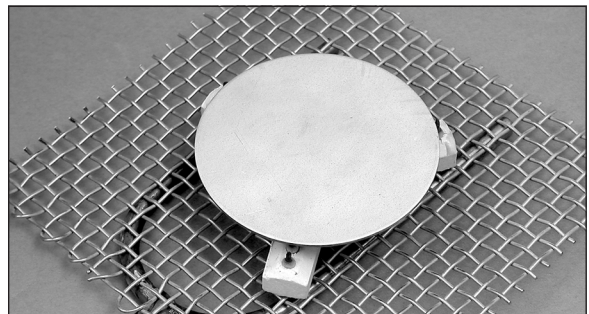
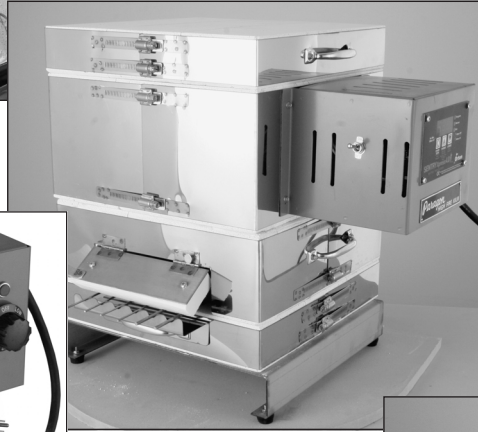
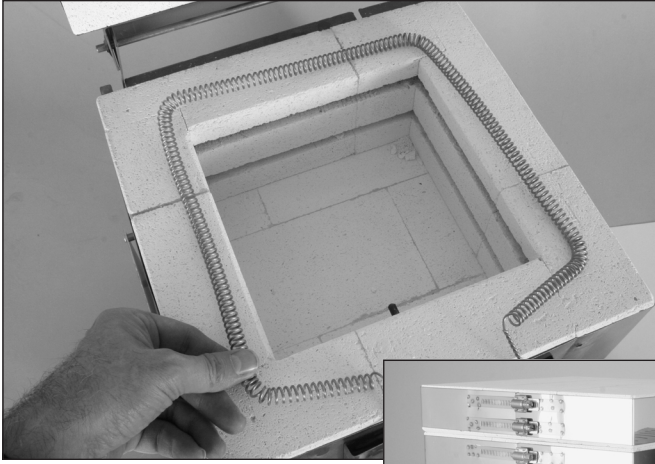


Paragon Caldera & FireFly Instruction & Service Manual



Recommended books at
www.paragonweb.com

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



Free video training! Watch
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Click the "Audio & Videos" link
near the top
of the home page.

Introduction

Thank you for choosing a Paragon kiln! We have designed it to give you many years of reliable service.

Please read this manual. It will help you gain the most enjoyment from your kiln. It will show you how to avoid damaging the kiln and will answer many questions. If your kiln is digital, your instruction packet will include a separate digital controller manual. Please save both manuals and write your kiln's serial number on the inside cover of both manuals.

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 your kiln, check the carton for damage. Check the kiln for both 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 to Thursday, 7 a.m. to 5:30 p.m. Central). If there were no signs of visible kiln damage and you discover it after the driver has left, notify the shipper immediately.

Save the packing materials. Use them to pack the kiln when you take it with you to seminars or on vacation.

Needless worries. Tremendous stresses are generated within the kiln. The insulating firebricks actually expand and contract with each firing. Do not be concerned if small cracks appear in the bricks. This is normal. These are surface cracks that close tightly when the heated brick expands.

During firing, you will hear an intermittent, distinct clicking. In a digital kiln, this is the sound of the relay sending power to the heating elements. In a manual kiln, it is the infinite control switch cycling on and off. Do not be concerned with this sound.

The Electrical data plate. Important information about your kiln is recorded on its electrical data plate. Please include this information when ordering parts or calling your dealer or the factory about your kiln.



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Safety

Overfiring

The warranty on your Paragon kiln does not cover damage from overfiring, regardless of the circumstances. It is the operator's responsibility to make sure the kiln turns off at the proper time.

Read the Manual!

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

Food or Drink Surfaces

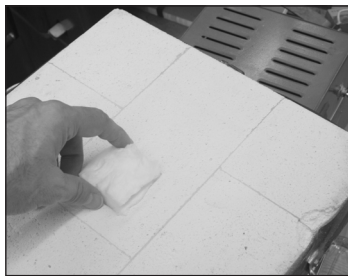
Some decorative materials may be unsafe and toxic when used for surfaces that will be in contact with food or drink. When you make food or drink containers, select a glaze or glass that has been formulated, tested and labeled as approved for surfaces that will be in contact with food or drink. Follow the glaze or glass manufacturer's instructions exactly, without any variations.

Mastering Cone 6 Glazes, by John Hesselberth and Ron Roy, covers food safe stoneware glazes in great detail. We recommend this book to every potter.

The Optional Glass Window

The glass window on the kiln top is rated to 2300°F / 1260°C, so it can easily withstand glass fusing temperatures. Please note, however, that the window reduces the kiln's maximum temperature to approximately 2100°F / 1148°C and is meant for glass fusing.

You can still fire porcelain and stoneware even with the window, but you will need to plug the window with ceramic fiber. The ceramic fiber should fill the entire window cavity in the firebrick top. Insert the fiber plug so that it fits securely against the view port. Friction will hold the fiber plug in place.



You can also temporarily plug the glass view port to reduce heat loss when firing silver clay and other materials that do not need visual inspection. If you ever need to order a replacement fiber plug, please specify view port size (2" x 2" or 50mm x 50mm).

Note: Always wear green #3 firing safety glasses when looking through the view port into the hot firing chamber. To find the glasses, enter firing safety glasses in the search line at www.paragonweb.com.

Important Safety Rules

An electric kiln is extremely safe to operate provided you follow these basic safety rules:

- Unplug kiln when not in use.
- Do not touch hot sides.
- Keep unsupervised children away.
- Place the Caldera kiln, with its separate steel stand, or the FireFly on a non-combustible surface. In the photo below, the kiln has been placed on a large kiln shelf. (The FireFly stand is built into the kiln.)



- Do not install closer than 12" (304 mm) from any wall or combustible surface.
- The Caldera kiln top and bottom must be in place before firing the kiln. (The top and bottom are attached to the FireFly.)
- Fire only in a well ventilated, covered and protected area.
- Keep cordset away from hot sides of kiln.
- **DANGEROUS VOLTAGE:** Do not touch heating elements with anything.
- Disconnect kiln before servicing.
- Do not leave kiln unattended while firing.
- Wear safety glasses when cutting glass.
- Wear green #3 firing safety glasses when looking into a hot kiln.
- Keep food away from your work area.
- Never fire tempered glass inside a kiln. It could explode.
- Avoid firing toxic materials inside the kiln, such as styrofoam (used as a core for silver clay hollow beads).

Setting Up the Kiln

Electrical Installation

You must plug your kiln into a circuit that no other appliance uses while the kiln is firing. Turn off the circuit breaker or unscrew the fuse for the circuit that your kiln will be plugged into. Check to see if other appliances shut off too. If that circuit powers appliances that must remain on while the kiln is firing, plug your kiln into a different circuit.



Note: 120 volt kilns: avoid extension cords if possible. If you must use one, never use one smaller than 12 gauge and longer than 20 feet (6.09 m). Never plug it into a ceiling outlet!

Voltage fluctuation can vary firing time from as little as half to more than twice the average time. If the voltage is too low, the kiln may never reach full temperature.

The receptacle must have a separate safety grounding wire. This protects you from serious electrical shock. Changing the cord plug will void your warranty!

The Caldera Kiln Stand

Find a fireproof surface for your Caldera. We recommend a large ceramic kiln shelf or steel table. Place the kiln on the steel stand that is included with the kiln.



Caution: The stand **MUST** be under the Caldera kiln during firing. It helps dissipate heat from under the kiln.

Seating the Elements

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

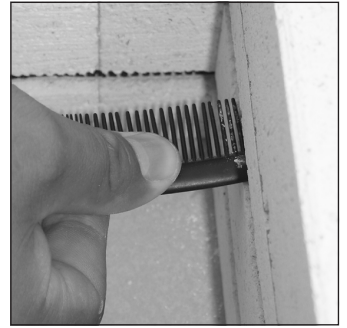
Kitchen Knife Test

Caution: Always unplug 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 and ruin a hot element.

