

Operating instructions and guidelines for normal startup, operation and shutdown of the furnace. Refer to chapter 6 to view operating instructions for optional equipment.

## 4.1 Furnace Operation




Daily operation of the furnace requires a routine start up procedure to assure long life of the furnace and to guard against premature failures. In particular, gas flow should be established before turning on the heating elements to protect temperature sensitive components from excessive heat. To prolong lamp life, do not operate at zone temperatures above 1000 °C.

### 4.1.1 Retained Control Settings:

When power is shut off to the furnace control system, these settings are retained:

- All zone controller parameters, values and settings.
- The belt speed setting.
- Energized lamp selections.
- Gas flow settings.
- The alert/alarm buzzer silenced status.

### 4.1.2 Start Up Procedure (Cold Start – controls OFF, lamps OFF)

Table 4-1 Cold Start Up	
Action	Comments / Changes
<b>1. Confirm MAIN POWER light ON</b>	If not on, turn on power to the furnace.
<b>2. Turn on the process gas supply valve</b>	Adjust gas flowmeters on GAS FLOW CONTROL panel for appropriate flow for the product being fired.
<b>3. Push CONTROLS green button</b>	Powers up the control system. Wait a few seconds for the zone controllers to initialize and display current zone and setpoint temperatures (Main Screen).
<b>4. Confirm desired setpoint temperatures</b>	Press controller  or  keys to enter the temperature, and  key to store the value.
<b>5. Confirm lamps to be energized</b>	Select on the ENERGIZE LAMPS panel.
<b>6. Confirm desired belt speed.</b>	Set using the TRANSPORT panel BELT SPEED knob.  Briefly examine the transport system, making sure the belt is moving smoothly.
<b>7. Push LAMPS green button</b>	Turns lamps ON. When the lamps first turn on, the SCR “soft start” capability limits the in-rush of current to the cold lamps.
<b>8. Wait for the green READY light</b>	The furnace is now ready to process product.

### 4.1.3 Change to a New Profile With a Hot Furnace (controls ON, lamps ON)




Table 4-2 Changing the Profile	
Action	Comments / Changes
1. Push LAMPS red button	Turns lamps OFF.  The red PV zone temperatures will start to fall as the zones cool. The furnace control system will stay on, as will the transport belt, cabinet and cooling fans.
2. Set any new setpoint temperatures	Press controller ▼ or ▲ keys to enter the temperature, and SET key to store the value.
3. Confirm lamps to be energized	Select on the ENERGIZE LAMPS panel.
4. Confirm desired belt speed	Set using the TRANSPORT panel BELT SPEED knob.  Briefly examine the transport system, making sure the belt is moving smoothly.
5. Set/confirm gas flowmeters	Adjust gas flowmeters on GAS FLOW CONTROL panel for appropriate flow for the product being fired.
6. Wait for zone temperatures to settle	Monitor zone controllers until all zone PV temperatures (red display) are at, or below, new SV temperatures (green display).
7. Push LAMPS green button	Turns lamps ON.  Zone PV temperatures will start to rise as increasing heat is reported by the zone thermocouples. The “soft start” controls will increase power gradually for the first 20 seconds of the warm up to limit the in-rush current to the lamps.
8. Wait for the green READY light	The furnace is now ready to process product.

**4.1.4 Place Hot Furnace in Standby Mode (controls ON, lamps OFF):**

Table 4-3 Standby	
Action	Comments / Changes
<b>1. Push COOL DOWN START button.</b>	COOL DOWN blue indicator turns ON. The red CLEAR pushbutton turns on.  Lamps turn OFF. The red PV zone temperatures will start to fall as the zones cool. All fans, the transport belt, and the zone controllers stay on.  You can press the CLEAR pushbutton at any time to cancel COOL DOWN mode.
<b>2a. If furnace is to be restarted in 1 hour or less ...</b>	Maintain operational gas flows during short shut down periods to assure rapid stabilization upon start up.
<b>2b. If furnace is to be in Standby Mode for more than 1 hour ...</b>	When all zone temperatures fall below 200 °C, shut off the process gas supply valve.

