ELECTRIC KILNS

SAFETY MANUAL

OPERATION & FIRING

Lynn Duryea
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1. KILN ROOM SAFETY RULES

Operations of kilns:

1. Learning how to fire kilns and passing kiln safety exams are requirements of clay classes @ ASU.

2. Never use a kiln unless you have been instructed and tested on its use and have been cleared on the safe and appropriate procedures.

3. Keep the safety equipment in place and in use at all times. Do not remove or override.

4. Appropriate flame retardant and heat resistant gloves and jackets are available for use and recommended for specific types of kiln work.

5. Goggles and other protective eye ware as well as full-face shields are also recommended in specific instances.

6. You are required to be on the premises while the kiln you are in charge of is above red heat.

7. Follow the close out procedures to make sure kiln is completely closed down.

REPORT BROKEN OR MALFUNCTIONING EQUIPMENT IMMEDIATELY

Personal Safety:

1. Wear required PPE (Personal Protection Equipment) – safety glasses/goggles/face shield, gloves, respirators, ear protection – know in what instances these are required.

2. Wear closed-toe shoes/boots (no sandals or bare feet)

3. Wear study, full-length pants and no loose clothing (sleeves, ties, etc)

4. Tie long hair back.

5. Never work in the clay studio under the influence of drugs or alcohol.

6. Never operate a kiln if you are ill or over-tired.

7. No smoking in the clay studio. (Breaks may be taken outside).
8. Know the locations of the safety exits and the emergency stop switch for machines.

9. Know the location of the gas main shut off valve.

10. Know the location of the controls for the air vents.

11. Know the emergency phone numbers for assistance. EMERGENCY PHONE NUMBERS AND THOSE FOR CURRENT FACULTY, FACILITIES MANAGER AND ASSISTANT, AS WELL AS THE MONITORS, ARE ON KILN ROOM BULLETIN BOARD.

2. OPERATION OF ELECTRIC KILNS

Electric kilns, in which heat is generated by electricity and conducted through elements, have specific temperatures (ratings) to which they can fire. Be sure to know the rating of the kiln you are firing and do not try to exceed it. Elements become increasingly fragile and have a reduced capacity as they age; care should be taken to keep the element channels free of debris and glaze.

The variables in firing electric kilns include

- the rate at which the heat increases
- the temperature to which you are firing
- the length of time for which the heat is held, or kept steady, at the end of the firing
- this is described as work-heat, or the effect of temperature on materials over time.

KILN PARTS:

- body, bottom & lid – soft firebrick with metal sheathing
- base / stand – use factory-provided metal stand or build a base of concrete blocks, helpful if wanting to keep cold drafts away from bottom of kiln
- switches on exterior of kilns that can be fired manually – settings of low, medium and high or numerical
- thermocouple – measures heat in the interior of kiln, conveys temperature to the controller
- timer – can set length of firing – a safety back-up device (test kiln @ ASU) if firing without a controller
- kiln sitter – functions as a control device when firing without a controller; functions as a safety back-up when firing with controllers. junior pyrometric cones placed in metal supports melt @ specific temperatures; when the cone melts the metal plate falls, turning off the kiln.
TO SET UP THE KILN SITTER:

- Raise trigger plate on outside of kiln, hold down claw to engage with plate.
- Carefully place small (junior) pyrometric cone inside kiln on metal cone supports – edge of # circle should line up with outside of supports and be facing into the kiln so the broader flat surface of the cone is facing downward.
- Cone should be one cone higher than desired firing temperature to allow computer to regulate the kiln.
- Use optical cones (cone packs) to verify kiln sitter.
- Press in plunger inside metal trigger plate that controls power to kiln.
3. LOADING & FIRING

STACKING THE KILN:
- place bottom shelf above floor of kiln with low posts, broken shelves or pieces of broken stilts; keep level – heat circulates more evenly
- next shelf 6" or higher – lessens chance of colder area @ bottom of kiln
- stack a kiln as evenly as possible, distributing mass & empty space – heat moves more evenly when kiln is evenly stacked
- shelves usually tri-posted; inner set can be shared if shelves are level; can use four with heavy work
- stack posts in a column so they support their own weight – prevents kiln shelves from warping & cracking & is especially important @ high temps
LOADING WARE:

- when loading Olympic kiln, be sure to use protective wooden cover on kiln wall; leaning into this kiln breaks down unprotected walls; remove before firing
- bone dry clay is very fragile; should be picked up with two hands – in case of accident, return work to shelf with a note
- load pieces as evenly as possible which helps heat circulation in kiln
- work can touch in a bisque firing – can be stacked foot to foot / rim to rim or one piece inside of another with sufficient support and space – do not put a heavy piece inside a thin or fragile one
- put a layer of grog under heavy or wide pieces
- glazed areas cannot touch each other or kiln shelf – glazed surfaces will fuse
- when finishing loading, leave kiln carts clear of boards

HOW HEAT MOVES:
How a kiln is stacked will affect the movement of heat. Electric kilns radiate heat from outside in, so objects near elements will heat up faster. Leave 1-2” space around elements.

Heat is transferred in three ways:
- convection: heated air rises, air currents circulate heat – occurs early in firing & usually promotes more heat @ top of kiln
- conduction: transfer of heat through solids from outside in
- radiation: effective @ higher temperatures. hot objects (ware, kiln furniture and bricks) radiate heat in all directions – helps to even out kiln temperatures

FIRING MANUALLY VS. KILN PROGRAMS:
Electric kilns can be fired manually by using switches or with computer controllers that are programmed to regulate the firing. When firing manually, kiln switches are set to low / medium / high for desired length of time (see attached chart). See section More About Firing for further details. Since computers are not always available, it is helpful to know how to fire kilns manually.

