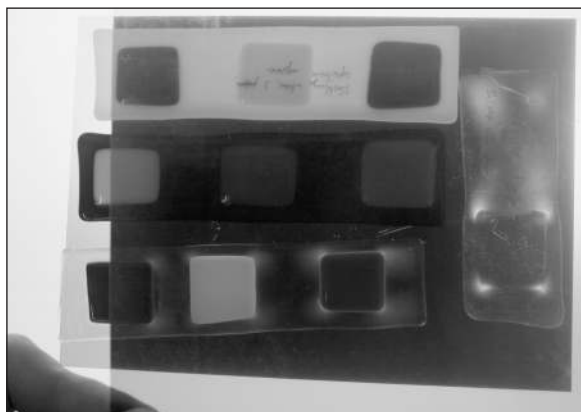


Paragon Glass Kiln Instruction & Service Manual



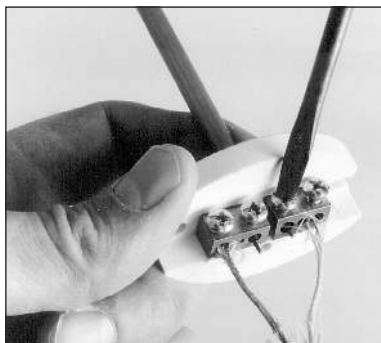
You are about to enter the magical world of kiln-fired glass. To safely find your way around and to master your kiln, read this manual. Save for future reference.

The First Firing: See pages 20 - 21



Free video training! Watch kiln videos at www.paragonweb.com

Click the "Audio & Videos" link near the top of the home page.



Recommended books at www.paragonweb.com

Click "Products" near the top of the home page. Then click "Books & DVDs" from the drop menu.

Introduction

Thank you for choosing a Paragon glass kiln! We have designed it to give you many years of reliable service. You will find that owning a kiln will give you the freedom to experiment with new ideas and to fire any time you want. Owning a kiln will take your glass skills to exciting levels.

Please read this manual. The more you know about your kiln, the more you will enjoy it and the longer it will last. You will actually save time by reading the manual, because it contains distilled information gathered over many years. Sometimes a single paragraph can save you hours of trial-and-error learning. We keep track of the questions people ask and the mistakes they make, and the answers are eventually added to the manual. So, many questions that will occur to the beginner are answered here. Your instruction packet also includes a separate digital controller manual. Please save the manuals.

Firing schedules A firing schedule is a set of temperatures and rates of speed needed to fire a glass project. We have not included firing schedules in this manual, because we feel that you should use the firing schedules formulated by the glass manufacturers. Please visit their websites to see their latest firing schedules. For a list of useful website addresses, visit www.paragonweb.com and click on Support. Then select Resource Links from the drop menu.



Recommended reading At www.paragonweb.com select “Products,” then “Books & DVDs” from the drop menu. The books we recommend will enhance your kiln experience. You can also email or phone us with questions. We are glad to help.



Online videos At www.paragonweb.com you will find online videos for many of the procedures shown in this manual. As you read each section, you can go online to watch an actual demonstration on your computer. Check the videos before performing kiln maintenance procedures.

Inspect the kiln. When you receive it, check the carton for damage. Check the kiln for interior and exterior damage. If the kiln is damaged, you can refuse the shipment and have it returned, or accept the shipment after having the driver note the damage on the Bill of Lading. Then call Paragon at 800-876-4328 or 972-288-7557 (open Monday through Thursday, 7:00 A.M. to 5:30 P.M. Central Standard Time). Check the Bill of Lading to ensure that you received the correct number of packages. Note any shortages on the Bill of Lading and have the driver sign the copy. If there were no signs of visible kiln damage and you discover it after the driver has left, notify the shipper immediately.

Sounds of a kiln Do not be concerned with the clicking sound that the kiln makes during operation. Digital kilns contain relays, which send power to the elements. The relays click as they cycle on and off to maintain the correct temperature. You will also hear the elements hum. This is only the sound of element coils vibrating in their grooves. Once you become familiar with these sounds, you may find them a reassuring indication that the kiln is firing normally.

Ceramic fiber During the first few firings of a ceramic fiber kiln, you may also smell an odor. This is normal and is caused by the burning of binders in the ceramic fiber firing chamber. This odor is accompanied by a discoloration, which will disappear after the kiln reaches 1000°F / 537°C.

Cracks in the firing chamber We are accustomed to using products that stay new looking for years—cars, furniture, cameras. But kilns are different. The high temperatures they reach generate tremendous stress. Since the insulating firebricks and ceramic fiber expand and contract with each firing, hairline cracks will appear in the bricks or fiber while the kiln is cold—even in a new kiln. Do not be concerned with these. They are normal. The cracks close tightly when the heated firing chamber expands. The cracks function as expansion joints and will not affect the firing. Though the insulating firebrick is fragile enough to carve with a fingernail, it is a miracle of physics and when properly maintained can last for many years.

Light around the lid Do not be concerned with the light that appears around the edge of the lid or door. As long as the lid/door is closed all the way, there is little heat loss. Discolored paint is also inevitable and doesn't affect firing results. Check your new kiln frequently during the first few firings and note the color change inside the kiln. After awhile you can learn to estimate, with considerable accuracy, when the kiln is about to shut off just by observing the color.

Monitor the kiln Even though your Paragon kiln may be designed to shut off automatically, check the kiln before the expected shutoff time. The warranty on your kiln does not cover damage from overfiring regardless of the circumstances. It is the operator's responsibility to make sure the kiln turns off when the firing is completed. Never leave your kiln unattended near the end of the firing.

The electrical data plate To find your kiln's model number, which is needed to fill out the warranty card, please see the electrical data plate attached to the side of the kiln. Important information about your kiln is recorded on the data plate. Please include this information when ordering parts or calling your dealer or the factory about your kiln. Write that information here for quick reference:

P/N _____ SN _____ Model _____ Volts _____

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Record the information from your kiln's electrical dataplate on the inside cover of this manual.

Safety

IMPORTANT

Read each page of this manual in detail before you install or operate your kiln. Warranty does not cover damage caused by failure to follow instructions.

Note: Experienced kiln operators keep a small timer with them as a reminder that the kiln is firing. You could set the alarm on a digital wristwatch for the estimated firing time, less 20 minutes. When the alarm sounds, go to the firing room to check the kiln. Do not leave the kiln unattended, especially near the estimated shutoff time.



FOOD-SAFE GLASS

Some glazes and glass may not be designed for surfaces that will be in contact with food or drink. If you make food or drink containers, select a glass that has been formulated, tested, and labeled as approved for surfaces that will be in contact with food or drink. Follow the glass manufacturer's instructions exactly, without any variations.

Insurance Companies

If your insurance company ever inspects your kiln room, tell the inspector that you follow the safety and installation guidelines shown on pages 4, 5, and 7. What insurance companies also want to see:

- Fire extinguishers and smoke detectors
- An electrical shut-off near the kiln (not needed for 120 volt models)
- You have removed combustibles from the kiln room.
- A licensed electrician installed the circuit.

Important Safety Rules

Following these safety pointers will add little extra time to your daily routine. There is little danger of a serious burn from accidental contact if you exercise the same caution you would use with an electric iron.

- Place the kiln on the stand recommended by Paragon. When a kiln is safety tested, the lab fires the kiln on the stand designed for it. Cinder blocks or bricks can inhibit the flow of air under the kiln. They can also change the kiln's heating characteristics.

- Place the kiln on a non-combustible surface.
- Do not install closer than 12" (304 mm) from any wall or combustible surface.
- Fire only in a well ventilated, covered, and protected area.
- Do not open the lid or door until the kiln has cooled to room temperature and all switches are off. This is for your safety and also avoids the risk of thermal shocking the glass. The resulting sharp edges of broken glass can injure hands.

- Some artists crash cool the kiln, which means cracking the lid or door to halt the progress of fusing or slumping. We generally don't recommend crash cooling, because it is rarely necessary. If you must crash cool, lift the lid or open the door just an inch for a few seconds after the kiln reaches process temperature (the temperature at which the glass has fused or slumped). Wear high-temperature gloves and a full-face mask. Stand back from the kiln, because when you crack open the kiln, hot air will rush out. Use a Paragon Lid Lifter for top-loading kilns. (See Accessories, page 23.)



- Techniques such as glass raking or embossing require inserting tools into the kiln while the glass is hot enough to manipulate. This should not be attempted with a top-loading kiln. Use either a front-loading kiln or a clamshell kiln. Wear long high-temperature gloves and a full-face mask. Stand back from the kiln since hot air will rush out. Before inserting a tool into the kiln, please temporarily turn off the power to the elements. (Kilns with the optional door safety switch should automatically turn off the power to the elements when the door or lid is opened.) Crack the door or clamshell just wide enough to insert the tool, and for only a few seconds. Drag the rod across or press the embossing tool into the glass surface. (It takes very little pressure.) Then remove the tool and close the kiln. Turn the power back on if necessary.



The door safety switch is optional on some kiln models.

- **DANGEROUS VOLTAGE!** Do not touch heating elements with anything. Disconnect kiln or furnace before servicing.

- Do not leave kiln unattended while firing. Do not leave a kiln turned on at your studio while you are at home sleeping.

- Unplug the kiln or turn off the electrical shut-off box or circuit breaker when the kiln is not in use especially if you are concerned that someone could turn it on while you are away.



Install an electrical shut-off box near studio kilns.

- Keep the kiln lid or door closed when the kiln is not in use. This keeps dust out of the kiln. Also, should someone turn on the kiln while you are away, the closed lid will keep the heat safely inside the firing chamber.

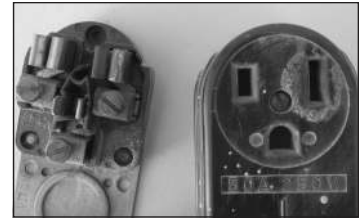
- Some kilns have a swing-away vent latch. When the kiln is not in operation, keep the swing-away vent latch in the closed position. The lid should remain closed when the kiln is not in use.



Keep the swing-away vent latch in the closed position when the kiln is not in use.

- Never place anything on the kiln lid even when the kiln is turned off. If people become accustomed to placing papers and other objects on the kiln, they may forget and do that while the kiln is firing.
- Remove all tripping hazards from around the kiln. Keep the kiln's supply cord out of traffic areas.
- Do not let the cord touch the side of the kiln; it becomes hot enough to damage the cord.
- Avoid using extension cords.
- Examine kiln shelves for glass particles before applying kiln wash or glass separator. Sharp slivers of glass stuck to the shelf can cut hands. Before rubbing a hand over a shelf, be sure the shelf is free of glass shards.
- Fire only approved materials purchased from a knowledgeable supplier. Do not fire marbles, rocks, and other objects. Rapid heating to a high temperature can cause violent reactions in many materials. Never fire tempered glass inside a kiln. It could explode.
- Clay molds must be bone dry before firing. Moist clay can explode inside the kiln, damaging the kiln. Place the mold against the inside of your wrist. If it feels cool, it is too wet to fire.
- Do not fire cracked kiln shelves. They can break during firing. Store kiln shelves in a dry area. Moist shelves can explode inside a kiln.

- If you smell burning plastic, turn the kiln off. Examine the wall outlet and supply cord for signs of burning.



This wall outlet burned because of either a loose wire connection or loose spring tension against the plug prongs. Occasionally inspect the wall outlet.

- As the kiln fires, it is a good habit to place your hand on the kiln's power cord to check the temperature. It is okay if the cord is slightly warm, but it should never feel hot. Make sure the plug is pushed all the way into the receptacle.
- Never place extra insulation around the kiln in an attempt to conserve energy. The extra insulation can cause the switch box wiring to over-heat and the steel case to warp.
- Do not wear loose-fitting clothing around a hot kiln.
- Remove flammable materials from the kiln room. If you fire a kiln in the garage, park your car outside. Remove the lawn mower, gasoline, and other flammable materials. Keep packing materials such as shredded newspapers out of the kiln room.
- Keep unsupervised children and pets away.
- Do not breathe brick dust, kiln wash, glass separator, ceramic fiber paper (after it has been fired), or kiln repair cement. Prolonged exposure may cause lung injury. Vacuum the kiln with a HEPA filtered vacuum cleaner or a central vacuum that takes the dust outside.
- Whenever you open the kiln's switch box to maintain your kiln, turn off the circuit breaker to the kiln, tape the breaker box door shut, and leave a note on the box saying, "WORKING ON KILN. BREAKER OFF."

Safety Equipment

Wear green #3 firing safety glasses when looking into a hot kiln. To find the glasses, visit www.paragonweb.com and enter firing safety glasses on the search line. Or see your Paragon kiln distributor.



Wear green #3 firing safety glasses when looking into a hot kiln.

Wear clear safety glasses when cutting, grinding, or shaping glass. This is extremely important, because tiny shards of glass become airborne during these operations.

Keep a Class C fire extinguisher and a smoke alarm in the kiln room. Mount the extinguisher near the door to the room.

Basic Kiln Set Up

How to Lift and Move Your Kiln

Never lift a kiln by the door handle or peephole. Use the hand-lifts, or lift from the bottom of the kiln.

When moving a top-loading kiln out of the way when not in use, avoid pushing the kiln on the stand (unless the stand has casters). Doing this can damage the stand legs. Instead, lift the kiln. If you move the kiln frequently, get a stand with casters.

Moving a Kiln Through a Narrow Doorway

Most kilns will fit through a 32" (812 mm) doorway. The larger ones require a 36" (914 mm) or wider doorway. You may need to remove the door to the room to get the kiln through. You can remove most doors with a screwdriver.

In some cases you can turn a front-loading kiln onto its back and carry it through a doorway. For instance, a customer had a 28" (711 mm) wide doorway in an older home. The Pearl-22 glass kiln requires 32" (812 mm) of doorway clearance. However, the kiln can be moved through the 28" (711 mm) doorway by turning the kiln sideways. Be sure the lid is secured in the closed position. Handle the kiln gently, and have several helpers on hand. Turning the kiln sideways for a short time will not hurt it.

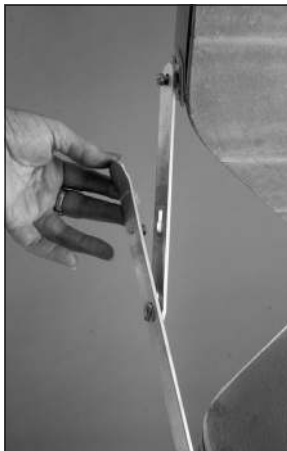
Before turning a used kiln sideways, vacuum the interior, especially the kiln-washed floor. After the kiln is set up, vacuum the element grooves. This is to remove flakes of kiln wash that may have fallen into the groove. Kiln wash in the grooves can burn out an element.

It can be difficult to move a kiln through a narrow hallway, especially one that has a 90-degree turn. If you are not sure the hallway is wide enough, draw a diagram. Then try to move a paper diagram of the kiln through the diagram of the hallway.

How To Care For a Kiln Lid

Handle the kiln lid as gently as you would a laptop computer. Slamming the lid can crack the bricks the first time it happens.

Top-loading kilns with a locking support arm: Fully disengage the arm before lowering the lid. Otherwise you can break the lid near the hinge. While loading and



unloading the kiln, do not touch the lid support.

Lids with a spring counterbalance, and clam-shell-style glass kilns: Hold the lid handle and guide the lid or kiln top until it is fully opened. If you let go of the handle too soon, the lid will slam backward to the fully opened position, damaging the firebricks.



A small gap will appear under the lid or door of the kiln. This is normal. The front of the lid should not rise during firing, however. If the lid rises 1/2" (12.5 mm) or so, do not place a weight such as a brick on top of the lid to hold it down. The weight will add stress to the firebricks near the lid hinge. Instead, adjust the hinge so the lid doesn't rise. (See page 40.)



Do not let go of the lid until it reaches the fully opened position. Letting go too soon may cause the lid to slam upward.

Occasionally vacuum the inner lid surface with the brush attachment of a vacuum cleaner. From time to time, check the condition of the lid support or spring system and the lid handle.



Occasionally vacuum the inner lid surface.

Keep the lid closed when you are not using the kiln. This keeps dust out and prevents the lid from dropping while you are away. Do not store anything inside the kiln or on top.

Where to Locate Your Kiln

- Plan your firing area near a present electrical outlet or where a new circuit can easily be installed. Place the kiln in an area where it can be easily loaded and unloaded yet out of the way when not in use.
- Place your kiln in a well-ventilated, covered, and protected area such as the garage, basement, storage building, utility, or hobby room. Good ventilation is especially important if you fire glass paints, molds, enamels, and decals.

Q Is it okay to place the kiln on a covered porch or in a carport?

A Yes. As long as the kiln is protected from the weather, it can be installed in a roofed-in area with open sides such as a carport. But especially in humid areas, the kiln may rust faster than it would inside an enclosed building.

- Do NOT store gasoline, paint, or other flammable liquids in the kiln room. Keep these items in a storage shed if your kiln is in the garage. Otherwise you will spend time removing them every time you fire the kiln.



If necessary during hot weather, use a fan to move the heat away from the kiln's switch box.

- Never allow the room temperature of your firing room to exceed 100° - 110°F / 37° - 43°C. (Room temperature is the temperature measured three or more feet (91 cm) away from the kiln.) If necessary, use a fan to move the heat away from the kiln's switch box.
- Provide a minimum of 12" (304 mm) clearance between the kiln and the closest wall.



Never allow the room temperature of your firing room to exceed 100° - 110°F / 37° - 43°C.

- Never place the kiln near curtains or other combustible materials such as art room supplies.
- Position the kiln stand on a level surface that will not be damaged by heat. We recommend a cement floor. However, a sheet of protective material may be used under the stand. Consult your hardware or building supply store for a recommendation.
- Avoid placing the kiln stand on rubber tile, linoleum or any surface that might tend to mar or discolor when heated.
- Keep unsupervised children and pets away from the firing area.
- Do not allow the kiln's power supply cord to contact the side of the kiln. This could burn the cord. Before each firing, check all around the kiln to make sure nothing is touching the kiln case.

Cold Weather

It is okay to store and fire the kiln in an unheated building during winter. But before operating, raise the temperature of the kiln's switch box to at least 32°F / 0°C with a space heater.

Q What is the difference in the cost to fire a kiln in a warm room compared to firing in a cold room?

A Room temperature has almost no effect on the electrical cost of firing a kiln. However, if your kiln is under a carport that has open sides, protect the kiln from wind. Air blowing against the case can raise the electrical cost slightly.