Press the elements into their grooves by 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. 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 there is minimal danger of breaking the elements. After firing, however, the elements must be reset if they bulge out of the groove. See "Reseating a Bulging Element," page 18.



Where to Locate the Kiln

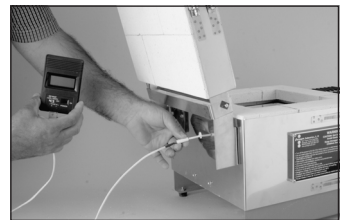
- 1 Place your kiln in a well ventilated, covered and protected area such as the garage, basement, utility or hobby room. Some people keep their kiln outside on a covered patio. This is okay as long as the kiln is not subjected to excessive humidity or rain.
- 2 Remove gasoline, paint, and other flammable materials from the kiln room.
- 3 Never allow the room temperature of your firing room to exceed 100 - 110° F / 37 - 43° C. Measure the temperature about 3 feet (91 cm) from the kiln. If necessary, use fans to lower room temperature.
- 4 Keep the kiln away from curtains or other combustible materials.
- 5 Position kiln on a level, fire-proof surface. We recommend an 18" x 18" (457 mm x 457 mm) piece of sheet metal, a steel table, or a large ceramic kiln shelf.

There is little danger of serious burn from accidental contact if you exercise the same caution you would use with an electric iron.

Installing the Manual FireFly Thermocouple

A pyrometer comes with the Manual FireFly. You will find a rod, called the thermocouple, packaged with your pyrometer. The thermocouple senses temperature.

The thermocouple should extend into the firing chamber by $\frac{3}{4}$ " - 1" (19 mm - 25 mm). Insert the thermocouple into the kiln through the pre-drilled hole near the hinge. When the thermocouple is positioned properly, make a pencil mark on the outside of the thermocouple that is even with the kiln case. During firing, the pencil mark near the kiln case will indicate that the thermocouple is positioned in the firing chamber by the correct distance.



4/ Monitor the kiln during operation.

Basic Operation

Accessories

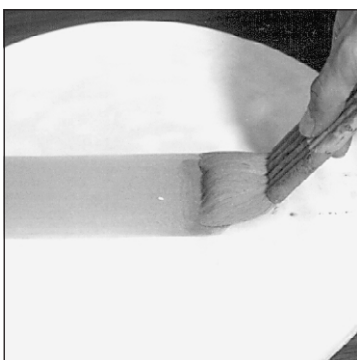
Ceramic Shelves & Posts

Shelves and posts are fireclay that has been fired to a higher temperature than will be encountered in your kiln. Ware is placed on the shelves. Shelves can be stacked using posts.



Glass Separator & Kiln Wash

Glass separator and kiln wash are mixtures of finely ground minerals that will not melt and fuse together at high temperatures. They prevent glass and ceramic glaze from sticking to shelves and the firebrick bottom. The main difference between glass separator and kiln wash is that the separator is ground more finely to leave a smooth back to glass pieces laid on the shelf.



In powder form, glass separator and kiln wash have an unlimited shelf life. Do not breathe the powder when mixing.

Caution: If glass separator or kiln wash contact a heating element, that element may burn out in the next firing. NEVER apply glass separator or kiln wash to the walls or top of the firing chamber.

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.



Ceramic Fiber Blanket

Delicate silver or gold clay shapes may need extra support during firing to minimize warping. Place these shapes on a piece of ceramic fiber blanket.

Stilts

Stilts are points embedded in a ceramic base. The points separate enameling and glazed ceramics from the shelf and firebrick bottom.

Enameling Racks for the Caldera

Enameling is the art of firing glass onto metal. The metal shapes are loaded onto a high temperature wire rack. The enameled pieces and wire rack are loaded into a hot kiln, fired for just a few minutes, and removed red hot. To load and unload the rack safely, use an enameling fork.

The heating element under power is dangerous. Do not touch the element with anything! Turn the kiln switch off before inserting the enameling fork into the firing chamber.



Place the Enameling Collar between the Caldera and the kiln bottom as shown. Wear green #3 firing safety glasses and protective gloves.

Safety Glasses

Wear *clear* safety glasses when cutting or chipping glass. Wear *firing green #3* safety glasses when looking into a hot kiln, such as when checking the progress of glass.



Important Guidelines

The Clicking Noise

Do not be concerned if your kiln makes a clicking sound during firing. Digital kilns contain a relay, which sends power to the element. The relay clicks as it cycles on and off to maintain the correct temperature. Manual kilns use an infinite control switch that clicks as it cycles on and off.

Manual Kilns: The Infinite Control Switch

The manual kilns use an infinite control switch. A bimetallic timer inside the switch cycles on and off to regulate heating. The higher the switch setting, the longer the element stays on during each cycle. On High, the element stays on continuously. This is why the clicking noise stops after the switch is turned to High.



The pilot light serves as the pointer mark for the infinite control switch knob.

Check Thermocouple

You will find a rod called the thermocouple extending into the firing chamber of the Caldera, Caldera-S, and the Digital FireFly kilns. The digital controller senses temperature by reading a small voltage from the thermocouple. If the tip of

this rod is pushed out of the firing chamber, the kiln will assume that the firing chamber is cold. On digital kilns, this will result in an over-fire. When loading the kiln, check that the rod extends into the firing chamber by 1" (25 mm) or more.



Vacuum the Kiln

Clean the kiln interior before firing glass, enameling, or ceramic glaze. (Cleaning is not necessary when firing silver or gold clay.) Use a soft brush nozzle on a vacuum cleaner. Digital models: Keep the nozzle at least 2" (50 mm) away from the thermocouple and the controller. Static electricity from the vacuum cleaner can damage the controller.

Removing Hot Ware from the Caldera

We recommend the Caldera Enameling Collar for removing hot ware. Place the Enameling Collar between the Caldera and the kiln bottom as shown.



Turn off the kiln. Carefully slide an enameling fork under the shelf or enameling rack. Place the hot shelf/rack onto a large ceramic kiln shelf in front of the kiln. Wear thick work gloves.

Firing Log Book

Record the following information in a firing log book:

- Date
- Digital: Firing speed and Hold or Ramp/Hold program
- Starting time and total firing time
- Type of pieces and firing results

As you gain experience, you will find a wealth of information in your firing records.

Low Temperature Holds (Digital Kilns)

A low temperature hold (i.e. 200° - 300° F / 93° - 148° C) is more difficult to maintain than higher temperature holds (1400° - 1700° F / 760° - 926° C). At low temperatures, turning on the heating element affects firing temperature to a larger degree than at high temperatures.

To hold at a low temperature, heat the kiln slowly. Otherwise the temperature may overshoot the hold temperature before the heating element cycles off.

Avoid Contaminating the Heating Element

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 element.

Note: If glaze or glass drips onto a firebrick wall, unplug the kiln and dig out the glaze with a screw-

driver. Otherwise it may melt into a brick groove during the next firing.

Loading the Kiln

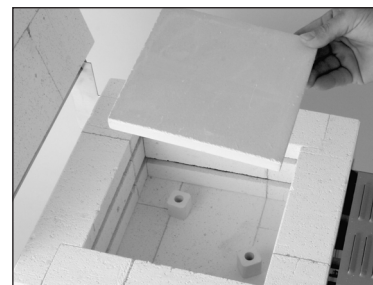
Place Ware on the Kiln Bottom or on a Protective Shelf

Ceramics can be fired directly on the firebrick bottom or on a shelf. Fire glass only on a shelf or mold, never directly on the brick bottom.

Types of shelves and containers:

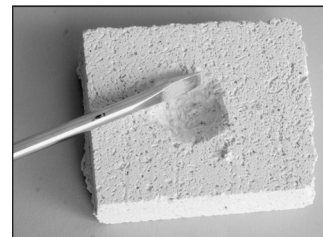
Fireclay Shelf

Ceramic fireclay shelves, available from Paragon, protect the firing chamber bottom and provide a smooth surface. Use a ceramic shelf in your kiln to fire ceramics, glass, and china painting. Support delicate silver clay pieces by pouring a mound of vermiculite or alumina hydrate onto the fireclay shelf.



Insulating Firebrick Piece

Insulating firebricks are porous, light-weight, and can be shaped to support delicate silver clay designs. Carve the firebrick with a knife or hacksaw. You can also fill the recessed area of the brick with vermiculite or alumina hydrate. (Vermiculite is available from garden supply stores.)