The furnace can be left in this mode indefinitely without harm.

**4.1.5 Resume Operation From Standby Mode (controls ON, lamps OFF):**

Table 4-4 Resume Operation from Standby	
Action	Comments / Changes
<b>1. Turn on the process gas supply valve</b>	Adjust gas flowmeters on GAS FLOW CONTROL panel for appropriate flow for the product being fired.
<b>2. Confirm desired setpoint temperatures</b>	Press controller  or  keys to enter the temperature, and  key to store the value.
<b>3. Confirm lamps to be energized</b>	Select on the ENERGIZE LAMPS panel.
<b>4. Confirm desired belt speed.</b>	Set using the TRANSPORT panel BELT SPEED knob.  Briefly examine the transport system, making sure the belt is operating smoothly.
<b>5. Push LAMPS green button</b>	Turns lamps ON.
<b>6. Wait for the green READY light</b>	The furnace is now ready to process product.

### 4.1.6 Completely Shut Down a Hot Furnace (controls OFF, lamps OFF):

Table 4-5 Shut Down	
Action	Comments / Changes
1. Push COOL DOWN START button	COOL DOWN blue indicator turns ON. Lamps turn OFF. The red PV zone temperatures will start to fall as the zones cool.
2. Push CONTROLS red button	Turns controls OFF. The COOL DOWN Mode will keep the transport belt, cabinet and cooling fans ON until all zone temperatures are <100 °C. When that condition exists, all displays, the belt, the fans, zone controllers and the PLC shut off automatically.
<b>IMPORTANT NOTE:</b> To exit COOL DOWN at any time, push the CONTROLS green button to turn the controls ON and press the red CLEAR pushbutton to cancel COOL DOWN. You are now in STANDBY mode; see 4.1.5 to resume operation.	
3. When all zones are below 200 °C ...	Shut off the process gas supply valve.

## 4.2 Furnace Alerts & Alarms

### 4.2.1 With the CONTROLS button ON:



Table 4-6 Alerts & Alarms – Controls ON	
Problem	Comments/Remedies
A zone controller displays <b>no Cont</b> or <b>Err InPt</b> instead of the process and setpoint temperatures:	<p>The thermocouple or its connection to the controller may be bad.</p> <p>Check the input wiring and the thermocouple (replace if necessary).</p>
A zone controller displays <b>Err Proa</b> instead of the process and setpoint temperatures:	<p>There is an error within the controller.</p> <p>Cycle the power to the controller by pressing the CONTROLS red button to shut down the control system, waiting 10 seconds, then pressing the CONTROLS green button to restart the control system. This should clear the problem and the Main Screen should appear.</p>

### 4.2.2 With the LAMPS button ON:

The buzzer sounds and/or the CLEAR button is lit.

Turn SILENCE switch clockwise to silence the buzzer.

Check STATUS panel LED indicators for source of error.

