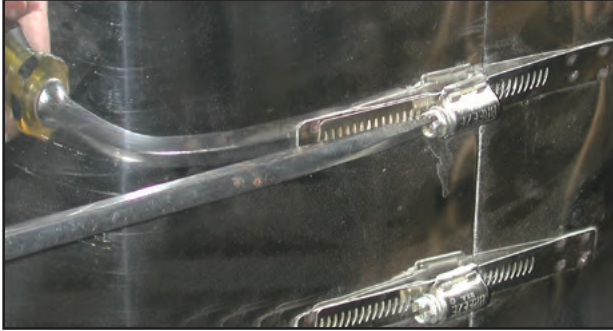
[hotkilns.com/replace-side-brick-kiln](https://www.hotkilns.com/replace-side-brick-kiln)
[hotkilns.com/replace-side-brick-davinci](https://www.hotkilns.com/replace-side-brick-davinci)

- 1) The brick will shrink slightly over time. This is more pronounced when using the kiln at higher temperatures like cone 10. If you only use the kiln for low fire bisque you may never notice this condition.
- 2) If the bricks shrink too much they will become loose.

TROUBLESHOOTING AND FIXING BRICK PROBLEMS

3) Tighten the case by turning the screws of the case clamps. Do this 1/4 of a turn at a time on each of the clamps. Keep a balanced tightening (i.e don't tighten one clamp too much at one time). Slow is good.

Tightening the bands:



4) You can do this on the bands around the top and bottom also. This will help maintain the integrity of those slabs even if there is a crack.

REPLACING FIREBRICK IN SIDES

See these videos:

hotkilns.com/replace-side-brick-kiln

hotkilns.com/replace-side-brick-davinci

1) If you need to replace a firebrick piece in one of the sections do the following. While it does not require a great deal of experience to accomplish it does take time and patience.

2) Order the firebrick precut and prerouted from L&L Kiln. You can order this with the proper element holders already in place or you can reuse the holders from your old brick. Be sure to order it for your specific model kiln. Also, be sure to say whether it is a brick where the element connections come through (because this has different element holders).

3) There are no holes drilled in the brick for either peepholes or element connections. This has to be done in the field.

4) Take the section off the kiln and put it on a flat surface like a flat floor or table. Elements will have to be removed and probably replaced. If the elements are old they will be brittle. They may break so be prepared to get new elements.

5) Loosen up the adjustable clamps that hold the stainless steel wrapping. Loosen them just enough to allow the brick to slide out with slight hand pressure (so that the other bricks stay in place). NOTE: If you don't have the section on a flat surface then the bricks will all come out of proper alignment at this point.

6) Slide the bad brick(s) up and out and put in new brick(s). Be sure the element holders line up with the other holders on either side. Note there is a top and a bottom in the element holder so be sure to get the orientation correct.

7) Retighten the clamps on the wrap. Alternately tighten the two or three clamps (about a 1/4 or 1/2 turn at a time) so that you don't cock the stainless casing.

8) Sand off the top surface of the firebrick to match the surface of the other firebricks. Sandpaper will work fine. Reface with Brick Facing.

9) You can see this action in this video:

hotkilns.com/replace-side-brick-kiln

DRILLING HOLES FOR PEEPHOLES

1) Some of the bricks that you may need to replace will need to have holes drilled in them in the field. These holes can not be drilled in the factory because the alignment would not be perfect.

2) To drill out for peepholes use a 1" diameter drill bit or hole saw. You can also drill with a smaller drill and then file out with a round hasp type file. Drill slowly through the firebrick using the prepunched hole in the stainless steel. You may have to remove the bit several times and clean it out as you drill deeper. **It is a good idea to have someone help you by watching from the side to make sure you are drilling straight. It is hard to see this when you are doing the drilling.**

3) For sections that have two element rows: the hole is drilled perpendicular to the stainless case.

4) For sections that have three element rows: the hole is not drilled at a perfect 90° perpendicular angle to the kiln case. It will be drilled at a slightly down angle (about 5° to 7°). This is to miss the element holders.

5) Before drilling, as a precaution, you can measure down from the top of the brick to the top of the existing hole in the stainless steel case. This measurement on the inside will show you where the top of the drill bit will protrude. Adjust your angle of drilling accordingly.

Drilling the peephole:



TROUBLESHOOTING AND FIXING BRICK PROBLEMS

DRILLING ELEMENT CONNECTIONS

- 1) Use a 1/8" to 3/16" diameter drill bit and drill out from the center of the hole in the stainless steel case. Do this slowly with a speed control.
- 2) Do this perpendicular to the case.

REPLACING BOTTOMS

- 1) Remove the kiln sections.
- 2) Take the old bottom off the stand.
- 3) Put the new bottom on the stand.
- 4) Relevel the kiln. (This is important).
- 5) Replace the kiln sections.

NOTE: You may want to experiment with using the old bottom as a secondary back up bottom if it is not too badly damaged. Just make sure it is totally flat so that it doesn't crack the new bottom. Some people find that having this extra insulation thickness helps firing times and bottom uniformity.

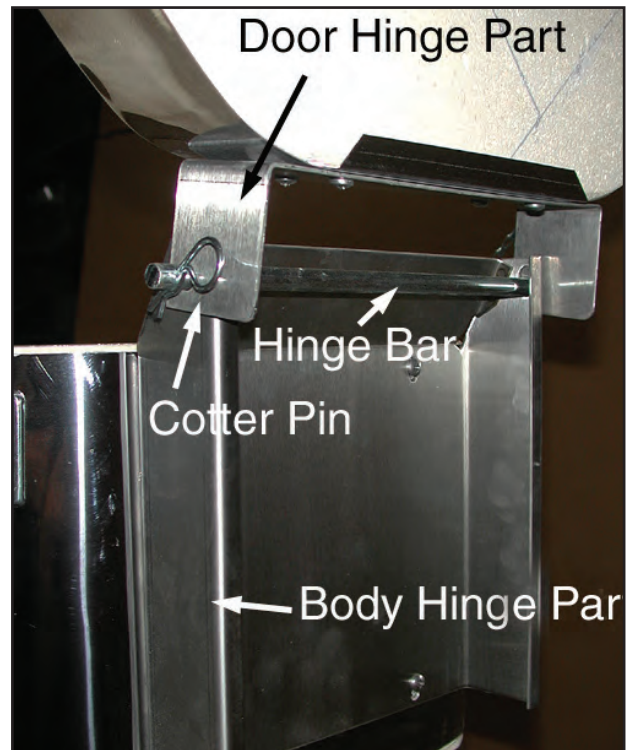
REPLACING EASY-LIFT LIDS

- 1) Remove the Hinge Pin and take the old top off the kiln. See the Assembly Instructions for guidance if you have questions about how to do this. Use the Hinge Tool to take the tension off the spring. **BE SURE TO USE SAFETY GLASSES - THERE IS A LOT OF TENSION ON THE SPRING AND INJURY COULD RESULT.**
- 2) Remove the Top Hinge Part from the old lid. Note that there are three parts to this. There is the main Top Hinge Part. Then there is the Front Hinge Part (the little 3" x 4" aluminized steel plate with a small hole that gets attached to the front of the top with the screws for the Handle). Then there is the Handle. Note that the hole in the Front Hinge Part should be centered around the little stud that protrudes from the Top Hinge Part.
- 3) Using the old top as a guide, install the Top Hinge Part onto the new lid.
- 4) Reinstall the top and reset the spring. See the Assembly Instructions if you have questions about how to do this.
- 5) See this video: hotkilns.com/replace-easy-fire-lid

REPLACING SMALL NON-SPRING HINGE LIDS

- 1) Remove one of the Cotter pins from the Hinge Bar.
- 2) Pull out the Hinge Bar.
- 3) Unscrew the chains from the stainless steel case of the lid.
- 4) Remove the Top Hinge Part from the old lid.

A simple hinge with parts marked



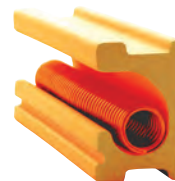
- 5) Using the old top as a guide, install the Top Hinge Part onto the new lid.
- 4) Reinstall the top.

REPLACING DAVINCI LIDS

See this video: hotkilns.com/replace-davinci-lid

DAVINCI INSTRUCTION MANUAL

SERVICE
& WARRANTY



L&L Kiln's patented
hard ceramic
element holders
protect your kiln.

SERVICE FOR L&L KILNS

IN GENERAL

SERVICE FOR YOUR KILN

L&L kilns are designed to be as easy to work on and fix as possible. This is one of the great advantages of L&L kilns.

TROUBLESHOOTING GUIDE

Check out the "Support" section of our web site, **hotkilns.com** for all of our troubleshooting references. We are constantly adding to our troubleshooting guides and the web site has the most up-to-date information on it. Also try the search engine on our website with your question.

THE MOST COMMON ERROR MESSAGES AND WHAT TO DO ABOUT THEM

Error 1, Err1: **hotkilns.com/e1**

Error D, ErrD: **hotkilns.com/e-d**

All Error messages on the DynaTrol:
hotkilns.com/error-codes

Adjusting and Calibrating the DynaTrol for More Accurate Firing: **hotkilns.com/calibrating-kiln**

What to do if the kiln fires slowly?: **hotkilns.com/slow-kiln**

YOUR LOCAL RESELLER

Call your local reseller, most of whom service the kilns they sell. If they don't they may be able to direct you to a local kiln service person.

OTHER KILN REPAIR PEOPLE

Search for a local kiln service person online or try your local yellow pages. L&L may also be able to recommend a local service person. We maintain a listing of kiln service people around the country. If you can't find a person experienced specifically in kiln repair, then a good electrician is often more than adequate to repair most problems that commonly occur.

REMOVABLE CONTROL PANELS

Some of the more difficult problems occur within the control panel. One of the unique features of most L&L kilns is the easy ability to remove this panel and send it back to the factory for inspection and/or repair. Call the factory for details on your kiln.

CUSTOMIZED TECHNICAL SUPPORT

To get technical support from L&L Kilns please send an email to service@hotkilns.com

Include in your email the following important information:

1. Your name.
2. Your organization name.
3. The Serial Number, Model Number and Voltage information from your Data Nameplate.
4. Your phone number and possible times to reach you during business hours.
5. A description of the problem you are having and anything you have done so far to troubleshoot it.

6. Send Photos!

You will get prompt, effective, and detailed expert answers. We are committed to answering service emails within one business day but normally they are answered far more quickly. If you need a phone call we can help you better if we have this information before we call.

Note about element resistance values: You can find the proper ohms for your elements on the wiring diagram which comes with your instruction manual.

PREPARING FOR A TECHNICAL SUPPORT PHONE CALL

Get Your Wiring Diagram

Be sure to get your wiring diagram if you don't have it. You can get this emailed free from our office if you know your model number, serial number and voltage. This is the key to understanding what is happening electrically and it makes a great visual reference to share with the tech support department over the phone.

Get A Multimeter

Get a "Digital Multimeter". Digital Multi-meters are inexpensive. For around \$50 or less you can get one at a place like Amazon or Home Depot. Get one that can test at least 250 volts AC and 28 volts DC, also ohms from 0 to 200, and is able to show at least the tenths decimal place for accuracy.

If You Need An Electrician

Sometimes you may need get an electrician or experienced person, to test live electricity if you cannot. If you get someone to provide on-site service, the kiln must be hot

SERVICE FOR L&L KILNS

and exhibiting its problem when they test it. Sometimes it is difficult to coordinate the electrician, a hot kiln, and our technical support on the phone all at the same time, but it can be necessary to make the most of the electrician's time, and to fix the kiln in a timely fashion. It is usually best also to discuss with our technical support department the date and approximate time an electrician is expected to arrive.

Be Aware Of Limitations

As a practical matter the technical support staff is limited by the fact that we are at a distance from your kiln, communicating by email or telephone and are often working with you through multiple sessions to fix your kiln's problem. We rely heavily on your accurate and complete description of the problem, and your responses to our questions. We rely on you to remember where we are in the process of fixing your kiln each time we talk. (Email is easier because there is a recorded thread of communication).

Application Support

Resellers often offer a degree of application support. For instance if you are having problems with firing your work the first place to go for answers is the people who supply your clay and glazes. We offer some application support on this web site but it is minimal. Generally, this is outside the scope of our service. Look at the External Links for many great sites that can help you.

Be Comprehensive And Proactive

We have found through long experience that is best when trouble starts to replace all of a certain part. If your elements are old and one burns out – change the whole set of elements. The same is true for thermocouples, thermocouple wires, element terminal screws, power cords, and contactors. Do not expect control panel components to reliably perform after 15 or 20 years. The heat of kilns causes unavoidable oxidation of electrical components - some that you can't see. Kilns need to be rebuilt occasionally. Changing JUST the part that is causing the immediate problem is just asking for more trouble in short order.

WHERE TO BUY PARTS

You can order parts through your local reseller or directly from the factory. L&L stocks almost all parts we sell including elements. We normally ship within one to three days although some parts do take longer. Most parts are listed at hotkilns.com/parts.

FREE LIFETIME SUPPORT IS CONTINGENT ON THE USE OF L&L FACTORY PARTS. USE OF NON-L&L PARTS WILL VOID THE WARRANTY.

WHAT WE CAN'T DO

We can not give you advice over the phone on hooking up your kiln to your electrical system. You must have a qualified electrician who can physically see what your specific electrical situation is and who understands any local codes.

SELECTING AN ELECTRICAL CONTRACTOR

A quality electrical contractor:

1. Complies with state and local codes and regulations.
2. Carries the proper business and workers compensation insurance.
3. Is knowledgeable on a wide range of new equipment, technology and design procedures.
4. Has a local facility, and is willing to have you visit.
5. Is prompt and courteous and provides fast, reliable service -- attempting to perform service at your convenience.
6. Is neat and well groomed. This neatness should be reflected in their vehicles and offices as well as their personal appearance.
7. Provides a detailed written proposal, clearly outlining the work to be done and the agreed upon cost, including labor and materials. Make sure you understand every word of any contract before you sign it.
8. Asks in detail about any problems and offers understandable solutions.

CONSIDER THE FOLLOWING

1. Ask for references. Find out if other customers were satisfied. Check with the local Better Business Bureau regarding any filed complaints.
2. Compare price. Get bids from a few contractors. Make sure you give each contractor the same specifications and materials needed for the job.
3. Remember! How a company treats you now reflects how they will treat you if there's a problem. A quality electrical contractor listens to your problems, understands what you want accomplished and is willing to follow up after the work is completed.

STANDARD LIMITED THREE YEAR WARRANTY FOR L&L KILNS

THREE YEAR LIMITED KILN WARRANTY

L&L Kilns are warranted to be free of defects in workmanship for a period of three (3) years, starting on the date of original purchase from L&L Kiln Mfg., Inc. (L&L) or from an authorized L&L reseller, subject to the following terms and conditions, including but not limited to, the exclusions and limitations set forth herein.

1. A sales receipt may be required for proof of purchase.
2. In addition, L&L may require you to deliver defective parts to L&L for examination to determine the applicability of these warranty provisions. *Do not discard parts before contacting L&L for instructions. Failure to adhere to L&L's instructions, including those contained in the instruction manual and as stated herein, will void this warranty.*
3. L&L will replace or repair any defective part that is covered by this warranty and sent freight-prepaid to L&L. L&L will prepay return shipping cost without charge in the Continental United States. Shipping outside the Continental United States is at cost.
4. On-site labor is not part of this warranty and is not covered by L&L. Any warranty labor provided by resellers is provided at their own discretion and expense.
5. Warranty is not valid for second-hand or damaged kilns that are sold by unauthorized sellers.
6. Any modifications to the original kiln by anyone other than the factory or someone specifically authorized in writing by the factory will void the warranty. Any modification is made solely at the risk of the customer. L&L takes no responsibility for hazardous conditions created by unauthorized modifications.

APPLICATION

Applies to Easy-Fire, Jupiter, Davinci, Doll/Test, JH Series, Quad-Pro kilns, eFL Series and Fuego kilns when used for ceramics and glass.

EXCLUSIONS AND LIMITATIONS

The following are examples of items that are not covered by and/or circumstances that will void L&L's warranties:

1. **Use of elements and/or other parts other than genuine L&L Kiln parts.**

2. Kiln warranty may be voided by firing materials that introduce harmful atmospheres into the kiln. Atmospheres containing carbon, reducing atmospheres (caused, for example, by introducing carbonaceous gasses or solids like graphite or paper into the kiln), binders from lustres and decals, wax burn out effluents, fluorines, halogens, acids, metal oxides, and salts are some of the corrosive and harmful atmospheres that will damage a kiln. Most ceramic processes will release some of these harmful constituents into the kiln and venting will prevent most of the problems that those processes would cause. Also, depending on the concentration of the harmful gasses, kiln source ventilation (such as our Vent-Sure) may limit the damage to the kiln. It is the customer's sole responsibility to ensure that the materials and the processes used are not harmful. This is of particular importance for industrial uses where processes may be unusual.
3. Over-firing damage for any reason and regardless of cause. **IMPORTANT: We specifically warn you not to fire the kiln unattended. Neither the DynaTrol, Genesis, One-Touch control, nor any other electronic control used by L&L is designed to be a failproof shut off device. L&L is not responsible for damage caused by failure of any of these controls.**
4. Controls made by Orton, Future Controls, Eurotherm, Honeywell or other manufactures are warranted by their manufacturers. L&L is not responsible for damage caused by failure of one of these controls.
5. Also note that it is easy to melt clay if you inadvertently fire it hotter than its rating. It is possible in some controls to limit the upper firing limit of the kiln to avoid accidental overfirings of this type. Contact factory or read your control instruction manual if you would like further information on this.
6. Firebrick by its nature is fragile and will chip, crack, and create dust. L&L designs its kilns to minimize the effects of this but can not warrant against cracking, breakage, spalling or dusting. There is specifically no warranty for cracked arches, tops, lids or bottoms.
7. Corrosion of the case is specifically not warranted. Corrosion is typically due to use of a kiln in an unheated outside shed (where morning dew condenses on the kiln and humidity attacks the kiln) or from an unvented kiln (where the water vapor and fumes generated by firing ceramic materials attack the kiln case). However, even a vented kiln can corrode due to all the

STANDARD LIMITED THREE YEAR WARRANTY FOR L&L KILNS

environmental and process conditions that a kiln can be exposed to. Exposure to other ambient conditions, including but not limited to humidity, rain, snow, dust, and salt air will also cause corrosion.

8. Damage due to neglect, inadequate room or kiln ventilation, mechanical abuse, improper storage, inadequate maintenance, improper use or freight damage.
9. Damage to the elements or element holders due to failure to properly keep the kiln clean (i.e. allowing glaze or ceramic chards from exploding pots) to make contact with the element holders.
10. Damage to the kiln caused for firing in ambient conditions that are too hot for the control or other components in the kiln. The DynaTrol or Genesis is rated for use up to 125°F (52°C). That means that the room that you fire in should be less than 100°F (38°C) (because the control will be slightly hotter than room air due to transferred heat from the kiln). Note that direct sunlight on the control face may raise the temperature of the board beyond what you would expect from the ambient temperature or the kiln heat. Also note that the DynaTrol specifically allows the operator to check the control board temperature.
11. Failure to report defect within fifteen (15) days after it becomes manifest or known.
12. Any alteration of parts or design that vary from factory designs.
13. Thermocouple Protection Tubes are not warranted against breakage.
14. L&L's warranty is strictly limited to repair or replacement of defective items. Kilns may not be returned.
15. Resellers are not authorized by L&L to modify and/or assume any other obligations or liabilities other than those expressed in this limited warranty and any such additional obligations are null and void.
16. EXCEPT AS SPECIFICALLY WARRANTED HEREIN, KILNS ARE SOLD AS IS. L&L MAKES NO OTHER WARRANTY, EXPRESS OR IMPLIED, COVERING THE GOODS AND SPECIFICALLY DISCLAIMS ALL IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. Purchaser acknowledges that certain conditions or circumstances may be created or incurred by Purchaser or user or over which L&L has no control, including, but not limited to, climactic conditions, improper use, inadequate maintenance, and Purchaser, as a

condition of purchase or use, assumes responsibility for and releases L&L from liability arising out of the use of the kilns attributable to such causes.

17. L&L SHALL NOT BE LIABLE FOR ANY INCIDENTAL, SECONDARY, OR CONSEQUENTIAL DAMAGES, INCLUDING BUT NOT LIMITED TO BODILY INJURY OR DEATH, LOST PROFITS, LOSS OF USE, OR OTHER ECONOMIC LOSSES. Purchaser agrees that L&L's total liability for any damages or remedies arising hereunder shall be limited to direct damages, in an amount not exceeding the purchase price actually paid. Replacement or repair or refund, at L&L's sole discretion, of the purchase price of the equipment purchased shall constitute the exclusive and sole remedy available to Purchaser. Any action for breach of contract or negligence must be commenced by Purchaser within 6 months after delivery of the equipment to Purchaser.
18. L&L's full Terms and Conditions of Sale are available at hotkilns.com/terms.

3 YEAR PRO-RATED ELEMENT & THERMOCOUPLE LIMITED WARRANTY

Elements and thermocouples are warranted for three (3) years on a pro-rated basis with the following exceptions:

1. Glaze damage to the elements caused by accidentally scraping edges of unfired glazed ware against element groove. WARNING: causing unfired glaze to contaminate element will damage elements and can lead to element failure, and creates a fire hazard.
2. Firing of kiln to a temperature that exceeds the lower of either the maximum rating of kiln or 2350°F (1290°C).
3. Damage to elements caused by explosion of ceramic object. WARNING: this may cause damage to the elements and can lead to element failure, and creates a fire hazard.
4. **Elements are warranted on a prorated schedule based on the ship date of the kiln.** All dates are based on ship date from factory if sold direct or drop shipped to customer. If sold from a reseller's warehouse the date would be based on when it was shipped and/or sold from the reseller. The warranty is not extended for any period of where operation of the kiln is delayed for shipping, warehousing, or other reasons.

STANDARD LIMITED THREE YEAR WARRANTY FOR L&L KILNS

5. Labor to replace elements is not covered.
6. **The pro-rated discount schedule only is valid for elements that you are actually replacing.** In other words you can't buy a whole set of elements at these prices for anticipated future replacement. We reserve the right to ask for replaced elements in return.
7. This replacement schedule is limited to new kilns.

PRO-RATED SCHEDULE FOR KILNS THAT DO HAVE A VENT-SURE INSTALLED

Date from time of shipment from factory	Price of thermocouples and elements
0-12 Months	No Charge
12-24 Months	25% of full list price
24-36 Months	50% of full list price

PRO-RATED SCHEDULE FOR ALL KILNS THAT DO NOT HAVE A VENT-SURE INSTALLED AND ALL JH SERIES KILNS

JH KILNS

The pro-rated schedule for elements for the JH series kilns varies because of the hard use these kilns get during the crystalline glaze firing process.

KILNS WITHOUT VENTS

In kilns used without an automatic Vent-Sure, the elements will corrode a lot quicker than normally and fail more quickly and this pro-rated schedule takes this into account. NOTE: The vent on the kiln must be an L&L Vent-Sure downdraft vent or this exclusion will apply even with a vent made by other companies.

Date from time of shipment from factory	Price of thermocouples and elements
0-6 Months	No Charge
6-12 Months	25% of full list price
12-24 Months	50% of full list price

3 YEAR LIMITED VENT WARRANTY

L&L VS-1 Vent-Sure is warranted to be free of defects in workmanship for a period of (3) years, starting from date of original purchase from L&L Kiln Mfg., Inc. or from an authorized L&L reseller. A sales receipt is required for proof of purchase. In addition, L&L may require you to send in defective parts for examination to determine the applicability of these warranty provisions. DO NOT DISCARD PARTS BEFORE CONTACTING L&L. L&L Kiln Mfg., Inc. will replace or repair any defective part sent freight-prepaid to L&L Kiln Mfg., Inc. following L&L's written acknowledgement and authorization regarding the specific issue. L&L Kiln Mfg., Inc. will prepay return shipping cost without charge in the Continental United States. On site labor is not covered by the factory; however, local resellers or dealers may offer this service.

EXCLUSIONS & LIMITATIONS

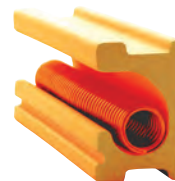
1. The Vent-Sure must be used as instructed in our vent instructions.
2. The use of any wax process that might cause condensation of wax or other similar substance in the vent system will void the warranty.
3. The Vent-Sure is not warranted to vent highly corrosive fumes, and any such use will void any warranties otherwise provided.

PARTS WARRANTY

1. L&L does not warrant replacement elements and thermocouples except for catastrophic failure (for instance, a situation where the element end broke off without fault of the operator).
2. Parts (aside from elements and thermocouples) are warranted for ninety (90) days from time of shipment. Complete control panels are warranted for one (1) year from time of shipment. Warranty is for replacement or repair only and does not include labor.

DAVINCI INSTRUCTION MANUAL

PARTS



L&L Kiln's patented
hard ceramic
element holders
protect your kiln.

PARTS FOR ALL KILNS (ONLINE DATABASE)

PARTS LIST

A comprehensive and up-to-date listing of parts that pertain to all Kiln Series' built by L&L Kiln Mfg., Inc. can be found on our website at: hotkilns.com/parts

DATA NAMEPLATE

Have the Nameplate Information

You can get Model Number, Serial Number and voltage information about your kiln from the Data Nameplate affixed to your kiln. You will typically find this on the control panel. Please have this available when ordering parts. It helps us make sure you are getting the proper parts!

This is a Data Nameplate that you will find on your kiln. Obtain the Serial Number, Model Number, Voltage, Phase, Amps and Watts from this nameplate.



If you cannot find the data nameplate

If the nameplate has come off your kiln we can help you determine the model number by the number of ring sections and the diameter of the rings. You will need to know your voltage by checking your line voltage with a voltmeter. Most household voltage in the United States is 240 volts single phase. Industrial, commercial and institutional locations often have 208 volts and may be either three phase or single phase. THIS NEEDS TO BE KNOWN! Check with an electrician if you aren't sure.

HOW TO ORDER PARTS

Delivery Times for Parts

We ship most parts such as elements, kiln shelves and posts, switches and other electrical items, and ceramic parts usually very quick. See each part number on the website for specific lead times.

How to Place an Order

You can place an order by phone or by using the handy order form in the back of this parts list. This order form can be faxed to 856.294.0070. Be sure to include your Visa or Mastercard number and expiration date, three digit verification code, your name, phone number and correct shipping address. For more information see: hotkilns.com/ordering-parts

Payment

Most customers pay by Visa, Mastercard or American Express. For more information see: hotkilns.com/payment

Shipment

Most parts ship by UPS. Unless you specify we choose the carrier based on the cheapest price. You can specify overnight or second day shipment or Saturday delivery. Kiln sections and tops and bottoms must ship by motor freight. for more information see: hotkilns.com/shipping-policy

Packing Charges

For packing and crating charges see: hotkilns.com/shipping-policy. UPS, USPS or FedEx shipping charges are billed at cost.

Returning Parts

Some parts are returnable; some are custom and cannot be returned. The policy for each part is listed on the page for that part. For the general policy see: hotkilns.com/return-parts

Sales Tax

For where we collect sales tax and for sales tax exemption policies see: hotkilns.com/sales-tax

FAX ORDER FORM FOR L&L KILNS AND PARTS

Fax to 856.294.0070

ORDERED BY:

Date: _____

Company _____

Name _____

Street Address _____

City _____

State _____ Zip/Postal Code _____

Day Phone _____

Fax: _____

Email: _____

SHIP TO: (if different from "ORDERED BY")

Company _____

Name _____

Street Address _____

City _____

State _____ Zip/Postal Code _____

Day Phone _____

Fax: _____

Email: _____

QTY	ITEM NO.	VOLTS	DESCRIPTION	AMOUNT	TOTAL

PAYMENT METHOD:

☐ Purchase Order: _____
 Purchase Orders must have preapproved credit with L&L.

☐ Visa ☐ Mastercard ☐ AmerExp ☐ Discovery

CHARGE TO:

Card Account Number _____

Name on Card _____

Issuing Bank _____

CSV (3 Digit V-Code on back of Card) _____

Expiration Date _____

Customer Signature _____

Merchandise Total:		
6% sales tax for shipments to PA or NJ: (unless accompanied by a sales tax exempt form):		
Standard Packing & Handling Charge (See below. To be filled in by L&L)		
UPS, Fed X or Common Carrier Charges. (To be filled in at time of shipment. Based on Actual Cost.)		
TOTAL:		

To be filled out by L&L

PLEASE PROVIDE THIS TECHNICAL INFORMATION

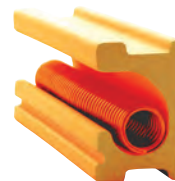
MODEL# _____

SERIAL# _____

VOLTS: _____ PHASE: _____

DAVINCI INSTRUCTION MANUAL

SAFETY DATA
SHEETS



L&L Kiln's patented
hard ceramic
element holders
protect your kiln.

