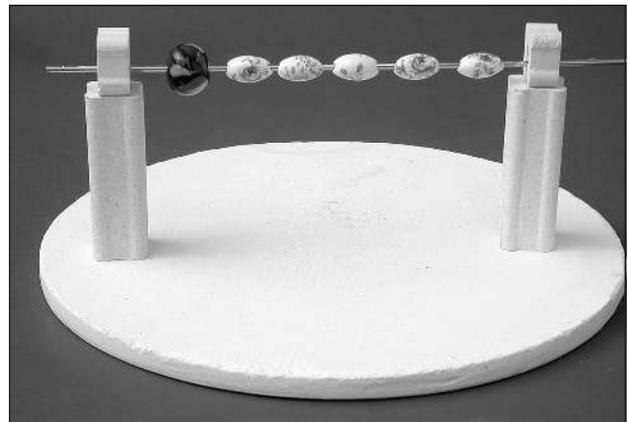
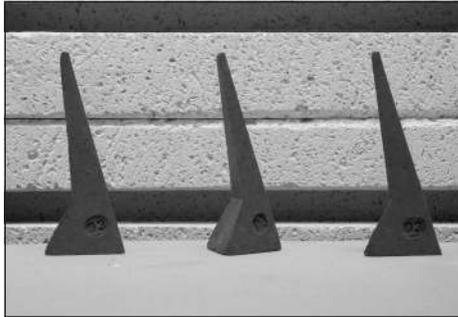


# Paragon Ceramic Kiln Instruction & Service Manual



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



---

**The First  
Firing—  
See page 29**

---

# INTRODUCTION

Thank you for purchasing a Paragon kiln. We are confident that the kiln will give you many years of relaxation and creative enjoyment. Before using your kiln, read the manuals that came with it. They will save you many hours as you learn about your kiln. The more you know about your kiln, the more you will enjoy it and the longer it will last.

**This manual does not cover the digital controller or the Kiln Sitter and switches. They are covered in a separate manual included in your instruction packet.**

In the instruction packet for your kiln, you should find a copy of “Safe Installation of the Electric Kiln,” “Firebrick Maintenance,” and a manual that covers your kiln’s control system. Please contact the factory if you do not have copies. You can also find them at [www.paragonweb.com](http://www.paragonweb.com). Select “Support” and then “Instruction Manuals” from the drop menu. The manuals are listed alphabetically.

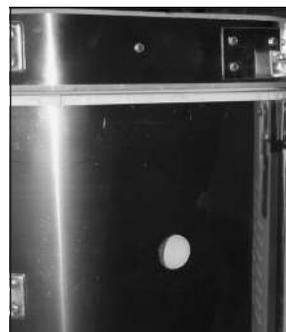
At [www.paragonweb.com](http://www.paragonweb.com) select “Products,” then “Books & DVDs” from the drop menu. The books we recommend will enhance your kiln experience. You can also email or phone us with questions. We are glad to help.

At [www.paragonweb.com](http://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.

**Even though your Paragon kiln may be designed to shut off automatically, check the kiln before the expected shut-off 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.**

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.

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 stresses. Since the insulating firebricks expand and contract with each firing, hairline cracks will appear in the bricks 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 bricks expand. 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 survive for many years.



Please do not be concerned with the line of light that appears around the lid. It is normal.

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.

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. And the infinite switches of manual kilns make a clicking noise too. You will also hear the elements hum. This is only the sound of element coils vibrating in their brick grooves. Once you become familiar with these sounds, you may find them a reassuring indication that the kiln is firing normally.

If you call us about your kiln, please have the model number, part number (P/N), and voltage from the kiln’s electrical data plate handy. (The plate is on the side of the switch box.) Write that information here for quick reference:



P/N \_\_\_\_\_ SN \_\_\_\_\_ Model \_\_\_\_\_ Volts \_\_\_\_\_

Thank you again for purchasing a Paragon kiln. We wish you many years of relaxation and creative enjoyment with your new purchase! 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 ceramic skills to a new and exciting level.

# CONTENTS

<b>Introduction</b> .....	<b>2</b>	<b>Firing The Kiln</b> .....	<b>25</b>
<b>Contents</b> .....	<b>3</b>	The Stages of Firing .....	25
<b>Important Safety Rules</b> .....	<b>4</b>	When to Speed Up the Firing .....	25
<b>Setting Up</b> .....	<b>6</b>	Venting .....	26
Setting Up The Stand .....	6	Cooling .....	27
Attach the Lock-In Lid Support .....	6	The Basics of Firing .....	28
Where to Locate Your Kiln .....	6	The First Firing in Your New Kiln .....	29
Seating the Elements .....	7	Loading and Firing Low-Fire Greenware .....	30
Cleaning the Kiln .....	8	Loading and Firing Low-Fire Glaze .....	30
<b>The Electric Circuit</b> .....	<b>8</b>	Loading and Firing Overglaze .....	31
Electrical Shutoff .....	8	Loading and Firing Ceramic and Glass Decals .....	32
Circuit Breaker Panel .....	8	Loading and Firing Porcelain Greenware .....	32
Circuit Wire .....	8	Loading and Firing Porcelain Glaze .....	33
Voltage Affects Firing Time .....	9	Loading and Firing Stoneware Greenware or Glaze .....	33
Check the Electrical Installation .....	9	<b>Imperfections</b> .....	<b>34</b>
<b>Preparing The Kiln</b> .....	<b>9</b>	General .....	34
Kiln Features .....	9	Bisque .....	34
Monthly Kiln Maintenance .....	10	Glaze .....	34
<b>Pyrometric Cones</b> .....	<b>11</b>	Underglaze .....	35
Cone Numbers .....	11	Overglaze .....	35
Heat Work .....	12	Porcelain .....	36
Using Cones .....	12	<b>Kiln Maintenance</b> .....	<b>36</b>
Pyrometric Cone Charts .....	12, 13	<b>Note:</b> 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."	
How to Position Cones on the Shelf .....	14	How to Open the Switch Box .....	36
Using Cones in Digital Kilns .....	15	Preventive Maintenance	
The Bending of the Cone .....	15	Inside the Switch Box .....	37
<b>Firing Accessories</b> .....	<b>16</b>	Element Maintenance .....	37
<b>Preparing To Fire The Kiln</b> .....	<b>17</b>	Firebrick Maintenance .....	43
Vacuuming the Kiln .....	17	Tightening the Lid Band .....	45
Drying Greenware .....	18	Adding a Steel Base Plate .....	45
Shelf Preparation .....	19	Replacing the Steel Base Plate and Turning Over the Bottom .....	45
<b>Loading The Kiln</b> .....	<b>21</b>	<b>Glossary</b> .....	<b>47</b>
How to Store Kiln Furniture .....	21	<b>Index</b> .....	<b>Back Cover</b>
Guidelines for Loading the Kiln .....	21		
Distances Inside the Kiln .....	22		
Glazed Ware .....	23		
Heat Distribution Inside the Kiln .....	23		
How to Position Posts .....	24		
Bead Rods .....	24		
Firing Large Ware Across Half Shelves .....	24		
Tile Holders .....	24		

"Pottery, as you know, is frustrating. But we could not fully enjoy success if we did not experience failure. The whole experience is profound."

—Steve Burt

# 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 GLAZES

**Some glazes may not be designed for surfaces that will be in contact with food or drink. When you make food or drink containers, select a glaze that has been formulated, tested, and labeled as approved for surfaces that will be in contact with food or drink. Follow the glaze manufacturer's instructions exactly, without any variations. Have custom glazes tested for food safety by a lab such as Alfred Analytical Laboratory. You can learn more about glaze safety in *Mastering Cone 6 Glazes*, by John Hesselberth and Ron Roy.**

## Insurance Companies

If your insurance company ever inspects your kiln room, tell the inspector that you follow the safety and installation guidelines shown next. What insurance companies 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.

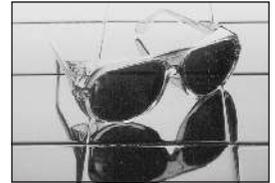
*“Centering the clay has a way of putting me into that altered state where time doesn’t happen.”*

*—Millie Carpenter*

## Important Safety Rules

Following these safety pointers will add little extra time to your daily routine. There is little danger of 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" from any wall or combustible surface.
- Fire only in a well ventilated, covered, and protected area.
- Do not open the lid until kiln has cooled to room temperature and all switches are off.
- Dangerous voltage: do not touch the heating elements with anything.
- Disconnect kiln 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.
- Wear firing safety glasses when looking into a hot kiln.
- 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.
- 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.
- Never place anything on the kiln lid, even when the kiln is idle. 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.



- Wear gloves when you load and unload your kiln. The gloves should be thick enough to protect you from glaze shards and bits of pyrometric cones that have stuck to shelves, sharp edges of broken ware, and sharp stilt marks on the bottom of glazed ware. Razor-sharp glaze fragments can be so small that they are difficult to see.



- Do not remove the ware from the kiln until the kiln has cooled to room temperature. It is possible for thermal shock to break hot ceramic pieces. The sharp edges of broken ware can injure hands.
- After firing glazed ware in your kiln, examine the shelves for glaze particles. Sharp slivers of glaze stuck to the shelf can cut hands. Before rubbing a hand over a shelf, be sure the shelf is free of glaze shards.
- Fire only approved materials purchased from a knowledgeable supplier. Do not fire marbles, pieces of concrete, rocks, and other objects. Rapid heating to high temperature can cause violent reactions in many materials.
- Avoid firing toxic materials such as moth balls inside the kiln. Moth balls create toxic fumes inside a kiln and can even explode.

- Never fire tempered glass inside a kiln. It could explode.

- Greenware, which is unfired clay, must be bone dry before firing. Moist greenware can explode inside the kiln, damaging the ware and the kiln. Place a piece of greenware against the inside of your wrist. If it feels cool, it is too wet to fire.



- Do not fire cracked shelves. They can break during firing, damaging the ware inside the kiln.
- 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.
- 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 away.
- Keep a Class C fire extinguisher and a smoke alarm in the kiln room. Mount the extinguisher near the door to the room.
- Do not breathe brick dust, kiln wash, 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.
- Only vitrified ware should be used in a microwave oven. (Vitrified clay has been fired to a point where the particles become glass-like and no longer absorb water.) Non-vitrified clay such as earthenware is generally not suitable for microwave use, because the clay absorbs water. The water in the pores of the clay can expand rapidly enough in a microwave to cause the ware to crack or even explode. Ware that has been decorated with metallic glazes should not be used in a microwave oven.
- 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."

## How to Avoid an Over-Fire

Suggestions by Mel Jacobson, Potter

- 1 Use an alarm clock. I use the old wind-up kind with a loud ringer. Set it for a certain time, and make sure you follow the ring. Place a small battery-operated oven timer in your pocket if you need extra reminders.
- 2 Get a large bulldog clip and paint KILN in red. Clip it to your jacket, or hang it from a doorknob. Or place a sign where you hang your apron: KILN ON.
- 3 When I was a high school teacher, I had the janitor turn off the master breaker to the kiln every night at 8. No kiln would ever be on past 7, ever, anyway.

# SETTING UP

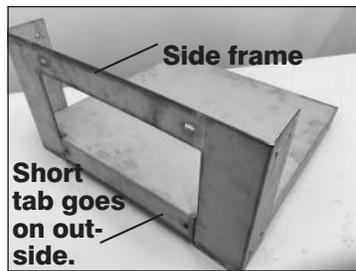
## Setting Up The Stand

Operate your Paragon kiln only on the stand provided. (Sometimes people buy used kilns that are missing the original stand and place the kiln on cinder blocks or bricks. This is not a good idea, because bricks may inhibit the flow of air under the kiln. Cinder blocks could also change the kiln's heating characteristics.)

We recommend that you wear tight-fitting gloves such as mechanic's gloves while assembling the stand.

You will find 2 shelves, 2 side frames, and a bag of nuts and screws in the stand kit. The shelf with the hole in the center is a top shelf. The solid shelf goes on the bottom. The side frames have bottom mounting holes for casters.

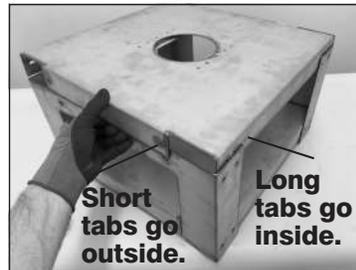
- 1 Insert a short tab from the solid shelf into a side frame. The tab goes on the outside of the side frame.



The short bent tab goes on the outside of the side frames.

- 2 Repeat Step 1 for the other side frame.

- 3 Lay the top shelf (the one with the hole in the center) over the side frames. The short tabs go on the outside of the side frames. The long tabs go on the inside of the side frames.



The long bent tabs go on the inside of the side frames. The short bent tabs go on the outside.

- 4 Insert the screws and nuts.
- 5 Install the casters. You can leave off the casters if you want to make the stand shorter.

**Caution:** You **MUST** lock the casters before placing the kiln on the stand.

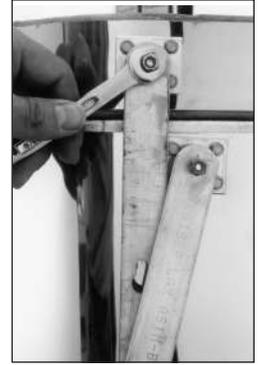
## Install the Orton Vent Cup

Skip this step if your kiln does not have an Orton Vent.

- 1 Attach the hose to the vent cup with the clamp that came with the Orton Vent.
- 2 Slide the vent cup up inside the stand and into the flange supports in the top shelf. Rotate the vent cup a little as you slide it into the flange supports.
- 3 Place the gasket that came with the vent over the vent cup.

## 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.



## Where to Locate Your Kiln

In addition to these guidelines, please see "Safe Installation of the Electric Kiln," a separate publication shipped with your kiln.

- Plan your firing area near a present electrical outlet or where a new circuit can easily be installed.
- Place your kiln in a well-ventilated, covered, and protected area such as the garage, basement, storage building, utility or ceramic hobby room.

**Caution:** The fumes from ware fired in a kiln can corrode metal and etch windows. If you are installing your kiln in a living area such as the basement or in the garage, it should be vented with a motorized vent. Please see "Safe Installation of the Electric Kiln."

**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.
- Never allow the room temperature of your firing room to exceed 100 - 110°F. (Room temperature is the temperature measured three or more feet away from the kiln.) If necessary, use a fan to move the heat away from the kiln's switch box.
- Electrical components such as switches, the digital controller, relays, and wiring last longer when they stay cool. The easiest way to lower the temperature of a kiln's switch box is to blow air into the side louvers with a fan. It does not need to be a large fan; one with 4" - 8" diameter blades on low speed is effective. The air should go in one side of the switch box and out the louvers of the other side. Do not allow air to blow into the kiln through the peepholes or lid.



Lower the switch box temperature with air movement. This is especially useful during hot summers.

- Provide a minimum of 12" clearance between the kiln and the closest wall.
- 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.
- Place the kiln in an area where it can be easily loaded and unloaded yet out of the way when not in use. For convenience in moving the kiln when not in use, consider the reinforced, deluxe stand with casters.
- Keep unsupervised children 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. If you use a fan to lower the temperature of the switch box, position the fan so that the air blows into the

switch box louvers but not onto the firing chamber case.

## Installing the Kiln in an Institutional Setting

Sometimes maintenance employees are not familiar with kilns. For this reason you might want to place a sign on top of the kiln when the kiln is not in use:

**Do not stand on the kiln.**

**Do not move the kiln.**

**Do not place anything on top.**

(Reminder: Remove any signs from your kiln before you fire it.)

Place a sign on the door of the kiln room: Kiln is Firing.

Every year hold a short kiln orientation session for the maintenance staff. You could also send the same information by e-mail to the school principal and the maintenance department. Explain the following:

- 1 The kiln is fragile.
- 2 During operation, the kiln makes a clicking noise. This is normal.
- 3 If you use a temperature alarm on your digital kiln, explain the beeping noise. Otherwise it will frighten students and maintenance people because they will assume that something is wrong.

## 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 the kiln before touching an element with anything.

**Caution:** 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 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.



**Note:** 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

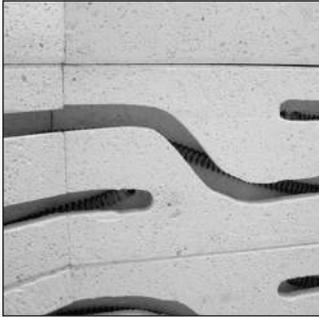


Expanding coils with automotive snap-ring pliers.

coils just a little where the element fits into the wall brick corners. It 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. In fact, elements will not lie flat in their terminal bricks (right behind switch box).

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 38.



As shown here, new elements do not lie flat in a curved groove.

## Cleaning the Kiln

Clean your kiln before firing. Use a vacuum cleaner (preferably with a soft brush nozzle) to remove brick dust from inside the kiln, especially from the grooves. A damp cloth or damp sponge may also be used to gently wipe dust from the sidewalls and brick bottom. Clean the kiln again whenever you notice dust inside.



**Note:** Vacuum the kiln with a HEPA filtered vacuum cleaner or a central vacuum that takes the dust outside. Keep the vacuum hose away from the controller on digital kilns.