Computer controllers are either dedicated, meaning an integral part of the kiln, which cannot be fired without the controller (Olympic coffin kiln @ ASU), or separate (wall-mounted Skutt KilnMasters @ ASU). Kilns with separate controllers can be fired independent of the controller.

PROGRAMMING COMPUTER CONTROLLED KILNS: Generally computer-regulated kilns are fired in one of two ways: CONE FIRE method and RAMP / HOLD. See attached sheets for sample programs

1. CONE FIRE METHOD: Heat climbs according to a preset program (see attached charts). Enter three pieces of information: cone # (temp), rate of speed of firing, hold time. The speed chosen (slow / medium / fast) will determine the ramp time and rate of climb.
• SLOW takes about 12 hours to reach desired temperature: good for bisquing work or firing to higher temperature ranges
• MEDIUM takes about 8 hours: good for low-fire glaze
• FAST takes about 4 hours: not good for bisquing or for glazes that need time to develop

2. **RAMP HOLD METHOD (VARY-FIRE ON OLYMPIC KILN):** This allows you to create your own firing profiles with up to 8 ramp and hold segments. Up to 6 programs can be stored in permanent memory. See attached charts.

   Sample calculation of ramp times for Vary-Fire and Ramp / Hold: To go from room temperature to 750 degrees in 3 hours:
   • Start with temperature you want to reach, subtract room temperature inside the kiln (which will be flashing on control panel) and divide by # of hours you want to take to reach temperature
   • EXAMPLE: 750 – 70 (inside kiln) = 680 divided by 3 gives ramp rate of 227 degrees an hour

USER #1 is for class bisques. Always double check the programming before starting the kiln in case someone has changed it.

**OTHER FEATURES:**
• REVIEW function is to check a program that has been entered; all segments will be displayed in sequence.
• VIEW function is used during Ramp / Hold firing to display the segment of firing currently in operation.
• DELAY allows you to delay the start of the kiln and is programmed in @ end of selection of firing cycles – a delay prompt will appear on control panel.
• CONE TABLE allows you to check Fahrenheit temperature equivalent for Orton cones.
**Controller**

Features and benefits:

- Programable High Temperature
- Continuous display with rpm.
- The environment changes, and you can change the environment to monitor different parameters up to eight different settings.
- The jump/hold function allows you to set a jump/hold value in the jump/hold mode.
- The memory allows the controller to maintain memory of power settings.
- The jump/hold function allows you to jump/hold a parameter when jumping/holding.
- The jump/hold function allows you to jump/hold the values in the memory in case of power.

- The jump/hold function allows you to jump/hold the values in the memory in case of power.
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- The jump/hold function allows you to jump/hold the values in the memory in case of power.
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- In Jump mode, the jump/hold function allows you to jump/hold the values in the memory in case of power.
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Cone Fire Mode

The Cone Fire mode uses a method that provides you with a specified hold time at a desired speed. The cone fire mode allows you to specify a hold time at a speed to choose from slow, medium, or fast speeds. Choose the hold time and Cone Fire mode, and the cone fire will take the appropriate time to complete. The cone fire mode is extremely easy to use and provides your access to many advanced features. You only have to enter the speed and hold time cone values.

Desiration

Duck
Cone A: Medium Speed

<table>
<thead>
<tr>
<th>Segment</th>
<th>Rate</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.120/hr</td>
<td>1996</td>
</tr>
<tr>
<td>0</td>
<td>0.169/hr</td>
<td>1951</td>
</tr>
<tr>
<td>0</td>
<td>0.115/hr</td>
<td>1810</td>
</tr>
<tr>
<td>0</td>
<td>1.000/hr</td>
<td>1690</td>
</tr>
<tr>
<td>0</td>
<td>2.500/hr</td>
<td>1580</td>
</tr>
</tbody>
</table>

The graph at right illustrates the set.

If you were to program the segments for either side or a higher moisture content, use the chart at the bottom 75 hours to the next cone.

The graph indicates that the cone will probably medium to the speed you will probably.
Appendix 3

Compares the difference
between the time you
entered and the one
while you were away.

1. Start
2. Press Stop
3. Enter your name or address
4. Enter the number of days
5. Press Enter
6. Enter the number of hours
7. Press Enter
8. Enter the number of minutes
9. Press Enter
10. Press Start

Press when the alarm
is on.

Press what time the
alarm is set at.

Press to cancel the
alarm.

Press to display the
alarm time.

Press to display the
day of the week.

Press to display the
month.

Press to display the
year.

Press to display the
hour.

Press to display the
minute.

Press to display the
date.

Press to return to the
main menu.

Press to exit the
program.

Press to return to
the previous screen.

Press to display the
temperature.

Press to display the
humidity.

Press to display the
clock time.

Press to display the
calendar.

Press to display the
weather.

Press to display the
clock time.

Press to display the
calendar.

Press to display the
weather.

Press to display the
clock time.

Press to display the
calendar.

Press to display the
weather.

Press to display the
clock time.

Press to display the
calendar.

Press to display the
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Press to display the
clock time.

Press to display the
calendar.

Press to display the
weather.

Press to display the
clock time.

Press to display the
calendar.

