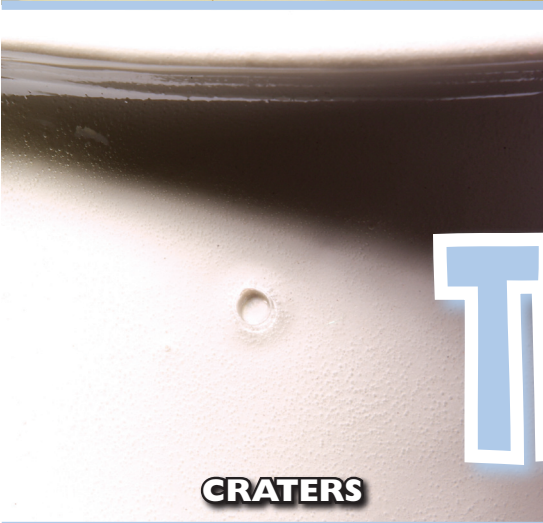




CRACKING



GLAZE STARVATION



CRATERS



HARD SPOTS



CRAWLING

STUDIO TECHNICAL GUIDE



MILKY OR HAZY COLORS



CRAZING



SHIVERING

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Limitations Notice

This Technical Guide is designed to offer studios an overview of the majority of bisque, glaze, and firing issues they may encounter. It offers pictures and descriptions to assist the identification of problems and basic methods of resolving the problems. It is not comprehensive but should work well as a reference or training manual for new employees. If a studio encounters a problem not covered in the manual or the offered solutions do not resolve the problem, please contact the supplier of the products or equipment for further assistance. Moreover, the technical portion of the CCSA website is an excellent resource for further and more in depth technical information.

Special Acknowledgements

We thank the following supplier members for their contribution to this Technical Guide

- Duncan Ceramics • Gare/Bisquefire • Mayco Colors •
- Skutt Kilns • Orton Cone • Paragon Kilns •
- American Art Clay Company •

Shivering



What is Shivering?

In the glaze firing, the bisque will basically expand during the firing and contract during the cooling phase. Shivering is typically defined as occurring when the bisque and glaze shrink at different rates. If the bisque shrinks more than the glaze, the glaze has nowhere to go but “shiver” or “flake” off the bisque.

Potential Causes

- Underfired bisque (and on some occasions over fired bisque).
- Clay or slip used in the making of the bisque does not fit the glazes and therefore creates an incompatibility of fit between the bisque and color and/or glaze. There can be multiple causes for this problem. Clay is mined from the earth and is an inexact science. Bisque suppliers are continuously getting their bisque from multiple suppliers from different parts of the world. This means there are more types of bisque being introduced into the market place all the time. Make sure you are using a reputable bisque supplier(s) and they have a history of consistent quality. We should emphasize that even reputable bisque suppliers may, as they develop additional sources, deliver bisque that shivers.
- Heavy color and or glaze application.
- Bisque Quality. Cast bisque being cleaned too much around the edges. Pressed bisque being compacted too much on certain areas of the pieces like the edges. Sometimes, bisque when shipped can rub against the box and create a polished surface that does not allow the color to adhere.
- Oils, dust and soluble salts on the bisque can cause shivering because they do not permit the glaze to bond properly with the bisque.
- Rushing the ceramic process by:
 - Firing too fast
 - Using a hairdryer to dry the color and/or glaze
 - Firing wet color or glaze. When heated, the moisture from the color can turn to steam and cause a poor fit between color and bisque.. Note: Some colors are more susceptible than others in this situation.

With this many potential causes, it can be quite difficult to diagnose the cause of the problem. To help diagnose almost any ceramic issue, it is recommended a studio keep a thorough log of problems which includes such things as the type of bisque and color used, application of color, where on the piece the shivering occurred, etc. This log will help you organize facts to present to your supplier who will then be in a better position to help determine what may have caused the problem.

Potential Remedies

- Use bisque suppliers with a history of good quality bisque.
- Make sure that the application of color is not too heavy.
- Try to limit “rushing” the ceramic process either by firing too fast, using hairdryers on a hot setting, or firing potentially wet color or glaze.
- Make sure customers’ hands are clean and the bisque is wiped down with a damp sponge before painting so any dust or oils from lotions or food have been cleaned from the surface.

Can I fix the piece for my customer?

Unfortunately, in most cases shivering can not be repaired.

Pinholes



What are Pinholes and Craters?