*"What is it about that meditative quiet when kids are working with clay? I teach 3rd, 4th and 5th graders in a very poor neighborhood, and even the toughest 5th grader will let down his 'cool and tough' act for clay."*

—Grace Sheese

# 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 a qualified 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.

## Electrical Shutoff

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' of the fuse or circuit breaker panel. For every additional 50' from the panel, increase the circuit wire size by one gauge.

But do not place the kiln right in front of the electrical panel. Keep the panel at least 3' - 4' 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.

**Note:** 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.

**WARNING:** Changing the cord plug on Paragon kilns 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 worse than copper and require greater installation care. Avoid using extension cords.

The Paragon kiln catalog and website show recommended breaker and wire sizes for the circuit. (These recommendations assume that the circuit is dedicated, which means that it powers only the kiln and no other appliance.) Local codes supersede our catalog recommendations.

You may already have a heavy-amperage circuit conveniently located where you will keep your kiln. But do not assume that the circuit is the correct size. Clothes dryer circuits are too small for most studio kilns. Even if you have the correct wall outlet, you should verify that the wire and breaker sizes are also correct.

## Voltage Affects Firing Time

Voltage fluctuation can vary the firing time for a given pyrometric cone from as little as one half to more than twice the average time. If the voltage is too low, the kiln will never reach full temperature. This can be corrected only by having the utility company adjust the voltage. (However, 208 volts cannot be adjusted to 240 volts, and vice versa.)

## 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.

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 in the Paragon factory.

# PREPARING THE KILN

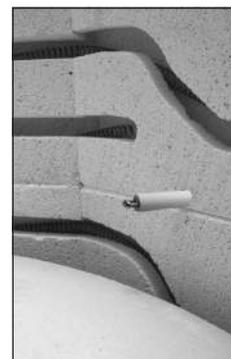
## Kiln Features

### Kiln Firebricks

Premium, hand-selected insulating refractory bricks are lightweight, porous, and precision cut to fit tightly and store heat in the walls, bottom, and lid. The form-fitted jacket snugly holds the bricks together. Because the firebricks store heat so efficiently, the cost of electricity to fire the kiln is surprisingly low. Kiln brick is extremely fragile and will chip easily; always handle your kiln and its brick with care. Never let a shelf bump against the firebrick. Firebrick damage is not covered by warranty.

**Note:** Allow only trusted people to load and unload your kiln. Beginners may not understand that the firebricks are fragile.

The temperature required for ceramics is well above the melting point of most metals, and tremendous stresses are generated during the firing. The insulating firebricks expand and contract with each firing. In time, cracks will appear in the brick while the kiln is cold. This is normal and will not affect your kiln's operation.



### Heating Elements

The heating elements in your Paragon kiln are heavy duty for long life. All high temperature, heavy duty elements are quite brittle after being heated to a high temperature and will break if bent while cold. By heating to a dull red glow with a propane torch, an element may be bent safely.

Never allow glaze, glass, silica sand, kiln wash, or other foreign materials to touch the elements since they will destroy the element when the kiln is fired.

### Peepholes

Large peepholes (view ports), tapered for a wide view without heat loss, are used for observing the progress of your firing so you can see when the pyrometric cones bend. Use at least one large cone on the shelf during every firing—even in a digital kiln. With venting as their secondary function, peepholes allow oxygen to be drawn into the kiln's chamber and serve as an escape passage for smoke and water vapor.



When looking through the peepholes, always wear firing safety glasses, which are available from Paragon. They

## Monthly Kiln Maintenance

- 1 Make sure the kiln is centered on the stand and that the stand is stable. Check the area around the kiln and remove flammable materials that have accumulated.
- 2 Vacuum the kiln with the soft brush nozzle of a vacuum. (You can use a hard plastic nozzle as long as you don't touch the bricks with it.) Remember to vacuum the brick grooves. If you have difficulty removing debris inside the grooves, use a narrow wand-type vacuum cleaner nozzle being careful not to scrape the brick walls. (See page 17.)
- 3 Vacuum around and under the kiln: floor, shelves, and walls. This keeps the kiln interior cleaner and adds life to the option vent motor.
- 4 Check the kiln wash on shelves and kiln bottom for cracks and bare spots in the coating. Remove any glaze drips. Reapply kiln wash if needed. (See page 19.)
- 5 Check the power cord and outlet for heat damage. Has the cord touched the side of the kiln during firing? This will damage the cord insulation. Replace the cordset or wall outlet that shows signs of heat damage.
- 6 Make sure elements are not bulging out of the grooves. Repair if necessary. (See page 38.)
- 7 Kiln Downdraft Vent: Check the vent duct for leaks. (See page 26.)
- 8 Digital kilns: Make sure the thermocouple extends far enough into kiln:

1/4" diameter thermocouple: 1" into the kiln

1/8" diameter thermocouple: 5/8" into the kiln



protect your eyes from the bright glare of the firing chamber and make it easier to see the cones at high temperatures.

Peephole plugs are used to stop air from entering the kiln, not to prevent heat loss. It is beneficial to have some air entering the kiln at all times, so it is not necessary that the plugs fit tightly.

You can leave the peephole plugs out for some firings. This improves oxygenation inside the kiln. However, this may cause cold spots in the kiln, especially if there are air drafts in your firing room. If you leave the peephole plugs out, keep ware at least 3" from the peephole. If your ware develops problems from cool air drafts, such as a glazed piece with a crazed spot, insert the peephole plugs after the kiln reaches 1000°F (537°C), or about half way through the firing. If you use a motorized downdraft Orton Master Vent, keep peephole plugs inserted and the lid closed all the way for the entire firing.



Wear firing safety glasses when looking through a peephole into a hot kiln.

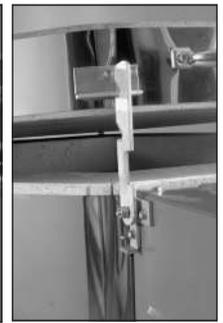
### Prop-R-Vent



Leave the lid closed if you have a motorized downdraft vent.



The Prop-R-Vent in the first position.



The Prop-R-Vent in the extended position.

Ceramic pieces release gases and water vapor during firing. Venting allows these gases to escape. Paragon's fall away Prop-R-Vent is installed on the switch box of most top-loading kilns. The prop supports the lid in an open position during the venting period. The Prop-R-Vent vents the lid in two stages.

To close the lid after venting, lift the lid handle an inch to let the Prop-R-Vent fall. Lower the lid gently; warranty does not cover damage to the kiln or the ware due to a dropped lid. For lusters and overglazes, engage the Prop-R-Vent in its second position for additional venting. Do not rush the cooling of your kiln with the Prop-R-Vent. This can damage your ware.

Do not drop the lid. Some people touch the lid handle for the first time to lower the lid from venting and drop the lid because the handle is hot. Use a heat-resistant glove or a lid lifter (sold by Paragon) to lower the lid.

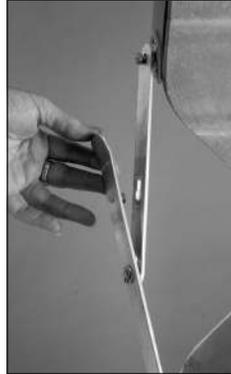
## Full-Formed Steel Base

The galvanized steel base under the brick bottom strengthens the kiln. It covers the entire bottom from edge to edge.



## The Lid Support

Your kiln has either the lock-in lid support or the LiteLid spring counter-balance. Please do not let unattended children raise the lid. Do not let the lid drop. It is fragile and must be lowered gently.



Do not exert downward pressure on the lid until the lock-in lid support is completely disengaged.

Do not exert downward pressure on the lid until the lock-in lid support is completely disengaged.

Keep the kiln lid 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.

## The LiteLid Support

1 Begin raising the lid using the center lid handle. When the lid feels weightless, hold a side lid handle with your other hand to guide the lid the rest of the way up.



2 Do not let go of the side lid handle until the lid reaches its fully opened position. Otherwise the lid could slam upward, damaging the firebricks near the hinge. (Please note: This type of damage is not covered by warranty.)

The LiteLid spring can pinch fingers. Please keep unattended children away from the kiln.

3 Stay clear of the lid when raising or lowering. This is to prevent injury should the lid drop.

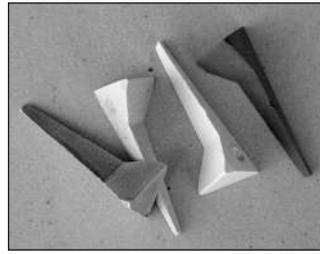


Do not let go of the side lid handle until the lid reaches its fully opened position.

## Dust-Free Refractory Coating

The dark coating on the lid, the top rim of firebricks, and in the peepholes reduces dust and hardens the firebrick surface for longer life. Though it will lighten after the first firing, the coating will last for several years.

# PYROMETRIC CONES



A selection of self-supporting cones. See the cone charts on pages 12 and 13 for a list of cone colors.

Ceramists of early times judged when the firing was completed by the color of the kiln interior and the length of firing. In 1886, a German ceramist named Seger made clay cones that bent when the ceramic ware received the proper heat work. He positioned the cones on a shelf inside the kiln. By looking through a peephole, he

could see the cones bend and knew when to turn off the kiln. His cones took the guesswork out of firing.

Today we still use Seger's cones. They are called pyrometric cones and are small pyramids of clay and mineral oxide that soften and bend when exposed to heat. They indicate when your ware has fired to maturity. When consulting your dealer with a glaze problem, you should have a bent cone from that firing. The cone will help trouble shoot the problem. The cone lets you compare one firing to the next. Cones are manufactured by the Orton Ceramic Foundation and are available from your distributor.

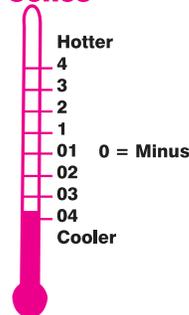
## Cone Numbers

The most confusing thing about cones is the way they are numbered. They are easier to understand when you know the reason behind the numbers. Pyrometric cones are numbered from 022 through 01 and 1 through 10. Cone 022 matures at the lowest temperature, and 10 matures at the highest.

Seger numbered his original cones from 1 to 20, with 1 being the lowest temperature. Later, cones of even lower temperatures than cone 1 were needed. To avoid changing all the cone numbers, the new numbers started with "0" and went from 01 to 022, with higher numbers getting progressively cooler.

To avoid confusion, mentally replace the "0" with a minus sign. Numbers without the "0" are positive. The higher the positive number, the higher the temperature. Numbers with the "0" (or a minus sign) are negative. The higher the negative number, the lower the temperature. With this in mind, you can quickly see that cone 5 is hotter than 05.

### Pyrometric Cones



**Note:** Store boxes of cones in numerical order from lowest to highest temperature so that you

will be less likely to inadvertently pick up the wrong box.

The number is stamped on the base of the cone. The cone number for each material is usually stated on the label by the clay or glaze manufacturer. Your supplier can also give you the cone number.

## Heat Work

Cones are rated by temperature. But it is more accurate to think of them as measuring heat work, not temperature alone. Heat work is the combined effect of time, temperature, and the atmosphere inside the kiln. All these factors affect the maturity of your ware and not just temperature. For instance, firing to a lower temperature for a longer time will produce the same maturity as firing to a higher temperature for a shorter time. The "Temperature Equivalents" chart (next column) shows that a self-supporting 05 cone requires a temperature of 1911°F to bend to 6 o'clock, yet when fired slower, it will bend at 1870°F.

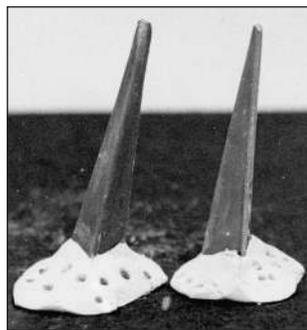
During the last 100 - 200 degrees of firing, the firing rate affects the bending temperature of a pyrometric cone. The faster the rate, the higher the temperature when the cone bends. But the firing speed before the last 100 - 200 degrees has no influence on the final temperature of the pyrometric cone. The exception is an extremely fast firing that bloats the cone.

Consult your supplier for the recommended firing rate of your clays and glazes. The thicker the clay, the slower it should be fired. Firing clay is like making cookies in an oven. Heat the cookies fast, and they will be brown on the outside but still gooey on the inside. Heat the cookies slowly, and they will be brown all the way through.

## Using Cones

Place the cones on a kiln shelf with the ware. As the cones heat and bend, they form a glassy material that will stick to a bare shelf. Therefore, apply kiln wash to the shelves to prevent sticking. Do not apply kiln wash to the cones. (See page 19 for kiln wash.) The cones slant 8 degrees from vertical and bend in the direction of the slant. They will not bend accurately if they are slanted at the wrong angle. Position a cone so it will not touch nearby ware as it bends.

Large cones come in either standard or self-supporting. Standard large cones must be mounted in a clay or wire plaque with 2" of the cone exposed above the cone holder. Or you can mount large cones in a pat of clay. The clay should be dry before firing. To speed drying, make indentions in the clay with the end of a small



Standard large cones in clay cone packs.

## °F Temperature Equivalents For Orton Self-Supporting Pyrometric Cones

Cone Number	Self-Supporting Cones			Cone 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.

## °C Temperature Equivalents For Orton Self-Supporting Pyrometric Cones

Cone Number	Self-Supporting Cones			Pre-Fire Color
	Heated at: 15° C Per Hour*	60° C Per Hour*	150° C Per Hour*	
022	—	586	590	Green
021	—	600	617	Fuschia
020	—	626	638	Orange
019	656	678	695	Yellow
018	686	715	734	White
017	705	738	763	Pink
016	742	772	796	Light Blue
015	750	791	818	Violet
014	757	807	838	Gray
013	807	837	861	Green
012	843	861	882	Fuschia
011	857	875	894	Orange
010	891	903	915	Dark Red
09	907	920	930	Dark Red
08	922	942	956	Dark Red
07	962	976	987	Dark Red
06	981	998	1013	Dark Red
05 1/2	1004	1015	1025	Dark Red
05	1021	1031	1044	Dark Red
04	1046	1063	1077	Dark Red
03	1071	1086	1104	Dark Red
02	1078	1102	1122	Dark Red
01	1093	1119	1138	Dark Red
1	1109	1137	1154	Dark Red
2	1112	1142	1164	Dark Red
3	1115	1152	1170	Dark Red
4	1141	1162	1183	Gray
5	1159	1186	1207	Green
5 1/2	1167	1203	1225	White
6	1185	1222	1243	Fuchsia
7	1201	1239	1257	Orange
8	1211	1249	1271	Yellow
9	1224	1260	1280	White
10	1251	1285	1305	Pink

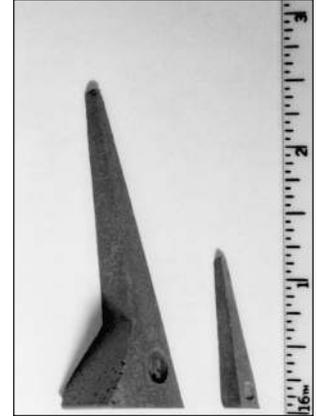
\*Rate of temperature increase during last 90 - 120 minutes of firing. Tables by courtesy of the Edward Orton, Jr. Ceramic Foundation.

brush handle after the cone is inserted. Self-supporting cones stand upright without holders. We recommend self-supporting cones; they are easier and faster to use than standard large cones.

Handle cones carefully. They are fragile because they are unfired clay. If dropped, they may develop cracks that could affect their performance. Age and normal humidity do not affect the accuracy of cones. Even if a box of cones is 20 years old, you can still use them. However, do not use them if they become wet.

Standard pyrometric cones come in two lengths: 1 1/8" and 2 1/2". The small cone is used in the Kiln Sitter and the large cone is used on the kiln shelf.

**Note:** The Kiln Sitter is a mechanical shut-off device that is triggered by the bending of a small cone. Digital controllers do not use the small Kiln Sitter cone.



A self-supporting cone next to a small Kiln Sitter cone.

Self-supporting cones are 2 3/8" long. They are packaged as sets of double cones so that they will be less fragile in shipping. You will need to separate the cones. Hold the large section of the cones with the thumb and forefinger of each hand and twist. They will snap apart.



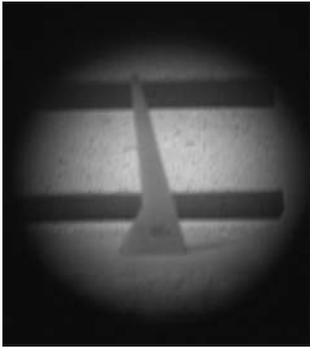
Separate the cones with thumb pressure.

Check the accuracy of your Kiln Sitter or digital controller by placing cones on the shelf. Mount behind each peephole a large cone of the same number you are firing to. This is the firing cone. Next to the firing cone place a large cone of the next lower temperature; this is the guard cone. For example, if you are firing to cone 05, place large cones 05 and 06 on the shelf behind the peepholes. We recommend at least one large shelf cone in every firing.

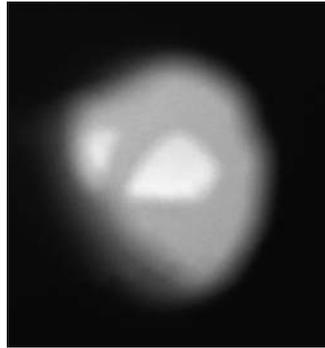
Place large cones on the shelf at least 3" away from a peephole. This is to avoid cool air drafts.