Keep important firing instructions on the wall at a convenient height so you don't have to spend time hunting for it. Find a convenient place for your firing logbook and kiln instruction manuals. A document holder on the wall is a good location.

The Need for a Table or Stand

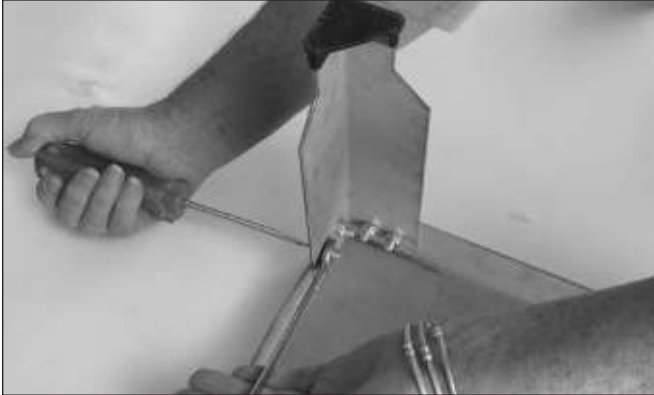
Some of the large kilns have a built-in stand that raises the kiln floor to a comfortable working height. These models do not need an extra table. However, the smaller table-top kilns do need one, because the kilns are too low to operate comfortably. The table must be steel and strong enough to support the weight of the kiln.

Top-loading kilns that are shipped with a separate stand must be mounted on the supplied stand. If you buy a used kiln that does not have a stand, contact us to find out if we make a stand for that model.

Setting Up the Stand

Note: Tabletop kilns do not come with a separate stand. Tabletop kilns should be mounted on a steel table or on the optional Paragon ST-8 stand. The oval kilns come with two stands. Place the stands side by side under the kiln.

- 1 Insert the mar-proof plastic tips on the stand legs.



- 2 Place two stand side pieces in front of you as in the illustration above. Place a stand leg inside the side frames. Insert bolts, tighten nuts.



The legs should be installed inside the horizontal top sections of the stand as shown here.

- 3 Assemble the other corners the same way.
- 4 Position the stand on a concrete floor or a high temperature protective sheet.

- 5 Center the kiln on the stand providing for a minimum of 12" (304 mm) clearance between the kiln and the closest wall. The kiln should be close enough to the wall outlet to avoid straining the cord.

Make sure the kiln is sturdy on the stand.

Level the Kiln

If the kiln is unlevel, some projects such as glass fired through drop rings could become distorted.

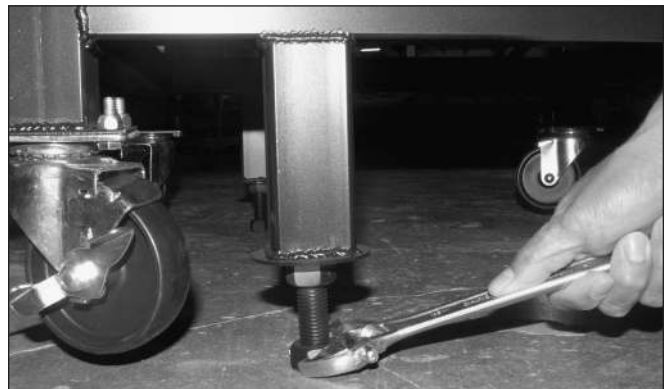
Note: You can level either the kiln floor or the shelf in the kiln. To level the shelf, place the shelf (or shelves) inside the kiln on $\frac{1}{2}$ " (12.5 mm) posts. (Remove the shelf and posts later to coat the kiln bottom with kiln wash or glass separator.) Then follow steps 1 and 2 below.



You can level either the kiln floor or a shelf inside the kiln.

- 1 First, remove all packing materials from the firing chamber. Place a spirit level on the kiln floor, checking the level from front to back and side to side. Adjust the kiln until the bubble is centered between the two lines in the spirit level.
- 2 To level the kiln, place a shim UNDER the appropriate leg or legs, not between the kiln bottom and the stand or table.

If your kiln has leveling feet, turn the adjustable leveling bolts with a box-end wrench to change the height of the stand legs. Once the kiln is level, tighten the leveling feet lock nuts. If the floor of the kiln room is already level, you won't need to use the leveling screws. In that case, lock the casters if your kiln has them. Adjusting the screws will lift one or more casters off the floor. But you don't need to remove the casters.



If your kiln has casters but no leveling feet, place a shim under the appropriate caster or casters to level the kiln. The shims should be large enough to keep the kiln level should the casters move. The shims should be sheet metal of about 8" x 8" (203 mm x 203 mm) in size.



To level a stand that has casters, place a steel shim under one or more casters.

Install the GL-Series Door Handle

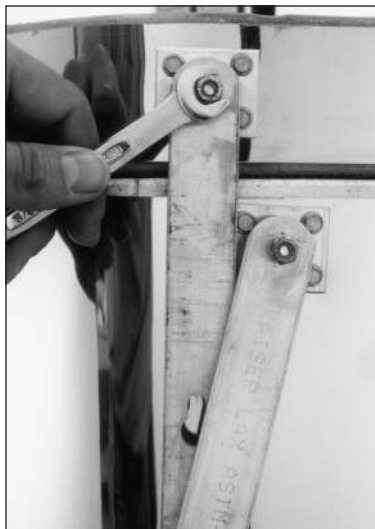
Note: If you have a top-loading kiln, please ignore the instructions on door handle installation.



Some front-loading models are crated with the door handle removed. Installation is simple. Attach the door handle to the door handle bracket with furnished nuts and bolts as illustrated.

Attach the Lock-In Lid Support

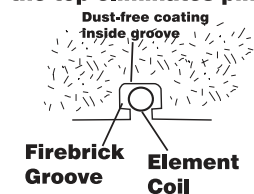
Models with the lid support: Connect the lid support to the stud on the side of the kiln. Tighten the lock nut until it is snug.



Inspect and Seat the Sidewall Elements

The elements in the lid or top of most kilns are mounted in ball grooves. The elements stay in the grooves without pins because the coils in the elements are wider than the groove opening. For this reason only the sidewall elements need to be in-

The element groove in the top eliminates pins.



spected. Please skip this section if your kiln has only elements in the top of the kiln.

Note: Elements in the sidewall grooves of four-sided kilns generally do not need inspection, because they are held in place with element pins.

Shipping may dislodge the elements of your kiln. Please perform the kitchen knife test to make sure the elements are seated in their grooves.

Kitchen Knife Test

Always unplug the kiln before touching an element with anything. Touch only a cold element, never a hot one, with a plastic object such as a comb. Plastic will melt on and ruin a hot element.



Press the elements into their grooves by very gently running a blunt kitchen knife, plastic comb, or similar blunt object completely around each groove. Do this before the first firing, because it may not be evident to the eye whether the coil is in its groove.

Don't force the element into the groove corners. If the element won't fit easily, lengthen it with automotive snap-ring pliers (available from auto parts stores). Stretch the space between the coils just a little where the element fits into the wall brick corners. The element should then easily seat into the corners.

If the element doesn't lie flat in the bottom of its groove, you needn't be concerned as long as the element fits all the way back into each corner and doesn't bulge outside the groove.

Before the kiln is fired, the elements are malleable; there is no danger of breaking the elements when you bend them. After firing, however, the elements become brittle and must be reheated if they bulge out of the groove. See "Reseating a Bulging Element," page 30.

The Electric Circuit

Please have only a qualified electrician install your kiln circuit in compliance with local codes. If you plan to use an existing circuit, have the electrician check the circuit and compare the wire and breaker sizes with those shown in the Paragon catalog and website. The circuit must never be used by other appliances while the kiln is firing. Our recommended breaker and wire sizes assume that the circuit is dedicated, which means that it powers only the kiln and no other appliance. Local codes supersede our catalog recommendations.

Electrical Shutoff

For the larger 240 volt kilns, we recommend an electrical shutoff box near the kiln in addition to having a circuit breaker at the electrical panel. The shutoff box is a must for direct-wired kilns, which can't be unplugged to disconnect the power. We recommend disconnecting the power when the kiln is not in use. If you unplug the kiln



frequently, the spring tension on the wall outlet may eventually weaken. The shutoff box disconnects the power without having to unplug the kiln.

Note: The shutoff box is not needed for 120 volt kilns.

Circuit Breaker Panel

Install the kiln within 25' (7.62 m) of the fuse or circuit breaker panel. For every additional 50' (15.24 m) from the panel, increase the circuit wire size by one gauge.

Do not place the kiln right in front of the electrical panel; keep the kiln at least 3' - 4' (92 - 121 cm) away. Otherwise, the breakers may trip more easily on a hot day.

This is because a circuit breaker is triggered by heat, and a nearby kiln can raise the temperature of the electrical panel.

Do not use the circuit breaker to disconnect the kiln. Frequently switching the circuit breaker will weaken it. Instead, use a shutoff box located near the kiln.



Circuit Wire

Use a circuit wire size large enough for the wall receptacle amperage, even if the kiln amperage is less than the wall receptacle amperage.

Caution: Changing the cord plug on Paragon kilns to a lower-amperage plug may void your warranty.

Trying to save money on the circuit installation by using a smaller diameter wire is not cost effective, because the thinner wire generates more heat than the thicker wire. The heat means wasted electricity and sometimes slightly lower voltage.

Use copper wire. Do not allow an electrician to use aluminum wire on your new circuit. Aluminum terminals corrode and require greater installation care. Avoid using extension cords.

Voltage Affects Firing Time

Voltage fluctuation can vary the firing time. Even a small drop in voltage can slow the kiln. If your kiln is slowing down, do not assume that it is due to worn elements. The voltage to your building may be low due to peak demand. If so, try firing your kiln when electrical demand is lower and the voltage is higher. Fire at night or early morning. For more information please see page 28.

Check the Electrical Installation

Check the receptacle voltage with a voltmeter before plugging in your kiln. Measure between the two slots where the flat blades on the plug are inserted. Only a qualified person should perform this test, because improper use of a voltmeter can result in shock to the user. The voltage should measure within 10 volts of the kiln's rated voltage. Please see page 28.



Set a multimeter to Volts AC. See your meter's instruction manual.

Note: In North America, wall receptacles and plugs have a NEMA configuration number. NEMA = National Electrical Manufacturing Association.

Verify that the safety grounding wire is properly connected in accordance with the National Electric Code (or equivalent for your country). This can be proven only by visual inspection of the receptacle wiring. Sometimes circuits have been installed by homeowners with limited electrical experience.



Checking the voltage of a wall outlet.

Preparation for Firing

Vacuum the Kiln



Vacuuming the lid grooves.



Vacuuming the sidewall grooves.

Vacuum your kiln before firing. Use a HEPA filtered vacuum cleaner or a central vacuum that takes the dust outside. Static electricity can build up around a vacuum nozzle especially in dry weather. Static can damage electronics. So before vacuuming, disconnect the power to the kiln. Keep the vacuum nozzle at least 2" (50 mm) away from the digital controller, the kiln's switch box, and the thermocouple tip that extends into the firing chamber. (The digital controller is the panel with the keypad and display window. The thermocouple is the small rod that measures temperature.)

Use a soft brush nozzle to vacuum the element grooves and the inner surface of the kiln lid or roof. Vacuum the kiln every few firings and examine the walls and floor for embedded glass particles. Dig these out with a screwdriver or small putty knife. Otherwise the particles will embed deeper into the firebrick or ceramic fiber during the next firing.

Check the Thermocouple

You will find a small rod, called the thermocouple, extending into the firing chamber. The thermocouple senses temperature. If this rod is pushed out of the firing chamber, the kiln will assume that the firing chamber is cold. This could result in an over-fire.

A 1/8" (3.17 mm) diameter thermocouple should extend into the firing chamber 1/2" - 5/8" (12.5 - 15.8 mm).

A 1/4" diameter thermocouple should extend into the firing chamber 1" (25 mm) or more.



Start a Kiln Log Book

Record the following information in a kiln log book:

- 1) Date
- 2) Firing schedule, which includes the temperature, speed, and hold of each firing stage.
- 3) Starting time
- 4) Total firing time
- 5) Type of glass project, brand and colors of glass
- 6) Firing results, with notes on how to improve the next firing. Notes should indicate any changes to the firing schedule, such as "Fire process temperature 10° hotter" or "Add 10 minute hold." Try to understand why the glass turned out the way it did so you can make corrections to future firings. Do not hesitate to alter firing schedules to suit your kiln and glass.

As you gain experience, you will find a wealth of information in your firing logs. Keeping records will give you a "feel" for how your kiln fires and will enable you to duplicate the best results.

Also keep a record of upgrades that you make to your kiln. This will prevent errors when ordering parts later. For example, a customer ordered heating elements for the lid of a glass kiln. According to the kiln's serial number, the lid had the discontinued plunge groove (the type that requires pins). However, the customer had changed the lid to the newer pinless ball groove without telling us, so we sent the wrong elements.

Other examples of kiln upgrades: Changing the kiln's voltage (i.e., from 240 to 208) because you moved to a different building or a different country; upgrading from a single relay to dual relays or a mercury relay. In addition to recording this in your kiln log book, write the date and type of upgrade on a sheet of paper stapled to the inside cover of this manual.

Avoid Contaminating the Heating Elements

Contact with silica or silica bearing compounds, such as kiln wash, glass separator, alumina hydrate, glass, enameling powder, and ceramic glaze will ruin the heating elements. Never fire glass directly on the firing chamber bottom. Use a ceramic shelf on short posts to protect the bottom from glass shards and decorative items such as stringers and frit.

If a contaminant such as dripping glass or glaze embeds into the firing chamber, unplug the kiln. With the kiln at room temperature, use a knife to gently scrape off the contaminant. Vacuum the kiln. (See also "Ceramic Fiber Maintenance," page 44, and "Firebrick Maintenance," a separate publication.)

Applying Glass Separator or Kiln Wash to Shelves and the Kiln Firebrick Bottom

Kiln wash and glass separator are mixtures of finely ground minerals that do not fuse at high temperatures. They act as a barrier against glass. The kiln shelf, kiln bottom, and sagging molds must be coated with glass separator or kiln wash to keep glass from sticking to them. (Both glass separator and kiln wash will be referred to as "separator" here.)

A coat of separator will usually last several firings. The lower the fusing temperature, the more firings you can get from one application of separator. When the shelf coating begins to crack or chip, apply a fresh coat. Recoat the shelf after every full fuse. (Full fuse means heating the glass until the separate pieces of glass become one smooth surface.)

To examine the coating of separator after it has been fired, shine a side light across the shelf surface. With light shining directly across the shelf, it is easier to see cracks and flakes in the glass separator.



Caution: Do not apply separator to the walls and lid of a kiln. Apply only to the bottom of firebrick kilns. If the firebrick floor has heating elements,

do not apply separator to the floor. The separator could ruin the floor elements.

Note: Do not apply glass separator to ceramic fiber kilns. If you do mistakenly apply the separator to the ceramic fiber floor, however, you do not need to sand the glass separator off the floor.



When recoating a shelf, remove most of the old coating with a putty knife held at a sharp angle. Then recoat the shelf using the following directions. (Wear a HEPA respirator and clear safety glasses when scraping separator off kiln shelves.)

Keep the separator away from the heating elements.

- 1 Mix the separator with water following the directions on the bag. Stir.
- 2 Use a haik brush or a soft paint brush to apply the separator to the shelf. (The haik brush may be easier to use because it lays down a more even coating than most household paint brushes.) Each time you dip your brush into the separator mixture, swirl the brush around the bottom of the container. This is because the separator settles quickly. Use two or three thin coats changing the direction of the brush stroke 90° with each coat.



- 3 Dry the shelf before firing. To speed dry, place the shelf on 3 - 1/2" (12.5 mm) posts inside the kiln. Heat at full rate to 300°F / 148°C and hold for 15 - 30 minutes. Then turn off the kiln and leave the shelf inside.

- 4 After the separator has dried and the shelf is cool, you can smoothen the separator further by rubbing your hand lightly over the separator. Or rinse the brush and apply a light coating of water. The smoother the separator, the smoother the back side of the glass.

Remove any buildup of separator from the edges of the shelf by tracing around it with a finger.

For a velvety smooth surface, fire the freshly applied separator to around 1000°F / 537°C. After the shelf cools, rub grit cloth over the separator. (Grit cloth is an abrasive-coated mesh that allows residue to pass through. It can be rinsed with water and reused many times.) As you rub the separator, watch the brush-stroked surface. Remove just enough separator to remove the brush strokes. It takes just a moment.

If glaze or glass sticks to the shelf, scrape it off with a putty knife at a 45-degree angle. Wear safety glasses—sometimes chipped glass becomes airborne. Then recoat the shelf.

Firing Across Multiple Shelves

Glass is fired across multiple shelves in oval kilns and long, rectangular kilns.

- 1 Level each shelf in the kiln with a carpenter's spirit level. Support the shelves with 1/2" (12.5 mm) or longer posts to allow air circulation under the shelves. Center posts under butted shelves.
- 2 Lay a straight edge across butted shelves to be sure the shelves are even across the firing chamber.
- 3 Place fiber paper over the shelves to help hide the seams.

Basic Glass Tools

Reservoir Glass Cutter uses a reservoir of oil to lubricate the cutter wheel.

Running Pliers are for breaking glass after scoring.



Left to right: nippers, pistol-grip cutter, straight cutter, breaking pliers, running pliers, and two sizes of grozing pliers

Breaking Pliers are for controlled breaking after scoring.

Grozing Pliers shape the glass by chipping away uneven edges. They are often used when the score line doesn't break clean. Note that rough edges will become smooth when fired to fusing temperature.

How to Cut Glass

Caution: Always wear clear safety glasses while cutting glass. Tiny particles fly in all directions.

A quality glass cutter with oil reservoir, available from art glass suppliers, is much easier to use than the inexpensive cutters sold in hardware stores.

- 1 Lay the glass on a clean, flat surface. Mark off the cut with a grease pencil or felt-tip marker at each end of the glass. Lay a straight edge over the glass and line it up to the marks you just made.



Press the glass cutter just hard enough to make a steady, unbroken cutting sound.

- 2 Press firmly against the straight edge. Holding the cutter vertically and not slanted, score the glass. Press just hard enough to make a steady, unbroken scoring noise.



Place the straight edge under the score line and press down.

- 3 Place the straight edge under the glass so an edge is lined up with the score line you just made. Press down on the glass. It will break cleanly.