After firing, you may see small “pin sized” holes on the surface of the ware (pinholes above) or you may see larger “crater like” impressions like the surface of the moon (craters opposite page).

While there are many things that can cause pinholes and craters, the causes are related to gases coming from either the clay body or where color and/or glazes that have not smoothed over after firing. The clay body, and even the glaze, contains clays mined from the earth. These clays contain some organic matter (i.e. plants, etc.), carbon and more. These materials form gases during the firing process and can result in pinholes and/or craters.

Small Pinholes

Potential Causes:

- Heavy glaze application.
- Fast firing and/or under firing of the bisque. This does not give enough time for the organics, etc/ to burn out.
- Fast firing or under firing of the glazes. Does not give enough time for the color and/or glazes to smooth over the surface of the bisque.
- Not enough oxygen in kiln for carbon to properly burn out although this cause is usually associated with bisque firing.

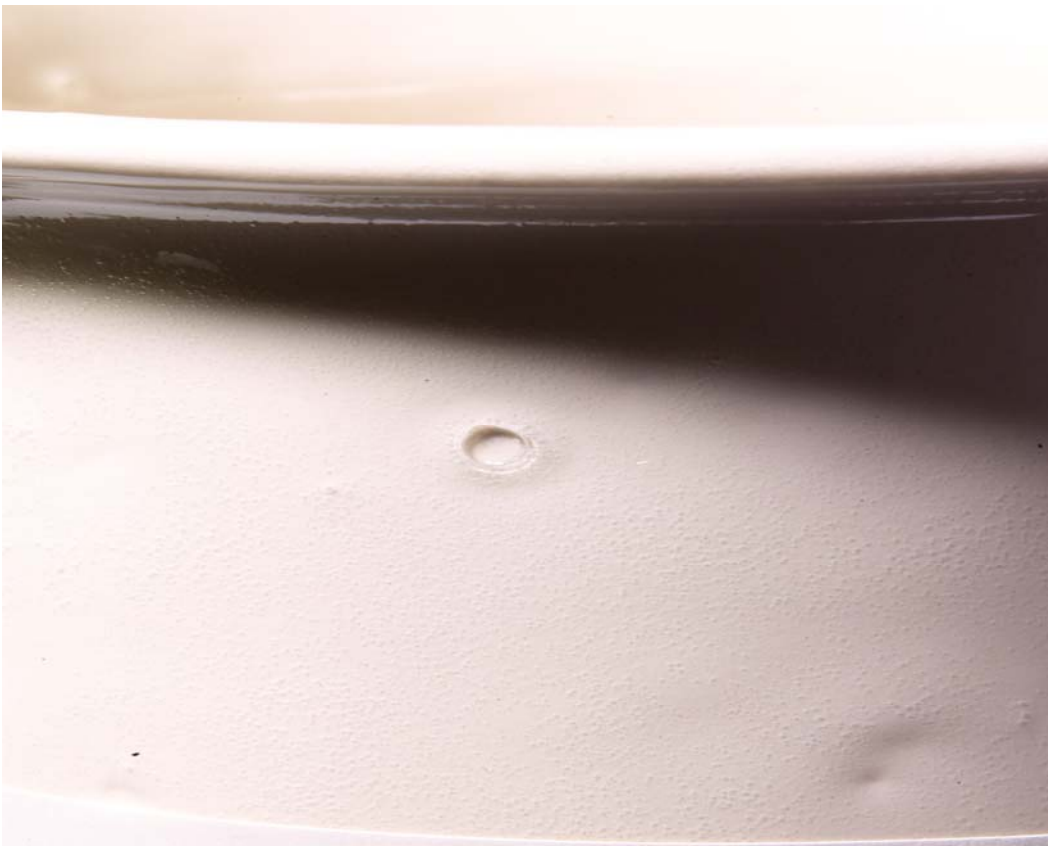
Potential Remedies:

- Maintain the proper heatwork (firing temperature, firing speed, and proper cooling) and you should be able to greatly reduce or eliminate these surface defects.
- Watch for heavy color or clear glaze application.
- Insure that there is 2 (two) cones difference between your bisque fire and your glaze fire (bisque fire is hotter). Bisque fire should be cone 04 and glaze fire is cone 06.

Can I fix the piece for my customer?

In the case of heavy color or glaze application, the piece probably cannot be repaired.

If the problem is fast firing, refiring to the proper heatwork at a slower speed should repair the problem.



Craters

Large Pinholes: also called craters, fisheyes or bubbles.