Always use Paragon firing safety glasses when looking into the peepholes. These glasses are specially coated to filter out the infra-red and ultra-violet light inside a kiln. They also protect your eyes from heat and reduce glare, making the pyrometric cones easier to see.

## How to Position Cones on the Shelf



A cone seen through a peephole while the kiln is at room temperature.



A same cone silhouetted by a heating element at cone 7—2262°F (1239°C).



Wear firing safety glasses when viewing a witness cone.

Position the witness cones so that you can see them through a peephole during firing. If the kiln takes longer than usual to fire, you may wonder if something has gone wrong and the kiln is over-firing. But by seeing the cones, you will know how the firing is actually progressing.

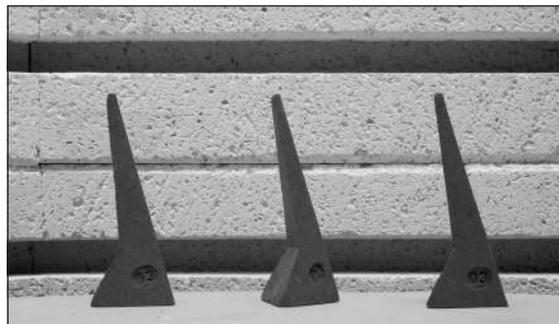
If you follow these guidelines, you should be able to see the cones even at cone 10:

- 1 Place the cones 8" - 12" away from a peephole. Positioning them closer makes them difficult to see and may also subject them to cool air drafts.

**Note:** Keep cones at least 2" from an element.

- 2 Have enough space around the cones to keep them from touching a piece of ware when they bend.

- 3 Position cones so that when viewed from the peephole, they are silhouetted by an element on the opposite kiln wall. If the size of your ware doesn't per-



Line up the heating element with the lower part of the cones.

mit placing a shelf at peephole level, use a post to raise the cones.

- 4 The element that silhouettes the cones should be level with the lower part of the cone. If the element is in line with the upper part of the cone, the cone will disappear from view when it bends.

**Note:** The center elements in some kiln models do not glow brightly even at high temperatures. In this case, position the witness cones level with a top or bottom element. The element must glow brightly to silhouette the cones.



The top and bottom elements glow brighter than the center elements in some kilns.

- 5 If you use the three-cone system, always have the higher temperature cone on the same side in every firing. Otherwise you can lose track of which cone is which.

- 6 Wear kiln firing safety glasses when viewing the cones through the peephole.

**Note:** You may find it easier to see the cones by holding a small mirror at a 45° angle in front of the peephole. You will still need firing safety glasses.



**Caution:** Some ceramists blow into the peephole to momentarily darken the cone so they can see it better. Please do not do this. This can blow brick dust onto the ware and is a safety hazard. Cool air also changes the temperature at which the cone bends.

**Caution:** Some ceramists coat the witness cones with red iron oxide to make them easier to see. Avoid this. It changes the temperature at which the cone bends.

“Working in my small studio keeps me sane and happy. I forget about everything else and am grateful to do what I do.”

—Heidrun Schmid

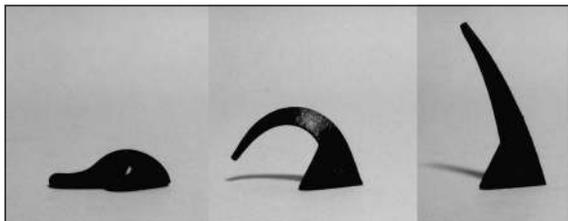
## The Bending of the Cone

You can watch the cones as they bend. If you want to slow down the bending for greater control, add a digital temperature hold near the end of the firing. (See the separate controller manual.)

The large standard and self-supporting witness cones have reached maturity when the tip bends to the 6 o'clock position.

**Large standard cone:** The tip should bend straight down until it just begins to touch the cone holder.

**Self-supporting cone:** The self-supporting cone should bend downward until the tip is even with the top of the base. The tip should be about ½" above the shelf surface. If the self-supporting cone tip touches the shelf, the cone is over-fired by a few degrees of temperature.



Self-supporting cones: Left, over-fired or "puddled"; Center, fired to maturity; Right, under-fired.

## Using Cones in Digital Kilns

Although the digital controllers do not need cones to operate, we recommend them anyway. Place at least one self-supporting cone on a shelf behind a peephole in every firing.

If the bending of the witness cones varies slightly from firing to firing, you need not be concerned. Slight variations in the bending of the cone are normal and may be due to the location of the cones on the shelf, the distance of the cones from ceramic ware, and even variations in cones from box to box. This normal variation will have no effect on your ware.

If your digital kiln shuts off before the large cone on the shelf bends and you're there when it happens, program the controller to a higher temperature or add a hold. (See the separate digital controller manual for your kiln.) Then turn the kiln back on.

**Q** When a kiln is taking longer than usual to complete a firing, how do you know whether something has gone wrong and the kiln is over-firing?

**A** You should place pyrometric witness cones on the shelf so that you can see them through a peephole.

Here's another way to help prevent an over-fire: Learn to estimate kiln temperature by the color of light showing around the lid and peepholes. That way, you can tell at a glance if all is well with your kiln when you check it.



The light around the edge of the lid and inside the peephole changes color as the kiln gets hotter. You can learn to estimate temperature by the color of that light.

**Q** Is it okay to use old cones?

**A** Yes. Age does not affect the cones.

**Q** Do you need to look at witness cones during a firing or only after the kiln has cooled?

**A** Position the cones so that you can see them through a peephole. Form the habit of looking at the cones near the expected shutoff time especially if the firing is taking longer than expected.

*"My grandmother, who has taught china painting for 60 years, coached me during my first firing. I treasure the memory of that moment of my life with her."*

—Darcy Giesseman

*"When I couldn't get my first little half pound ball of clay to center, my teacher knelt down beside my wheel, waited for me to stop, and said, 'Hey, it's just mud. Don't let it control you. You control it.' When I have a problem, especially with centering, I just zone out with my hands in position on the clay, relax my shoulders, and tell myself, 'It's just mud.' And the clay obeys."*

—Sheron Roberts

*"I love the impossibility of ceramics. Just when I think I've got it figured out, something bursts my bubble once again. It keeps me humble. It keeps me interested, challenged, enthralled."*

—Kelley Webb Randel

# FIRING ACCESSORIES

These accessories can be purchased from Paragon through an authorized dealer:

## Shelves

Shelves are flat slabs of fire-clay that have been fired to a higher temperature than will be encountered in your kiln. With multiple shelves, you can stack more ware in your kiln than you could ever place on the bottom of the kiln alone.



Half shelves increase kiln space by making it possible to fire tall pieces on one side of the kiln and one or more layers of small items on the other side.

Shelves are strong and will not sag if properly supported and not overfired. But like any other pottery, they will break if dropped.

## Posts

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



½" and 1" posts are used to obtain heights not in your post assortment. Avoid using posts taller than 10" by placing tall ware on the top shelf of your kiln.

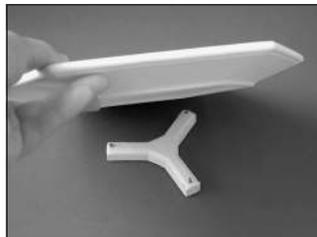
## Recommended Furniture Kits

Furniture kits are carefully selected assortments of shelves and posts that allow you to make the most of your kiln's firing capacity.

Shelves should be 1" - 2" smaller than the firing chamber of the kiln. If shelves are larger, breakage of the fire-brick walls may occur, because you will not have enough space for your fingers as you place the shelves in and out of the kiln.

## Stilts

At high temperatures, glaze becomes molten and sticks permanently to anything it touches, such as the kiln shelf. Stilts prevent this. A stilt is high temperature wire embedded in a ceramic base. The stilt suspends glazed ware on the wire points to separate the piece from the kiln shelf. Stilts also allow air to circulate around



large, flat pieces. Stilts are needed for glazed ware, not greenware.

Stilts can be used in firings up to 2000°F (1093°C). They cannot be used to fire porcelain and stoneware, which fire to cone 6 - 10. At those temperatures, the wire points would embed into the clay or bend. Stilts, however, can be used to fire overglaze onto porcelain at china painting temperatures.

Stilt points are made of a high temperature metal alloy. You can straighten metal points by bending gently with pliers. Remove glaze buildup on the points with a stilt stone or emery cloth. The oxidation of the wire can discolor the glaze at the stilt mark. Cleaning the wire points with a stilt stone solves that problem.



Straighten stilt pins with pliers.



Clean the points with a stilt stone.



Stilts come in a wide variety of shapes and sizes. The 3-point triangular stilts support bowls, plates, and cups. Bar stilts support longer pieces. Load ornaments and eggs on stilt posts.

Remove the stilts from the ware after firing by breaking the thin film of glaze holding them. The stilt points leave a sharp edge in the glaze. Handle the ware carefully to avoid injury. Remove the sharp stilt marks with a stilt stone.



## Tile and Plate Setters

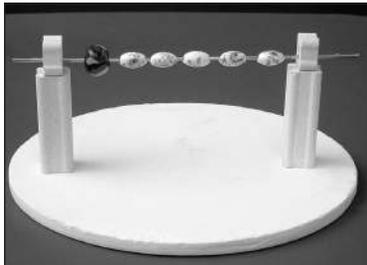
These are holders used to stack plates and tiles inside the kiln. Firing plates and tiles is more efficient with a tile or plate setter than placing these items flat on the shelf. The setters not only save space in the kiln but also allow air circulation around the ware, preventing warping and breakage. The ware heats more uniformly in a setter than when placed directly onto a kiln shelf.



Tile setters conserve space inside the kiln when firing tiles.

## Bead Rods

Ceramic greenware beads can be piled onto the kiln shelf. But once the beads have been bisque-fired and then glazed, they must be suspended by stilt rods (also called bead rods). Since the beads are glazed all over, they cannot be placed on the kiln shelf. Stilt rods are made from the same type of wire as kiln heating elements though the rods are thicker than elements.



Separate the glazed beads so they do not stick together on the bead rod.

The beads must not be glazed inside the hole and around the edge of the hole. Otherwise they will stick to the rod. Space the beads so they do not touch. Suspend the stilt rods between two posts.

## All Purpose, High Fire Kiln Wash

High fire kiln wash is a mixture of finely ground minerals that do not fuse at porcelain and stoneware temperatures. It acts as a barrier between the shelf and dripping glaze. The kiln shelf must be coated with kiln wash to keep ceramic glaze and glass from sticking to it. Without a barrier, the glaze would embed permanently into the shelf.



Kiln wash protects shelves and the kiln's brick bottom from drops of hot glaze.

**Caution:** Contact with kiln wash will destroy heating elements.

Brush kiln wash on the tops of kiln shelves and on the kiln bottom to prevent glaze drippings from sticking permanently to these surfaces. As a powder, high fire kiln wash has an unlimited shelf life. (See page 19.)

# PREPARING TO FIRE THE KILN

## Vacuumping the Kiln

**Note:** Do not breathe brick dust. Vacuum the kiln with a HEPA filtered vacuum cleaner or a central vacuum that takes the dust outside.

One of the easiest kiln maintenance tasks you can perform is regular vacuuming. This is especially important if you fire glazes. Vacuum the kiln before every glaze firing. This helps to prevent dust particles from landing on glazed ware during firing. Vacuum every four bisque firings.



If you vacuum with a plastic nozzle, do not let the nozzle touch the fragile firebricks.

Use the soft brush nozzle on a vacuum cleaner. Be sure to vacuum the element grooves, the inner surface of the kiln lid or roof, and the underside of kiln shelves.

Vacuumping the element grooves may extend element life by removing brick dust that settles in the bottom of the grooves. Vacuuming the grooves is essential if anything has exploded inside the kiln. Pieces of greenware that lodge inside the grooves can burn out an element.

**Note:** Over time, brick dust may accumulate in the bottom of the element grooves. This can interfere with heat transfer from the elements and actually slow down the firings.

Vacuum the kiln often if you use silica sand on the shelves. The sand, which is used to support ware during firing, can ruin the elements if it filters down into an element groove.

As you vacuum the kiln, examine the walls for glass or glaze particles that have embedded into the firebricks. Dig these out carefully with a screwdriver. Otherwise the particles will embed deeper into the firebrick during the next firing.

**Digital kilns:** A static electric charge may build up on the vacuum hose especially in dry weather. Static electricity can damage electronics. Disconnect the power to the kiln before vacuuming. Keep the vacuum away from the digital controller, the switch box, and the thermocouple tip that extends into the firing chamber.

## Drying Greenware

Ordinarily, do not use the kiln to dry greenware. The most expensive way to dry greenware is to heat it in a kiln. The moisture in the clay rusts the kiln, wears out elements faster, wastes electricity, and if fired too rapidly can cause the ware to explode. Moisture trapped in the clay expands tremendously at the boiling temperature of water.

**Note:** If the ware explodes inside the kiln, let the kiln cool to room temperature. Then vacuum the interior.

Wet clay contains about 30% water by weight. During firing, moisture from the greenware turns to steam. As the temperature rises and the heated air in the kiln expands, moisture escapes by pushing its way into the pores of the firebricks. When the moisture reaches the cooler stainless kiln case and galvanized steel base plate, it condenses, causing water to drip around the kiln.

The firebricks in a typical 8-sided kiln can absorb approximately 50 pounds of moisture from wet greenware. This reduces the insulating capacity of the firebrick. It also takes a tremendous amount of electric power to convert water to steam during firing. This slows the kiln to a crawl.

If your kiln has been dripping water, fire the kiln empty overnight on low heat to burn off the moisture in the firebricks.

An efficient way to dry greenware is to place it inside an enclosure such as a metal cabinet that contains a small electric heater. This is called a hot box. The moisture in the clay raises the humidity inside the cabinet. The humidity keeps the clay surface moist, which prevents the surface from closing up and trapping moisture inside the ware. Thus, the humidity allows the clay to dry evenly. As the clay continues to dry and moisture slowly leaves the cabinet, the humidity drops, which causes the clay to finish drying.

The following suggestions will help you determine when the greenware is dry and what to do if it won't dry completely:

**1** Give the greenware enough time to dry. Drying time depends on the thickness of the clay, the method of drying, and the humidity in your area.

**2** Touch the greenware to the inside of your wrist or to your cheek. If it feels warm, it is usually dry. Be sure to check the bottom of a piece, which retains moisture longer than the upper, thinner sections. Dry longer if the clay feels cool or if it has dark patches, which



Greenware that feels cool against the wrist still contains moisture.

indicate moisture. Note, however, that in humid areas, even damp greenware can feel warm. Greenware feels cool due to evaporation. Damp greenware can feel warm when the moisture in it stops evaporating.

**3** If the greenware is still somewhat moist after an extended drying period or you are under a tight deadline, load the greenware into the kiln. Prop the lid with the Prop-R-Vent in the extended position and leave out the peephole plugs. Fire to 200°F (93°C) slowly. Maintain 200°F (93°C) until the greenware is completely dry.



The Prop-R-Vent is shown here in the extended position.

**Note:** If you have a downdraft kiln vent, you can leave the vent on during preheat with the lid closed and peephole plugs inserted. The vent will help to remove moisture.

**Electronic kilns:** Use the Preheat feature in Cone-Fire mode, or program a 200°F (93°C) preheat segment in Ramp-Hold mode.

**Manual fire kilns:** Turn the bottom switch on low; leave the other switches off. (The switch setting varies depending on the size of the kiln.)

“Candling” means firing the kiln at 200°F (93°C) or lower until moisture in the ware has evaporated. If you leave the lid well vented or leave a downdraft vent turned on during candling, you can get away with using the kiln to dry the ware. But you will probably increase the corrosion of steel parts in the kiln especially if moisture is still in the ware as the temperature goes up past the candling temperature.

**Note:** Bisque ware has already been through the bisque firing, so it does not have the drying problems of greenware. Nevertheless, after applying glaze to bisque, allow the glaze to dry before firing. This usually takes a few hours.

### Checking for Dryness with a Mirror

Hold a mirror above the lid or top peephole where hot air from the kiln will move across the mirror's surface. If the mirror fogs, the greenware is still releasing moisture. Keep the lid propped and maintain 200°F (93°C) in the kiln until the mirror no longer fogs. (If you are firing with a downdraft kiln vent, you will need to remove a peephole plug or prop the lid to perform the mirror test.)



Moisture condenses on a mirror held near the peephole or the vented lid.

**Note:** The first time you fire the kiln, water in the firebricks may fog the mirror for an extended period.

For this test to work, the mirror must be at room temperature. The mirror fogs when moisture in the hot air condenses on the cooler mirror. If you hold the mirror too long near the kiln, the mirror will heat up and will no longer fog when moisture hits it. So hold it at the lid for only a moment at a time.

**Note:** You can dry the greenware by placing it around the kiln during a firing. This uses heat from the kiln that otherwise would be wasted. You can place the greenware on metal shelves or rollaway metal tables. Be careful if you place ware directly onto the lid of a kiln. Too much weight can crack the lid.

## Shelf Preparation

### High Fire Kiln Wash

Kiln wash prevents glaze and glass from sticking permanently to the kiln shelf and firebrick kiln bottom. Brush kiln wash on the tops of kiln shelves and on the kiln's firebrick bottom.

