

# EQUIPMENT OPERATION

## 2.1 Power Controls and Indicators

### 2.1.1 Power Status Indicators

#### A. MAIN POWER ON - White Indicator

This lamp burns continuously whenever power is available to the furnace. The 3-phase disconnect switch (optional) and main circuit breaker (optional) must be turned on.

#### B. FURNACE POWER ON – Yellow/Amber Indicator

This lamp burns continuously when the control circuits are energized, and indicates that power is available to actuate the control circuits.

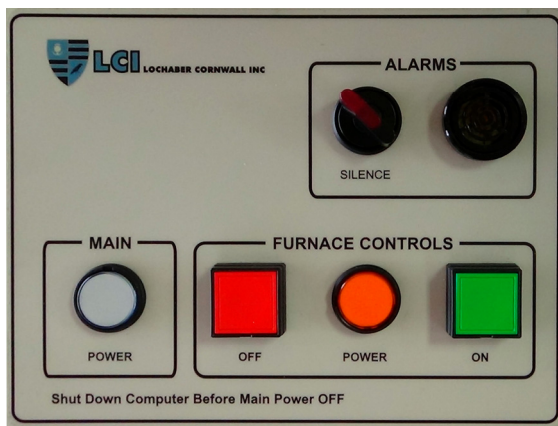


Figure 2-1 Control Console  
Showing Furnace Power ON and OFF & Indicator  
Lights



Figure 2-2 Control Console  
with keyboard & monitor.

#### C. ALARM HORN -Black Audible Alarm

This horn provides audible feedback for furnace system alarm conditions.

#### D. UCD - Fill, Run & Drain Indicating Lamps – (option not included)

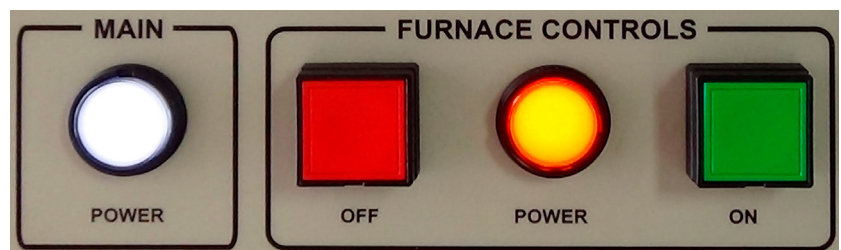
Lamps light to indicate status of Ultrasonic Cleaner Dry system. See logic table on drawing 802-101787.

#### E. USB Ports

Two (2) USB 2.0 ports are provided on the side of the professional computer monitor to connect a jump drive, camera or other device. USB 2.0 ports are also provided on the front of the furnace for connecting profiling equipment.

### 2.1.2 Power Console

Figure 2-3 Power Buttons  
Main Power ON



## Section 2

### A. MAIN FURNACE POWER

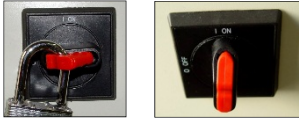

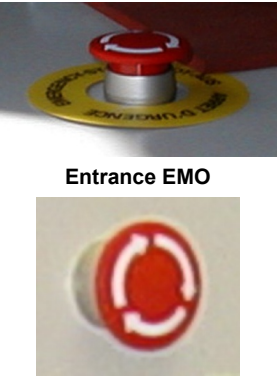

Table 2-1 Main Furnace Power		
MODE	ON	OFF
MAIN FACILITY BREAKER	Power to TR0 only: 1. MAIN POWER light (white) on 2. PC-S1 and PC-S2 sockets live for PC and monitor	No power to furnace, computer or monitor
3-PHASE INTERLOCK DISCONNECT SWITCH  	Lockable switch interlocked with safety panel cover. Switch must be turned OFF to enable removal of lower access panel. When switch is OFF, Power is disconnected from all furnace circuits (except 3-phase power connection to hot side of disconnect switch inside switch enclosure). Padlock switch to assure power remains OFF during maintenance.  Switch must be turned to ON to provide power to furnace.	No power to furnace, computer or monitor
3-PHASE CIRCUIT BREAKER DISCONNECT  	Lockable circuit breaker furnace disconnect switch. Switch must be turned ON to provide power to furnace.	No power to furnace, computer or monitor
EMO SWITCHES  		Operator activated Emergency Power Off switch located at furnace entrance and exit immediately cuts power to furnace and PLC controller. Computer and monitor stay on.  Rotate EMO knob to reset.  FURNACE POWER ON button must be pressed to re-introduce power.
EPO PANEL SWITCHES  	For maintenance purposes only, pulling out on all exposed interlock switches will allow operation of the furnace.  FURNACE POWER ON button must be pressed to re-introduce power.	If a lower panel is removed, emergency power interlocks will automatically cut power to furnace, including PLC controller. Computer and monitor stay on.

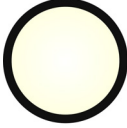


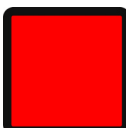
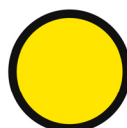


Table 2-1 Main Furnace Power		
MODE	ON	OFF
<p>MAIN POWER ON</p> <div style="text-align: center;">  </div> <p style="text-align: center;">POWER</p>	<p>Lamp illuminates indicating that 3-phase power is connected to the furnace and the main disconnect switch is ON.</p>	<p>No power to furnace, computer or monitor</p>
<p>FURNACE CONTROLS ON</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  <p>POWER</p> </div> <div style="text-align: center;">  <p>ON</p> </div> </div> <p>FURNACE CONTROLS OFF</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  <p>OFF</p> </div> <div style="text-align: center;">  <p>POWER</p> </div> </div>	<p>Power to furnace and furnace PLC controller. Pressing this momentary switch causes the furnace to go through its power up sequence, providing the MAIN POWER lamp is lit and the EMOs (Emergency Power Off switches) and interlocks located in the doors are released. 24 Vac controls active only if EMO and panel interlocks allow:</p> <ol style="list-style-type: none"> <li>1. K2 mechanical relay latches up, FURNACE POWER light (yellow) on.</li> <li>2. K6 mechanical relay sends switched 117 Vac power to belt motor, Opto22, gas supply valves, EM, and hour meter.</li> <li>3. K3 contactor energizes phase transformers TR1, TR2 &amp; TR3; all 117 and 24 Vac power control signals and accessories turn on.</li> </ol>	<p>Cuts power to furnace and furnace PLC controller. Pressing the OFF button causes the furnace to begin a timed power shutdown sequence. The heaters are shut down immediately. After Cool-Down (below 100°C), the fans, transport belt, and other functions are shut down.</p> <ol style="list-style-type: none"> <li>1. K2 mechanical relay turns off entire control system.</li> <li>2. K6 mechanical relay turns off. Belt motor, Opto22, gas supply valves, EM, and hour meter stop instantly, unless COOL DOWN clicked on PROCESS screen prior to OFF button being pushed.</li> <li>3. K3 contactor turns off. All 117 Vac and 24 Vac control signals and accessories stop instantly, unless COOL DOWN clicked on PROCESS screen prior to OFF button being pushed.</li> <li>4. K1 lamp contactor shuts off, removing power to lamps and edge heaters.</li> </ol>
<p>POWER FAILURE</p>		<p>Cuts power to furnace, including computer and monitor.</p>