Potential Causes:

- Caused by gases escaping during firing due to:
 - underfired bisque
 - glaze application too thick
 - firing glaze while wet
 - glaze firing not hot enough or piece was fired too fast.

Potential Remedies:

- Bisque should be fired to shelf cone 04. A difference of two cones between bisque fire and glaze fire is necessary.
- Allow glazes to dry completely prior to firing (timing depends on climate).
- Fire glazes to shelf cone 06 or recommended cone. Glazes need correct heatwork which consists of time & temperature for correct maturation. Allow glazes to dry completely prior to firing (duration depends on climate).

Can I Fix the Piece for My Customer?

- If the issue is the glaze firing (i.e. it might be under fired or fast fired), you may want to re-fire to the proper heatwork.
- If the problem may have occurred in the bisque firing, try grinding down any of the thick craters with a dremel tool, brush on a thin coat of clear glaze, and re-fire to the proper cone 06 heatwork or one cone cooler to shelf cone 07 on slow speed.
- If the glaze has been applied too heavy, a re-firing will probably not work.

Crawling and Glaze Starvation



Crawling



Starvation

What is Crawling?

Small spots where the clear glaze and/or color seems to “crawl” away from the bisque and “bead up” is called glaze crawling.

Potential Causes

- Over application of color and/or clear glaze. This often happens on mugs, vases, etc. because it is a likely spot for the clear glaze to pool at the bottom after dipping.
- Applying wet color over wet color without allowing the color to dry between coats or too heavy application of color.
- Dust or debris has collected at the bottom of the piece (or oils or lotions from hands on the surface of other pieces).
- Piece was fired too wet.
- Hard spot on the bisque.

Potential Remedies

- Make sure the excess clear glaze is drained from the inside of the piece.
- Allow color to dry between coats, apply thinner coats.
- Make sure that the bisque is properly cleaned with a damp sponge prior to painting including the inside bottom of pieces.
- Make sure hands are clean of oils, hand lotions, etc.
- Allow color and/or glazes to dry completely prior to firing (timing depends on climate).

Can I fix this piece for my customer?

Sometimes crawling can be corrected by dremeling the area that has additional color, reapplying color to the bare bisque area, and refiring.

What is Glaze Starvation?

The fired glaze surface will be inconsistent, textured and dull in appearance. The piece may look underfired or the underlying color may look muted or white.

Potential causes:

- Glaze viscosity is too thin.
- Glaze is too thinly applied

Potential remedies:

- Check viscosity prior to each dipping session.

Can I fix this piece for my customer?

Try reapplying the glaze and refiring.

Hard or Yellow Spots

What are Hard or Yellow spots?

Hard spots are areas on the bisque that will not take color properly. Yellow spots after glaze firing can be either due to either hard spots or improper spacing of load in kiln.

Potential causes:

- The cause of hard spots occurs in the pouring of the greenware. If the slip hits the same spot during the greenware pouring process, it can sometimes concentrate and pack the clay in an area thus creating a hard spot.
- Yellowish spots on bisque occur in the glaze firing because items are too close together or too close to elements which does not allow for proper ventilation between pieces. This can allow the impurities from the maturing glaze on one piece to “flash” to another. The resulting flash is the yellowish spot on the piece(s).

Potential Remedies

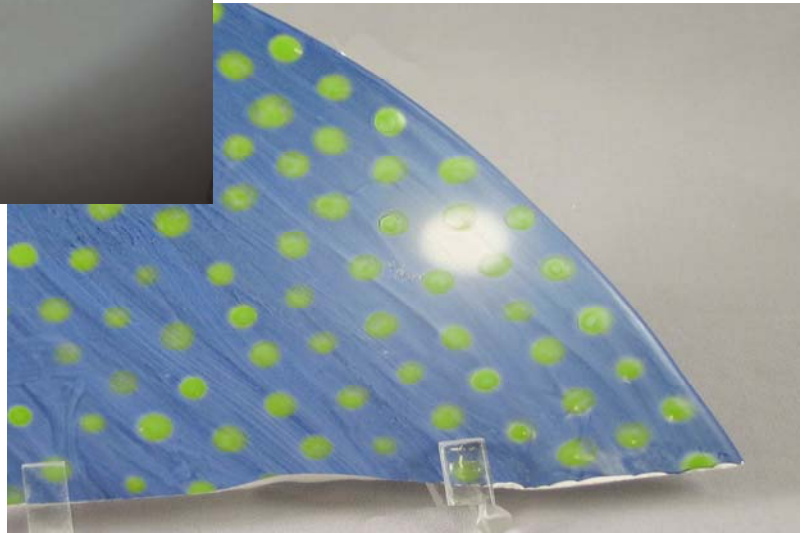
- Use bisque suppliers with a history of good quality
- Be sure to allow 1” to 2” of space between pieces while firing

Can I fix this piece for my customer?