After scoring, use breaking pliers to separate narrow pieces of glass. When making a long cut, do not lift the glass as you break it with breaking pliers. Lifting can put a slight bow in the glass, which causes it to separate erratically. Instead, leave the glass flat on the table, pull a little of it out from the edge, and break it with the pliers.

Fusing Compatibility of Glass

When glass changes temperature, it expands and contracts. The rate at which glass changes size is called the coefficient of thermal expansion (COE). If you fuse two glass pieces together and one changes size faster or slower than the other, the fused piece may crack—even several months after it is removed from the kiln.

Viscosity is the measure of resistance to flow within glass. Glasses that do not match in viscosity will produce strain when fused together. Viscosity is as important as coefficient of expansion in determining whether glass pieces can be fused together.

Different glasses that are close enough in coefficient of expansion and viscosity to fuse successfully without internal strain are called fusing compatible. Buy glass labeled fusing compatible, or fuse glass pieces together that have been cut from the same sheet.

At the time of printing, the two most commonly used types of fusing glass were labeled COE 90 and COE 96. Do not fuse COE 90 and COE 96 to each other. Otherwise the finished piece will probably break perhaps weeks after you fire it. In your shop, separate glass by COE number and clearly label all containers.

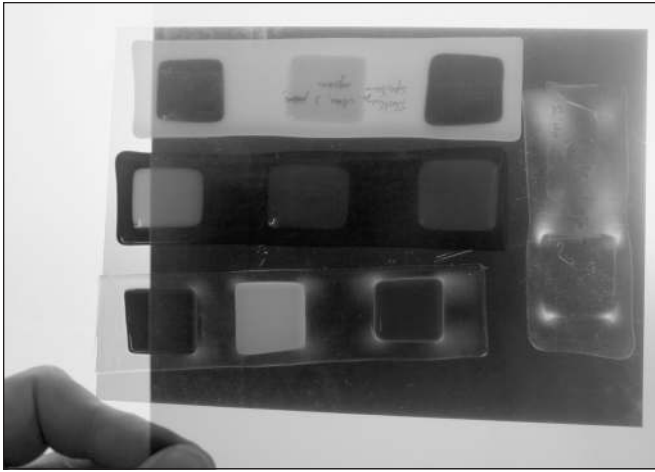
Test for Fusing Compatibility

Note: If you buy only one brand of glass that has been tested and labeled fusing compatible, you shouldn't ever need to test for compatibility with polarizing filters. However, the test can reveal strain in the glass caused by rapid annealing.

To test glass for fusing compatibility, fuse ½" (12.5 mm) sample squares of different glasses onto a larger base piece of clear transparent. The base should extend beyond the small sample pieces by about 1" (25 mm) on each side. Heat the glass to a temperature that rounds the edges of the small sample pieces.

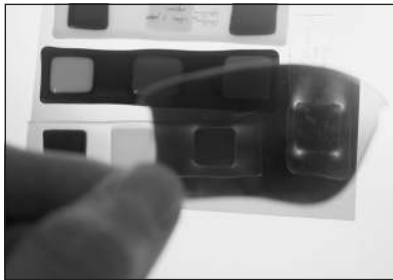
Setting Up the Polarizing Filters

- 1 Order a sheet of polarizing film from Bullseye Glass Company. Cut the filter in half. The filters scratch easily; handle them carefully. Store them in plastic page protectors.



The stress appears at the corners of the square glass samples. Use a light table to illuminate the polarizing filters.

- 2 Place a filter on a clean light table, coated side of filter down. (To determine which side is coated, make a tiny scratch in one corner of the filter. The coated side scratches off easily.) The uncoated side should go up to avoid scratches from contact with the glass test samples.



In combination with a polarizing filter, a polarizing sunglass lens shows the stress around the edges of glass samples.

- 3 Turn the light table on and dim the overhead lights. Place the glass samples on top of the polarizing filter. Hold the other filter over the samples and rotate the filter until it turns dark. Stress in the glass will appear almost magically as glowing halos around the edges of the test squares.

Analyzing the Test Pieces

The brighter the glowing halos, the greater the incompatibility between the glass. (The base layer of glass should be clear so you can see the halos.)

Cleaning and Gluing the Glass

Grease, dirt, and fingerprints etch permanently into the glass during firing. Clean the glass with glass cleaner (the type without silicones), rubbing alcohol, or even plain water just before assembling the pieces on the kiln shelf.

Use an inexpensive hair spray to hold the glass pieces together after you place them on the kiln shelf. You could also use Elmer's white glue diluted 1:1 with water. Apply only a pinpoint of Elmer's with a toothpick. Avoid using glue on the coated side of dichroic glass. If you lay

dichroic glass carefully onto the piece, glue is unnecessary, so avoid it altogether if you do not know which side of the dichroic is coated.

Load Glass Into the Kiln

The shelf should not be in direct contact with the bottom of the kiln, because direct contact would pull heat from the shelf and into the kiln bottom. Therefore place three or four 1/2" (12.5 mm) posts in the kiln. (They come with the shelf kit for your kiln.) Lay the shelf over the posts. Depending on the height of the firing chamber and



A shelf on 1/2" (12.5 mm) posts. The space between the kiln bottom and the shelf improve the heat distribution through the glass.

the placement of sidewall elements, you may get better heat circulation by placing 1" - 2" (25 - 50 mm) high posts under the shelf instead of 1/2" (12.5 mm) posts.



1" (25 mm) posts may give better heat circulation than 1/2" (12.5 mm) posts, depending on the size of your kiln.

Note: Other reasons for not firing glass directly on the kiln bottom: A shelf protects the bottom from glass spills. Glass is also more difficult to cool evenly when it is against the firebrick bottom.

Sagging molds should be placed on top of a kiln shelf. Place ½" to 1" (12.5 to 25 mm) high posts between the molds and the shelf. (The shelf should also have posts under it.) You will need at least a 2" (50 mm) gap between the glass that is on top of the mold and the lid elements.



Separate a sagging mold and kiln shelf with ½" (12.5 mm) high posts.

Note: If your firing chamber is not tall enough for a shelf under the sagging mold, then separate the mold from the kiln bottom with ½" (12.5 mm) posts.

Q. In the first fusing classes I took, the store did a tack-fuse and a full-fuse in one kiln load using multiple kiln shelves. What temperature is required for this technique?

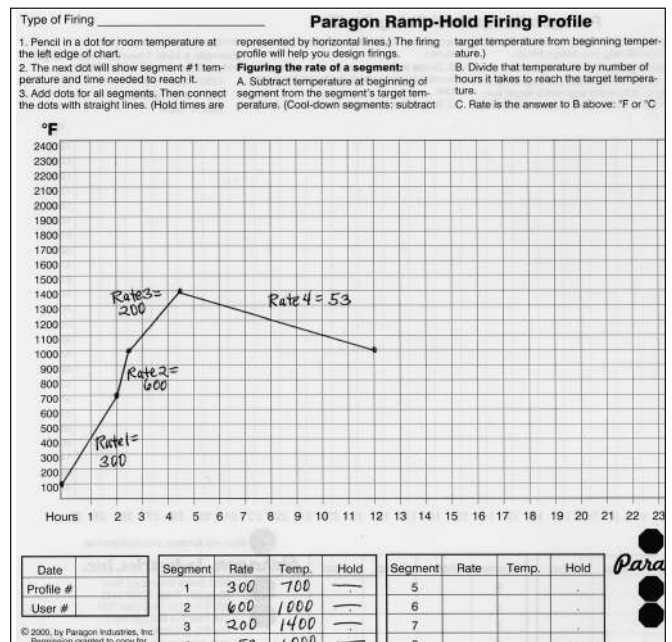
A. The elements in the lid or roof heat evenly across the glass on a single shelf. Stacking one shelf over another in a top-fire kiln is not generally advisable. However, it is possible to successfully fire stacked shelves in a glass kiln that has a fairly deep firing chamber and top elements, such as the GL-24AD. Fire two shelves stacked vertically and separated by posts. The glass on the top shelf will reach full-fuse; the glass on the bottom shelf will reach tack-fuse. You will need to experiment with post height, firing speed, and temperature—all factors that will affect the results. The ideal way to experiment is to check the glass visually as it fuses. (You will need green #3 firing safety glasses.)

Firing the Kiln

The Firing Stages of Glass

Glass fusing is the process of softening glass at high temperature until the separate pieces stick together. Thousands of years ago the Romans and Egyptians fused and slumped glass. You can see ancient glass at the Corning Glass Museum in New York.

The ideal firing speeds vary depending on the size and thickness of the glass. The thicker and larger the project, the slower you must fire it to avoid cracking. Small jewelry pieces, such as earrings, typically fire at full speed.



Drawing a graph of a firing schedule may help you to visualize the stages of firing.

1 Beginning Stage

The first critical stage of firing is from room temperature to 800°F / 426°C. In this range, glass is especially susceptible to thermal shock. Heat the glass slowly to avoid breakage. Glass that is positioned on a kiln shelf can fire faster than glass that is suspended over a mold, because the shelf helps to even out the temperature in the glass.

2 Bubble Squeeze

Under certain conditions, larger fused pieces can form bubbles. The bubble squeeze holds the temperature before the outer edges of glass fuse together and trap air between layers. To do a bubble squeeze, hold the temperature for typically 15 minutes at roughly 100°F / 55°C below the process temperature. (Add the bubble squeeze between 1100°F - 1250°F / 593°C - 676°C.)

3 Process Temperature

The glass takes its final fused shape at the process temperature.



Left to right: tack fuse, medium fuse, and full fuse

Tack-fuse The separate layers of glass just begin to stick together, and the edges of glass are no longer sharp but not yet rounded.

Medium-fuse As the glass gets hotter, the edges become rounded, and separate pieces no longer have distinctly separate layers.

Full-fuse At a higher process temperature, the layers merge together into one flat surface.

A design can go through dramatic changes from tack fuse to full fuse. Commercially available fusing glass typically reaches tack fuse at around 1300°F / 704°C and full fuse at around 1500°F / 815°C. These are process temperatures.

Adding a short hold time at or just below the process temperature will give you better control in determining exactly when to shut off the kiln. This is because the temperature hold causes the glass to fuse more slowly. By watching the glass through a peephole (the view or vent hole on the side of some kiln models) or glass window, you can control the exact level of fusing. Be aware, however, that the longer the glass is near the process temperature, the more likely that it will devitrify (form a dull finish on the glass).

Caution: Be sure to wear green #3 firing safety glasses. See “Viewing the Glass During Firing,” page 20.

When the glass fuses to the exact degree that you want, use your controller’s Skip Segment feature to begin the cooling stage of the firing. Please see the separate digital controller instruction manual.

4 From Process Temperature to Annealing

Between the process temperature and the annealing temperature, program a rapid cooling. (This is a FULL rate. See your temperature controller manual for specific instructions.) Rapid cooling at the beginning of the annealing phase lessens the chance of devitrification, which is the formation of a dull surface on the glass.

5 Annealing

Each type of glass has a temperature range that it must pass through slowly when it cools. This is called the annealing range. This slow cooling gives hot glass the time it

needs to release the stress of cooling. If you cool the glass too fast through the annealing range, it will break from thermal shock.

The annealing range for most glass is between 950°F / 510°C and 700°F / 371°C. Cool slowly through this range. Leave the kiln top or door closed all the way rather than vented. This will slow the cooling adequately through the annealing range for most smaller projects without turning on the heating elements. You may need a slower cooling for larger, thicker projects, however. In that case, program a separate segment for cooling. See the kiln’s digital controller manual.

Note: Fusing glass manufacturers post the annealing ranges of their glass on their websites.

For safest cooling, leave the glass inside the kiln until the kiln reaches room temperature.

Annealing Flame-Worked Glass Beads

These instructions are for kilns that have the optional bead door(s).

Glass is sensitive to breakage as it cools through the annealing range. This is approximately 950°F / 510°C through 700°F / 371°C. The larger the piece, the slower it must cool.

To safely cool flame-worked glass beads, anneal them in your kiln using the bead door. If you are interrupted while making a bead, you can place the mandrel in the kiln until you are ready to resume working.



Programming the Kiln for Beads

Program the controller in Ramp-Hold for the following two segments. (See the separate digital controller manual.) If your bead-making session will be longer than four hours, program a longer hold time in segment 1.

Segment	Rate	Temp.	Hold
1	1799°F / 999°C	1000°F / 537°C	04.00
2	100°F / 222°C	700°F / 371°C	00.00

Fire the kiln. When it reaches 1000°F / 537°C, it will maintain that temperature for four hours.

Annealing the Beads

- 1 At 1000°F / 537°C, the kiln is ready to receive the bead mandrels loaded with hot beads.

Allow freshly finished beads to cool slightly before inserting. This is to prevent the beads from flattening on one side when they are placed in the kiln. You can place the beads directly onto the floor of the kiln provided they have cooled slightly as described above.

- 2 Open the bead door. Insert the mandrels as you complete the beads. Leave the door slightly ajar with the end of the bead mandrel extending outside the kiln.
- 3 When you have finished the batch of beads, perform a Skip Segment. This will end the temperature hold and begin segment 2. The kiln will slowly cool through the annealing range.

After the kiln shuts off, leave the beads in place. Do not remove them until the kiln has reached room temperature.

Firing Schedules

By observing the color of the firing chamber, the ancient artists knew when to adjust the temperature of their kilns. Their knowledge of firing came from years of experience. Today the digital controller simplifies glass fusing so you can concentrate more on creating glass and less on the technical details. Nevertheless, just as in ancient times, glass still requires knowledge of heating and annealing rates.

The key to successful firing is in the firing schedule. Once you have a good firing schedule, you can duplicate results from one firing to the next. This is why it is important to keep records of every firing. You can obtain recommended firing schedules from friends, online glass discussion forums, and the websites of the fusing glass manufacturers. For current website addresses, visit www.paragonweb.com and click on Support. From the drop menu, select Resource Links.

The firing times and temperatures listed in a firing schedule are not exact. They are only general guidelines. Feel free to experiment with temperatures and hold times. Every kiln model is different. People who own several types of kilns alter their firing schedules to suit each kiln. As you gain confidence, you will alter firing schedules the way a cook alters recipes.

Whether you fuse glass as the ancients did, or you use a digital controller, the kiln is only a tool. No matter what type of control system you use, the results, ultimately, depend solely upon your own creative judgment.

How to Vent the Kiln

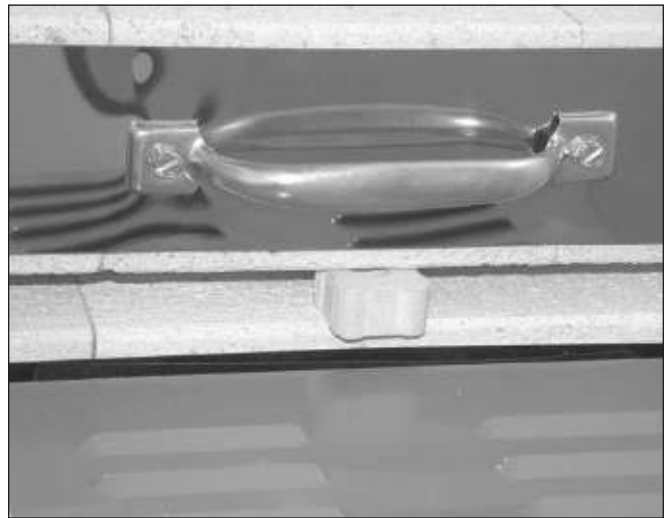
Venting the kiln allows fumes to escape the firing chamber. Fusing or sagging glass does not produce fumes. You do not need to vent the kiln for these types of firings. However, if you are hardening a mold or firing enamels, paints, decals, or some types of ceramic fiber



Remove the peephole plug to vent the kiln.

paper, you should vent the kiln to remove fumes. Venting increases the chance that large or thick glass will thermal shock. For this reason, do not vent the kiln unless it is necessary.

The venting period is at the beginning of the firing from room temperature to approximately 500°F / 260°C. To vent a kiln that has peepholes, leave out the peephole plug(s). Insert the plug(s) after the venting period.



If your kiln does not have a peephole in the side, vent the lid using a 1/2" (12.5 mm) long post.

To vent clamshell kilns and top-loading kilns that do not have a peephole, place a 1/2" (12.5 mm) tall post under the lid. This will create a 1/2" gap for the fumes to escape. Remove the post after the venting period is over using high temperature gloves or tongs.



At the end of the venting period, remove the post with a Lid Lifter and hot glove (available from Paragon).

Some kilns have a swing-away vent latch. Raise the lid to the vented position. After the venting period is over, move the swing-away vent latch to the fully closed position.



The swing-away vent latch in the closed position

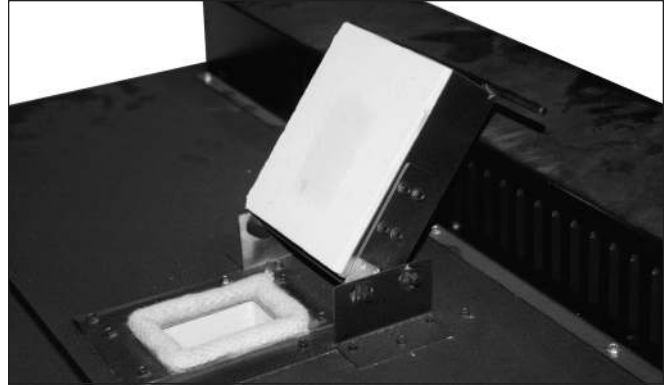


The swing-away vent latch in the vented position

Note: When the kiln is not in operation, keep the swing-away vent latch in the closed position. The lid should remain closed when the kiln is not in use.

Some clamshell kilns, such as the Pearl-56, have vent holes in the top of the kiln. Do not use the vent holes to look at the glass during firing. They are for venting only. Look into the firing chamber through the front peepholes.

Note: The top vent holes in some models have woven “rope” seals. It is okay if the vent hole covers do not lie completely horizontal against the kiln. As the woven seals become compressed with use, the covers will close farther.



Do not use the top vent holes in the Pearl-56 to look at the glass during firing. They are for venting only.

Venting front-loading kilns: Leave peephole plugs out. Open the door ¼" (6.35 mm).



Open the door about ¼" (6.35 mm) to vent a front-loading kiln.

Note: Kilns equipped with a lid or door safety switch will turn off the power to the heating elements when the lid is raised or the door is opened. With the kiln turned off, open the lid or door until you hear a click. That is the point where the safety switch will turn off the power. Vent the lid or door with a small enough gap to prevent the elements from turning off.