SAFETY DATA SHEET

Following Regulation 1910.1200

SDS Number: 151-1 Date of first issue: 28 March 1995 Date of last revision: 08 June 2021

1 - Identification of product

a - Product identifier used on the label

Tradenames: IFB 23 Tile, Insalcor, Isolmos 450, Isolmos 550, JM-20, JM-23, JM-23US, JM-26, JM-28, JM-30, JM-32, K-20, K-23, K-24, K-25, K-26, K-28, K-30, SR-90, TC-23, TC-26, TJM-26, TJM-28,

b - Other means of identification

INSULATING REFRACTORY BRICK

c - Recommended use of the chemical and restrictions on use

High Temperature Thermal Insulation

d - Name, address, and telephone number

Morgan Advanced Materials
P. O. Box 923; Dept. 300
Augusta, GA 30903-0923
Telephone: 706-796-4200

e - Emergency Phone Number

For Product Stewardship and Emergency Information:
Hotline - 1-800-722-5681
Fax - 706-560-4054

For additional SDSs and to confirm this is the most current SDS for the product, visit our web page www.morganthermalceramics.com or send a request to MT.NorthAmerica@morganplc.com

2 - Hazard Identification

a - Classification of the chemical in accordance with paragraph (d) of §1910.1200

The U.S. Occupational Safety and Health Administration (OSHA) Hazard Communication Standard (HCS) 2012 indicates that IARC Group 1 corresponds to OSHA HCS 2012 Category 1A carcinogen classification (see, e.g., §1910.1200, Appendix F, Part D).

b - Signal word, hazard statement(s), symbol(s) and precautionary statement(s) in accordance with paragraph (f) of §1910.1200

Under OSHA HCS 2012, crystalline silica (inhaled in the form of quartz or cristobalite from occupational sources) is classified as a GHS category 1A - Known human carcinogen.

Hazard Pictograms



Signal Words

Danger

Hazard Statements

May cause cancer by inhalation.

Precautionary Statements

Do not handle until all safety instructions have been read and understood.
Use respiratory protection as required; see section 8 of the Safety Data Sheet.
If concerned about exposure, get medical advice.
Store in a manner to minimize airborne dust.
Dispose of waste in accordance with local, state and federal regulations.

Emergency Overview

Respirable dust from these products may contain crystalline silica, which is known to cause respiratory disease.
(See Section 11 for more information)

c - Describe any hazards not otherwise classified that have been identified during the classification process

d - Mixture Rule

Not applicable.

3 - Composition / Information On Ingredients

a - Composition table

COMPONENTS	CAS NUMBER	% BY WEIGHT
Ceramic Matrices (consist of glass, mullite and anorthite)	NONE	95 - 99
Crystalline Silica	14808-60-7 or 14464-46-1	Up to 5

b - Common Name

(See Section 8 "Exposure Controls / Personal Protection" for exposure guidelines)

d - Impurities and Stabilizing Additives

Not applicable.

4 - First-Aid measures

a - Description of necessary measures, subdivided according to the different routes of exposure, i.e., inhalation, skin and eye contact, and ingestion

Eyes

Flush with large amounts of water for at least 15 minutes. Do not rub eyes.

Skin

Wash affected area gently with soap and water. Skin cream or lotion after washing may be helpful.

Respiratory Tract

Remove affected person to dust free location. See Section 8 for additional measures to reduce or eliminate exposure.

Gastrointestinal

Unlikely route of exposure.

c - Indication of immediate medical attention and special treatment needed, if necessary

5 - Fire-fighting measures

a - Suitable (and unsuitable) extinguishing media and

Use extinguishing media suitable for type of surrounding fire

c - Special Protective Equipment and Precautions for Firefighters

NFPA Codes: Flammability: 0 Health: 1 Reactivity: 0 Special: 0

b - Specific hazards arising from the chemical (e.g., nature of any hazardous combustion products):

None

6 - Accidental Release Measures

a - Personal precautions, protective equipment, and emergency procedures

Avoid creating airborne dust. Follow routine housekeeping procedures. Vacuum only with HEPA filtered equipment. If sweeping is necessary, use a dust suppressant and place material in closed containers. Do not use compressed air for clean-up. Personnel should wear gloves, goggles and approved respirator.

b - Methods and materials for containment and cleaning up

Pick up large pieces and dispose in a closed container. Follow precaution stated in above section for clean up.

7 - Handling and storage

a - Precautions for safe handling

Limit the use of power tools unless in conjunction with local exhaust. Use hand tools whenever possible. Frequently clean the work area with HEPA filtered vacuum or wet sweeping to minimize the accumulation of debris. Do not use compressed air for clean-up.

b - Conditions for safe storage, including any incompatibilities

Store in a manner to minimize airborne dust.

c - empty containers

Product packaging may contain residue. Do not reuse.

8 - Risk Management Measures / Exposures Controls / Personal Protection

a - OSHA permissible exposure limit (PEL), American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV), and any other exposure limit used or recommended by the chemical manufacturer, importer, or employer preparing the safety data sheet, where available

EXPOSURE GUIDELINES			
MAJOR COMPONENT	OSHA PEL	ACGIH TLV	MANUFACTURER'S REG
Crystalline Silica	0.05 mg/m ³ (1)	0.025 mg/m ³ (respirable dust)	NONE
(1) OSHA new Permissible Exposure Limit (PEL) for respirable crystalline silica is 0.05 mg/m ³ (8-hr TWA), an Action Level (AL) of 0.025 mg/m ³ (8-hr TWA), together with associated ancillary requirements listed under General Industry and Maritime Standard (29 CFR 1910.1053) and Construction Standards (29 CFR 1910.1153).			
<u>OTHER OCCUPATIONAL EXPOSURE LEVELS (OEL)</u> Ontario Canada OEL - Silica, Crystalline: Quartz/Tripoli = 0.1 mg/m ³ (R); Cristobalite = 0.05 mg/m ³ (R). Industrial hygiene standards and occupational exposure limits vary between countries and local jurisdictions. Check which exposure levels apply to your facility and comply with local regulations. If no regulatory dust or other standards apply, a qualified industrial hygienist can assist with a specific workplace evaluation including recommendations for respiratory protection.			

b - Appropriate Engineering Controls

Use engineering controls, such as ventilation and dust collection devices, to reduce airborne particulate concentrations to the lowest attainable level.

c - Individual protection measures, such as personal protective equipment

PPE - Skin

Wear full body clothing, gloves, hat, and eye protection as necessary to prevent skin irritation. Washable or disposable clothing may be used. If possible, do not take unwashed work clothing home. If soiled work clothing must be taken home, employers should ensure employees are trained on the best practices to minimize or avoid non-work dust exposure (e.g., vacuum clothes before leaving the work area, wash work clothing separately, rinse washer before washing other household clothes, etc.).

PPE - Eye

As necessary, wear goggles or safety glasses with side shields.

PPE – Respiratory

When it is not possible or feasible to reduce airborne crystalline silica or particulate levels below the appropriate PEL/OEL through engineering controls, or until they are installed, employees are encouraged to use good work practices together with respiratory protection. Before providing respirators to employees (especially negative pressure type), employers should 1) monitor for airborne crystalline silica and/or dust concentrations using appropriate NIOSH analytical methods and select respiratory protection based upon the results of that monitoring, 2) have the workers evaluated by a physician to determine the workers' ability to wear respirators, and 3) implement respiratory protection training programs. Use NIOSH-certified particulate respirators (42 CFR 84), in compliance with OSHA Respiratory Protection Standard 29 CFR 1910.134 and 29 CFR 1926.103, for the particular hazard or airborne concentrations to be encountered in the work environment. For the most current information on respirator selection, contact your supplier.

9 - Physical and chemical properties

a - Appearance	Solid Brick or Block
b - Odor	Not applicable
c - Odor Threshold	Not applicable
e- pH	Not applicable
d - Melting Point	2750°F to 3660°F (refer to specific product data sheets)
f- Initial Boiling Point/Range	Not applicable
g- Flashpoint	Not applicable
h - Evaporation Rate	Not applicable
i - Flammability	Not applicable
j - Upper/Lower Flammability or Explosive Limits	Not applicable
k - VAPOR PRESSURE	Not applicable
l - VAPOR DENSITY	Not applicable
m - Solubility	Not soluble in water
n - Relative Density	Not applicable
o - Partition Coefficient: n-Octanol/water	Not applicable
p - Auto-ignition temperature	Not applicable
q - Decomposition Temperature	Not applicable
r - Viscosity	Not applicable

10 - Stability and Reactivity

a - Reactivity

None.

b - Chemical Stability

This is a stable material.

c - Possibility of Hazardous Reaction

Will not occur.

d - Conditions to Avoid

None

e - Incompatible Materials

Powerful oxidizers; fluorine, manganese trioxide, oxygen disulfide

f - Hazardous decomposition products

None

11 - Toxicological information

a - TOXICOKINETICS, METABOLISM AND DISTRIBUTION

Dust samples from these products have not been tested. They may contain respirable crystalline silica.

b - Acute Toxicity

c - Epidemiology

No studies have been undertaken on humans exposed to these products in occupational environments.

Crystalline silica

Exposure to crystalline silica can cause silicosis, and exacerbate pulmonary tuberculosis and bronchitis. IARC (Monograph vol. 68, 1997) concluded that "crystalline silica from occupational sources inhaled in the form of quartz or cristobalite is carcinogenic to humans (Group 1)", and noted that "carcinogenicity in humans was not detected in all industrial circumstances studied" and "may be dependent on inherent characteristics of the crystalline silica or on external factors affecting its biological activity".

d - Toxicology

Crystalline silica

Some samples of crystalline silica administered to rats by inhalation and intratracheal instillation have caused fibrosis and lung cancer. Mice and hamsters, similarly exposed, develop inflammatory disease including fibrosis but no lung cancer.

International Agency for Research on Cancer and National Toxicology Program

IARC, in 1997, Monograph v.68, classified crystalline silica inhaled in the form of quartz or cristobalite from occupational sources is carcinogenic to human (group 1).

The Ninth Annual Report on Carcinogens (2000), prepared by the National Toxicology Program (NTP), classified silica, crystalline (respirable size), as a substance known to be a human carcinogen.

12 - Ecological information

a - Ecotoxicity (aquatic and terrestrial, where available)

These products are not reported to have any ecotoxicity effects.

c - Bioaccumulative potential

No information for the product.

d - Mobility in soil

No information for the product.

e - Other adverse effects (such as hazardous to the ozone layer)

No information available for the product.

13 - Disposal Considerations

Waste Management and Disposal

To prevent waste materials from becoming airborne during waste storage, transportation and disposal, a covered container or plastic bagging is recommended.

Additional information

This product, as manufactured, is not classified as a listed or characteristic hazardous waste according to U. S. Federal regulations (40 CFR 261). Any processing, use, alteration or chemical additions to the product, as purchased, may alter the disposal requirements. Under U. S. Federal regulations, it is the waste generator's responsibility to properly characterize a waste material, to determine if it is a "hazardous" waste. Check local, regional, state or provincial regulations to identify all applicable disposal requirements.

14 - Transport information

a - UN number.

Hazard Class: Not Regulated United Nations (UN) Number: Not Applicable
Labels: Not Applicable North America (NA) Number: Not Applicable
Placards: Not Applicable Bill of Lading: Product Name

b - UN proper shipping name

Not applicable.

c - Transport hazard class(es)

Not applicable.

d - Packing group, if applicable

Not applicable.

e - Environmental hazards (e.g., Marine pollutant (Yes/No))

No.

f - Transport in bulk (according to Annex II of MARPOL 73/78 and the IBC Code)

Not regulated.

g - Special precautions which a user needs to be aware of, or needs to comply with, in connection with transport or conveyance either within or outside their premises

Not applicable.

International

INTERNATIONAL

Canadian TDG Hazard Class & PIN: Not regulated

Not classified as dangerous goods under ADR (road), RID (train), IATA (air) or IMDG (ship).

15 - Regulatory information

15.1 - United States Regulations

UNITED STATES REGULATIONS

SARA Title III: This product does not contain any substances reportable under Sections 302, 304, 313 (40 CFR 372). Sections 311 and 312 apply.

OSHA: Comply with Hazard Communication Standards 29 CFR 1910.1200 and 29 CFR 1926.59 and Respiratory Protection Standards 29 CFR 1910.134 and 29 CFR 1926.103.

TSCA: All substances contained in this product are listed in the TSCA Chemical Inventory

California: "Silica, crystalline (airborne particles of respirable size)" is listed in Proposition 65, The Safe Drinking Water and Toxic Enforcement Act of 1986 as a chemical known to the State of California to cause cancer.

Other States: Crystalline silica products are not known to be regulated by states other than California; however, state and local OSHA and EPA regulations may apply to these products. Contact your local agency if in doubt.

15.2 - International Regulations

INTERNATIONAL REGULATIONS

Canadian WHMIS: Class D-2A Materials Causing Other Toxic Effects

Canadian EPA: All substances in this product are listed, as required, on the Domestic Substance List (DSL).

16 - Other Information

initial statement

Devitrification

Product Stewardship Program

HMIS HAZARD RATING

HMIS Health	1* (* denotes potential for chronic effects)
HMIS Flammable	0
HMIS Reactivity	0
HMIS Personal Protective Equipment	X (To be determined by user)

TECHNICAL DATA SHEETS

114-3, 114-2

Revision Summary

Revision date updated.

MSDS prepared by

SDS Prepared By: MORGAN THERMAL CERAMICS ENVIRONMENTAL, HEALTH & SAFETY DEPARTMENT

Disclaimer

The information presented herein is presented in good faith and believed to be accurate as of the effective date of this Safety Data Sheet. Employers may use this SDS to supplement other information gathered by them in their efforts to assure the health and safety of their employees and the proper use of the product. This summary of the relevant data reflects professional judgment; employers should note that information perceived to be less relevant has not been included in this SDS. Therefore, given the summary nature of this document, Morgan Thermal Ceramics does not extend any warranty (expressed or implied), assume any responsibility, or make any representation regarding the completeness of this information or its suitability for the purposes envisioned by the user.

1. Identification

Product identifier	TAYCOR 320-TR MORTAR; TAYCOR 320-DC MORTAR
Other means of identification	
Brand Code	8802, 929B
Recommended use	For Industrial Use Only
Recommended restrictions	Users should be informed of the potential presence of respirable dust and respirable crystalline silica as well as their potential hazards. Appropriate training in the proper use and handling of this material should be provided as required under applicable regulations.

Manufacturer/Importer/Supplier/Distributor information

Manufacturer

Company name	HarbisonWalker International
Address	1305 Cherrington Parkway, Suite 100 Moon Township, Pennsylvania 15108 US
Telephone	General Phone: 412-375-6600
Website	www.thinkHWI.com
Emergency phone number	CHEMTREC 24 HOUR 1-800-424-9300 EMERGENCY #

2. Hazard(s) identification

Physical hazards	Not classified.	
Health hazards	Carcinogenicity	Category 1A
	Specific target organ toxicity, repeated exposure	Category 1
Environmental hazards	Not classified.	
OSHA defined hazards	Not classified.	
Label elements		



Signal word	Danger
Hazard statement	May cause cancer. Causes damage to organs through prolonged or repeated exposure.
Precautionary statement	
Prevention	Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Do not breathe dust. Wash thoroughly after handling. Do not eat, drink or smoke when using this product. Wear protective gloves/protective clothing/eye protection/face protection.
Response	If exposed or concerned: Get medical advice/attention.
Storage	Store locked up.
Disposal	Dispose of contents/container in accordance with local/regional/national/international regulations.
Hazard(s) not otherwise classified (HNOC)	None known.
Supplemental information	Users should be informed of the potential presence of respirable dust and respirable crystalline silica as well as their potential hazards. Overexposure to the respirable dust of crystalline silica (quartz or cristobalite, less than or equal to 5 microns in size) may lead to silicosis in humans, which is a progressive and irreversible lung disease. Appropriate training in the proper use and handling of this material should be provided as required under applicable regulations.

3. Composition/information on ingredients

Mixtures

Chemical name	Common name and synonyms	CAS number	%
Aluminium Oxide (Non-Fibrous)		1344-28-1	60 - 80
Kaolin		1332-58-7	2.5 - 10
Quartz (SiO ₂)		14808-60-7	2.5 - 10
Silicic Acid, Sodium Salt		1344-09-8	2.5 - 10
Mullite		1302-93-8	0.1 - 1
Titanium Dioxide		13463-67-7	0.1 - 1
Other components below reportable levels			10 - 20

*Designates that a specific chemical identity and/or percentage of composition has been withheld as a trade secret.

4. First-aid measures

Inhalation	Move to fresh air. Call a physician if symptoms develop or persist.
Skin contact	Wash off with soap and water. Get medical attention if irritation develops and persists.
Eye contact	Do not rub eyes. Rinse with water. Get medical attention if irritation develops and persists.
Ingestion	Rinse mouth. Get medical attention if symptoms occur.
Most important symptoms/effects, acute and delayed	Dusts may irritate the respiratory tract, skin and eyes. Prolonged exposure may cause chronic effects.
Indication of immediate medical attention and special treatment needed	Provide general supportive measures and treat symptomatically. Keep victim under observation. Symptoms may be delayed.
General information	IF exposed or concerned: Get medical advice/attention. If you feel unwell, seek medical advice (show the label where possible). Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves.

5. Fire-fighting measures

Suitable extinguishing media	Use fire-extinguishing media appropriate for surrounding materials.
Unsuitable extinguishing media	Not available.
Specific hazards arising from the chemical	Not applicable.
Special protective equipment and precautions for firefighters	Not available.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures	Keep unnecessary personnel away. Keep people away from and upwind of spill/leak. Wear appropriate protective equipment and clothing during clean-up. Do not breathe dust. Use a NIOSH/MSHA approved respirator if there is a risk of exposure to dust/fume at levels exceeding the exposure limits. Ensure adequate ventilation. Local authorities should be advised if significant spillages cannot be contained. For personal protection, see section 8 of the SDS.
Methods and materials for containment and cleaning up	Avoid dispersal of dust in the air (i.e., clearing dust surfaces with compressed air). Collect dust using a vacuum cleaner equipped with HEPA filter. Stop the flow of material, if this is without risk. Large Spills: Wet down with water and dike for later disposal. Shovel the material into waste container. Following product recovery, flush area with water. Small Spills: Sweep up or vacuum up spillage and collect in suitable container for disposal. Never return spills to original containers for re-use. Put material in suitable, covered, labeled containers. For waste disposal, see section 13 of the SDS.
Environmental precautions	Avoid discharge into drains, water courses or onto the ground.

7. Handling and storage

Precautions for safe handling	Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Minimize dust generation and accumulation. Provide appropriate exhaust ventilation at places where dust is formed. Do not breathe dust. Do not breathe dust. Avoid prolonged exposure. When using, do not eat, drink or smoke. Should be handled in closed systems, if possible. Wear appropriate personal protective equipment. Wash hands thoroughly after handling. Observe good industrial hygiene practices.
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Conditions for safe storage, including any incompatibilities

Store locked up. Store in original tightly closed container. Store in a well-ventilated place. Store away from incompatible materials (see Section 10 of the SDS).

8. Exposure controls/personal protection**Occupational exposure limits**

The following constituents are the only constituents of the product which have a PEL, TLV or other recommended exposure limit. At this time, the other constituents have no known exposure limits.

US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000)

Components	Type	Value	Form
Aluminium Oxide (Non-Fibrous) (CAS 1344-28-1)	PEL	5 mg/m3	Respirable fraction.
Kaolin (CAS 1332-58-7)	PEL	15 mg/m3	Total dust.
		5 mg/m3	Respirable fraction.
		15 mg/m3	Total dust.
Quartz (SiO ₂) (CAS 14808-60-7)	PEL	0.05 mg/m3	
Titanium Dioxide (CAS 13463-67-7)	PEL	15 mg/m3	Total dust.

US. OSHA Table Z-3 (29 CFR 1910.1000)

Components	Type	Value	Form
Aluminium Oxide (Non-Fibrous) (CAS 1344-28-1)	TWA	5 mg/m3	Respirable fraction.
Kaolin (CAS 1332-58-7)	TWA	15 mg/m3	Total dust.
		50 mppcf	Total dust.
		15 mppcf	Respirable fraction.
		5 mg/m3	Respirable fraction.
		15 mg/m3	Total dust.
		50 mppcf	Total dust.
Quartz (SiO ₂) (CAS 14808-60-7)	TWA	15 mppcf	Respirable fraction.
		0.1 mg/m3	Respirable.
Titanium Dioxide (CAS 13463-67-7)	TWA	2.4 mppcf	Respirable.
		5 mg/m3	Respirable fraction.
		15 mg/m3	Total dust.
		50 mppcf	Total dust.
		15 mppcf	Respirable fraction.

US. ACGIH Threshold Limit Values

Components	Type	Value	Form
Aluminium Oxide (Non-Fibrous) (CAS 1344-28-1)	TWA	1 mg/m3	Respirable fraction.
Kaolin (CAS 1332-58-7)	TWA	2 mg/m3	Respirable fraction.
Quartz (SiO ₂) (CAS 14808-60-7)	TWA	0.025 mg/m3	Respirable fraction.
Titanium Dioxide (CAS 13463-67-7)	TWA	10 mg/m3	

US. NIOSH: Pocket Guide to Chemical Hazards

Components	Type	Value	Form
Kaolin (CAS 1332-58-7)	TWA	5 mg/m3	Respirable.
		10 mg/m3	Total
Quartz (SiO ₂) (CAS 14808-60-7)	TWA	0.05 mg/m3	Respirable dust.

Biological limit values

No biological exposure limits noted for the ingredient(s).

Exposure guidelines

Occupational exposure to nuisance dust (total and respirable) and respirable crystalline silica should be monitored and controlled. Occupational exposure to nuisance dust (total and respirable) and respirable crystalline silica should be monitored and controlled.

Appropriate engineering controls

Good general ventilation (typically 10 air changes per hour) should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level. If engineering measures are not sufficient to maintain concentrations of dust particulates below the Occupational Exposure Limit (OEL), suitable respiratory protection must be worn. If material is ground, cut, or used in any operation which may generate dusts, use appropriate local exhaust ventilation to keep exposures below the recommended exposure limits.

Individual protection measures, such as personal protective equipment**Eye/face protection**

Chemical respirator with organic vapor cartridge, full facepiece, dust and mist filter.

Skin protection**Hand protection**

Wear appropriate chemical resistant gloves.

Other

Use of an impervious apron is recommended.

Respiratory protection

Use a NIOSH/MSHA approved respirator if there is a risk of exposure to dust/fume at levels exceeding the exposure limits.

Thermal hazards

Wear appropriate thermal protective clothing, when necessary.

**General hygiene considerations**

Observe any medical surveillance requirements. Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants.

9. Physical and chemical properties**Appearance****Physical state**

Solid.

Form

Powder.

Color

Not available.

Odor

Not available.

Odor threshold

Not available.

pH

Not available.

Melting point/freezing point

Not available.

Initial boiling point and boiling range

Not available.

Flash point

Not available.

Evaporation rate

Not available.

Flammability (solid, gas)

Not available.

Upper/lower flammability or explosive limits**Flammability limit - lower (%)**

Not available.

Flammability limit - upper (%)

Not available.

Explosive limit - lower (%)

Not available.

Explosive limit - upper (%)

Not available.

Vapor pressure

Not available.

Vapor density

Not available.

Relative density

Not available.

Solubility(ies)**Solubility (water)**

Not available.

Partition coefficient (n-octanol/water)

Not available.

Auto-ignition temperature

Not available.

Decomposition temperature

Not available.

Viscosity Not available.

Other information

Explosive properties Not explosive.

Oxidizing properties Not oxidizing.

10. Stability and reactivity

Reactivity The product is stable and non-reactive under normal conditions of use, storage and transport.

Chemical stability Material is stable under normal conditions.

Possibility of hazardous reactions Hazardous polymerization does not occur.

Conditions to avoid Contact with incompatible materials.

Incompatible materials Acids. Chlorine.
Incompatibility is based strictly upon potential theoretical reactions between chemicals and may not be specific to industrial application exposure.

Hazardous decomposition products No hazardous decomposition products are known.

11. Toxicological information

Information on likely routes of exposure

Inhalation May cause damage to organs through prolonged or repeated exposure by inhalation. Dust may irritate respiratory system.

Skin contact Dust or powder may irritate the skin.

Eye contact Dust may irritate the eyes.

Ingestion Expected to be a low ingestion hazard.

Symptoms related to the physical, chemical and toxicological characteristics Dusts may irritate the respiratory tract, skin and eyes.

Information on toxicological effects

Acute toxicity Not known.

Skin corrosion/irritation Prolonged skin contact may cause temporary irritation.

Serious eye damage/eye irritation Direct contact with eyes may cause temporary irritation.

Respiratory or skin sensitization

Respiratory sensitization Not a respiratory sensitizer.

Skin sensitization This product is not expected to cause skin sensitization.

Germ cell mutagenicity No data available to indicate product or any components present at greater than 0.1% are mutagenic or genotoxic.

Carcinogenicity In 1997, IARC (the International Agency for Research on Cancer) concluded that crystalline silica inhaled from occupational sources can cause lung cancer in humans. However in making the overall evaluation, IARC noted that "carcinogenicity was not detected in all industrial circumstances studied. Carcinogenicity may be dependent on inherent characteristics of the crystalline silica or on external factors affecting its biological activity or distribution of its polymorphs." (IARC Monographs on the evaluation of the carcinogenic risks of chemicals to humans, Silica, silicates dust and organic fibres, 1997, Vol. 68, IARC, Lyon, France.) In June 2003, SCOEL (the EU Scientific Committee on Occupational Exposure Limits) concluded that the main effect in humans of the inhalation of respirable crystalline silica dust is silicosis. "There is sufficient information to conclude that the relative risk of lung cancer is increased in persons with silicosis (and, apparently, not in employees without silicosis exposed to silica dust in quarries and in the ceramic industry). Therefore, preventing the onset of silicosis will also reduce the cancer risk..." (SCOEL SUM Doc 94-final, June 2003) According to the current state of the art, worker protection against silicosis can be consistently assured by respecting the existing regulatory occupational exposure limits. May cause cancer. Occupational exposure to respirable dust and respirable crystalline silica should be monitored and controlled.

IARC Monographs. Overall Evaluation of Carcinogenicity

Quartz (SiO₂) (CAS 14808-60-7)

1 Carcinogenic to humans.

Titanium Dioxide (CAS 13463-67-7)

2B Possibly carcinogenic to humans.

US. National Toxicology Program (NTP) Report on Carcinogens

Quartz (SiO₂) (CAS 14808-60-7)

Known To Be Human Carcinogen.

US. OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

Not regulated.

Reproductive toxicity	This product is not expected to cause reproductive or developmental effects.
Developmental effects	
Quartz (SiO ₂)	0
Developmental effects - EU category	
Quartz (SiO ₂)	0
Embryotoxicity	
Quartz (SiO ₂)	0
Reproductivity	
Quartz (SiO ₂)	0
Specific target organ toxicity - single exposure	Not classified.
Specific target organ toxicity - repeated exposure	Causes damage to organs through prolonged or repeated exposure.
Aspiration hazard	Not an aspiration hazard.
Chronic effects	Causes damage to organs through prolonged or repeated exposure. Prolonged inhalation may be harmful. Prolonged exposure may cause chronic effects.

12. Ecological information

Ecotoxicity	The product is not classified as environmentally hazardous. However, this does not exclude the possibility that large or frequent spills can have a harmful or damaging effect on the environment.
Persistence and degradability	No data is available on the degradability of this product.
Bioaccumulative potential	No data available.
Mobility in soil	No data available.
Other adverse effects	No other adverse environmental effects (e.g. ozone depletion, photochemical ozone creation potential, endocrine disruption, global warming potential) are expected from this component.

13. Disposal considerations

Disposal instructions	This product, in its present state, when discarded or disposed of, is not a hazardous waste according to Federal regulations (40 CFR 261.4 (b)(4)). Under RCRA, it is the responsibility of the user of the product to determine, at the time of disposal, whether the product meets RCRA criteria for hazardous waste.
Hazardous waste code	Since this product is used in several industries, no Waste Code can be provided by the supplier. The Waste Code should be determined in arrangement with your waste disposal partner or the responsible authority.
Waste from residues / unused products	Not available.
Contaminated packaging	Not available.

14. Transport information

DOT

Not regulated as dangerous goods.

IATA

Not regulated as dangerous goods.

IMDG

Not regulated as dangerous goods.

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code Not applicable.

15. Regulatory information

US federal regulations	This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200. All chemical substances in this product are listed on the TSCA chemical substance inventory where required.
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TSCA Section 12(b) Export Notification (40 CFR 707, Subpt. D)

Not regulated.