Table 2-2 Special Controls		
MODE	ON	OFF
<p>SILENCE Switch</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  <p>SILENCE</p> </div> <div style="text-align: center;">  <p>SILENCE</p> </div> </div> <p><b>Inactive (OFF)    Active (ON)</b></p> <p>Located on Control Console</p>	<p>When active, Silence switch mutes audible alarms sound. Lights when active to indicate alarms are silenced. Software indicates alarm condition normally by flashing Alert or Alarm button and logs alarm.</p>	<p>DEFAULT. Audible alarms sound normally. Software indicates alarm condition by flashing Alert or Alarm button and logs alarm</p>

## Section 2



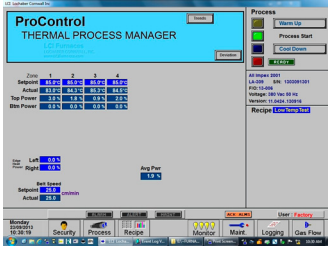
Table 2-2 Special Controls		
MODE	ON	OFF
<p>LOW PRESSURE ALARM Bypass Switch</p>  <p>Service switch - located on left side of the PLC panel</p>	<p>When in Disable Alarms position, prevents system detection of low pressure condition. Software will NOT detect or log low process gas pressure condition.</p>	<p>DEFAULT. Enable Alarms. Alarms sound normally. Software indicates alarm condition by flashing Alert or Alarm button and logs alarm</p>
<p>CONTROLLER POWER Switch</p>  <p>Service switch - located on upper left side of PLC panel</p>	<p>DEFAULT. Controls AC power to PCL panel DC power supplies that supply power for Controller and control auxiliaries, including pressure alarms and element monitoring system. ON during all normal furnace operations.</p>	<p>Useful to cycle or service controller or control system analog and digital I/O devices.</p>

Table 2-3 Software – Furnace Control		
SOFTWARE MODE	WARMUP	COOL DOWN
<p>PROCESS SCREEN</p> 	<p>If FURNACE POWER is ON,</p> <ol style="list-style-type: none"> <li>energizes lamps and edge heaters via K1 lamp contactor,</li> </ol> <p>If FURNACE POWER is OFF, no effect</p>	<p>If furnace is in WARM UP or PROCESS READY modes,</p> <ol style="list-style-type: none"> <li>provides power to K6 mechanical relay and K3 contactor until temperature reading in all zones &lt; 100C; then</li> <li>shuts off K6 and K3 (see FURNACE POWER button OFF),</li> </ol> <p>Otherwise no effect</p>

### B. COMPUTER POWER

COMPUTER UNSWITCHED (Default). The computer has been wired to be powered from an un-switched power source. The computer and monitor remain ON unless either is individually shut down at the computer or monitor or if Main Power is removed from the furnace. This mode offers the best protection for the computer operating system, files and hard drives. Power to the computer is supplied when Main Power is supplied to the furnace.

The momentary power button on the front of the computer must be pressed to start the computer.

Note: Pressing the red FURNACE CONTROLS OFF button on the Furnace Console will not cut power to the computer or monitor.

## 2.2 Starting the Furnace

### 2.2.1 Main Power Indicator

The MAIN POWER indicator must be lit to make sure facility power is provided to the furnace.

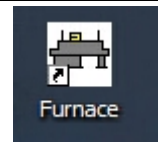
### 2.2.2 Process Gas Pressure

Assure that clean dry compressed process gas is supplied to the furnace at a minimum of 4.8 bar (70 psig). Compressed gas must be delivered to the furnace walls, exit stack venturi and belt tensioners for proper operation of the furnace. If furnace is supplied with Auto Gas Shutoff feature, process gas will flow when Furnace Power ON is pressed.

### 2.2.3 Power On/Startup

Follow the steps per the STARTUP table to start the furnace. See section 0 if restarting from Auto Shutdown

<b>1. Main Power</b>	Verify the white Main Power ON button is lit. Furnace Disconnect switch should be ON, all panels in place and EMO switches reset.
<b>2. Furnace ON</b>	Press Furnace Controls ON button. Yellow Furnace Controls Power light illuminates. Power is provided to the furnace controller.
<b>3. Computer ON</b>	Open the computer enclosure door, press the Computer start button on the tower to start the computer. The computer boots up and the logo screen is displayed. Furnace software starts. Computer and PLC begin to communicate.
<b>4. Monitor ON</b>	Press the power button on the monitor if you do not see the logo screen.
<b>5. Start Program</b>	Press Furnace program icon to initialize communication with the PLC and start the furnace program.
<b>6. Log-In</b>	Log in to furnace software. Log-in is only possible when PLC and Computer are communicating.



**CAUTION:** Dangerous voltages are now present throughout the electrical systems of the furnace. Make sure that any probes in the furnace are placed on the belt surface only. Probes extending over the sides of the belt may contact high voltage terminals!

### 2.2.4 Fans

Check that the cabinet cooling exhaust fans, and optional cooling tunnel exterior fans and product cooling fans are turning. If the exhaust for the furnace is located on the bottom of the machine, it is important to have the bottom impeller fan speed greater than or equal to the speed of the top fan to allow the cooling system to work properly.

### 2.2.5 Screen Menu Bar (located at bottom of screen)

The Screen Menu Bar allows operator to select the desired screen by moving the cursor and clicking on the chosen screen button. Note: Menu bar will vary according to furnace features and user log-in level.



Figure 2-4 Screen Button Menu

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### 2.2.6 Furnace Log-on and Initial Operation

Select “Security” button to access the “Security and User Information” screen.

#### A. Security and User Information

The Security and User Information screen allows the operator to select access level, log-on or log-off, add or delete users, and modify password and access codes.

#### B. Access Level

Select Access Level by clicking on the User List, click Log-On and enter the appropriate password and select Ok.

The system is shipped with three (3) access levels, each with its own password. See the Furnace Reference Manual, Chapter 5 Software, for information on managing users and passwords.