Although it is not possible to “fix” a hard spot, it is sometimes possible to camouflage a hard spot or yellow spot with color & refire the piece.



Hard Spot



Yellow Spot

Crazing



What is Crazing?

Crazing is a fine network of hairline cracks that appear on the glaze surface. There are two types of crazing, immediate and delayed.

Potential Causes:

Immediate crazing:

- Incompatibility between bisque & color/glaze
- Improperly or under fired bisque.
- Opening the kiln too soon before it has cooled properly.
- Fast Firing

Delayed crazing:

- Moisture in ware
- A dry-footed piece comes in contact with moisture

Potential Solutions:

- Make sure your bisque is fired two cones hotter than the glaze firing.
- Insure that your bisque supplier is properly firing bisque.
- Do not open the kiln until it is below 150°F or is cool to the touch.
- Do not dry-foot items that are intended for food or liquid. Dry-footing should only be considered for decorative items such as figurines.

Can I fix this piece for my customer?

Immediate crazing:

Refiring to the proper heat work will sometimes help, especially if the cause was opening the kiln too soon. It may also work to apply a thin coat of glaze with a mop brush and refire to witness cone 07 on a slow setting.

Delayed crazing:

It is possible to refire to witness cone 05 to add maturity to the bisque. However, the piece may craze again at a later date. If a piece has crazed due to dry footing it is possible to repair but **caution** should be used. If water has been absorbed into the ware or the ware has been in the microwave (not recommended) repeatedly, the piece may craze again.

Cracking



What is Cracking?

Cracking or breaking may occur as the ware is being heated up in the glaze firing, but is more common during the cooling down phase of the firing.

Potential Causes

- During the cool down phase, the usual cause is thermal shock. If the crack or break occurred during cooling, the edges of the crack are usually very sharp. This is because as the kiln begins to cool, so does your pieces. With a large, flat piece like a platter, it cools from the outside to the inside. If your platter, for example, is close to or sitting on a shelf, the top of the platter can cool at a much faster rate than the bottom which is close to the still hot shelf causing thermal shock.
- There may already be a hairline crack in your piece before it is decorated and fired. The crack grows larger during the heating up phase of the kiln cycle. When the split is caused when the ware is heating up, the edges are rounded since the glaze will have time to round over the edges of the split.

Potential Solutions

- Preferred placement for large platters is in the middle of the kiln and away from the elements.
- DO NOT DRYFOOT.
- Properly stilt your ware – use the largest diameter stilt to fit the piece that still provides good support and room for air to circulate.
- Don't fire too fast or cool down too fast. A 7 ½ to 8 hour firing is recommended. Do not open kiln until it is cool on the outside and pieces can be handled without gloves.
- Check your bisque carefully for hairline cracks.

Can I fix this piece for my customer?

Unfortunately, a cracked piece cannot be repaired.

Milky or Hazy Colors



What is Milky or Hazy Colors?

Milky or hazy colors are colors which appear muted due to tiny bubbles trapped in the clear glaze.

Potential causes:

- Too heavy a glaze application.
- Glaze firing which does not achieve the correct heatwork (time & temperature).

Potential remedies:

- Check viscosity prior to each dipping session.
- Be sure your kiln is firing correctly by using witness cones throughout your kiln.

Can I fix this piece for my customer?

If the problem was incorrect heatwork, it is possible to refire in order to allow more time for the bubbles to work their way up through the glaze.

If the problem was too heavy of a glaze application (especially where dipping lines overlap), it is probably not possible to repair. (Note: some colors are more susceptible to a heavy glaze application.)

More Questions?

What is meant by proper heatwork?

- Firing to the correct temperature – usually to witness cone 06
- Firing at the correct speed – usually medium
- Proper cooling – allowing the kiln to be cool to the touch before opening & when pieces are cool enough to handle without gloves

If color and glaze are fired using proper heat work, can final product be placed in the Dishwasher or microwave?

No. The reason for both is the colors and bisque bodies are made of low fire earthenware.

What causes small debris on ceramic ware after firing?