CERCLA Hazardous Substance List (40 CFR 302.4)

Not listed.

SARA 304 Emergency release notification

Not regulated.

US. OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

Not regulated.

Superfund Amendments and Reauthorization Act of 1986 (SARA)

Hazard categories Immediate Hazard - No
Delayed Hazard - Yes
Fire Hazard - No
Pressure Hazard - No
Reactivity Hazard - No

SARA 302 Extremely hazardous substance

Not listed.

SARA 311/312 Hazardous chemical No

SARA 313 (TRI reporting)

Chemical name	CAS number	% by wt.
Aluminium Oxide (Non-Fibrous)	1344-28-1	60 - 80

Other federal regulations**Clean Air Act (CAA) Section 112 Hazardous Air Pollutants (HAPs) List**

Not regulated.

Clean Air Act (CAA) Section 112(r) Accidental Release Prevention (40 CFR 68.130)

Not regulated.

Safe Drinking Water Act (SDWA) Not regulated.

US state regulations WARNING: This product contains a chemical known to the State of California to cause cancer.

US - California Proposition 65 - CRT: Listed date/Carcinogenic substance

Quartz (SiO ₂) (CAS 14808-60-7)	Listed: October 1, 1988
Titanium Dioxide (CAS 13463-67-7)	Listed: September 2, 2011

US. California. Candidate Chemicals List. Safer Consumer Products Regulations (Cal. Code Regs, tit. 22, 69502.3, subd. (a))

Quartz (SiO ₂) (CAS 14808-60-7)
Titanium Dioxide (CAS 13463-67-7)

International Inventories

Country(s) or region	Inventory name	On inventory (yes/no)*
Australia	Australian Inventory of Chemical Substances (AICS)	Yes
Canada	Domestic Substances List (DSL)	No
Canada	Non-Domestic Substances List (NDSL)	No
China	Inventory of Existing Chemical Substances in China (IECSC)	Yes
Europe	European Inventory of Existing Commercial Chemical Substances (EINECS)	No
Europe	European List of Notified Chemical Substances (ELINCS)	No
Japan	Inventory of Existing and New Chemical Substances (ENCS)	No
Korea	Existing Chemicals List (ECL)	No
New Zealand	New Zealand Inventory	Yes
Philippines	Philippine Inventory of Chemicals and Chemical Substances (PICCS)	No
United States & Puerto Rico	Toxic Substances Control Act (TSCA) Inventory	No

*A "Yes" indicates that all components of this product comply with the inventory requirements administered by the governing country(s)

A "No" indicates that one or more components of the product are not listed or exempt from listing on the inventory administered by the governing country(s).

16. Other information, including date of preparation or last revision

Issue date 03-23-2017
Version # 01

Disclaimer

This information is based on our present knowledge on creation date. However, this shall not constitute a guarantee for any specific product features and shall not establish a legally valid contractual relationship.

Revision information

This document has undergone significant changes and should be reviewed in its entirety.

SAFETY DATA SHEET

Following Regulation 1910.1200

SDS Number: 358 Date of first issue: 20 January 2001 Date of last revision: 23 December 2020

1 - Identification of product

a - Product identifier used on the label

Tradenames: FireMaster Door Seal +, FireMaster TCHTF, Mix 411-E Expandable Felt, Superwool 607 351-E Paper,

b - Other means of identification

ALKALINE EARTH SILICATE (AES) WOOL PRODUCT

c - Recommended use of the chemical and restrictions on use

Application as thermal insulation, heat shields, heat containment, gaskets and expansion joints in industrial furnaces, ovens, kilns, boilers and other process equipment and in the aerospace, automotive and appliance industries, and as passive fire protection systems and firestops. (Please refer to specific technical data sheets for more information)

d - Name, address, and telephone number

Morgan Advanced Materials P. O. Box 923; Dept. 300 Augusta, GA 30903-0923 Telephone: 706-796-4200

e - Emergency Phone Number

For Product Stewardship and Emergency Information:
Hotline - 1-800-722-5681
Fax - 706-560-4054

For additional SDSs and to confirm this is the most current SDS for the product, visit our web page www.morganthermalceramics.com or send a request to MT.NorthAmerica@morganplc.com

2 - Hazard Identification

a - Classification of the chemical in accordance with paragraph (d) of §1910.1200

Not classified. Read the entire safety data sheet.

b - Signal word, hazard statement(s), symbol(s) and precautionary statement(s) in accordance with paragraph (f) of §1910.1200

None.

Emergency Overview

CLASSIFICATION OF THE SUBSTANCE/MIXTURE

The Twelfth Annual Report on Carcinogens (2011), prepared by the National Toxicology Program (NTP), classified "Certain Glasswool Fibers (inhalable)" as a substance reasonably anticipated to be a carcinogen.

The State of California, pursuant to Proposition 65, The Safe Drinking Water and Toxic Enforcement Act of 1986, has listed "glasswool fibers (airborne particles of respirable size)" as a material known to the State of California to cause cancer.

In Europe, Superwool products were developed after the IARC classification was made (1987). They are exonerated from any carcinogenic classification under Directive 97/69/EC in the European Union.

LABELING ELEMENTS

GHS labeling pending

OTHER HAZARDS WHICH DO NOT RESULT IN CLASSIFICATION

Mild mechanical irritation to skin, eyes and upper respiratory system may result from exposure. These effects are usually temporary.

c - Describe any hazards not otherwise classified that have been identified during the classification process

Mild mechanical irritation to skin, eyes and upper respiratory system may result from exposure. These effects are usually temporary.

d - Mixture Rule

3 - Composition / Information On Ingredients

a - Composition table

COMPONENTS	CAS NUMBER	% BY WEIGHT
Alkaline-Earth Silicate Wool ⁽¹⁾	436083-99-7	Up to 90
Graphite	7782-42-5	Up to 40
Latex	NONE	2 - 10
Fibrous Glass	65997-17-3	1 - 5

⁽¹⁾ **CAS definition:** Alkaline Earth Silicate (AES) consisting of silica (50-82 wt %), calcia and magnesia (18-43 wt %), alumina, titania and zirconia (less than 6 wt %), and trace oxides. This CAS composition also covers Morgan Thermal Ceramics products Calcium-Magnesium-Silicate Wool (CAS no. 329211-92-9) and Calcium-Magnesium-Zirconium-Silicate Wool (CAS no. 308084-09-5).

b - Common Name

(See Section 8 "Exposure Controls / Personal Protection" for exposure guidelines)

d - Impurities and Stabilizing Additives

Not applicable.

4 - First-Aid measures

a - Description of necessary measures, subdivided according to the different routes of exposure, i.e., inhalation, skin and eye contact, and ingestion

Eyes

If eyes become irritated, flush immediately with large amounts of lukewarm water for at least 15 minutes. Eyelids should be held away from the eyeball to ensure thorough rinsing. Do not rub eyes.

Skin

If skin becomes irritated, remove soiled clothing. Do not rub or scratch exposed skin. Wash area of contact thoroughly with soap and water. Using a skin cream or lotion after washing may be helpful.

Respiratory Tract

If respiratory tract irritation develops, move the person to a dust free location. See Section 8 for additional measures to reduce or eliminate exposure.

Gastrointestinal

If gastrointestinal tract irritation develops, move the person to a dust free environment.

c - Indication of immediate medical attention and special treatment needed, if necessary

5 - Fire-fighting measures

a - Suitable (and unsuitable) extinguishing media and

Use extinguishing media suitable for type of surrounding fire

c - Special Protective Equipment and Precautions for Firefighters

NFPA Codes: Flammability: 0 Health: 1 Reactivity: 0 Special: 0

b - Specific hazards arising from the chemical (e.g., nature of any hazardous combustion products):

None

6 - Accidental Release Measures

a - Personal precautions, protective equipment, and emergency procedures

Minimize airborne dust. Compressed air or dry sweeping should not be used for cleaning. See Section 8 "Exposure Controls / Personal Protection" for exposure guidelines.

b - Methods and materials for containment and cleaning up

Pick up large pieces and dispose in a closed container. Follow precaution stated in above section for clean up.

7 - Handling and storage

a - Precautions for safe handling

Limit the use of power tools unless in conjunction with local exhaust. Use hand tools whenever possible. Frequently clean the work area with HEPA filtered vacuum or wet sweeping to minimize the accumulation of debris. Do not use compressed air for clean-up.

b - Conditions for safe storage, including any incompatibilities

Store in a manner to minimize airborne dust.

c - empty containers

Product packaging may contain residue. Do not reuse.

a - OSHA permissible exposure limit (PEL), American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV), and any other exposure limit used or recommended by the chemical manufacturer, importer, or employer preparing the safety data sheet, where available

EXPOSURE GUIDELINES				
MAJOR COMPONENT	OSHA PEL	ACGIH TLV	MANUFACTURER'S REG	
Alkaline-Earth Silicate Wool	None Established	None Established	1 f/cc, 8-hr TWA	
Graphite ⁽¹⁾	15 mg/m ³ (total dust) 5 mg/m ³ (respirable dust)	2 mg/m ³	NONE	
Fibrous Glass	None Established	1 f/cc	1 f/cc	
Latex ⁽²⁾	None Established	None Established	NONE	

⁽¹⁾ Trace amount of sulfuric acid and nitric acid fumes may release from acid treated graphite during heating of this product. The current OSHA PELs for these acids are: 1 mg/m³ (8 hr.TWA); for sulfuric acid 2 ppm and 4 ppm (STEL) for nitric acid.

⁽²⁾ Trace amount of formaldehyde may release from latex during initial heating of this product. The current OSHA PELs for formaldehyde are: 0.75 ppm (8 hr. TWA) and 2 ppm (STEL).

OTHER OCCUPATIONAL EXPOSURE LEVELS (OEL)

Industrial hygiene standards and occupational exposure limits vary between countries and local jurisdictions. Check which exposure levels apply to your facility and comply with local regulations. If no regulatory dust or other standards apply, a qualified industrial hygienist can assist with a specific workplace evaluation including recommendations for respiratory protection.

b - Appropriate Engineering Controls

Use engineering controls such as local exhaust ventilation, point of generation dust collection, down draft work stations, emission controlling tool designs and materials handling equipment designed to minimize airborne fiber emissions.

c - Individual protection measures, such as personal protective equipment

PPE - Skin

Wear personal protective equipment (e.g gloves), as necessary to prevent skin irritation. Washable or disposable clothing may be used. If possible, do not take unwashed clothing home. If soiled work clothing must be taken home, employees should be informed on best practices to minimize non-work dust exposure (e.g., vacuum clothes before leaving the work area, wash work clothing separately, and rinse washer before washing other household clothes).

PPE - Eye

As necessary, wear goggles or safety glasses with side shields.

PPE – Respiratory

When engineering and/or administrative controls are insufficient to maintain workplace concentrations below the appropriate REG/PEL/REL, the use of appropriate respiratory protection, pursuant to the requirements of OSHA Standards 29 CFR 1910.134 and 29 CFR 1926.103, is recommended. A NIOSH certified respirator with a filter efficiency of at least 95% should be used. The 95% filter efficiency recommendation is based on NIOSH respirator selection logic sequence for exposure to particulates. Selection of filter efficiency (i.e. 95%, 99% or 99.97%) depends on how much filter leakage can be accepted and the concentration of airborne contaminants. Other factors to consider are the NIOSH filter series N, R or P. (N) Not resistant to oil, (R) Resistant to oil and (P) oil Proof. These recommendations are not designed to limit informed choices, provided that respiratory protection decisions comply with 29 CFR 1910.134. The evaluation of workplace hazards and the identification of appropriate respiratory protection is best performed, on a case by case basis, by a qualified industrial hygienist.

You may also refer to health and safety information on the HTIW Coalition website www.HTIWCoalition.org

9 - Physical and chemical properties

a - Appearance	Flexible paper or mat like material
b - Odor	Not applicable
c - Odor Threshold	Not applicable
e- pH	Not applicable
d - Melting Point	1093°C (2000°F) to 1275°C (2327°F)
f- Initial Boiling Point/Range	Not applicable
g- Flashpoint	Not applicable
h - Evaporation Rate	Not applicable
i - Flammability	Not applicable
j - Upper/Lower Flammability or Explosive Limits	Not applicable
k - VAPOR PRESSURE	Not applicable
l - VAPOR DENSITY	Not applicable
m - Solubility	Less than 1 mg/litre
n - Relative Density	2.5 - 3.0
o - Partition Coefficient: n-Octanol/water	Not applicable
p - Auto-ignition temperature	Not applicable
q - Decomposition Temperature	Not applicable
r - Viscosity	Not applicable

10 - Stability and Reactivity

a - Reactivity

None.

b - Chemical Stability

Stable under conditions of normal use.

c - Possibility of Hazardous Reaction

None

d - Conditions to Avoid

None

e - Incompatible Materials

Avoid contact with strong acids

f - Hazardous decomposition products

Decomposition of the latex binder will occur at temperatures above 200°C releasing smoke, water, carbon monoxide, carbon dioxide and hydrocarbons. The duration and the amount of release will depend upon the applied temperature, the thickness and area of the material and binder content. During the first heating cycles increased ventilation or the use of suitable respirator protection may be required.

11 - Toxicological information

a - TOXICOKINETICS, METABOLISM AND DISTRIBUTION

b - Acute Toxicity

IRRITANT PROPERTIES

Superwool fibers are negative when tested using approved methods (Directive 67/548/EEC, Annex 5, Method B4). Like all man-made mineral fibers and some natural fibers, fibers contained in this product can produce a mild mechanical irritation resulting in temporary itching or rarely, in some sensitive individuals, in a slight temporary reddening. Unlike other irritant reactions, this is not the result of allergy or chemical skin damage but is caused by mechanical effects.

c - Epidemiology

Silicon carbide

Bruusgaard (1949) found that X-rays of 10 out of 32 workers exposed to average levels of 34 mppcf of silicon carbide for 15 years or more, demonstrated pulmonary changes; these 10 workers were also tuberculin-positive. Miller, Davis, Goldman, and Wyatts (1953) described three cases of pulmonary reactions and hyperglobinemia in tungsten carbide industry workers; these authors concluded that exposure to silicon carbide was not a hazard unless the exposed workers already had pulmonary tuberculosis.

Crystalline silica

Exposure to crystalline silica can cause silicosis, and exacerbate pulmonary tuberculosis and bronchitis. IARC (Monograph vol. 68, 1997) concluded that "crystalline silica from occupational sources inhaled in the form of quartz or cristobalite is carcinogenic to humans (Group 1)", and noted that "carcinogenicity in humans was not detected in all industrial circumstances studied" and "may be dependent on inherent characteristics of the crystalline silica or on external factors affecting its biological activity".

d - Toxicology

Fibers contained in the products listed in the title have been designed to be rapidly cleared from lung tissue. This low biopersistence has been confirmed in many studies on AES using EU protocol ECB/TM/27(rev 7). When inhaled, even at very high doses, they do not accumulate to any level capable of producing a serious adverse biological effect. In lifetime chronic studies there was no exposure-related effect more than would be seen with any "inert" dust. Subchronic studies at the highest doses achievable produced at worst a transient mild inflammatory response. Fibers with the same ability to persist in tissue do not produce tumors when injected into the peritoneal cavity of rats.

International Agency for Research on Cancer and National Toxicology Program

12 - Ecological information

a - Ecotoxicity (aquatic and terrestrial, where available)

These products are not reported to have any ecotoxicity effects.

c - Bioaccumulative potential

No bioaccumulative potential.

d - Mobility in soil

No mobility in soil.

e - Other adverse effects (such as hazardous to the ozone layer

No adverse effects of this material on the environment are anticipated.

13 - Disposal Considerations

Waste Management and Disposal

Unless wetted, such a waste is normally dusty and should therefore be properly sealed in containers for disposal. At some authorized disposal sites dusty waste may be treated differently, in order to ensure that they are dealt with promptly and to avoid them being windblown. Check for any national and/or regional regulations which may apply.

Additional information

This product, as manufactured, is not classified as a listed or characteristic hazardous waste according to U. S. Federal regulations (40 CFR 261). Any processing, use, alteration or chemical additions to the product, as purchased, may alter the disposal requirements. Under U. S. Federal regulations, it is the waste generator's responsibility to properly characterize a waste material, to determine if it is a "hazardous" waste. Check local, regional, state or provincial regulations to identify all applicable disposal requirements.

14 - Transport information

a - UN number.

Hazard Class: Not Regulated United Nations (UN) Number: Not Applicable
Labels: Not Applicable North America (NA) Number: Not Applicable
Placards: Not Applicable Bill of Lading: Product Name

b - UN proper shipping name

Not applicable.

c - Transport hazard class(es)

Not applicable.

d - Packing group, if applicable

Not applicable.

e - Environmental hazards (e.g., Marine pollutant (Yes/No))

No.

f - Transport in bulk (according to Annex II of MARPOL 73/78 and the IBC Code)

Not regulated.

g - Special precautions which a user needs to be aware of, or needs to comply with, in connection with transport or conveyance either within or outside their premises

Not applicable.

International

INTERNATIONAL

Canadian TDG Hazard Class & PIN: Not regulated

Not classified as dangerous goods under ADR (road), RID (train), IATA (air) or IMDG (ship).

15 - Regulatory information

15.1 - United States Regulations

UNITED STATES REGULATIONS

SARA Title III: This product does not contain any substances reportable under Sections 302, 304, 313 (40 CFR 372). Sections 311 and 312 apply.

OSHA: Comply with Hazard Communication Standards 29 CFR 1910.1200 and 29 CFR 1926.59 and Respiratory Protection Standards 29 CFR 1910.134 and 29 CFR 1926.103.

TSCA: AES wools have been assigned several CAS numbers; however, as "article", they are not required to be listed on the TSCA inventory.

CERCLA: AES wool contains fibers with an average diameter greater than one micron and thus is not considered a CERCLA hazardous substance.

CAA: AES wool contains fibers with an average diameter greater than one micron and thus is not considered a hazardous air pollutant.

States: AES wools are not known to be regulated by any State. If in doubt, contact your local regulatory agency.

15.2 - International Regulations

Canada WHMIS: No Canadian Workplace Hazardous Materials Information System categories apply to this product.

Canadian EPA: All substances in this product are listed, as required, on the Domestic Substance List (DSL).

European Union: These products are exonerated from any carcinogenic classification in the countries of the European Union under the provisions of Nota Q of the European Commission Directive 97/69/EC.

initial statement**Devitrification****PRECAUTIONARY MEASURES TO BE TAKEN AFTER SERVICE UPON REMOVAL**

High temperature insulating wool (HTIW) is typically used in insulation applications to keep temperature exposure at 900°C or above in a closed space. The exposure temperature maximum occurs at the hot face surface of the insulation. The heat exposure on the insulation decreases from the hot face to the cold face as the insulation "insulates itself". As a result, only thin layers of the hot face surface of the insulation become devitrified and respirable dust generated during removal operations typically do not contain detectable levels of crystalline silica (CS).

Toxicological evaluation of the effect of the presence of CS in artificially heated HTIW material has not shown any increased toxicity in vitro and in vivo. The results from different factor combinations such as increased brittleness of fibers or micro crystals embedded in the glass structure of the fiber and therefore not biologically available, may explain the lack of toxicological effects. IARC evaluation as provided in Monograph 68 is not relevant since CS is not biologically available in after-service HTIW.

Product Stewardship Program

High concentrations of fibers and other dusts may be generated when after-service products are mechanically disturbed during removal. Therefore, ECFIA and HTIW Coalition recommend:

- a) Controlled measures are taken to reduce dust emissions and
- b) All personnel directly involved wear an appropriate respirator to minimize and comply with local regulatory limits.

For more information, call the Morgan Thermal Ceramics Product Stewardship Hotline (800-722-5681).

HMIS HAZARD RATING

HMIS Health: 1
HMIS Flammable: 0
HMIS Reactivity: 0
HMIS Personal Protective: To be determined by user

TECHNICAL DATA SHEETS

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Revision Summary

Revision date updated.

MSDS prepared by

SDS Prepared By: MORGAN THERMAL CERAMICS ENVIRONMENTAL, HEALTH & SAFETY DEPARTMENT

Disclaimer

The information presented herein is presented in good faith and believed to be accurate as of the effective date of this Safety Data Sheet. Employers may use this SDS to supplement other information gathered by them in their efforts to assure the health and safety of their employees and the proper use of the product. This summary of the relevant data reflects professional judgment; employers should note that information perceived to be less relevant has not been included in this SDS. Therefore, given the summary nature of this document, Morgan Thermal Ceramics does not extend any warranty (expressed or implied), assume any responsibility, or make any representation regarding the completeness of this information or its suitability for the purposes envisioned by the user.

SAFETY DATA SHEET

Following Regulation 1910.1200

SDS Number: 201 Date of first issue: 01 October 1985 Date of last revision: 21 February 2022

1 - Identification of product

a - Product identifier used on the label

Tradenames: Cerablanket, Cerablanket HTA, Cerachem 112 AZS, Cerachem Blanket, Cerachem Bulk, Cerachem Enfil Engineered Fiber, Cerafiber 111 Bulk, Cerafibre Bulk, Cerwool FP, Cerwool HP Bulk, Cerwool HTA, Cerwool HTZ Bulk, Cerwool RT Bulk, FireMaster FP60, Kaowool Blanket SZR, Kaowool, Kaowool Blanket, Kaowool Blanket S, Kaowool Bulk, Kaowool High Purity Bulk, Kaowool RT, Kaowool RT Blanket, Kaowool S Blanket, Kaowool S Spun Fibre, Kaowool Tank Car Blanket, Kaowool Veneering Modules - HP and ZR Grades, K-Shield BF Paper, Monomax Modules, Preflex HP Module, Preflex HTZ Module, Premax HP Module, Premax HTA Module, Premax HTZ Modules, Pyro-Bloc Burner Bloc, Pyro-Bloc E and E2 Modules, Pyro-Bloc M and M2 Modules (R and ZR Grades), Pyro-Bloc Veneering Modules (C Grade), Pyro-Bloc Veneering Modules (R and ZR Grade), Pyro-Bloc Y Modules (R and ZR Grades), Pyro-Bloc Y2 Modules (R and ZR Grades), Pyro-Fold M Modules (HP, ZR and CR Grades), Pyro-Fold Y Modules (HP and ZR Grades), Pyro-Log and Pyro-Packing Fibre (R and ZR Grades), Pyroscat FP, Pyro-Stack Modules (HP, ZR, CR Grades), RCF Enfil Engineered Fibers, SBH-5 End Cones, Ultrafelt Paper, Unibloc Modules (HP, ZR and CR Grades), Z-Blok Modules (HP and ZR Grades)

b - Other means of identification

REFRACTORY CERAMIC FIBER PRODUCT

c - Recommended use of the chemical and restrictions on use

Primary Use: Refractory Ceramic Fiber (RCF) materials are used primarily in industrial high temperature insulating applications. Examples include heat shields, heat containment, gaskets, expansion joints, industrial furnaces, ovens, kilns, boilers and other process equipment at applications up to 1400°C. RCF based products are not intended for direct sale to the general public. While RCFs are used in the manufacture of some consumer products, such as catalytic converter mats and wood burning stoves, the materials are contained, encapsulated, or bonded within the units

Secondary Use: Conversion into wet and dry mixtures and articles (refer to section 8) **Tertiary Use:** Installation, removal (industrial and professional) / Maintenance and service life (industrial and professional) (refer to section 8).

Uses Advised Against: Spraying of dry product.

d - Name, address, and telephone number

Morgan Advanced Materials P. O. Box 923; Dept. 300 Augusta, GA 30903-0923 Telephone: 706-796-4200

e - Emergency Phone Number

For Product Stewardship and Emergency Information:

Hotline - 1-800-722-5681

Fax - 706-560-4054

For additional SDSs and to confirm this is the most current SDS for the product, visit our web page www.morganthermalceramics.com or send a request to MT.NorthAmerica@morganplc.com

2 - Hazard Identification

a - Classification of the chemical in accordance with paragraph (d) of §1910.1200

The U.S. Occupational Safety and Health Administration (OSHA) Hazard Communication Standard (HCS) 2012 indicates that IARC Group 2B corresponds to OSHA HCS 2012 Category 2 carcinogen classification (see, e.g., §1910.1200, Appendix F, Part D).

b - Signal word, hazard statement(s), symbol(s) and precautionary statement(s) in accordance with paragraph (f) of §1910.1200

Under OSHA HCS 2012, RCF is classified as GHS category 2 carcinogen.

Hazard Pictograms



Signal Words

Warning

Hazard Statements

Suspected of causing cancer by inhalation.

Precautionary Statements

Do not handle until all safety instructions have been read and understood.
Use respiratory protection as required; see section 8 of the Safety Data Sheet.
If concerned about exposure, get medical advice.
Store in a manner to minimize airborne dust.
Dispose of waste in accordance with local, state and federal regulations.

Supplementary Information

May cause temporary mechanical irritation to exposed eyes, skin or respiratory tract.
Minimize exposure to airborne dust.

Emergency Overview

c - Describe any hazards not otherwise classified that have been identified during the classification process

Mild mechanical irritation to skin, eyes and upper respiratory system may result from exposure.
These effects are usually temporary.

d - Mixture Rule

Not applicable.

3 - Composition / Information On Ingredients

a - Composition table

COMPONENTS	CAS NUMBER	% BY WEIGHT
Refractories, Fibers, Aluminosilicate	142844-00-6	40 - 100
Water	7732-18-5	0 - 60

b - Common Name

RCF, ceramic fiber, Alumino Silicate Wool (ASW), synthetic vitreous fiber (SVF), man-made vitreous fiber (MMVF), man-made mineral fiber (MMMMF), high temperature insulation wool (HTIW).

d - Impurities and Stabilizing Additives

Not applicable.

4 - First-Aid measures

a - Description of necessary measures, subdivided according to the different routes of exposure, i.e., inhalation, skin and eye contact, and ingestion

Eyes

If eyes become irritated, flush immediately with large amounts of lukewarm water for at least 15 minutes. Eyelids should be held away from the eyeball to ensure thorough rinsing. Do not rub eyes.

Skin

If skin becomes irritated, remove soiled clothing. Do not rub or scratch exposed skin. Wash area of contact thoroughly with soap and water. Using a skin cream or lotion after washing may be helpful.

Respiratory Tract

If respiratory tract irritation develops, move the person to a dust free location. See Section 8 for additional measures to reduce or eliminate exposure.

Gastrointestinal

If gastrointestinal tract irritation develops, move the person to a dust free environment.

c - Indication of immediate medical attention and special treatment needed, if necessary

5 - Fire-fighting measures

a - Suitable (and unsuitable) extinguishing media and

Use extinguishing media suitable for type of surrounding fire

c - Special Protective Equipment and Precautions for Firefighters

NFPA Codes: Flammability: 0 Health: 1 Reactivity: 0 Special: 0

b - Specific hazards arising from the chemical (e.g., nature of any hazardous combustion products):

None

6 - Accidental Release Measures

a - Personal precautions, protective equipment, and emergency procedures

Minimize airborne dust. Compressed air or dry sweeping should not be used for cleaning. See Section 8 "Exposure Controls / Personal Protection" for exposure guidelines.

b - Methods and materials for containment and cleaning up

Frequently clean the work area with vacuum or wet sweeping to minimize the accumulation of debris. Do not use compressed air for clean-up.

7 - Handling and storage

a - Precautions for safe handling

Handle fiber carefully to minimize airborne dust. Limit use of power tools unless in conjunction with local exhaust ventilation. Use hand tools whenever possible.

b - Conditions for safe storage, including any incompatibilities

Store in a manner to minimize airborne dust.

c - empty containers

Product packaging may contain residue. Do not reuse.