Table 4-7 Alerts & Alarms – Lamps ON	
Problem	Comments / Remedies
<b>ZONE TEMP DEVIATION</b> LED is ON:	<p>This is an Alert and the furnace will continue operation.</p> <p>Check all zone controllers for an ALM1 LED (red) indicator ON. That zone has experienced a process temperature outside the setpoint temperature +/- the ALM1 limits set in the controller. The factory set ALM1 limits are +/- 10°C.</p> <p>Try to remedy the situation while the furnace continues to run. Remedies include:</p> <p><b>Do nothing.</b> It may have been a transient anomaly.</p> <p><b>Check eductor gas flow.</b> You may have to adjust the entrance exhaust eductor flow slightly up or down to pull more or less zone heat towards front of furnace.</p> <p><b>Check zone gas flows.</b> You may have to increase zone gas flow to increase flow stability through the zone.</p> <p><b>Change the zone setpoint.</b> A slightly higher or lower temperature might better accommodate temperature fluctuations in this particular profile. Adjust the zone controller setpoint using the  or  keys to enter the temperature, and press <b>SET</b> key to store the value.</p> <p><b>Autotune the zone PID settings.</b> See 5. Modifying Control Strategies, below.</p> <p><b>Widen the <b>AL<sub>1H</sub></b> and/or <b>AL<sub>1L</sub></b> limits set for the zone.</b> See 5. Modifying Control Strategies, below.</p>
<b>AIR PRESSURE LOW</b> or <b>N2 PRESSURE LOW</b> or <b>FG PRESSURE LOW</b> LED is ON:	<p>This is an Alert and the furnace will continue operation.</p> <p>The indicated gas manifold has seen a drop in gas pressure.</p> <p>Remedy the situation while the furnace continues to run by immediately turning on the identified gas supply (or supplies) to the furnace.</p> <p><b>Note:</b> If the gas supply (or supplies) cannot be restored <b>immediately</b>, push the <b>COOL DOWN</b> button to avoid damage to furnace components and do not operate furnace with lamps on until the gas supply can be restored.</p>

**When the alert condition is remedied, and the ALM1 LED turns OFF, reset the alarm system and buzzer:**

**Push the CLEAR button.** The CLEAR lamp and the ZONE TEMP DEVIATION LED turn OFF.

**Turn the lighted SILENCE switch counterclockwise.** The SILENCE lamp turns OFF and the audible buzzer is enabled.

Verify the green READY lamp is ON and return to normal furnace operation.

**4.2.3 If the IR lamps shut off, buzzer sounds, the CLEAR lamp turns ON:**

Turn the SILENCE switch clockwise to silence the buzzer.

Check STATUS panel LED indicators for source of error.

Table 4-8 Over Temperature Alarm	
Problem	Comments/Remedies
<b>OVER TEMPERATURE</b> LED is ON:	<p>This is an Alarm and the furnace cannot continue with the LAMPS turned ON.</p> <p>Check all zone controllers for a PV temperature at or near 1005 °C. That zone has experienced a process temperature higher than the ALM2 limit set in the controller. The factory set ALM2 limit is 1005 °C.</p> <p>Remedy the situation while the furnace cools down. Remedies include:</p> <p><b>Check eductor gas flow.</b> You may have to adjust the entrance exhaust eductor flow slightly up or down to pull more or less heat towards front of furnace.</p> <p><b>Check zone gas flow.</b> You may have to increase zone gas flow to increase flow stability through the zone.</p> <p><b>Change the zone setpoint.</b> A slightly higher temperature might better accommodate temperature fluctuations in this particular profile. Adjust the zone controller setpoint using the , or . keys to enter the temperature, and press ; key to store the value.</p> <p><b>Autotune the zone PID settings.</b> See 5. Modifying Control Strategies, below.</p> <p><b>Check affected zone SCR for “output stuck open” failure</b> (i.e. applying full power to lamps with no control input signal). If confirmed, replace zone SCR immediately. See 4.3.2 for more information.</p>

**When the alarm condition is remedied, and the ALM2 LED on the affected zone turns OFF, reset the alarm system and buzzer:**

**Push the CLEAR button.** The CLEAR lamp and the OVER TEMPERATURE LED turn OFF.

**Turn the lighted SILENCE switch counterclockwise.** The SILENCE lamp turns OFF and the audible buzzer is enabled.

Push LAMPS green button to turn the lamps ON.

Verify the green READY lamp is on and then return to normal furnace operation.