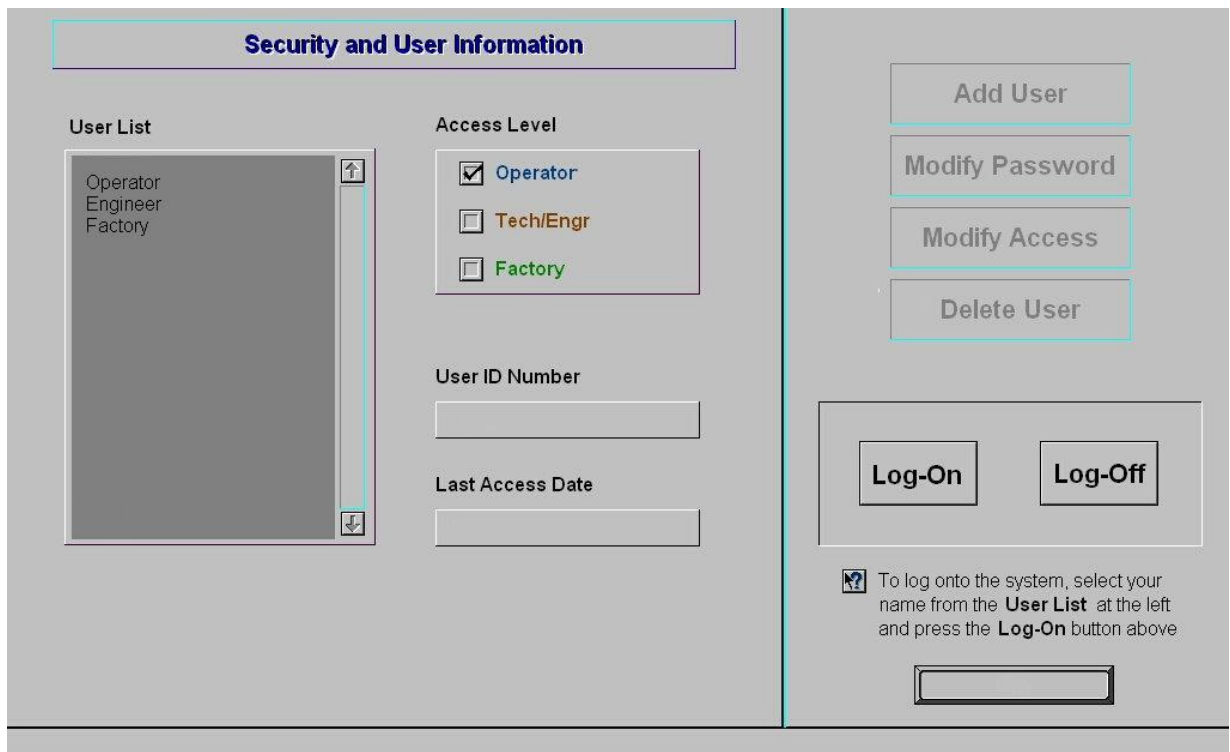


Figure 2-5 Security Screen, Log-on

- |                          |  |
|--------------------------|--|
| Access Level 1 password: | 1. Operator level, and allows the operator to load and run a recipe and initiate a process. (Initial password is set to “1”.)  |
| Access Level 2 password: | 2. Tech/Engr level. It allows the Technician or Engineer to do all of the above, as well as changing parameters such as temperature setpoints, power distribution, and belt speed. (Initial password is set to “2”.) |
| Access Level 3           | restricted to Manufacturer’s personnel only.   |

**NOTE: Before turning off furnace computer, you must “Log-Off” through the Security screen and shut down Windows OS via the START button on the computer Desktop display.**

## 2.2.7 Atmosphere Supply Gas - CDA

### A. FURNACE PROCESS GAS SYSTEM

Plant supply process gas must be filtered and regulated to 4.8 bar (70 psi) before the furnace is started to assure consistent clean dry process gas is supplied during furnace operation. An internal gas reservoir with check valve further regulates gas pressure to 15 psi for the belt tensioner.

If the furnace air pressure drops below the set point during operation, the operator should put the furnace into Cool Down. The operator can reset the system to Warm Up when air pressure is again over 70 psig.

Table 2-5 Gas Supply Pressure		
Location	Default Setting	
Plant Process Gas Regulator supply to furnace	65-70 psig	4.5-5.0 bar
Furnace Regulator (option not supplied)	- psig	- bar
Low Gas Pressure Alarm Switch	60 psig	4.1 bar

See Section 3 for information calibration and service of the pressurized gas (N<sub>2</sub>/CDA) system.

**WARNING:** The flowmeters on these furnaces are rated at 5 bar (70 psi) maximum. Operating above 70 psi exposes the operator to possible injury.

### B. Flow Meter Default Settings

Select the Gas Flow button. The Gas Flow screen will be shown. Open the furnace flowmeter access panel and adjust the gas flow to the default flows indicated on the screen or per process recipe requirements. See Owner's Manual, Engineering section for default settings. See Reference Manual, Chapter 9, Balancing Gas Flow for information on setting the flow meters to balance the system gas flow.

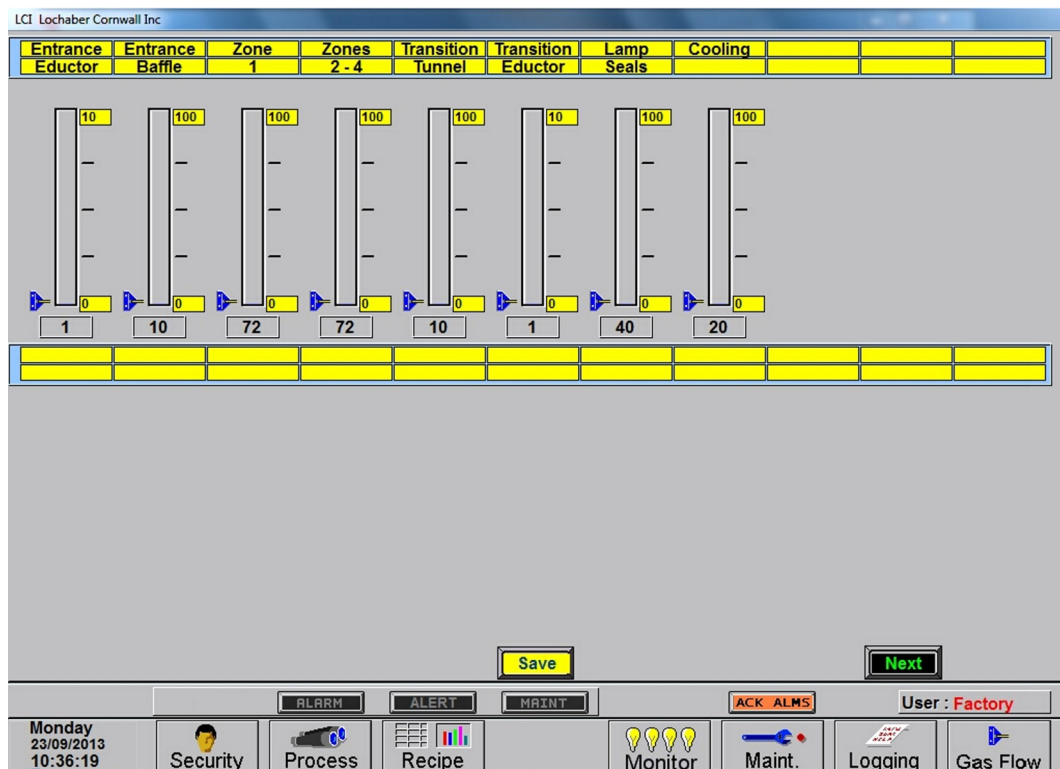


Figure 2-6 Gas Flow Screen

### 2.2.8 Furnace Process Screen

#### A. Process screen overview

Select the Process button on the menu bar view the Process screen. The Process screen displays the setpoint temperature, the current recipe, process state and status, transport speed, and other information such as percentage of power to elements and edge heaters. Alarm and alert dialog box also is displayed here along with event status.