Caution: Avoid breathing alumina hydrate dust. Alumina hydrate can destroy the heating element on contact.

Ceramic Fiber Blanket

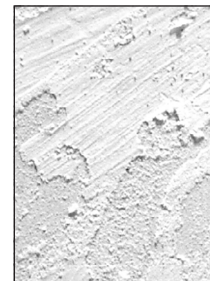
Place the blanket scrap directly on the firing chamber bottom. Use the blanket to support delicate silver and gold clay, but never ceramics, enameling or glass.

Applying Glass Separator or Kiln Wash

The kiln shelf, kiln bottom, and sagging mold must be coated with glass separator to keep glass or ceramic glaze from sticking to them.

A coat of glass separator or kiln wash will usually last through several firings. When the shelf coating begins to crack or chip, apply a fresh coat.

When recoating a shelf, remove most of the old coating with grit cloth (available from Paragon). This is an abrasive-coated mesh that allows residue to pass through. You could also use coarse sandpaper. Removing the old



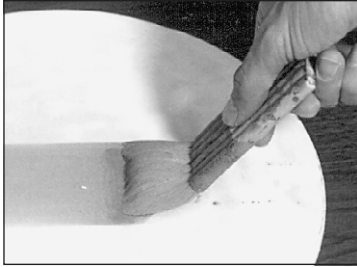
Apply new separator when the old coat begins to flake.

coating gives you a smooth surface to start with. Then recoat the shelf using the following directions. (Both glass separator and kiln wash will be referred to as “separator.”)

Caution: Keep separator away from the 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 is easier to use because it lays down a more even coating.) 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 - ½” (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 your shelf is cool, you can smoothen the separator further by rubbing your hand lightly over the shelf. The smoother the separator, the smoother the back side of the glass.

A coat of glass separator will usually last several firings.



Using Posts

Ceramic posts support ceramic fireclay shelves. When firing glass, place 3 - ½” (12.5 mm) posts under the ceramic shelf on the firebrick bottom. This improves heat distribution around the shelf. You can fire two or more ceramic shelves in your Caldera and one or possibly two in the FireFly. When you load multiple shelves, use a slower firing rate. This aids in heat distribution. Always fire glass on a shelf and not directly on the brick bottom.

Venting the Kiln

Some types of firings, such as ceramics or lost wax casting, produce fumes that must be vented from the kiln. Silver and gold clay need no venting unless you are firing them with a material that burns out to produce a hollow shape or you are combining them with other materials such as glass. To vent the kiln, place a ½” (12.5 mm) post under the top.

When the venting is completed, remove the ½” (12.5 mm) post to conserve energy for the rest of the firing. Venting will be explained in greater detail in sections on glass and ceramics.



Glass Fusing & Slumping

You will probably fire mostly art glass, but you can also fire standard float (window) glass. Some types of float glass devitrify (form a dull, frosty surface) when fused.

Caution: Never fire tempered glass. It could explode if heated inside a kiln.

Basic Glass Tools

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

Running Pliers are for breaking glass after scoring.

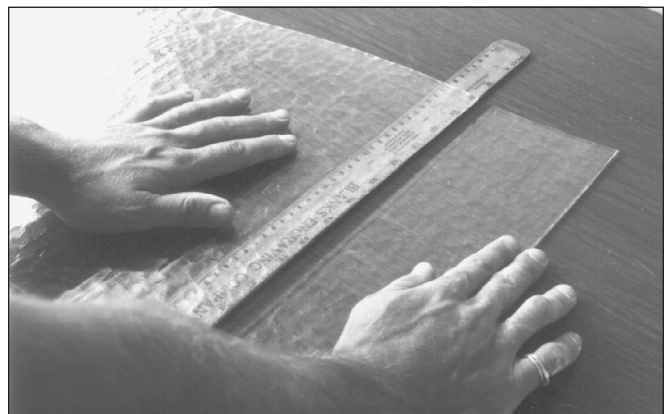
Breaking Pliers are for controlled breaking after scoring.

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: IMPORTANT! Wear safety glasses when cutting or chipping glass.

- 1 Lay the glass on a clean surface. Mark off the cut with a grease pencil or felt-tip pen. A small mark on each end of the glass will do. Lay a wooden straight edge over the glass and line it up with the marks you just made.



Fire in a well ventilated area. /7

- 2 Hold the straight edge firmly and score the glass with the glass cutter. Press just hard enough so that the scoring noise sounds steady and unbroken.
- 3 Place the straight edge under the glass so that an edge is lined up with the score line you just made. Press down on the glass. It should break cleanly.

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.

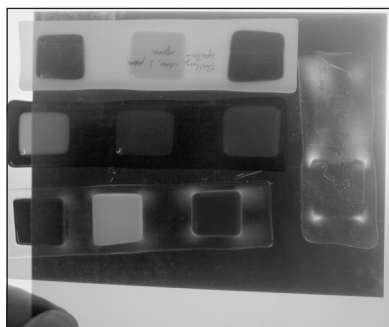
Viscosity is the measure of resistance to flow within glass. Glasses that do not match in viscosity will produce strain when fused together. Viscosity is as important as coefficient of expansion in determining whether glass pieces can be fused together.

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.

Test for Fusing Compatibility

- 1 Order two sheets of polarizing film. The sheets of film scratch easily; handle them carefully. Store them in plastic page protectors.
- 2 Place a polarizing film 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 film. The coated side scratches off easily.) The uncoated side should go up to avoid scratches from contact with the glass test samples.
- 3 Turn the light table on and dim the overhead lights. Place the glass samples on top of the polarizing film. Hold the other film over the samples and rotate the film 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.)

The Annealing Range

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

The larger and thicker the glass, the slower it must pass through its annealing range. You cannot over-anneal, so err on the side of caution if you aren't sure how long to anneal. Small projects such as earrings rarely need annealing time as they cool.

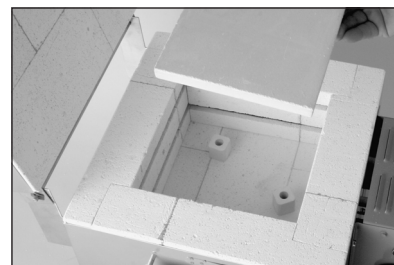
Cleaning and Gluing the Glass

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

Air should circulate between the shelf and the bottom of the kiln, so place three or four ½" (12.5 mm) posts in the kiln. Lay the shelf over the posts.



Firing the Glass

Firing speed varies depending on the size and thickness of the glass project. The thicker and larger the project, the slower you must fire it. Otherwise the glass may crack. Small jewelry pieces, such as earrings, can usually fire at full speed.

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.

Viewing the Glass During Firing

Watch the glass through the optional window in the top of the kiln. If you do not have the window, move the standard Caldera top over just enough to where you can see inside the kiln. Look for several seconds at a time. Wear green #3 firing safety glasses and protective gloves.

Note: When you move the Caldera top, do not slide it, or dust particles could land on the glass. Gently lift it slightly. With every firing, be sure you are near the kiln before the expected shut-off time.



Digital Kilns

The first time you fire a particular brand or type of glass,



Caldera: To look at the glass during firing, move the Caldera top slightly. Look inside the kiln for a second or two. Wear firing safety glasses and gloves.



FireFly: Lift the lid just enough to check on the progress of glass. Look for only several seconds at a time. Wear firing safety glasses and gloves.

program the controller for a higher temperature than the estimated fusing temperature. Shut the kiln off when the glass fuses the way you want. Make a note of the shut-off temperature. For future firings, program the kiln for that rate and temperature.

Manual Kilns

Shut the kiln off when the glass fuses the degree that you want. Make a note of the shut-off temperature shown on the pyrometer. For future firings, begin watching the glass 100°F - 200°F / 55°C - 111°C below the final temperature.

Annealing the Glass

The annealing range for most glasses is between 950°F / 510°C and 700°F / 371°C. Cool slowly through this range. Leave the top closed, rather than vented, during cooling. This will slow the cooling enough for most projects.

Digital Kilns: If you need even slower cooling, program a separate segment for cooling. (See the controller manual.)

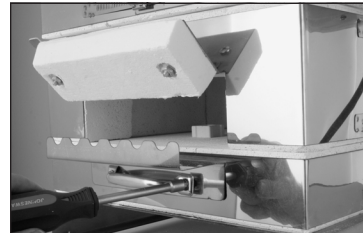
Manual Kilns: If you need even slower cooling, turn the kiln on again for about 30 minutes while the glass anneals. Use a low to medium switch setting.