There are several possibilities:

- Bits of firebrick and flakes from heating elements that have loosened or fallen. Due to the extreme heat during the firing of the kiln, a kind of convection effect is created and debris can blow throughout the kiln and deposit onto your ware. The solution is to vacuum kiln before each firing or as necessary.
- Dipping glaze may have become contaminated from any of a number of sources.
- Ware stored after dipping may have debris fall on it from heating ducts, abraded aluminum trays or shelves or other contaminants.

Housekeeping Rules

There are some general rules that should be put into place for every studio.

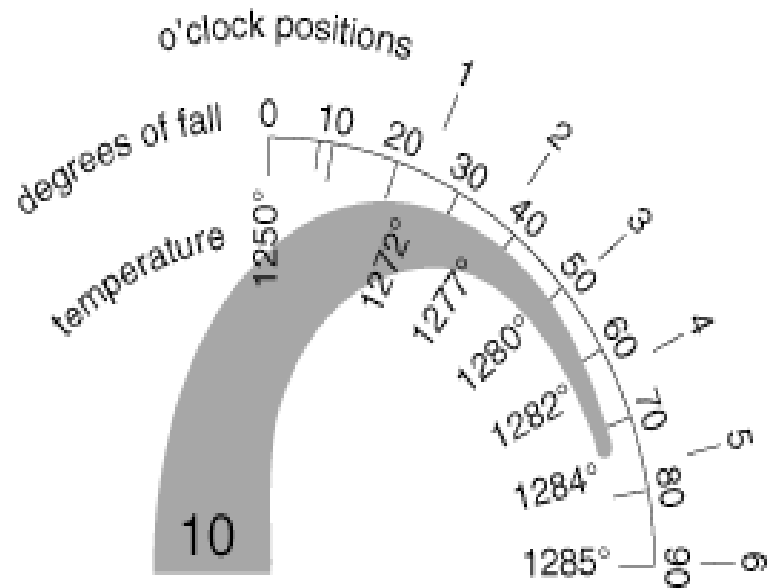
- Keep the kiln and/or dipping room(s) neat and clean.
- Working surfaces should be uncontaminated by dust or dried glaze. Spills should be wiped up promptly from all surfaces (counters, walls, & floors).
- Avoid activities that generate dust.

Sweeping generates dust, solution: use a wet mop instead.

Finger sanding generates dust, solution: improved glazing practices

- Partner a hepa filter system with good ventilation to avoid the buildup of fumes or dusts.
- Do not eat, drink or smoke when working with chemical products or glazes.
- Post safety signs up in the glazing and/or kiln room.
- Meet with employees on a regular basis to review your housekeeping rules.

Using Pyrometric Cones



Fired at 60 degrees per hour

Why?

- If you under or over fire your ware, you can have a variety of problems with the fired items. If you do not use cones, you will not be able to properly diagnose what happened inside the firing chamber or how to prevent it in the future. The use of cones is required even if the kiln is electronically controlled.
- It is the best way to assure your ware is being fired to the right temperature. Many assume if an automatic kiln light says the kiln temperature is firing to cone 06, it must be accurate. That is not always true.
- The firing temperature can be off as much as one cone from the top to the bottom in some kilns. Internal temperatures will also vary with the type of kiln vent used if any.
- Parts within the kiln wear with use. Kiln parts may begin to show noticeable wear after 50-75 firings. You need to know when to replace parts and what parts to replace. Cones again can help you diagnose the problem. Contact your kiln supplier for further information.

How to:

Place a series of three witness cones, 07, 06, 05 (self-supporting cones are the most convenient to use) one series located on the outside perimeter of the ware setting, and the second series located in the center of each shelf.

Once cool, remove the cones marking their location in the kiln and log 'degree' for future reference and for troubleshooting. (Recommendation: place witness cones on a 4" tile treated with kiln wash for easy removal.)

Kiln Firing Routine:	Step 1 Recommended	Step 1 Minimum	Step 2	Step 3
Daily firing	Place a series of three cones: 07, 06, 05 1 st series: outside perimeter of each shelf 2 nd series: center area of each shelf.	2x per week (same days) i.e. Every Monday & Thursday kiln firing use cones. Place randomly throughout kiln	Using Orton's Measuring template (available from your supplier) Log "degree" firing results for future reference.	See a variation. 1. Test fire 2. Log results 3. Contact supplier for assistance
Occasionally firing	Place a series of three cones: 07, 06, 05 1 st series: outside perimeter of each shelf 2 nd series: center area of each shelf.	1x per week (same day) i.e. Every Monday kiln firing use cones. Place randomly throughout kiln	Using Orton's Measuring template (available from your supplier) Log "degree" firing results for future reference.	See a variation. 1. Test fire 2. Log results 3. Contact supplier for assistance