The door safety switch turns off the elements when the door is opened.

To remove fumes from the kiln room, mount a vent over the kiln. See “Safe Installation of the Electric Kiln” for more information on overhead vents. The publication is available from www.paragonweb.com. Select Support. From the drop menu, select Instruction Manuals.

Viewing the Glass During Firing

When you use a firing schedule for the first time—even a schedule from a trusted source such as a glass manufacturer or a friend—watch the glass. Visually inspect the glass during firing and write down the ideal process temperature for a particular type of glass. Then program that temperature into your controller for future firings.

Set the controller's temperature alarm for around 100°F / 55°C below the estimated process temperature. Look at the edges of the glass when the alarm goes off or when the light around the door or lid becomes red. Watch the glass by cracking the lid or door just enough to see inside the kiln. Look for several seconds at a time. Watching the glass is more convenient if your kiln has a glass window in the side.



At the end of the venting period, remove the post with a Lid Lifter and hot glove (available from Paragon).

Caution: Always wear green #3 firing safety glasses when visually inspecting hot glass. Use the Paragon Lid Lifter and hot glove to crack open the kiln's lid.



Caution: Do not look at the glass through the top vent holes. They are for venting. Look into the firing chamber through the front or side peep-holes.

As you watch the glass, you will observe that the glass edges will stay sharp until the kiln interior begins to turn orange. Then the glass will gradually begin to soften. The edges will round. At that point, look at the glass every few minutes. Shut the kiln off when the glass has reached the desired level of fusing. When sagging glass into a mold, shut the kiln off as soon as the glass slumps into the mold.

Note: Note: Crack the kiln door or lid only if the kiln is hotter than 1000°F / 537°C. At lower temperatures you could thermal shock the glass. After the kiln has reached the process temperature

and has begun to cool, keep the lid or door completely closed until the kiln reaches room temperature.

Sidewall Elements

The sidewall element in the standard Fusion-series kiln turns on in unison with the lid elements. The lid elements in the Fusion-series are the main heat source. Sidewall elements add heat to the outer edges of the shelf to improve heat distribution. The level of heat from the sidewall element remains the same with every firing.

Power Ratio Elements

In many of the large, four-sided kilns, the ratio of heat can be adjusted between the top and side elements. The ratio is programmed using the Power Ratio feature of the controller. If your kiln has Power Ratio elements, you should find a separate Power Ratio instruction sheet in the instruction packet that came with your kiln. You can also download the instructions from our website. Visit www.paragonweb.com and select Support. Then select Instruction Manuals from the drop menu.

If the outer edges of the shelf are hotter than the center, then reduce the side heat and turn up the top heat, and vice versa. Power Ratio also allows you to fire with only the side heat or only the top heat.

The First Firing

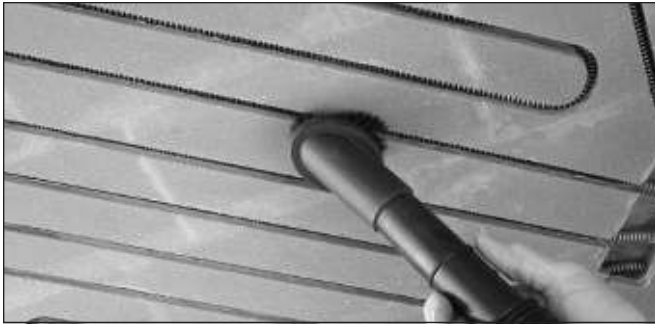
Caution: Please read the previous pages—especially the safety guidelines on pages 4, 5, and 7—before your first firing.

Make sure the power cord is pressed all the way into the wall outlet and that the firing room is free of flammable materials. As the kiln fires, place your hand on the kiln's power cord to check the temperature. It is okay if the cord is slightly warm, but it should never feel hot.

Do not be concerned with the light that appears around the edge of the door or lid. It is normal. As long as the lid or door is closed all the way, there is little heat loss. Do not be concerned with the clicking sound from the kiln.

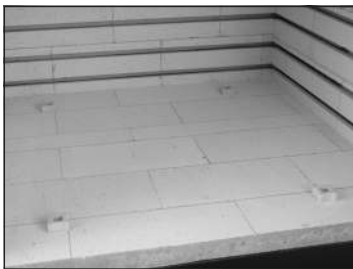
Note: Ceramic fiber kilns have a strong odor during the first firing. This is normal and is caused by the burning of binders in the ceramic fiber. The odor is accompanied by a discoloration of the fiber, which disappears after the kiln reaches 1000°F / 537°C.

- 1 Seat sidewall elements (if any) in their grooves.
- 2 Empty the kiln and clean with the brush attachment on a vacuum cleaner.



3 Apply kiln wash to the kiln bottom and the tops of shelves (pages 12-13).

4 Load the posts and shelf (or shelves if your kiln holds more than one) into the kiln. Heat must circulate around the shelf, so place posts between the kiln bottom and the shelf. If you are firing several shelves, do not stack them together. They must be separated with posts. Shelves that are stacked together will probably crack.



Place posts between the kiln bottom and kiln shelf.

5 Load a small test sample of glass such as a sample tile or a pendant onto the shelf.

Program the controller to the fusing temperature of the glass in the kiln. If you are firing the kiln with only the kiln furniture, enter this program:

Segment	Rate	Temperature °F	Hold
1	500	100	00
2	Full	1360	0
3	Full	960	0
4	140	125	00

Occasionally check on the kiln during this first firing. After the kiln shuts off, leave the lid closed until the kiln has cooled to room temperature. Always make sure the kiln has shut off before leaving it for the night. Do this with every firing.

Firing Your Kiln in Hot Weather

The controllers on Paragon kilns shut off when the switch box where the controller circuit board is located is hotter than 176°F / 80°C. The error message ETH (Electronics Too Hot) will appear. Our recommended maximum controller board temperature is 158°F / 70°C.

You can fire your kiln in the sweltering summertime, but you may need extra ventilation. Use a fan to blow air through the switch box ventilation slots. Do not let the air blow directly into a peephole. The air should go in one side of the switch box and out the other to create a cross-current. Also, open windows.



Glass Sagging

Sagging glass into a mold requires two firings. First, fuse the glass. Then sag it into a mold in a separate firing. Fuse and sag separately because fusing requires a higher



Separate a sagging mold and kiln shelf with ½" (12.5 mm) high posts.

temperature than sagging. Sagging requires slower firing than fusing. The glass is one thick piece after it has been fused and needs slower firing than individual separate pieces stacked together.

Firing Decals onto Glass

Fire to the temperature recommended by your decal supplier. Decals are an excellent beginner's project, because you can achieve success with your first firing. Don't worry if you ruin the first few decals. Applying them takes practice. Before starting, clean the glass with water.

- 1 Cut out the decal and soak in lukewarm water until you can slide the image from the paper backing onto the glass. Slide the image off the backing rather than attempt to lift the image off.



- 2 Position the decal on the glass. The side of the decal that was down on the paper is the same side that goes down on the glass.
- 3 Use a damp sponge or rubber squeegee to squeeze out air bubbles and water from the decal. For flat surfaces, use a rubber squeegee; for curved surfaces, use a damp sponge.
- 4 Dry the glass with decal overnight before firing.
- 5 Fire the glass on a kiln shelf that has been coated with kiln wash or glass separator.
- 6 Fire in a well ventilated area. Vent the kiln during the first hour or until the smoke and odor disappear. (See pages 18-19.)
- 7 After the kiln shuts off, leave the lid or door completely closed until the kiln cools to room temperature.

Q. I have recently tried slumping wine bottles in my kiln. After a few days, the bottom cracks off. What am I doing wrong?

A. It sounds like the bottles cooled too quickly. The thicker the bottle, the slower it has to cool. Bottles are especially prone to cracking if you fire them a second time to add a decal. This is because the glass is fused together and is thicker than it was as the original bottle in the first firing. Fire and cool the glass more slowly.

Firing Accessories

Two Types of Safety Glasses: Clear and Green #3

Wear clear safety glasses when cutting or chipping glass. Wear dark green #3 firing safety glasses when looking into a hot kiln, such as when checking the progress of glass. Green #3 firing safety glasses are coated to filter the infra-red and ultra-violet light inside a kiln. They reduce glare, protect your eyes from heat, and make the kiln interior easier to see.



Green #3 firing safety glasses.

Hot Gloves

The gloves sold by Paragon are silicone-impregnated. They are fire-resistant but will scorch if left in contact with a hot lid handle too long. The gloves are not intended for handling hot glass or hot kiln shelves.



Kiln Shelves

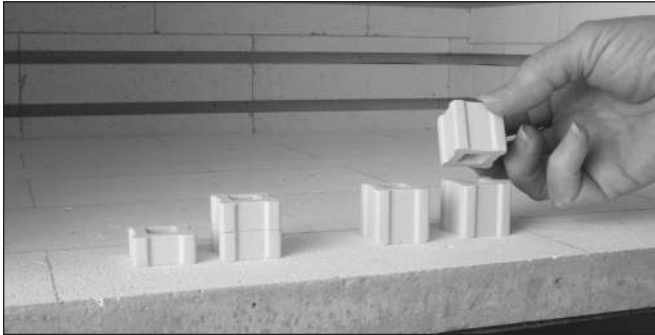
Most shelves are flat slabs of fireclay that can withstand high temperatures. Shelves will break if dropped.

Ceramic fiber shelves are also suitable for glass fusing. Though the surface is hardened, ceramic fiber shelves are delicate and must be handled with care to avoid gouging the surface.



Kiln Posts

Posts are made from the same material as fireclay shelves. Posts support and separate the layers of shelves in a kiln. Posts can be stacked upon one another to achieve a greater height, but a single long post is more stable.



Ceramic Fiber Shelf Paper

Ceramic fiber paper is placed under the glass to prevent the glass from sticking to the kiln shelf. The fiber paper makes the glass separator coating on the shelf last longer. Laying fiber paper on the shelf requires less time than the application of glass separator.

Some brands of fiber paper curl at the edges and touch the glass, causing discoloration. To prevent this, weigh the outer edges of the paper with scrap glass, or lay the glass close to the edge of the paper.

The fiber paper turns to dust after the firing. Wear a respirator when vacuuming the shelves with a HEPA vacuum cleaner.

A Fiber Paper Project

- 1 Cut 2 pieces of $\frac{3}{4}$ " (19 mm) x $1\frac{1}{2}$ " (38 mm) glass.
- 2 With scissors or razor blade, cut a strip of $\frac{1}{8}$ " thick fiber shelf paper to form the channel for the cord or chain. Size: $\frac{1}{8}$ " thick x $\frac{1}{8}$ " wide x 1" long (3.17 x 3.17 x 25 mm).
- 3 Clean fingerprints from the glass. Then handle only by the edges.
- 4 Lay the fiber paper across one piece of glass so that it is parallel with the $\frac{3}{4}$ " (19 mm) side and $\frac{3}{8}$ " (9.5 mm) from the edge.
- 5 Gently lay the second piece of glass over the



You can use a strip of $\frac{1}{8}$ " thick fiber paper to make a channel for a cord in a glass pendant.

first. Sprinkle broken pieces of dichroic glass over the top piece of glass.

- 6 Load the piece into a small kiln on a kiln-washed shelf. Fire the glass until the glass pieces have fused together and the top piece has curled around the fiber paper scrap that you inserted in Step 2. Turn the kiln off before the dichroic glass flattens into the surface.

Lid Lifter

Use the Lid Lifter to lower a vented lid to the closed position or to crack the lid to check the progress of fused glass. Place the hook under the lid handle. $12\frac{1}{2}$ " (317 mm) overall length. Wear long heat-resistant gloves when using the Lid Lifter.



Liquid Kiln Repair Cement

This repair cement is the same type we use in the factory to make lids and bottoms. Comes pre-mixed for immediate use. Replace broken brick sections or repair cracks. It is also available in powdered form.

Liquid Kiln Coating

Comes pre-mixed for immediate use. Apply as a dust-free coating on the inner surface of firebrick lids.

Kiln Wash or Glass Separator

Kiln wash and glass separator are mixtures of finely ground minerals that do not fuse at high temperatures. They act as a barrier against hot glass. The kiln shelf must be coated with kiln wash or glass separator to keep glass from sticking to it.



Haik Brush

The haik brush is used to apply glass separator to the kiln shelf in a smooth, thin layer. The smoother the glass separator, the smoother the underside of the glass.



Pyrolite Fiber Repair Filler

This is a permanent, high temperature refractory fiber cement used to repair holes or cracks in the ceramic fiber firing chamber.



Glass Troubleshooter

For more detailed troubleshooting, please visit the websites of the glass manufacturers. Some of the glass fusing books include extensive troubleshooting. For a reading list, visit www.paragonweb.com and select “Products,” then “Books & DVDs” from the drop menu.

Glass Cracks

Probable Causes:

- Heating the kiln too fast
- Cooling the kiln too fast
- Fusing incompatible glass
- Not enough glass separator on the shelf

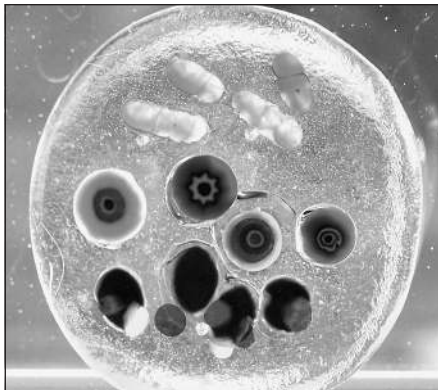
Most problems in fusing are caused by rushing the firing. The glass must change temperature slowly during the critical temperature range of 100°F - 500°F / 37°C - 260°C. This critical range applies to both heating and cooling.

The second critical temperature range is annealing, which is the cooling range of 960°F - 700°F / 515°C - 371°C average. Cool the glass slowly during this range so the stress in the glass will have time to dissipate.

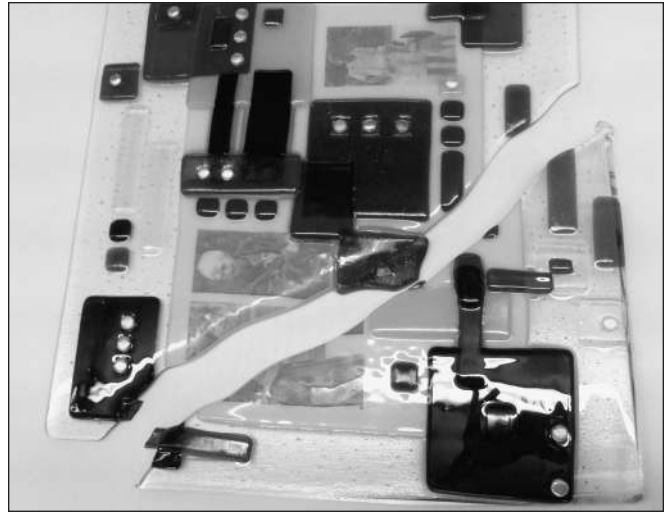
If you become impatient after the glass has fused and you crack open the lid/door of the kiln for a few seconds to peek inside, you may hear a “ping,” which is the sound of glass cracking. After you begin the annealing phase, keep the lid or door closed until the kiln has cooled to room temperature. Some artists schedule their fusing so that it is completed before they go to bed. That way they will be asleep while the glass cools and they won’t be tempted to open the kiln.

After each firing, examine the shelf. Recoat if the kiln wash is chipped. Glass can crack if it sticks to a bare section of shelf.

Cracks that form along an edge of one of the pieces in the fused design indicate incompatibility between the glass pieces. If the edges of the break are sharp, and the pieces fit together, the break occurred during cooling. Rounded edges along the break mean the crack occurred during heating.



These cracks are caused by firing incompatible glass. 104 COE millifiori and some enamel stringers were fused to a piece of 90 COE Bulls-eye glass. Photo courtesy of Linda Rheault.



The rounded edges of this crack indicate that the piece cracked on the way up in temperature. The edges would have been sharp if the crack formed during cooling.

Glass Bubbles

Probable Causes:

- Heating the kiln too fast
- Air trapped between layers of glass
- Grease or dirt between layers of glass
- Uneven glass volume
- Moisture or trapped air between the glass and the kiln shelf

Suggestions for preventing air bubbles:

- 1 Moisture in the shelf and fusing molds can cause bubbles, because the moisture trapped under the glass forms steam. To be sure that a shelf is completely dry after applying separator, place the empty shelf in the kiln and heat to around 300°F / 148°C for 20 minutes. Load the shelf with glass while the shelf is still warm. Some people pre-heat large shelves before every firing.
- 2 Make sure the shelf is smooth and clean before placing glass on top. Debris on the shelf can burn and form gases under the glass, causing bubbles.
- 3 If the bubble appears over the same area of the shelf every time, it may be due to a low spot or gouge in the shelf. Lay a ruler on edge along the shelf surface. Do you see a depression where the bubble forms? If so, turn the shelf over and try using the other side.



Note: Do not throw away a warped shelf. Save it for small glass projects such as pendants that won't be affected by the shelf warpage.

- 4 Design your fused piece so air between layers of glass has an escape route. Place several tiny slivers of glass under the outer edges of the base piece. As the glass softens, gaps under the edges will help air to escape. To blend in, the glass slivers should be the same type and color of glass as the base piece.
- 5 A sheet of ceramic fiber paper between the glass and kiln shelf helps eliminate bubbles. The paper is porous and allows air to escape from under the glass.
- 6 Hold the temperature at 100°F / 55°C below the process temperature for 15 minutes. If a bubble has already formed, look at the glass occasionally during the hold. Is the glass going back down and flattening out? If not, leave on hold longer. Once the hold is done, resume firing to the fusing temperature.

Sharp Needle Edges

Sharp edges form on the glass corners when the glass has been over-heated. Fire slower or to a lower temperature. Fire directly on the kiln-washed shelf instead of on fiber paper. (This is because some brands of fiber paper tend to prevent the glass from expanding freely, causing needle-points on the glass edges.)



Photo courtesy of Jan O'Highway.

Discoloration Between Layers

Too much glue can cause gray spots between layers of glass. Apply tiny dots of glue with a toothpick, or eliminate the glue altogether. If you have a clamshell kiln, you can assemble a fused piece directly on the shelf after it has been loaded into the kiln. This usually eliminates the need for glue.

Glass Separator Sticks To Glass

Probable Cause: Firing too hot

Instead of firing to a full fuse temperature, try firing 25°F - 50°F / 14°C - 28°C cooler and holding at that temperature for several minutes.