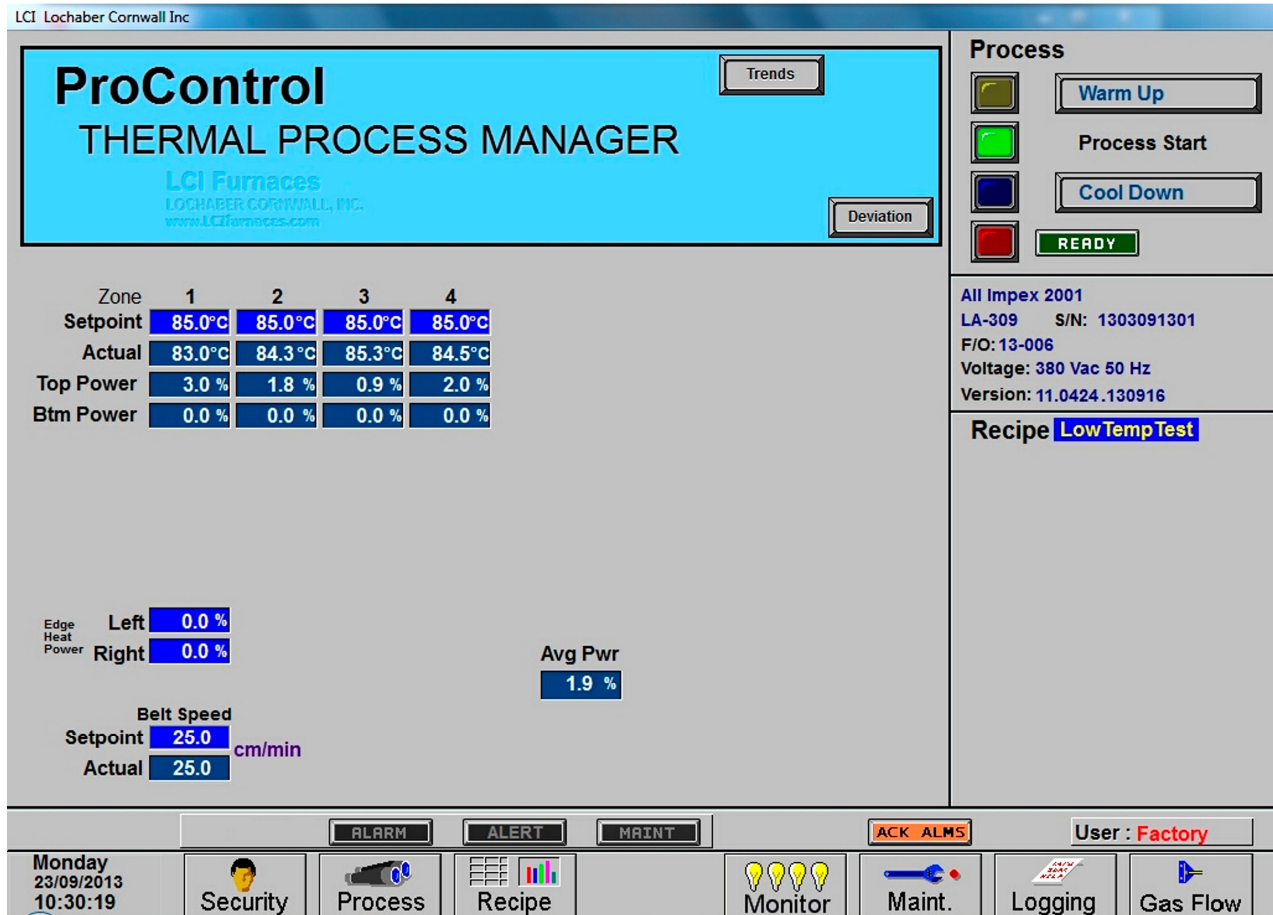


Figure 2-7 Process Screen

#### B. Zone Setpoint temperature fields

To enter or change zone setpoint temperatures, click on the Setpoint field and enter the new temperature in degrees Celsius.

#### C. Zone Actual temperature fields

The actual temperature field shows the temperature measured in each zone by the zone thermocouple in degrees Celsius.

#### D. Top Power / Btm Power fields

The Top and Btm Power fields display the percent power used by each zone by the lamps above and below the belt.

Change any value by clicking on the field and entering a value from 1-100%. For values less than 100% the furnace program will multiply the entered percentage times the resulting PID control value. For example if 50% is entered into the Top Power field for Zone one, when the PID value calculates a value of 3.0% power, the actual power applied and displayed will be 1.5% for that location.



## E. Edge Heat Power (option)

If edge heaters are included, enter value (0-100%) to apply linear heat to sides of furnace wall. Since edge heaters only apply the preset amount of heat to their entire length, the lowest acceptable value should be used to achieve even distribution of heat across the belt.

## F. Belt Speed fields

Click on the Setpoint field to enter a new belt speed. The Actual Belt Speed field displays the belt speed determined by the motor speed as calibrated.

## G. Trends button (option)

If SuperTrends are enabled, the Trends button will open a zone dialog box. Once a zone is selected the SuperTrends will open. See technical note on use of SuperTrends feature.

## H. Deviation button

When on the Process Screen, the user can activate the Deviation screen by clicking on the Deviation button. The Temperature Deviation screen will show the deviation of measured temperature from set point for each zone. The vertical bars are green for process ready conditions by zone, and change color independently as the deviation in a given zone changes.

The user can drag the Deviation screen to another location on the Process Screen or close the screen at any time.



Figure 2-8 Temperature Deviation Screen

## I. Avg Pwr field

The Avg Pwr field on the Process screen reflects the calculated actual power being used by the machine. This number is based on the % power applied to each zone and the lamp power of each zone. Edge heaters are not included in the calculation.

## J. ALERT & ALARM buttons

Pressing the Alert or Alarm button will open list of current alerts and alarms. ALERTs are notification of an issue or potential problem, while ALARMS indicate a serious problem, shut-down the lamps and/or take the furnace out of the READY state or WARM UP state. After an ALARM has been corrected, the Furnace Controls ON button must be pressed to restart the furnace.

## K. ACK ALMS button

Pressing the ACK ALMS button will “Acknowledge” or reset the alarm. If the source of the alarm is still a problem, the ALARM button will continue to blink and the alarm continue to sound.

While the machine is heating, check for alerts and alarms and listen for the alarm buzzer. In particular, check for any exhaust fan failure alarms. Check for failed elements. The effect of an element failure is generally minimal unless two failed elements are adjacent to each other.

**NOTE:** Allow the system to stabilize and to enter the PROCESS READY or PROCESS START mode as indicated by a green light on the screen before processing any product.

You must be in “Process Off” condition to exit (indicated by a red light).

## L. Process action buttons & indicators

The Process buttons include Warm Up, Process Start, Cool Down and Ready. Press the Warm Up button to introduce power to the heating lamps. The furnace remains in Warm Up until all zones are  $\pm 2\%$  of setpoint for over 60 seconds, then the green Process Start indicator and green READY box will lite. Pressing the Cool Down button starts the cool down sequence.

## Section 2

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### **M. Recipe indicator**

The Recipe indicator displays the recipe currently in running in the furnace controller.

### **N. Power Limit Feature (option)**

If Power Save is enabled, the power can be limited by a “Maximum power” value entered on the Maintenance/Calibration screen. If this value is set at 0, no power is calculated and no limit is set on the power used by the machine. Any non-zero value will cause the system to calculate the power and limit it to this value.

Default maximum power is set to 100% . When enabled, the total power will then always stay below the number set by the user. Edge heaters are not included in the calculation.