### 4.3 Energizing Lamps

The ability to turn banks of lamps off and on via the zone switches on the ENERGIZE LAMPS panel allows the user great flexibility in applying energy to each zone. Use just the top lamps in each zone for drying moisture or volatile organic compounds from the top surface of substrates or trays, or curing thermosetting compounds or coatings on wafers or polycarbonate materials. Use both top and bottom lamps in traditional furnace applications. Use just the bottom lamps to emphasize conduction heating of parts from the transport belt and from IR radiation on the bottom of metallic or ceramic parts carriers.

#### 4.3.1 Selecting banks of lamps

Top lamps only, bottom lamps only, both top and bottom lamps, or no lamps at all can be selected in each zone to give the user flexibility in applying energy to each zone. Select which lamps you want to energize before pressing on the Lamps ON button to ensure smooth power up to operating temperatures.

#### 4.3.2 Troubleshooting & resolving zone control issues using Zone Switches

Zone switches are also useful for testing lamps (see section 4-9) and checking for blown lamp fuses (see Table 7-2 Troubleshooting Power).

If heat in any zone increases rapidly into a “runaway” condition even if the zone controller OUT1 LED indicator is dark (the controller output is OFF), the heat can be stopped by shutting off the affected zone top and bottom switches. In this event, the zone SCR most likely has failed with an *output stuck open fault* and needs to be replaced.

If the heat in any zone steadily stays above the SV (temperature setpoint value), but is not in a *runaway* condition, shut off the affected zone top and bottom switches and see if the heat decreases. If it does not, the furnace has a process gas flow problem or the SV in adjacent zones may need to be lowered.

### 4.4 Belt Speed Considerations

The LA-309P is designed to continuously move parts through the process zones of the furnace. To promote long life of the equipment and assure best processing results, make sure belt is adjusted to a speed within the its specified range and appropriate for the processing temperatures in the furnace.

Extremely low belt speeds (for instance, <0.5 ipm) can create hot spots and warping of the belt at temperatures above 800°C for Nichrome-V belts, or above 425°C for 316 stainless steel belts.

High belt speeds require consideration of exit temperatures of the belt and processed parts.

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**DANGER: At high temperatures and high belt speeds, workers may be exposed to dangerously hot surfaces that may be a potential threat to human safety and cause serious injury.**

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Adjust belt speed so parts can be safely removed from the furnace. Provide protective barriers if the product temperature is too high to safely handle.

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**Warning: At temperatures above 600°C make sure that the belt speed selected does not result in the belt exiting the furnace at too high a temperature and causing damage to the drive system rollers.**

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Adjust belt speed so that the belt is at or below 150°C (300°F) by the time it reaches the end of the furnace. Increasing transition tunnel and CACT cooling gas flow can help lower the belt temperature to a safe temperature.



## 4.5 Testing Lamps

Whenever the lamps are on, the TOP LAMP STRINGS and BOTTOM LAMP STRINGS LED displays on the TEST panel indicate that power is being delivered to each string of lamps selected to be ON via the ENERGIZE LAMPS panel zone switches. However, especially at zone temperatures below 300 °C, sometimes the lamps require very little power to maintain the SV temperature. When current in the lamps falls below the threshold of detection, the LED display for that string will turn OFF, indicating a *potential* burned out lamp. The user can test for burned out lamps using the zone calibration signal in the following manner.