To remove glass separator, soak the glass in vinegar. Then scrub with a household plastic scouring pad.

Preventive Kiln Maintenance

The best time to perform preventive maintenance is when you have opened the kiln's switch box to change a thermocouple or other parts.

- 1 Dust can cause components in the switch box to overheat, because dust acts as an insulator. Whenever you open the switch box, blow out the dust with canned air. (It is available from computer stores or even Wal-Mart.) Wear a facemask. Do not hold the canned air upside down, and never spray yourself. (The air gets cold enough to cause injury.) Hold the air nozzle 6" (152 mm) away from the parts you are spraying.



Whenever you open the switch box, blow out the dust with canned air.

We do not recommend a vacuum cleaner or dry paint brush for cleaning the switch box of digital kilns. They can create a static charge that could damage the electronic controller.

- 2 Examine the wires in the switch box. Use a flashlight if lighting is dim. After decades of heat, the insulation on wires becomes brittle. Signs of aging insulation are white wires that are brownish and colored wires that are fading. When you bend wires, do you hear or feel the insulation cracking? When insulation cracks off the wires, it is also likely that strands of wire are breaking, which can raise the resistance and cause the wires to overheat. Replace damaged wires.

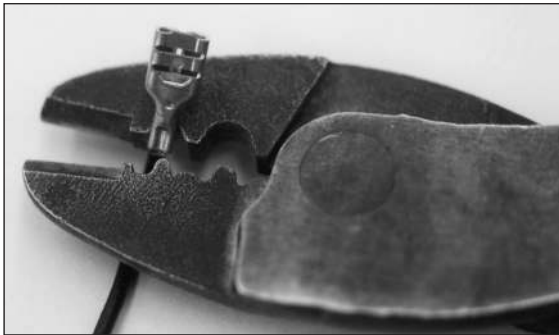
Caution: Do not use electrical tape to repair wiring inside a kiln switch box. The tape tends to deteriorate.

- 3 Check the wire terminals for tightness. Squeeze loose push-on terminals with pliers to tighten. Replace terminals that are loose due to heat damage.



Squeeze loose push-on terminals with pliers to tighten. Replace terminals that show signs of heat damage.

- 4 Check the element connectors for corrosion, which will turn the connectors white or green. Corrosion is usually due to a loose screw holding the connector and sometimes due to a loose wire terminal. Tighten corroded element connectors if they are loose.
- 5 As you reinstall the switch box, arrange the wires so that when the switch box is placed against the kiln, no wire touches an element connector or the kiln case. These get hot enough to eventually burn off wire insulation, which could cause a short circuit.



If you crimp new terminals onto wires, use only the terminals available from Paragon, and a quality crimping tool. (Shown here is the Klein 1006 crimping tool.)

Electrical Maintenance

Before buying kiln parts, look for the simplest repair solutions.

- 1 Before changing an element that won't heat, check the switch-to-element wires. Do you see a loose wire? Has the element burned off at the element connector? If so, you probably don't need to buy a new element; just reconnect the old one. (See page 32.)
- 2 In many cases, cracked or broken firebricks can be left alone. The damage is typically only cosmetic.
- 3 If the controller won't turn on, check the kiln's switch box fuse. (The fuse holder is mounted on the kiln.) Don't assume that you need a new controller.
- 4 If the temperature on your controller is suddenly inaccurate, you don't necessarily need a new thermocouple. Check to make sure the old one hasn't been pushed into the kiln wall. Also check for loose thermocouple wire connections and a bare thermocouple wire touching the case.

How to Set a Multimeter

The multimeter measures volts, ohms, and amps. The most confusing thing about the meter is setting it for each type of measurement. In addition to reading this section, refer to your meter's instruction sheet. You can often find it online.

Voltmeter

Select the voltage type on the meter. To measure the voltage from the digital controller to the relays, select DCV. To measure voltage in a building, select ACV.

Your meter may have a voltage range setting. If so, select the range of volts that is the next higher range than you expect to measure. To measure 120 volts, set the meter to the next higher setting, such as 200 volts. Some meters automatically detect the type of voltage you are measuring and the voltage range.

Make sure the probes are inserted in the correct holes on the meter.



See your multimeter instructions. The instructions for most brands of meters can be found online.

Ohmmeter

Select ohms on your meter. Ohms is represented by the omega, or horseshoe, symbol. Plug the probes into the correct red (+) and black (-) holes on the meter. Then place the ohms range switch in the lowest setting.

Ammeter

The number of electrons passing a point in a period of time is measured in amperes (amps). To measure amps, you will need a multimeter that has an ammeter clamp on the end. Place the probes in the correct holes on the meter. Then set the meter switch to Amps. Place the range switch to a higher range than the expected amps.

Interpreting a Voltmeter

Often customers who phone us for advice about their kilns tell us, "I know all the elements are okay, because I've checked each one with a voltmeter." Voltage at the element connectors does not mean the element is okay, however.

Test your elements with an ohmmeter, not a voltmeter. A voltmeter will read voltage across the two connectors of an element even if the element is broken. This is because a voltmeter reads the voltage that is available at the element connectors. A break in the element does not cut off the power coming to the element from a relay or switch.

The voltmeter is useful in checking switches, relays, and wire connections. If voltage is not detected at the element connectors while the elements are receiving power, then a switch or relay has burned out or a wire is disconnected.

Caution: Please observe safety precautions when using a voltmeter. If you are not familiar with a voltmeter, then use the ohmmeter instead. The ohmmeter is used with the power disconnected from the kiln.

When a New Part Fails

When a new part fails each time it's replaced, then replacing that part may be solving the wrong problem. Here are reasons for repeated failure of replacement parts:



The wire burned off this terminal because of a loose connection.

- 1 Push-on connectors to a switch or relay are loose. This will result in burned switch terminals and melted plastic, because the loose connectors cause the new parts to overheat.
- 2 The wrong element has been installed, subjecting the switch or relay to excessive amperage. Please make sure you install the element that was designed for your kiln. Elements from different kiln models are usually not interchangeable.

- 3 Contamination is hidden inside an element groove. After you remove a broken or worn element, check the groove with a small mirror, especially where the element broke. Dig out any discolored areas in the groove.
- 4 The ambient room temperature is too high. This can cause premature failure of the kiln's switch box components.

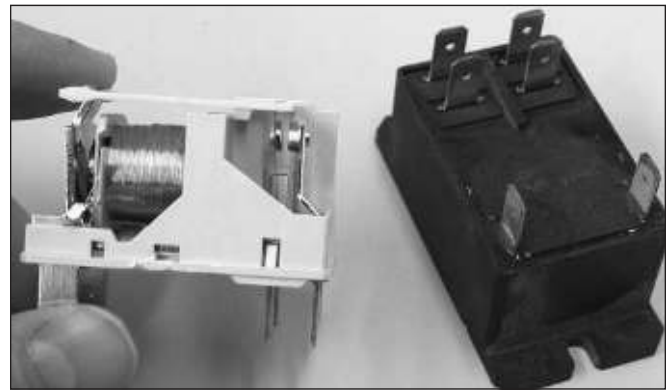
Locating Electrical Trouble

The Kiln Doesn't Shut Off: A Runaway Relay

How a Mechanical Relay Operates

Relays turn on the heating elements of digital kilns. The relays make that clicking noise that you hear while the kiln fires.

A relay contains a small electromagnet. When the controller needs to turn on the kiln's heating elements, it sends a 12-volt signal to the electromagnet, which then



Shown here is the inside of a mechanical relay. Note the electromagnet, which closes and opens the electrical contacts.

pulls a pivoting bar toward the magnet. The bar, in turn, releases a pair of electric contacts, which allows them to come together. The elements are wired to the relay so that when the relay contacts close, electricity flows to the elements. The contacts inside the relay are positioned on the end of spring strips. When the signal from the controller turns off, the electromagnet loses power, and the spring strips separate the contacts.

Finding the Runaway Relay: Visual Inspection

Look at the elements while the controller is idle. After you determine which element is still on (either because the element is glowing or because heat is coming from it), unplug the kiln and remove the kiln's switch box. You will see a pair of connectors for each element. (The connectors are on the other side of the kiln wall or top where the element ends disappear from the firing chamber.) Find the connectors for the element that would not turn off. You will find two wires that go from those element connectors to a relay. Replace that relay. See page 37.

Finding the Runaway Relay: The Ammeter Test

Unplug the kiln. Remove the kiln's switch box so that you can see the element connectors and the relays. Posi-



Caution: Do not perform the ammeter test unless you are an experienced technician.

tion the switch box so it remains upright without having to hold it. Plug the kiln back in. (At this point, do not touch any electrical parts. The element connectors and some of the components inside the switch box are “live” and will shock you if touched.) The controller should display Idle. If a relay is locked on, you will hear one or more elements hum. Check the relay wires, one at a time, with an ammeter. The

ammeter has a clamp. Place the clamp around one wire that goes from an element connector to a relay. (Do not place the clamp around both wires.) Replace the relay that has amperage going to an element. See page 37.

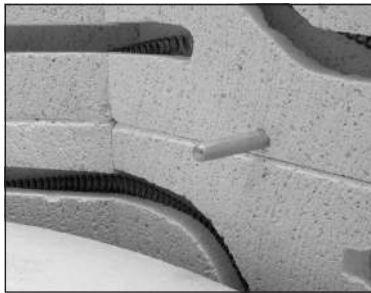


Temperature is Inaccurate

Do not allow a shelf to touch the thermocouple. This will cause an inaccurate temperature reading. A shelf should be at least $\frac{1}{2}$ " (12.5 mm) from the thermocouple.

Make sure the thermocouple is pushed 1" (25 mm) or more into the firing chamber.

The thermocouple-to-controller wires must not be grounded. The wires can ground when pinched under a switch box or when the insulation is stripped too far, allowing a bare wire to touch the switch box. A grounded thermocouple wire can throw the temperature way off. A temperature reading that is close to normal at room temperature indicates that the thermocouple is okay.

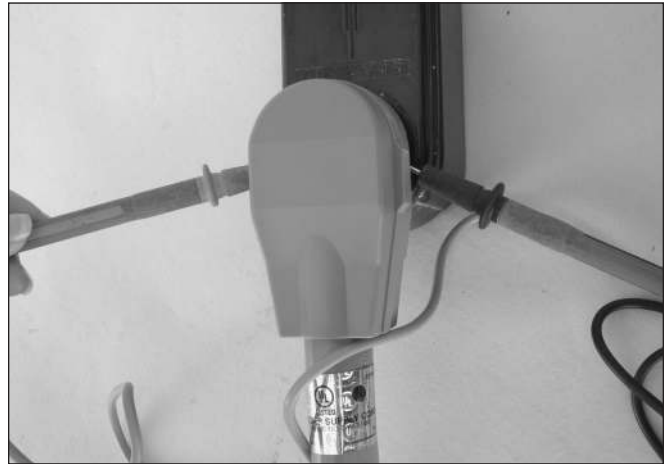


A shelf should be at least $\frac{1}{2}$ " (12.5 mm) from the thermocouple.

Kiln Fires too Slowly: Low Voltage

A kiln can fire slowly because of worn out elements or low voltage. The best way to check the voltage is “under load,” or while the kiln is firing. This gives the most accurate measurement, because voltage can drop when the kiln turns on.

Caution: Please do not touch the voltmeter probe tips or the plug prongs while you check the voltage. Only a qualified person should perform this test, because improper use of a voltmeter can result in shock to the user.



To check the voltage under load, pull out the plug about $\frac{1}{8}$ " (3 mm) so that you have room to touch the prongs with the voltmeter probes. Then turn on the kiln. Measure between the two flat blades on the plug.

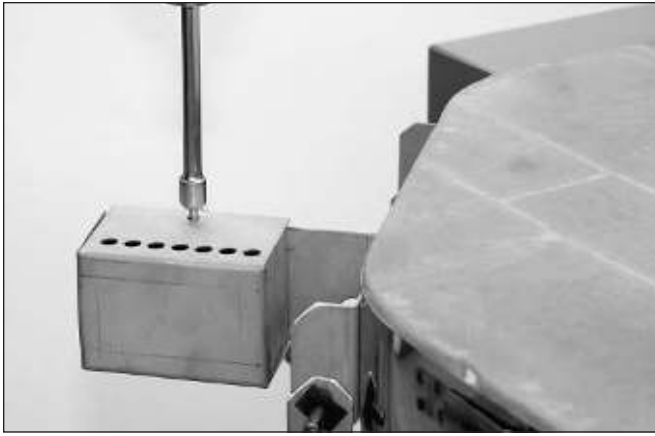
If you have low voltage, schedule your firing during off-peak periods. The voltage may be higher at night.

Kiln Stops Firing Due to a Door or Lid Safety Switch

A door or lid safety switch that is out of adjustment can turn off the elements unexpectedly. The run light on the controller will stay lit even though the elements are not heating. Sometimes the safety switch turns off the elements partway through a firing due to expansion of the door or lid at high temperatures.



The door safety switch is usually mounted to the top of the kiln.



The lid safety switch is mounted near the hinge.

We have three types of door or lid safety switches. For instructions on adjusting them, go to www.paragonweb.com and click on Support, then Instruction Manuals from the drop menu. Publications are listed in alphabetical order. Scroll down the list of manuals to “Safety Switch Adjustment.”

Circuit Breaker Trips Immediately

If your kiln shuts off, check the fuse or circuit breaker first. Wire heats when an electric current passes through it. If the same current passes through both a small wire and a large wire, the smaller wire will reach a higher temperature. A fuse uses this principle to protect the wiring in a building. It has a small, short wire of low melting temperature metal connected in such a manner that all current passing through the circuit must also pass through the fuse. The fuse wire size is selected so that the maximum safe current the wiring can handle will generate enough heat to melt the wire (i.e. blow the fuse). A circuit breaker uses a tiny heating element to heat a thermostat, which interrupts the current when the maximum safe amount is reached.



A blown fuse or tripped circuit breaker is not necessarily an indication of electrical trouble with your kiln or wiring. A short circuit or “short” causes a large amount of current to flow, generating so much heat that the fuse or breaker opens the circuit almost instantly.

If the circuit breaker trips or a fuse blows when you first turn on the kiln, unplug the kiln and look for a short. Here is where to look:

- Remove the main control panel or switch box from the kiln and look for a pinched wire. It will be under one of the switch box mounting screws. A screw that breaks through the wire insulation will cause a short.

- A cord set connection that touches the kiln case can burn and cause a short. This will shut off the breaker when you plug in the kiln. Look near the cord set for the damaged connection or burned insulation.
- Kilns have porcelain insulators under the element connectors. The porcelain insulators, which look like small mushrooms with a hole in the center, must be pressed all the way into the heat shield. A porcelain insulator pushed out of the heat shield can cause a short.
- The excess ends of the element that extend past the element connectors must be cut off. Bending the twisted element ends to the side or leaving them sticking out straight can cause a short in the switch box.
- Do not use electrical tape inside the switch box. A wire can short against the kiln case when the tape burns off.
- Make sure wire connections are tight. A loose connection can overheat and burn off a wire, which can short out against the kiln case. Look at the kiln’s element connectors. If one is missing, it has probably burned off and fallen inside the switch box. The element connector hanging in the switchbox can cause a short.
- An element pin that is long enough to touch the kiln case can cause a short.

Circuit Breaker Trips But Not Immediately

If your kiln should blow a fuse after firing for some time, there is little probability of a short. Replace the fuse or reset the breaker, and if it does not blow again as soon as the kiln is turned back on, there is no short in your kiln wiring. Here are reasons for a delayed tripped breaker:

- If the circuit breaker trips after the kiln has fired for awhile, make sure no other appliances are operating on the same circuit as the kiln.
- A loose or poor connection at the fuse or breaker generates heat. If the fuse or circuit breaker panel feels unusually warm, have your electrician check for loose connections, particularly at the center screw of the fuse socket, even in a new fuse box.
- The fuse can blow or breaker can trip in hot weather because the kiln is right in front of the electrical panel. Keep the kiln at least 3' - 4' (91 - 122 cm) from the panel. Circuit breakers are triggered by heat, and a nearby kiln can raise the temperature of the electrical panel.
- A circuit breaker may become weak as it ages and become more prone to tripping.
- Two element pins that touch inside the firebrick wall can pull more amperage, tripping the breaker.

Element Maintenance

The elements in your Paragon kiln should last for many years of normal use. With time, however, the elements gradually draw less power, and firings take longer. Elements should be replaced when firing time becomes excessive. Record the firing times in a firing logbook.

Before you replace the elements, be sure that excessive firing times are not due to low voltage. Sometimes the voltage drops temporarily during periods of heavy electrical demand.

High temperature elements are damaged by contact with silica or silica bearing compounds, such as glass and kiln wash. This type of damage is not covered by warranty.

Reseating a Bulging Sidewall Element

Once an element has been fired, it becomes brittle and will break if it is bent while cold. Follow this procedure to heat the element.

Caution: Please be very careful when using a propane torch to repair a bulging element. Use only the type of propane torch recommended below.

- 1 Always unplug the kiln or disconnect the power before touching the element with anything!

Caution: Whenever you turn off the circuit breaker to your kiln, tape the breaker box door shut and leave a note saying, "WORKING ON KILN. BREAKER OFF."



- 2 Heat the element with a propane torch until the element is red hot. Press the igniter and hold the flame near the bulging element. You will see the element turn red in just a few seconds. Then release the push-button igniter.

Note: You can purchase a propane torch from a home improvement center. Buy the type that has a push-button igniter. A blue flame appears when you press the button. The flame goes out when you release the button. For element maintenance, do not use the older manual propane torches that have the twist knob. Turning them on and off is awkward when working on elements.

- 3 With a pair of long-nose pliers (dime store quality will work fine), shrink the bulging portion of the element by pressing the individual turns in the coils together slightly. Take a little from each turn so that no two turns are pressed tightly enough to touch.



- 4 As the element shrinks, work it back toward the groove and into place. Work rapidly, and at the first sign of stiffness in the coils, stop bending and reheat the kiln. The elements do not have to be red to be bent safely, as the stiffening can be felt through the pliers.

- 5 To lengthen the element to fit into the corners, reverse the above procedure and expand the distance between coils by using snap-ring pliers. Use caution, as your warranty covers elements that fail only in service under normal use and not from being broken while cold.

Note: You can purchase snap-ring pliers from an automotive parts store.



The snap-ring pliers are shown outside the element groove to give you a better view.