Press to display the
weather.
### Calibration for Critical Work

If the shift come boards to maturity
self-supporting comes at the end of the
spires observe the degradation of the
performing win losses come on the
udy check the accuracy of the thermometer
which needs each instruments' probes
for those who are doing critical work

---

#### Ramp/Hold Mode

![Diagram](image)

- **Temperature**
  - 15°C
  - 25°C
  - 35°C
  - 45°C
  - 55°C
  - 65°C

- **Ramp**
  - 8

---

*Note: The inclusions provided may need slight adjustment based on the context of the document.*
Device Instruction Manual: 3-4

Hold the button labeled "MODE" to enter the programming mode. Use the "+" and "-" buttons to select the desired function. Adjust the temperature as necessary. Use the "SET" button to confirm your selection.

Table:

<table>
<thead>
<tr>
<th>Set</th>
<th>Target</th>
<th>Set 1</th>
<th>Set 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>199°F</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>199°F</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Hold</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Temperature Range: 0°F to 200°F

Mode Options:

- **Ramp/Hold Mode**: The device will continue to adjust until the desired temperature is reached. Use the "RAMP/SET" button to select this mode.

- **Hold**: Hold the current temperature.

- **Temperature**: Adjust the temperature as needed.

- **Set Point**: Set the target temperature.

- **Set 1-2**: Select additional set points.

- **Mode**: Select the desired operating mode.

- **Set**: Confirm the selected setting.

- **Set 1-2**: Select additional set points.

- **Temperature Range**: 0°F to 200°F

Note: The current set point is 199°F.
The feature is not available in this device.

If the display still shows the new segment, press enter again.

The display will show STP (stop). Press enter again to stop the routine.

To stop the balance of a segment, press the balance of a segment.
## Error Messages

The following errors may appear in the window of your controller. Along with the error number, the display indicates elapsed time in hours and minutes and also the temperature the kiln reached when the error occurred. Please call your distributor or Skutt Ceramic Products at (503) 231-7726.

In addition to the error messages in the chart at right, all of which indicate a problem which needs to be corrected, there is an informational error message: **ErrP**. When it flashes, a brief, non-critical power outage has occurred. The controller was able to resume firing and the load of ware is not in danger. It continues to alternates display with the internal temperature until you press Enter.

<table>
<thead>
<tr>
<th>Error and description</th>
<th>Possible cause</th>
<th>Correction</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1</strong> Ramp up and rate is less than 12° per hour. Rise is checked every 7.5 minutes. Rate must persist for 22.5 minutes before display.</td>
<td>Kiln-sitter has tripped. Limit timer has expired. Elements are weak. Load is heavy. Relay failed. Low voltage.</td>
<td>Place one cone hotter in Kiln-Sitter. Add time to limit timer. Check elements. Reduce size of load. Check relays. Check voltage.</td>
</tr>
<tr>
<td><strong>2</strong> Program in hold, temperature 50° or more above hold temperature. Error must persist for more than 18 seconds before error is triggered.</td>
<td>Excessive heating rate going into the hold. One or more relays are stuck in the closed position.</td>
<td>Reprogram lower heating rate. Turn Off and unplug. Check resistance at plug with ohmmeter.</td>
</tr>
<tr>
<td><strong>3</strong> Program in hold, temperature 50° or more below hold temperature. Error must persist for more than 18 seconds before error is triggered.</td>
<td>Kiln cannot maintain temperature to reach hold. Lid opened during firing. Elements may be weak.</td>
<td>Do not open lid during firing. Check elements with ohmmeter.</td>
</tr>
<tr>
<td><strong>4</strong> Program ramping down and temperature more than 50° above last hold temperature. Error must persist for more than 18 seconds before error is triggered.</td>
<td>Relays may be stuck closed (failed closed).</td>
<td>Turn Off and unplug. Check circuit at plug with ohmmeter.</td>
</tr>
<tr>
<td><strong>5</strong> Program ramping down and temperature more than 50° below local set point. Must persist for 18 seconds to trigger.</td>
<td>Normally kiln will have plenty of power to maintain a cooling rate. Was lid opened? Elements failing?</td>
<td>Do not open lid until the kiln has reached at least 500° F. Check elements.</td>
</tr>
<tr>
<td><strong>6</strong> Negative reading detected at thermocouple, indicating it is wired improperly.</td>
<td>Thermocouple wires have been switched. Somewhere lead wires have been crossed.</td>
<td>Check and fix any backward connections.</td>
</tr>
<tr>
<td><strong>7</strong> Ramp up and temperature 50° above local set point.</td>
<td>Possible relay failure in the closed position.</td>
<td>Turn Off and unplug. Check relay.</td>
</tr>
<tr>
<td><strong>8</strong> Controller in positive ramp, kiln temperature is ramping down. Negative rate must persist for 22.5 minutes to trigger error.</td>
<td>On Wall-Mount KM-1, The Kiln-Sitter may have tripped or timer depleted and turned Kiln-Sitter off.</td>
<td>Use hotter cone in Kiln-Sitter. Add more time to limit timer.</td>
</tr>
<tr>
<td><strong>FAIL</strong> System cannot sense thermocouple.</td>
<td>Thermocouple broken or disconnected.</td>
<td>Secure or replace thermocouple.</td>
</tr>
</tbody>
</table>
Controller Front Panel

VARY-FIRE
Programmer for setting and saving your own firing profiles

OPTIONS section
for setting delay start and alarm. Set one of nine "Other" options: Default reset, Preheat stage time, Controller ID, 16 segment program, Cone offset, Change °F to °C, set Error codes off, set T/C offset, check board temperature.

CON P- FIRE
section for choosing one of four preset cone fire speeds.

LED DISPLAY
-four digit display showing times and temperatures.

Number keys
section for entering temperatures and times.

VIEW section to look up cone temperatures, review the selected program, view the current segment, or skip to the next firing segment.