**WARNING:** A low power limit may prevent the machine from reaching the Process Ready state, since the user value may not be high enough to reach the desired temperature. For example, setting a maximum of 30 kW will most likely not be enough to reach a steady state in a high temperature furnace when trying to go to 900°C. In this case, the machine will just stay in the Warm Up mode.

## 2.3 Normal Furnace Operation

### A. Check for Alarms & Alerts

Check to assure that there are no active alarms or alerts. If needed, move cursor to and click on “ACK ALMS” to clear or silence an alarm/alert in order to proceed with furnace operation. If alarm/alert does not clear, see Troubleshooting in Section 3.

### B. Set Process parameters

Verify correct recipe is loaded. If not, click on RECIPE button for the “Recipe” screen (Figure 2-9) or enter desired process parameters including zone set point temperatures, power, edge heater and belt speed by clicking on respective the blue fields and typing the correct values.

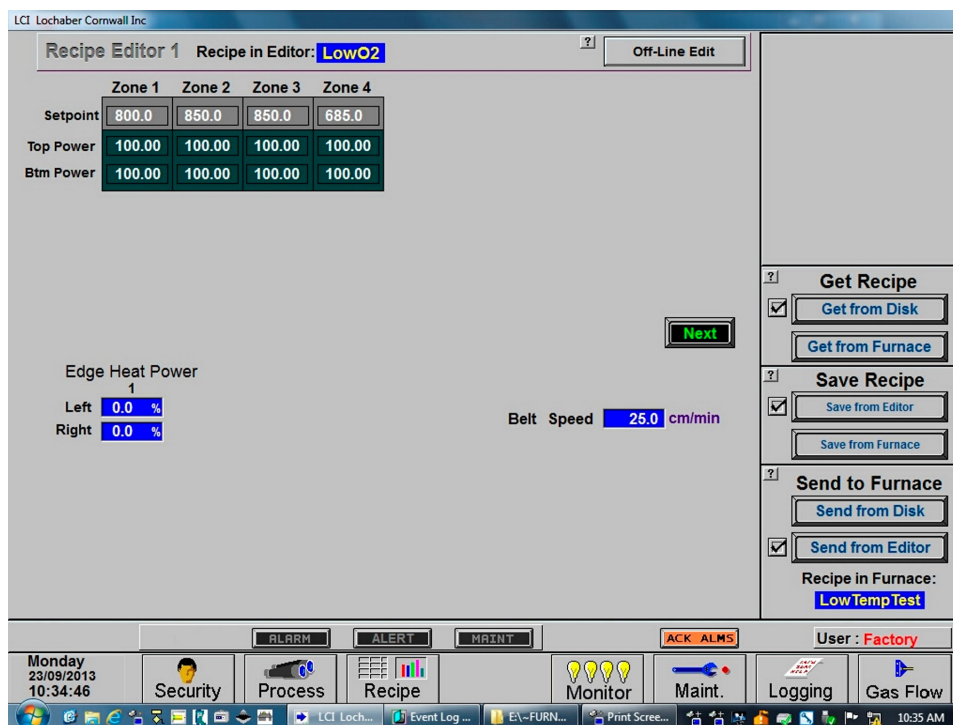


Figure 2-9 Get Recipe Menu and Editor

### C. Select WARM UP

In the Process field, select “WARM UP” to initiate the process selected (Figure 2-10). In the “WARM UP” mode, the heating elements are energized. After 20 minutes, check the system for instability or cycling, and correct if necessary.

### D. Process Start

When the furnace has stabilized the green Process Start button indicator and the READY box will lite. Product man now be placed on the belt for processing (Figure 2-10).

NOTE: Allow the system to stabilize and to enter the PROCESS READY or PROCESS START mode as indicated by a green light on the screen before processing any product.

## Section 2



Figure 2-10 Process Start

## 2.4 Furnace Shut Down

### 2.4.1 Shut Down Modes

There are five basic levels of shut down on the furnace:

1. EMO – Emergency Off
2. Control System Off
3. Cool Down
4. Auto Shut Down
5. Complete Shut Down

### 2.4.2 EMO Shut Down

For immediate shut down of the furnace:

1. EMO - Press any of the Emergency OFF (EMO) buttons.
2. All systems will immediately shut down, except for furnace computer and monitor.

### 2.4.3 Furnace Control System Shut Down

For immediate shut down of the furnace:

1. Press FURNACE POWER OFF button on Control Console .
2. All systems will immediately shut down, except for furnace computer and monitor.

### 2.4.4 Cool Down

To place the furnace in “standby” mode for quick restart (to load and run new recipe):

1. Using PC mouse, click the COOL DOWN button on the PROCESS screen to remove power from the heating elements. The heating elements turn off immediately. You will hear the K1 lamp power contactor release with a click. The furnace control system will continue to run the belt, cabinet cooling fans, product cooling fans, and keep process gas flowing during COOL DOWN.
2. When all zones are below 100°C, COOL DOWN is complete. The furnace may be left in this condition with belt running and process gas flowing indefinitely. You may manually turn off the process gas flow at this point without causing harm to the furnace, although you must remember to turn it back on prior to restarting the furnace.
3. To restart the furnace (after loading a new recipe or to run the current recipe again), click the WARM UP button on the Process screen , referring to item 5) in the Furnace Operation (Process Screen) section 2.3.

### 2.4.5 Shut Down Considerations

The furnace should be shut down when more than an hour or two will elapse between production runs. A shutdown conserves energy and prolongs the life of the furnace and elements. Follow the steps in sections 2.4.6 for short duration shutdowns.

The furnace computer is often left running if the furnace is to be down for less than 2-3 days. Leaving the computer on for longer period will not harm the system.

### 2.4.6 Auto Shut Down

Auto Shut Down allows an operator to initiate the shutdown sequence and not have to be present when the furnace completes COOL DOWN to complete the sequence. After Auto Shut Down is complete, the furnace computer remains running, although the rest of the furnace is shut down completely and must be restarted to resume operation (see section 2.4.10).

To initiate the Auto Shut Down sequence while in PROCESS START or WARM UP mode on the PROCESS screen follow steps 1 and 2. If all furnace zones are below 100°C, go to step 2:

#### **AUTO SHUT-DOWN STEPS:**

1. Click COOL DOWN on Process screen
2. Press FURNACE POWER OFF button

**COOL DOWN.** Using the PC mouse, click the COOL DOWN button on the PROCESS screen to remove power from the heating elements. The heating elements turn off immediately. You will hear the K1 lamp power contactor release with a click. The furnace control system will continue to run the belt, cabinet cooling fans, product cooling fans, and keep process gas flowing during COOL DOWN.

You may move to Step 2) at any time after clicking COOL DOWN, or the furnace can be left in this condition without problem. However, until FURNACE POWER OFF is pressed, the belt and auxiliary systems will continue to run even after COOL DOWN is through.

**FURNACE POWER OFF.** Press the FURNACE POWER OFF button on the control console.

While still in COOL DOWN, the MAIN POWER light remains “on” and the FURNACE POWER OFF button light is “off”. All controls and accessories (belt motor, fans, light tower, etc.) remain “on”. When all zones are below 100°C, COOL DOWN is complete and the control system will stop the belt automatically and shut off any other automatic systems.