8 - Risk Management Measures / Exposures Controls / Personal Protection

a - OSHA permissible exposure limit (PEL), American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV), and any other exposure limit used or recommended by the chemical manufacturer, importer, or employer preparing the safety data sheet, where available

EXPOSURE GUIDELINES			
MAJOR COMPONENT	OSHA PEL	ACGIH TLV	MANUFACTURER'S REG
Refractories, Fibers, Aluminosilicate	None Established*	0.2 f/cc, 8-hr. TWA	0.5 f/cc, 8-hr. TWA**
*Except of in the state of California, there is no specific regulatory standard for RCF in the U.S. OSHA's "Particulate Not Otherwise Regulated (PNOR)" standard [29 CFR 1910.1000, Subpart Z, Air Contaminants] applies generally - Total Dust 15 mg/m ³ ; Respirable Fraction 5 mg/m ³ . The PEL for RCF in California is 0.2 f/cc, 8-hr TWA			
** HTIW Coalition has sponsored comprehensive toxicology and epidemiology studies to identify potential RCF-related health effects [see Section 11 for more details], consulted experts familiar with fiber and particle science, conducted a thorough review of the RCF-related scientific literature, and further evaluated the data in a state-of-the-art quantitative risk assessment. Based on these efforts and in the absence of an OSHA PEL, HTIW Coalition has adopted a recommended exposure guideline (REG), as measured under NIOSH Method 7400 B. The manufacturers' REG is intended to promote occupational health and safety through feasible exposure controls and reductions as determined by extensive industrial hygiene monitoring efforts undertaken voluntarily and pursuant to an agreement with the U.S. Environmental Protection Agency.			
OTHER OCCUPATIONAL EXPOSURE LEVELS (OEL) RCF-related occupational exposure limits vary internationally. Regulatory OEL examples include: Canada – 0.2 to 1.0 f/cc; Ontario Canada – 0.5 f/cc. United Kingdom – 1.0 f/cc. Non-regulatory OEL examples include: HTIW Coalition REG – 0.5 f/cc. The objectives and criteria underlying each of these OEL decisions also vary. The evaluation of occupational exposure limits and their relative applicability to the workplace is best performed, on a case-by-case basis, by a qualified Industrial Hygienist.			

b - Appropriate Engineering Controls

Use engineering controls such as local exhaust ventilation, point of generation dust collection, down draft work stations, emission controlling tool designs and materials handling equipment designed to minimize airborne fiber emissions.

c - Individual protection measures, such as personal protective equipment

PPE - Skin

Wear personal protective equipment (e.g gloves), as necessary to prevent skin irritation. Washable or disposable clothing may be used. If possible, do not take unwashed clothing home. If soiled work clothing must be taken home, employees should be informed on best practices to minimize non-work dust exposure (e.g., vacuum clothes before leaving the work area, wash work clothing separately, and rinse washer before washing other household clothes.

PPE - Eye

As necessary, wear goggles or safety glasses with side shields.

PPE – Respiratory

When engineering and/or administrative controls are insufficient to maintain workplace concentrations below the 0.5 f/cc REG or a regulatory OEL, the use of appropriate respiratory protection, pursuant to the requirements of OSHA Standards 29 CFR 1910.134 and 29 CFR 1926.103, is recommended. A NIOSH certified respirator with a filter efficiency of at least 95% should be used. The 95% filter efficiency recommendation is based on NIOSH respirator selection logic sequence for exposure to manmade mineral fibers. Pursuant to NIOSH recommendations, N-95 respirators are appropriate for exposures up to 10 times the NIOSH Recommended Exposure Limit (REL). With respect to RCF, both the NIOSH REL and the industry REG have been set at 0.5 fibers per cubic centimeter of air (f/cm³). Accordingly, N-95 would provide the necessary protection for exposures up to 5 f/cm³. Further, the Respirator Selection Guide published by 3M Corporation, the primary respirator manufacturer, specifically recommends use of N-95 respirators for RCF exposures. In cases where exposures are known to be above 5.0 f/cm³, 8 hour TWA, a filter efficiency of 100% should be used. Other factors to consider are the NIOSH filter series N, R or P -- (N) Not resistant to oil, (R) Resistant to oil and (P) oil Proof. These recommendations are not designed to limit informed choices, provided that respiratory protection decisions comply with 29 CFR 1910.134.

The evaluation of workplace hazards and the identification of appropriate respiratory protection is best performed, on a case by case basis, by a qualified Industrial Hygienist.

Other Information

Concentrations based upon an eight-hour time weighted average (TWA) as determined by air samples collected and analyzed pursuant to NIOSH method 7400 (B) for airborne fibers. The manufacturer recommends the use of a full-facepiece air purifying respirator equipped with an appropriate particulate filter cartridge during furnace tear-out events and the removal of used RCF to control exposures to airborne fiber and the potential presence of crystalline silica.

9 - Physical and chemical properties

a - Appearance	White, odorless, fibrous material
b - Odor	Not applicable
c - Odor Threshold	Not applicable
e- pH	Not applicable
d - Melting Point	1760°C (3200°F)
f- Initial Boiling Point/Range	Not applicable
g- Flashpoint	Not applicable
h - Evaporation Rate	Not applicable
i - Flammability	Not applicable
j - Upper/Lower Flammability or Explosive Limits	Not applicable
k - VAPOR PRESSURE	Not applicable
l - VAPOR DENSITY	Not applicable
m - Solubility	Not soluble in water
n - Relative Density	2.50 - 2.75
o - Partition Coefficient: n-Octanol/water	Not applicable
p - Auto-ignition temperature	Not applicable
q - Decomposition Temperature	Not applicable
r - Viscosity	Not applicable

10 - Stability and Reactivity**a - Reactivity**

Stable under conditions of normal use.

b - Chemical Stability

This is a stable material.

c - Possibility of Hazardous Reaction

Not applicable.

d - Conditions to Avoid

Please refer to handling and storage advise in Section 7.

e - Incompatible Materials

None

f - Hazardous decomposition products

None

a - TOXICOKINETICS, METABOLISM AND DISTRIBUTION

Exposure is predominantly by inhalation or ingestion. Man-made vitreous fibers of a similar size to RCF have not been shown to migrate from the lung and/or gut and do not become located in other organs of the body.

b - Acute Toxicity**c - Epidemiology**

In order to determine possible human health effects following RCF exposure, the University of Cincinnati has been conducting medical surveillance studies on RCF workers in the U.S.A; this epidemiological study has been ongoing for 25 years and medical surveillance of RCF workers continues. The Institute of Occupational Medicine (IOM) has conducted medical surveillance studies on RCF workers in European manufacturing facilities.

Pulmonary morbidity studies among production workers in the U.S.A. and Europe have demonstrated an absence of interstitial fibrosis. In the European study a reduction of lung capacity among smokers has been identified, however, based on the latest results from a longitudinal study of workers in the U.S.A. with over 17-year follow-up, there has been no accelerated rate of loss of lung function (McKay et al. 2011).

A statistically significant correlation between pleural plaques and cumulative RCF exposure was evidenced in the U.S.A. longitudinal study.

The U.S.A. mortality study showed no excess mortality related to all deaths, all cancer, or malignancies or diseases of the respiratory system including mesothelioma (LeMasters et al. 2003).

d - Toxicology

- *Acute toxicity: short term inhalation*

No data available: Short term tests have been undertaken to determine fiber (bio) solubility rather than toxicity; repeat dose inhalation tests have been undertaken to determine chronic toxicity and carcinogenicity.

- *Acute toxicity: oral*

No data available: Repeated dose studies have been carried out using gavage. No effect was found.

- *Skin corrosion/irritation*

Not a chemical irritant according to test method OECD no. 404.

- *Serious eye damage/irritation*

Not possible to obtain acute toxicity information due to the morphology and chemical inertness of the substance.

- *Respiratory or skin sensitization*

No evidence from human epidemiological studies of any respiratory or skin sensitization potential.

- *Germ cell mutagenicity/genotoxicity*

Method: In vitro micronucleus test

Species: Hamster (CHO)

Dose: 1-35 mg/ml

Routes of administration: In suspension

Results: Negative

- *Carcinogenicity*

Method: Inhalation, multi-dose

Species: Rat

Dose: 3 mg/m³, 9 mg/m³ and 16 mg/m³

Routes of administration: Nose only inhalation

Results: Fibrosis just reached significant levels at 16 and 9 mg/m³ but not at 3 mg/m³. None of the parenchymal tumor incidences were higher than the historical control values for this strain of animal.

Method: Inhalation, single dose

Species: Rat

Dose: 30 mg/m³

Routes of administration: Nose only inhalation

Results: Rats were exposed to a single concentration of 200 WHO fibers/ml specially prepared RCF for 24 months. High incidence of exposure-related pulmonary neoplasms (bronchoalveolar adenomas and carcinomas) was observed. A small number of mesotheliomas were observed in each of the fiber exposure groups (Mast et al 1995a).

Method: Inhalation, single dose

Species: Hamster

Dose: 30 mg/m³

Routes of administration: Nose only inhalation

Results: Hamsters were exposed to a single concentration of 260 WHO fibers/ml specially prepared RCF for 18 months and developed lung fibrosis, a significant number of pleural mesotheliomas (42/102) but no primary lung tumors (McConnell et al 1995).

Method: Inhalation, single dose

Species: Rat

Dose: RCF1: 130 F/ml and 50 mg/m³ (25% of non fibrous particles)

RCF1a: 125 F/ml and 26 mg/m³ (2% of non fibrous particles)

Routes of administration: Nose only inhalation

Results: Rats were exposed to RCF1 and RCF1a for 3 weeks. The objective of the study was to compare lung retention and biological effects of the original RCF1 compared to RCF1a. The main difference of these 2 samples was the non-fibrous particle content of respectively 25% versus 2%. The post treatment observation was 12 months. Alveolar clearance was barely retarded after RCF1A exposure. After RCF1 exposure, however, a severe retardation of clearance was observed. (Bellmann et al 2001).

After intraperitoneal injection of ceramic fibers into rats in three experiments (Smith et al 1987, Pott et al 1987, Davis et al 1984), mesotheliomas were found in the abdominal cavity in two studies, while the third report (Pott et al 1987) had incomplete histopathology. Only a few mesotheliomas were found in the abdominal cavity of hamsters after intraperitoneal injection in

one experiment (Smith et al 1987). However, the ceramic fibers tested were of relatively large diameter. When rats and hamsters were exposed via intraperitoneal injection, tumor incidence was related to fiber length and dose (Smith et al 1987, Pott et al 1987, Miller et al 1999, Pott et al 1989). (From SCOEL publication (EU Scientific Committee on Occupational Exposure Limits) SCOEL/SUM/165, September 2011).

- *Reproductive toxicity*

Method: Gavage

Species: Rat

Dose: 250mg/kg/day

Routes of administration: Oral

Results: No effects were seen in an OECD 421 screening study. There are no reports of any reproductive toxic effects of mineral fibers. Exposure to these fibers is via inhalation and effects seen are in the lung. Clearance of fibers is via the gut and the feces, so exposure of the reproductive organs is extremely unlikely.

- *STOT-Single exposure*

Not applicable

- *STOT-Repeated exposure*

Not applicable

- *Aspiration hazard*

Not applicable

See the following review publications for a summary and discussion:

Interpretation of these animal experiments is complex and there is not complete agreement among scientists internationally. A summary of the evidence relating to RCF carcinogenicity in vivo can be found in SCOEL/SUM/165 and in Utell and Maxim 2010.

Other information

Numerous studies indicate the relevance of biopersistence as a determinant of toxic effects of fiber exposure. (Maxim et al 2006).

Irritant Properties

Negative results have been obtained in animal studies (EU method B 4) for skin irritation. Inhalation exposures using the nose only route produce simultaneous heavy exposures to the eyes, but no reports of excess eye irritation exist. Animals exposed by inhalation similarly show no evidence of respiratory tract irritation.

Human data confirm that only mechanical irritation, resulting in itching, occurs in humans. Screening at manufacturers' plants in the UK has failed to show any human cases of skin conditions related to fiber exposure.

International Agency for Research on Cancer and National Toxicology Program

IARC, in 1988, Monograph v.43 (and later reaffirmed in 2002, v.81), classified RCF as possibly carcinogenic to humans (group 2B). IARC evaluated the possible health effects of RCF as follows:

There is inadequate evidence in humans for the carcinogenicity of RCF. There is sufficient evidence in experimental animals for the carcinogenicity of RCF. The Annual Report on Carcinogens (latest edition), prepared by NTP, classified respirable RCF as "reasonably anticipated" to be a carcinogen). Not classified by OSHA.

12 - Ecological information

These products are not reported to have any ecotoxicity effects.

c - Bioaccumulative potential

No bioaccumulative potential.

d - Mobility in soil

No mobility in soil.

e - Other adverse effects (such as hazardous to the ozone layer

No adverse effects of this material on the environment are anticipated.

13 - Disposal Considerations

Waste Management and Disposal

To prevent waste materials from becoming airborne during waste storage, transportation and disposal, a covered container or plastic bagging is recommended.

Additional information

This product, as manufactured, is not classified as a listed or characteristic hazardous waste according to U. S. Federal regulations (40 CFR 261). Any processing, use, alteration or chemical additions to the product, as purchased, may alter the disposal requirements. Under U. S. Federal regulations, it is the waste generator's responsibility to properly characterize a waste material, to determine if it is a "hazardous" waste. Check local, regional, state or provincial regulations to identify all applicable disposal requirements.

14 - Transport information

a - UN number.

Hazard Class: Not Regulated United Nations (UN) Number: Not Applicable
Labels: Not Applicable North America (NA) Number: Not Applicable
Placards: Not Applicable Bill of Lading: Product Name

b - UN proper shipping name

Not applicable.

c - Transport hazard class(es)

Not applicable.

d - Packing group, if applicable

Not applicable.

e - Environmental hazards (e.g., Marine pollutant (Yes/No))

No.

f - Transport in bulk (according to Annex II of MARPOL 73/78 and the IBC Code)

Not regulated.

g - Special precautions which a user needs to be aware of, or needs to comply with, in connection with transport or conveyance either within or outside their premises

Not applicable.

International

INTERNATIONAL

Canadian TDG Hazard Class & PIN: Not regulated

Not classified as dangerous goods under ADR (road), RID (train), IATA (air) or IMDG (ship).

15 - Regulatory information

15.1 - United States Regulations

UNITED STATES REGULATIONS

EPA: Superfund Amendments and Reauthorization Act (SARA) Title III - This product does not contain any substances reportable under Sections 302, 304, 313, (40 CFR 372). Sections 311 and 312 (40 CFR 370) apply (delayed hazard).

Toxic Substances Control Act (TSCA)— RCF has been assigned a CAS number; however, it is not required to be listed on the TSCA inventory.

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and the **Clean Air Act (CAA)** - RCF contains fibers with an average diameter greater than one micron and thus is not considered a hazardous air pollutant.

OSHA: Comply with **Hazard Communication Standards** 29 CFR 1910.1200 and 29 CFR 1926.59 and the **Respiratory Protection Standards** 29 CFR 1910.134 and 29 CFR 1926.103.

California: Ceramic fibers (airborne particles of respirable size) is listed in **Proposition 65, The Safe Drinking Water and Toxic Enforcement Act of 1986** as a chemical known to the State of California to cause cancer.

Other States: RCF products are not known to be regulated by states other than California; however, state and local OSHA and EPA regulations may apply to these products. If in doubt, contact your local regulatory agency.

15.2 - International Regulations

INTERNATIONAL REGULATIONS

Canada:

Canadian Workplace Hazardous Materials Information System (WHMIS) - RCF is classified as

Class D2A - Materials Causing Other Toxic Effects

Canadian Environmental Protection Act (CEPA)- All substances in this product are listed, as required, on the Domestic Substances List (DSL)

European Union:

European Directive 97/69/EC classified RCF as a Category 2 carcinogen; that is it "should be regarded as if it is carcinogenic to man."

REACH Regulation:

RCF is classified under the CLP (classification, labelling and packaging of substances and mixtures) regulation as a category 1B carcinogen. On January 13, 2010 the European Chemicals Agency (ECHA) updated the candidate list for authorization (Annex XV of the REACH regulation) and added 14 new substances in this list including aluminosilicate refractory ceramic fibers.

As a consequence, EU (European Union) or EEA (European Economic Area) suppliers of articles which contain aluminosilicate refractory ceramic fibers in a concentration above 0.1% (w/w) have to provide sufficient information, available to them, to their customers or upon requests to a consumer within 45 days of the receipt of the request. This information must ensure safe use of the article, and as minimum contains the name of the substance.

initial statement**Devitrification**

As produced, all RCF fibers are vitreous (glassy) materials which do not contain crystalline silica. Continued exposure to elevated temperatures over time may cause these fibers to devitrify (become crystalline). The first crystalline formation (mullite) begins to occur at approximately 985° C (1805° F). Crystalline phase silica may begin to form at approximately 1100° C (2012° F). When the glass RCF fibers devitrify, they form a mixed mineral crystalline silica containing dust. The crystalline silica is trapped in grain boundaries within a matrix predominately consisting of mullite. The occurrence and extent of crystalline phase formation is dependent on the duration and temperature of exposure, fiber chemistry and/or the presence of fluxing agents or furnace contaminants. The presence of crystalline phases can be confirmed only through laboratory analysis of the "hot face" fiber.

IARC's evaluation of crystalline silica states "Crystalline silica inhaled in the form of quartz or cristobalite from occupational sources is carcinogenic to humans (Group 1)" and additionally notes "carcinogenicity in humans was not detected in all industrial circumstances studied." IARC also studied mixed mineral crystalline silica containing dusts such as coal dusts (containing 5–15 % crystalline silica) and diatomaceous earth without seeing any evidence of disease. (IARC Monograph Vol. 68, 1997). NTP lists all polymorphs of crystalline silica as substances which may "reasonably be anticipated to be carcinogens".

IARC and NTP did not evaluate after-service RCF, which may contain various crystalline phases. However, an analysis of after-service RCF samples obtained pursuant to an exposure monitoring agreement with the EPA, found that in the furnace conditions sampled, most did not contain detectable levels of crystalline silica. Other relevant RCF studies found that (1) simulated after-service RCF showed little, or no, activity where exposure was by inhalation or by intraperitoneal injection; and (2) after-service RCF was not cytotoxic to macrophage-like cells at concentrations up to 320 micrograms/cm² - by comparison, pure quartz or cristobalite were significantly active at much lower levels (circa 20 micrograms/cm²).

Product Stewardship Program

Morgan Thermal Ceramics has established a program to provide customers with up-to-date information regarding the proper use and handling of High Temperature Insulation Wool, including Refractory Ceramic Fiber (RCF). In addition, Thermal Ceramics has established a program to monitor airborne fiber concentrations at customer facilities. If you would like more information about this program, please call your local supplier or the Product Stewardship Information Hotline listed at the front of this SDS.

Morgan Thermal Ceramics is a member of the HTIWC (High Temperature Insulation Wool Coalition).

In 2002, OSHA endorsed a five year voluntary product stewardship program called PSP 2002. On May 23, 2007, HTIW Coalition's predecessor, RCFC, and its member companies renewed this voluntary product stewardship agreement with OSHA. On April 16, 2012, HTIW Coalition renewed this agreement for a second time.

This new five year program, called PSP 2012, continues and builds upon the earlier programs. PSP 2012 is a highly acclaimed, multifaceted strategic risk management initiative designed specifically to reduce workplace exposures to Refractory Ceramic Fiber (RCF). For more information regarding PSP 2012, please visit <http://www.htiwcoalition.org>

HMIS HAZARD RATING

HMIS Health	1* (* denotes potential for chronic effects)
HMIS Flammable	0
HMIS Reactivity	0
HMIS Personal Protective Equipment	X (To be determined by user)

TECHNICAL DATA SHEETS

514-500, 514-200, 514-1065, 514-1060, 514-1055, 514-1050, 514-1040, 514-1030, 514-1020, 514-1012, 514-1011, 514-1010, 514-1006, 514-1005, 514-1005, 514-1001, 514-1000, 514-956, 514-955, 514-946, 514-945, 514-935, 514-906, 514-905, 514-806, 514-805, 514-804, 514-803, 514-801, 514-800, 514-250, 514-220, 514-215, 514-205

Revision Summary

Revision date updated.

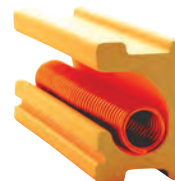
MSDS prepared by

SDS Prepared By: MORGAN THERMAL CERAMICS ENVIRONMENTAL, HEALTH & SAFETY DEPARTMENT

Disclaimer

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DAVINCI INSTRUCTION MANUAL



L&L Kiln's patented
hard ceramic
element holders
protect your kiln.

DaVinci

Top-Loading Square & Rectangular Kilns

This is a heavy production kiln for production potters, tile makers and industry. It has a stronger shape than an oval kiln.

- Square & Rectangular kilns are perfect for some types of work (like tiles) and allow larger volume
- Plug-in sectional construction makes DaVinci kilns very flexible. They can be easily taken apart and expanded or reduced in size
- Hard Ceramic Element Holders protect brick and make element changes fast and easy
- Dynamic Zone Control keeps temperatures uniform throughout kiln
- Remote Floor Standing Panel protects electronics and makes servicing easy
- Protected Thermocouples
- Spring-Assist counterbalanced lid makes loading easy
- Super-Strong welded steel stand supports heavy loading
- Customize to meet your exact needs.
Every kiln is built to order



Unique L&L Features with Lasting Benefits

CONE 10 RATING FOR ALL MODELS

Cone 10, 2350°F, 1290°C

3" K23 FIREBRICK INSULATION

3" K23 firebrick for all models.

PATENTED CERAMIC ELEMENT HOLDERS

Protect brick from loading damage, keep elements from falling out of grooves, make changing elements easy, and optimize heat transfer to load. Kiln lasts longer! No pins. (hotkilns.com/ceramic-holders)



HEAVY-DUTY LARGE ELEMENTS

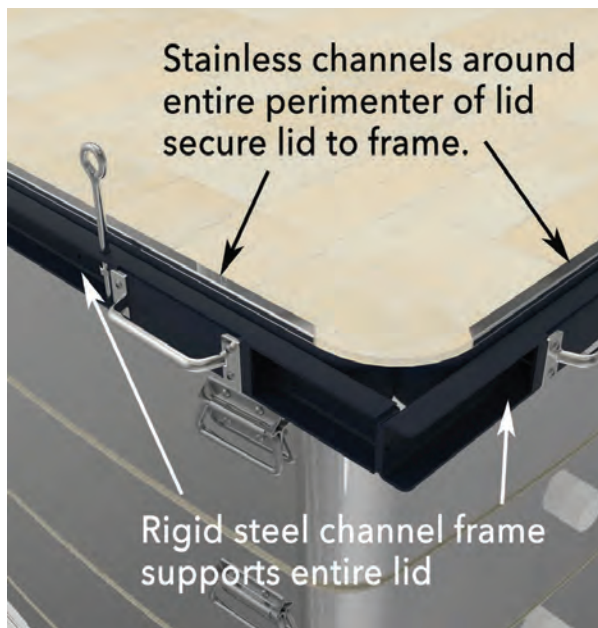
Heavy-duty. Three elements per section. *Quad elements, which increase the element wire by having four rows of elements per section, are optional on all models. See Page 7.*

THE ULTIMATE SECTIONAL KILN

Sectional kiln construction makes DaVinci kilns easy to move, set up and disassemble for maintenance or for loading. Sections are completely separate from the control panel. Each section has its own plug that plugs into a special receptacle in the control panel. Bottom is reversible.

(hotkilns.com/sectional-davinci)

LID BRICK IS SECURED WITH CLIPS



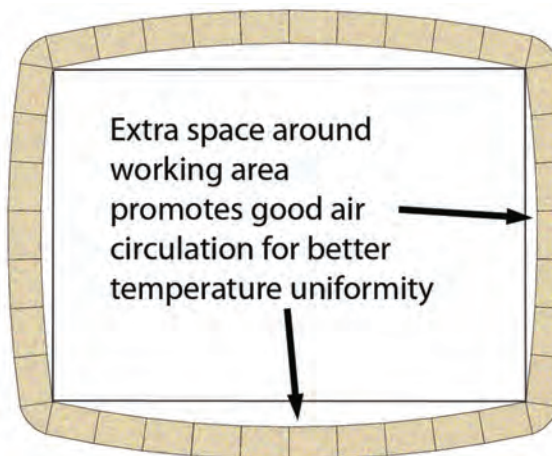
(hotkilns.com/davinci-lid)

EXTRA CASE CLAMPS

Stainless worm gear case clamps keep case together and allow for adjustment over time. Three per 9" section, Two on the top and bottom. (hotkilns.com/case-clamps)

EXTRA SPACE WITH ARCHED SIDES

Arched sides make the sides of DaVinci kilns stronger than oval kiln designs and provide extra space for air to circulate and radiant heat to promote even heating. (hotkilns.com/arched-sides)

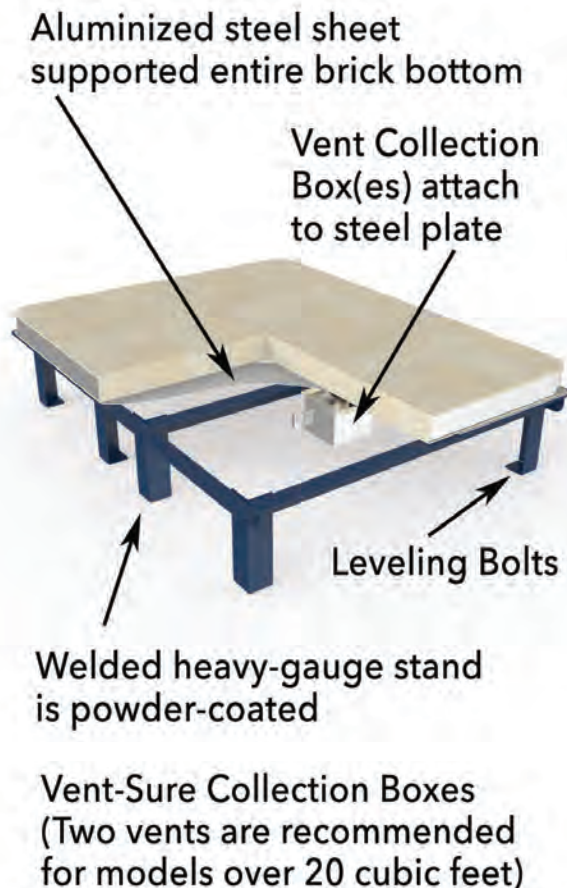


SPRING COUNTERBALANCED HINGE



HEAVY-DUTY FULL-SUPPORT STAND

(hotkilns.com/full-stand)



SOLID PEEPHOLE PLUGS

Solid (non-fragile) ceramic plug with heat-locked mushroom head. 3/4" diameter full-view non-tapered.

(hotkilns.com/peephole-plugs)



SEPARATE COOL-FIRING CONTROL PANEL



All controls and components are mounted in a separate control panel that floor mounted. Cords from the kiln sections plug into the panel. There is an air space between the panel and the kiln which keeps the controls cool - which is critical for long term health of the electronics. (hotkilns.com/davinci-panel)

MERCURY FREE RELAYS

Mercury free relays are standard. See Page 10 for optional electronic SSRs for extra long element life and quiet operation.

EASY MULTI-PROGRAM DYNATROL



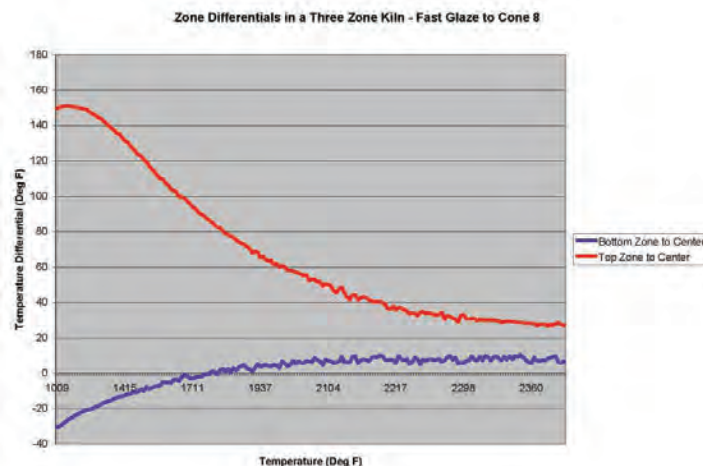
The time-tested DynaTrol with 4 Easy-Fire programs, 6 Vary-Fire programs, PreHeat, Delay, Program & Segment Review, and Diagnostics.

Optional Genesis control (see page 8) features touch screen and free

Wifi App for monitoring kiln. (hotkilns.com/dynatrol)

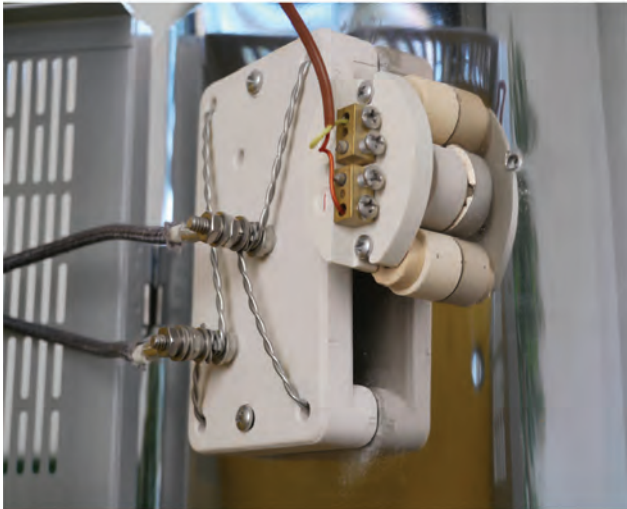
DYNAMIC ZONE CONTROL

This is a *standard* feature with either a DynaTrol or touch-screen Genesis control. The control separately measures temperatures in the bottom, middle, and top of the kiln and automatically adjusts the heat of two or three zones during the firing. Kiln temperatures are automatically equalized to within 1/2 cone or better. Zone control automatically compensates for many loading issues and element resistance changes. Additionally, L&L kilns are fundamentally uniform because the element holders radiate the heat more evenly. (hotkilns.com/zone-control)



CERAMIC ELEMENT CONNECTIONS

MOLDED CERAMIC ELEMENT
TERMINAL
STRONG, SIMPLE,
EASY TO SERVICE



Proprietary all-ceramic element connection block makes changing elements easy. Terminal hardware allows you to get good contact with the element with minimal effort. (hotkilns.com/ceramic-terminal)

**HEAVY-GAUGE TYPE K THERMOCOUPLES**

Type K 8 gauge thermocouple is protected by an open ceramic protection tube. This allows the thermocouple to accurately read the kiln temperature but protects the delicate tip of the thermocouple from damage while loading. Also any metallic flakes from the thermocouple will tend to drop inside the tube where they can be vacuumed out during normal maintenance. (hotkilns.com/protected-thermocouples)

**FOUR CHEST HANDLES PER KILN SECTION**

Chest Handles make the sections easy to lift.