Note: For safest cooling, leave the ware inside the kiln until the kiln reaches room temperature. If you remove the ware too soon, the sudden temperature change can crack the piece.

Annealing Flame-Worked Glass Beads in the Caldera

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

To safely cool flame-worked glass beads, anneal them in your Caldera kiln using the optional Caldera Bead Collar.



- 1 Remove the handle from the kiln bottom. Line up the holes in the bead holder (see above photo). Reinstall screws so that the bead holder is under the handle.
- 2 Place the Bead Collar between the kiln and the separate bottom. The kiln top should be in place.
- 3 **Digital Kilns:** 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 three hours, program a longer hold time in segment 1.

Segment	Rate	Temp.	Hold
1	1799°F / 999°C	1000°F / 537°C	03.00
2	400°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 three hours.

Manual Kilns: Fire the kiln with the switch on High. At 900°F / 482°C, lower the switch setting to Med. Then keep adjusting the switch to maintain a temperature of 1000°F / 537°C.

- 4 At 1000°F / 537°C, the kiln is ready to receive the bead mandrels loaded with hot beads. Allow a freshly finished bead to cool slightly before inserting. This is to help prevent the bead from flattening on one side when it is placed inside the kiln.

Open the bead door. Insert the mandrels as you complete the beads. Leave the door ajar with the end of the bead mandrel extending outside the kiln.

- 5 **Digital Kilns:** 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. **Manual Kilns:** Turn the kiln off and let it cool slowly.

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

Enameling in the Caldera

The Caldera Enameling Collar is necessary for firing enamel. The enamel pieces are inserted and removed through the side door of the collar.

How to Load the Caldera

- 1 Open the enameling door. Place several ½" (12.5 mm) posts on the floor of the kiln.
- 2 Lay a wire enameling rack on top of the posts. If the enameled piece is bare on the back, place the piece directly onto the rack. If the back of the piece is enameled, support the piece with a stilt on top of the rack.
- 3 Close the enameling door and fire the kiln. (See firing instructions, page 11.)
- 4 To remove the piece, turn off the power. Open the enameling door. Slide in an enameling fork and remove the enameling rack. Then close the door.



Place the Enameling Collar between the Caldera and the kiln bottom as shown.

Preparation of the Copper

Enamels come in transparent or opaque. They can be purchased directly from Thompson Enamel, P.O. Box 310, Newport, Kentucky 41072. Their Lead Free Enamels come ready to use: no enamel washing is needed.

Start with one of the many pre-shaped copper forms available, or shape and trim the copper to your own design.

- 1 Heat the copper on an enameling rack to about 1400°F / 760°C to burn off oil or grease. Heat the copper to just until smoke from oil or grease stops coming off the metal and its color has changed to a purple-red-pale green iridescence that moves across the copper. This indicates that the grease has vaporized. *Do not fire the copper any longer than this point.* Otherwise excess fire scale will form, making the next cleaning step difficult.
- 2 After the copper cools, brush any loose scale from the copper. Use a brush or paper towel, being sure that you do not put any grease or oil onto the copper, such as fingerprints. Clean the copper with a 3M Scotch-Brite® pad. This pad does such a good job that in most cases no further cleaning will be re-



quired. Additional copper cleaning products are available in the Thompson Enamel Catalog, including Sparex No. 2.

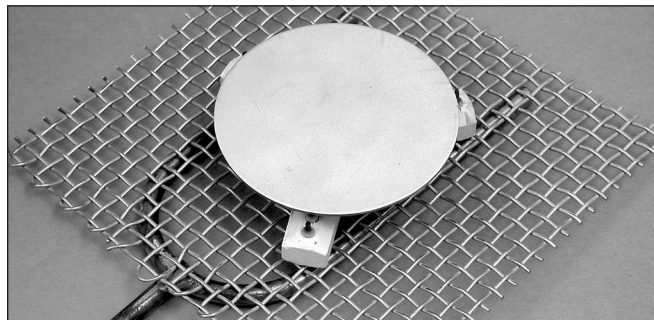
It is best to clean the copper just before you decorate it. If you wait too long to decorate after cleaning, the copper could get dirty again.

Decorating the Copper

Counter Enameling

Most enameled pieces should be counter enameled on the back side. This gives the piece a much more finished look, it eliminates a great deal of fire-scale cleaning, and it controls the chipping and cracking that can result from the different rates of expansion and contraction in copper and enamel after the enamel has been fired.

Counter or backing enamel, a mixture that gives a mottled effect, can be used for counter enameling. Or you can use regular enamel. Counter enamel is applied by the sifting method described next.



When firing counter enamel, underfire it so that the fire scale on the front of the piece isn't too difficult to remove. You can purchase a masking preparation from your supplier to help prevent fire scale. You must place the piece on a stilt when firing the other (front) side of the piece. The stilt prevents the back of the counter enameled piece from sticking to the enameling rack.

Applying Enamels

Apply enamel over a clean sheet of paper so you can pour the excess back into the bottle for reuse. Transparent enamels should be applied in several thin coats and can be mixed with fairly good results. If opaque enamels are mixed, however, a grainy effect results. The two basic methods of applying enamels are by sifting or by using a spatula.

Sifting Enamel

Spray or brush Thompson holding agent onto the copper. Then sift a 1/32" (.79 mm) layer of enamel onto the copper. Use a #60 mesh sifter. If the coat is too thin, you can easily

add another coat after firing. But a coat that is too thick will bubble and crack. The enamel must dry completely before firing.

Spatula or Inlaid Method

You can use this method to decorate a small area with many different colors. Using a diluted solution of Thompson holding agent, dampen the enamels just to the saturation point, and maintain this moisture while working with the enamels. Apply the enamels onto the copper with a small spatula, and spread them out with a spreader to a coat of about 1/32" (.79 mm) thick. Lines of contact can be formed by the spatula blade. Then spray the enamels with the holding agent to keep the grains of enamel in place. Allow the enamel to dry completely before firing.

Firing Enamel

1 Heat the kiln to 1450°F / 787°C for most enameling.

Digital kilns: Use a Single Segment. Please see your digital controller instruction manual.

Segment	Rate	Temp.	Hold
1	1799°F / 999°C	1450°F / 787°C	01.00

Note: Hold time should be the length of time you will be firing enameled pieces. In the above example, hold time is one hour.

Manual Kilns: Fire the kiln with the switch on High. At 1300°F / 700°C, lower the switch setting to Medium. When the temperature reaches 1450°F / 787°C, keep adjusting the switch to maintain that temperature.

2 Lay the copper shape on an enameling rack. If the part that touches the rack is enameled, place a stilt under the copper. Some bowls or other shapes have enameled sides that might run during firing. These should be fired with a stilt even if the piece has a plain bottom. Use an enameling fork to place the rack into the kiln.

Note: Firing should take about three minutes and requires undivided attention!

3 Look at your piece every 15 seconds by opening the Enameling Collar door.

4 When the copper piece appears a rosy red and the enamel is smooth, turn off the power to the kiln. Open the door and remove the enameling rack with an enameling fork. Close the door. Turn the power on if you want to make more enameling pieces.

5 Place the rack on a steel pad or ceramic shelf and let it cool completely.

6 After counter enameling, you will need to clean the fire scale off the front of the piece. A 3M Scotch Brite® pad works well for this. Then clean it with Thompson Sparex No. 2.

Ceramics

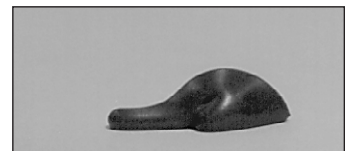
Pyrometric Cones

Pyrometric cones are small pyramids of clay and mineral oxide that soften and bend when exposed to heat. They indicate when ceramic ware has fired to maturity.

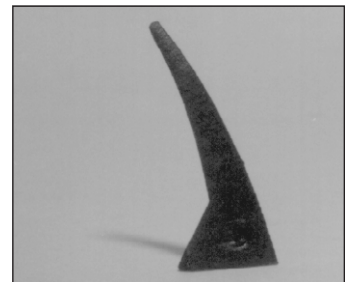
Pyrometric cones come in 1 1/8" (28.5 mm) and 2 1/2" (63 mm) lengths. Use the 2 1/2" (63 mm) cones. Cones mounted on the kiln shelf must be slanted 8° from vertical. They will not bend accurately if they are slanted to the wrong angle. Self-supporting large cones have the correct slant built into the base. Standard cones must be mounted in a clay or wire plaque.