Table 4-9 Lamp String Test																													
Action	Comments / Changes																												
1. Confirm MAIN POWER light ON.	If not on, turn on power to the furnace.																												
2. Confirm process gas supply ON.																													
3. Press CONTROLS green button.	Powers up the control system.																												
4. Select banks of lamps to be tested	Using the zone switches on the ENERGIZE LAMPS panel, turn each switch clockwise to ON to select.																												
5. Press LAMPS green button.	Turns LAMPS ON.																												
6. On the TEST panel, press the CALIBRATE pushbutton (ON).	<p>For each zone switch turned ON, verify that these LAMP STRINGS indicators on the TEST Panel turn ON:</p> <p>For 380-480 Vac LA-309P Standard Power furnaces,</p> <table border="1"> <thead> <tr> <th>Zone Switch</th> <th>LAMP STRINGS</th> </tr> </thead> <tbody> <tr> <td>ZONE 1 TOP</td> <td>T1, T2</td> </tr> <tr> <td>ZONE 2 TOP</td> <td>T3, T4</td> </tr> <tr> <td>ZONE 3 TOP</td> <td>T5, T6</td> </tr> <tr> <td>ZONE 1 BOTTOM</td> <td>B1, B2</td> </tr> <tr> <td>ZONE 2 BOTTOM</td> <td>B3, B4</td> </tr> <tr> <td>ZONE 3 BOTTOM</td> <td>B5, B6</td> </tr> </tbody> </table> <p>For 380-480 Vac LA-309P High Power furnaces,</p> <table border="1"> <thead> <tr> <th>Zone Switch</th> <th>LAMP STRINGS</th> </tr> </thead> <tbody> <tr> <td>ZONE 1 TOP</td> <td>T1, T2</td> </tr> <tr> <td>ZONE 2 TOP</td> <td>T3, T4, T5</td> </tr> <tr> <td>ZONE 3 TOP</td> <td>T6, T7</td> </tr> <tr> <td>ZONE 1 BOTTOM</td> <td>B1, B2</td> </tr> <tr> <td>ZONE 2 BOTTOM</td> <td>B3, B4, B5</td> </tr> <tr> <td>ZONE 3 BOTTOM</td> <td>B6, B7</td> </tr> </tbody> </table> <p>If all 2 or 3 lamp strings are ON, that bank of lamps is good.</p> <hr/> <p>If one of the lamp strings LEDs is OFF, the string has a burned out lamp that needs to be replaced. See section 7.6.5.</p> <p>If both lamp strings LEDs are OFF for any pair of zone switches for the same zone (for instance T1 &amp; T2, B1 &amp; B2), it means that the zone has a blown fuse (most likely, check F33-F35 on the Power Control Schematic 802-101780-01) or an SCR controller (least likely) that needs to be replaced (section 7.9.1).</p>	Zone Switch	LAMP STRINGS	ZONE 1 TOP	T1, T2	ZONE 2 TOP	T3, T4	ZONE 3 TOP	T5, T6	ZONE 1 BOTTOM	B1, B2	ZONE 2 BOTTOM	B3, B4	ZONE 3 BOTTOM	B5, B6	Zone Switch	LAMP STRINGS	ZONE 1 TOP	T1, T2	ZONE 2 TOP	T3, T4, T5	ZONE 3 TOP	T6, T7	ZONE 1 BOTTOM	B1, B2	ZONE 2 BOTTOM	B3, B4, B5	ZONE 3 BOTTOM	B6, B7
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7. Press the LAMPS red button.	Shuts the lamps OFF.																												
8. Press the CLEAR button on the ALARM panel.	Ends CALIBRATE MODE and returns control of the lamp SCRs to the zone controllers.																												

### 4.6 Gas Flow Control

The process gas flowmeters are located on the Control Console. The flowmeters control process gas flow to the furnace elements as labeled.