**Caution:** Do not apply kiln wash to the kiln walls or lid, the underside of shelves, or the posts. Contact with kiln wash will destroy heating elements. Wear a respirator to avoid breathing kiln wash dust.

Never use a low-fire ceramic type kiln wash, because after firing the kiln above cone 04, the ceramic kiln wash will harden and be difficult, if not impossible, to remove later when you want to fire to hotter temperatures. All purpose, high fire kiln wash **MUST** be used in all kilns rated to 2300°F (1260°C), even though the kiln is usually fired at lower temperatures.

**Note:** When unloading the kiln, move away from the kiln before wiping off kiln wash from the bottom of the pieces. If you wipe off the kiln wash while holding the pieces above the kiln, the dust can settle into an element groove and destroy an element.

### How to Use Kiln Wash

- 1 Pour a little water into a disposable container and add powdered kiln wash until it has the consistency of coffee cream. Stir until lumps dissolve.



Applying kiln wash with a haik brush.

- 2 Use a haik brush (available from

Paragon) or a soft paint brush to apply the kiln wash to the shelf. (The haik brush lays down an even coating.) Each time you dip your brush into the kiln wash mixture, swirl the brush around the bottom of the container. This is because the kiln wash settles quickly.

**Note:** Start the brush stroke an inch or so from the edge of the shelf and work toward the opposite side. This is to avoid a buildup of kiln wash on the edges.

- 3 Apply two or three thin coats of kiln wash changing the direction of the brush stroke 90° with each coat. Let the kiln wash dry for a few minutes between coats. Do not apply thick coats; they tend to flake off.
- 4 Remove any buildup of kiln wash from the edges of the shelf by tracing around it with a finger. Excess kiln wash may break off the edges and fall onto ware positioned below the shelf. Dry the shelves completely before firing.

- 5 Brush kiln wash onto the kiln bottom. Protect the kiln walls and elements from kiln wash with a piece of cardboard. Never apply kiln wash to kiln walls or to the underside of shelves.



Protect the elements when you apply kiln wash to the brick bottom.

- 6 Let the kiln wash dry overnight. You can speed drying by placing shelves in the kiln and heating to around 200°F (93°C) for an hour. The kiln-washed shelves are still wet if they feel cool to the touch.

**Note:** Do not apply kiln wash to pyrometric cones. Kiln wash changes the maturing temperature of the cone.

**Note:** If glaze or glass sticks to the shelf, scrape it off with a putty knife at a sharp angle. Wear safety glasses—sometimes chipped glaze becomes airborne. Then recoat the bare spot with more kiln wash.



Use a putty knife to remove flaking or cracked kiln wash.

**Q** I have applied kiln wash to my shelves. Should I also kiln wash the underside of the lid?

**A** Kiln wash should never be applied to the lid or walls of the kiln, because it could flake off and fall into an element groove or onto glazed ware. It is especially important to keep the kiln wash away from elements.

**Q** The kiln wash is flaking off some of my shelves.

**A** If the kiln wash is flaking from the shelves, you may be applying it too thick. Remove the kiln wash and apply a new coat.



You can also remove loose kiln wash with grit cloth and then apply a new coat.

### Recoating a Shelf with Kiln Wash

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 sand paper. Removing the old coating gives you a smooth surface to start with. Wear a respirator when removing kiln wash. Then recoat the shelf using the directions on page 19.

Kiln wash will usually last for many firings. When the kiln wash begins to crack or chip, apply a fresh coat. Scrape glaze drops off the shelves or dig them out of the brick bottom as soon as they appear. Then apply a new coat of kiln wash to the bare area.

### 100 Mesh Alumina Hydrate Sand

Shelves can become warped at stoneware and porcelain temperatures. Large, flat stoneware pieces placed directly onto a warped shelf become warped at high temperatures. But there is a way around this: Place the ware over a layer of alumina hydrate that has been sprinkled onto the shelf. The sand evens out the warped surface so the bottom of the ware remains flat during firing. In addition, alumina hydrate acts as miniature ball bearings to allow the clay to move as it shrinks during firing and helps to separate the ware from the shelf for more even heating of the piece. You can use the alumina hydrate over and over. It is available from pottery supply distributors.

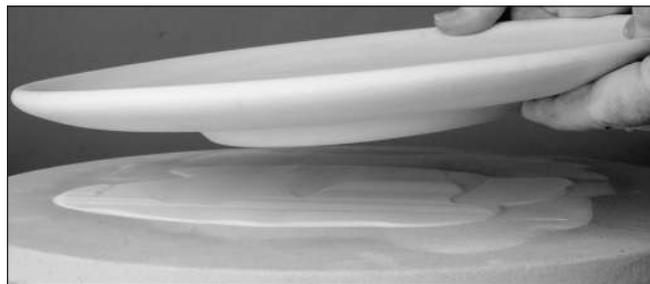
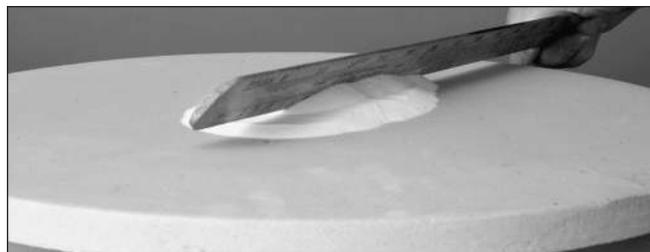
**Note:** We do not recommend the silica sand available from home improvement centers as a substitute for alumina hydrate unless you first test it. If the sand contains iron particles, it will stick to the ware.

**Caution:** Do not breathe alumina hydrate dust. Wear a respirator.

### How to Use Alumina Hydrate

**Note:** If you use a fan to lower the firing room temperature, do not aim the fan directly at the kiln. The breeze can stir the sand (alumina hydrate) inside the kiln. This could ruin glazed pieces and scatter sand into the element grooves. It is okay to use a down draft kiln vent such as the Orton Vent Master. When correctly installed, the vent does not create enough airflow to stir up dust inside the kiln.

- 1 Do not place sand on the kiln's brick bottom. Use it only on the shelves. The sand can work its way between the firebricks. Pour the sand onto the shelf before lowering the shelf into the kiln. If you pour the sand on the shelf inside the kiln, dust particles are more apt to float inside the firing chamber, scattering onto your pieces.
- 2 Do not pour the sand onto the shelf from a large bag. Use a scoop instead. A scoop stirs up less dust. After you have poured the sand onto the shelf, a small ruler is helpful in spreading the sand.



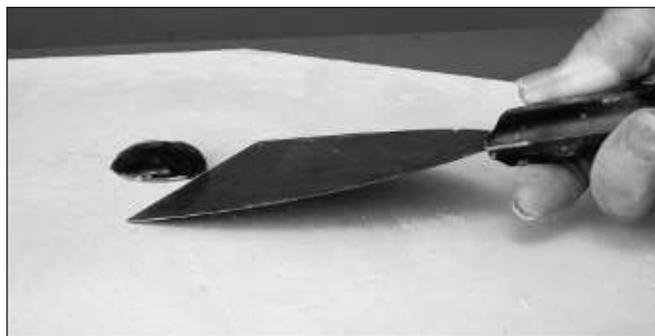
- 3 Use the sand sparingly on the shelf for most projects. Use a thicker layer under the ware if you are concerned about glazes running.
- 4 Keep the sand 2" - 3" away from the edges of the shelf. If the sand falls off the edges, it may filter down into the element grooves or onto glazed ware on the shelf below. This is especially important with half shelves.
- 5 As you lower the shelf into the kiln, hold the shelf level. If it tilts, the sand could fall off the edges.
- 6 When unloading the kiln, remove the shelf and the ware together. If the ware is too heavy to lift out with the shelf, then hold each piece of ware away from the kiln before rubbing the sand off

the bottom of the piece. If you hold the ware over the shelf as the sand falls from the piece, the particles could fall into an element groove.

- 7 Pour the alumina hydrate from the shelf into a storage container. Use a wide-mouth container that will catch the sand as you tilt the shelf. A plastic container with lid works well. Save the sand for future firings.
- 8 Vacuum the kiln after every firing with a soft brush attachment. Be sure to vacuum the element grooves.

### Removing Glaze from the Shelves

- 1 Place the shelf on a soft surface such as a thin sheet of Styrofoam.
- 2 Wearing a dust mask and safety glasses, gently tap the glaze drippings at a sharp angle with a putty knife.



Hold the putty knife at a sharp angle to remove glaze from a shelf.

“When you concentrate on making a pot, you have no time to dwell on your problems. I know a therapist who used clay in working with suicidal teens. She has worked wonders with these kids.”

—Mike Gordon

“The profound experience of working with clay is to have a three dimensional image in your head, and then have it come out through your hands.”

—Marie Gibbons

“Many of our customers, in very stressful jobs, find release through clay. One, a doctor, found clay to be the road back from a mental breakdown.”

—Stephen Mills

## LOADING THE KILN

### How to Store Kiln Furniture

Store kiln furniture in a dry area. Moist shelves can crack or even explode inside the kiln. A freshly kiln-washed shelf should be allowed to dry thoroughly, then fired slowly to allow any moisture in the shelf to evaporate.

There is less danger of cracking if you store shelves vertically in a shelf rack or even leaning against a wall rather than flat. If a piece of clay or other material lodges between horizontally stacked shelves, weight pressing down can crack a shelf. (However, as long as the stack is no higher than three or four shelves and the shelves are clean, you can store them flat, too.)

Store shelves so that the sides with kiln wash face each other. This prevents flakes of kiln wash from transferring to the underside of other shelves.

Store posts of the same length together.

If a shelf cracks, break it apart at the cracks and use the pieces as smaller shelves.

**Note:** You may find it helpful to draw a shelf pattern on a table and plan the load for each shelf before you begin loading the kiln.

### Guidelines for Loading the Kiln

Loading a kiln is like putting together a jigsaw puzzle. You may find it the most interesting aspect of firing, because it requires thought and planning.

#### How To Handle Kiln Shelves

One of the secrets to keeping your kiln in good condition is in the way you hold the shelves when you load or unload the kiln:

- 1 Check each shelf for cracks.
- 2 Work slowly and carefully. Treat the kiln as if it were a piece of fine furniture that you didn't want to scratch. Don't touch the firebrick walls if you can help it.



Do not let the shelf touch the walls.

- 3 Tilt the shelf as you lower it into the kiln. Center it so it doesn't touch the kiln walls. At all times, be aware of the location of the thermocouple or Kiln

Sitter tube so that you avoid bumping the shelf against it.

- 4 As you level the shelf into position, center it in the firing chamber. **Top-loading kilns:** Position your hands so that they are at the firebrick corners. This offers more space than straight sections of the walls.
- 5 If full shelves are too heavy for you to load, use half shelves. Not only are they lighter, but they are also less apt to touch the walls during loading and unloading.
- 6 Do not jar the kiln after loading, or the ware or a shelf could fall over and break. Shelves should be 1" - 2" smaller than the firing chamber.
- 7 Do not allow anyone to load or unload your kiln until you have trained them.

## The Basics of Loading

Disconnect the power before loading the kiln.

Hang a portable light from the kiln's lid handle if your room is poorly lit.

Before loading the kiln, be sure all the ware is rated to the same pyrometric cone. Low-fire ware fired with a load of stoneware could melt into a puddle, ruining kiln shelves.

Avoid back strain. When possible, load empty tile setters into the kiln. Then add the tiles to the setters that are already in position. This is easier than lifting fully loaded tile setters into the kiln.

Ordinarily, load pieces of medium height on the bottom shelf and tall pieces on the top shelf. This improves the stability of posts since short posts in the bottom of the kiln are more stable than tall ones. But if you have difficulty reaching down into a deep kiln, leave the bottom shelf in place and load tall pieces onto it. A short stepladder or concrete block is an aid to reaching into a deep kiln.

We urge the use of at least one large pyrometric cone behind the peephole on a kiln shelf in every firing. Place cones 8" - 12" from the peephole. (The minimum distance between the cone and a peephole is 3". This is to prevent exposure to cool air.) Check the cone through the peephole before placing a shelf over it.

Large, heavy greenware pieces will fire best if placed across two half shelves positioned at an even height.

After loading the kiln, close the lid gently. Jarring the lid will not only damage



Large greenware pieces can be fired across two half shelves.

it but will also cause dust to fall onto glazed ware on the top shelf.

## Loading for Efficiency

To make full use of your kiln's firing capacity, group similar sizes of ware together inside the kiln. (Begin grouping similar sized ware as you lay the pieces out to dry prior to firing.) Fill empty areas of the shelf with small pieces such as medallions. They make good glaze testing samples that you can sell or give away later.



Use half shelves to load layers of ware next to tall pieces.

Stack ware on half shelves to take advantage of blank space next to tall pieces.

When firing pieces of varying heights on the same shelf, the tall pieces should go in the center. This is to avoid blocking radiant heat from reaching the shorter pieces.

To save space during the low-fire ceramic or stoneware bisque firing, you can place bisque ware within other larger pieces. The ware shrinks during firing, so pieces that are stacked together must have shrinkage room. Otherwise they will crack.



Place small, light greenware pieces directly on the floor of the kiln. Leave ample room for air to circulate around their bases since this area is difficult to heat.

A good place for tall pieces is the top shelf, with no posts or shelves above them.

## Distances Inside the Kiln

**Keep ware at least 1" away from a heating element.** Glazes may bubble and land on an element if the ware is too close. If you fire a piece that is so large that a tip of it comes closer than 1" to a kiln wall, place that section of the piece between element grooves and not directly opposite an element.



Keep ware at least 1" away from the elements. If ware extends closer than 1" to a wall, place it between rows of elements.

**The minimum spacing between shelves is 2 ½".** You can achieve this minimum 2 ½" height by stacking a ½" post on top of a 2" post. Shelves must be stacked so there is at least one row of heating elements between any two shelves.



Minimum spacing between shelves is 2 ½". You can stack posts to achieve that height.

**The posts used with each layer of ware should be at least 1" taller than the ware.** Keep a ruler near your kiln. As you fill a shelf with ware, lay the ruler across two posts or the top of the kiln to make sure the ware is not too tall.



Lay a ruler across the top of the kiln to make sure the ware is not too high.

**Keep all ware and kiln shelves at least 1" away from the side, top, and bottom of the end of the Kiln Sitter tube or digital thermocouple.** If the kiln is nudged during firing and the shelves momentarily shift position, the Kiln Sitter or thermocouple could malfunction.



Keep ware and shelves at least 1" away from the thermocouple.

**Make sure at least one element groove is between the top shelf and the top of your kiln.** The top of ware should be at least 1" lower than the lid. If the ware on your top shelf is over- or under-firing, try using two half shelves instead of a full shelf. Stagger the height of the shelves.



Have at least one element groove between the top shelf and the top of the kiln.

## Glazed Ware

As you load each shelf into the kiln for a glaze firing, wipe off or vacuum dust from the underside of the shelf.

Lower the lid gently. Rough handling will crack the lid. This may result in dust falling from the cracks onto glazed ware on the top shelf. If your lid is cracked, load

smaller items on the top shelf leaving a blank space on the shelf under the lid crack.

Separate glazed ware by ½". If pieces are placed too close together, a glaze of one color may contaminate the glaze of a different color on the next piece.

Do not wipe dried glaze drips from the ware while you are standing over the kiln. The glaze particles may fall into the kiln and land in an element groove or fall into the louver of a switch box. This could cause an element to burn out or a wire connection to fail.

Some glazes tend to run off the ware and onto the shelf. In the worst cases, the running glaze eats through the kiln wash and embeds into the shelf. You can prevent this by placing broken pieces of kiln shelf under the ware. The shelf piece will catch the glaze. Or roll out a ¼" thick layer of clay, cut it into circles with a can (similar to using a cookie cutter), and coat the clay with kiln wash. Place the round "coaster" under the ware to protect the shelf.

For kilns with a downdraft vent such as the Orton Master Vent, do not load glazed ware directly under the air intake holes in the lid.

Ware that is prone to warping, such as ware with thin walls or flared tops or large bowls, should be placed away from the elements. The bottom of ware that extends out past the edge of a shelf may warp.

Pieces that go together, such as matching cups and saucers, should be placed next to each other on the kiln shelf. This helps assure uniformity in glaze color. To keep holes in glazed salt and pepper shakers from closing in with glaze, insert tooth pick pieces in the holes. They will burn away during the firing.

## Heat Distribution Inside the Kiln

You may remember from early science class that heat rises. This is called convection. Kilns tend to fire cooler on the bottom, but not because heat rises. Movement of heat through convection ends at around 1100°F (593°C). At 1700°F (926°C), air has only about one-tenth the number of molecules as at room temperature. This is why there is little airflow in an electric kiln at high temperatures.

The bottom and top tend to stay cooler because the brick bottom and lid are large thermal masses that absorb energy. Paragon compensates for this by making the bottom and top elements fire hotter than the center elements.

You can improve heat distribution by loading less ware in a cool section of the kiln and more ware in a hot section. Slowing the firing also helps.

The best way to determine how to load your kiln for even heating is to place witness cones on every shelf. You will quickly know which section fires hotter and therefore should be loaded heavier. The heavier a section of firing chamber is loaded with ware, the cooler it will fire.

**Q** How do you load the kiln if you are firing it half empty such as when you are firing several pieces for a show that has a tight deadline?