When both AUTO SHUT-DOWN steps have been initiated and are complete, the furnace will be completely shut down electrically, except for the furnace computer and monitor. If the furnace is not equipped with Auto Gas Valve Shutdown, the process gas will still be flowing to the furnace until the valve is manually closed. The furnace can be left in this state indefinitely without harm to the furnace. For complete shutdown of the furnace see section 2.4.7.

### 2.4.7 Complete Shut Down

For complete shutdown of all systems and power to the furnace follow steps 1-5:

1. Click COOL DOWN on Process screen
2. Press FURNACE POWER OFF button
3. Computer system OFF
4. Process Gas OFF
5. Main Power

**COOL DOWN.** See section 2.4.5, subsection 0.

**FURNACE POWER OFF.** See section 2.4.5 , subsection 0.

**COMPUTER SYSTEM.** The computer system is normally left ON between short periods of furnace shut down. However, after COOL DOWN is finished, for Complete Shutdown, exit the Furnace program from the Process or Security screen. Then, click on Windows Start/Shut Down to turn the computer OFF. The computer will Power OFF after the operating system closes all files are closed.

**PROCESS GAS.** For furnaces equipped with the Auto Gas Shutoff feature, the process gas valves will close after COOL DOWN is finished. For complete shutdown, manually close process gas supply valves, but only after COOL DOWN is complete.

**MAIN POWER.** The main power is not automatically disconnected from the furnace. If you wish to disconnect the main power to the furnace, wait until steps 1-3 are complete before throwing the facility power breaker.

### 2.4.8 Turning Off Furnace PC and Monitor

Shutdown of Windows operating system and the furnace computer is only required if you are disconnecting facility power to the furnace.

1. **LOG OFF.** Using the PC mouse, go to the Security screen. Click your user name in the User List and click Log-Off. Clicking on the Exit button will take you out of furnace operation mode when all zones are below 100°C and the belt has stopped.
2. **SHUT DOWN.** From the Windows Desktop, select start, then select Shut Down. The computer will Power OFF after the operating system closes all files.

### 2.4.9 Exiting a Frozen Furnace Program

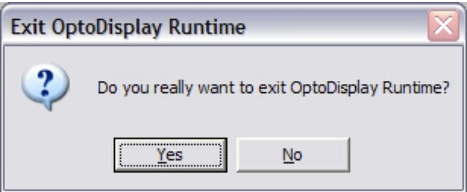
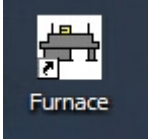
1. **EXIT FROZEN PROGRAM.** Using the PC keyboard, press ALT-F4 to exit the active program.
2. This method of closing the furnace program should only be used to exit a frozen program. It will not affect the program running in the furnace Controller. If still in Cool Down, the furnace will continue to run until the Cool Down sequence is complete.

Note: If communication is lost to the PLC LCM4 controller, the furnace program will freeze. To exit any frozen Windows® program, Press Alt-F4 on the keyboard.

## Section 2

### 2.4.10 Restarting the Furnace after Auto Shut Down

Auto shutdown turns off process gas and the Opto22 PLC after Cool Down. Since the computer remains on, the PLC must be re-initialized. Follow the steps per the RESTART table to start the furnace after Auto shutdown.

<b>Table 2-6 Restarting the Furnace after Auto Shut Down</b>	
<p>After Auto Shutdown, the furnace computer left ON, while furnace belt, lamps and all auxiliaries are OFF. In this state the furnace program will not be communicating with the PLC and, therefore, must be closed and reopened after the furnace is restarted to re-establish communication with the furnace.</p>	
<p><b>1. Close Furnace program</b></p>	<p>Click in the center of the furnace program screen and use Alt-F4 to close the furnace program.</p> <p>Note: Alt-F4 is a Windows command to close the active window. If Alt-F4 does not close the main furnace program, repeat the Alt-F4 command until you see the Exit OptoDisplay Runtime dialog box. Do not restart the furnace program until the furnace is ON.</p>
	
<p><b>2. Main Power</b></p>	<p>Verify the Main Power ON button is lit. Disconnect switch should be on, all panels in place and EMO switches reset.</p>
<p><b>3. Furnace ON</b></p>	<p>Press Furnace Power ON button. Furnace ON light illuminates.</p> <p style="text-align: center;"><b>Wait 5 minutes for the Opto22 PLC to sync with the Furnace computer.</b></p>
<p><b>4. Start Furnace Program</b></p> <p><b>5. Log-in</b></p>	<p>Press Furnace program icon to initialize communication with the PLC and start the furnace program.</p> <p>Log in to the furnace software. Log-in is only possible when PLC and Computer are communicating.</p>
	

**CAUTION:** Dangerous voltages are now present throughout the electrical systems of the furnace. Make sure that any probes in the furnace are placed on the belt surface only. Probes extending over the sides of the belt may contact high voltage terminals!



## 2.5 Modifying Control Strategies

### 2.5.1 Recipe Screen (Off Line Edit)

#### A. Go to Recipe Screen (Recipe Editor1)

NOTE: When editing this screen the process is not changed.

Level 1 access will allow the operator to inquire, select, and run preset parameters and recipes. Level 2 access will allow the operator to edit and save recipe data.

When initializing the “Load & Run” field, the process screen is updated and the Recipe Setup screen is changed to On Line Edit.

The screenshot displays the 'Recipe Editor 1' interface for 'Default' recipe. It features a table for zone parameters and various control fields.

	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8
Setpoint	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0
Top Power	30.00	30.00	50.00	50.00	50.00	50.00	50.00	30.00
Btm Power	30.00	30.00	50.00	50.00	50.00	50.00	50.00	30.00

Other visible parameters include: Edge Heat Power (Left/Right: 5.0%), Belt Speed (0.0 in/min), MA Alert/Alarm (-25 °C / -30 °C), Atmosphere Purge Time (5 min), H2 Gas Fill Time (5 min), Zone 4 O2 (0 ppm), Pre-Purge Cycle (8.0 min), Product Length (5.0 in), Exit Transit Time (25 s), and Data Log Interval (10 min).

Right-side controls include: O2/MA Sampling (On, Source, Zone 1, Zone 4, Zone 8), Get Recipe (Get from Disk, Get from Furnace), Save Recipe (Save from Editor, Save from Furnace), and Send to Furnace (Send from Disk, Send from Editor). The current recipe in the furnace is 'Default'.

Bottom status bar shows: Friday 09/30/2011 14:51:01, Security, Process, Recipe, Profile, Monitor, Maint., ACK ALMS, User: FPD, Logging, Gas Flow.

Figure 2-11 Recipe Editor 1

#### B. Load Recipe (Access Levels 1 and 2)

#### C. Delete Recipe (Access Level 2)

#### D. Edit Stored Recipe, Save Stored Recipe (Access Level 2)

NOTE: Do not use this feature on the current recipe while in ready mode and while processing parts.

## Section 2

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### 2.5.3 Changing Recipe Set points (Access Level 2)

#### A. Change Temperature (Access Level 2)

Place the cursor on the temperature setting to be modified. Type the new setting and press enter from the keyboard.

NOTE: Temperature display is in degrees Celsius.

#### B. Change Power Distribution (Access Level 2)

##### 1. Heating Element Power distribution

Default value is 100% top and bottom.

Place the cursor on the power distribution setting to be changed. Type in the new setting and press enter from the keyboard. This can be between 0% and 100%.