On the following pages the individual sections of the controller front panel will be explained in more detail.
PROGRAMMING

1. CONE FIRE

The CONE FIRE mode allows you to fire to a cone number with one of four different speeds.

To use CONE FIRE:

1. Make sure the temperature is flashing. Pressing the "1" key will clear the display of errors (Err) or FAIL.

2. Press one of the 4 firing speed buttons (see appendix A for the ramp profiles)

   | Slow Bisque - Used for setting a slow bisque firing profile. ** 13 hours to fire to cone 04.** |
   | Fast Bisque - Used for setting a fast bisque firing profile. ** 10 hours to fire to cone 04.** |
   | Slow Glaze - Used for setting a slow glaze firing profile. ** 7 hours to fire to cone 04.** |
   | Fast Glaze - Used for setting a fast glaze firing profile. ** 4 hours to fire to cone 04.** |

3. Press ENTER
4. Type the cone number you want (acceptable values are from 022 to 10).
   If you type a wrong number, press zero 3 times or until all zeros appear in the display, press ENTER, then type the correct number (only three digits are displayed at this time)
5. Press ENTER.
6. Type the hold time if you want to add a "soak" at the end of the firing or leave it at zero.
7. Press ENTER. CPL will be displayed briefly, then the current temperature will be flashing in the display.
8. Press START/STOP to begin firing.

NOTE: With any of the CONE FIRE modes, a preheat stage is available. During the preheat stage the temperature is increased at a rate of 60 °F per hour until 200 °F is reached; the 200° temperature is then held for the programmed amount of time. Preheat is automatically set to zero during cone fire programming and at the end of each firing, so if a preheat stage is wanted, it must be reprogrammed before each cone firing. See SECTION 4 - "OTHER" options for programming "Preheat".
APPENDIX A - CONE FIRE TEMPERATURE PROFILES

Firing Profiles for cone 04, temperature 1945°F (1063°C)

<table>
<thead>
<tr>
<th>Slow Bisque</th>
<th>Segment</th>
<th>Rate°F/hr</th>
<th>Temperature</th>
<th>Stage Time</th>
<th>Segment</th>
<th>Rate°F/hr</th>
<th>Temperature</th>
<th>Stage Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>80</td>
<td>250</td>
<td></td>
<td>2.25</td>
<td>5</td>
<td>150</td>
<td>250</td>
<td>1.20</td>
</tr>
<tr>
<td>4</td>
<td>200</td>
<td>1000</td>
<td></td>
<td>3.75</td>
<td>6</td>
<td>400</td>
<td>1695</td>
<td>3.61</td>
</tr>
<tr>
<td>5</td>
<td>100</td>
<td>1100</td>
<td></td>
<td>1.00</td>
<td>7</td>
<td>120</td>
<td>1945</td>
<td>2.08</td>
</tr>
<tr>
<td>6</td>
<td>180</td>
<td>1695</td>
<td></td>
<td>3.31</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>80</td>
<td>1945</td>
<td></td>
<td>3.13</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13 hrs</td>
<td>26 mins</td>
<td>Total Time</td>
<td>13.43</td>
<td></td>
<td>6 hrs</td>
<td>54 mins</td>
<td>Total Time</td>
<td>6.90</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fast Bisque</th>
<th>Segment</th>
<th>Rate°F/hr</th>
<th>Temperature</th>
<th>Stage Time</th>
<th>Segment</th>
<th>Rate°F/hr</th>
<th>Temperature</th>
<th>Stage Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>120</td>
<td>250</td>
<td></td>
<td>1.50</td>
<td>6</td>
<td>570</td>
<td>1695</td>
<td>2.85</td>
</tr>
<tr>
<td>4</td>
<td>300</td>
<td>1000</td>
<td></td>
<td>2.50</td>
<td>7</td>
<td>200</td>
<td>1945</td>
<td>1.25</td>
</tr>
<tr>
<td>5</td>
<td>150</td>
<td>1100</td>
<td></td>
<td>0.67</td>
<td></td>
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<td>6</td>
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<td>1695</td>
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<tr>
<td>7</td>
<td>108</td>
<td>1945</td>
<td></td>
<td>2.31</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 hrs</td>
<td>17 mins</td>
<td>Total Time</td>
<td>10.29</td>
<td></td>
<td>4 hrs</td>
<td>6 mins</td>
<td>Total Time</td>
<td>4.10</td>
</tr>
</tbody>
</table>

This chart shows the segments for the four cone fire speeds. Notice that the firing profiles all end with segment 7 but they do not start at segment 1. If you program a very-fire to mimic these profiles you would start numbering with segment 1. The firing rates for other cone numbers are the same as these but the end and final segment temperatures vary. The last segment always starts 250°F below the cone temperature. The actual temperature reached during the firing will vary based on the rate of temperature rise during the last segment. This ensures the correct amount of heat-work is done with each cone fire program.

APPENDIX B - ERROR CODES

<table>
<thead>
<tr>
<th>Error Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Err0</td>
<td>Software Error. Recheck the selected program, and reprogram if necessary.</td>
</tr>
<tr>
<td>Err1*</td>
<td>The temperature is increasing less than 12 degrees per hour during a ramp segment (in either cone fire or vary-fire mode), where the temperature is programmed to increase. This slow rate must persist for 22.5 minutes before the error is displayed and the firing stopped. Pressing the &quot;1&quot; key clears the Err1 and briefly displays the temperature and then the firing time at which the error occurred.</td>
</tr>
<tr>
<td>Err2*</td>
<td>During a hold segment the temperature rises to greater than 50 degrees above the hold temperature which was set. The temperature must stay 50 ° above this set temperature for 18 seconds before the error is displayed.</td>
</tr>
<tr>
<td>Err3*</td>
<td>During a hold segment the temperature is more than 50 degrees below the hold temperature which was set. The temperature must stay 50 ° below this set temperature for 18 seconds before the error is displayed.</td>
</tr>
<tr>
<td>Err4*</td>
<td>The temperature is more than 50 degrees above the previous hold temperature during a ramp segment where the temperature is programmed to decrease. The temperature must stay 50 ° above this set temperature for 18 seconds before the error is displayed.</td>
</tr>
</tbody>
</table>

Quick View

If error persists, return controller for service.