CORROSION RESISTANT CONSTRUCTION

Stainless steel wrapped around brick. All stainless screws on case. Vent parts are stainless steel or aluminum. Stand and hinge are powder-coated welded steel. Control box is powder coated steel. (hotkilns.com/case)

DIRECT WIRING

All DaVinci kilns are direct wired.

COMPLETE VISUAL INSTRUCTIONS

No one has a better or more complete instruction manual. Our visual instructions address the needs of the artist, the installer, and the repair person. You get a fully illustrated operation and service manual. Many instructional videos are available. (hotkilns.com/videos)

L&L KILNS ARE EASY TO TROUBLESHOOT

Open up any L&L kiln control panel and see how easy it is to check amps, element resistance, and voltage. No other kiln can be serviced as quickly, easily, or inexpensively as an L&L kiln.

THREE-YEAR LIMITED WARRANTY

See hotkilns.com/warranty. Email, web and phone support.

IN-DEPTH SUPPORT

One customer said: "I am truly impressed with your website, it is more than informative and your products are well designed. The fact that all the information, including repair manuals, are listed, speaks well of your dedication to customer service." Our website has thousands of pages of technical help - all easily searchable - plus we provide expert support with phone and email.

SUSTAINABLE MANUFACTURING

We use solar energy as our primary energy source.

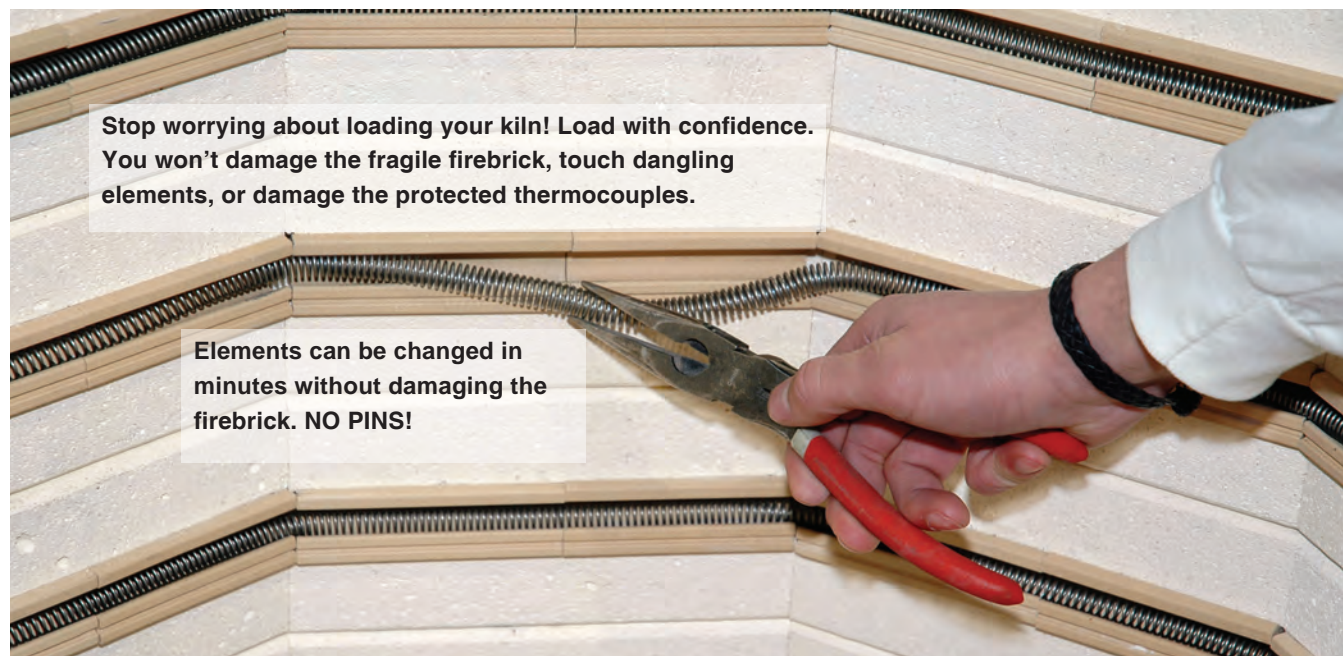
SUPERIOR PACKAGING

Kilns are securely packed with tubes of foam molded to the kiln. Kilns are shipped in skidded cartons or wooden crates depending on their size.

MET UL499 LISTING



c-MET-us listed to UL499 standards assures highest safety standards. (hotkilns.com/met)



Optional Kiln Furniture, Fiber Tops, & Quad & APM Element Options

CONE 11 FURNITURE KITS

Shelves are high alumina cone 11 shelves. Each post kit includes six each 1/2", 1", 2", 4", 6" and 8" high square (1.5" x 1.5") cordierite posts. Some kits come with two post kits (see specification pages). All furniture kits include one pair heat-resistant gloves. (hotkilns.com/kiln-furniture)



QUAD ELEMENT DESIGN

The combination of 1/2" diameter element coils, the doubled surface area of the Quad element design, and superior heat transfer of L&L's patented ceramic element holders, make this the best element system in the world today. (hotkilns.com/quad-option)



APM ELEMENTS

Special sintered alloy provides the ultimate in element life. The special sintered alloy inhibits grain growth and resistance change in the elements. (hotkilns.com/apm)

OPTIONAL FIBER TOP

These are ideal for T3400 kilns and X3200 kilns used for tough industrial applications. The lid firebrick is replaced with ceramic fiber modules. 2600°F ceramic fiber is folded and formed into 4" thick modules that have an alloy support system inside. The internal support of the module is bolted to a metal frame that matches the normal metal frame that we use in the firebrick lid. These lids will never crack or spall and will last indefinitely. The ceramic fiber is rated to a higher temperature than the kiln rating so there is no concern about shrinkage of the fiber.



Warning: Refractory ceramic fiber has hazards associated with its use. The RCF fiber is only intended for industrial use in production facilities.

Genesis Touch Screen Control with App

GENESIS TOUCH SCREEN CONTROL

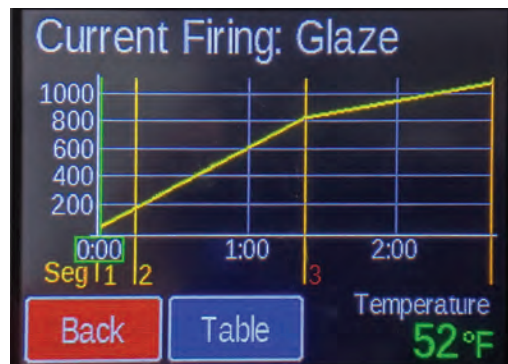
The Genesis control includes a touch screen interface and WIFI connectivity added to the proven software of the DynaTrol. More programming options and memory. Free App available to monitor kiln via WiFi. (hotkilns.com/genesis)



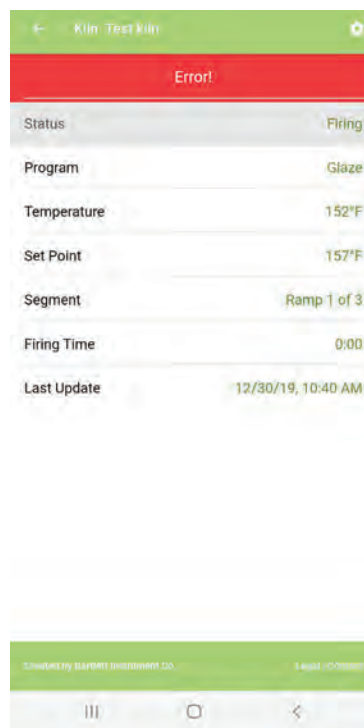
GENESIS FEATURES

- Touch-screen intuitive technology for easy user interface.
- Easy-to-follow screen descriptions.
- Different user-interface levels, which can be set to match the user's firing knowledge.
- Graphical display of the firing process right at the controller. This means you can graph the firing in real time and compare the program with actual results.
- Glass programs included.
- Store up to 30 custom user programs.
- Up to 32 segments per program.
- Ability to make adjustments during a firing such as add segments, add temperature, and skip segments.
- Built in diagnostics testing
- Alarm
- Error Codes
- WiFi enabled for easy software updating.
- Included Phone App allows you to monitor kiln operation remotely (with no subscription fee).

The Genesis control fits right into the control box to replace the DynaTrol. That means you can upgrade anytime!



See a graph of your firing before you fire, while you fire and after you fire.

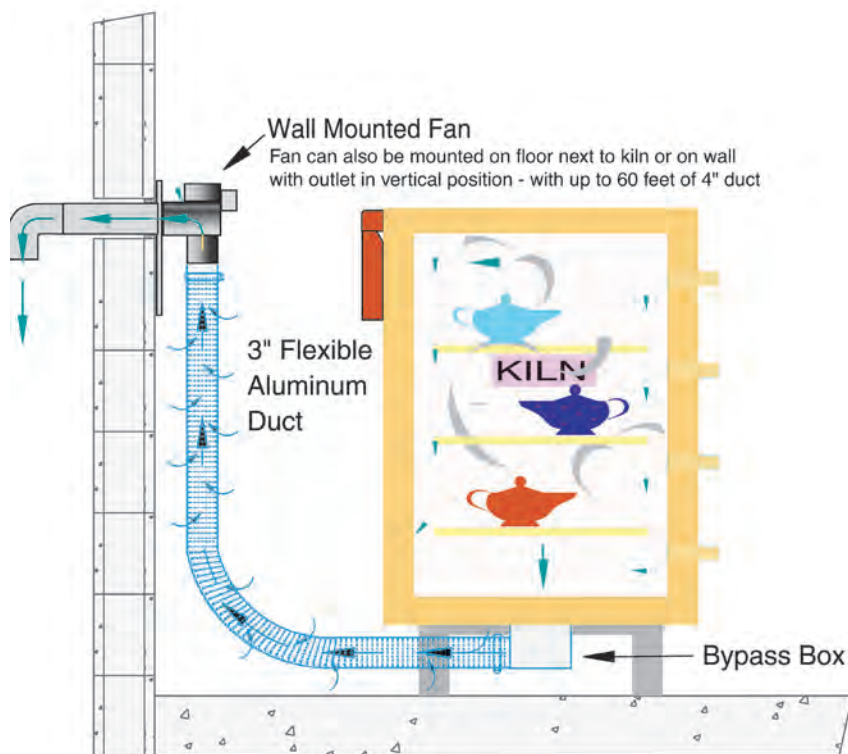


This shows the view you get on your phone with the Kiln Aid Phone app. Simply download the Kiln Aid phone app from your Google Play Store or Apple App Store, add your kiln, and begin monitoring as your kiln progresses through a firing. See temperatures, where you are in a program cycle, what program you are firing and error notifications.

Ventilation Options & Accessories

DOWNDRAFT VENT SYSTEM

Vent-Sure downdraft vent vents fumes from kiln out of room and away from kiln. (hotkilns.com/vent)



VENT-SURE FEATURES

- Downdraft venting pulls air down to bottom of kiln
- Improves temperature uniformity inside the kiln
- Powerful 130 CFM fan motor, typically mounted on wall, allows fumes to be under vacuum in your studio
- The strong fan motor helps overcome static pressure in long exhaust lines. The duct may be up to 60 feet in length, and include up to four 90° bends
- 120 volts with on/off switch on cord (240 volts available)
- 15 foot long flexible aluminum duct
- Bypass collection box mounted on kiln allows adjustment of venting.
- Fan motor, mounted away from the kiln, stays cool and no vibration is transmitted to the kiln
- The included Multi-Mounting Bracket allows you to mount the vent on the floor or, alternately, to mount the vent on a wall so that the output of the vent is pointing up.
- Three-year Limited Warranty
- c-MET-us Listed to UL499 standards for use on c-MET-us L&L Kilns



VENT CONTROL

Allows vent to be controlled with an event switch in the DynaTrol or Genesis. (For use with one kiln.) (hotkilns.com/vent-control)



HOW MANY VENTS?

We recommend one vent for kilns that are 25 cubic feet or less and two vents for kilns that are 25 cubic feet or more. See the specification pages for cubic foot specifications.

More Control & Power Options

TYPE S THERMOCOUPLES

The best thermocouple for constant high fire applications. No thermocouple drift. Priced per thermocouple. Note that kilns with four or more sections still only have a three zone control.

(hotkilns.com/type-s)

PYROCIL SHEATHED THERMOCOUPLES

For greater sensitivity to temperature change. Use below 2200°F for sensitivity (glass is a good example). Priced per thermocouple. These are useful for sensitive industrial applications.

(hotkilns.com/pyrocil-tc)

SOLID STATE RELAYS

Industrial Grade Solid State Relays are quiet and result in longer element life because the switching time is so fast the elements don't expand and contract as much. The whole system includes extra large heat sinks, special fast acting fuses, cooling fan and extra safety relays. c-MET-us listed option.

(hotkilns.com/ssr)

HIGH LIMIT BACK UP CONTROL

Bartlett High Limit Control with latching relay acts as a back up to the main control. If the main control fails for any reason then this acts as a "back stop" and shuts the kiln down.

(hotkilns.com/high-limit)

BACK UP CONTACTORS

Actuated by the High Limit Back Up Digital Control, back up contactors are completely redundant power contactors so that if one or more contactors fail in a closed position, then the kiln still cannot climb above the High Limit set point. (hotkilns.com/high-limit)

120 VOLT POWER SUPPLY

If there are problems with short power outages, voltage spikes, voltage drops, or excessive environmental line noise, this can cause unpredictable behaviour in the electronic control. With this option the control is powered by a separate 120 volt line (with a standard 6 foot long cord) and that voltage is filtered through an EMI (Electrical Magnetic Interference) noise filter. (hotkilns.com/noise)

NEMA1 CONTROL PANEL



These are typically used for 480 volt models. They include integrated panel stand legs.

480 VOLT OPTION

Available on all DaVinci kilns. The typical wiring is to use a floating Wye system and run the elements on 277 volts. However, on the quad models there are two 240 volt elements in series. The amperage ratings of those models are slightly different. check on the website for details.

Pull-Apart Option

“PULL-APART” OPTION FOR SCULPTURE AND INDUSTRY

Includes floor mount stand for control panel, lift off lid with extra handles but no hinge. This option allows the entire kiln to be dismantled to make it easy to load large sculptural pieces. The kiln sections are unplugged and then taken off one at a time. You can order a hinge as well but the hinge makes the kiln harder to take apart.



Custom cross sections and
heights available

Electrical Specifications for X2300 Series (USA)

Standard Models								High Powered Models				
Model Number	Part Number	Volt/ Phase	Watts	Amps	Wire Size	Fuse Size	Model Number	Part Number	Watts	Amps	Wire Size	Fuse Size
XB2318-D-240	K-X-2318/31	240/1P	8,936	37.2	6 ga	50 *						
XB2318-D-240-3P	K-X-2318/32	240/3P	8,936	32.2	6 ga	50 *						
XB2318-D-208	K-X-2318/21	208/1P	8,936	43.0	6 ga	60						
XB2318-D-208-3P	K-X-2318/22	208/3P	8,936	37.2	6 ga	50						
XB2318-D-480-3P	K-X-2318/62	480/3P	8,936	10.8	14 ga	15						
XB2318-D-480-3P-QD	K-X-231N/62	480/3P	8,936	16.1	12 ga	25						
X2327-D-240	K-X-2327/31	240/1P	11,704	48.8	4 ga	70 *	XB2327-D-240	K-X-232B/31	13,404	55.9	4 ga	70 *
X2327-D-240-3P	K-X-2327/32	240/3P	11,704	28.2	8 ga	40 *	XB2327-D-240-3P	K-X-232B/32	13,404	32.2	6 ga	50 *
X2327-D-208	K-X-2327/21	208/1P	11,704	56.3	3 ga	80 *	XB2327-D-208	K-X-232B/21	13,404	64.4	2 ga	90
X2327-D-208-3P	K-X-2327/22	208/3P	11,704	32.5	6 ga	50 *	XB2327-D-208-3P	K-X-232B/22	13,404	37.2	6 ga	50
X2327-D-480-3P	K-X-2327/62	480/3P	11,704	14.1	14 ga	20	XB2327-D-480-3P	K-X-232B/62	13,404	16.1	12 ga	25
X2327-D-480-3P-QD	K-X-232Q/62	480/3P	11,704	14.1	14 ga	20	XB2327-D-480-3P-QD	K-X-232N/62	13,404	16.1	12 ga	25
X2336-D-240	K-X-2336/31	240/1P	15,604	65.0	2 ga	90 *	XB2336-D-240	K-X-233B/31	17,872	74.5	1 ga	100 *
X2336-D-240-3P	K-X-2336/32	240/3P	15,604	43.0	6 ga	60 *	XB2336-D-240-3P	K-X-233B/32	17,872	49.3	4 ga	70 *
X2336-D-208	K-X-2336/21	208/1P	15,604	75.0	1 ga	100 *	XB2336-D-208	K-X-233B/21	17,872	85.9	1 ga	110
X2336-D-208-3P	K-X-2336/22	208/3P	15,604	49.6	4 ga	70 *	XB2336-D-208-3P	K-X-233B/22	17,872	56.8	3 ga	80
X2336-D-480-3P	K-X-2336/62	480/3P	15,604	18.8	12 ga	25	XB2336-D-480-3P	K-X-233B/62	17,872	21.5	10 ga	30
X2336-D-480-3P-QD	K-X-233Q/62	480/3P	15,604	21.5	10 ga	30	XB2336-D-480-3P-QD	K-X-233N/62	17,872	24.6	8 ga	40
X2345-D-240	K-X-2345/31	240/1P	19,505	81.3	1 ga	110 *	XB2345-D-240	K-X234B/31	22,340	93.1	1/0	125 *
X2345-D-240-3P	K-X-2345/32	240/3P	19,505	56.3	3 ga	80 *	XB2345-D-240-3P	K-X234B/32	22,340	64.5	2 ga	90 *
X2345-D-208	K-X-2345/21	208/1P	19,505	93.8	1/0	125 *	XB2345-D-208	K-X234B/21	22,340	107.4	3/0	150
X2345-D-208-3P	K-X-2345/22	208/3P	19,505	65.0	2 ga	90 *	XB2345-D-208-3P	K-X234B/22	22,340	74.4	1 ga	100
X2345-D-480-3P	K-X-2345/62	480/3P	19,505	23.5	10 ga	30	XB2345-D-480-3P	K-X234B/62	22,340	26.9	8 ga	40
X2345-D-480-3P-QD	K-X-234Q/62	480/3P	19,505	28.2	8 ga	40	XB2345-D-480-3P-QD	K-X234N/62	22,340	18.6	12 ga	25

ELECTRICAL NOTES

MET UL499 Listing: All models are c-MET-us listed to UL499 standard.

Cone Rating: All models are rated to Cone 10.

Wiring Diagrams: See the **Electrical Tab** for each kiln model to get the wiring diagram for each voltage.

Power connection: Direct wired.

Elements: All elements are of equal resistance value. Quad elements are the same resistance but longer and thicker.

XB MODELS: XB models have more power than the regular X model kilns. The higher powered XB elements are always used on the XB2318 because of the large ratio of unheated surface area.

(*) Control Panels: In the Fuse Size column if there is an asteric (*) then the kiln gets a Jupiter type kiln mount panel. All other kilns get a floor standing panel. NEMA 1 panel are recommended but not required for 480 volts.

Electrical Specifications for X2300 Series (World)

Standard Models								High Powered Models				
Model Number	Part Number	Volt/Phase	Watts	Amps	Wire Size	Fuse Size	Model Number	Part Number	Watts	Amps	Wire Size	Fuse Size
XB2318-D-220	K-X-2318/41	220/1P	8,936	40.6	6 ga	60						
XB2318-D-380-3PY	K-X-2318/52	380/3PY	8,936	20.3	10 ga	30						
XB2318-D-400-3PY	K-X-2318/82	400/3PY	8,936	19.4	12 ga	25						
XB2318-D-415-3PY	K-X-2318/72	415/3PY	8,936	18.6	12 ga	25						
X2327-D-220	K-X-2327/41	220/1P	11,704	53.2	4 ga	70 *	XB2327-D-220	K-X-232B/41	13,404	60.9	3 ga	80
X2327-D-380-3PY	K-X-2327/52	380/3PY	11,704	17.7	12 ga	25 *	XB2327-D-380-3PY	K-X-232B/52	13,404	20.3	10 ga	30
X2327-D-400-3PY	K-X-2327/82	400/3PY	11,704	17.0	12 ga	25 *	XB2327-D-400-3PY	K-X-232B/82	13,404	19.4	12 ga	25
X2327-D-415-3PY	K-X-2327/72	415/3PY	11,704	16.3	12 ga	25 *	XB2327-D-415-3PY	K-X-232B/72	13,404	18.6	12 ga	25
X2336-D-220	K-X-2336/41	220/1P	15,604	70.9	2 ga	90 *	XB2336-D-220	K-X-233B/41	17,872	81.2	1 ga	110
X2336-D-380-3PY	K-X-2336/52	380/3PY	15,604	35.5	6 ga	50 *	XB2336-D-380-3PY	K-X-233B/52	17,872	40.6	6 ga	60
X2336-D-400-3PY	K-X-2336/82	400/3PY	15,604	33.9	6 ga	50 *	XB2336-D-400-3PY	K-X-233B/82	17,872	38.9	6 ga	50
X2336-D-415-3PY	K-X-2336/72	415/3PY	15,604	32.5	6 ga	50 *	XB2336-D-415-3PY	K-X-233B/72	17,872	37.2	6 ga	50
X2345-D-220	K-X-2345/41	220/1P	19,505	88.7	1/0	125 *	XB2345-D-220	K-X-234B/41	22,340	101.5	3/0	150
X2345-D-380-3PY	K-X-2345/52	380/3PY	19,505	35.5	6 ga	50 *	XB2345-D-380-3PY	K-X-234B/52	22,340	40.6	6 ga	60
X2345-D-400-3PY	K-X-2345/82	400/3PY	19,505	33.9	6 ga	50 *	XB2345-D-400-3PY	K-X-234B/82	22,340	38.9	6 ga	50
X2345-D-415-3PY	K-X-2345/72	415/3PY	19,505	32.5	6 ga	50 *	XB2345-D-415-3PY	K-X-234B/72	22,340	37.2	6 ga	50

ELECTRICAL NOTES

MET UL499 Listing: All models are c-MET-us listed to UL499 standard.

Cone Rating: All models are rated to Cone 10.

Wiring Diagrams: See the **Electrical Tab** for each kiln model to get the wiring diagram for each voltage.

Power connection: Direct wired.

Elements: All elements are of equal resistance value. Quad elements are the same resistance but longer and thicker.

XB MODELS: XB models have more power than the regular X model kilns. The higher powered XB elements are always used on the XB2318 because of the large ratio of unheated surface area.

(*) Control Panels: In the Fuse Size column if there is an asteric (*) then the kiln gets a Jupiter type kiln mount panel. All other kilns get a floor standing panel.

Dimension & Weight Specifications for X2300 Series

Model Number	Inside Height	Cubic Feet	Furniture Kit	Furniture Kit Part No.	Outside Dimensions	Shipping Dimensions (with Kit)	Ship Weight Kiln Only	Ship Weight Kiln + Kit
XB2318-D	18"	5.0	4 shelves, 1 post kit	H-X-K318/00	43" W x 74" H x 41" D	1 crate: 44" W x 46" H x 48" D 1 crate: 45" W x 84" H x 48" D	555 lbs	625 lbs
X2327-D	27"	7.6	6 shelves, 1 post kit	H-X-K327/00	43" W x 87" H x 41" D	1 crate: 44" W x 54" H x 48" D 1 crate: 44" W x 93" H x 48" D	640 lbs	730 lbs
X2336-D	36"	10.1	8 shelves, 2 post kits	H-X-K336/00	43" W x 96" H x 41" D	1 crate: 44" W x 64" H x 48" D 1 crate: 44" W x 93" H x 48" D	800 lbs	915 lbs
X2345-D	45"	12.6	10 shelves, 2 post kits	H-X-K345/00	43" W x 105" H x 41" D	1 crate: 44" W x 54" H x 48" D 1 crate: 44" W x 93" H x 48" D 1 crate: 44" W x 42" H x 48" D	920 lbs	1,055 lbs
METRIC DIMENSIONS (CM, LITERS & KG)								
XB2318-D	45.7	143 L	4 shelves, 1 post kit	H-X-K318/00	109 W x 188 H x 104 D	1 crate: 112 W x 117 H x 122 D 1 crate: 115 W x 214 H x 122 D	252 KG	284 KG
X2327-D	68.6	215 L	6 shelves, 1 post kit	H-X-K327/00	109 W x 221 H x 104 D	1 crate: 112 W x 138 H x 122 D 1 crate: 112 W x 237 H x 122 D	291 KG	332 KG
X2336-D	91.4	286 L	8 shelves, 2 post kits	H-X-K336/00	109 W x 244 H x 104 D	1 crate: 112 W x 163 H x 122 D 1 crate: 112 W x 237 H x 122 D	363 KG	416 KG
X2345-D	114.3	357 L	10 shelves, 2 post kits	H-X-K345/00	109 W x 267 H x 104 D	1 crate: 112 W x 138 H x 122 D 1 crate: 115 W x 237 H x 122 D 1 crate: 112 W x 107 H x 122 D	418 KG	479 KG

DIMENSION & SHIPPING NOTES

Cross section of Inside: Approximately 22" wide by 22" deep. (56 cm by 56 cm)

Hearth Setting Area: 20" wide by 20" deep. (50.8 cm by 50.8 cm)

Recommended Minimum Space Requirements: 75.6" wide by 70.8" deep (192 cm by 180 cm)
(See General Dimension Diagram for details).

MORE: See each model page on hotkilns.com to download PDF General Dimension Drawings for more outside and inside dimensions, minimum space requirements, BTU ventilation requirements, and kiln weight. See the Shipping Tab on the model page for complete shipping dimension and shipping weight information.

Moving and installation: The kiln comes assembled but can be quickly disassembled and reassembled to move through any door or up stairs. It comes packed in a skidded carton with secure foam-in-place packaging.

XB2318

Temperature Rating: Cone 10

Volume: 5.0 Cubic Feet

Brick Thickness: 3" Brick

Inside: 22" W x 18" High

Outside Dimensions: 43" W x 74" H x 41" D

Shipping Dim with Vent & Furn Kit: 2 Crates (44" W x 46" H x 48" D & 44" W x 54" H x 48" D)

Ship Weight (Kiln): 555 LBS

Ship Weight (Kiln, Vent & Furn Kit): 625 LBS

FURNITURE KIT FOR XB2318

Part Number: H-X-K318/00

Includes: Four 20" X 10" Rectangular Shelves (3/4" thick), Six Each 1/2", 1", 2", 4", 6", and 8" Square Posts, Heat Resistant Gloves.



X2327

Temperature Rating: Cone 10

Volume: 7.6 Cubic Feet

Brick Thickness: 3" Brick

Inside: 22" W x 27" High

Outside Dimensions: 43" W x 87" H x 41" D

Shipping Dim with Vent & Furn Kit: 2 Crates (44" W x 54" H x 48" D & 44" W x 84" H x 48" D)

Ship Weight (Kiln): 640 LBS

Ship Weight (Kiln, Vent & Furn Kit): 730 LBS

FURNITURE KIT FOR X2327

Part Number: H-X-K327/00

Includes: Six 20" X 10" Rectangular Shelves (3/4" thick), Six Each 1/2", 1", 2", 4", 6", and 8" Square Posts, Heat Resistant Gloves.