- 6 When you have the coils positioned above the dropped recess in the grooves, reheat the element section and run a blunt kitchen knife around the elements to seat them into the grooves. Do not use a plastic object, such as a comb, to press hot elements into their grooves. Melted plastic ruins elements.

How to Test for a Burned Out Element

Method One: The Newspaper Test

- 1 With the kiln turned off, place a small strip of newspaper in each element groove so the newspaper touches an element.
- 2 Turn on the kiln. Within 10 minutes, the elements should get hot enough to scorch the newspaper that is in each groove.

Method Two: The Ohmmeter Test

How to Use an Ohmmeter

An ohmmeter is an inexpensive aid in determining if an element is broken. The ohmmeter measures the electrical resistance of a wire in ohms. The higher the ohms, the greater the resistance. As an element ages, the resistance increases, and the ohms reading becomes higher.

There are two types of ohmmeters: needle indicator (analog), and digital. Ohmmeters have two probes. When you touch the probes together, the analog ohmmeter needle should move all the way over. A digital meter should read zero ohms.



Testing an element with an ohmmeter. The ohmmeter leads are touching the two connectors of the element being tested.

Q The kiln should be unplugged before touching the ohmmeter to the element. So, how does the ohmmeter check the element if the kiln is not plugged in?

A The ohmmeter contains a battery that sends a small electric current through the element. If the element is broken, the electricity cannot make a complete circuit back to the ohmmeter. If the element is not broken, the ohmmeter reads the electrical resistance in the element.

You can test the elements with an ohmmeter or a simple battery-operated continuity tester available from auto parts stores. The light comes on if the element is good.

To test an element, find the ohms for that element from the kiln's wiring diagram. If an ohmmeter test gives a resistance that is close to the correct resistance, the element is not broken.

Some Paragon kilns have elements wired in series. Elements wired in series with a burned out element all stop

firing. So you can't always tell which element is firing by turning the kiln on, opening the lid, and watching for elements that turn red. With an ohmmeter, however, you can find a burned out element in any Paragon kiln.

If an element burns out, the kiln will either not heat up or will fire to a drastically lower temperature. If the elements are wearing out, they will gradually take longer to fire until they can no longer reach the desired temperature.

- 1 The kiln should be cold when you test the elements. UNPLUG the kiln or disconnect the power before removing the switch box or touching elements.

Caution: Whenever you turn off the circuit breaker to your kiln, tape the breaker box door shut and leave a note saying, "WORKING ON KILN. BREAKER OFF."

- 2 The element connectors are covered by a switch box. Remove the screws holding the switch box to the kiln. Remove or open the switch box.
- 3 You will see two connectors for each element. There is no need to remove the lead wires from the connectors provided you have only one insulated lead wire attached to each element connector. If you have more than one lead wire on each connector, your elements are wired in series/parallel. In that case, temporarily remove the wires from one of the connectors. Otherwise current from the ohmmeter battery can pass through other elements than the one you are testing, causing an incorrect reading. Hold the element connector with locking pliers as you remove the screw. Be gentle to avoid breaking the element. (Elements are brittle after being fired.) Do not disturb the screw holding the element, only the one holding the lead wires. Reconnect the wires securely after testing the element.
- 4 Touch the ohmmeter leads to the two connectors of the element you are testing. You may need to clean a spot on the connectors to get a good electrical contact. For best results, touch the probes to the element connectors and not to the twisted element ends.

A burned out element will show as infinity ohms on a digital meter or no needle movement on an analog meter.

A worn out element is roughly 10 percent higher in ohms than a new element. (See your kiln's wiring diagram for the ohms of the elements in your kiln.) However, if your ohm readings are high, that does not always mean the elements are worn out. Your meter may be inaccurate. A better indication of element wear is the length of firing time.

- 5 As you move the switch box back into place, make sure no wire touches the kiln case or element connectors. Wires touching the case or element connectors will burn.

How to Repair a Burned Out Element Connector

When an element burns out at the connector, you may be able to install a new connector and salvage the element. This type of failure is due to a loose connection, which builds up enough heat in the connector to break the element wire. This is why it is important to securely tighten element connectors when replacing an element.

- 1 UNPLUG the kiln or disconnect the power before removing the switch box or touching elements.

Caution: Whenever you turn off the circuit breaker to your kiln, tape the breaker box door shut and leave a note saying, "WORKING ON KILN. BREAKER OFF."

- 2 Open the switch box. You will see two element connectors for each element in your kiln. If the element has burned at the connector, you will usually see a bare, twisted section of element with a missing connector. This is because the element connector has fallen off the broken element end.
- 3 Does the burned element end have $\frac{1}{2}$ " (12.5 mm) of length so that you can install another element connector? If not, gently and slowly pull the element end with needle-nose pliers. There is sometimes play in the element, which you will feel as you pull the element end toward you.

If necessary, heat the element where it enters the firing chamber. Use a propane torch as shown on page 30. This will allow you to stretch the element slightly to gain extra length.

With $\frac{1}{2}$ " (12.5 mm) of exposed element length, you can install a new element connector. Do not remove the porcelain insulator located under the element. Removing the insulator would give you extra element length, but the insulator is there to prevent the element from shorting out against the case.

- 4 Clean the end of the element pigtail gently with emery cloth before installing the new connector. Do not attempt to reuse the old connector. Always use a new one. Check the element lead wire for heat damage. If the insulation is brittle, replace the wire.
- 5 Use the stainless screw in the element connector to hold the element. (The brass screw holds the lead wire eyelet.) Hold the barrel of the connector with locking pliers (not regular pliers) as you tighten the screw with a $\frac{1}{4}$ " nut driver. Tighten the hex-head



screw to 30 inch pounds (about $1\frac{1}{4}$ turns past the point of firm resistance).

Suppose the head of the screw or bolt on the element connector twists off? That's okay as long as the threads are still holding.

How to Replace a Ball Groove Element

UNPLUG or disconnect the kiln and allow it to cool to room temperature.

Caution: Whenever you turn off the circuit breaker to your kiln, tape the breaker box door shut and leave a note saying, "WORKING ON KILN. BREAKER OFF."

Position the Lid or Top

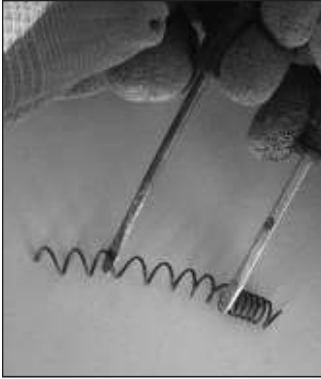
Top-loading kilns: For large, heavy kilns, try to replace the element while the lid is in the open position. You may prefer to remove the lid on a small kiln and turn it upside down onto a table. If so, remove the hinge rod and then remove the lock nut on the lid support. Carefully place the lid upside down on a table padded with cardboard.

Front-loading kilns: Remove the roof. See "Replacing the Paragon GL-18, GL-22, or GL-24 series Roof," pages 42-43.

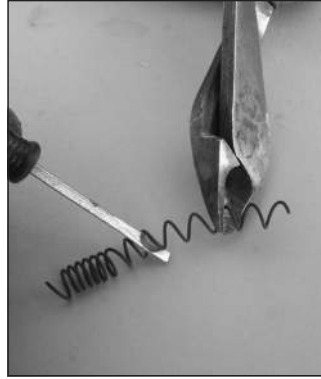
Remove Old Element

- 1 Remove the screws on the switch box that is attached to the lid. Some front-loading kilns have an element cover on the side of the kiln. Remove the element cover.
- 2 With a $\frac{1}{4}$ " nut driver, remove the screws in the element connectors that hold the element lead wires to the element you are replacing. Hold the connectors with locking pliers as you loosen the screws.
- 3 On the same connectors, loosen the screws that hold the element and throw the old connectors away. Always use the new connectors furnished with the new element.
- 4 Remove and save the porcelain insulators that were behind the element connectors.
- 5 Remove the old element from the ball grooves. First cut the two element ends where they enter the grooved lid or roof. Use diagonal cutters.
- 6 Before the first turn in the ball groove, stretch a 1" section of element with two small flat-bladed screwdrivers. This will spread the element coils apart. Then reach into the groove with needle-nose pliers and very gently pull the element toward the groove opening. Still holding the element with needle-nose pliers, reach into the groove with diagonal pliers and cut the element

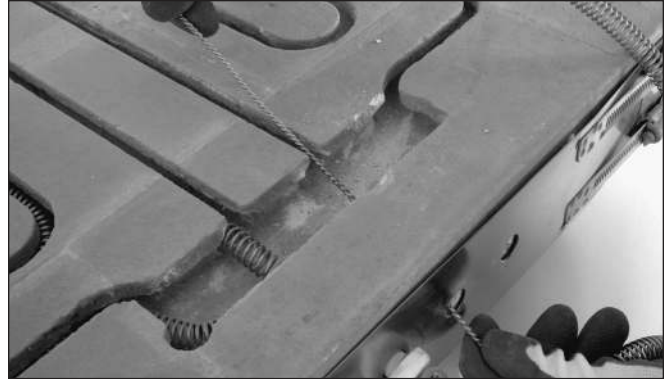




Shown outside the groove: Stretch the element with two screwdrivers.



Shown outside the groove: Cut the element after stretching it.



Use a section of the old element pigtail to guide the new element pigtail into the hole. Note that the porcelain insulator goes in the outer side of the hole.

where the coils are spread apart. Remove the section of element that you just cut. Snake it through to the end of the groove.

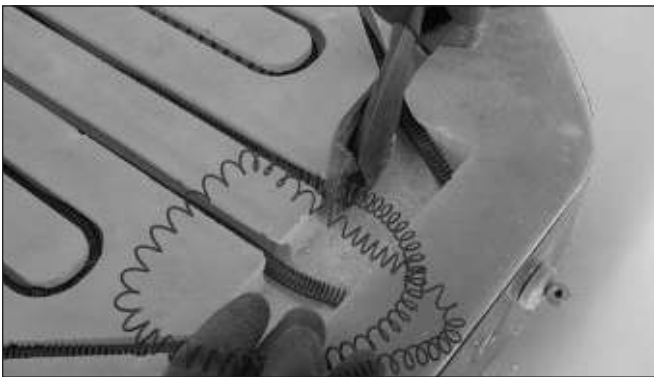
- 7** Keep cutting the element in sections of several inches each. Then gently pull the broken sections through the ball groove to remove them.



- 9** To pull the element into the ball groove, hold the twisted pigtail outside the groove. Pull the pigtail where the element enters the groove while you push the element with the other hand.



- 10** Keep pushing and pulling the element



Note: If the old element burned out due to contact with glass, there may be a melted, glazed spot in the element groove. Glazed spots left in the grooves may ruin the new element, so dig out any of these spots with a screwdriver. The small hole left in the groove will not affect the new element.

Install New Element

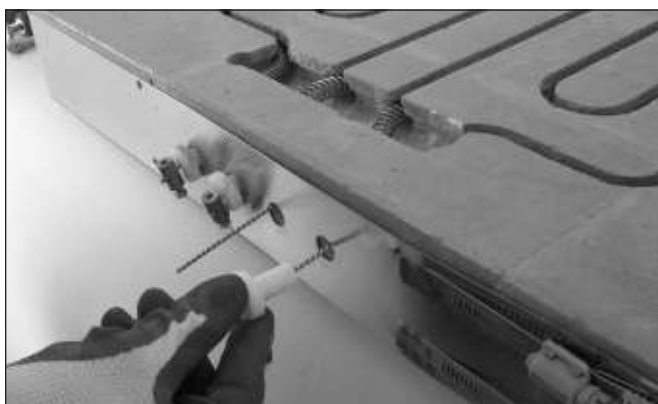
Note: Protect the new element from coming in contact with kiln wash by placing newspaper on the kiln bottom.

- 8** Thread one end of the element into the hole that goes toward the porcelain insulator. Use a pigtail section of old element to guide the pigtail of the new element into the hole.



Note the small flat-blade screwdriver in the right hand above.

past the first groove turn. When you come to the second groove turn, begin snaking the element sections with two small flat-bladed screwdrivers. Pull an element section forward with one screwdriver while alternately pushing the other end of that section with the other screwdriver. Compress the coils together by pushing, and expand them by pulling. This is similar to the movement of a caterpillar.



10 Keep pushing and pulling the element past the turns in the grooves. Then thread the second pigtail into the other hole that goes toward the porcelain insulator.

11 Reinstall the porcelain insulators. Push them flush against the heat shield. They protect the element from contact with the case and heat shield, so they must not work their way out after the element connectors are tightened into place.

12 Sandpaper the eyelet of the element lead wires until bright and clean of all oxidation. (Install new lead wires if the insulation on old ones is brittle.) Use the brass screw to connect the lead wire eyelets to the new element connectors. Before tightening the screw, adjust the eyelet to where it will be tilted away from the heat shield when the connector is attached to the element. Then hold the connector with locking pliers and tighten the brass screw securely with a 1/4" nut driver.

13 Pull the end of the element tight and install new element connectors snugly against the porcelain

insulators to prevent insulators from slipping away from the heat shield, case, or lid band.

Use the stainless screw in the element connector to hold the element. (The brass screw holds the lead wire eyelet.) Hold the barrel of the connector with locking pliers (not regular pliers) as you tighten the screw with the 1/4" nut driver. Tighten the hex-head screw to 30 inch pounds (about 1 1/4 turns past the point of resistance).



If, when tightening the element connector, you feel the threads strip out, remove the connector and install another. A connector with stripped threads will burn out. Suppose the head of the screw or bolt on the element connector twists off? That's okay as long as the threads are still holding.

14 Cut off the twisted end of element even with the side of the element connectors. Leaving the ex-



cess element sticking out past the element connector could ruin your new element! (The element could short against something in the switch box.)

15 As you move the switch box back into place, check that no wire touches the case or an element connector. Wires and wire nuts will burn if they touch the case or element connectors. Reinstall the screws in the switch box and tighten.

How to Replace a Sidewall Element

Note: If the sidewall groove opening is narrower than the element coils, follow the preceding section, "How to Replace a Ball Groove Element."

Q Should all the elements be changed at the same time?

A If one element breaks due to contamination with a foreign material such as kiln wash, replace only that element. If the elements are at the end

of a wear cycle, and you need to replace a broken one, replace them all.

Most Paragon replacement elements are formed to the shape of the kiln at the factory. However, a little stretching or compressing may be necessary for a perfect fit. It is safe to bend and stretch new elements before they have been fired, but once fired and allowed to cool, elements become brittle and will break if bent.

Some of our employees wear thin cotton gloves while installing elements. This is a good idea. Make sure the gloves are clean. Flakes of kiln wash can transfer from the gloves to the new elements, which can cause premature element failure. So do not wear cotton gloves that have kiln wash or glass separator on them.

Q. Can oils from your hands damage a new element?

A. Oils will burn off harmlessly the first time you fire the element. Salts can damage an element. However, the amount of salt on the hands is so small that it would have no effect on element life. But do not allow kiln wash to touch a new element.

If a top/bottom element is reversed with a center element, the kiln will fire unevenly. So when you receive a new set of elements, check the element labels. Install elements marked TOP/BOTTOM and CENTER in the correct locations. (Some kilns, though, use only one type of element throughout the firing chamber.)

Install the Paragon replacement elements designed for your model. Do not install non-standard higher amperage elements. They could cause a fire hazard.

- 1 UNPLUG or disconnect the kiln and allow it to cool to room temperature.

Caution: Whenever you turn off the circuit breaker to your kiln, tape the breaker box door shut and leave a note saying, "WORKING ON KILN. BREAKER OFF."

- 2 Remove the screws on the kiln's switch box and open the box.



- 3 With a 1/4" nut driver, remove the screws in the element connectors that hold the element lead wires to the element you are replacing. Hold the connectors with locking pliers as you loosen the screws.

- 4 On the same connectors, loosen the screws that hold the element and throw the old connectors away. Always use the new connectors furnished with the new element.

- 5 Remove and save the porcelain insulators that were behind the element connectors.

- 6 Lift the old element up out of the groove with a pencil or small screwdriver. Then remove the element carefully to prevent breaking the lip of the element grooves.

If the old element burned out due to contact with foreign materials, there will probably be a melted, glazed spot in the element groove. Glazed spots left in the grooves may ruin the new element, so dig out any of these spots. The small hole left in the groove will not affect the new element.

- 7 Remove small pieces of firebrick and dust in the grooves with a dry brush (such as a household paint brush) or vacuum cleaner.

- 8 Protect the new element from coming in contact with kiln wash by placing newspaper on the kiln bottom.

Note: Top loading kilns To keep from tangling up the element, keep it on the top rim of the kiln's side-wall when you feed it into the grooves. (If you place the element in the bottom of the kiln, the element will tangle up.)



- 9 Thread the new element into either element hole inside the kiln.

To guide the element through, you can look into the hole where the porcelain insulator goes. Or you can use a twisted end of the old element to thread the new element into the holes. To do this, insert the end of the old element into the hole where the porcelain insulator fits until the element appears in the firing chamber. Press the end of the new element against the end of the old one and push the new element all the way through.

- 10 For most models, the element is bent slightly where it fits into each firebrick corner. The bend must fit all the way into the back of each corner. As you feed the element, hold it with both hands in such a way that you are applying constant pressure that pushes the element into the corners. If you let go before the element is completely threaded, it will spring back out of the corners.



After the first element bend is in its corner, do the next corner. If the next element bend will not

reach the next corner, gently stretch that section of element with your hands. If the element is too long between bends, let that section of element curve out of the groove. Then continue threading the element into the other corners. When the element is completely installed, go back to the section that was too long. Compress coils with long-nose pliers until the element fits into its groove. No two coils should be compressed tightly enough to touch.

Remember, if you do not push the element fully to the back of each corner, the element will not stay in the grooves when fired.

- 11 Press the element down into the lower part of the groove with a plastic comb or wooden tongue depressor.
- 12 Reinstall the porcelain insulators. Push them flush against the heat shield. They protect the element from contact with the case and heat shield, so they must not work their way out after the element connector is tightened into place.
- 13 Sandpaper the eyelet of the element lead wires until bright and clean of all oxidation. (Install new lead wires if the insulation on old ones is brittle.) Use the brass screw to connect the lead wire eyelets to the new element connectors. Before tightening the screw, adjust the eyelet to where it will be tilted away from the heat shield when the connector is attached to the element. Then hold the connector with locking pliers and tighten the brass screw securely with a 1/4" nut driver.
- 14 Pull the end of the element tight and install new element connectors snugly against the porcelain insulators to prevent insulators from slipping away from the kiln.