A self-supporting cone fired to maturity. Do not be concerned if the tip is slightly higher or lower than shown.



A "puddled" over-fired cone.



An under-fired cone.

The chart on page 12 shows the temperatures of pyrometric cones.

Digital Kilns: Program your controller to the cone recommended for the ceramic ware that you are firing. Use Cone-Fire mode.

Manual Kilns: For small ceramic pieces, such as figurines, fire at a rate of about 400°F / 222°C per hour. Ceramic jewelry can be fired even faster. Fire to the temperature shown in the 108°F column of the Temperature Equivalents chart for the cone number you are firing. (See next page.) Before deciding on the firing speed of important pieces, test fire samples.

Viewing the Cones

Move the Caldera kiln top 1/2" - 1" (12.5 - 25 mm) to see the cone on the shelf. (Be sure to wear firing safety glasses and heat-resistant gloves.) Turn the kiln off when the cone bends to 6 o'clock.



Caldera: To look at the glass during firing, move the Caldera top slightly. Look inside the kiln for a second or two. Wear firing safety glasses and gloves.



FireFly: Lift the lid just enough to check on the progress of glass or pyrometric witness cones. Look for only several seconds at a time. Wear firing safety glasses and gloves.

°F Temperature Equivalents For Orton Self-Supporting Pyrometric Cones

Cone Number	Self-Supporting Cones			Pre-Fire Color
	Heated at: 27° F Per Hour*	108° F Per Hour*	270° F Per Hour*	
022	—	1087	1094	Green
021	—	1112	1143	Fuschia
020	—	1159	1180	Orange
019	1213	1252	1283	Yellow
018	1267	1319	1353	White
017	1301	1360	1405	Pink
016	1368	1422	1465	Light Blue
015	1382	1456	1504	Violet
014	1395	1485	1540	Gray
013	1485	1539	1582	Green
012	1549	1582	1620	Fuschia
011	1575	1607	1641	Orange
010	1636	1657	1679	Dark Red
09	1665	1688	1706	Dark Red
08	1692	1728	1753	Dark Red
07	1764	1789	1809	Dark Red
06	1798	1828	1855	Dark Red
05 1/2	1839	1859	1877	Dark Red
05	1870	1888	1911	Dark Red
04	1915	1945	1971	Dark Red
03	1960	1987	2019	Dark Red
02	1972	2016	2052	Dark Red
01	1999	2046	2080	Dark Red
1	2028	2079	2109	Dark Red
2	2034	2088	2127	Dark Red
3	2039	2106	2138	Dark Red
4	2086	2124	2161	Gray
5	2118	2167	2205	Green
5 1/2	2133	2197	2237	White
6	2165	2232	2269	Fuchsia
7	2194	2262	2295	Orange
8	2212	2280	2320	Yellow
9	2235	2300	2336	White
10	2284	2345	2381	Pink

*Rate of temperature increase during last 90 - 120 minutes of firing. Tables by courtesy of the Edward Orton, Jr. Ceramic Foundation.

Firing Overglaze

Overglaze is decoration applied over fired glaze or polished porcelain bisque. Overglazes include china paints, gold, and luster, which fire from cone 022 to 014.

Load overglazed ware the same way you would load ceramic glaze. Use stilts and make sure ware is not touching other ware. Ware must be completely dry before firing.

China paints will crack or peel if overglaze is applied heavily. Apply several light coats instead, firing between each, until you get the shade you want. Not all china paint colors reach maximum color saturation at the same temperature even when fired on the same ware. So you must know which colors you should fire first at higher temperatures to prevent burning out the original colors in later firings. For example, reds mature at a lower temperature than other colors and are fired after the other colors have been fired. Reds and yellows should not be fired side by side. Colors also mature at a lower temperature on ceramic pieces than on porcelain or hard china. Check the overglaze manufacturer's literature for the best cone to use with each color and type of ware.

Vent the kiln during the first hour of firing by placing a ½" (12.5 mm) post under the kiln top. Allow kiln to cool to room temperature before opening the kiln.

Firing Low Fire Greenware

Low-fire greenware has a firing range from cone 06 to 02. The greenware must be bone dry before firing. Otherwise, it will crack or even explode in the kiln. Check for dryness by touching to cheek or inside of wrist. Moist ware will be cold.

Low-fire greenware may be stacked so that it touches each other. It can be loaded without stilts. Load pieces directly on the firebrick bottom.

Ware should be fired in the position in which it will be used when finished, except for large pieces with flat, vertical surfaces such as wall plaques and clocks. These should be fired flat to prevent warping. Pieces to be used together should be fired in place, such as a box with its lid, to ensure a good fit.

Low-fire greenware firing is simple. Just be certain the greenware is fired to the pyrometric cone recommended by the clay supplier. If the greenware is not fired hot enough, the piece will absorb moisture after it has been glaze-fired causing the glazed surface to crack. This is called "crazing," and is most often due to underfired greenware. To help eliminate crazing, fire greenware at least one cone hotter than glaze, and even hotter if glaze can still be applied easily to the hard bisque. While glaze may be applied to greenware and fired once, separate firings produce better quality, so we do not recommend single firing of greenware and glaze.

Vent the kiln during the first hour of firing by placing a ½" (12.5 mm) post under the top. Allow kiln to cool to room temperature before opening.

Firing Low Fire Glaze

Low fire glazed ware must not touch each other, the floor, or a shelf in your kiln during firing. If this happens they will permanently bond together by melted glaze and be ruined.

Clean the firing chamber before each glaze firing. Wipe surfaces with a clean, damp cloth or vacuum with the soft brush nozzle attachment of a vacuum cleaner.

Use stilts to support low-fire glazed ware during firing. The shelf tops and kiln floor *MUST* be kiln washed with all purpose, high fire kiln wash for protection from glaze drops.

Glazed pieces must be thoroughly dry before firing and should not be fired with greenware unless both mature at the same cone. Check to make sure that first, no two pieces of glazed ware are touching each other, the kiln walls, the floor or the shelf; and second, that the underside of the kiln shelf is clean before you place it over glazed pieces. Any dust falling on your ware will cause pinholes.

You can prevent glazed pieces from sticking to the shelf or kiln bottom by “dry footing.” To dry foot a piece, remove all glaze from the portion of the piece that will rest on the shelf. Using a wet sponge or a piece of grit cloth, clean off the glaze from the bottom of the ware and slightly above the base so that it will not run down and touch the base. Dry footing should not be used for low-fire glazed pieces that will be placed in water while used or cleaned.

During the first hour of firing, vent the kiln by placing a ½” (12.5 mm) post under the top. Wait until the kiln has cooled to room temperature before opening the kiln.

Remove the stilts from the ware after firing by breaking the thin film of glaze holding them. Handle with caution; the glaze is sharp where the points touch. Remove the sharp stilt edges by rubbing with a stilt stone or electric grinder.

Firing Porcelain Greenware

Loading porcelain greenware is similar to loading glazed ware, since both will stick to anything during firing. Greenware must be completely dry before firing, including the joints on pieces that are attached. If a piece is broken before firing, mend the break but do not attempt to fire it until the mend is also bone dry. Damp greenware or damp mended areas will form bumps on the fired ware.

Stilts CANNOT be used to support porcelain greenware. They would embed into the porcelain. To protect porcelain from sticking to the shelves or kiln floor, apply a coat of high fire kiln wash to the shelf tops and brick bottom. Then place your ware directly on a kiln washed shelf.

Pieces of ware that are to be used together must be fired together, such as a box and its lid. Dry all purpose, high fire kiln wash can be used to separate these pieces during firing. Wet kiln wash would be too difficult to remove. Pieces likely to warp in firing should be supported by rolls of porcelain clay shaped to fit the objects at points of strain. Apply dry silica or high fire kiln wash to the points of contact to prevent sticking. Before firing, the support rolls must also be dry.

Since a kiln is slightly hotter near its sidewalls, the side of the ware next to the walls will tend to shrink more than the opposite side. This can be used to your advantage with porcelain figurines that tend to warp during firing. Turn the inclined side of the figure away from the elements so the heat can help hold the piece straight.