X2336

Temperature Rating: Cone 10

Volume: 10.1 Cubic Feet

Brick Thickness: 3" Brick

Inside: 22" W x 36" High

Outside Dimensions: 43" W x 96" H x 41" D

Shipping Dim with Vent & Furn Kit: 2 Crates (44" W x 52" H x 48" D & 44" W x 84" H x 48" D)

Ship Weight (Kiln): 800 LBS

Ship Weight (Kiln, Vent & Furn Kit): 915 LBS

FURNITURE KIT FOR X2336

Part Number: H-X-K336/00

Includes: Eight 20" X 10" Rectangular Shelves (3/4" thick), Twelve Each 1/2", 1", 2", 4", 6", and 8" Square Posts, Heat Resistant Gloves.



X2345

Temperature Rating: Cone 10

Volume: 12.6 Cubic Feet

Brick Thickness: 3" Brick

Inside: 22" W x 45" High

Outside Dimensions: 43" W x 105" H x 42" D

Shipping Dim with Vent & Furn Kit: 3 Crates (44" W x 54" H x 48" D, 44" W x 36" H x 48" D & 44" W x 84" H x 48" D)

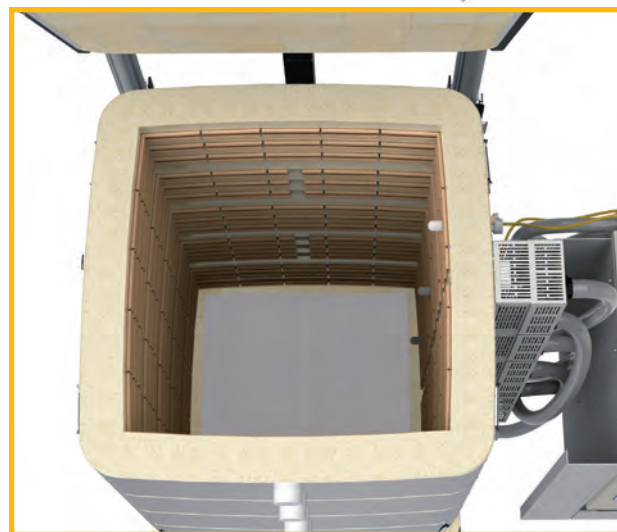
Ship Weight (Kiln): 920 LBS

Ship Weight (Kiln, Vent & Furn Kit): 1,055 LBS

FURNITURE KIT FOR X2345

Part Number: H-X-K345/00

Includes: Ten 20" X 10" Rectangular Shelves (3/4" thick), Twelve Each 1/2", 1", 2", 4", 6", and 8" Square Posts, Heat Resistant Gloves.



Electrical Specifications for X2800 Series (USA)

Standard Models							Powered Bottom Models				
Model Number	Part Number	Volt/Phase	Watts	Amps	Wire Size	Fuse Size	Part Number	Watts	Amps	Wire Size	Fuse Size
XB2818-D-240	K-X-2818/31	240/1P	11,592	48.3	4 ga	70	K-X-281W/31	15,456	64.4	2 ga	90
XB2818-D-240-3P	K-X-2818/32	240/3P	11,592	41.8	6 ga	60	K-X-281W/32	15,456	41.8	6 ga	60
XB2818-D-208	K-X-2818/21	208/1P	11,592	55.7	4 ga	70	K-X-281W/21	15,456	74.3	1 ga	100
XB2818-D-208-3P	K-X-2818/22	208/3P	11,592	48.3	4 ga	70	K-X-281W/62	15,456	48.3	4 ga	70
XB2818-D-480-3P	K-X-2818/22	480/3P	11,592	20.9	10 ga	30	K-X-281W/22	15,456	20.9	10 ga	30
X2827-D-240	K-X-2827/31	240/1P	14,930	62.2	3 ga	80	K-X-282P/31	18,250	76.0	1 ga	100
X2827-D-240-3P	K-X-2827/32	240/3P	14,930	35.9	6 ga	50	K-X-282P/32	18,250	48.4	4 ga	70
X2827-D-208	K-X-2827/21	208/1P	14,930	71.8	2 ga	90	K-X-282P/21	18,250	87.7	1 ga	110
X2827-D-208-3P	K-X-2827/22	208/3P	14,930	41.5	6 ga	60	K-X-282P/22	18,250	55.8	4 ga	70
X2827-D-480-3P	K-X-2827/62	480/3P	14,930				K-X-282P/62	18,250	24.0	10 ga	30
XB2827-D-240	K-X-282B/31	240/1P	17,388	72.5	1 ga	100	K-X-282W/31	21,252	88.6	1/0	125
XB2827-D-240-3P	K-X-282B/32	240/3P	17,388	41.8	6 ga	60	K-X-282W/32	21,252	56.3	3 ga	80
XB2827-D-208	K-X-282B/21	208/1P	17,388	83.6	1 ga	110	K-X-282W/21	21,252	102.2	3/0	150
XB2827-D-208-3P	K-X-282B/22	208/3P	17,388	48.3	4 ga	70	K-X-282W/22	21,252	65.0	2 ga	90
XB2827-D-480-3P	K-X-282B/62	480/3P	17,388	20.9	10 ga	30	K-X-282W/62	21,252	27.9	8 ga	40
X2836-D-240	K-X-2836/31	240/1P	19,907	82.9	1 ga	110	K-X-283P/31	23,226	96.8	1/0	125
X2836-D-240-3P	K-X-2836/32	240/3P	19,907	54.9	4 ga	70	K-X-283P/32	23,226	65.9	2 ga	90
X2836-D-208	K-X-2836/21	208/1P	19,907	95.7	1/0	125	K-X-283P/21	23,226	111.7	3/0	150
X2836-D-208-3P	K-X-2836/22	208/3P	19,907	63.3	3 ga	80	K-X-283P/22	23,226	76.1	1 ga	100
X2836-D-480-3P	K-X-2836/62	480/3P	19,907	20.7	10 ga	30	K-X-283P/62	23,226	30.0	8 ga	40
XB2836-D-240	K-X-283B/31	240/1P	23,184	96.6	1/0	125	K-X-283W/31	27,050	112.7	3/0	150
XB2836-D-240-3P	K-X-283B/32	240/3P	23,184	63.9	3 ga	80	K-X-283W/32	27,050	76.8	1 ga	100
XB2836-D-208	K-X-283B/21	208/1P	23,184	111.5	3/0	150	K-X-283W/21	27,050	130.0	4/0	175
XB2836-D-208-3P	K-X-283B/22	208/3P	23,184	73.7	1 ga	100	K-X-283W/22	27,050	88.6	1/0	125
XB2836-D-480-3P	K-X-283B/62	480/3P	23,184	27.9	8 ga	40	K-X-283W/62	27,050	34.9	6 ga	50
X2845-D-240	K-X-2845/31	240/1P	24,885	103.7	3/0	150	K-X-284P/31	28,203	117.5	3/0	150
X2845-D-240-3P	K-X-2845/32	240/3P	24,885	71.9	2 ga	90	K-X-284P/32	28,203	71.8	2 ga	90
X2845-D-208	K-X-2845/21	208/1P	24,885	119.6	3/0	150	K-X-284P/21	28,203	135.6	4/0	175
X2845-D-208-3P	K-X-2845/22	208/3P	24,885	82.9	1 ga	110	K-X-284P/22	28,203	82.9	1 ga	110
X2845-D-480-3P	K-X-2845/62	480/3P	24,885	29.9	8 ga	40	K-X-284P/62	28,203	35.9	6 ga	50
XB2845-D-240	K-X-284B/31	240/1P	29,980	120.8	4/0	175	K-X-284W/31	32,845	136.9	4/0	175
XB2845-D-240-3P	K-X-284B/32	240/3P	29,980	83.7	1 ga	110	K-X-284W/32	32,845	83.7	1 ga	110
XB2845-D-208	K-X-284B/21	208/1P	29,980	139.3	4/0	175	K-X-284W/21	32,845	157.9	250 mcm	200
XB2845-D-208-3P	K-X-284B/22	208/3P	29,980	96.5	1/0	125	K-X-284W/22	32,845	96.5	1/0	125
XB2845-D-480-3P	K-X-284B/62	480/3P	29,980	34.9	6 ga	50	K-X-284W/62	32,845	41.9	6 ga	60

SEE PAGE 20 FOR ELECTRICAL NOTES

Electrical Specifications for X2800 Series (World)

Standard Models							Powered Bottom Models				
Model Number	Part Number	Volt/Phase	Watts	Amps	Wire Size	Fuse Size	Part Number	Watts	Amps	Wire Size	Fuse Size
XB2818-D-220	K-X-2818/41	220/1P	11,592	69.7	2 ga	90	K-X-281W/41	15,456	70.3	2 ga	90
XB2818-D-380-3PY	K-X-2818/52	380/3PY	11,592	26.3	8 ga	40	K-X-281W/52	15,456	26.4	8 ga	40
XB2818-D-400-3PY	K-X-2818/82	400/3PY	11,592	25.2	8 ga	40	K-X-281W/82	15,456	25.2	8 ga	40
XB2818-D-415-3P4	K-X-2818/72	415/3PY	11,592	24.2	8 ga	40	K-X-281W/72	15,456	24.2	8 ga	40
X2827-D-220	K-X-2827/41	220/1P	14,930	67.9	2 ga	90	K-X-282P/41	18,250	83.0	1 ga	110
X2827-D-380-3PY	K-X-2827/52	380/3PY	14,930	22.6	10 ga	30	K-X-282P/52	18,250	37.7	6 ga	50
X2827-D-400-3PY	K-X-2827/82	400/3PY	14,930	21.6	10 ga	30	K-X-282P/82	18,250	36.1	6 ga	50
X2827-D-415-3PY	K-X-2827/72	415/3PY	14,930	20.7	10 ga	30	K-X-282P/72	18,250	34.6	6 ga	50
XB2827-D-220	K-X-2827/41	220/1P	17,388	79.0	1 ga	100	K-X-282W/41	21,252	96.6	1/0	125
XB2827-D-380-3PY	K-X-2827/52	380/3PY	17,388	26.3	8 ga	40	K-X-282W/52	21,252	43.9	6 ga	60
XB2827-D-400-3PY	K-X-2827/82	400/3PY	17,388	25.2	8 ga	40	K-X-282W/82	21,252	42.0	6 ga	60
XB2827-D-415-3PY	K-X-2827/72	415/3PY	17,388	24.2	8 ga	40	K-X-282W/72	21,252	40.2	6 ga	60
X2836-D-220	K-X-2836/41	220/1P	19,907	90.5	1/0	125	K-X-283P/41	23,226	105.6	3/0	150
X2836-D-380-3PY	K-X-2836/52	380/3PY	19,907	45.2	6 ga	60	K-X-283P/52	23,226	45.3	6 ga	60
X2836-D-400-3PY	K-X-2836/82	400/3PY	19,907	43.3	6 ga	60	K-X-283P/82	23,226	43.3	6 ga	60
X2836-D-415-3PY	K-X-2836/72	415/3PY	19,907	41.5	6 ga	60	K-X-283P/72	23,226	41.5	6 ga	60
XB2836-D-220	K-X-2836/41	220/1P	23,184	105.4	3/0	150	K-X-283W/41	27,050	123.0	4/0	175
XB2836-D-380-3PY	K-X-2836/52	380/3PY	23,184	52.7	4 ga	70	K-X-283W/52	27,050	52.7	4 ga	70
XB2836-D-400-3PY	K-X-2836/82	400/3PY	23,184	50.4	4 ga	70	K-X-283W/82	27,050	50.4	4 ga	70
XB2836-D-415-3PY	K-X-2836/72	415/3PY	23,184	48.3	4 ga	70	K-X-283W/72	27,050	48.3	4 ga	70
X2845-D-220	K-X-2845/41	220/1P	24,885	113.1	3/0	150	K-X-284P/41	28,203	128.2	4/0	175
X2845-D-380-3PY	K-X-2845/52	380/3PY	24,885	45.2	6 ga	60	K-X-284P/52	28,203	45.3	6 ga	60
X2845-D-400-3PY	K-X-2845/82	400/3PY	24,885	43.3	6 ga	60	K-X-284P/82	28,203	43.3	6 ga	60
X2845-D-415-3PY	K-X-2845/72	415/3PY	24,885	41.5	6 ga	60	K-X-284P/72	28,203	41.5	6 ga	60
XB2845-D-220	K-X-2845/41	220/1P	28,980	131.7	4/0	175	K-X-284W/41	32,845	149.3	250 mcm	200
XB2845-D-380-3PY	K-X-2845/52	380/3PY	28,980	52.7	4 ga	70	K-X-284W/52	32,845	52.7	4 ga	70
XB2845-D-400-3PY	K-X-2845/82	400/3PY	28,980	50.4	4 ga	70	K-X-284W/82	32,845	50.4	4 ga	70
XB2845-D-415-3PY	K-X-2845/72	415/3PY	28,980	48.3	4 ga	70	K-X-284W/72	32,845	48.3	4 ga	70

ELECTRICAL NOTES FOR X2800 SERIES

For Model Number Powered Bottom Model: Add a "PB" after the "D" (Example = X2827-D-PB-240-1). Note: Powered Bottoms on the X2800 models are by special order only.

UL Listing: All models are c-MET-us listed.

Control Panels: All X2800 kilns get a floor standing panel. NEMA 1 panel are recommended but not required for 480 volts.

XB MODELS: XB models have more power than the regular X model kilns. The higher powered XB elements are always used on the XB2818 because of the large ratio of unheated surface area.

480 Volt Models with Quad Element Option: See website kiln pages for electrical specifications.

Power Bottoms for X2800: These are special order only. Electrical specifications are included above.

Dimension & Weight Specifications for X2800 Series

Model Number	Inside Height	Cubic Feet	Furniture Kit	Furniture Kit Part No.	Outside Dimensions	Shipping Dimensions (with Kit)	Ship Weight Kiln Only	Ship Weight Kiln + Kit
XB2818-D	18"	7.3	4 shelves, 1 post kit	H-X-K818/00	59" W x 74" H x 46" D	1 crate: 48" W x 46" H x 48" D 1 crate: 45" W x 84" H x 48" D	800 lbs	915 lbs
X2827-D	27"	11.0	6 shelves, 1 post kit	H-X-K827/00	59" W x 84" H x 46" D	1 crate: 48" W x 72" H x 48" D 1 crate: 45" W x 93" H x 48" D	825 lbs	930 lbs
X2836-D	36"	14.6	8 shelves, 2 post kits	H-X-K836/00	59" W x 93" H x 46" D	1 crate: 48" W x 82" H x 48" D 1 crate: 45" W x 93" H x 48" D	910 lbs	1045 lbs
X2845-D	45"	18.3	10 shelves, 2 post kits	H-X-K845/00	59" W x 102" H x 46" D	1 crate: 48" W x 54" H x 48" D 1 crate: 48" W x 93" H x 48" D 1 crate: 45" W x 42" H x 48" D	1045 lbs	1205 lbs
METRIC DIMENSIONS (CM, LITERS & KG)								
XB2818-D	45.7	208 L	4 shelves, 1 post kit	H-X-K818/00	150 W x 188 H x 117 D	1 crate: 122 W x 117 H x 122 D 1 crate: 115 W x 214 H x 122 D	363 KG	416 KG
X2827-D	68.6	311 L	6 shelves, 1 post kit	H-X-K827/00	150 W x 213 H x 117 D	1 crate: 122 W x 183 H x 122 D 1 crate: 115 W x 237 H x 122 D	375 KG	422 KG
X2836-D	91.4	415 L	8 shelves, 2 post kits	H-X-K836/00	150 W x 236 H x 117 D	1 crate: 122 W x 209 H x 122 D 1 crate: 115 W x 237 H x 122 D	413 KG	475 KG
X2845-D	114.3	357 L	10 shelves, 2 post kits	H-X-K845/00	150 W x 259 H x 117 D	1 crate: 122 W x 138 H x 122 D 1 crate: 122 W x 237 H x 122 D 1 crate: 122 W x 213 H x 107 D	475 KG	547 KG

DIMENSION & SHIPPING NOTES

Cross section of Inside: Approximately 27" wide by 27" deep. (68.6 cm by 68.6 cm)

Hearth Setting Area: 23" wide by 23" deep. (58.4 cm by 58.4 cm)

Recommended Minimum Space Requirements: 89.7" wide by 75.6" deep (227.8 cm by 192 cm)
(See General Dimension Diagram for details).

MORE: See each model page on hotkilns.com to download PDF General Dimension Drawings for more outside and inside dimensions, minimum space requirements, BTU ventilation requirements, and kiln weight. See the Shipping Tab on the model page for complete shipping dimension and shipping weight information.

XB2818

Temperature Rating: Cone 10

Volume: 7.3 Cubic Feet

Brick Thickness: 3" Brick

Inside: 26.5" D x 18" H

Outside Dimensions: 59" W x 74" H x 46" D

Shipping Dim with Vent & Furn Kit: 2 Crate (48" W x 46" H x 48" D & 48" W x 74" H x 48" D)

Ship Weight (Kiln): 800 LBS

Ship Weight (Kiln, Vent & Furn Kit): 915 LBS

FURNITURE KIT FOR XB2818

Part Number: H-X-K818/00

Includes: Four 23" X 11-1/2" Rectangular Shelves (3/4" thick), Six Each 1/2", 1", 2", 4", 6", and 8" Square Posts, Heat Resistant Gloves.



X2827

Temperature Rating: Cone 10

Volume: 11.0 Cubic Feet

Brick Thickness: 3" Brick

Inside: 26.5" D x 27" H

Outside Dimensions: 59" W x 84" H x 46" D

Shipping Dim with Vent & Furn Kit: 2 Crate (48" W x 82" H x 48" D & 48" W x 84" H x 48" D)

Ship Weight (Kiln): 825 LBS

Ship Weight (Kiln, Vent & Furn Kit): 930 LBS

FURNITURE KIT FOR X2827

Part Number: H-X-K827/00

Includes: Six 23" X 11-1/2" Rectangular Shelves (3/4" thick), Six Each 1/2", 1", 2", 4", 6", and 8" Square Posts, Heat Resistant Gloves.



X2836

Temperature Rating: Cone 10

Volume: 14.6 Cubic Feet

Brick Thickness: 3" Brick

Inside: 26.5" D x 36" H

Outside Dimensions: 59" W x 93" H x 46" D

Shipping Dim with Vent & Furn Kit: 2 Crate (48" W x 82" H x 48" D & 48" W x 84" H x 48" D)

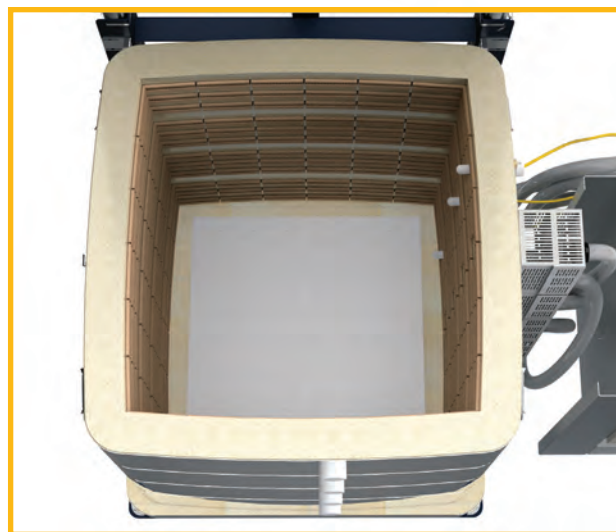
Ship Weight (Kiln): 910 LBS

Ship Weight (Kiln, Vent & Furn Kit): 1,045 LBS

FURNITURE KIT FOR X2836

Part Number: H-X-K836/00

Includes: Eight 23" X 11-1/2" Rectangular Shelves (3/4" thick), Twelve Each 1/2", 1", 2", 4", 6", and 8" Square Posts, Heat Resistant Gloves.



X2845

Temperature Rating: Cone 10

Volume: 18.3 Cubic Feet

Brick Thickness: 3" Brick

Inside: 26.5" D x 45" H

Outside Dimensions: 59" W x 102" H x 46" D

Shipping Dim with Vent & Furn Kit: 3 Crate (48" W x 54" H x 48" D, 48" W x 36" H x 48" D, & 48" W x 84" H x 48" D)

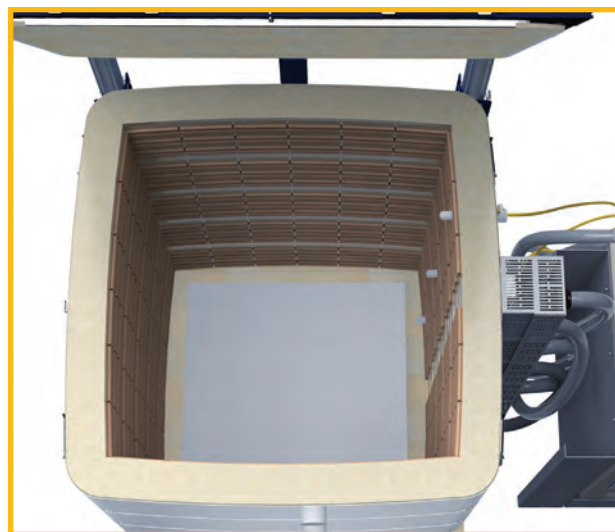
Ship Weight (Kiln): 1,045 LBS

Ship Weight (Kiln, Vent & Furn Kit): 1,205 LBS

FURNITURE KIT FOR X2845

Part Number: H-X-K845/00

Includes: Ten 23" X 11-1/2" Rectangular Shelves (3/4" thick), Twelve Each 1/2", 1", 2", 4", 6", and 8" Square Posts, and One Pair Heat Resistant Gloves.



Electrical Specifications for X3200 Series (USA)

Standard Models							Powered Bottom Models				
Model Number	Part Number	Volt/Phase	Watts	Amps	Wire Size	Fuse Size	Part Number	Watts	Amps	Wire Size	Fuse Size
XB3218-D-240	K-X-3218/31	240/1P	14,196	59.2	3 ga	80	K-X-321P/31	18,928	78.9	1 ga	100
XB3218-D-240-3P	K-X-3218/32	240/3P	14,196	51.2	4 ga	70	K-X-321P/32	18,928	51.2	4 ga	70
XB3218-D-208	K-X-3218/21	208/1P	14,196	68.3	2 ga	90	K-X-321P/21	18,928	91.0	1/0	125
XB3218-D-208-3P	K-X-3218/22	208/3P	14,196	59.1	3 ga	80	K-X-321P/22	18,928	59.1	3 ga	80
XB3218-D-480-3P	K-X-3218/62	480/3P	14,196	17.1	12 ga	25	K-X-321P/62	18,928	25.6	8 ga	40
X3227-D-240	K-X-3227/31	240/1P	18,039	75.2	1 ga	100	K-X-322P/31	22,047	91.9	1/0	125
X3227-D-240-3P	K-X-3227/32	240/3P	18,039	43.4	6 ga	60	K-X-322P/32	22,047	58.5	3 ga	80
X3227-D-208	K-X-3227/21	208/1P	18,039	86.7	1 ga	110	K-X-322P/21	22,047	106.0	3/0	150
X3227-D-208-3P	K-X-3227/22	208/3P	18,039	50.1	4 ga	70	K-X-322P/22	22,047	67.4	2 ga	90
X3227-D-480-3P	K-X-3227/62	480/3P	18,039	21.7	10 ga	30	K-X-322P/62	22,047	28.9	8 ga	40
XB3227-D-240	K-X-322B/31	240/1P	21,294	88.7	1/0	125	K-X-322W/31	26,026	108.4	3/0	150
XB3227-D-240-3P	K-X-322B/32	240/3P	21,294	51.2	4 ga	70	K-X-322W/32	26,026	69.0	2 ga	90
XB3227-D-208	K-X-322B/21	208/1P	21,294	102.4	3/0	150	K-X-322W/21	26,026	125.1	4/0	175
XB3227-D-208-3P	K-X-322B/22	208/3P	21,294	59.1	3 ga	80	K-X-322W/22	26,026	79.6	1 ga	100
XB3227-D-480-3P	K-X-322B/62	480/3P	21,294	25.6	8 ga	40	K-X-322W/62	26,026	34.2	6 ga	50
X3236-D-240	K-X-3236/31	240/1P	24,052	100.2	3/0	150	K-X-323P/31	28,060	116.9	3/0	150
X3236-D-240-3P	K-X-3236/32	240/3P	24,052	66.3	2 ga	90	K-X-323P/32	28,060	79.7	1 ga	100
X3236-D-208	K-X-3236/21	208/1P	24,052	115.6	3/0	150	K-X-323P/21	28,060	134.9	4/0	175
X3236-D-208-3P	K-X-3236/22	208/3P	24,052	76.5	1 ga	100	K-X-323P/22	28,060	91.9	1/0	125
X3236-D-480-3P	K-X-3236/62	480/3P	24,052	28.9	8 ga	40	K-X-323P/62	28,060	36.2	6 ga	50
XB3236-D-240	K-X-323B/31	240/1P	28,392	118.3	3/0	150	K-X-323W/31	33,124	138.0	4/0	175
XB3236-D-240-3P	K-X-323B/32	240/3P	28,392	78.2	1 ga	100	K-X-323W/32	33,124	94.0	1/0	125
XB3236-D-208	K-X-323B/21	208/1P	28,392	136.5	4/0	175	K-X-323W/21	33,124	159.3	250 mcm	200
XB3236-D-208-3P	K-X-323B/22	208/3P	28,392	90.3	1/0	125	K-X-323W/22	33,124	108.5	3/0	150
XB3236-D-480-3P	K-X-323B/62	480/3P	28,392	43.2	6 ga	50	K-X-323W/62	33,124	42.7	6 ga	60
X3245-D-240	K-X-3245/31	240/1P	30,065	125.3	4/0	175	K-X-324P/31	34,074	142.0	250 mcm	200
X3245-D-240-3P	K-X-3245/32	240/3P	30,065	86.8	1 ga	110	K-X-324P/32	34,074	86.8	1 ga	110
X3245-D-208	K-X-3245/21	208/1P	30,065	144.5	250 mcm	200	K-X-324P/21	34,074	163.8	300 mcm	225
X3245-D-208-3P	K-X-3245/22	208/3P	30,065	100.1	3/0	150	K-X-324P/22	34,074	100.2	3/0	150
X3245-D-480-3P	K-X-3245/62	480/3P	30,065	36.2	6 ga	50	K-X-324P/62	34,074	43.4	6 ga	60
XB3245-D-240	K-X-324B/31	240/1P	35,490	147.9	250 mcm	200	K-X-324W/31	40,222	167.6	300 mcm	225
XB3245-D-240-3P	K-X-324B/32	240/3P	35,490	102.5	3/0	150	K-X-324W/32	40,222	102.5	3/0	150
XB3245-D-208	K-X-324B/21	208/1P	35,490	170.6	300 mcm	225	K-X-324W/21	40,222	193.4	350 mcm	250
XB3245-D-208-3P	K-X-324B/22	208/3P	35,490	118.2	3/0	150	K-X-324W/22	40,222	118.2	3/0	150
XB3245-D-480-3P	K-X-324B/62	480/3P	35,490	42.7	6 ga	60	K-X-324W/62	40,222	51.3	4 ga	70

SEE PAGE 27 FOR ELECTRICAL NOTES

Electrical Specifications for X3200 Series (World)

Standard Models							Powered Bottom Models				
Model Number	Part Number	Volt/Phase	Watts	Amps	Wire Size	Fuse Size	Part Number	Watts	Amps	Wire Size	Fuse Size
XB3218-D-220	K-X-3218/41	220/1P	14,196	64.5	2 ga	90	K-X-321P/41	18,928	86.0	1 ga	110
XB3218-D-380-3PY	K-X-3218/52	380/3PY	14,196	32.3	6 ga	50	K-X-321P/52	18,928	32.3	6 ga	50
XB3218-D-400-3PY	K-X-3218/82	400/3PY	14,196	30.9	8 ga	40	K-X-321P/82	18,928	30.9	8 ga	40
XB3218-D-415-3P4	K-X-3218/72	415/3PY	14,196	29.6	8 ga	40	K-X-321P/72	18,928	29.6	8 ga	40
X3227-D-220	K-X-3227/41	220/1P	18,039	82.0	1 ga	110	K-X-322P/41	22,047	100.2	3/0	150
X3227-D-380-3PY	K-X-3227/52	380/3PY	18,039	27.3	8 ga	40	K-X-322P/52	22,047	45.5	6 ga	60
X3227-D-400-3PY	K-X-3227/82	400/3PY	18,039	26.1	8 ga	40	K-X-322P/82	22,047	43.6	6 ga	60
X3227-D-415-3PY	K-X-3227/72	415/3PY	18,039	25.1	8 ga	40	K-X-322P/72	22,047	41.7	6 ga	60
XB3227-D-220	K-X-3227/41	220/1P	21,294	96.8	1/0	125	K-X-322W/41	26,026	118.3	3/0	150
XB3227-D-380-3PY	K-X-3227/52	380/3PY	21,294	32.3	6 ga	50	K-X-322W/52	26,026	53.8	4 ga	70
XB3227-D-400-3PY	K-X-3227/82	400/3PY	21,294	30.9	8 ga	40	K-X-322W/82	26,026	51.4	4 ga	70
XB3227-D-415-3PY	K-X-3227/72	415/3PY	21,294	29.6	8 ga	40	K-X-322W/72	26,026	49.3	4 ga	70
X3236-D-220	K-X-3236/41	220/1P	24,052	109.3	3/0	150	K-X-323P/41	28,060	127.5	4/0	175
X3236-D-380-3PY	K-X-3236/52	380/3PY	24,052	54.7	4 ga	70	K-X-323P/52	28,060	54.7	4 ga	70
X3236-D-400-3PY	K-X-3236/82	400/3PY	24,052	52.3	4 ga	70	K-X-323P/82	28,060	52.3	4 ga	70
X3236-D-415-3PY	K-X-3236/72	415/3PY	24,052	50.1	4 ga	70	K-X-323P/72	28,060	50.1	4 ga	70
XB3236-D-220	K-X-3236/41	220/1P	28,392	129.1	4/0	175	K-X-323W/41	31,124	150.6	250 mcm	200
XB3236-D-380-3PY	K-X-3236/52	380/3PY	28,392	64.5	2 ga	90	K-X-323W/52	31,124	64.5	2 ga	90
XB3236-D-400-3PY	K-X-3236/82	400/3PY	28,392	61.7	3 ga	80	K-X-323W/82	31,124	61.7	3 ga	80
XB3236-D-415-3PY	K-X-3236/72	415/3PY	28,392	59.2	3 ga	80	K-X-323W/72	31,124	59.2	3 ga	80
X3245-D-220	K-X-3245/41	220/1P	30,065	136.7	4/0	175	K-X324P/41	34,074	154.9	250 mcm	200
X3245-D-380-3PY	K-X-3245/52	380/3PY	30,065	54.7	4 ga	70	K-X324P/52	34,074	54.7	4 ga	70
X3245-D-400-3PY	K-X3245/82	400/3PY	30,065	52.3	4 ga	70	K-X324P/82	34,074	52.3	4 ga	70
X3245-D-415-3PY	K-X3245/72	415/3PY	30,065	50.1	4 ga	70	K-X324P/72	34,074	50.1	4 ga	70
XB3245-D-220	K-X3245/41	220/1P	35,490	161.3	300 mcm	225	K-X324W/41	40,222	182.8	350 mcm	250
XB3245-D-380-3PY	K-X3245/52	380/3PY	35,490	64.5	2 ga	90	K-X324W/52	40,222	64.5	2 ga	90
XB3245-D-400-3PY	K-X3245/82	400/3PY	35,490	61.7	3 ga	80	K-X324W/82	40,222	61.7	2 ga	80
XB3245-D-415-3PY	K-X3245/72	415/3PY	35,490	59.2	3 ga	80	K-X324W/72	40,222	59.2	3 ga	80

ELECTRICAL NOTES FOR X3200 SERIES

For Model Number of Powered Bottom Model: Add a "PB" after the "D" (Example = X3227-D-PB-240-1).