Power distribution is a scaled percentage of maximum power output to the top and bottom heating elements.

The maximum power is typically set at 1.5 times the actual percentage of power used when the furnace is in the "Ready" mode.

##### 2. Edge Heater Power Distribution (Access Level 2)

The edge heaters are located at the outer edges of the belt and run the entire length of the heated chamber. They can be used to improve the temperature uniformity across the width of the belt. Click on the blue cell to modify the percentage on. The range is 0-100% and can be set in increments of 1%. See the Reference Manual for more on using the edge heaters.

#### c) Change Transport Speed (Access Level 2)

Place the cursor on the Belt Speed field, click, type in the new value and press enter from the keyboard.

NOTE: Transport speed is displayed in inches per minute or cm/min.

##### 3. O2/MA Sampling (option)

If equipped with an integrated sampling system with oxygen analyzer and/or moisture analyzer, the O2/MA sampling panel will appear in the upper right hand portion of the screen. Select default state of sampling system (ON/OFF) and sampling port (Source, Zone 1,4,8).

If an oxygen analyzer is supplied, enter alarm value for O2 ppm.

If a moisture analyzer is supplied, enter values in degrees Celsius for moisture analyzer and oxygen analyzer alerts and alarms.

##### 4. SMEMA (option)

If equipped with SMEMA product tracking, enter length of product or product carrier in inches. Also enter the amount of time it takes from the time the part leaves the furnace until it reaches the an integrated moisture analyzer, enter values in degrees Celsius for moisture analyzer and oxygen analyzer alerts and alarms. Store in recipe file.

##### 5. Hydrogen/FG Furnace (option)

If equipped as a hydrogen or Forming Gas furnace, you can enter setpoint time for Pre-Purge cycle (min) for the time the gas will take to purge the furnace zones with nitrogen before combustible gas can be started.

### 2.5.4 PID Zone Tuning (Access Level 2)

On the recipe screen, “Next” button to view the Recipe Editor 2 screen. Enter new values for Gain, Integral and Derivative and save in recipe file.

Parameter	Initial Values
Proportional Gain	9
Integral	45
Derivative	0-1

Click on the desired Zone title pushbutton to monitor and Edit Zone PID Settings. A Zone Tuning dialog box (Figure 2-13 ) will appear with default values for proportional gain, integral, and derivative. Place the cursor on the value to be modified and click. Type the new setting and press enter from the keyboard. See Reference Manual, Chapter 9 for Process Engineering considerations in establishing PID parameters. Also see section 3.14.1 to completely retune a zone.



Figure 2-12 Recipe Editor2: Zone PID Parameters

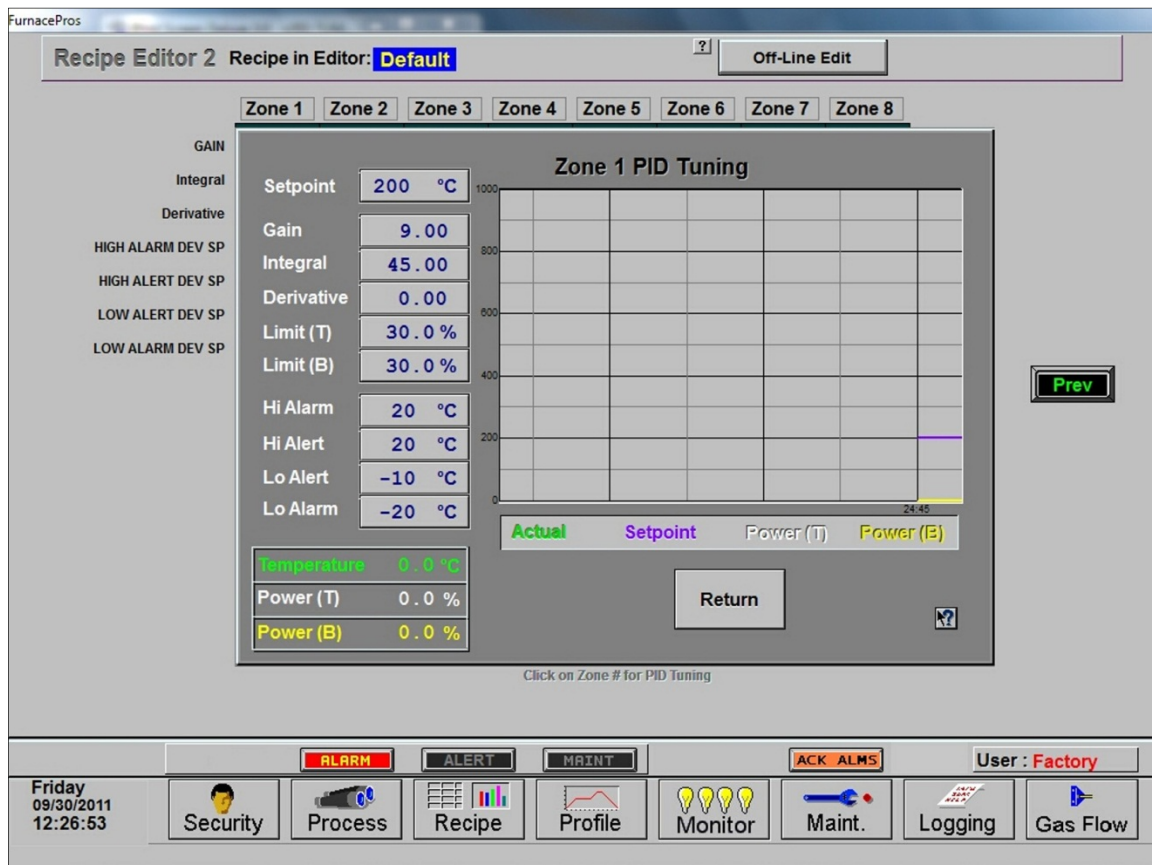


Figure 2-13 Recipe Editor 2: Zone PID Tuning

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### A. Gain (Proportional)

Gain influences the proportional response of the PID by amplifying the error between set point and actual temperature to establish an output level. The proportional band, in degrees Celsius, is defined as 100 divided by the gain. An increase in the gain reduces the amount of temperature deviation required to turn the heating elements on at full distributed power or decrease it. Too small a value will cause the system to be sluggish in response. Too high a value will cause the system to overshoot and be unstable.

### B. Integral

The integral (or Reset) function corrects temperature offset.

### C. Derivative

Derivative is a rate function that clamps temperature overshoot/oscillation. The maximum set point for the derivative function should be  $\frac{1}{4}$  of the integral value.

### D. Exit

For each Zone PID Tuning popup opened, you will need to click the “Return” button until all are closed. Click “Prev” button to return to Recipe Editor 1 screen.

## 2.5.5 Store Gas Flow Settings

Record flowmeter settings and store for each recipe using the Gas Flow screen. Enter flowmeter values by clicking on the value in the box below each flowmeter to record new values for the recipe being edited. See section 2.2.7 for more information. If stored with the recipe file, when a recipe is later opened, the operator can verify and adjust the flowmeters to match each recipe.