**A** Do not leave the top half of the kiln empty. Distribute the ware evenly throughout a lightly loaded kiln. But if you are firing a tall piece or for some other reason you cannot distribute the load evenly, then fire the kiln slowly.

**Q** Is it okay to place ware directly onto the brick bottom?

**A** Yes. Since the massive firebrick bottom absorbs so much heat, you should place only light pieces on the bottom, or pieces that can be fired to a slightly lower temperature. Do not place glazed ware on the brick bottom; running glaze will damage the firebricks. Instead, place 1" posts on the firebrick bottom and a shelf on top of the posts. The bottom shelf will protect the firebrick bottom from glaze.

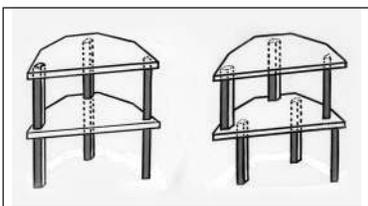
**Note:** You can also support the bottom shelf with small broken pieces of shelves. They will help to distribute the weight of the kiln load over a larger area of the kiln bottom than would 3 or 4 separate posts.



You can support the bottom shelf with small shelf pieces.

## How to Position Posts

Stack posts so they are directly in line with each other vertically. If posts are stacked vertically offset from each other, shelves will be less stable and more prone to warp at stoneware and porcelain temperatures. A cantilevered shelf can break from stress. The weight on vertically aligned posts will also help to hold up a shelf that cracks.



Posts should be vertically aligned as shown in the left diagram.

Use 3 posts for a kiln load of full shelves. Three posts are more stable than 4 posts, because with 3 points of support, the shelves will not rock. Use 6 posts for a set of half shelves.

When possible, position posts toward the kiln walls and away from the center of the kiln. This places most of the weight of the kiln load close to the kiln stand and away from the kiln center, which has less support.



Use 3 posts per shelf.

## Bead Rods

Fire small low-fire or stoneware glazed beads on bead rods that are suspended between two posts. Keep the beads separated on the rod. If they touch, the glaze will make them stick together. Keep the glaze away from the bead holes.



You can also center a bead rod (also called a stilt rod) over a horizontal post so that the rod extends past the post on each side. Then load an equal number of beads on each end of the rod. This is an efficient way to fire many beads since one short post can hold several rods. Be careful not to jar the kiln, or the rods could fall.

## Firing Large Ware Across Half Shelves

Large ware such as platters sometimes extend over two half shelves. If the shelves are uneven, the platter may warp during firing. To solve this problem, pour a small amount of alumina hydrate onto each shelf. The powder will form an even surface for the ware. You could also place small clay balls or pencil-sized strands of clay under the ware. Another alternative is to place the ware on a small shelf that spans the two half shelves.



You can fire large pieces across half shelves.

## Tile Holders



Tile holders are a special type of kiln furniture. They make efficient use of kiln space and allow air to circulate around tiles for even heating, thereby reducing tile warpage and cracking. Tile holders can be stacked inside the kiln.

Some tile holders can hold tiles horizontally or vertically. Position the tiles horizontally when using glazes that tend to run down a vertical plate or tile during firing. On the other hand, positioning the tiles vertically in the holders lessens the chance of dust falling onto the glaze.

# FIRING THE KILN

Check the kiln from time to time during operation. Observe the sounds that it makes, and write down the length of firing time. Once you are familiar with the normal operation of your kiln, you will often know just by observation if something goes wrong. This can alert you to interrupt the firing before the ware is damaged.

## The Stages of Firing

Ceramists like to fire their kilns fast to save time and energy. Fast firing, however, can cause many mistakes.

Fire greenware slowly especially during the early stages. A fast greenware firing does not save time if it causes glaze crazing, pinholes, or cratering. You can usually fire glazed ware faster than greenware, but slow the firing near the end so that glaze defects have time to heal.

The thicker the ware and the more densely packed the kiln, the slower the kiln must fire to insure that the heat reaches all of the ware. Pieces that have thin and thick areas must also be fired slowly to allow the thick areas to catch up in temperature with the thin areas.

### Stage One: Water Smoking—Up to 800 - 900°F (426 - 482°C)

All clays contain water. The first stage of firing burns off the water in ceramic greenware. As the water heats, it expands and is pushed out of the clay. This is called water smoking.

Fast firing during this stage can lead to disaster. If the kiln heats past the boiling point of water—212°F (100°C)—the water in the clay will expand too quickly. When the ware breaks during firing, it is usually at this first critical stage. Water boiling inside the clay can explode, damaging not only the ware but also the walls of the kiln. When the ware sounds like popcorn inside the kiln, you know you have fired too fast.

Maintain temperature at 200°F (93°C) or lower during water smoking, and vent the kiln so that the water can escape. If you don't have a pyrometer or digital controller, leave the bottom switch on low and the other switches turned off.

### Stage Two: Dehydration and Quartz Inversion—900° - 1100°F (482°C - 593°C)

After the initial water smoking stage, the clay continues to lose water at a molecular level until about 1100°F (593°C). At that point, the clay changes chemically into fired ware. At around 1060°F (571°C), the clay goes through quartz inversion, which is the point at which the silica in the clay expands. Through 900° - 1100°F (482°C - 593°C), the molecular water must exit the clay slowly, especially if the clay pieces are large.

### Stage Three: Oxidation—500° - 2000°F (260°C - 1093°C)

Impurities burn out of the clay from the very beginning of the firing, but especially during the Oxidation stage. The kiln atmosphere must have oxygen to burn the impurities. The ware must be heated slowly to give impurities, such as carbon, enough time to become gases and combine with oxygen. The thicker the ware and the heavier the load, the slower the ware must be fired.

As the clay reaches higher temperatures, the components of the clay fuse together, sealing the clay surface. At this point, remaining carbon and other impurities become trapped inside the ware. The trapped gases expand beneath the surface, bloating and cracking the ware.

Glaze pinholes, bubbles, crazing, and peeling are often caused by gases that had not burned out fully in the greenware firing. These gases are pushed to the surface during the glaze firing. Lead-free glazes are especially sensitive to trapped gases. These glazes lack the flux that smooths out glaze defects. Trapped impurities turn white bodies gray and weaken the finished ware. They cause mildew in porcelain.

### Stage Four: Maturity—1300° - 2300°F (704°C - 1260°C)

This is the stage where the heat has transformed the ware to the degree intended by the clay manufacturer.

#### Over-glazes

**1000° - 1500°F (537° - 815°C)**

#### Low-fire ceramics

**1700° - 2100°F (926° - 1148°C)**

#### Porcelain and stoneware

**2100° - 2400°F (1148° - 1315°C)**

See your clay supplier for the recommended firing temperature of your clay. It is listed as a pyrometric cone number.

## When to Speed Up the Firing

After the quartz inversion—1000° - 1100°F (537° - 593°C)—clays in the bisque, or greenware firing, can be fired faster. By this stage, the water has been completely driven out of the clay. Actual speed will depend on how many impurities the clay contains. Slow the firing again during the last 200°F (111°C) of the firing.

How fast you should fire depends on the thickness of ware and type of clay. Thin-walled, low-fire ceramics can be fired much faster than stoneware. Fire test pieces in a small kiln. Experiment with firing speed before risking an entire load of ware. Always test-fire clays you are unfamiliar with. If test results are satisfactory, but you want to fire faster, try further tests at increasingly faster rates.

Firing the ware too fast and with insufficient venting causes more problems than any other firing practice. So long as the clay and glaze are designed properly, you will

get almost foolproof results by firing slowly, venting thoroughly, and using witness cones. These are the basics of firing.

**Note:** Firing speed, especially during cooling, can have a dramatic effect on the glaze.

## Venting

At the beginning of a ceramic firing, the fumes and moisture inside the kiln must be removed by venting. Moisture not vented out of the kiln early will rust the kiln. As the heated air in the kiln expands, it escapes by pushing its way into the pores of the firebricks and out to the stainless steel case and switch box.

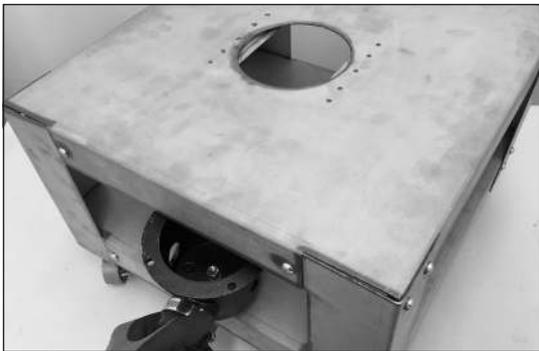
**Note:** If you are using a fan to lower room temperature, do not let the fan blow air into the open peepholes.

### Manual Venting (Without a Motorized Vent)

The simplest form of venting is to remove the peep-hole plug(s) and prop the lid with the Prop-R-Vent (see page 10). After the vented period is over, lower the lid all the way, and close the bottom peephole (if you kiln has more than one peephole). You can leave the top peephole plug out throughout the firing. But if you are getting a glaze defect near the peephole, then insert the top peephole plug after the venting period is over. Sometimes exposure to air crazes the glazed ware that is placed near an open peephole.

**Note:** After the venting period, you may want to leave out the top peephole plug. This allows extra venting throughout the firing.

### The Downdraft Vent



Installing the Orton Vent Master. The fan and fan housing are separate from the air intake cup shown above. The intake cup slides into the flange supports in the top of the kiln stand.

The downdraft vent system pulls a small amount of air from the kiln, dilutes it with room air, and vents the air to the outside. The vent air collection cup is positioned under a top-loading kiln and usually on the back wall of a front-loading kiln. The vent removes fumes through small holes drilled into the firebricks. There are several brands of vents available; one is the Orton Vent Master.

The patented Orton Vent Master not only vents fumes from the kiln but also improves firing results. It pulls fresh oxygen into the kiln for brighter colors, especially noticeable with red and orange glazes and decals. The Vent Master draws air from the kiln, dilutes it with room air, and pushes it outdoors through a vent hose.

The extra oxygen and increased air movement help burn carbon out of the clay, which eliminates a host of firing problems: bloating, dark patches in the clay, porcelain mildew, pinholes, pitting, blisters, and bubbles. The Vent Master prevents fumes from entering the firing room. You can fire even lusters, decals, metallics, and pate-de-verre glass without strong odor.

The flow of fresh air helps even out the temperature throughout the kiln.

**Note:** On switch-operated kilns, the vent also extends the life of the Kiln Sitter tube assembly since fumes by-pass the tube.

With manual venting, the peephole plugs are removed and the lid is propped. With a downdraft vent, however, keep the lid closed and peephole plugs inserted throughout the firing. Otherwise the Orton Master Vent will not remove the fumes. This is because the Master Vent requires negative air pressure inside the kiln.

The Vent Master increases firing time by about 5 minutes for firings up to cone 4; 12 minutes for firings from cone 4 to 10. It has little effect on the kiln's ability to reach maximum temperature.

Keep the kiln room clean. Dust that enters the downdraft vent fan can cause the vent to wear out prematurely.

**Q** Does the downdraft vent circulate enough air inside the kiln to stir up dust or specks of kiln wash?

**A** No. There is little air flow inside the kiln from a properly installed downdraft vent.

### The Downdraft Vent Air Intake Holes

If you order your top-loading kiln with the downdraft vent, the lid will have  $\frac{1}{4}$ " air intake holes drilled in the lid. Try not to place ware directly under these lid vent intake holes. The room temperature air coming in through the holes can cause small areas of glaze imperfection such as crazing, cloudiness, or even cracking of the ware. The vent intake holes should be drilled toward the outer edges of the lid so they won't affect ware placed in the main area of the top shelf.

One way to protect ware from cool air under an intake hole is to temporarily plug the intake hole with ceramic fiber. Then re-route the air into the kiln through a drilled peephole plug (available from Paragon). The hole in the plug should be no wider than  $\frac{1}{4}$ ". Keep ware at least 3" from the drilled peephole plug.

Sometimes a loose peephole plug allows the vent to pull enough air into the kiln to cause glaze blemishes. In this case, keep ware 3" away from the peephole. Or wrap



Keep the peephole plugs inserted if your kiln has a motorized downdraft vent.



The drilled peephole plug available from Paragon has a 1/8" hole.

the peephole plug with a small piece of ceramic fiber blanket to make it fit snugly. (Ceramic fiber is available from ceramic distributors.)



If a peephole plug falls out of the kiln, wrap it with a small piece of ceramic fiber paper. That will hold it in place.

### The Downdraft Vent Air Exit Holes

In most top-loading kilns, the exit holes are drilled in the kiln bottom. You can place ware near the vent exit holes. Unlike air from the intake holes, the air at the exit holes is hot, so air movement there will not affect the ware. Keep the exit holes free of dirt. If the holes become plugged, the vent will no longer remove fumes from the kiln.

If you fire a top-loading kiln with the Orton Vent Master turned off or removed for repair, cover the air exit holes in the kiln bottom. An easy way to do this is to place a kiln shelf supported by 1" posts over the holes.

### The Downdraft Vent During Candling

Candling is a stage of firing where the temperature is kept below 212°F (100°C). (See page 18.) You can leave the downdraft vent on during candling. Moisture will get into the fan and vent duct but will dry out later as the kiln heats up. Leave the lid closed and peepholes plugged.

### When to Turn Off the Downdraft Vent

After the kiln has completed the firing and shut off, leave the vent on for at least another 30 minutes. This is because even though the ware has fired to maturity, it still releases fumes.

You can leave the vent on throughout the cooling period. From the top temperature down to 1000°F (537°C), the vent has no effect on cooling time. From 1000°F (537°C) down to room temperature, the vent will decrease cooling time by about two hours.

## Odors Detected in the Kiln Room When Running the Downdraft Vent

If you can detect odors even with the vent running, check the following:

- 1 Make sure you can hear the fan spinning.
- 2 The holes that draw air out of the kiln must be free of obstructions. If the exit air holes are in the bottom of your kiln, the bottom shelf should be positioned at least 1" above the kiln floor. The shelf must not block the holes.
- 3 The intake and exit vent holes must be of the correct number, size, and location in your kiln. See the vent instruction manual to be sure, or call the vent manufacturer. The vent housing must cover the air exit holes on the outside of the kiln.
- 4 Hold a match near an air intake hole to verify that the vent has created a negative pressure inside the kiln. The flow of air should cause the smoke and flame to move toward the hole.
- 5 Insert all the peephole plugs and keep the lid/door fully closed throughout the firing.
- 6 Check the vent duct for leaks especially where the duct attaches to the outside flapper in the wall.
- 7 Make sure the duct is free of obstructions and that the vent flapper on the outside of the building can open freely. Go outside. You should feel warm air coming out of the vent.
- 8 Is it a windy day? Wind can blow air into the outside vent duct opening.
- 9 Check the condition of the fan. It may be clogged with dirt.
- 10 If you fire ware that contains many impurities, you may need to fire smaller loads.

## Cooling

### Slow Cooling

The rate of cooling dramatically affects the appearance of some glazes. People are surprised to find that by slowing the cooling of their electric kiln, they can get a glaze effect that they thought was possible only in a gas kiln. Sometimes a glaze looks better on the inside of a pot than the same glaze on the outside simply because the inside cools more slowly.

The temperature range that has the strongest effect on glaze appearance during cooling is 1800°F - 1400°F (1000°C - 760°C). Turn the elements back on to slow the cooling in this range.

## Fast Cooling

There may be times when you need to cool a load rapidly because of a tight deadline. A downdraft vent such as the Orton Vent Master reduces cooling time by around 2 hours.



A small 4" diameter fan can reduce cooling time by 1 ½ hours.

Another method is to aim a small fan at the kiln. This will reduce cooling time by about 1 ½ hours. Make sure the lid is closed all the way and the peephole plugs are inserted. Do not aim the fan directly at the peepholes; aim it on the other side of the kiln away from the peepholes.

Cooling too rapidly may cause problems such as breakage of the ware. If this happens, cool more slowly from 1000°F - 500°F (537°C - 260°C).

## When Can You Unload the Kiln?

Wait until the kiln cools to room temperature before unloading. The ware should be cool enough to unload bare-handed. Otherwise glazes may craze. If this happens, the ware will make a faint pinging sound as the glaze contracts on the ware.

**Note:** When unloading the kiln, wear leather gloves to protect your hands from small glaze shards.



## The Basics of Firing

### Keep a Firing Logbook

One of the easiest ways to learn about your kiln is to keep a firing logbook. When firing the kiln for the first time in awhile, you can review your logbook to regain a quick “feel” for the kiln. The logbook is vital if you are experimenting with glazes or other materials. Information to record in your logbook:

- Date
- Digital: a) Cone-Fire firing speed and Hold or b) Ramp-Hold program
- Starting time
- Total firing time
- How long the lid was vented
- Type of pieces

- Firing results (i.e., color of glazes)

In addition, think of the logbook as a diary. Write down anything you learn about your kiln each time you fire it.

Include a simple sketch showing shelf spacing inside the kiln. Include the height of posts and the type of ware on each shelf. Sketch a diagram of the pyrometric cones showing how far they bent. Even a rough sketch contains a lot of information.

## Low- and High-Fire Clay

Clay is usually fired twice. The first firing is the greenware, or bisque, firing; the second is the glaze firing. The greenware firing hardens the raw clay so that it can accept glaze.