UL Listing: All models are c-MET-us listed.

Control Panels: All X3200 kilns get a floor standing panel. NEMA 1 panel are recommended but not required for 480 volts.

XB MODELS: XB models have more power than the regular X model kilns. The higher powered XB elements are always used on the XB3218 because of the large ratio of unheated surface area.

480 Volt Models with Quad Element Option: See website kiln pages for electrical specifications.

Dimension & Weight Specifications for X3200 Series

Model Number	Inside Height	Cubic Feet	Furniture Kit	Furniture Kit Part No.	Outside Dimensions	Shipping Dimensions (with Kit)	Ship Weight Kiln Only	Ship Weight Kiln + Kit
XB3218-D	18"	9.7	4 shelves, 1 post kit	H-X-K218/00	63" W x 74" H x 51" D	1 crate: 48" W x 60" H x 50" D 1 crate: 45" W x 84" H x 48" D	800 lbs	915 lbs
X3227-D	27"	14.5	6 shelves, 1 post kit	H-X-K227/00	63" W x 84" H x 51" D	1 crate: 48" W x 72" H x 50" D 1 crate: 45" W x 93" H x 50" D	1,020 lbs	1,170 lbs
X3236-D	36"	19.4	8 shelves, 2 post kits	H-X-K236/00	63" W x 93" H x 51" D	1 crate: 48" W x 84" H x 50" D 1 crate: 45" W x 93" H x 48" D	1,120 lbs	1,310 lbs
X3245-D	45"	24.2	10 shelves, 2 post kits	H-X-K245/00	63" W x 102" H x 51" D	1 crate: 48" W x 54" H x 50" D 1 crate: 45" W x 93" H x 48" D 1 crate: 48" W x 42" H x 50" D	1,265 lbs	1,495 lbs
METRIC DIMENSIONS (CM, LITERS & KG)								
XB3218-D	45.7	275 L	4 shelves, 1 post kit	H-X-K218/00	160 W x 188 H x 130 D	1 crate: 122 W x 188 H x 153 D 1 crate: 115 W x 188 H x 214 D	363 KG	416 KG
X3227-D	68.6	412 L	6 shelves, 1 post kit	H-X-K227/00	160 W x 213 H x 130 D	1 crate: 122 W x 183 H x 127 D 1 crate: 115 W x 237 H x 127 D	463 KG	531 KG
X3236-D	91.4	549 L	8 shelves, 2 post kits	H-X-K236/00	160 W x 236 H x 130 D	1 crate: 122 W x 214 H x 127 D 1 crate: 115 W x 237 H x 127 D	509 KG	595 KG
X3245-D	114.3	686 L	10 shelves, 2 post kits	H-X-K245/00	160 W x 259 H x 130 D	1 crate: 122 W x 138 H x 127 D 1 crate: 115 W x 237 H x 127 D 1 crate: 122 W x 107 H x 127 D	574 KG	679 KG

DIMENSION & SHIPPING NOTES

Cross section of Inside: Approximately 32" wide by 32" deep. (81.3 cm by 81.3 cm)

Hearth Setting Area: 28" wide by 28" deep. (71.1 cm by 71.2 cm)

Recommended Minimum Space Requirements: 94.4" wide by 80.3" deep (239.7 cm by 204 cm)
(See General Dimension Diagram for details).

MORE: See each model page on hotkilns.com to download PDF General Dimension Drawings for more outside and inside dimensions, minimum space requirements, BTU ventilation requirements, and kiln weight. See the Shipping Tab on the model page for complete shipping dimension and shipping weight information.

XB3218

Temperature Rating: Cone 10

Volume: 9.7 Cubic Feet

Brick Thickness: 3" Brick

Inside: 30.5" D x 18" H

Outside Dimensions: 63" W x 74" H x 51" D

Shipping Dim with Vent & Furn Kit: 2 Crate (48" W x 60" H x 50" D & 48" W x 60" H x 50" D)

Ship Weight (Kiln): 800 LBS

Ship Weight (Kiln, Vent & Furn Kit): 915 LBS

FURNITURE KIT FOR XB3218

Part Number: H-X-K218/00

Includes: Four 28" X 14" Rectangular Shelves (3/4" thick), Six Each 1/2", 1", 2", 4", 6", and 8" Square Posts, and One Pair Heat Resistant Gloves.



X3227

Temperature Rating: Cone 10

Volume: 14.5 Cubic Feet

Brick Thickness: 3" Brick

Inside: 30.5" D x 27" H

Outside Dimensions: 63" W x 84" H x 51" D

Shipping Dim with Vent & Furn Kit: 2 Crate (48" W x 72" H x 50" D & 48" W x 60" H x 50" D)

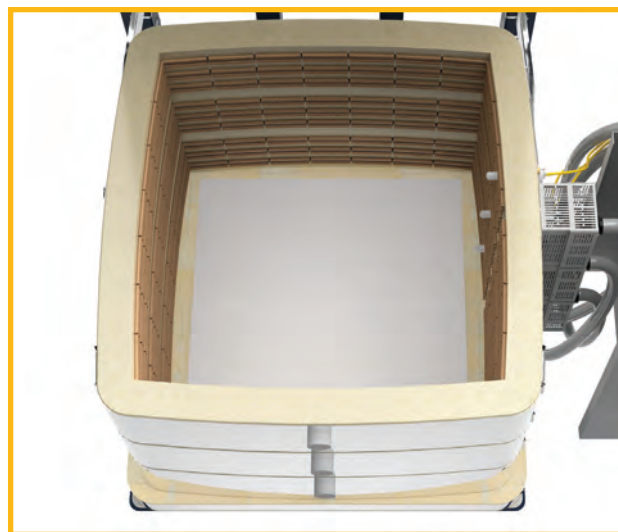
Ship Weight (Kiln): 1,020 LBS

Ship Weight (Kiln, Vent & Furn Kit): 1,170 LBS

FURNITURE KIT FOR X3227

Part Number: H-X-K227/00

Includes: Six 28" X 14" Rectangular Shelves (3/4" thick), Six Each 1/2", 1", 2", 4", 6", and 8" Square Posts, and One Pair Heat Resistant Gloves.



X3236

Temperature Rating: Cone 10

Volume: 19.4 Cubic Feet

Brick Thickness: 3" Brick

Inside: 30.5" D x 36" H

Outside Dimensions: 63" W x 93" H x 51" D

Shipping Dim with Vent & Furn Kit: 2 Crate (48" W x 84" H x 50" D & 48" W x 60" H x 50" D)

Ship Weight (Kiln): 970 LBS

Ship Weight (Kiln, Vent & Furn Kit): 1,120 LBS

FURNITURE KIT FOR X3236

Part Number: H-X-K236/00

Includes: Eight 28" X 14" Rectangular Shelves (3/4" thick), Twelve Each 1/2", 1", 2", 4", 6", and 8" Square Posts, and One Pair Heat Resistant Gloves.



X3245

Temperature Rating: Cone 10

Volume: 24.2 Cubic Feet

Brick Thickness: 3" Brick

Inside: 30.5" D x 45" H

Outside Dimensions: 63" W x 102" H x 51" D

Shipping Dim with Vent & Furn Kit: 3 Crate (48" W x 54" H x 50" D, 48" W x 60" H x 50" D, & 48" W x 60" H x 50" D)

Ship Weight (Kiln): 1,265 LBS

Ship Weight (Kiln, Vent & Furn Kit): 1,495 LBS

FURNITURE KIT FOR X3245

Part Number: H-X-K245/00

Includes: Ten 28" X 14" Rectangular Shelves (3/4" thick), Twelve Each 1/2", 1", 2", 4", 6", and 8" Square Posts, and One Pair Heat Resistant Gloves.



Electrical Specifications for T2300 Series (USA)

Standard Models							Powered Bottom Models				
Model Number	Part Number	Volt/Phase	Watts	Amps	Wire Size	Fuse Size	Part Number	Watts	Amps	Wire Size	Fuse Size
TB2318-D-240	K-T-2318/31	240/1P	15,340	63.9	3 ga	80	K-T-231P/31	20,453	85.2	1 ga	110
TB2318-D-240-3P	K-T-2318/32	240/3P	15,340	55.4	4 ga	70	K-T-231P/32	20,453	55.4	4 ga	70
TB2318-D-208	K-T-2318/21	208/1P	15,340	73.8	1 ga	100	K-T-231P/21	20,453	98.3	1/0	125
TB2318-D-208-3P	K-T-2318/22	208/3P	15,340	63.9	3 ga	80	K-T-231P/22	20,453	63.9	3 ga	80
TB2318-D-480-3P	K-T-2318/62	480/3P	15,340	18.5	12 ga	25	K-T-231P/62	20,453	27.7	8 ga	40
T2327-D-240	K-T-2327/31	240/1P	19,510	81.3	1 ga	110	K-T-232P/31	23,844	99.4	1/0	125
T2327-D-240-3P	K-T-2327/32	240/3P	19,510	46.9	6 ga	60	K-T-232P/32	23,844	63.2	3 ga	80
T2327-D-208	K-T-2327/21	208/1P	19,510	93.8	1/0	125	K-T-232P/21	23,844	114.6	3/0	150
T2327-D-208-3P	K-T-2327/22	208/3P	19,510	54.2	4 ga	70	K-T-232P/22	23,844	72.9	1 ga	100
T2327-D-480-3P	K-T-2327/62	480/3P	19,510	23.5	10 ga	30	K-T-232P/62	23,844	31.3	8 ga	40
TB2327-D-240	K-T-232B/31	240/1P	23,010	95.9	1/0	125	K-T-232W/31	28,123	117.2	3/0	150
TB2327-D-240-3P	K-T-232B/32	240/3P	23,010	55.4	4 ga	70	K-T-232W/32	28,123	74.6	1 ga	100
TB2327-D-208	K-T-232B/21	208/1P	23,010	110.6	3/0	150	K-T-232W/21	28,123	135.2	4/0	175
TB2327-D-208-3P	K-T-232B/22	208/3P	23,010	63.9	3 ga	80	K-T-232W/22	28,123	86.0	1 ga	110
TB2327-D-480-3P	K-T-232B/62	480/3P	23,010	27.7	8 ga	40	K-T-232W/62	28,123	36.9	6 ga	50
T2336-D-240	K-T-2336/31	240/1P	26,013	108.4	3/0	150	K-T-233P/31	30,347	126.4	4/0	175
T2336-D-240-3P	K-T-2336/32	240/1P	26,013	71.7	2 ga	90	K-T-233P/32	30,347	86.2	1 ga	110
T2336-D-208	K-T-2336/21	208/1P	26,013	125.1	4/0	175	K-T-233P/21	30,347	145.9	250 mcm	200
T2336-D-208-3P	K-T-2336/22	208/3P	26,013	82.7	1 ga	110	K-T-233P/22	30,347	99.4	1/0	125
T2336-D-480-3P	K-T-2336/62	480/3P	26,013	31.3	8 ga	40	K-T-233P/62	30,347	39.1	6 ga	50
TB2336-D-240	K-T-233B/31	240/1P	30,680	127.8	4/0	175	K-T-233W/31	35,793	149.1	250 mcm	200
TB2336-D-240-3P	K-T-233B/32	240/1P	30,680	84.6	1 ga	110	K-T-233W/32	35,793	101.6	3/0	150
TB2336-D-208	K-T-233B/21	208/1P	30,680	147.5	250 mcm	200	K-T-233W/21	35,793	172.1	300 mcm	225
TB2336-D-208-3P	K-T-233B/22	208/3P	30,680	97.6	1/0	125	K-T-233W/22	35,793	117.3	3/0	150
TB2336-D-480-3P	K-T-233B/62	480/3P	30,680	36.9	6 ga	50	K-T-233W/62	35,793	46.2	6 ga	60
T2345-D-240	K-T-2345/31	240/1P	32,515	135.5	4/0	175	K-T-234P/31	36,850	153.5	250 mcm	200
T2345-D-240-3P	K-T-2345/32	240/3P	32,515	93.9	1/0	125	K-T-234P/32	36,850	93.9	1/0	125
T2345-D-208	K-T-2345/21	208/1P	32,515	156.3	250 mcm	200	K-T-234P/21	36,850	177.2	300 mcm	225
T2345-D-208-3P	K-T-2345/22	208/3P	32,515	108.3	3/0	150	K-T-234P/22	36,850	62.5	3 ga	80
T2345-D-480-3P	K-T-2345/62	480/3P	32,515	39.1	6 ga	50	K-T-234P/62	36,850	47.0	6 ga	60
TB2345-D-240	K-T-234B/31	240/1P	38,350	159.8	250 mcm	200	K-T-234W/31	43,463	181.1	350 mcm	250
TB2345-D-240-3P	K-T-234B/32	240/3P	38,350	110.7	3/0	150	K-T-234W/32	43,463	110.7	3/0	150
TB2345-D-208	K-T-234B/21	208/1P	38,350	184.4	350 mcm	250	K-T-234W/21	43,463	209.0	400 mcm	275
TB2345-D-208-3P	K-T-234B/22	208/3P	38,350	127.7	4/0	175	K-T-234W/22	43,463	127.8	4/0	175
TB2345-D-480-3P	K-T-234B/62	480/3P	38,350	46.1	6 ga	60	K-T-234W/62	43,463	55.4	4 ga	70

SEE PAGE 34 FOR ELECTRICAL NOTES

Electrical Specifications for T2300 Series (World)

Standard Models							Powered Bottom Models				
Model Number	Part Number	Volt/Phase	Watts	Amps	Wire Size	Fuse Size	Part Number	Watts	Amps	Wire Size	Fuse Size
TB2318-D-220	K-T-2318/41	220/1P	15,340	69.7	2 ga	90	K-T-231W/41	20,453	93.0	1/0	125
TB2318-D-380-3PY	K-T-2318/52	380/3PY	15,340	34.9	6 ga	50	K-T-231W/52	20,453	34.9	6 ga	50
TB2318-D-400-3PY	K-T-2318/82	400/3PY	15,340	33.3	6 ga	50	K-T-231W/82	20,453	33.4	6 ga	50
TB2318-D-415-3P4	K-T-2318/72	415/3PY	15,340	32.0	8 ga	40	K-T-231W/72	20,453	32.0	8 ga	40
T2327-D-220	K-T-2327/41	220/1P	19,510	88.7	1/0	125	K-T-232P/41	23,844	108.4	3/0	150
T2327-D-380-3PY	K-T-2327/52	380/3PY	19,510	29.6	8 ga	40	K-T-232P/52	23,844	49.3	4 ga	70
T2327-D-400-3PY	K-T-2327/82	400/3PY	19,510	28.3	8 ga	40	K-T-232P/82	23,844	47.1	6 ga	60
T2327-D-415-3PY	K-T-2327/72	415/3PY	19,510	27.1	8 ga	40	K-T-232P/72	23,844	45.1	6 ga	60
TB2327-D-220	K-T-232B/41	220/1P	23,010	104.6	3/0	150	K-T-232W/41	28,123	127.8	4/0	175
TB2327-D-380-3PY	K-T-232B/52	380/3PY	23,010	34.9	6 ga	50	K-T-232W/52	28,123	58.1	3 ga	80
TB2327-D-400-3PY	K-T-232B/82	400/3PY	23,010	33.3	6 ga	50	K-T-232W/82	28,123	55.6	4 ga	70
TB2327-D-415-3PY	K-T-232B/72	415/3PY	23,010	32.0	8 ga	40	K-T-232W/72	28,123	53.3	4 ga	70
T2336-D-220	K-T-2336/41	220/1P	26,013	118.2	3/0	150	K-T-233P/41	30,347	137.9	4/0	175
T2336-D-380-3PY	K-T-2336/52	380/3PY	26,013	59.1	3 ga	80	K-T-233P/52	30,347	59.1	3 ga	80
T2336-D-400-3PY	K-T-2336/82	400/3PY	26,013	56.6	3 ga	80	K-T-233P/52	30,347	56.6	3 ga	80
T2336-D-415-3PY	K-T-2336/72	415/3PY	26,013	54.2	4 ga	70	K-T-233P/72	30,347	54.2	4 ga	70
TB2336-D-220	K-T-233B/41	220/1P	30,680	139.5	4/0	175	K-T-233W/41	35,793	162.7	300 mcm	225
TB2336-D-380-3PY	K-T-233B/52	380/3PY	30,680	69.7	2 ga	90	K-T-233W/52	35,793	69.7	2 ga	90
TB2336-D-400-3PY	K-T-233B/82	400/3PY	30,680	66.7	2 ga	90	K-T-233W/82	35,793	66.7	2 ga	90
TB2336-D-415-3PY	K-T-233B/72	415/3PY	30,680	63.9	3 ga	80	K-T-233W/72	35,793	63.9	3 ga	80
T2345-D-220	K-T-2345/41	220/1P	32,515	147.8	250 mcm	200	K-T-234P/41	36,850	167.5	300 mcm	225
T2345-D-380-3PY	K-T-2345/52	380/3PY	32,515	34.2	6 ga	50	K-T-234P/52	36,850	59.1	3 ga	80
T2345-D-400-3PY	K-T-2345/82	400/3PY	32,515	32.5	6 ga	50	K-T-234P/82	36,850	56.6	3 ga	80
T2345-D-415-3PY	K-T-2345/72	415/3PY	32,515	31.3	8 ga	40	K-T-234P/72	36,850	54.2	4 ga	70
TB2345-D-220	K-T-234B/41	220/1P	38,350	174.3	300 mcm	225	K-T-234W/41	43,463	197.6	350 mcm	250
TB2345-D-380-3PY	K-T-234B/52	380/3PY	38,350	69.7	2 ga	90	K-T-234W/52	43,463	69.7	2 ga	90
TB2345-D-400-3PY	K-T-234B/82	400/3PY	38,350	66.7	2 ga	90	K-T-234W/82	43,463	66.7	2 ga	90
TB2345-D-415-3PY	K-T-234B/72	415/3PY	38,350	63.9	3 ga	80	K-T-234W/72	43,463	63.9	3 ga	80

ELECTRICAL NOTES FOR T2300 SERIES

For Model Number of Powered Bottom Model: Add a "PB" after the "D" (Example = T2327-D-PB-240-1).

UL Listing: All models are c-MET-us listed.

Control Panels: All T2300 kilns get a floor standing panel. NEMA 1 panel are recommended but not required for 480 volts.

TB MODELS: TB models have more power than the regular T model kilns. The higher powered TB elements are always used on the TB2318 because of the large ratio of unheated surface area.

480 Volt Models with Quad Element Option: See website kiln pages for electrical specifications.

Dimension & Weight Specifications for T2300 Series

Model Number	Inside Height	Cubic Feet	Furniture Kit	Furniture Kit Part No.	Outside Dimensions	Shipping Dimensions (with Kit)	Ship Weight Kiln Only	Ship Weight Kiln + Kit
TB2318-D	18"	9.6	4 shelves, 1 post kit	H-T-K418/00	68" W x 72" H x 47" D	1 crate: 49" W x 46" H x 59" D 1 crate: 45" W x 84" H x 48" D	905 lbs	1,005 lbs
T2327-D	27"	14.4	6 shelves, 1 post kit	H-T-K427/00	68" W x 84" H x 47" D	1 crate: 49" W x 72" H x 59" D 1 crate: 45" W x 93" H x 48" D	1,035 lbs	1,170 lbs
T2336-D	36"	19.2	8 shelves, 2 post kits	H-T-K436/00	68" W x 93" H x 47" D	1 crate: 49" W x 82" H x 59" D 1 crate: 45" W x 93" H x 48" D	1,135 lbs	1,315 lbs
T2345-D	45"	24.0	10 shelves, 2 post kits	H-T-K445/00	68" W x 102" H x 47" D	1 crate: 49" W x 72" H x 59" D 1 crate: 45" W x 93" H x 48" D 1 crate: 49" W x 48" H x 59" D	1,285 lbs	1,500 lbs
METRIC DIMENSIONS (CM, LITERS & KG)								
TB2318-D	45.7	272 L	4 shelves, 1 post kit	H-T-K418/00	173 W x 183 H x 119 D	1 crate: 125 W x 117 H x 150 D 1 crate: 115 W x 214 H x 122 D	411 KG	456 KG
T2327-D	68.6	408 L	6 shelves, 1 post kit	H-T-K427/00	173 W x 213 H x 119 D	1 crate: 125 W x 183 H x 150 D 1 crate: 115 W x 237 H x 122 D	470 KG	531 KG
T2336-D	91.4	544 L	8 shelves, 2 post kits	H-T-K436/00	173 W x 236 H x 119 D	1 crate: 125 W x 209 H x 150 D 1 crate: 115 W x 237 H x 122 D	515 KG	597 KG
T2345-D	114.2	24.0 L	10 shelves, 2 post kits	H-T-K445/00	173 W x 259 H x 119 D	1 crate: 125 W x 183 H x 150 D 1 crate: 115 W x 237 H x 122 D 1 crate: 125 W x 122 H x 150 D	583 KG	681 KG

DIMENSION & SHIPPING NOTES

Cross section of Inside: Approximately 36" wide by 28" deep. (91.4 cm by 71.1 cm)

Hearth Setting Area: 33" wide by 22" deep. (83.8 cm by 55.9 cm)

Recommended Minimum Space Requirements: 98.3" wide by 76.5" deep (249.7 cm by 194.3 cm)
(See General Dimension Diagram for details).

MORE: See each model page on hotkilns.com to download PDF General Dimension Drawings for more outside and inside dimensions, minimum space requirements, BTU ventilation requirements, and kiln weight. See the Shipping Tab on the model page for complete shipping dimension and shipping weight information.

TB2318

Temperature Rating: Cone 10

Volume: 9.6 Cubic Feet

Brick Thickness: 3" Brick

Inside: 34.75" D x 18" H

Outside Dimensions: 68" W x 72" H x 47" D

Shipping Dim with Vent & Furn Kit: 2 Crate (49" W x 46" H x 59" D & 49" W x 84" H x 59" D)

Ship Weight (Kiln): 905 LBS

Ship Weight (Kiln, Vent & Furn Kit): 1,005 LBS

FURNITURE KIT FOR TB2318

Part Number: H-T-K418/00

Includes: Six 22" X 11" X 3/4" Rectangular Shelves (3/4" thick), Six Each 1/2", 1", 2", 4", 6", and 8" Square Posts, and One Pair Heat Resistant. Gloves.



T2327

Temperature Rating: Cone 10

Volume: 14.4 Cubic Feet

Brick Thickness: 3" Brick

Inside: 34.75" D x 27" H

Outside Dimensions: 68" W x 84" H x 47" D

Shipping Dim with Vent & Furn Kit: 2 Crate (49" W x 72" H x 59" D & 49" W x 84" H x 59" D)

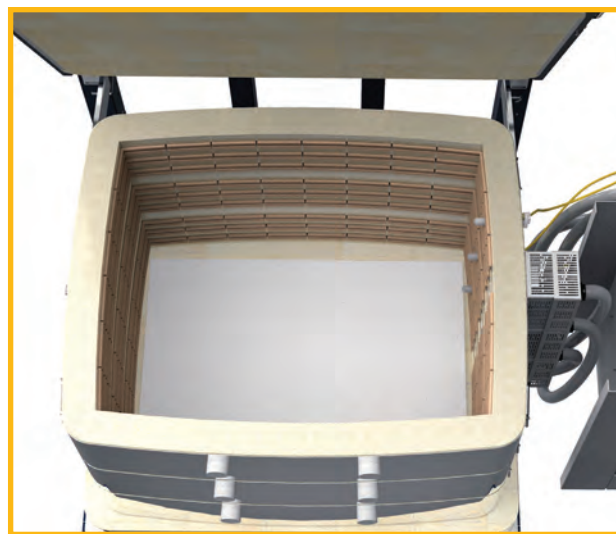
Ship Weight (Kiln): 1,035 LBS

Ship Weight (Kiln, Vent & Furn Kit): 1,170 LBS

FURNITURE KIT FOR T2327

Part Number: H-T-K427/00

Includes: Nine 22" X 11" X 3/4" Rectangular Shelves (3/4" thick), Six Each 1/2", 1", 2", 4", 6", and 8" Square Posts, and One Pair Heat Resistant Gloves.



T2336

Temperature Rating: Cone 10

Volume: 19.2 Cubic Feet

Brick Thickness: 3" Brick

Inside: 34.75" D x 36" H

Outside Dimensions: 68" W x 93" H x 47" D

Shipping Dim with Vent & Furn Kit: 2 Crate (49" W x 82" H x 59" D & 49" W x 84" H x 59" D)

Ship Weight (Kiln): 1,135 LBS

Ship Weight (Kiln, Vent & Furn Kit): 1,315 LBS

FURNITURE KIT FOR T2336

Part Number: H-T-K436/00

Includes: Twelve 22" X 11" X 3/4" Rectangular Shelves (3/4" thick), Twelve Each 1/2", 1", 2", 4", 6", and 8" Square Posts, and One Pair Heat Resistant Gloves.



T2345

Temperature Rating: Cone 10

Volume: 24.0 Cubic Feet

Brick Thickness: 3" Brick

Inside: 34.75" D x 45" H

Outside Dimensions: 68" W x 102" H x 47" D

Shipping Dim with Vent & Furn Kit: 3 Crate (49" W x 72" H x 59" D, 49" W x 36" H x 59" D, & 49" W x 84" H x 59" D)

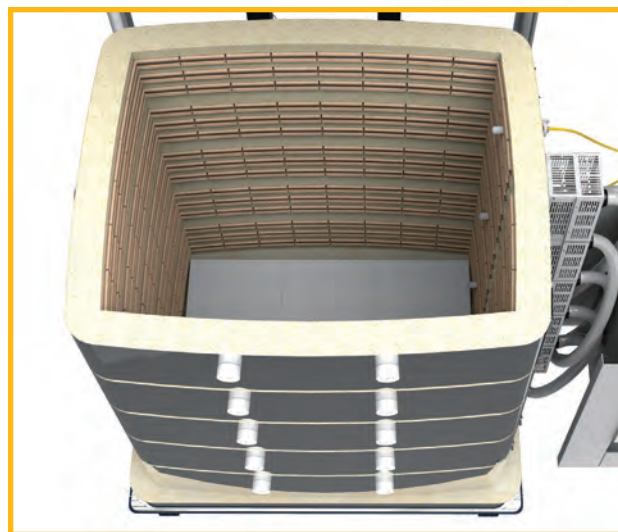
Ship Weight (Kiln): 1,285 LBS

Ship Weight (Kiln, Vent & Furn Kit): 1,500 LBS

FURNITURE KIT FOR T2345

Part Number: H-T-K425/00

Includes: Fifteen 22" X 11" X 3/4" Rectangular Shelves (3/4" thick), Twelve Each 1/2", 1", 2", 4", 6", and 8" Square Posts, and One Pair Heat Resistant Gloves.