Cone 05 Cone 06 Cone 07

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

If some of the locations indicate that you did not reach cone 06, the tip of cone 06 is not bent enough, you will need to modify your firing cycle on your controller. By having cone 07 along side cone 06 you can determine by how much you failed to reach a cone 06 firing. Cone 07 measures a lesser amount of heat work than cone 06, therefore if cone 07 is bent so that the tip is at the same level as the top of the foot of the cone you are only one cone away from the desired heat work.

For more information on the use of Cones, please contact your manufacturer.

Glaze

Glazing

- To ensure the product is non-toxic, read your manufacturer's label. The product should bear the AP NON-TOXIC Approved Product Seal & should state "conforms to ASTM-D4236." This label is not required by law and is an independent certification. If your product does not contain this label, please contact your manufacturer to insure that the product is NON-TOXIC.
- For specifics on application, heat-work, & viscosity guidelines, please refer to the manufacturer's label or instructions.
- For each dipping session follow the manufacturer's instructions for:
 - Mixing glaze thoroughly with powered or hand mixer
 - Testing viscosity (thickness or thinness of glaze). Be sure to use the manufacturer's recommended vessel/viscosity cup for measuring the viscosity.
 - Adjusting viscosity: use distilled water only. Note: Adding too-much water can cause solids to separate and settle which may lead to glaze firing issues.
 - Frequency of stirring to avoid separation.
- Glaze container/tank should hold enough glaze to submerge your largest ceramics piece. A 20-25 gallon capacity tank is sufficient. It is recommended that the container have a lid that can be adequately secured to help prevent contamination and/or evaporation.
- Do not store glaze in areas with extreme heat or cold.
- Keep a log of all lot numbers from the pails of the dipping glaze.
- Change/clean dipping tanks a minimum of 4 times a year or once each quarter
- Submerge ware in glaze with a quick smooth motion using the following dipping techniques:
 - For a Single dip method (recommended):
 - Wearing latex-free rubber gloves hold by hand & dip.
 - Use dipping tongs to dip entire piece.
 - Wipe gloves or tongs after each dipping to remove moist glaze that could cause surface smearing on the next piece dipped
 - For ½ & ½ dipping method: use the KISS or MISS-IT technique
 - Kiss: glaze lines will touch, but not overlap
 - Miss-it: glaze lines will not meet
 - Dip 98% of the piece leaving a small area unglazed where you are holding the piece.
- After using your preferred dipping method:
 - Shake off excess glaze. Rock hand back & forth to minimize drips
 - Touch up tong marks, glaze lines, & any unglazed areas with a soft fan brush that is moistened with dipping glaze by gently patting using the flat side of the brush. Do not brush on glaze as this could cause color to smear.
 - Set glazed pieces on drying rack
 - Remember: NO finger-sanding!
- Clean dipping container with a damp sponge on the walls of the container or vat so dried particles will not fall into the dipping glaze after you have finished dipping.
- Keep kiln room clean at all times by following the CCSA recommended Housekeeping Rules.
- In the event of accidental ingestion – Call doctor or local poison control
- Rinse mouth or eyes with water if splashed with glaze.

Kilns & Firing

Kilns & Firing

- Properly ventilate kiln to outside. See manufacturer for details.
- Use shelf (witness) cones regularly to detect heatwork irregularities. Log results for easy reference.
- Vacuum kiln interior on a regular basis
- Keep all paper and combustibles/flammable materials at least 18 inches away from kiln and ventilation area.
- Kiln exterior will become very hot during firing cycle. Do not allow customers near the kiln.
- Fill 'peep holes' with kiln plugs during firing cycle.
- When loading kiln use a consistent & uniform density throughout the load.
- Do not unload kiln until it is cool to the touch (125 degrees in chamber).
- Coat firing surface of kiln shelves with kiln wash.
- Only fire dry pieces (they are no longer cool to the touch).

Refer to your 'Annual Maintenance Checklist' to keep
your kiln working great!

[http://www.ccsaonline.com/members/technical/
technical_annual_check.html](http://www.ccsaonline.com/members/technical/technical_annual_check.html)

Post firing

- Be aware of sharp stilts when loading and unloading kiln.
- Always wear safety glasses when using a dremel tool or other grinding tools.