Use the stainless screw in the element connector to hold the element. (The brass screw holds the lead wire eyelet.) Hold the barrel of the connector with locking pliers (not regular pliers)



as you tighten the screw with the 1/4" nut driver. Tighten the hex-head screw to 30 inch pounds (about 1 1/4 turns past the point of resistance).

If, when tightening the element connector, you feel the threads strip out, remove the connector and install another. A connector with stripped threads will burn out. Suppose the head of the screw or bolt on the element connector twists off? That's okay as long as the threads are still holding.

- 15 Cut off the twisted ends of the element even with the side of the element connectors. Leaving the excess element sticking out past the element connector could ruin your new element! (The element could short against something in the switch box.)

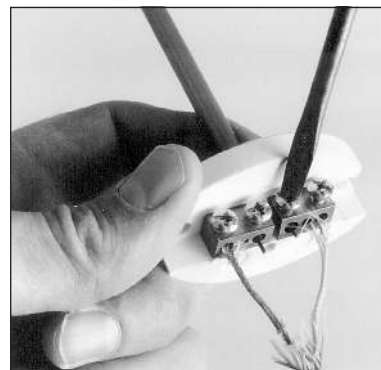


- 16 As you move the switch box back into place, check that no wire touches the case or an element connector. Wires and wire nuts will burn if they touch the case or element connectors. Reinstall the screws in the switch box and tighten.

Reconnecting or Replacing the Thermocouple

A Loose Thermocouple Connection

The thermocouple is the rod that extends into the firing chamber. It senses the temperature. Sometimes people replace perfectly good thermocouples because of a loose or faulty connection at a terminal. So, don't automatically assume that you have a bad thermocouple when your controller shows a FAIL, TC, or TC2 message. (Please see your controller instruction manual for a list of error codes.)



Look at where the thermocouple extends into the firing chamber of your kiln. On the other side of the kiln wall, usually inside a control panel, you should find a connection block. On most kilns, it is an oval porcelain block with four screws. Two screws are for the thermocouple-to-controller wires; the other two are for the wires from the thermocouple. (There are two wires at the end of the thermocouple. They are on the opposite end from the tip that extends into the firing chamber.)

An over-tightened screw can break a thermocouple wire. You won't be able to see the broken wire, because it will be hidden under the connection screw. If you can remove the thermocouple by loosening only one screw, then you know the wire under the other screw was broken.

Sometimes you can repair the thermocouple by pushing it 1/8" closer to the connection block so that the shorter wire that broke can reach the connection. This allows you to install both wires under the connection screws. If you do this, make sure the thermocouple still extends into the firing chamber by four times its diameter.

A Short in the Thermocouple Wires

If the display window on your kiln shows a temperature in the 100°F - 150°F (37°C - 65°C) range even though the firing chamber is much hotter, the problem is most likely due to bare thermocouple wires that are touching inside the switch box.

Disconnect the power, open the control panel (switch box), and check the thermocouple wires, especially at the back of the controller circuit board. You will find two wires (a red and a yellow) that run from the controller to the thermocouple.

Look for bare areas of the wire where the insulation has been stripped too far. The first place to check is the wire ends that attach to the back of the controller. If the bare ends cross over and touch, the thermocouple will register the temperature of the switch box instead of the firing chamber.

This problem takes only a moment to fix. Remove the wires, cut them a little shorter, and reattach the wires to the controller.

Replacing the Thermocouple

- 1 UNPLUG or disconnect the kiln and allow it to cool to room temperature.

Caution: Whenever you turn off the circuit breaker to your kiln, tape the breaker box door shut and leave a note saying, "WORKING ON KILN. BREAKER OFF."

- 2 Remove the screws on the sides of the switch box that hold it to the kiln. Gently lift the box away from the kiln.

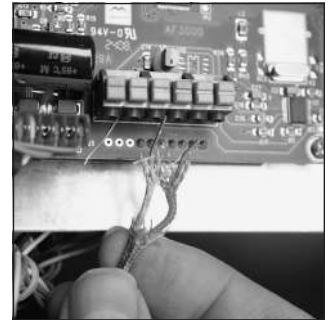
- 3 Remove the two screws securing the thermocouple ceramic block. Pull the thermocouple from its firing chamber hole. Loosen the screws holding the thermocouple to the ceramic block.



- 4 Slide the new thermocouple into the thermocouple hole in the kiln. The thermocouple should protrude into the firing chamber 1" (25 mm) or more. To adjust the thermocouple length, change the gap between the thermocouple and the ceramic block. Then securely tighten the 4 screws in the ceramic block.

- 5 Fasten the ceramic block to the heat shield with the two screws removed in Step 3.
- 6 Remove the controller faceplate (or pyrometer) from the front of the switch box.
- 7 Remove the 2 thermocouple wires attached to the back of the controller. They are held in place by button connectors. To remove the wires, press down on the button connectors and pull the wires out.
- 8 Strip 1/2" (12.5 mm) of insulation from the ends of the new thermocouple wires. Be sure the wire ends are separated where the insulation has been stripped. If bare ends touch, the thermocouple will not work properly.

- 9 Attach the wires to the back of the controller or pyrometer. One wire is yellow, the other red. Make sure the wires connect to the correct terminals, which are color coded. Reinstall the controller or pyrometer to the switch box.



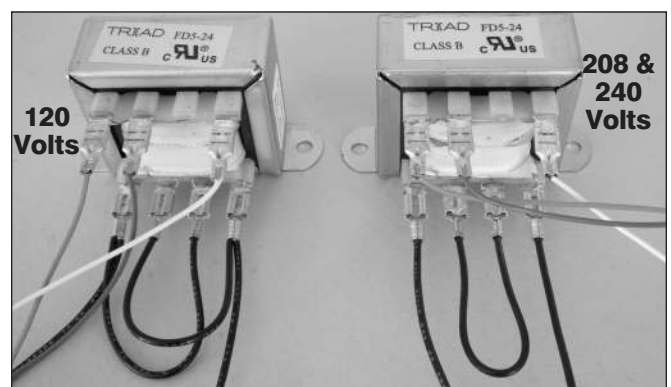
- 10 Position the thermocouple wires so they are away from the hot sides of the kiln case and other electrical wires. (Placing thermocouple wires next to or looped around other wires could cause erratic controller readings.)

- 11 Check that no wires touch the kiln case or element connectors. Wires touching element connectors or kiln case will burn. Reinstall switch box.

Replacing a Relay or Transformer

See also "The Runaway Relay," pages 27-28.

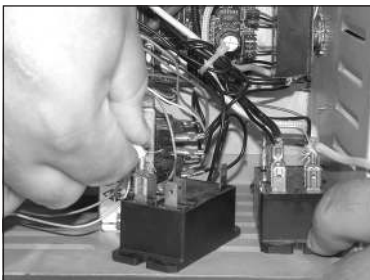
Note: If you are replacing the transformer, examine the new one. Make sure the jumper wires on the new transformer are wired the same way as the jumpers on the old one. The jumper wires must be properly wired for your kiln's voltage. (See the kiln's wiring diagram.)



- 1 UNPLUG or disconnect the kiln and allow it to cool to room temperature.

Caution: Whenever you turn off the circuit breaker to your kiln, tape the breaker box door shut and leave a note saying, “WORKING ON KILN. BREAKER OFF.”

- 2 Remove the screws on the sides of the switch box that hold it to the kiln. Gently lift the box away from the kiln.



- 3 The transformer and relay are bolted to the inside of the switch box. Hold the new part next to the one you are replacing, aligned in the same direction. Remove and transfer one wire at a time from the old part to the new one. Make sure each connection is tight.
- 4 Replace push-on connectors and wires damaged by heat. If wire connectors do not fit snugly on terminals, gently squeeze the end of the terminal with pliers.
- 5 Remove the old part from the switch box. Install the replacement. Note: Most relays are held in place with two sets of nuts and bolts. When you replace a relay, check to see if it has slots or holes where the bolts fasten. If the relay has slots, remove only one bolt and nut. Loosen the other. Then slide out the relay from the loosened bolt. This will save you a lot of time especially if you are working in a cramped switch box.
- 6 Check to see that wires are not touching the kiln case or the element connectors. Wires touching element connectors or the kiln case will burn out. Move the switch box into place and reinstall switch box screws.

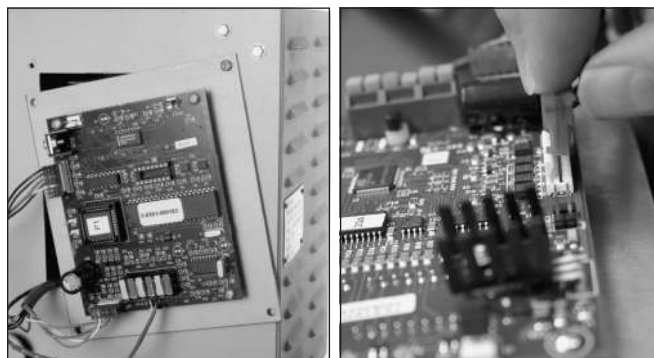
Replacing a Temperature Controller

Remove the Controller

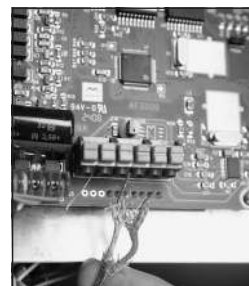
- 1 UNPLUG or disconnect the kiln and allow it to cool to room temperature. (Some of the components on the back of the circuit board can be damaged if they touch a grounded object while the kiln is plugged in.)

Caution: Whenever you turn off the circuit breaker to your kiln, tape the breaker box door shut and leave a note saying, “WORKING ON KILN. BREAKER OFF.”

- 2 Remove the 4 screws holding the controller board faceplate to the control panel.
- 3 Gently lift the faceplate out of the control panel and let the board hang on the box with the back of the board facing you.



- 4 Remove the 2 red connection plugs from the back of the controller board.
- 5 Remove the 2 thermocouple wires (a red and a yellow) from the bottom of the board by pressing the button connectors. Then pull the wires out.



Install the Controller

- 1 UNPLUG or disconnect the kiln.

Caution: Whenever you turn off the circuit breaker to your kiln, tape the breaker box door shut and leave a note saying, “WORKING ON KILN. BREAKER OFF.”

- 2 Install the 2 thermocouple wires (a red and a yellow) onto the back of the new controller observing the color coding (red wire to red terminal and yellow wire to yellow terminal). Use the center connectors if your kiln has only one thermocouple. Make sure the thermocouple wires are tight. After pushing the wires into the button connectors, pull each wire, one at a time, to be sure they are tight.

Make sure there is sufficient insulation on the thermocouple wires to prevent them from shorting out against each other. If the insulation is stripped too far back, the bare thermocouple wires can touch.

- 3 Install the 2 red connection plugs that you removed in Step 4 above. Do not force the plugs into place. They should slide on easily.
- 4 Gently place the controller faceplate into the control panel. Install the 4 corner screws to the front of the controller faceplate.

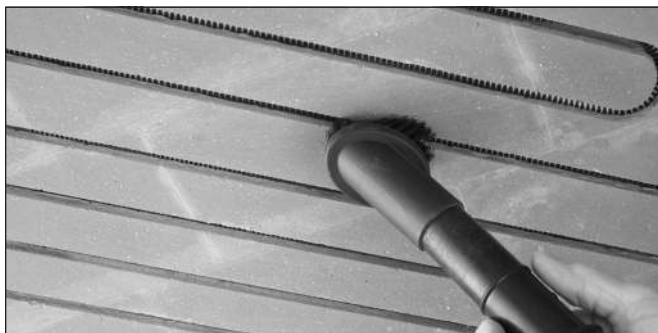
Lid or Roof Maintenance

Please also see “Firebrick Maintenance,” which is available at www.paragonweb.com. Select Support, and then Instruction Manuals from the drop menu.

Eliminating Dust from a Firebrick Lid

An old firebrick kiln lid sometimes drops dust into the firing chamber, usually from lid cracks. The dust can ruin fused glass.

The heat from the kiln expands the firebricks, which frees the loose particles. You can remove the particles before the firing by vacuuming the lid with a brush nozzle. The brush is necessary; a vacuum nozzle held near the lid without the brush is not strong enough to remove all the loose particles.



Some of the particles may be from refractory lid coating that has been applied too heavily. Thick layers of coating flake off. An especially thick coating looks like a network of peeling cracks on the inside lid surface. Remove the loose coating by gently sandpapering.

Please also see “Firebrick Maintenance,” which is available at www.paragonweb.com. Select Support, and then Instruction Manuals from the drop menu.

A Gap Under the Lid

Some people worry about the line of light that appears around a kiln lid (or door) at high temperatures. They wonder if the light means heat is escaping.

The kiln expands as it heats. The larger the kiln, the greater the overall expansion of parts. Since the hot inner surface of the lid expands more than the cooler outer surface, the center of the lid or door bows slightly toward the firing chamber. This causes a small gap, where light from the firing chamber is visible. The gap is more pronounced on the ends of an oval lid than on a round lid.

But unless the lid rises during firing, there is little heat loss from the gap under the lid. At high temperatures, the molecules in air are so far apart that they no longer trans-

fer heat through convection. This is why heat does not pour out of a peephole when you remove the plug.

On some models, we add a gap between the lid (or door) and kiln at the hinge. As the kiln gets hot, the gap closes due to the expansion of the firing chamber.

Replacing a Lid on Kilns Equipped With the LiteLid

These instructions are for 10- and 12-sided kilns equipped with the LiteLid spring counter-balance.

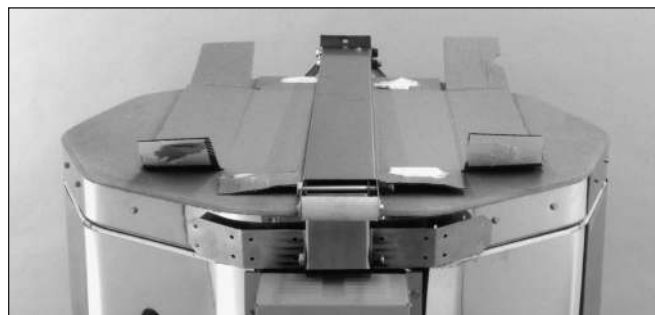
Drill holes with a 1/8" bit. Tap a mark in the metal with a center punch or nail to start holes. Do not over-tighten screws. Stop turning when the screw feels snug. Wear safety glasses when drilling.

1 Raise the lid. Have someone hold the lid in its upright position while you remove the bolts that secure the bottom spring loop(s). With the spring pressure released, close the lid.

2 Using a 1/4" nut driver, remove all screws fastening the front and rear LiteLid brackets to the lid. Lift the horizontal arm of the LiteLid up and out of the way.

3 Lift off the old lid. Gently place the new lid onto the kiln. Line up the edges of the lid with the sides of the kiln.

4 Lower the horizontal arm of the LiteLid onto the lid, using cardboard to protect the lid from scratches.



5 Center the LiteLid **front** lid brackets vertically between the upper and lower edges of the lid. Hold the bracket in this position while you mark two holes for each bracket with a felt-tipped pen. Move the brackets out of the way. Drill holes. Screw the

brackets onto the lid. Then drill the other holes for the brackets and install screws.



- 6** The LiteLid hinge has play in it to allow the lid to float at high temperatures. This adjusts for heat expansion. Lift a rear lid bracket to feel this play. The rear lid brackets must be in the lower part of this play when you attach them to the back of the lid.

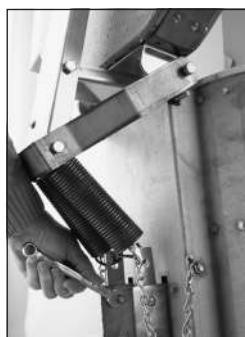


In addition, there should be a 1/16" (1.5 mm) gap between the back of the lid and the kiln wall. This is to insure sufficient room for expansion. Place several sheets of paper with a total thickness of about 1/16" (1.5 mm) under the lid at the hinge area. Then mark two holes on the lid with a



felt-tipped pen for each bracket. Drill holes and install two screws in each bracket. Then drill the other holes and install the rest of the screws.

- 7** Install the lid handles on the new lid.
- 8** Have someone hold the lid in the open position while you attach the lower spring loop(s) using the nuts and bolts removed in Step 1.



Adjusting a LiteLid That Rises in the Front

During firing, the firebricks expand and the kiln actually rises, becoming taller. The lid has vertical play at the hinge that is designed to allow the lid to float. This compensates for the expansion of the kiln. If the lid is tight at

the hinge, the front of the lid will lift up during firing. This happens when the hinge is not adjusted properly or is binding.

Note: If the lid rises in the front, please do not put a weight on the lid to hold it down. That could damage the lid. Instead, check for binding and adjust:

- 1** The lid must have vertical play in the hinge. To check for play, close the lid all the way. Have someone hold a side handle and lift the lid while you watch the back of the lid. You will find a lid bracket attached to each side of the lid. The lid bracket on the side that you lift should go up about 1/8" (3 mm) when someone lifts the side handle. (If you cannot lift the back of the lid, it may be due to a tight hinge bolt. See Step 2.)
- 2** The nut on the lid hinge bolt must not be too tight. Otherwise the lid can bind, causing the lid to rise in the front during firing. If the lid could not lift up in Step 1 above, loosen the nut on the hinge bolt. If, after loosening the nut, the lid still cannot lift up, go to Step 3.
- 3** The lid bracket holds the back of the lid to the hinge. The hinge bolt passes through a slotted hole in each lid bracket. That slotted hole is not easy to see, because the LiteLid rear arm covers it. But if you position yourself so the hinge bolt is at eye level, you can see the slotted hole.



With the lid closed, the hinge bolt should be at the top of the slot in the lid bracket. If the bolt is at the bottom of the slotted hole, the lid was installed improperly. If this is the case, please call the factory for additional help.

- 4** If the lid still rises during firing after all the above checks out okay, insert a screwdriver between each rear lid bracket and rear LiteLid arm. Twist the screwdriver to ease possible binding. Or use locking pliers such as Vice-Grips to bend the



metal to remove binding. Or bend the yoke with your hands. When the binding is relieved, the lid will float.

Replacing the Lid on a Paragon Fusion Kiln

Remove the Old Lid

- 1 UNPLUG or disconnect the kiln and allow it to cool to room temperature.

Caution: When you turn off the circuit breaker, tape the breaker box door shut and leave a note saying, "WORKING ON KILN. BREAKER OFF."



Grab a spring clip with needle nose pliers. Then slide the clip off the shaft.