**Note:** Greenware is unfired clay. Bisque is fired clay that has not yet gone through the glaze firing.

**Q** What is the difference between firing low- and high-fire greenware and glaze?

**A** Low-fire greenware is fired to a higher temperature than the glaze firing. High-fire greenware is fired to a lower temperature than the glaze firing.

**Caution:** Do not fire plaster, plaster of paris, or polymer clay in the kiln. They are not designed to be fired to high temperatures.

## Glazes

Glaze and clay must expand and contract at the same rate. If the glaze shrinks more than the clay, the glaze will “craze,” forming a pattern of small cracks. If it expands more than the clay, it will “shiver,” breaking off in sections. Test each clay and glaze combination using clay scraps such as broken bisque pieces.

**Note:** Instead of making glaze test samples on throwaway clay scraps, create something useful from the tests. For instance, test glazes on small clay disks that include a hole for a chain and a stamped design on the front. Give them away or sell them as pendants. What you consider glaze imperfections or ugly test colors may be beautiful jewelry to others.

Your hands must be clean when touching glazed ware. Oil and hand lotion will leave fingerprints. If you scrape off or damage the color during handling, you can usually repair it by applying more glaze over the damaged spot before firing. Allow the glazes to dry before firing.

## Scheduling a Firing

In your notes, write down the total firing time for each type of ware. Then calculate when to begin the next firing so you will be near the kiln at the expected shut-off time. Never leave a kiln unattended, especially near the shut-off time.

If a firing would ordinarily end after you leave the studio, start it sooner. One way to do this is to pre-heat the

ware the night before on low heat—200°F (93°C)—so that the next day the kiln will fire to completion sooner.

## Basic Guide to Firing Ceramics

Even if you are a beginner, you should get good results by following these guidelines:

- 1 Dry the greenware thoroughly before firing. Place the ware against the inside of your wrist. The ware should feel warm. Drying the greenware will help eliminate explosions caused by moisture in the clay turning to steam.
- 2 Know the cone number for each clay and glaze, and fire to the correct cone. Correctly label clay storage containers.
- 3 Make sure all the pieces that you fire in a kiln load are rated to the same cone number. Firing low-fire pieces in a high-fire load can melt clay into a puddle and ruin shelves.



Self-supporting cones on the kiln shelf verify that the clay and glazes receive the correct amount of heat work.

- 4 Place pyrometric self-supporting witness cones on a kiln shelf. The cones are inexpensive, take only a moment to use, and verify that the clay and glazes receive the correct amount of heat work.
- 5 Keep shelves and ware at least 1" away from the thermocouple or Kiln Sitter tube. Ware or shelves placed too close to the thermocouple can cause inaccurate readings. Items placed too close to the Kiln Sitter (used on switch-operated kilns) can cause an overfire by preventing the rod from dropping.
- 6 Vent the firing chamber during the initial stage of firing. Either prop the lid or use a down-draft kiln vent.
- 7 Fire slowly enough to burn out impurities from the clay. Most firing problems are caused by either a poor fit between clay and glaze or firing too fast.



Keep shelves and ware at least 1" away from the thermocouple or Kiln Sitter tube.

- 8 Monitor the kiln during firing. Occasionally check the kiln, especially near the end of the firing.
- 9 Become familiar with the color around the lid and with the noises that a kiln makes during firing. With practice you can judge the approximate kiln temperature just by the color of light around the lid.

## The First Firing in Your New Kiln

The first firing should be to cone 01 - 2046°F (1119°C), which is hot enough to soften the elements and seat them properly in their recessed grooves. It will also form a good oxide coating on the elements for longer element life.

Foreign materials interfere with the formation of this oxide layer. So for your first firing, position only posts and kiln-washed shelves in the kiln with pyrometric cones placed in front of a peephole. Air must circulate around the empty shelves, so separate them with posts as if the shelves were loaded with ware. The shelves may crack if you stack them in the bottom of your kiln.

**Note:** Test-fire new kiln furniture any time you buy it in the future. Load the furniture in the kiln as described above, and fire it without ware. This removes moisture from the new furniture and prevents a hidden crack in a shelf from breaking the first time and ruining a load of ware.

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 for a couple of seconds 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 that the kiln makes during operation. It is the sound of relays on digital kilns or infinite control switches on manual kilns and is normal.



The line of light that appears under the lid is normal for a kiln.

- 1 Seat the elements in their grooves by performing the kitchen knife test (page 7).
- 2 Empty the kiln and clean with the brush attachment on a vacuum cleaner.
- 3 Apply Paragon all-purpose, high fire kiln wash to the kiln bottom and the tops of shelves (page 19).
- 4 **Manual-fire kilns:** Adjust and test the Kiln Sitter. (See the separate "Paragon Switch Operated

Ceramic Kiln Instruction and Service Manual.”) Insert an 01 small cone on the Kiln Sitter cone supports. (Reminder: Remove and save the firing gauge.)

**5** Load the shelves into the kiln, separating them with posts. Do not load ware into the kiln for this first firing. Place an 01 large cone on a shelf where it can be seen through a peephole.

**6** Prop the lid with the Prop-R-Vent. Close the lid after one hour. Leave the peephole plugs out of the peepholes. (Unless you are firing with a motorized downdraft vent. See page 26.)



Monitor the kiln closely during this first firing. Periodically look at the cone through the peephole. (Be sure to wear firing safety glasses.) When the shelf cone bends to 6 o'clock, the kiln should shut off. If it doesn't, turn it off within 10 minutes. Write down the total firing time. This will help you predict future firing times. After the kiln shuts off, leave the lid closed until the kiln has cooled to room temperature. Cooling time is usually twice the firing time.

Always make sure the kiln has shut off before leaving it for the night. Do this with every firing!

**Q** I have noticed a soft buzzing noise while my kiln fires. This worries me.

**A** Magnetism is formed when electricity passes through a coil of wire such as a heating element. Depending on where you live, AC electricity changes direction 50 to 60 times per second. When it flows in one direction, the coils attract each other. When it changes direction, they repel each other. That causes the humming noise. You will notice that the humming lessens as the kiln gets hotter. This is because the element coils become soft and no longer vibrate.

## Loading and Firing Low-Fire Greenware

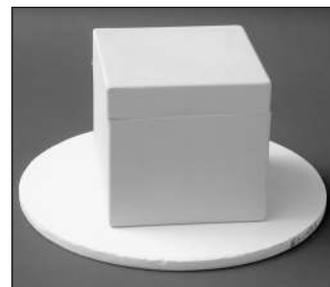
Low-fire greenware has a firing range from cone 06 to 02. The greenware must be bone dry before firing. Otherwise, it will crack or even explode in the kiln. Check for dryness by touching to a cheek or against the inside of a wrist. Ware will be cold if it is not dry. Another indicator of moisture is patches of darker color in the clay.

Handle greenware carefully. Cradle the pieces from the bottom with both hands. Do not lift by a rim. Low-fire greenware pieces do not stick together during firing. Therefore, greenware may be stacked so that it touches each other. Fill shelves by placing small items around larger ones. You can also place light greenware pieces in-

side larger ones. This is called nesting. Be sure there is plenty of room for expansion inside the larger pieces. Pack nested pieces lightly so that heat can still circulate freely around each piece. Black rings in the fired ware indicate that the nested pieces were packed too tightly to burn off all the carbon.

Greenware does not need stilts. Load small, short pieces directly on the firebrick bottom. If you load large, flat pieces on the firebrick bottom, place short posts under them for air circulation. Large, heavy pieces of greenware will fire best if placed across two half shelves positioned at an even height. This allows air to circulate under them. To make full use of the kiln's capacity, place ware of the same height in each layer.

Fire ware 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, such as a box with its lid, should be fired in place to ensure a good fit. You can also stack mugs and bowls rim to rim.



Pieces to be used together, such as a box with its lid, should be fired in place.

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.

Peephole plugs are supplied with your kiln. See page 9 for instructions on peephole plugs. Allow the kiln to cool to room temperature before opening the lid.

## Loading and Firing Low-Fire Glaze

The difference between loading greenware and glazed ware is that glazed pieces must not touch each other, the floor, or a shelf in your kiln during firing. If this happens they will be permanently bonded together and ruined by the melted glaze.

The natural expansion and contraction of the insulating firebrick during each firing generates tremendous stresses within the firing chamber. As a result, fine grains of firebrick may form on the surface of the sidewalls and should be removed before each firing. Wipe the sidewalls with a clean, damp cloth or vacuum the sidewalls 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 coated 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. Even then, separate the glaze from the greenware by loading glazed pieces in the bottom of the kiln and greenware on shelves above. Low-fire glaze usually fires to a lower cone than greenware, so firing time will be shorter if glazed pieces are loaded separately.

Check to make sure that first, no two pieces of glazed ware are touching each other, the kiln walls, the floor or the shelves; 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 glaze pinholes.

To eliminate stilt marks, you can prevent glazed pieces from sticking to the shelf or kiln bottom by “dry footing.” This is an alternative to stilting. 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. Do not use dry footing for low-fire glazed pieces that will be placed in water while used or cleaned. The unglazed areas will absorb water, which can cause glaze crazing. The foot ring may also turn gray.



To “dry foot” a piece, remove all glaze from the portion of the piece that will rest on the shelf.

If you are firing ware draped with lace, prop the lid with the Prop-R-Vent until all smoke disappears.

**Note:** For instructions on stilts, see page 16.

Peephole plugs are supplied with your kiln. See page 9 for instructions on peephole plugs. Allow the kiln to cool to room temperature before opening the lid.



Prop the lid in the extended position when firing ware draped with lace. Lower the lid when all smoke disappears.

## Loading and 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. Before loading the kiln, make sure your pieces are clean and completely dry. Remove smudges

and fingerprints from the bottom of pieces, and gently wipe off any dust with a soft cloth.

China paints will crack or peel if 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 to 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. Do not fire reds and yellows 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 information on which cone to use with each color and type of ware.

Fumes in the kiln will dull the colors—especially gold and lusters. Vent at low temperatures to remove the fumes. Overglaze may require extra venting with the Prop-R-Vent until all smoke and odors from china paint oil and other organic materials have vanished. How long this takes depends on how much decoration is on the ware.

**Note:** Some artists vent throughout the entire firing for best results.

Plates fire better when supported by a plate holder or placed on edge vertically to permit even heating. If fired on edge vertically, plates may be supported at the bottom with large spur stilts, which can also be used to separate adjoining plates. Tall posts can be used to prevent plates from touching the kiln wall.

Plates, tiles, and ware with uneven thicknesses may crack when fired directly on a kiln shelf or kiln bottom. This is because the sections that touch the shelf are cooler than the rest of the piece. To prevent cracking, place a stilt under the piece to lift it off the shelf.

You can use stilts to separate a stack of horizontal plates. Place a three-point stilt under the bottom plate and between each plate stacked on top. Line the stilts up vertically. Be careful not to scratch the painted surfaces of the plates with the stilts. You can use this technique to stack several plates.



You can use stilts to separate a stack of horizontal plates. But do not stilt soft glazed pieces. Test if you are not sure.

**Caution:** Do not stilt soft glazed pieces. Test if you are not sure.

Overglazes can usually be fired and cooled rapidly. The exception is pieces with uneven thicknesses, such as a vase with thin walls and a thick base. In general, fire china paints 2 - 2 ½ hours.

**Note:** Some artists find that slow firing helps bring out the full color of china paints.

**Note:** Try adding a 20-minute “hold” or “soak” to the end of a china paint firing. Some artists find that this improves color saturation. (Switch operated kilns: Use a pyrometer and adjust the switches to hold the temperature.)

Allow the kiln to cool to room temperature before opening the lid.

## Loading and Firing Ceramic and Glass Decals

You can fire ceramic or glass decals in any kiln that can reach 1450°F (787°C). Decals are an excellent beginner’s project, because you can achieve success with your first firing. You can fire decals onto glazed ceramic cups, tiles, light switches, photo frames, and much more. See your local ceramic supplier for blank ceramic ware and the decals to fire on them.

Don’t worry if you ruin the first few decals. Applying them takes practice. Before starting, clean the ceramic or glass piece with water.

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



Slide the decal off the paper backing.

- 2 Position the decal on the ceramic or glass piece. The side of the decal that was down on the paper is the same side that goes down on the ceramic or 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.



Squeeze out air bubbles and water from the decal.

- 4 Dry the ceramic or glass piece overnight before firing.
- 5 Fire a glazed ceramic blank on a stilt. Glazed pieces must not touch each other. Fire glass directly on a kiln shelf. The shelf must be coated with kiln wash.

- 6 Fire in a well ventilated area. Keep the top vent plug out during the first hour or until the smoke and odor disappear.
- 7 Fire at a rate of 500°F (275°C) to the recommended temperature for the decal you purchased. Most decals fire to cone 015 - 018.
- 8 After the kiln shuts off, leave the lid or door closed until the kiln cools to room temperature.

## Loading and Firing Porcelain Greenware

Porcelain greenware refers to clay bodies that mature at a point between cones 4 to 10. Porcelain is vitreous, and the white color will usually show the shadow of the hand if held up to a strong light.

**Note:** Porcelain greenware is very fragile. You will have an easier time cleaning it by soft-firing it to cone 018. At this temperature the ware is still soft enough to clean yet not as fragile as 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 surface of the fired ware.

Stilts CANNOT be used to support porcelain greenware. They would embed into the porcelain at high temperatures. 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 the kiln-washed surfaces.

**Caution:** Never use a low-temperature ceramic kiln wash in a kiln that will ever be fired to porcelain temperatures, as the ceramic kiln wash will harden at high temperatures and be impossible to remove.

Pieces of ware that are to be used together must be fired together, such as a box and its lid. Dry high fire kiln wash can be used to separate these pieces during firing. Wet kiln wash would be too difficult to remove.





You can support delicate porcelain with wads of ceramic fiber.



Rolls of porcelain clay are used here to support a delicate piece.

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 bone 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.



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. It is not necessary to use peephole plugs. If you decide to use them, leave them out until the firing is half over. If you are firing ware draped with lace, you may need to vent the lid with the Prop-R-Vent. Lower the lid fully after all smoke disappears.

Peephole plugs are supplied with your kiln. See page 9 for instructions on peephole plugs. Allow the kiln to cool to room temperature before opening the lid.

**“I used to have this wonderful haiku pinned up above my kiln when I had my studio:**

**“Now that my house has burned down, I have a better view of the rising moon.”**

**“During firing, I would lose stuff that I had made. Things I thought would be beautiful turned out ugly. The haiku helped me realize that I had to live with loss and ‘failure’ and learn from it.”**

**—Sandra Dwiggin**

## Loading and Firing Porcelain Glaze

Loading porcelain glaze is similar to loading porcelain greenware. For good heat circulation, keep the ware at least ¾" from the sidewalls.

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.



To dry foot a piece, remove all glaze from the portion of the piece that will rest on the shelf.

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.

Peephole plugs are supplied with your kiln. See page 9 for instructions on peephole plugs. Allow the kiln to cool to room temperature before opening the lid. Cooling time is usually twice the firing time.

## Loading and Firing Stoneware Greenware or Glaze

Stoneware is made from vitrifiable clays with a firing range of cone 2 to 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 to cone 04 - 06, 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. Place small items on the kiln bottom and large, heavy pieces across two half shelves.

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.

# IMPERFECTIONS

Keep detailed records of your firings. This will help you solve imperfections in the ware. The best way to prevent imperfections is to test glazes and clays. Use either a small test kiln, or place test pieces in a kiln load wherever you can find an empty spot on a shelf. Test every new batch of clay.

## General

**Breakage or cracks** Sometimes the ware breaks days or weeks after it was fired. Causes are a poor “fit” between the clay and the glaze, firing too rapidly, cooling too rapidly, removing the ware from the kiln before the kiln has cooled to room temperature, and different thicknesses in the ware (i.e. a cup with thin walls and thick bottom).

Some clays are prone to cracking no matter how they are thrown or fired. Experiment with different clays to find one less prone to cracking.

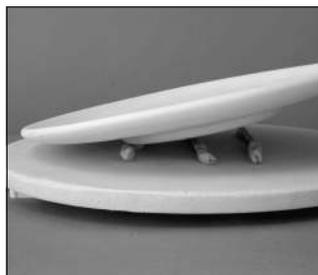
To cool slowly:

**Digital controllers:** Program a slow cooling.

**Switch-operated kilns:** Turn the kiln on Low for an hour at 1000°F (537°C) during the cooling cycle.



Place rolled strands of clay under large platters or plates.



Separating the plate from the shelf helps to prevent cracking of the ware.

Large platters can crack during firing if they are placed directly on the kiln shelf. This is because the section that is in contact with the shelf heats and cools at a different rate than the rest of the piece. To separate the piece from the shelf, place the piece on small mounds of alumina hydrate, small squares of firebricks, or thin coils of clay. (Roll the coils of clay in your hand to the thickness of a pencil. Press the ware down onto the coils while the coils are still pliable. This separates the ware from the shelves, which are thicker and therefore heat and cool more slowly than the ware. The part of the ware that is in direct contact with the shelf remains hotter or cooler than the rest of the piece.)

Place large flat items in the center of the shelf so that they receive more even heating than they would get when placed on the outside edge of a shelf.

Try firing to a higher temperature in the bisque firing. This strengthens the ware.