Electrical Specifications for T3400 Series (USA)

Standard Models							Powered Bottom Models				
Model Number	Part Number	Volt/ Phase	Watts	Amps	Wire Size	Fuse Size	Part Number	Watts	Amps	Wire Size	Fuse Size
TB3418-D-240	K-T-3418/31	240/1P	19,934	83.1	1 ga	110	K-T-341P/31	26,579	110.7	3/0	150
TB3418-D-240-3P	K-T-3418/32	240/3P	19,934	71.9	2 ga	90	K-T-341P/32	26,579	71.9	2 ga	90
TB3418-D-208	K-T-3418/21	208/1P	19,934	95.8	1/0	125	K-T-341P/21	26,579	127.8	4/0	175
TB3418-D-208-3P	K-T-3418/22	208/3P	19,934	83.0	1 ga	110	K-T-341P/22	26,579	83.0	1 ga	110
TB3418-D-480-3P	K-T-3418/62	480/3P	19,934	24.0	10 ga	30	K-T-341P/62	26,579	36.0	6 ga	50
T3427-D-240	K-T-3427/31	240/1P	24,936	103.9	3/0	150	K-T-342P/31	30,477	127.0	4/0	175
T3427-D-240-3P	K-T-3427/32	240/3P	24,936	60.0	3 ga	80	K-T-342P/32	30,477	80.8	1 ga	110
T3427-D-208	K-T-3427/21	208/1P	24,936	119.9	3/0	150	K-T-342P/21	30,477	146.5	250 mcm	200
T3427-D-208-3P	K-T-3427/22	208/3P	24,936	69.2	2 ga	90	K-T-342P/22	30,477	93.2	1/0	125
T3427-D-480-3P	K-T-3427/62	480/3P	24,936	30.0	8 ga	40	K-T-342P/62	30,477	40.0	6 ga	50
TB3427-D-240	K-T-342B/31	240/1P	29,901	124.6	4/0	175	K-T-342W/31	36,546	152.3	250 mcm	200
TB3427-D-240-3P	K-T-342B/32	240/3P	29,901	71.9	2 ga	90	K-T-342W/32	36,546	96.9	1/0	125
TB3427-D-208	K-T-342B/21	208/1P	29,901	143.8	250 mcm	200	K-T-342W/21	36,546	175.7	300 mcm	225
TB3427-D-208-3P	K-T-342B/22	208/3P	29,901	83.0	1 ga	110	K-T-342W/22	36,546	111.8	3/0	150
TB3427-D-480-3P	K-T-342B/62	480/3P	29,901	36.0	6 ga	50	K-T-342W/62	36,546	48.0	6 ga	60
T3436-D-240	K-T-3436/31	240/1P	33,248	138.5	4/0	175	K-T-343P/31	38,789	161.6	300 mcm	225
T3436-D-240-3P	K-T-3436/32	240/1P	33,248	91.6	1/0	125	K-T-343P/32	38,789	110.1	3/0	150
T3436-D-208	K-T-3436/21	208/1P	33,248	159.8	250 mcm	200	K-T-343P/21	38,789	186.5	350 mcm	250
T3436-D-208-3P	K-T-3436/22	208/3P	33,248	105.7	3/0	150	K-T-343P/22	38,789	127.1	4/0	175
T3436-D-480-3P	K-T-3436/62	480/3P	33,248	40.0	6 ga	50	K-T-343P/62	38,789	50.0	4 ga	70
TB3436-D-240	K-T-343B/31	240/1P	39,868	166.1	300 mcm	225	K-T-343W/31	46,513	193.8	350 mcm	250
TB3436-D-240-3P	K-T-343B/32	240/1P	39,868	109.9	3/0	150	K-T-343W/32	46,513	132.1	4/0	175
TB3436-D-208	K-T-343B/21	208/1P	39,868	191.7	350 mcm	250	K-T-343W/21	46,513	223.6	500 mcm	300
TB3436-D-208-3P	K-T-343B/22	208/3P	39,868	126.8	4/0	175	K-T-343W/22	46,513	152.4	250 mcm	200
TB3436-D-480-3P	K-T-343B/62	480/3P	39,868	48.0	6 ga	60	K-T-343W/62	46,513	60.0	3 ga	80
T3445-D-240	K-T-3445/31	240/1P	41,560	173.2	300 mcm	225	K-T-344P/31	47,101	196.3	350 mcm	250
T3445-D-240-3P	K-T-3445/32	240/3P	41,560	120.0	3/0	150	K-T-344P/32	47,101	120.0	3/0	150
T3445-D-208	K-T-3445/21	208/1P	41,560	199.8	350 mcm	250	K-T-344P/21	47,101	226.4	500 mcm	300
T3445-D-208-3P	K-T-3445/22	208/3P	41,560	138.4	4/0	175	K-T-344P/22	47,101	138.4	4/0	175
T3445-D-480-3P	K-T-3445/62	480/3P	41,560	50.0	4 ga	70	K-T-344P/62	47,101	60.0	3 ga	80
TB3445-D-240	K-T-344B/31	240/1P	49,835	207.7	400 mcm	275	K-T-344W/31	56,480	235.3	500 mcm	300
TB3445-D-240-3P	K-T-344B/32	240/3P	49,835	143.9	250 mcm	200	K-T-344W/32	56,480	143.9	250 mcm	200
TB3445-D-208	K-T-344B/21	208/1P	49,835	239.6	500 mcm	300	K-T-344W/21	56,480	271.5	500 mcm	350
TB3445-D-208-3P	K-T-344B/22	208/3P	49,835	166.0	350 mcm	225	K-T-344W/22	56,480	166.0	300 mcm	225
TB3445-D-480-3P	K-T-344B/62	480/3P	49,835	60.0	3 ga	80	K-T-344W/62	56,480	72.0	2 ga	90

SEE PAGE 41 FOR ELECTRICAL NOTES

Electrical Specifications for T3400 Series (World)

Standard Models							Powered Bottom Models				
Model Number	Part Number	Volt/ Phase	Watts	Amps	Wire Size	Fuse Size	Part Number	Watts	Amps	Wire Size	Fuse Size
TB3418-D-220	K-T-B348/41	220/1P	19,934	90.6	1/0	125	K-T-341P/41	26,579	120.8	4/0	175
TB3418-D-380-3PY	K-T-B348/52	380/3PY	11,592	45.3	6 ga	60	K-T-341P/52	26,579	45.3	6 ga	60
TB3418-D-400-3PY	K-T-B348/82	400/3PY	11,592	43.3	6 ga	60	K-T-341P/82	26,579	43.3	6 ga	60
TB3418-D-415-3P4	K-T-B348/72	415/3PY	11,592	41.5	6 ga	60	K-T-341P/72	26,579	41.5	6 ga	60
T3427-D-220	K-T-3427/41	220/1P	24,936	113.3	3/0	150	K-T-342P/41	30,477	138.5	4/0	175
T3427-D-380-3PY	K-T-3427/52	380/3PY	24,936	37.8	6 ga	50	K-T-342P/52	30,477	63.0	3 ga	80
T3427-D-400-3PY	K-T-3427/82	400/3PY	24,936	36.1	6 ga	50	K-T-342P/82	30,477	60.2	3 ga	80
T3427-D-415-3PY	K-T-3427/72	415/3PY	24,936	34.6	6 ga	50	K-T-342P/72	30,477	57.7	3 ga	80
TB3427-D-220	K-T-342B/41	220/1P	29,901	135.9	4/0	175	K-T-342W/41	36,546	166.1	300 mcm	225
TB3427-D-380-3PY	K-T-342B/52	380/3PY	29,901	45.3	6 ga	60	K-T-342W/52	36,546	75.5	1 ga	100
TB3427-D-400-3PY	K-T-342B/82	400/3PY	29,901	43.3	6 ga	60	K-T-342W/82	36,546	72.2	1 ga	100
TB3427-D-415-3PY	K-T-342B/72	415/3PY	29,901	41.5	6 ga	60	K-T-342W/72	36,546	69.2	2 ga	90
T3436-D-220	K-T-3436/41	220/1P	33,248	151.1	250 mcm	200	K-T-343P/41	38,789	176.3	300 mcm	225
T3436-D-380-3PY	K-T-3436/52	380/3PY	33,248	75.6	1 ga	100	K-T-343P/52	38,789	75.6	1 ga	100
T3436-D-400-3PY	K-T-3436/82	400/3PY	33,248	72.3	1 ga	100	K-T-343P/82	38,789	72.3	1 ga	100
T3436-D-415-3PY	K-T-3436/72	415/3PY	33,248	69.3	2 ga	90	K-T-343P/72	38,789	69.3	2 ga	90
TB3436-D-220	K-T-343B/41	220/1P	39,868	181.2	350 mcm	250	K-T-343W/41	46,513	211.4	400 mcm	275
TB3436-D-380-3PY	K-T-343B/52	380/3PY	39,868	90.6	1/0	125	K-T-343W/52	46,513	90.6	1/0	125
TB3436-D-400-3PY	K-T-343B/82	400/3PY	39,868	86.7	1 ga	110	K-T-343W/82	46,513	86.7	1 ga	110
TB3436-D-415-3PY	K-T-343B/72	415/3PY	39,868	83.1	1 ga	110	K-T-343W/72	46,513	83.1	1 ga	110
T3445-D-220	K-T3445/41	220/1P	41,560	188.9	350 mcm	250	K-T344P/41	47,101	214.1	400 mcm	275
T3445-D-380-3PY	K-T3445/52	380/3PY	41,560	75.6	1 ga	100	K-T344P/52	47,101	75.6	1 ga	100
T3445-D-400-3PY	K-T3445/82	400/3PY	41,560	72.3	1 ga	100	K-T344P/82	47,101	72.3	1 ga	100
T3445-D-415-3PY	K-T3445/72	415/3PY	41,560	69.3	2 ga	90	K-T344P/72	47,101	69.3	2 ga	90
TB3445-D-220	K-T344B/41	220/1P	49,835	226.5	500 mcm	300	K-T-344W/41	56,480	256.7	500 mcm	350
TB3445-D-380-3PY	K-T344B/52	380/3PY	49,835	52.5	4 ga	70	K-T-344W/52	56,480	90.6	1/0	125
TB3445-D-400-3PY	K-T344B/82	400/3PY	49,835	49.8	4 ga	70	K-T-344W/82	56,480	86.7	1 ga	110
TB3445-D-415-3PY	K-T344B/72	415/3PY	49,835	48.0	6 ga	60	K-T-344W/72	56,480	83.1	1 ga	110

ELECTRICAL NOTES FOR T3400 SERIES

For Model Number Powered Bottom Model: Add a "PB" after the "D" (Example = T3427-D-PB-240-1).

UL Listing: All models are c-MET-us listed.

Control Panels: All T3400 kilns get a floor standing panel. NEMA 1 panel are recommended but not required for 480 volts.

TB MODELS: TB models have more power than the regular T model kilns. The higher powered TB elements are always used on the TB3418 because of the large ratio of unheated surface area.

480 Volt Models with Quad Element Option: See website kiln pages for electrical specifications.

Dimension & Weight Specifications for T3400 Series

Model Number	Inside Height	Cubic Feet	Furniture Kit	Furniture Kit Part No.	Outside Dimensions	Shipping Dimensions (with Kit)	Ship Weight Kiln Only	Ship Weight Kiln + Kit
TB3418-D	18"	13.8	4 shelves, 1 post kit	H-T-K518/00	76" W x 72" H x 53" D	1 crate: 50" W x 46" H x 56" D 1 crate: 45" W x 74" H x 48" D	1,065 lbs	1,215 lbs
T3427-D	27"	20.7	6 shelves, 1 post kit	H-T-K527/00	76" W x 84" H x 53" D	1 crate: 50" W x 72" H x 56" D 1 crate: 45" W x 93" H x 48" D	1,215 lbs	1,420 lbs
T3436-D	36"	27.6	8 shelves, 2 post kits	H-T-K536/00	76" W x 93" H x 53" D	1 crate: 50" W x 82" H x 56" D 1 crate: 45" W x 93" H x 48" D	1,340 lbs	1,615 lbs
T3445-D	45"	34.6	10 shelves, 2 post kits	H-T-K545/00	76" W x 102" H x 53" D	1 crate: 50" W x 82" H x 56" D 1 crate: 45" W x 93" H x 48" D 1 crate: 50" W x 48" H x 56" D	1,505 lbs	1,840 lbs
METRIC DIMENSIONS (CM, LITERS & KG)								
TB3418-D	45.7	392 L	4 shelves, 1 post kit	H-T-K518/00	193 W x 183 H x 135 D	1 crate: 127 W x 117 H x 143 D 1 crate: 115 W x 213 H x 122 D	484 KG	552 KG
T3427-D	68.6	588 L	6 shelves, 1 post kit	H-T-K527/00	193 W x 213 H x 135 D	1 crate: 127 W x 183 H x 143 D 1 crate: 115 W x 237 H x 122 D	552 KG	645 KG
T3436-D	91.4	783 L	8 shelves, 2 post kits	H-T-K536/00	193 W x 236 H x 135 D	1 crate: 127 W x 209 H x 143 D 1 crate: 115 W x 237 H x 122 D	608 KG	733 KG
T3445-D	114.3	979 L	10 shelves, 2 post kits	H-T-K545/00	193 W x 259 H x 135 D	1 crate: 127 W x 143 H x 143 D 1 crate: 115 W x 237 H x 122 D 1 crate: 127 W x 122 H x 143 D	683 KG	835 KG

DIMENSION & SHIPPING NOTES

Cross section of Inside: Approximately 45" wide by 34" deep. (114.3 cm by 86.4 cm)

Hearth Setting Area: 42" wide by 28" deep. (106.7 cm by 71.1 cm)

Recommended Minimum Space Requirements: 107.6" wide by 79.0" deep (273.3 cm by 200.6 cm)
(See General Dimension Diagram for details).

MORE: See each model page on hotkilns.com to download PDF General Dimension Drawings for more outside and inside dimensions, minimum space requirements, BTU ventilation requirements, and kiln weight. See the Shipping Tab on the model page for complete shipping dimension and shipping weight information.

TB3418

Temperature Rating: Cone 10

Volume: 13.8 Cubic Feet

Brick Thickness: 3" Brick

Inside: 43.5" D x 18" H

Outside Dimensions: 76" W x 72" H x 53" D

Shipping Dim with Vent & Furn Kit: 2 Crate (50" W x 46" H x 46" D & 50" W x 74" H x 46" D)

Ship Weight (Kiln): 1,065 LBS

Ship Weight (Kiln, Vent & Furn Kit): 1,215 LBS

FURNITURE KIT FOR TB3418

Part Number: H-T-K518/00

Includes: Six 28" X 14" X 3/4" Rectangular Shelves (3/4" thick), Twelve Each 1/2", 1", 2", 4", 6", and 8" Square Posts, and One Pair Heat Resistant. Gloves.



T3427

Temperature Rating: Cone 10

Volume: 20.7 Cubic Feet

Brick Thickness: 3" Brick

Inside: 43.5" D x 27" H

Outside Dimensions: 76" W x 84" H x 53" D

Shipping Dim with Vent & Furn Kit: 3 Crate (50" W x 72" H x 46" D & 50" W x 84" H x 46" D)

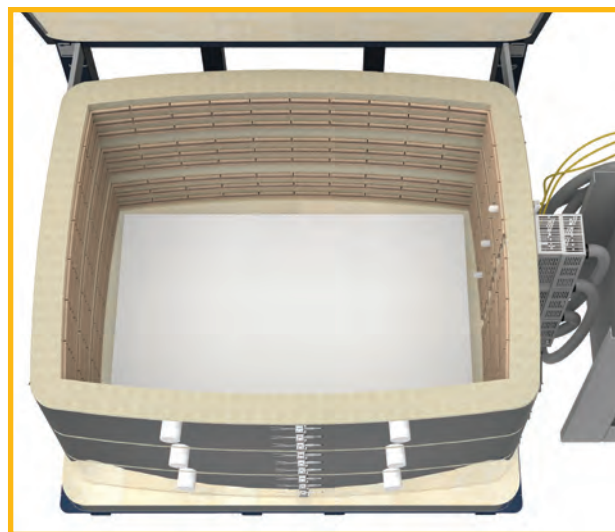
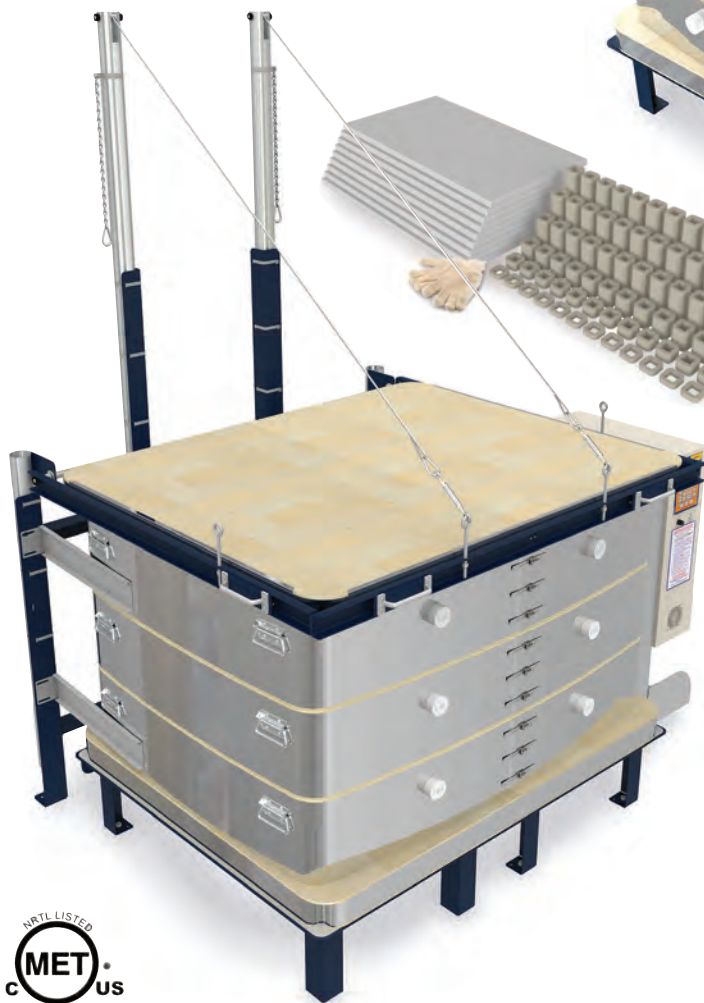
Ship Weight (Kiln): 1,215 LBS

Ship Weight (Kiln, Vent & Furn Kit): 1,420 LBS

FURNITURE KIT FOR T3427

Part Number: H-T-K527/00

Includes: Nine 28" X 14" X 3/4" Rectangular Shelves (3/4" thick), Twelve Each 1/2", 1", 2", 4", 6", and 8" Square Posts, and One Pair Heat Resistant Gloves.



T3436

Temperature Rating: Cone 10

Volume: 27.6 Cubic Feet

Brick Thickness: 3" Brick

Inside: 43.5" D x 36" H

Outside Dimensions: 76" W x 93" H x 53" D

Shipping Dim with Vent & Furn Kit: 2 Crate (50" W x 82" H x 46" D & 50" W x 84" H x 46" D)

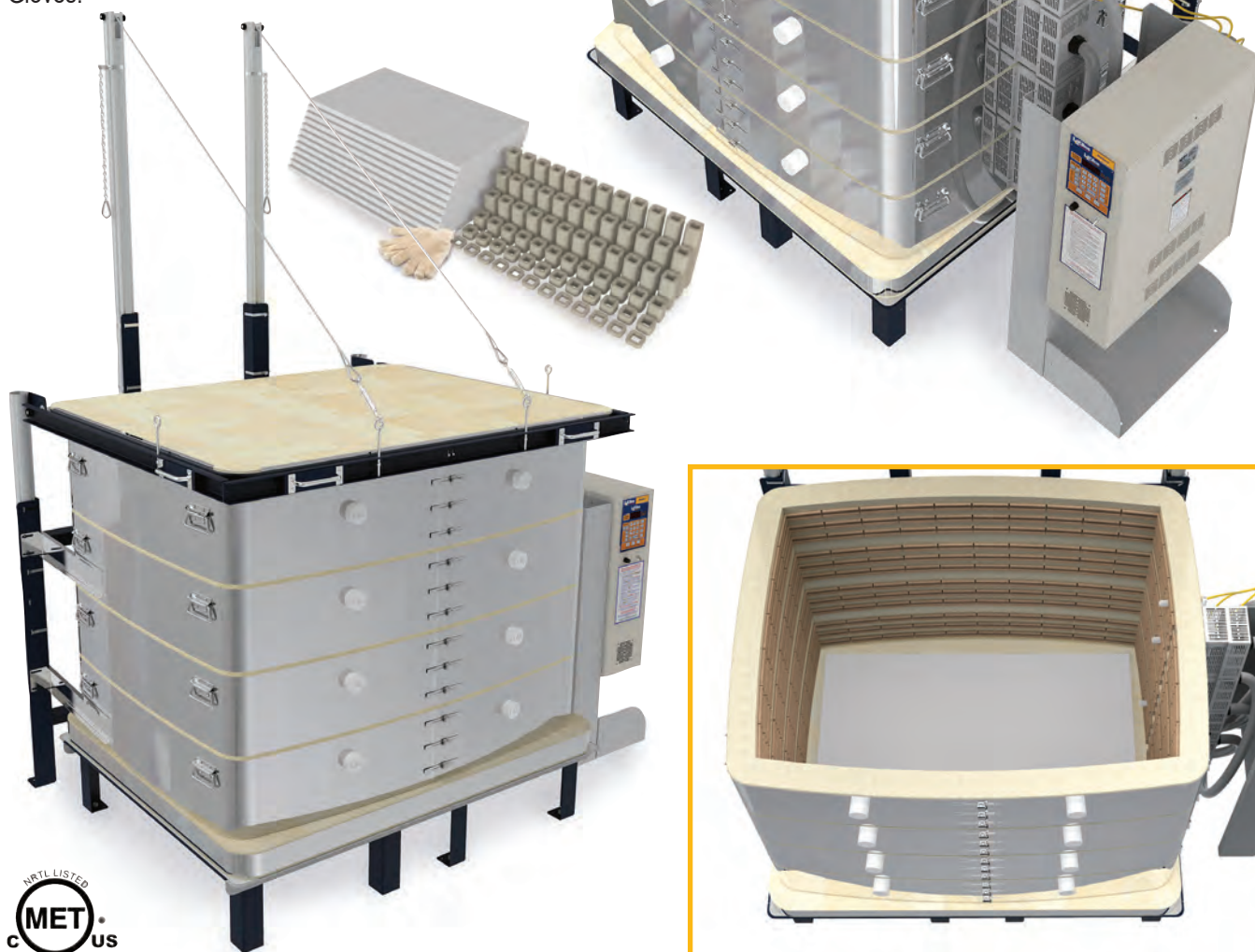
Ship Weight (Kiln): 1,340 LBS

Ship Weight (Kiln, Vent & Furn Kit): 1,615 LBS

FURNITURE KIT FOR T3436

Part Number: H-T-K536/00

Includes: Twelve 28" X 14" X 3/4" Rectangular Shelves (3/4" thick), Twelve Each 1/2", 1", 2", 4", 6", and 8" Square Posts, and One Pair Heat Resistant Gloves.



T3445

Temperature Rating: Cone 10

Volume: 34.6 Cubic Feet

Brick Thickness: 3" Brick

Inside: 43.5" D x 45" H

Outside Dimensions: 76" W x 102" H x 53" D

Shipping Dim with Vent & Furn Kit: 3 Crate (50" W x 82" H x 46" D, 50" W x 36" H x 46" D, & 50" W x 84" H x 46" D)

Ship Weight (Kiln): 1,505 LBS

Ship Weight (Kiln, Vent & Furn Kit): 1,840 LBS

FURNITURE KIT FOR T3445

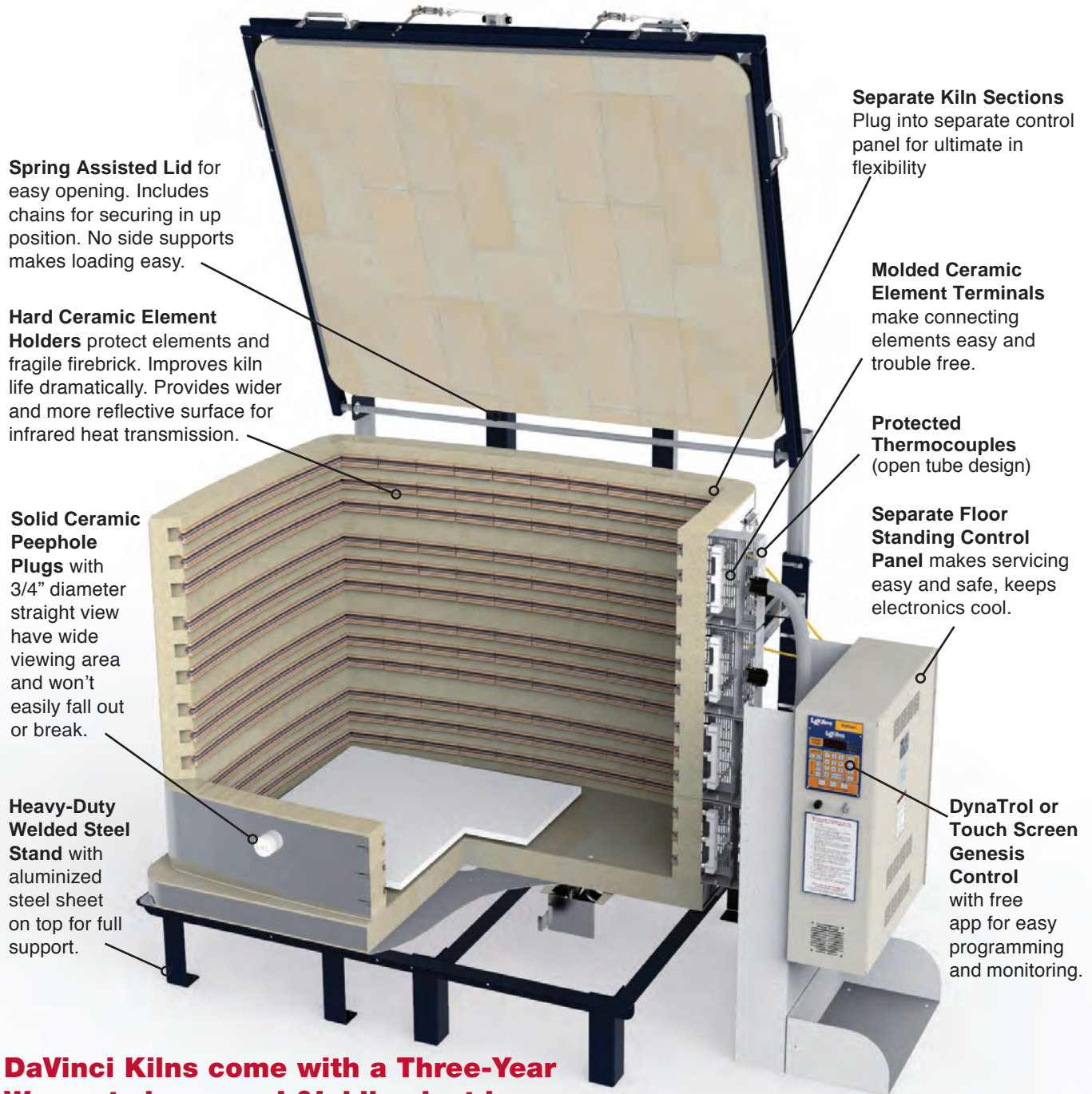
Part Number: H-T-K545/00

Includes: Fifteen 28" X 14" X 3/4" Rectangular Shelves (3/4" thick), Eighteen Each 1/2", 1", 2", 4", 6", and 8" Square Posts, and One Pair Heat Resistant Gloves.



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