Ramp segment
Temp. increase < 12°F/hr
Persist > 22.5 min.

Hold segment
> 50°F above set temp.
Persist > 18 sec.

Hold segment
> 50°F below set temp.
Persist > 18 sec.

Decreasing Ramp segment
> 50°F above last hold temp.
Persist > 18 sec.

Notes for Error codes. ">" means greater than; "<" means less than.
<table>
<thead>
<tr>
<th>Error Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Err5*</td>
<td>The temperature is more than 50 degrees below the travelling set-point temperature during a ramp segment where the temperature is programmed to decrease. The temperature must stay 50 °F below this set temperature for 18 seconds before the error is displayed.</td>
</tr>
<tr>
<td>Err6</td>
<td>A negative temperature is detected. This generally indicates the thermocouple is connected incorrectly. To correct this situation, ensure the red and yellow wires are connected correctly to the controller and at all t/c junctions. You can identify the red lead on an unmarked thermocouple with a magnet because a magnet will be attracted to the red lead.</td>
</tr>
<tr>
<td>Err7</td>
<td>No longer a valid error code. Errd replaced it.</td>
</tr>
<tr>
<td>Err8</td>
<td>When using the Cone Fire Mode, the temperature is decreasing during the last ramp segment indicating that a kiln sitter or timer may have turned the kiln off or an element or relay failed during the last segment.</td>
</tr>
<tr>
<td>ErrP</td>
<td>Continuous ErrP in display. Indicates a long term power outage. The kiln has been shut down. Press “1” to clear the display.</td>
</tr>
<tr>
<td>ErrP</td>
<td>ErrP and the current temperature are alternately flashing. To clear the display, press the “1” key. If a firing was in progress, it will continue.</td>
</tr>
<tr>
<td>Err-</td>
<td>The Err with a dash indicates there was a power loss to the controller while writing a program to the non-volatile memory chip.</td>
</tr>
<tr>
<td>ErrE or Errt</td>
<td>The controller software has detected a hardware error. The controller must be returned for service.</td>
</tr>
<tr>
<td>Errd*</td>
<td>The kiln temperature is more than 50°F above the travelling set-point. If a zone control then any one of the zone temperatures is more than 50 degrees F above the travelling set point.</td>
</tr>
<tr>
<td>ErrA</td>
<td>Invalid program variable.</td>
</tr>
<tr>
<td>Err</td>
<td>RAM (random access memory) does not equal EEPROM (memory chip). Reprogram and try to fire again. If error persists then controller will need repair.</td>
</tr>
<tr>
<td>ErrU</td>
<td>Invalid 16 segment firing is attempted. Reprogram and restart firing.</td>
</tr>
<tr>
<td>ErrH</td>
<td>Hardware error. Controller must be returned for repair.</td>
</tr>
<tr>
<td>StUc</td>
<td>Key was held too long or is stuck</td>
</tr>
<tr>
<td>FAIL</td>
<td>Steady FAIL display then all thermocouples (t/c) have failed. If t/c 1 alternately flashing with FAIL then t/c one in top section has failed. t/c 2 flashing with FAIL, then t/c 2 (middle section) has failed. t/c 3 flashing with FAIL, then t/c 3 (bottom section) has failed.</td>
</tr>
<tr>
<td>Decc</td>
<td>Decreasing Ramp segment &gt; 50°F below travelling set-point temp. Persists &gt; 18 sec.</td>
</tr>
</tbody>
</table>

* Indicates this error code is turned off when ErCd (Error Codes or Error Checking) is OFF. Err1 is automatically turned back on during the last segment of a cone fire program even when ErCd is OFF.
STARTING THE KILN:

- Be sure kiln sitter is set with appropriate junior cone placed in holder.
- Program the computer for your particular firing. If using an existing program (such as #1 for bisque firing), it's recommended you double check the programming.
- Use optical cone pack for information on how the kiln is firing.
- If using computer, be sure all switches are on high.
- Turn on kiln room fan (switch next to breaker box) and close kiln room door.

MONITORING THE KILNS:

- Arrive @ your designated time; sign in on the kiln chart and record temperature registering on the computer controller. Look in the spy hole where optical cone is located to monitor kiln firing. Note the color of the atmosphere of the kiln.
- Don't simply sign in and leave; pay attention to what is going on & know what temperature the kiln is firing to. In a bisque firing, there is a pre-heat period during which the kiln temperature will be steady (below 212) for a number of hours and then the heat will increase.
- IN CASE OF AN ERROR MESSAGE: which means the kiln is off, first check to be sure the button on kiln sitter is fully in. An error message may also mean the kiln sitter turned the kiln off before the computer controller. Check the optical cones to determine what temperature the kiln reached. Refer to chart in this manual and on kiln room wall for full listing of error messages; error codes on the Olympic is different than the Skuts.
- If the kiln needs resetting and you can't do it (there are operational manuals for the Skutt controllers and Olympic kiln on kiln room bulletin board) find one of the Instructional Assistants, Lynn, Lisa or Sonny.
- Electric kiln cords and plugs / outlets sometimes break down or overheat. It is essential that plugs be inserted fully into outlets. If you notice a strange or electric smell while an electric kiln is firing, place your hands on the cords. They should feel warm to the touch but not hot. If they are hot, locate a faculty member or the Facilities Manager. If this is not possible and you are concerned about the wiring, turn the kiln off. This can be done by pressing the STOP button.
- If an electric kiln fails to shut off, it will over fire. This can damage or ruin both work and kiln furniture and also cause fires.