**Note:** Only vitrified ware should be used in a microwave oven. (Vitrified clay has been fired to a point where the particles become glass-like and no longer absorb water.) Non-vitrified clay such as earthenware is generally not suitable for microwave use, because the clay absorbs water. The water in the pores of the clay can expand rapidly enough in a microwave to cause the ware to crack or even explode.

## Bisque

**Warped ware** can be caused by distorting upon removal of the piece from the mold, firing too close to the elements, firing a piece in an unnatural position, or firing on warped shelves. To prevent porcelain cups or bowls from warping when firing the greenware, edge the top of a cup with pinches of dry silica or DRY all purpose, high fire kiln wash and place a second cup on top of the first cup, lip to lip, with handles going in opposite directions. Porcelain greenware plates may require firing in plate saggars to prevent warping during firing.

**Explosions** The greenware contained moisture that reached the boiling point. Dry the greenware more thoroughly before firing; allow moisture to escape the ware before firing hotter than 200°F (93°C). Can also be caused by trapped air inside the clay.

**Sagging ware** is usually the result of overfiring. Porcelain objects can sag if not properly supported during firing.

**Black coring** When you break a piece of ware, a black line that appears down the center of the clay's cross section is called black coring. The carbon burned out of the clay surfaces but not all the way through the cross section of the clay. Vent longer; fire more slowly to give the carbon more time to burn out.

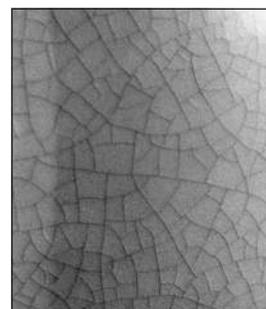


To prevent black coring, vent longer or fire more slowly.

**Bloating** If the ware is fired too rapidly during the beginning stages, the outside of the clay will become plastic before the gases have a chance to escape. This seals in the gases. Gases that escape too rapidly cause the clay to become bloated. Slow down the firing, or fire the bisque a little hotter.

## Glaze

**Crazing** appears as a network of tiny cracks in the glaze. To check the ware for crazing, dab the ink from a fountain pen



onto the ware or examine it under a magnifying glass. Crazeing is caused by a poor “fit” between the clay and glaze resulting in more shrinkage of the glaze than the clay during cooling. One of the signs of crazing is the faint plinking noise from the ware as it cools. Removing the ware before the kiln has cooled to room temperature can accelerate crazing. Find a better clay/glaze combination. You might also try a thinner application of glaze or fire the bisque to a higher temperature. Crazeing in spots can be caused by not having mixed the glaze thoroughly before using.

**Delayed crazing** is sometimes caused by moisture that absorbs into the ware. This is seen in low-fire, non-vitreous clays.

**Discolored glaze or variation in colors** Placing ware too close to a heating element can cause discoloration on the side that faces the element. Glaze of one color can affect the glaze of another color when ware is placed too close together in the kiln. Firing rapidly can also cause uneven colors, because the inside of vessels cool at a different rate than the outside. Slowing the firing gives these surfaces more time to become even in temperature. Other causes are insufficient venting during the early stages of firing or overfiring glazes in the red family.

**Glaze too thin in spots** can be caused by uneven glazing or a “hard spot” on low-fired bisque. Ceramic glaze should be applied in flowing coats; first in one direction and the next coat in an opposite direction (horizontal, then vertical or vice versa). Allow the glaze to dry between each coat. Some glazes may require twice the recommended coats because of thin application. Porcelain glaze should be sprayed or a brush-on type used. Hard spots are sometimes the first spot where the poured slip touches the mold. Heating bisque in an oven to approximately 120°F (49°C) will help in applying glaze to hard bisque.

**Black specks in the ware** are usually caused by organic materials not completely burned out in the bisque firing. This works its way to the surface during the glaze firing.

**Pinholes and bubbles in glaze** Carbon that did not burn out during the greenware firing is released during the glaze firing. Escaping gases rupture the glazed surface, causing bubbles and pinholes. Firing the glaze too fast may also cause this. Soak or slow down the kiln near the end of the firing. This gives the glaze more time to heal any bubbles that have formed. Pinholes or bubbles can also be caused by too heavy a glaze application, by se-



Glaze craters.

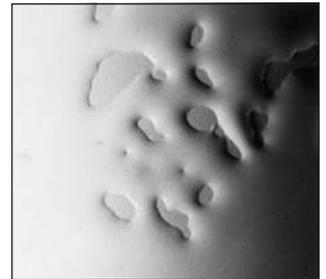


Glaze pinholes.

vere underfiring, or by dust on the bisque. Vacuum the kiln before firing a glaze load. Wipe dust from the underside of shelves before loading into the kiln. You can sometimes break the bubbles, fill in the craters with glaze, and refire the piece.

**Light edges on dark glass glaze pieces** may be caused by the flow of the glaze away from the edges in two directions. Try an extra coat of glaze on the edges, or apply a thin coat of underglaze in the following manner: Mix 1 part water with 2 parts of suitable dark or black underglaze and brush a thin wash coat of the underglaze over the bisque ware. Then, immediately apply the first regular coat of full strength glaze. Allow to dry thoroughly between coats. Continue with the number of coats recommended by the manufacturer.

**Crawling or bare spots on a fired piece** can be caused by applying the glaze too heavily. Oil from your skin that gets on the greenware before it is fired can also cause this. Crawling may be corrected by applying more glaze to these spots and refiring.



Glaze crawling.

**Shivering** The clay has contracted more than the glaze causing the glaze to flake off. Reformulate the clay or glaze for a better “fit.”

**Running glaze** Apply a thinner coat, fire to a lower temperature, or reformulate the glaze. Some glazes, such as crystalline glaze, almost always run. You can protect the kiln shelf by placing a flat, thin, circular slab of clay under the piece to catch the running glaze. Coat the clay “coaster” with kiln wash.

## Underglaze

**Streaks in underglaze** are usually caused by not applying enough coats to the greenware. After a piece has been decorated with underglaze and fired, you can check it for streaks by submerging it in water and immediately removing it. The piece will appear glossy, just as if it had been glazed, and streaks and thin spots will show up. The weak spots can be touched up and refired. Be sure the underglaze has been fired before putting it under water. For interesting designs, underglaze colors may be applied over unfired matte or texture glazes that do not flow.

## Overglaze

**Breaking during 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 prevent plate breakage.

**Purple spots in gold** are usually due to a thin application of gold or too much thinner. If gold is applied acci-

dentally to an area and then removed, it will show purple after being fired unless cleaned with a good gold remover.

**Dull gold** is caused by inadequate venting.

**Broken lines in gold** can be caused by overfiring or too heavy an application. However, this is can be very attractive when gold is crackled over a dark color of fired glaze.

**Peeling china paint** can be caused by applying the paint too heavily.

**Loss of color in china painting** is usually a result of overfiring or thinning your paint with too much medium when applying.

**Faded colors in overglaze decals** are a 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 decal supplier's recommendations. If the decal was underfired, refire to the proper firing cone. If the decal was overfired, the design may be repainted in china paints and refired.

**Blank spots in decals** are caused by air bubbles under the decal. Make sure the piece is clean and smooth before applying the decal and that excess water has been removed from under the decal.

**Weakening of luster colors** can be caused by overfiring. White spots in lusters or metals can be caused by moisture on the ware before it was placed in the kiln or from having been fired at the same time as other overglazes. Apply lusters only on a dry day.

**Powdering of luster colors** can be caused by too heavy an application.

## Porcelain

**Bumps in porcelain** are usually caused by firing wet greenware or by overfiring the porcelain bisque.

**Lack of translucency** in porcelain can be caused by pouring the ware too thick or underfiring.

**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 menders available from your supplier.

**Holes in lace or fabric** that appear after firing can be caused by inadequate application of the slip. Wash the fabric thoroughly before dipping it into the slip. Apply enough slip to the fabric so the clay will be strong enough to hold its own weight. The fabric must burn out before the clay matures, leaving only the clay shell, which must be strong enough to support its own weight.

**Gray marks** are caused by moisture trapped in porcelain during the porcelain bisque firing. This is called mildew. Vent moisture from the ware, and fire the porcelain to full maturity.

# KILN MAINTENANCE

**Note:** This section includes removing the switch box and changing elements. For instructions on replacing switch box components, see the separate switch or controller instruction manual that came with your kiln.

## How to Open the Switch Box

**Note:** The switch box is the metal housing that covers the element connectors and holds the electrical components such as switches or the digital controller.

**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."

### The Non-Hinged Box

- 1 Disconnect the power to the kiln.
- 2 Remove and save the screws at the side of the switch box that hold it to the kiln.
- 3 Remove the box, pulling straight out to avoid damaging the Kiln Sitter porcelain tube (if any). You may need to prop the switch box on a chair, wooden box, or other object as you lean the switch box against the kiln.



### The Hinged Drop Box

**Note:** Your switch box is hinged if it has a folding arm on the side of the box.

- 1 Disconnect the power to the kiln.
- 2 Remove the top two screws of the switch box. The box will open forward.
- 3 Opening the switch box will show the element cover. To gain access to the elements, remove the screws on the sides of the element cover. Lift out the element cover.





Removing the element cover to gain access to the element connectors. Not all kilns have an element cover.



## Preventive Maintenance Inside the Switch Box

The best time to perform preventive maintenance is when you have opened the kiln's switch box to change elements 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" away from the parts you are spraying.



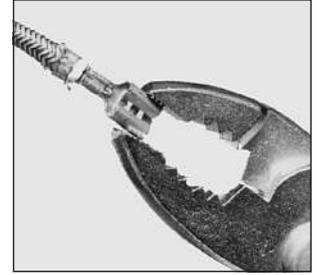
Cleaning the switch box with canned air.

**Note:** You could also use a vacuum cleaner and a dry paintbrush to clean the switch box of switch-operated kilns. But we do not recommend them 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, too, which can raise the resistance and cause the wires to overheat. Replace damaged wires.

**Note:** Do not use electrical tape to repair wiring inside a kiln switch box.

- 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 a loose connector to tighten, but replace connectors that have been damaged by heat.

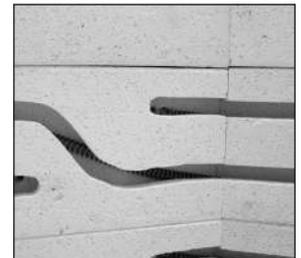
- 4 Check the element connectors for corrosion, which will turn the connectors white or green. Corrosion is usually due to a loose screw holding the connector and sometimes due to a loose wire terminal. A loose element connector will slow the firing, even if the element itself is okay. Tighten corroded 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.

## Element Maintenance

### How to Get the Longest Life Out of Your Elements

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.



**Note:** 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.

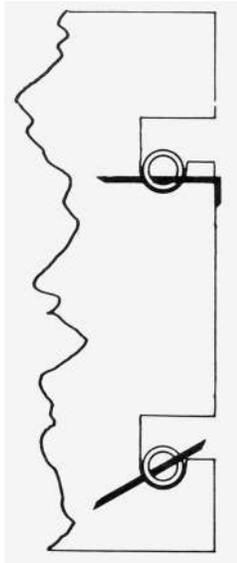
High temperature elements are damaged by contact with silica or silica bearing compounds, such as glaze and kiln wash. If silica touches an element, the element will burn out during the next firing. This type of damage is not covered by warranty.

Also, reduction firing, which removes the oxygen from your kiln, will ruin your elements. The elements are protected by a coating of oxidation, which reduction firing destroys. Reduction is performed at your own risk; elements damaged by reduction are not covered by warranty.

All heating element wires change in length with use. This is an inherent characteristic that metallurgical science has never found a way to control. This change can cause elements to shrink away from the corners and bulge outside the grooves into the kiln. At porcelain tem-

peratures, however, elements become quite soft and will not support their own weight. During high temperature firing, the elements soften to conform to the shape of their grooves.

If you never fire hotter than cone 05, the element never becomes soft enough to conform to the grooves, so bulging may occur. If you do not fire hotter than 05 and you are having a problem with bulging elements, you may want to pin the elements in place as follows:

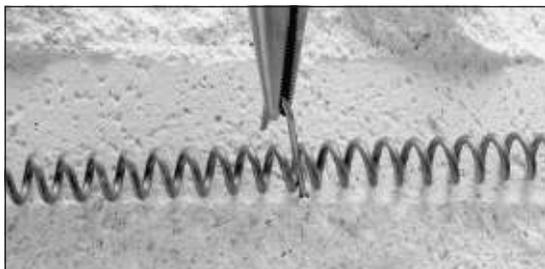


- 1 Disconnect the power from the kiln. Whenever you turn off the circuit breaker to your kiln, tape the breaker box door shut and leave a note saying, "WORKING ON KILN. BREAKER OFF."
- 2 Cut a Paragon element staple in half at an angle to leave a sharp point. (Use only element staples; do not use a substitute staple from a hardware store.)
- 3 Bend about  $\frac{3}{16}$ " at a right angle.
- 4 Grasp the bent portion with pliers and push it through the lip of the groove at a slight angle. The pin must go over the bottom of the turn in the element coil, holding it against the bottom of the groove.

#### Alternate Method

Push a straight piece of element staple wire, cut at an angle, over a turn of wire and into the back of the groove. This method does not fasten the element as securely as the above method. Its only advantage is neater appearance.

If you check to make sure the elements are seated when you set up your new kiln, and if you fire your kiln to cone 05 or hotter occasionally, your elements will probably stay in their grooves throughout their life. Should the elements start to bulge out of the grooves, they must be resealed immediately.



In addition to the two methods shown in the diagram above, you can also pin an element with a J-shaped pin.

## Reseating a Bulging 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.

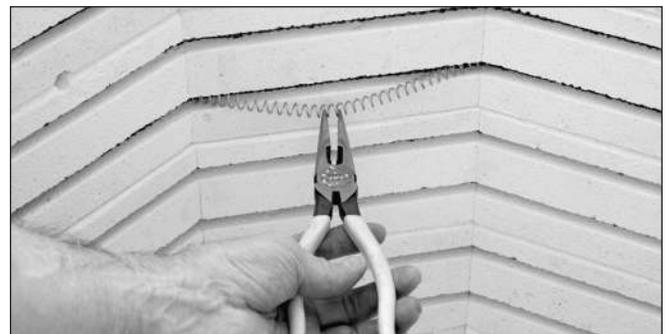
- 1 Always unplug the kiln or disconnect the power before touching the element with anything! Whenever you turn off the circuit breaker to your kiln, tape the breaker box door shut and leave a note saying, "WORKING ON KILN. BREAKER OFF."

- 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.



Using a propane torch with push button igniter to heat a bulging element.

**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 nosed 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.

- 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.

**Note:** Do not use a plastic object, such as a comb, to press hot elements into their grooves. Melted plastic ruins elements.

- 7 Fire the kiln to cone 01 or hotter to soften the elements completely.

## 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.

**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.

**Note:** 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.

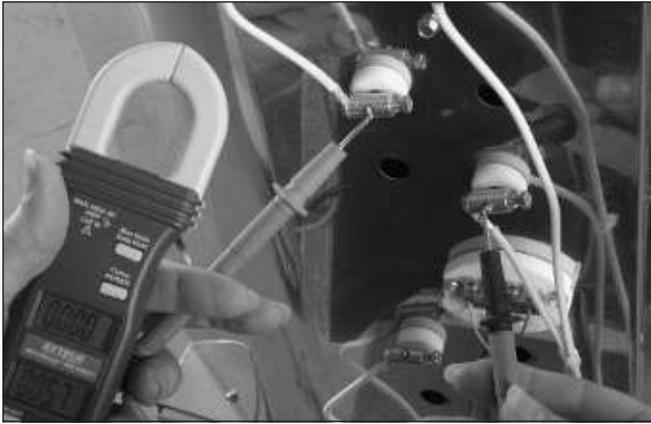
To test an element, find the ohms for that element from the kiln's wiring diagram. If an ohmmeter test gives a resistance that is close to the correct resistance, the element is not broken.

The center elements of most current Paragon kilns are cooler elements than the top and bottom ones. These cooler elements do not glow until the kiln has fired for some time. Also, 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.

**Note:** When an element breaks, it should no longer be able to carry electricity. Sometimes, however, a broken element will show continuity when tested with an ohmmeter or a continuity tester, because as the element cools, in rare cases the broken ends touch. Thus, electricity can still travel through the element. Yet when you fire the kiln, the element will produce little, if any, heat. If you suspect that the element is burned out even though you are still obtaining a resistance reading, check the element grooves with a flashlight. You should be able to see the break.

**Note:** 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 temperatures you normally fire to.

- 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. 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, which is usually on the front of the kiln. Remove the screws holding the switch box to the kiln. Remove or open the switch box. See "How to Open the Switch Box," page 36.
- 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. As the elements age, the firing time will gradually become longer.

- 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. 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 (see "How to Open the Switch Box," page 36). 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  $\frac{1}{2}$ " 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.

**Note:** If necessary, heat the element where it enters the firing chamber. Use a propane torch as shown on page 38. This will allow you to stretch the element slightly to gain extra length.

With  $\frac{1}{2}$ " 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 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).



Tightening the element connector.

**Note:** 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.

## Tightening the Connector on an APM Element

APM heating elements are made from powdered metal. They last longer than standard element wire and are recommended for cone 6 and hotter firings.