Make sure cones on the shelf are clearly visible. At porcelain temperatures, they are difficult to see. Vent the kiln during the first hour of firing by placing a ½” (12.5 mm) post under the top. Wait until kiln cools to room temperature before opening it.

Firing Porcelain Glaze

Porcelain pieces that have been fired together in the greenware firing *cannot* be fired together in the glaze firing. Both pieces *must* be dry footed. Since shrinkage has already occurred in the greenware firing, the pieces will still fit even when fired separately in the porcelain glaze firing. Stilts *must not* be used to support porcelain. Porcelain softens during firing, and stilts would embed into porcelain. Make sure your shelves and kiln bottom have a good coat of kiln wash before firing porcelain.

If a piece of ware had to be supported in the porcelain bisque fire, it will stand alone in the glaze fire. The lower temperature will prevent sagging.

Vent the kiln during the first hour of firing by placing a ½” (12.5 mm) post under the top. Wait until kiln cools to room temperature before opening the kiln.

Firing Stoneware Greenware or Glaze

Stoneware is made from vitrifiable clays with a firing range of cones 2 - 10. It has a wide range of colors and textures and is popular with the potter because of its excellent throwing qualities. Usually the greenware is fired below maturity, and on the second firing, the clay and glaze mature together to form an integrated body-glaze surface.

Like porcelain greenware, stoneware is placed directly upon the kiln-washed shelves in the greenware firing.

Glazed stoneware must not touch any other ware and must be dry footed before you place it on a kiln-washed shelf or kiln bottom. Never stilt stoneware during either firing.

Glaze Testing

Make batches of uniform clay shapes, such as circles or triangles. Each shape should have a smooth section and textured section. Glaze the test shapes. Prop them up vertically inside a dish and fire them. Keep detailed records in a glaze notebook. Save the test samples since they will become valuable later.

Silver & Gold Clay

With silver clay, it is possible to shape intricate, free-form silver jewelry in minutes—even as a beginner. (The clay is also available in gold; for simplicity we will refer to both metals as “silver clay.”)

Silver clay looks and feels like modeling clay. It is formed with simple tools such as a tooth pick, small knife, and razor blade. Its surface is pliable and accepts impressions from objects such as leaves, coins, and coarse fabrics. After the silver clay is formed, it is fired in a kiln. The recommended temperature and hold time are included with the silver clay.

Forming and firing silver clay is simple. There is nothing mysterious about making silver clay jewelry. The clay is made of micron-size silver (or gold) particles held in an organic binder. During firing, the binder burns away. The silver particles then fuse together forming real silver. Since the binder disappears, there is a certain amount of shrinkage during firing. Shrinkage varies depending on the type of silver clay you use.

Drying Time

Small, thin silver clay pieces can be placed into the kiln while they are still moist, and fired. Thicker pieces need time to dry. Otherwise they may warp during firing.

Note: To speed drying, use a hair dryer, or dry silver clay pieces near the kiln as it fires.

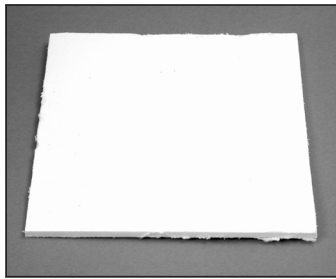
As a general rule, if the silver clay piece feels cool against the inside of your wrist, it is still wet.

Loading the Kiln

Silver clay pieces that have a flat side can be placed inside the kiln directly onto a soft ceramic fiber shelf.

- Silver clay pieces can be close together, but they must not touch.
- For more uniform heat, place ½” (12.5 mm) posts under the soft ceramic fiber shelf.
- Do not coat the ceramic fiber shelf with kiln wash or glass separator.
- You can also place the silver clay on a piece of ceramic fiber blanket, especially delicate rounded or hollow shapes that may need support to prevent collapsing.

If you are firing silver clay by itself on fireclay shelves, you do not need kiln wash. But if you combine the silver clay with glass, coat the fireclay shelf with kiln wash or glass separator.

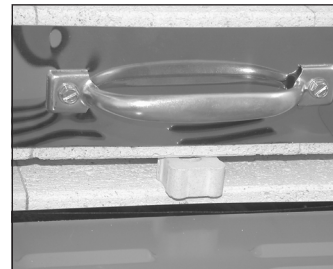


Place the clay silver on a ceramic fiber shelf, which has a soft surface.

Venting the Kiln

Silver clay by itself needs no venting. Load the kiln, lower the lid, and leave it closed until the clay silver is ready to remove.

The kiln needs venting if you fire ceramics with the clay silver, or if you make hollow objects that contain a core of organic materials. In those cases, vent the lid during the first hour of firing by placing a ½” (12.5 mm) post under the kiln top. When the venting is completed, remove the ½” (12.5 mm) post to conserve energy for the rest of the firing.



When firing cork clay, vent the top with the ½” (12.5 mm) post from the beginning until around 800 °F / 430°C. Hold for 1 hour. After the hold, remove the ½” (12.5 mm) post.

Caution: When venting materials such as cork clay, vent the kiln with a ½” (12.5 mm) post at the beginning of the firing. Starting the venting period later may cause the organic materials to flame up for a moment. Should this happen, close the top all the way so the flames can die out safely.

Note: Cork clay, cereal, pasta, and bread are good core materials. Do not use wax or styrofoam as a core. They emit harmful fumes.

Rate, Temperature and Hold

Each brand and type of silver clay fires at a specific rate, temperature, and hold time. This information is available from your silver clay supplier.

Select the heating rate that the silver clay manufacturer recommends if you are firing silver clay alone. If you fire glass or ceramics with the silver clay, select a rate best suited for the glass or ceramics.

You may also need a slower rate for hollow silver clay pieces that have core fillers to burn out. If the filler is completely enclosed, leave a small hole in the silver.

Note: Do not place hollow silver clay pieces that have a core filler into a hot kiln. The filler could flame up and crack the silver.

Note: It is okay to place silver clay pieces into a hot kiln (approximately 500°F / 260°C) provided the pieces are completely dry and do not contain other materials such as glass or stones. (Moist silver clay could explode or crack in a hot kiln.) Do not insert a fireclay shelf into a hot kiln.

After the kiln begins firing, leave the top closed. Do not lift the top until it is time to remove the silver clay. Visual inspection of the clay during firing is unnecessary.

On the other hand, if you are firing glass with the silver clay, you will need to check the fusing progress of the glass by moving the Caldera kiln top ½" (12.5 mm) or more and looking inside or by looking into the optional glass window. Look for just a second or two. As you gain experience, you will be able to program the correct temperature for the silver clay and glass combination, eliminating the need to visually check the glass.



Caldera: To look at the glass during firing, move the Caldera top slightly. Look inside the kiln for a second or two. Wear firing safety glasses and gloves.



FireFly: Lift the lid just enough to check on the progress of glass. Look for only several seconds at a time. Wear firing safety glasses and gloves.

Manual Kilns: Select the type of silver clay that has the shortest hold time. You will need to adjust the switch during the hold time to correct the temperature as it drifts.

Cooling Time

After the clay silver has fired to completion, you can lift the top an inch to speed cooling. If you are firing stones, glass, or other materials with the silver clay, it is safer to allow the kiln to cool slowly with the top down. Remove the piece when the kiln reaches room temperature.

Combining Silver Clay With Other Materials

There are two ways to fire silver clay with other materials such as glass. 1) Fire the silver clay first by itself. After you have cleaned and polished the silver clay, fire it a second time with glass. 2) Fire the silver clay and other materials, such as a stone, together in a single firing.

Glass is often fired with the silver clay in a single firing. Many types of glass, however, will melt at silver clay temperatures. If you are going to combine glass and silver clay in a single firing, test a small sample of the glass. To do this, fire the glass during a silver clay firing, keeping the glass separate from the silver clay piece (to avoid ruining the silver.)

Place the pieces on a ceramic fireclay shelf. You must coat the shelf with glass separator, or otherwise the glass sample will embed into the shelf. If the glass sample survives the firing, you can fire that type of glass with silver clay in a single firing. Note, however, that different types of glass fire to different temperatures.

Firing Mistakes

Silver Clay

Cracks that appear in fired silver clay may be due to too much water in the silver clay before it was fired. Another cause is careless handling of a dried, unfired piece. To repair, fill the crack with silver clay and fire again.