- 2 To remove the hinge shaft, first press a flat-bladed screwdriver behind a spring clip to move the clip out far enough so that you can grab the clip with needle nose pliers. Remove the clip with the pliers. Then pull out the hinge shaft.



- 3 Remove the screws in the upper hinge-half on the old lid using a 1/4" nut driver.
- 4 Remove the screws from the switch box on the old lid. Pull the switch box away from the lid.
- 5 You will see lead wires that go from the conduit and switch box to the element connectors on the lid. If necessary, label the wires with pieces of tape, and sketch the element connectors so you will know where to connect the wires on the new lid. (You should also have a wiring diagram, which shows how the elements and wires are connected.) Using a 1/4" nut driver, remove the brass screws that hold the lead wires to the element connectors. Do not disturb the screws that hold the elements.



- 6 Make a sketch of the way the lock-in lid support brackets line up on the kiln and lid. Then remove the lid support bracket from the old lid using the 1/4" nut driver.
- 7 Remove the old lid from the kiln.



Install the New Lid

- 1 Place the new lid on the kiln. Line up the sides of the lid with the sides of the kiln.
- 2 Place a piece of 1/16" (1.5 mm) thick cardboard under the lid near the hinge. (This will create a gap between the lid and body of the kiln. Heat expansion will close the gap during firing.)
- 3 Reinstall the hinge shaft that you removed in Step 2. Place the upper hinge-half against the lid. Move the upper hinge-half up and down. You will notice that there is about 1/8" (3 mm) of play in



the hinge. That play must be in the lid after installation. With the upper hinge-half at the bottom of its play, mark screw holes in the lid for the hinge. (Use a black felt-tip pen.)

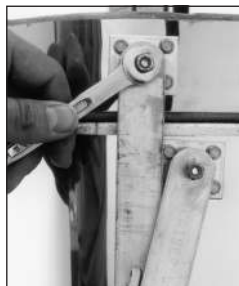


4 You may want to tap the marks that you made in Step 3 with a center punch. This prevents the drill bit from moving. Drill 1/8" holes for the hinge. Insert screws. Lift the lid at the hinge to make sure the lid has play.

5 Attach the wires to the element connectors. Tighten securely.

6 Install the switch box to the new lid.

7 Install the lid support bracket onto the new lid using the diagram you made that shows the alignment of the two lid support brackets.



8 Attach the lid handle to the front of the lid. If the kiln's switch box is under the handle, place a piece of cardboard under the lid to prevent metal shavings produced by drilling the handle holes from dropping down into the switch box.

Tightening the Lid Band

The lid stainless steel band may need tightening once a year.

1 Grasp the clamp with pliers to prevent the clamp from twisting.



2 Tighten the screw to take up the slack in the lid band. Tighten until the screw feels snug. Try not to over-tighten.

Replacing the Paragon GL-18, GL-22, or GL-24 series Roof

Remove the Old Roof

1 UNPLUG or disconnect the kiln and allow it to cool to room temperature.

Caution: Whenever you turn off the circuit breaker to your kiln, tape the breaker box door shut and leave a note saying, "WORKING ON KILN. BREAKER OFF."

2 Remove the door.

Do not disconnect the wiring on doors that have elements. Use a 3/8" wrench to remove the two bolts holding the top swivel bracket to the hinge rod. Lift the door upward to remove, leaving the bottom swivel bracket in place.



3 Remove the switch box from the side of the kiln using a 1/4" nut driver. You may need to prop the switch box to avoid straining the wires.

4 You will see lead wires that go from the switch box to the element connectors on the side of the roof. If necessary, label the wires with pieces of tape, and sketch the element connectors so you will know where to connect the wires on the new lid. (You should also have a wiring diagram, which shows how the elements and wires are connected.) Using a 1/4" nut driver, remove the brass screws that hold the lead wires to the roof element connectors. (If your kiln has both roof and sidewall elements, do not disturb the wires that are attached to the sidewall element connectors.)

5 Remove the element connectors for the roof elements. Remove and save the porcelain insulators that were behind element connectors.



6 Remove the screws in the sheet metal top. Place a nut driver or other tool against the lip of the sheet



metal top and tap upward with a hammer. Lift the top out of the way.

- 7** Gently lift the old roof from the kiln.

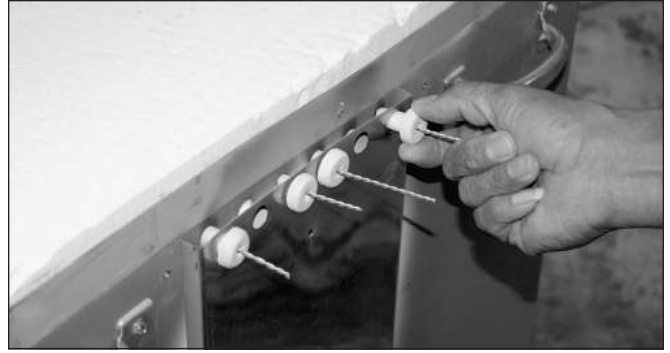


Install the New Roof

- 1** Place the new roof on the kiln.



- 2** Install the sheet metal top over the new roof. You may be able to use the old screw holes. However, do not force the sheet metal downward to line up the holes. Sand the tops of the walls that support the roof if the new roof is too high for the sheet metal screw holes to line up. Or drill new holes in the kiln case if necessary.
- 3** Reinstall the porcelain insulators. Push them flush against the kiln case/heat shield. They protect the elements from contact with the case, so they must



not work their way out after the element connectors are tightened into place.

- 4** Attach the wires that you removed from the old roof to the new element connectors. Sandpaper the eyelet of the element lead wires until bright and clean of all oxidation. (Install new lead wires if insulation on old ones is brittle.) Use the brass screw to connect the lead wire eyelets to the new element connectors. Before tightening the screw, adjust the eyelet to where it will be tilted away from the kiln case when the connector is attached to the element. Then hold the connector with locking pliers and tighten the brass screw securely with a 1/4" nut driver.

- 5** Pull the end of the element tight and install new element connectors snugly against porcelain insulators to prevent insulators from slipping away from the brick wall. Use the stainless screw in the element connector to hold the element. (The brass screw holds the lead wire eyelet.) Hold the connector with locking pliers as you tighten the screw with the 1/4" nut driver.

Tighten the screw to 30 inch pounds (about 1 1/4 turns past the point of firm resistance).



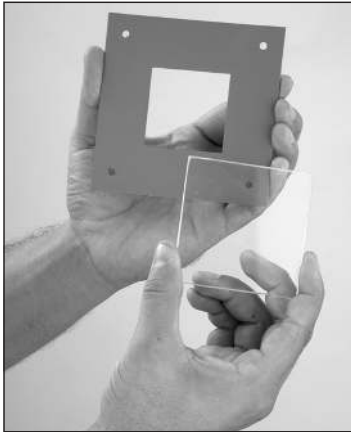
- 6** Cut off the twisted end of element even with the side of the element connectors. Leaving the excess element sticking out past the element connector could ruin your new element! (The element could short against something in the switch box.)
- 7** Install the switch box to the kiln. As you move the switch box back into place, check to see that no wire touches an element connector. Wires and wire nuts must also not touch the kiln's case inside the switch box. Wires and wire nuts will burn if they touch the case or element connectors. Reinstall screws in switch box and tighten.

- 8** Install the door.

Miscellaneous Firing Chamber Maintenance

Cleaning or Replacing the Glass View Port

- 1 Remove the screws holding the glass cover. (Hold the glass as you loosen the screws to prevent the glass from falling out and breaking.)
- 2 Remove the glass. Clean with glass cleaner. To remove scratches, take the glass to an eyeglass polisher.



Firebrick Maintenance

Please see “Firebrick Maintenance,” a separate publication available at www.paragonweb.com. Select Support, and then Instruction Manuals from the drop menu.

Ceramic Fiber Maintenance

If glass, ceramic glaze, or other materials drip onto the firing chamber, repair before the next firing. Otherwise the glaze will remelt and embed deeper into the fiber.

Minor Ceramic Fiber Repairs

- 1 Unplug the kiln.
- 2 Cut or scrape the ceramic fiber to remove the contaminant. Remove as little fiber as possible. If a heating element is located where you are scraping, avoid touching the element.
- 3 Use a vacuum cleaner to remove the dust from the damaged area of the firing chamber. Be sure to remove all the contaminant. Otherwise it will melt and embed deeper into the firing chamber the next time you fire the kiln.

Keep the vacuum cleaner nozzle at least 2" away from the thermocouple and the controller. This is to avoid damage to the controller from static electricity.

After you have removed the contaminant, minor gouges or scrapes in the firing chamber need no further repair. They are cosmetic and do not affect the firing of your kiln.

Larger Ceramic Fiber Repairs

- 1 Unplug the kiln.

- 2 Cut or scrape the ceramic fiber to remove glass, ceramic glaze, or other melted contaminant. Remove as little fiber as possible. If a heating element is located where you are scraping, avoid touching the element.



- 3 Use a vacuum cleaner to remove the dust from the damaged area of the firing chamber. Be sure to remove all the contaminant. Otherwise it will melt and embed deeper into the firing chamber the next time you fire the kiln.

Keep the vacuum cleaner nozzle at least 2" away from the thermocouple and the controller. This is to avoid damage to the controller from static electricity.



- 4 Squeeze Pyrolite into the gouge. Smooth the Pyrolite with a small putty knife.



Pyrolite adhesive comes in 10.3 ounce tubes.

Glossary

AFAP As fast as possible. This means the kiln will either heat as fast as possible by leaving the heating elements turned on throughout a particular segment, or it will cool as fast as possible by leaving the elements turned off throughout a segment.

anneal point The temperature where the glass begins to change from a solid to a liquid, when heated, or from a liquid to a solid, when cooled.

anneal To remove the inner stresses from glass by cooling gradually. The “annealing point” is the temperature where the annealing period begins. Please consult the glass manufacturer for the recommended annealing temperatures.

bisque Fired, unglazed clay.

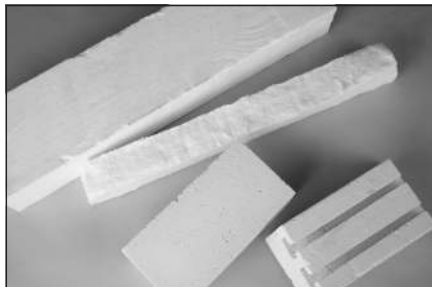
blank Glass cut to a specific size or shape for a project.

borosilicate glass Also called “boro,” this glass has a low coefficient of expansion. It is popular for making glass beads and figurines. It is used in ovenware because it can withstand a sudden change in temperature.

carborundum stone Silicon carbide, used to clean irregularities from the edges of glass before firing.

cathedral glass Transparent colored glass.

ceramic fiber A white, rigid insulation that heats and cools rapidly. During the first firing, you may smell organic matter burning out of the ceramic fiber.



Top to bottom: Ceramic fiber and insulating firebricks. The fiber heats and expands faster than the firebricks. The firebricks store more heat than the ceramic fiber.

coefficient of thermal expansion (COE) Degree of change in size of a material as it is heated. Different glasses fused together must expand and contract at the same rate to avoid breakage.

cold working Altering the glass by grinding, polishing, drilling, etc.

combing Pulling a rod across hot glass to blend colors or add a design in the surface. Do not press the rod too far into the glass. If you press the rod all the way through the glass, contaminants from the shelf will mix with the glass.

compatibility Refers to different glasses that have a similar coefficient of thermal expansion and viscosity. Different glasses are compatible if they can be fused together and remain stable after they have cooled. Incompatible

glass pieces can crack after they have been fused and removed from the kiln.

confetti Very thin shards of glass.

controller An electronic device that can be programmed to make a kiln fire to specific temperatures and rates. Paragon’s controllers measure rate as degrees of temperature change per hour.

crash cooling Opening the kiln lid 1" (25 mm) or kiln door ¼" (6.35 mm) to stop the fusing or drop the temperature quickly through the devitrification range. Crash cooling is usually unnecessary.



Crash cool by lifting the lid with a Lid Lifter.

crucible A ceramic pot that holds molten glass inside a kiln.

decal A design or picture printed in overglaze or underglaze colors on a protective coating. The decal is slipped from the paper backing onto the glass and fired for permanency.

devitrification A frosty appearance on the glass surface. Some types of glass are prone to devitrification. This can usually be prevented by brushing the following mixture onto the glass: 1 tablespoon 20 Mule Team Borax laundry detergent, 1 tablespoon Dawn dishwashing liquid, and 1 cup distilled water

dichroic glass A shiny, glittery glass that adds sparkle to projects.

DPH Degrees per hour in temperature change. This is also called Rate.

element A coil of wire that heats when electricity passes through it.

enamel Liquid or powder containing finely ground glass. Usually applied to metal, such as copper, and fired in a kiln. Some enamels can be applied to glass.

finding The metal part that is attached to earrings or pendants.

fire polishing Smoothing the surface of the glass by heating it to fusing temperature.

firing chamber The inside of the kiln where the glass is fired.

firing schedule A set of instructions that includes the temperatures, rates, and hold times needed to fire a particular glass project. A firing schedule is to a kiln what a recipe is to cooking food. Firing schedules are readily available on

glass websites, online forums, and from teachers. Do not hesitate to adjust a firing schedule to suit your kiln.

float glass Window glass. It is made by floating molten glass over molten tin.

frit Small particles of glass. Frit is useful in adding small bits of color to a fused glass piece.

full fuse Heating the glass until separate pieces become one flat surface.

furniture, kiln

The shelves and posts used to stack ware inside a kiln.



Kiln furniture: shelves and posts.

glass fusing Heating pieces of glass until they soften and merge together.

glass separator A powder mixed with water and brushed on top of shelves or molds and the bottom of a kiln's firing chamber. It prevents glass from sticking to these surfaces. (Also called "shelf primer.")

glaze A liquid composed of glass particles applied to ceramic and glass ware.

greenware Unfired clay objects.

haik brush A natural fiber brush used to coat glass separator onto the kiln shelf.



heat soak Maintaining a temperature inside the kiln. Heat soaking the glass just below fusing temperature allows finer control of the fusing.

hold time The length of time that a temperature is held, or maintained, inside a kiln; the length of a heat soak.

infinite control switch A switch that uses a bi-metallic timer to adjust current flow to the heating elements. It makes a clicking noise as the bi-metallic timer cycles on and off. When turned to HIGH, the power flows to the elements continuously.

insulating refractory firebrick The type of bricks used to line the interior of many Paragon glass fusing kilns. You can order firebrick and shape it with a knife to make your own sagging molds. (See photo, page 45, near the ceramic fiber entry.)

kiln wash Kiln wash is similar to glass separator. It is used to coat shelves and the kiln bottom for firing glass or ceramics. It prevents hot glass from embedding into the firebrick bottom or sticking to the kiln shelf permanently.

lost wax casting Removing wax from the cavities of a mold and then hardening the mold at high temperature. This is used to make jewelry.

mandrel A metal rod that is typically used to make glass beads. The glass is formed around the mandrel in the heat of a torch.

opalescent glass Milky, translucent glass.

pate de verre Fusing crushed glass in a mold.

pattern bar Stringers that have been bundled together and fused into a single rod. This technique is thousands of years old. The pattern bar can be sliced and added to other fused designs.

peephole The hole in the sidewall of a kiln used to see the interior of the kiln. (Remember to wear green #3 firing safety glasses when looking through the peephole.)



plate glass Window glass 3/16" or thicker.

process temperature The temperature where the glass fuses or sags. You can add a hold to this temperature for greater control.

pyrometer An instrument that measures temperature.

ramp Changing the temperature with a digital controller. If the temperature change is drawn in graph form, the resulting line looks like a ramp.

refractory Materials that can withstand high temperatures, such as firebricks, kiln shelves, posts, and glass separator.

relay A switch that turns on the heating elements in a kiln. Mechanical relays are triggered by an electromagnet; mercury relays are triggered by the movement of a small vial of mercury.

rigidizer A coating that is applied to ceramic fiber to harden the surface.

sagging Heating glass on a mold until the glass softens, sinks into the mold, and takes the shape of the mold. Begin the cooling phase of firing when you see (through a peephole or kiln window) the glass disappear into the mold.



segment A set of programmed instructions for the digital controller in Ramp-Hold mode. A segment changes firing speed and temperature. It can also hold the temperature for a specified period.

shelf Glass is fused on the shelf, a flat slab of fireclay inside the kiln, and not directly on the kiln bottom. In addition to the hard ceramic shelves, ceramic fiber shelves are also

available. Though the fiber is hardened on the surface, it is delicate and must be handled with care to avoid gouges.

shelf paper A thin sheet of ceramic fiber that is placed between the kiln shelf and the glass. This eliminates the need for glass separator.

shelf primer Another term for glass separator. It prevents glass from sticking to the kiln shelf.

single strength glass 3/32" window glass.

slumping (also called sagging) Heating a piece of glass over a mold until the glass softens and takes the shape of the mold.

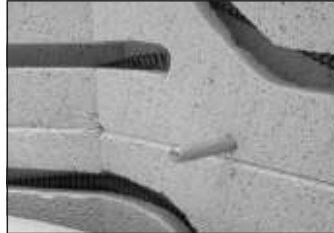
stress Strain within a fused glass piece. This is caused by either firing incompatible glass or cooling the glass too rapidly.

stringers Glass rods approximately 1/16" in diameter. They produce thin glass lines in fused pieces. (Also called "streamers.")

tack fuse Heating pieces of glass until they begin to soften and stick together. The surfaces of individual elements are still separate. This is the stage of fusing where stringers on the glass surface are still distinct and have not melted flat into the glass.

thermal shock Stress caused by sudden changes in temperature. This can break the glass. Glass is especially prone to thermal shock when suspended above a mold.

thermocouple A temperature-sensing probe mounted in the firing chamber of a kiln. The thermocouple is made of two dissimilar metals welded together at the tip. When heated, they generate an electric current in millivolts, which is read by a pyrometer or controller and converted to temperature.



transformer An electrical device in a kiln's switch box that changes the higher voltage from the wall outlet to 24 volts AC. The lower voltage powers the digital controller.

venting At the beginning of the firing, allows air to come into the kiln and vapor to escape. This is necessary when firing paints and decals.

vitrograph Heating glass until it is soft enough to flow out the bottom of a ceramic pot. This is used to create stringers with unique shapes and colors.

wire wrapping Bending wire around an object to enhance the design. This usually refers to jewelry that has been wrapped with silver or copper wire.

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