APM elements install the same way as standard elements shown below, except for the element connectors. To install the connectors properly, insert the twisted wire end through the hole in the connector. Then rotate the connector until the screw presses against two twisted strands of wire. If the screw presses against only one strand of wire, the connector can become loose. Because APM wire is harder than standard element wire, the element screws need more metal to bite into.

## How to Replace an Element

**Q** Should you replace all the elements 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.

No mechanical skill is necessary to install Paragon replacement elements. However, your local Paragon dealer will install the element for you at a reasonable charge. If you do not have a local dealer, see your appliance shop repairman. He is more experienced in servicing heating devices than an electrician.

**Note:** You can find a list of kiln technicians at [www.paragonweb.com](http://www.paragonweb.com). Select "Support" and then "Kiln Technicians" from the drop menu.

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.

**Note:** 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 the cotton gloves to handle elements if the gloves have also been used to wipe kiln wash from glazed ceramics.

**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.)

**Caution:** 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 switch box and open the box. See "How To Open the Switch Box," page 36.

**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 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. To keep from tangling up the element, keep it on the top rim of the kiln's sidewall when you feed it into the grooves. (If you place the element in the bottom of the kiln, the element will tangle up.) Also, arrange the element so you're feeding the bottom loop first instead of the top one.



Arranging the element so it doesn't tangle up as you install it.

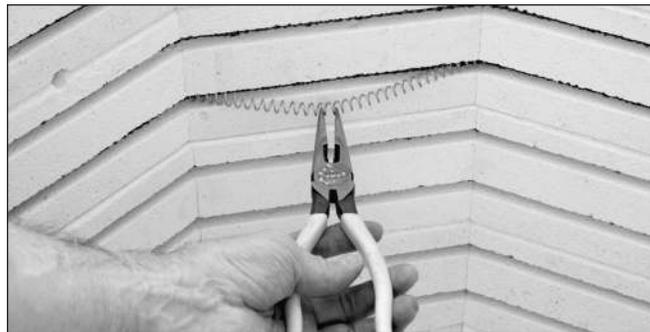
- 9** Thread the new element into the upper element hole inside the kiln.

To guide the element through, you can look into the hole where the porcelain insulator goes. Or you can use the 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** 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 brick wall.

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).



Installing the element connectors.

**Note:** If, when tightening the element connector, you feel the threads strip out, remove the connec-

tor 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 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.)



Install the element connector flush against the porcelain insulator. After tightening, cut off excess length.

- 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.

**Note:** Switch-operated kilns: Watch the kiln closely the first time you fire it after installing new elements. You may need to adjust your firing schedule, because the kiln will fire faster.

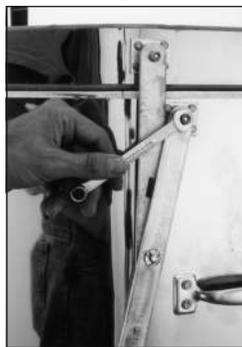
## Firebrick Maintenance

### Replacing a Standard Lid (No LiteLid)

These instructions are for kilns not equipped with the LiteLid spring counter-balance.

**Note:** Drill holes with a  $\frac{1}{8}$ " 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** Remove the nut that holds the lock-in lid support to the lid. (If your kiln is equipped with chains instead of a lid support, remove chains from lid.)
- 2** Remove the screws from the upper lid hinge using a  $\frac{1}{4}$ " nut driver. (Do not remove the lower hinge section from the kiln case. Leave hinge rod in place.) Lift the old lid off the kiln.



Install the hinge so that with the lid closed, the rod rests in the bottom of the slotted hole as shown here.

- 3** Gently place the new lid onto the kiln. Line up the edges of the lid with the sides of the kiln.

- 4** The hinge contains play to allow the lid to float at high temperature. This adjusts for heat expansion. Lift the upper hinge half up and down, and you will feel this play. The upper hinge must be in the lower part of this play when you attach the hinge to the lid. Mark holes in the lid with a felt-tipped pen. Drill holes. Install screws.

- 5** Lift up the back of the lid. The lid should have play in it. If there is no play, the front of the lid could tilt upward during firing.



- 6** Install the upper lock-in lid support stud with 4 screws. Align it as in the photo at right.

- 7** Fasten the lid support to upper stud with the nut removed earlier. (Install chains if kiln is equipped with chains.)



- 8** Install the lid handle and Prop-R-Vent latch.

### 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.

**Note:** Drill holes with a  $\frac{1}{8}$ " 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 two bolts that secure the bottom spring loop. With the spring pressure released, close the lid.

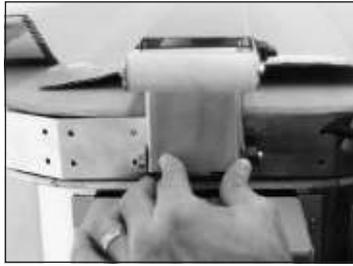


- 2** Using a  $\frac{1}{4}$ " nut driver, remove all screws fastening the front and rear LiteLid brackets to the lid. Lift the horizontal arm of the LiteLid up and out of the way.

- 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 horizontally between the kiln wall brick seams and vertically between the upper and lower edges of the lid.



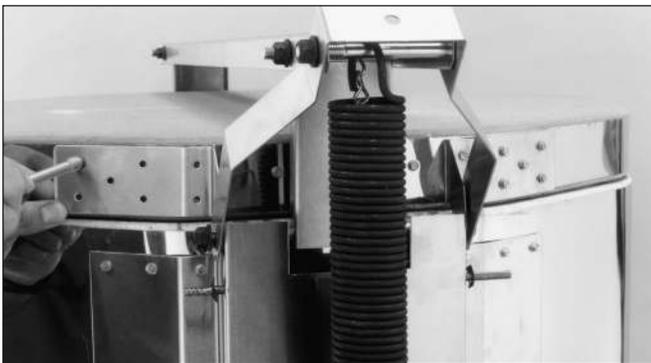
Hold the bracket in this position while you mark two holes for each bracket with a felt-tipped pen. Move the brackets out of the way. Drill holes. Screw the brackets onto the lid. Then drill the other holes for the brackets and install screws.

- 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.



Notice the  $\frac{1}{16}$ " gap in the lid and the position of the slotted hole.

In addition, there should be a  $\frac{1}{16}$ " 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  $\frac{1}{16}$ " 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.



Installing screws in the rear lid brackets.

- 7** Install the lid handles and Prop-R-Vent latch on the new lid.



Installing the Prop-R-Vent latch onto the new lid.

- 8** Have someone hold the lid in the open position while you attach the lower spring loop using the two 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.

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

- 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  $\frac{1}{8}$ " 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.)



To check for play in the hinge, have someone lift the back of the lid, or lift it with the end of a screwdriver.

- 2** The nut on the lid hinge bolt must not be too tight. (See photo above.) 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. (See 2nd photo from top, left column.)

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 in-

stalled 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 Lidelid 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 binding is removed, the lid will float again.

## 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.

## Adding a Steel Base Plate

Paragon 6-, 7-, 8-, 10-, and 12-sided kilns have a galvanized steel base plate under the firebrick bottom. The base plate covers the entire bottom and has tabs that fold up inside the stainless steel case on all sides. Though the base plate is galvanized steel, it may eventually rust especially if you fire moist greenware or live near the ocean.

The easiest way to repair a rusted base is to lay a piece of galvanized sheet metal between the kiln and kiln stand. You don't even need to remove the old base from the kiln.



You can buy the galvanized sheet metal from a hardware store. It should be large enough to protect the entire kiln bottom.

## Replacing the Steel Base Plate and Turning Over the Bottom

**Note:** Follow “Adding a Steel Base Plate” above if you only need to replace the steel base but do not need to turn the brick bottom over.

Replacing the base plate also turns the brick bottom over, giving you a fresh side. Paragon 6-, 7-, 8-, 10-, and 12-sided kilns have a galvanized steel base plate under the firebrick bottom. The base plate covers the entire bottom and folds up inside the stainless steel case on all sides.

Though the base plate is made of galvanized steel, it will eventually rust especially if you fire moist greenware or live near the ocean. A sign of rust is dark flecks of steel under the kiln. (Do not replace the base plate if it has only minor rust.) To replace the base plate, you will need several helpers.

### Non-Sectional Kilns

- 1 Remove the screws that hold the base plate to the kiln: You will find a screw near the bottom of the kiln on each flat side. Do not disturb the other screws in the stainless steel case.



Remove screws.

- 2 Have several people lift the kiln. The bottom and old base plate will remain on the kiln stand while your helpers lift the kiln. Have your helpers hold the kiln up while you work rapidly in Steps 3 and 4.





Place the new base plate on top of the brick bottom while your helpers hold up the kiln.

- Place a new base plate on top of the brick bottom. The bottom is now sandwiched between the new base plate and the old one. Carefully turn the bottom over so that the new base plate is underneath and against the kiln stand. You must use care in turning the bottom over. If it is cracked, the bottom could separate if handled carelessly.

- The old base plate is now on top of the brick bottom. Remove and discard the old base plate.

- Lower the kiln on top of the brick bottom. As you do this, slide the base plate tabs up inside the stainless steel kiln case. Drill new holes and install the screws that you removed earlier.



Slide the tabs on the new base plate under the stainless steel case.

- Vacuum the brick bottom. Apply kiln wash to the brick bottom before firing the kiln.

### Sectional Kilns

- You will find a screw near the bottom of the kiln on each flat side. Those screws hold the base plate to the kiln. Remove the screws.

- On the kiln bottom, you will find twist latches that hold the bottom to the kiln. Remove the screws from the lower section of the twist latches.



Remove the screws that hold the twist latches to the kiln bottom.

- Have several people lift the kiln. The bottom and old base plate will remain on the kiln stand while your helpers lift the kiln. Gently lay the kiln onto a protective sheet of cardboard.



- Place a new base plate on top of the brick bottom sliding the base plate tabs up inside the band. The bottom is now sandwiched between the new base plate and the old one. Carefully turn the bottom over so that the new base plate is against the kiln stand. You must use care in turning the bottom over. If it is cracked, the bottom could separate if handled carelessly.

- The old base plate is now on top of the brick bottom. Remove and discard the old base plate.

- Drill holes for the new base plate and install screws.

- Place the kiln on top of the brick bottom.

- Reinstall the bottom section of the twist latches that were removed in Step 2 drilling new screw holes.

- Vacuum the brick bottom. Apply kiln wash to the brick bottom before firing the kiln.



The kiln with the new steel base plate.

# GLOSSARY

**bisque** Fired, unglazed clay.

**bisque firing** Firing the greenware to harden and prepare for glazing. Also called greenware firing.

**cone, pyrometric** A small pyramid of ceramic materials that will react to the effect of time, temperature, and atmospheric condition inside the kiln in the same way as ceramic ware.

**crazing** Hairline cracks in glazed ware.

**crawling** Bare areas where the glaze did not adhere.

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

**dry footing** Removing all glaze from the bottom of ware before firing. This eliminates the need to stilt low-fire ware.

**earthenware** Low-fired ware that is porous.

**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.

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

**glaze firing** The bisque or greenware firing hardens the ware and prepares it for glaze. The glaze firing melts the glaze over the clay.

**greenware** Unfired clay objects.

**greenware firing** Firing the greenware to harden and prepare for glazing. Also called bisque firing.

**heat soak** Maintaining a particular temperature inside a kiln.

**hold time** The length of time that a temperature is maintained inside a kiln. See "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 most Paragon kilns.

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

**kiln sitter** A cone activated, mechanical device to shut off the kiln at the proper temperature.

**kiln wash** A powder mixed with water and brushed on top of shelves and bottom of kiln's firing chamber as protection from drops of fired glaze.

**limit timer** A Kiln Sitter with a back-up electrical power shut-off. When a clock on the Kiln Sitter runs out of time, it shuts the kiln off.

**luster** An iridescent overglaze, sometimes metallic.

**maturing point** The stage where clay or glaze has received the correct amount of "heat work." This is usually measured by the 6 o'clock bend of a large pyrometric cone placed on a kiln shelf beside the ware being fired.

**overglazes** China paints, lusters, gold, etc., usually used over a fired glaze but may also be applied on polished porcelain bisque and fired for permanency.

**peephole** The hole in the sidewall of a kiln used to see the interior of a hot kiln.

**plaster** A white powder used for making ceramic molds.

**porcelain** A vitrified, translucent ceramic ware.

**pyrometer** An instrument for measuring 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.

**relay** A switch triggered by an electromagnet. A digital controller sends power to the electromagnet, which closes a switch that turns on the heating elements.

**segment** A set of programmed instructions for the digital controller in the Ramp-Hold mode. A segment changes firing speed, temperature, and can add hold time.

**silica** A mineral that will not harden at a very high firing temperature, used for separating porcelain greenware during firing.

**slip** A liquid clay used in making ceramic objects by casting.

**stilts** Small clay- or metal-tipped supports used to prevent glazed objects from sticking to the kiln or shelf.

**stoneware** A vitreous ceramic body usually made from native clays.

**thermal shock** Stress caused by sudden changes in the temperature of ceramic ware. Can cause cracks or breaks.

**thermocouple** The measuring unit of a pyrometer that is inserted into the kiln's firing chamber.

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

**underglaze** A decoration applied to greenware or bisque, usually applied under the glaze.

**venting** At the beginning of the firing, allowing air to come into the kiln and vapor and gases to escape. This is one of the most important steps in firing.

**vitrify** To change into a glassy or a non-porous state by heat and fusion. Vitreous clay is strong and waterproof. It makes a ringing sound when struck.

# INDEX

## A

alarm clock, 5  
alumina hydrate, 20 - 21  
aluminum wire, 9  
APM heating elements, 41

## B

base plate, 18, 45  
bead rods, 17, 24  
bisque, 18, 28  
black coring, 34  
bloating, 25 - 26, 34  
bubbles, glaze, 26, 35  
buzzing noise, 30

## C

candling, 18, 27  
cement, 5  
china paint, 31, 36  
circuit, 8 - 9  
circuit breaker, 4 - 5, 8  
clicking noise, 2, 7, 29  
clothes dryer circuit, 9  
convection, 23  
cooling, 27, 34  
cordset, 4 - 5, 7  
cracking ware, 34  
cracks, firebrick, 2  
cratering, 25  
crawling, 35  
crazing, 25 - 26, 28, 30 - 31, 34

## D

decals, 32, 36  
downdraft vent, 18, 23, 26, 28, 29  
dry footing, 31, 33  
drying, 29

## E

earthenware, 5  
element connectors, 37, 40  
elements, 7, 9, 14, 17, 19, 20, 29, 36 - 37 - 39, 41  
extension cord, 4

## F

fan, 6 - 7, 20, 26, 28  
fire extinguisher, 4 - 5  
firebrick bottom, 24, 30  
firing logbook, 28  
firing safety glasses, 4, 13  
first firing, 29  
furniture kits, 16

## G

glaze discoloration, 35  
gold, 31, 35 - 36  
greenware, 5, 18 - 19, 22, 25, 28 - 30  
grit cloth, 20  
grounding wire, 9

## H

haik brush, 19

## I

insurance, 4

## K

kiln furniture, 21, 29  
kiln wash, 5, 12, 17, 19, 21, 23, 29, 31 - 32, 41

## L

lid, 20, 22 - 23  
lid coating, 11  
lid support, 6  
LiteLid, 11, 43  
lusters, 31, 36

## M

microwave oven, 5, 34  
mildew, 25 - 26, 36  
mirror, 18  
moisture, 18  
moth balls, 5

## O

ohmmeter, 39  
Orton Vent Master, 6, 10, 20, 26  
overglaze, 31

## P

peeling glaze, 25  
peephole, 6, 14, 26  
peephole plug, 18  
peephole plug, drilled, 26  
pinging or plinking sound, 28, 35  
pinholes, 25 - 26, 35  
plate holder, 35  
plates, 31  
porcelain, 16, 20, 24, 32 - 34, 36  
posts, 16  
propane torch, 9, 38  
Prop-R-Vent, 10, 18, 26, 30 - 31, 33  
putty knife, 19, 21  
pyrometer, 25  
pyrometric cones, 4, 11, 19, 22, 23, 25

## Q

quartz inversion, 25

## R

reduction firing, 37  
respirator, 19 - 20  
rust, 26, 45

## S

sand, 20  
sand paper, 20  
shelves, 16, 21  
shivering, glaze, 28, 35  
silica sand, 17  
smoke alarm, 5  
snap-ring pliers, 7, 39  
static electricity, 17  
steam, 18  
steel base, 11, 45, 46  
stilt stone, 16  
stilts, 6, 16, 30 - 33  
stoneware, 16, 20, 22, 24, 33

## T

thermocouple, 17, 21, 23, 29  
tile holder and setter, 17, 22, 24

## U

underglaze, 35

## V

vacuuming, 5, 8, 10, 17, 18, 21, 29 - 30, 41  
venting, 6, 25 - 26  
vitrified, 5, 32, 34  
voltmeter, 9

## W

wall outlet, 5, 29  
water smoking, 25



**Paragon Industries, L. P.**  
Better Designed Kilns™  
2011 South Town East Blvd.  
Mesquite, Texas 75149-1122  
Toll Free: 800-876-4328  
972/288-7557  
Toll Free Fax: 888-222-6450  
Fax: 972-222-0646  
info@paragonweb.com  
www.paragonweb.com