Brittle Silver clay will not reach full strength if underfired. You may be able to save the piece by firing again to the correct temperature and hold. Try firing the kiln 25°F / 14°C hotter or lengthening the hold time.

Too Much Shrinkage When silver clay is overfired, it shrinks too much and loses detail. If the kiln is firing hotter than the temperature programmed, check the position of the thermocouple. (See "Temperature is Inaccurate," page 16.) Replace the thermocouple if it is old.

Glass

Glass Cracking is caused by heating or cooling too fast or fusing incompatible glass. Not enough glass separator on the shelf can also cause glass cracking.

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

The second critical temperature range is annealing, which is the cooling range of 950° - 750°F / 510° - 398°C average. Cool the glass slowly through this range so the stress in the glass will have time to dissipate.

If you become impatient after the glass has fused and you tilt the kiln for a few seconds to peek inside, you may hear a "ping," which is the sound of glass cracking. Avoid the temptation to open the kiln. Wait 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 while it is still hot.

After each firing, examine the shelf. Recoat if the kiln wash is chipped. When glass sticks to a bare section of shelf, the glass may crack.

Glass Bubbles are often caused by heating the kiln too fast. Air, grease or dirt trapped between layers of glass can cause bubbles. Other causes are uneven glass volume, and moisture or air trapped between the glass and shelf.

Make sure the shelf is completely dry before firing. If you have applied fresh glass separator, leave the shelf in the kiln at 300°F/148°C for 20 minutes. Then allow the shelf to cool before placing glass on it.

One way to eliminate bubbles is to hold the temperature at 100°F / 55°C below fusing temperature for 15 minutes. This gives the shelf time to heat up to match the temperature of the glass.

Glass Separator Sticks To Glass when fired too hot. Instead of firing to a full fuse temperature, try firing 50°F / 28°C cooler and holding at that temperature for twenty minutes.

Ceramics

Overglaze

Breaking in Overglaze Firing can be caused by poorly fired bisque. A slow bisque fire is always better for ware that is to be china painted. The greenware should be completely dry *before* being placed in the kiln. Standing plates on edge or using a plate holder gives good heat circulation and will help in preventing plate breakage.

Peeling China Paint can be caused by applying the paint too heavily.

Loss of Color in China Paints is usually a result of overfiring, or thinning your paint with too much medium when applying.

Faded Colors in Overglaze Decals is the result of either underfiring or overfiring. If pinks and reds are drab, refire to a hotter cone. When used with a china paint background, apply and fire the decals first, then china paint and fire again. Check the recommendations of decal supplier. If decal was underfired, refire to proper firing cone. If decal was overfired, the design may be repainted in china paints and refired.

Weakening of Luster Colors can be due to overfiring.

Powdering of Luster Colors can be caused by too heavy an application.

Bisque

Warped Ware can be caused by distorting upon removal of the piece from the mold, firing too close to the elements, or firing a piece in an unnatural position.

Glaze

Crazing is usually caused by underfired bisque. Bisque should be fired to the highest temperature at which it will still take glaze. Crazed ware may be refired to the proper cone. *CAUTION: China paints and other overglazes will burn off when fired to 06.*

Crazing Immediately on Removing from the kiln can be caused by not firing the ware hot enough. Refire to the proper cone. Crazing in spots can be caused by not having mixed the glaze thoroughly before using.

Porcelain

Bumps in porcelain are usually caused by wet greenware and overfired porcelain bisque.

Lack of Translucency in porcelain can be caused by the ware being poured too thick and underfired.

Cracks in porcelain bisque are often the result of a strain on the greenware while drying. *Do not force-dry greenware.* Cracks may be mended with one of the new “magic menders” available from your supplier.

16/ **Monitor the kiln during operation.**

Kiln Maintenance

Trouble-Shooter

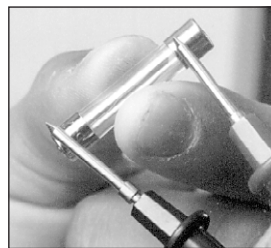
Kiln Does Not Turn On, Display is Blank

■ Make sure the circuit breaker is in the “on” position.

■ **Digital Kilns:** If the breaker is on, check the kiln’s fuse. It is located on the kiln’s switch box. Remove the fuse by pressing on the fuse holder and turning counter-clockwise half a turn. Check the fuse by placing the probes of an ohmmeter on the ends of the fuse. If the ohmmeter reads less than one ohm (digital meter) or reads 0 ohms (analog meter), the fuse is bad. Replacement fuse:

AGC ½ A 250V AC

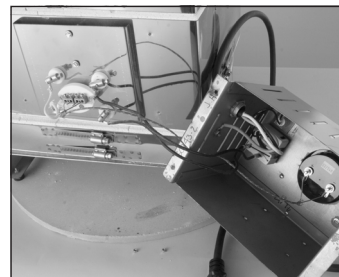
Note: If you do not have an ohmmeter, visually inspect the fuse. You will see a thin strand of unbroken wire in a good fuse. The wire usually appears broken in a burned fuse, like the filament in a light bulb.



Electric Circuit Breaker Trips

■ 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. The breaker may need replacing.

■ If the circuit breaker trips immediately after the kiln is turned on, the kiln may have a short circuit. Unplug the kiln. Open the kiln switch box and look for a loose wire touching the case.



Temperature is Inaccurate

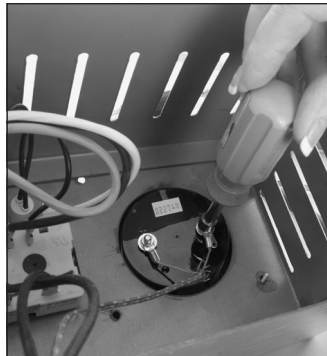
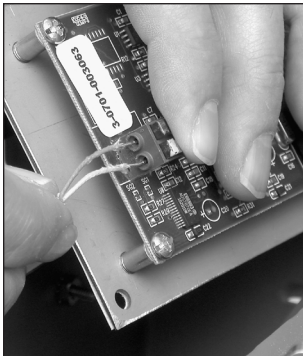
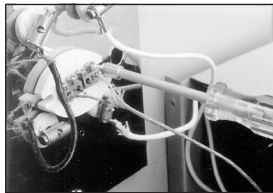
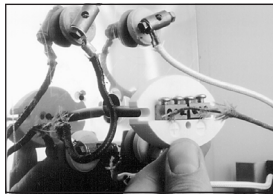
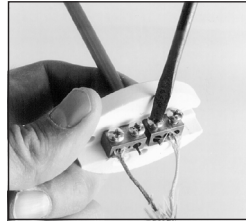
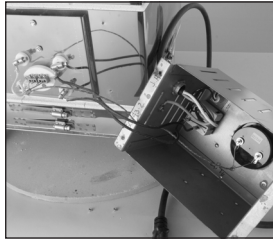
■ Make sure the thermocouple is pushed 1” or more into the firing chamber.

■ If the temperature is inaccurate even though the thermocouple extends into the firing chamber at least 1”, replace the thermocouple.



Replacing the Thermocouple

- 1 UNPLUG the kiln.
- 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 thermocouple from its firebrick hole. Loosen the screws holding the thermocouple to the ceramic block. Then remove the thermocouple.
- 4 Slide the new thermocouple into the thermocouple firebrick hole. The thermocouple should protrude into the firing chamber 1" (25 mm) or more. To adjust the thermocouple length, change the gap between the new thermocouple and the ceramic block. Follow the color coding. 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 **Digital Kilns:** Remove the controller faceplate from the front of the switch box.
- 7 **Digital Kilns:** Remove the two 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. **Manual Kilns:** Remove the two thermocouple wires from the back of the pyrometer.

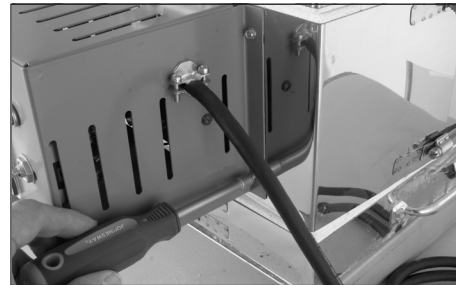


- 8 Strip 1/2" (12.5 mm) of insulation from the ends of the new thermocouple wires. Be sure the wire ends are separated where the insulation has been stripped. If bare ends touch, the thermocouple will not work properly.
- 9 Attach the wires to the back of the controller or pyrometer. One wire is yellow, the other red. Make sure the wires connect to the correct terminals, which are color coded. Reinstall the controller 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.