REMEMBER THAT NOTHING MECHANICAL IS FAIL SAFE:
COMPUTER CONTROLLERS REGULATE TEMPERATURE WHILE
KILN SITTERS ARE SAFETY BACK-UP DEVICES. ALL KILNS
MUST BE MONITORED WHILE THEY ARE BEING FIRED: A
COMPLETED KILN CHART MUST ACCOMPANY EACH AND
EVERY FIRING.
SHUTTING DOWN THE ELECTRIC KILNS:

- Once the firing is complete the control panel will flash cplt, the # of hours it took to fire, and the current temperature. If the control panel is blank it probably means the kiln sitter turned the kiln off before the computer. To help determine this, look @ the kiln sitter to see if metal plate has dropped and check optical cones inside the kiln.
- If the optical cones indicate that the kiln has reached the desired temperature, the kiln can be turned off by pressing the STOP button.
- Once you know the kiln has finished firing, note that on the kiln chart. Turn off room fan (unless the gas kiln is firing or cooling), unplug halogen light, close the kiln room door.

COOLING THE KILN:

- proper cooling is important for both the safety of the work and the maintenance of the kilns – sudden changes in temperature can weaken electric elements
- spy holes or door should not be opened until kiln temperature has dropped to 400 F., so kiln is below cristobalite inversion
- NOTE paper burns @ about 450 F. so a slip of paper can be inserted into spy hole if neither a pyrometer nor a computer controller is connected to the kiln
- below 400 kilns can be cooled slowly, by either pulling out the spy hole plugs or gradually lifting the lid – doing both can create a chimney effect, pulling in cold air which can adversely affect the work, causing either cracking of the clay or crazing of glaze

UNLOADING THE KILN:

- return posts and shelves to storage, arranged by size and kind
- scrape, clean & kiln wash shelves
- pots that are stuck to shelves, or with glazes that have run badly, are the responsibility of the student whose work it is to clean
- vacuum interior of kiln if necessary, being sure to keep element channels clear

4. MORE ABOUT FIRING

BISQUE FIRING:

- we usually bisque to cone 08, normal range is 010 – 06
- prevents pieces from slaking, reduces fragility of work, makes glazing easier
- burns out carbonaceous matter so gasses escape before glaze firing, helping to prevent glaze defects such as pinholing – if pinholing is a consistent problem try bisquing or clay body higher to burn off more organic materials
- under-bisquing results in fragile ware which could be overly absorbent
- over-bisquing results in ware that may be partially vitrified and not absorbent
usual schedule for the electric kilns @ ASU is a half day to load and pre-heat, starting in the afternoon, firing the following day, unloading the third day
PREHEAT holds the firing temperature below 212, the point at which steam forms and explosions can occur if work is not dry
Allow sufficient time for pre-heat which is determined by thickness and dampness of ware: large, thick, complex pieces require more pre-heat than do thin even pieces. It's best to fire work that is already dry; moisture leaving clay wears the elements.
8 hour preheat used for most class firings @ ASU - this slow firing cycle ensures work is completely dry and that bulk of firing occurs during hours that kiln can be easily monitored
if work being bisqued is small and dry, kiln can be fired faster with a shorter preheat or by selecting cone fire slow program; if work is unusually large or damp, pre-heat should be extended to 10 or 12 hours

SAFETY CONSIDERATIONS:
- since the early stages of bisque firing involve the oxidation of organic clay matter, resulting in carbon monoxide and other combustion gases, it is important to vent the kiln itself or entire kiln room when firing.
- later in firing cycle, sulfur breaks down producing highly irritating sulfur oxides
- @ ASU be sure to turn on kiln room fan and close the door to ensure proper ventilation.

QUARTZ INVERSION:
- during firing of a clay body, the silica (quartz) changes it crystalline structure several times – this is the free crystalline silica that is not in a chemical bond with other body components or fused into glass. The most profound change occurs @ 1063 F. when the quartz crystals change from alpha to beta, resulting in a sudden expansion. In the cooling the process is reversed. This is a reason why clay must be fired and cooled slowly.
- a second inversion of crystal structure occurs with any silica that has taken the form of cristobalite. cristobalite inversion occurs @ just over 400 F, and like quartz inversion, is accompanied by sudden expansion when heating and contraction when cooling

GLAZE FIRING:
- does not require a long pre-heat unless work is unusually large
- can generally be accomplished with cone fire method
- some glazes benefit from "soaking" @ end of cycle, i.e. holding temperature for a period of time
5. PYROMETRIC CONES

PYROMETRIC CONES measure work-heat, the effect of time & temperature on materials. Made of a combination of clay and glaze materials, they are formulated to melt @ very specific temperatures. Cones come in junior (small) and standard (large) sizes; there is a slight difference in firing temperature between differently-sized cones with same number. Small / junior cones are used in kiln sitters and in cone packs for electric kilns with small spy holes. Press "cone table" button on computer controller to check the temperature equivalent of pyrometric cones. See attached chart from Orton Cone Company for full listing.

Cones with "0" in front of number read like negative #s, so that 022, 018, 010, 06 is an ascending series. Cones without "0" read like regular numbers. There is no cone zero.