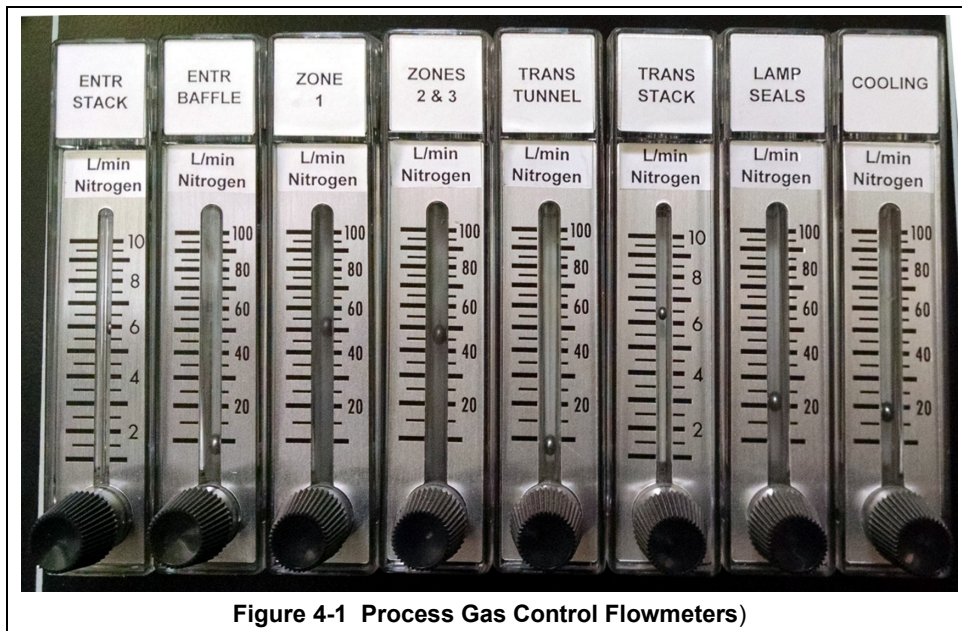


Figure 4-1 Process Gas Control Flowmeters)

On furnaces equipped with Dual Gas Option (DGO), the zone flowmeters are connected to Port 2 gas supply, all other flowmeters are connected to Port 1 gas supply.

On furnaces equipped with the CDA MIXING system, Gas 1 is connected to all GAS FLOW CONTROL flowmeters. Gas 2 is connected to the CDA MIXING flowmeter. Open the CDA Mixing ball valve and adjust the CDA MIXING flowmeter to add Gas 2 to Zones 2 & 3.

On furnace equipped with the SUPPLY GAS MIXING system, the zone flowmeters may receive gas from Port1, Port2 or a mixture of both. See section 3.4 for recommended initial settings. See sections for 8.5 through 8.5.5 for process engineering calculations.

#### 4.6.1 Adjusting Flowmeters

Turn the black flowmeter needle valve knob counterclockwise to increase gas flow and clockwise to decrease gas flow or close the valve completely.

Note: The STATUS ALARMS only report on LOW SUPPLY GAS PRESSURE to the gas manifolds. If the supply gas pressure is adequate, the alarms will NOT indicate absence of sufficient gas flow to the furnace elements even if the flowmeter valves are completely closed.

#### 4.6.2 Indicator Flags

Small plastic indicator flags may have been provided with the furnace to indicate preferred settings.

1. Press the indicator flag into place in front of scale with the red line on the back side next to the scale.
2. Slide the flag from the bottom of the top of the scale and back again 3 or 4 times to remove the mold release agent which is present on the flowmeter.
3. Slide the pointer flag to the desired location and place in service.

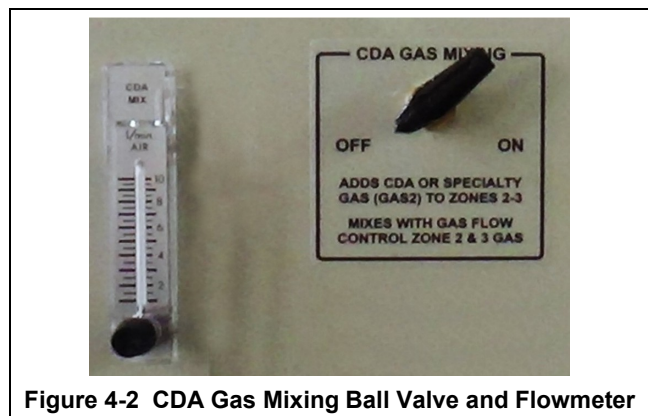


Figure 4-2 CDA Gas Mixing Ball Valve and Flowmeter