

Nan Smith, Professor  
University of Florida Ceramics Program  
e-mail: nan@ufl.edu  
website: www.nansmith.com

### Tips for Firing Large Scale Sculpture

The average safe heating climb for pottery and small scale works is documented to be 200 degrees per hour. Practical experience has led me to advise students to fire large or complex works much more slowly. All steam explosions occur at approximately 212 degrees Fahrenheit, so the initial heat up of ware must be slow. Most thick walled ware does not fully dry, in the Florida humidity. The center of the wall remains moist until it is heated in a drying chamber, or during a pre-heat cycle in a kiln.

- Pre-Heat Options - An overnight pre-heat cycle is a good rule of thumb for all sculptural work. Sometimes this 8 to 12 hour pre-heat cycle where a temperature of 80 to 100 degrees is maintained is not long enough. If you feel steam or see steam (on a mirror or glass placed in front of the top peep hole of the kiln) then continue the warming cycle until no steam is apparent. Jun Kaneko has said that he pre-heats his large thick walled pieces for three to five days to get them safely through the firing cycle. Using a pyrometer to track the temperature rise, understanding firing principles, and remaining responsive during a firing cycle will allow you to fire large scale and/or complex works successfully.

- Critical Heating Points - Since the clay is undergoing changes chemically and physically during the firing cycle; in the bisque and in the glaze you must travel gently and slowly through these critical heating points. They are:

0- 212 degrees: water of plasticity burns off

212 degrees: water becomes steam

650-750 degrees: chemically combined water burns off; your clay can still explode (clay is alumina, silica, and water in it's chemical composition)

900-1100 degrees: chemical quartz inversion takes place (this is a structural change in the clay where the silica/flint/quartz changes from alpha to beta quartz. The quartz crystalline structure actually changes by expansion and contraction). Cracking will eventuate if this 200 degree period is traveled through too quickly. Too fast, is on the average more than 200 degrees in one hour.

- Critical Cooling Points – Both electric and gas fired kilns cool quickly at the high end of the firing and slowly for the last few hundred degrees. If you monitor your kiln after shut down you will find that the heat in the chamber will drop approximately 400 degrees in the first hour. Firing principles are that the heat up and cool down of the ware should be similar or balanced. If the average heat up is safe at 200 degrees per hour one would presume that the average cool down should be the same. For sculpture, I recommend a gentle "fire down" so that these drastic changes do not occur. Another consideration is that often a large work spans the firing chamber vertically. The cooling of an electric kiln is designed for the ware to radiate the heat within the chamber. This keeps the chamber more uniform in warmth. Also a large piece which spans the chamber will be impacted by the fact that the top of the kiln stays hotter than the bottom longer. Akio Takamori has experienced cooling cracks on the bottom of his tall porcelain pieces when they are placed directly on the bottom of the kiln. To avoid the hair line cracks he posts the ware up from the bottom of the kiln. I also have begun to "fire down" on the cooling cycle especially for large works which span the kiln vertically.

The other key cooling points occur through quartz inversion between 900 and 1100 degrees Fahrenheit. It is advised not to allow the kiln to drop more than the two hundred degrees in one hour.

- Advanced Firing Resources and Equipment - If you are interested in reading the most updated information on electric kiln firing a good resource is: "Firing Line" by the Orton Company, Columbus, Ohio. A new, technological piece of equipment which can be used to set up specific firing goals are electric kiln controllers produced by many of the kiln manufacturers. Kiln controllers will allow you to program the firing cycle on an electric kiln, setting the climb per hour and any holding patterns desired at specific temperatures. Kiln controllers are an excellent tool which can be used once you understand firing principles. A hand held pyrometer or a digital pyrometer can inform you during the firing and cooling cycle on an electric and gas kiln, so that you can control the heating and cooling within the firing interactively.

- Suggested Firing Patterns (sculpture) -

0-80 degrees: pre-heat cycle (until no steam is present)

80 degrees per hour until 750 degrees

100 degrees per hour 750 degrees to 1100 degrees (pass chemical water burn off and chemical quartz inversion)

150 degrees to desired firing temperature for bisque or glaze

cooling cycle:

drop 100-150 degrees per hour to 900 degrees

drop 200 degrees per hour to 600 degrees

let ware cool naturally to 200 degrees and then crack the lid of the kiln.