Cones for various clays, processes & materials:

<table>
<thead>
<tr>
<th>Cone</th>
<th>Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>022 - 016</td>
<td>china paint, lusters, decals</td>
</tr>
<tr>
<td>010 - 06</td>
<td>range for bisque; we generally bisque to 08 (08 / 06 in cone pack)</td>
</tr>
<tr>
<td>06</td>
<td>raku, some low-fire commercial glazes</td>
</tr>
<tr>
<td>04 / 03</td>
<td>low-fire glazes (06 / 04 / 03 in cone pack)</td>
</tr>
<tr>
<td>4 - 7</td>
<td>mid range stoneware</td>
</tr>
<tr>
<td>8 - 10</td>
<td>high fire – stoneware, porcelain, most soda, salt, wood firing</td>
</tr>
</tbody>
</table>

Junior cones placed in kiln sitter should be one cone higher / hotter than temperature to which you are firing. This allows kiln controller to determine end of firing.

Optical (or sight) cone packs can be made up ahead of when they will be used so they can dry before heating. Water turns to steam @ 212 degrees; damp cone packs can blow up. If a cone pack explodes in early stages of a glaze firing, turn off kiln and clean out before re-starting.

Generally one cone pack is sufficient for bisque firing, two are recommended for a glaze firing if exact temperature is crucial, used top & bottom for more accuracy. Remember that pyrometers and cone packs register heat only @ the location they are placed in the kiln.

Guard Cone is lower than Firing Cone - indicates when heat is approaching desired temperature
Firing Cone is temperature to which you are firing
Guard Cone – hotter than Firing Cone

Sample Cone Packs:
Bisque: 08, 06
Low-fire glaze (firing to 04): 06, 04, 03 or 02
Mid-range glaze (firing to 6): 2, 4, 6, 7
High Fire (firing to 9): 4, 6, 8, 9, 10
Numerous prolonged firings significantly decrease life span of electric elements. Only our middle older Skutt is rated for Cone 10, but will not reach that temperature due to its age and heat loss through worn walls & rim. It is recommended that high fire be done in the gas kilns.

Remember work / heat, the effect of time and temperature on materials, which means length of firing affects temperature at which cone will bend. For example, if the rate of heat increase in kiln is 50 degrees / hr, an 04 cone will bend @ 1938; if rate is 200 degrees an hour, 04 will not bend until 1957. Thus cones can continue to drop after the kiln has been turned off since there is still heat inside.
<table>
<thead>
<tr>
<th>Cone</th>
<th>Centigrade</th>
<th>Fahrenheit</th>
<th>Color</th>
<th>What Happens to Clay</th>
<th>Type of Ware and Glaze</th>
</tr>
</thead>
<tbody>
<tr>
<td>—</td>
<td>0</td>
<td>32</td>
<td>—</td>
<td>Water freezes</td>
<td>—</td>
</tr>
<tr>
<td>—</td>
<td>100</td>
<td>212</td>
<td>—</td>
<td>Water boils</td>
<td>—</td>
</tr>
<tr>
<td>—</td>
<td>100–300</td>
<td>212–572</td>
<td>—</td>
<td>Chemical water driven off</td>
<td>—</td>
</tr>
<tr>
<td>—</td>
<td>470</td>
<td>878</td>
<td>—</td>
<td>Lowest point where red glow can be seen in the Dark</td>
<td>—</td>
</tr>
<tr>
<td>022</td>
<td>573</td>
<td>1063</td>
<td>—</td>
<td>Quartz inversion</td>
<td>Metallic lusters (gold, platinum, etc.)</td>
</tr>
<tr>
<td>021</td>
<td>605</td>
<td>1121</td>
<td>—</td>
<td>Lowest cone temperature</td>
<td>—</td>
</tr>
<tr>
<td>020</td>
<td>614</td>
<td>1137</td>
<td>—</td>
<td></td>
<td>Overglaze colors or enamels (China paints)</td>
</tr>
<tr>
<td>019</td>
<td>635</td>
<td>1173</td>
<td>—</td>
<td></td>
<td></td>
</tr>
<tr>
<td>018</td>
<td>683</td>
<td>1261</td>
<td>—</td>
<td></td>
<td></td>
</tr>
<tr>
<td>017</td>
<td>717</td>
<td>1323</td>
<td>Dull</td>
<td></td>
<td></td>
</tr>
<tr>
<td>016</td>
<td>747</td>
<td>1377</td>
<td>Red</td>
<td></td>
<td></td>
</tr>
<tr>
<td>015</td>
<td>792</td>
<td>1458</td>
<td>Organic matter in clay burns out</td>
<td>Inglaze lusters</td>
<td></td>
</tr>
<tr>
<td>014</td>
<td>804</td>
<td>1479</td>
<td>Orange</td>
<td></td>
<td>Raku</td>
</tr>
<tr>
<td>013</td>
<td>838</td>
<td>1540</td>
<td>Dark</td>
<td></td>
<td>Chromium red glazes</td>
</tr>
<tr>
<td>012</td>
<td>852</td>
<td>1566</td>
<td>Cherry</td>
<td></td>
<td>Lowfire lead glazes</td>
</tr>
<tr>
<td>011</td>
<td>884</td>
<td>1623</td>
<td>Red</td>
<td></td>
<td>Lowfired bisque</td>
</tr>
<tr>
<td>010</td>
<td>894</td>
<td>1641</td>
<td>White</td>
<td></td>
<td>Lowfired earthenware</td>
</tr>
<tr>
<td>009</td>
<td>906</td>
<td>1661</td>
<td>Yellow</td>
<td></td>
<td></td>
</tr>
<tr>
<td>008</td>
<td>922</td>
<td>1693</td>
<td>Dark</td>
<td></td>
<td></td>
</tr>
<tr>
<td>007</td>
<td>955</td>
<td>1731</td>
<td>Orange</td>
<td></td>
<td></td>
</tr>
<tr>
<td>006</td>
<td>984</td>
<td>1803</td>
<td>White</td>
<td></td>
<td></td>
</tr>
<tr>
<td>005</td>
<td>999</td>
<td>1830</td>
<td>Orange</td>
<td></td>
<td></td>
</tr>
<tr>
<td>004</td>
<td>1031</td>
<td>1888</td>
<td>Buff clays mature</td>
<td>Average bisque</td>
<td></td>
</tr>
<tr>
<td>003</td>
<td>1060</td>
<td>1940</td>
<td>Orange</td>
<td></td>
<td>Earthenware</td>
</tr>
<tr>
<td>002</td>
<td>1101</td>
<td>2014</td>
<td>Yellow</td>
<td></td>
<td></td>
</tr>
<tr>
<td>001</td>
<td>1120</td>
<td>2048</td>
<td>Dark</td>
<td></td>
<td>Highfire earthenware</td>
</tr>
<tr>
<td>01</td>
<td>1137</td>
<td>2079</td>
<td>Yellow</td>
<td></td>
<td>Semi-vitreous ware</td>
</tr>
<tr>
<td>1</td>
<td>1154</td>
<td>2109</td>
<td>Yellow</td>
<td></td>
<td>Sanitary ware</td>
</tr>
<tr>
<td>2</td>
<td>1182</td>
<td>2121</td>
<td>Yellow</td>
<td></td>
<td>Bone China glazes</td>
</tr>
<tr>
<td>3</td>
<td>1186</td>
<td>2167</td>
<td>Yellow</td>
<td></td>
<td>Lowfired stoneware</td>
</tr>
<tr>
<td>4</td>
<td>1196</td>
<td>2185</td>
<td>Yellow</td>
<td></td>
<td>Salt glazes</td>
</tr>
<tr>
<td>5</td>
<td>1223</td>
<td>2232</td>
<td>Yellow</td>
<td>Stoneware clays mature</td>
<td>Stoneware</td>
</tr>
<tr>
<td>6</td>
<td>1240</td>
<td>2264</td>
<td>White</td>
<td>Porcelain matures</td>
<td>China bodies—bisque</td>
</tr>
<tr>
<td>7</td>
<td>1263</td>
<td>2305</td>
<td>White</td>
<td>Porcelain</td>
<td>Porcelain</td>
</tr>
<tr>
<td>8</td>
<td>1280</td>
<td>2336</td>
<td>White</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>1305</td>
<td>2381</td>
<td>White</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>1315</td>
<td>2399</td>
<td>White</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>1326</td>
<td>2419</td>
<td>White</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>1346</td>
<td>2455</td>
<td>White</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>1366</td>
<td>2491</td>
<td>White</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: The temperature equivalents in this table apply only to large (2½ inch) Orton Pyrometric cones when heated at the rate of 150°C (270°F) per hour in an air atmosphere. The above list represents the temperature range within which studio potters and ceramists generally work. For industrial and scientific purposes, higher temperatures may be needed, with cones going to cone 42, the melting point of pure silica. The columnar temperature represents the approximate color of radiant light visible in the kiln.
### Kiln # 06