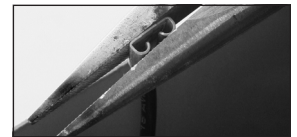
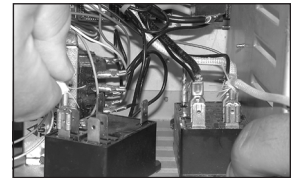
Replacing a Relay Or Transformer

(Digital Kilns Only)

- 1 UNPLUG kiln.
- 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 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.

Note: If you are replacing the transformer, examine the new one to make sure the jumper wire is properly wired for your kiln's voltage. (See the kiln's wiring diagram.)

- 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 switch box into place and reinstall switch box screws.

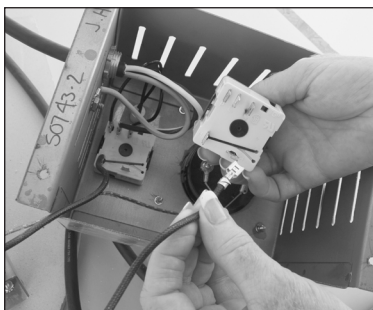
Replacing a Switch Or a Caldera-S Pyrometer

(Manual Kilns Only)

- 1 UNPLUG kiln.
- 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 **Switch:** Pull off the switch knob with fingertips. Hold the new switch at the side of the switch box in the same position as the defective switch, aligned in the same direction. Remove and transfer one wire at a time from the old switch to the new one. Make sure each connection is tight. 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. (See photo, bottom of page 17.)



Remove the single nut from the front of the defective switch. Remove the switch and put the new one in place making sure it is right side up. Reinstall the shaft nut checking to be sure it is not backwards. Tighten the switch so that it will not turn during operation.

Pyrometer: Remove the thermocouple wires from the pyrometer and the four 7 mm nuts holding the pyrometer in place. Install the new pyrometer. The



red wire attaches to the negative terminal, the yellow to the positive.

- 3 Check to see that wires are not touching kiln case or the element connectors. Wires touching element connectors or the kiln case will burn. Move switch box into place and reinstall switch box screws.

Replacing the Temperature Controller

(Digital Kilns Only)

- 1 UNPLUG kiln.



- 2 Remove the four corner screws holding the controller faceplate to the switch box. Carefully lift out faceplate.
- 3 Disconnect all the wires from the back of the board. You will find two plugs and two single wires.
- 4 Connect the wires to the new board. Reinstall faceplate.

Reseating a Bulging Element

To push a bulging element back into the groove, first heat the 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:

- 1 UNPLUG the kiln. 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.

- 2 With a pair of long nosed pliers, 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 will be pressed tightly enough to touch.

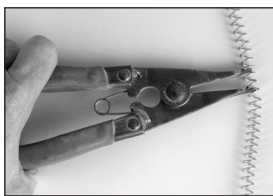


- 3 As the element shrinks, work it back toward the groove and into place. Work rapidly, and at the first sign of stiffness in the coils, stop bending and reheat the element. The elements do not have to be red to be bent safely, as the stiffening can be felt through the pliers.

These photos show how to shorten and lengthen an element. Use needle nose pliers to shorten; snap-ring pliers to lengthen.



- 4 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.



A closeup of snap ring pliers expanding the element coils.

- 5 When you have the coils positioned above the dropped recess in the grooves, press the element into the groove with a blunt kitchen knife.

Note: Do not use a plastic object, such as a comb, to press the hot element into the groove. Melted plastic ruins elements.

Replacing An Element

Paragon replacement elements are stretched to the proper length for the Caldera and FireFly 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.

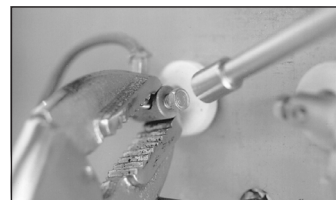
- 1 UNPLUG the kiln and allow to cool to room temperature. Place the kiln on a table at a comfortable working height. Caldera: Remove the top. FireFly: Open the lid.



- 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 screws in the element connectors that hold the element lead wires to the element you are replacing.

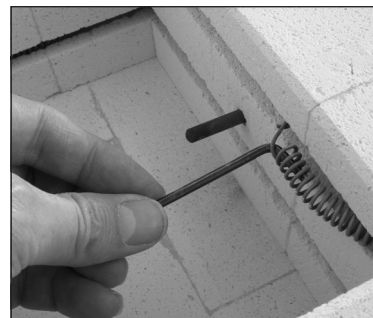


Hold the element connector with locking pliers when removing and installing the connector. Note the porcelain insulator behind the element connector.

- 4 On the same connectors, loosen the screws that hold the element and throw 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 Remove the old element carefully to prevent breaking the lip of the element grooves. Begin to push one end of the element into the firing chamber. Before the element touches the groove, lift the element up and guide it out of the groove using the short section of an allen wrench. After that, the rest of the element usually comes out of the groove effortlessly.



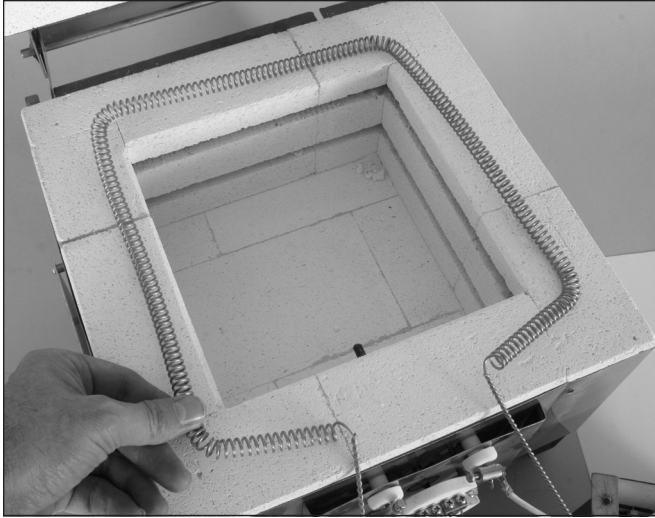
If the old element burned out due to contact with foreign materials, there will probably be a melted, glazed spot in the element groove. Glazed spots left in the grooves may ruin the new element, so dig out any of these spots. The small hole left in the groove will not affect the new element. Remove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

Changing an element in a small kiln seems difficult because of the limited working space. But as with most jobs, there is a way to simplify the task. The secret is first to bend the element where it will fit into the firebrick corners. Do this before you install the element. No tools are needed to bend the element. (See photo, top of next page, left column.)

- 7 Place the new element on top of the kiln walls. In that position, align an element end with one of the holes where the element enters the firing chamber. (The holes are behind the porcelain insulators and element connectors you removed in steps 4 and 5.)

- 8 Bend the element with your hands where the element aligns with the first groove corner. Continue making the bends for the other three corners.

- 9 The other end of the element should line up with the second element hole. Stretch or compress the ele-



Bend the element at the corners before installing it. You can tell where to bend the element by placing it on top of the kiln as shown above.

ment coils with your hands, if necessary, to make the element reach the second firebrick hole.

- 10** As you will see, once the element is bent for the corners, it installs easily even in a small kiln. Thread the new element into an element hole. The element must fit all the way into the back of each corner.

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

- 11** Press 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 stainless steel kiln 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 insulation on old ones is brittle.) Use the brass screw to connect lead wire eyelets to the new element connectors. Before tightening screw, adjust eyelet to where it will be tilted away from heat shield when connector is attached to element. Then hold connector with locking pliers and tighten brass screw securely with a 1/4" nutdriver.

- 14** Pull end of element tight and install new element connectors snugly against porcelain insulators to

prevent insulators from slipping away from brick wall.

Use stainless screw in the element connector to hold the element. (The brass screw holds the lead wire eyelet.) Hold connector with locking pliers as you tighten the screw with the 1/4" nutdriver. Tighten the screw to 30 inch pounds (about 1 1/4 turns past the point of firm resistance).



Hold the element connector with locking pliers when removing and installing the connector.

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



Tighten the element connectors according to step #14. Then cut off the element ends.

- 16** As you move the switch box back into place, check to see that no wire touches an element connector. Wires must also not touch kiln's case inside the switch box. Wires will burn if they touch the case or element connectors. Reinstall screws in switch box and tighten.

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