<table>
<thead>
<tr>
<th>Date</th>
<th>Name</th>
<th>Bisque Glaze</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optical 08, 06, cones: 05</td>
<td>Cone pack location</td>
<td>X</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time</th>
<th>Setting</th>
<th>Temp/Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>overnight 8:30</td>
<td>L L L</td>
<td>overnight low</td>
</tr>
<tr>
<td>overnight 8:30</td>
<td>L L</td>
<td>shut lid turn up timer</td>
</tr>
<tr>
<td>overnight 8:30</td>
<td>L L</td>
<td>put in plugs</td>
</tr>
</tbody>
</table>

SAMPLE BISQUE FIRING

By:  

### Kiln # 03

<table>
<thead>
<tr>
<th>Date</th>
<th>Name</th>
<th>Bisque Glaze</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optical 05, 04, cones: 03</td>
<td>Cone pack location</td>
<td>X</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time</th>
<th>Setting</th>
<th>Temp/Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>overnight 8:30</td>
<td>L L</td>
<td>overnight low</td>
</tr>
<tr>
<td>overnight 8:30</td>
<td>L L</td>
<td>shut lid turn up timer</td>
</tr>
<tr>
<td>overnight 8:30</td>
<td>L L</td>
<td>put in plugs</td>
</tr>
</tbody>
</table>

SAMPLE GLAZE FIRING

By:  

---

Conservative firing to ensure slow dry and

Dry work.
*** GAS LEAKS ***

IF you smell gas leaking:
1. Do not turn on/off lights and/or other electrical equipment in the room (this includes cell phones).

2. If possible, close the main gas valve in the room and open exterior doors and windows. Go outside and shut off the main gas valve on the supply tank, located in fenced-in area @ rear of the building. Key to fenced area is in red box by rear exit of clay room.

DO NOT RE-ENTER THE ROOM!

3. Immediately locate and notify faculty or staff of the situation. If they are not readily available call the University Police at 262-8000 or use the emergency “blue light” phone located outside of building (one located at edge of the Stadium parking lot at rear of building, the other is located between Wey Hall & and Farthing Auditorium ). Tell them you suspect a gas leak in Room 119 of Wey Hall.