The screenshot shows the 'FurnacePros' interface for setting gas flow. It features two rows of flowmeter controls. The top row contains eight flowmeters: Entrance Eductor (scale 0-100), Entrance Baffle (scale 0-400), Transition Tunnel Ed (scale 0-100), Transition Tunnel (scale 0-400), Element Plenums (scale 0-200), Cooling Gas (scale 0-400), Exit Baffle (scale 0-400), and Exit Eductor (scale 0-100). The bottom row contains eight flowmeters for different zones: N2 Zones 1 & 2 (scale 0-400), N2 Zones 3 & 4 (scale 0-400), N2 Zones 5 & 6 (scale 0-400), N2 Zones 7 & 8 (scale 0-400), H2 Zones 1 & 2 (scale 0-100), H2 Zones 3 & 4 (scale 0-100), H2 Zones 5 & 6 (scale 0-100), and H2 Zones 7 & 8 (scale 0-100). Each flowmeter has a vertical scale with tick marks and a numerical input box at the bottom, currently showing '0'. A yellow 'Save' button is located below the H2 Zones 3 & 4 flowmeter, and a green 'Next' button is to its right. The bottom status bar includes 'ALARM', 'ALERT', 'MAINT', 'ACK ALMS', and 'User: Engr/Tech'.

Figure 2-14 Recipe Gas Flow flowmeter settings

## 2.6 Super Trends

To view current or historical performance by zone:

6. Press the Trends button at the top of the Process screen,
7. Select desired zone to view.

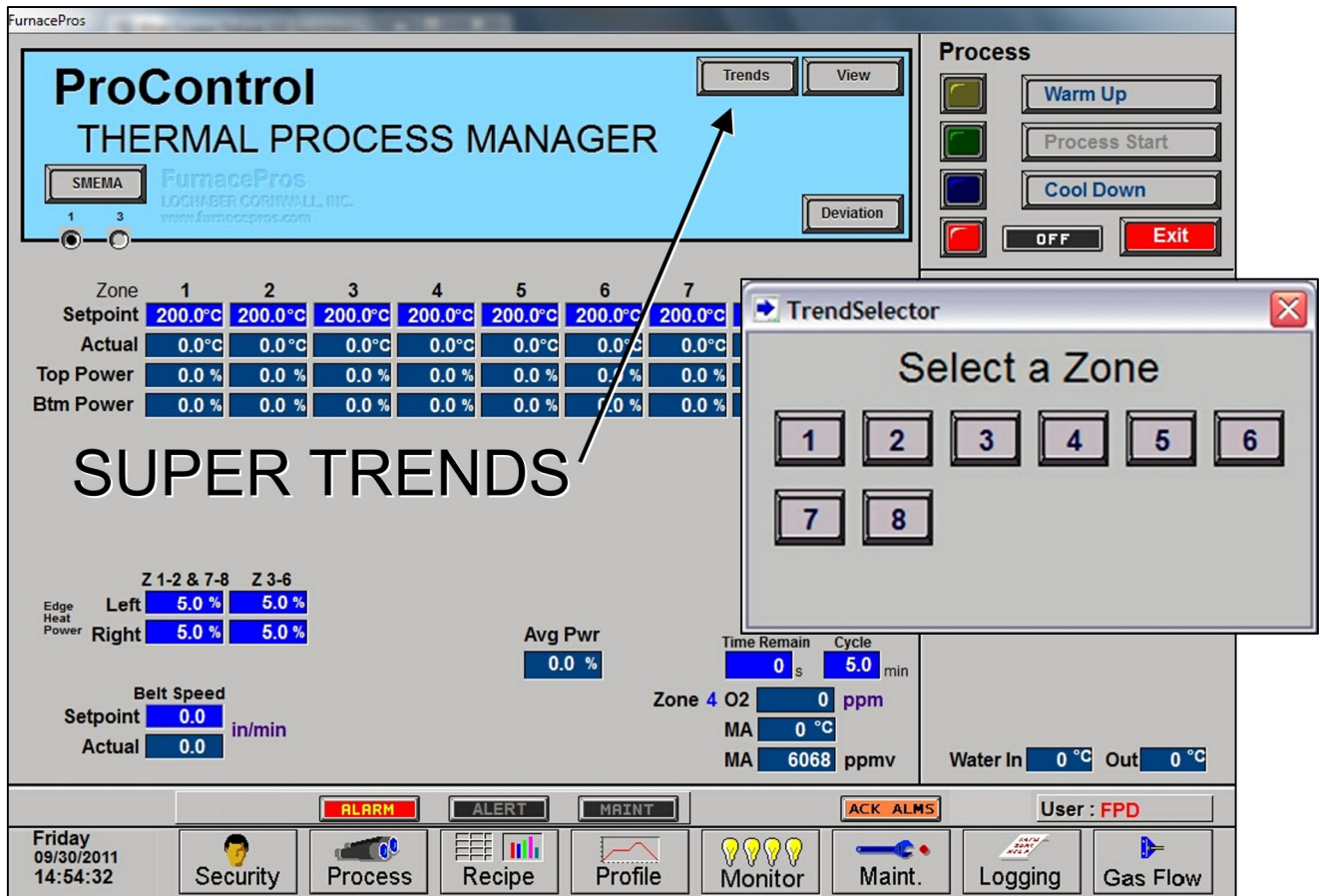



Figure 2-15 Super Trends button with Trend Selector

The Super trends graph appears as in Figure 2-16

Once the trends graph appears you can select the parameter to view. Selecting a specific parameter changes the vertical axis for that parameter. Press the  button to change the scale for the selected parameter. (see Figure 2-18). All parameters are shown on the screen at all times, although the scale is adjusted for the selected parameter.

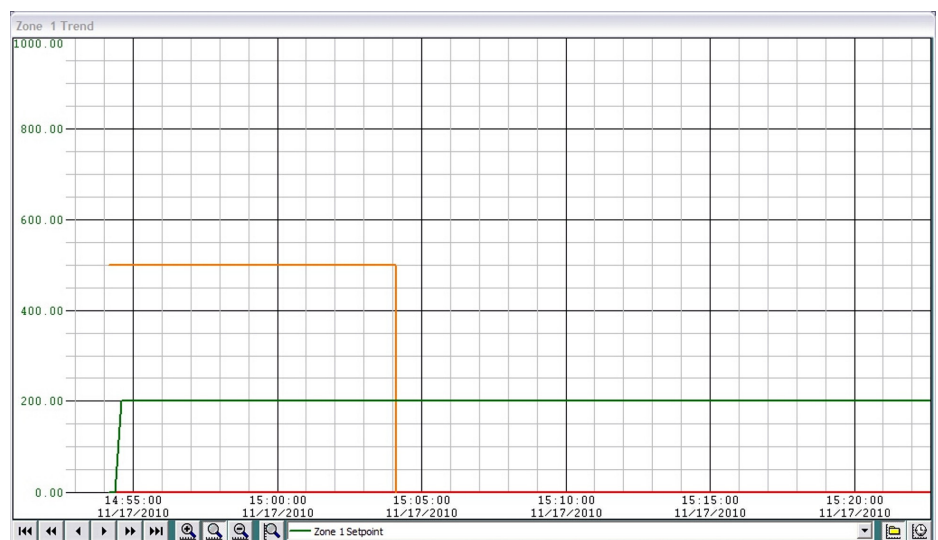


Figure 2-16 Super Trends graph

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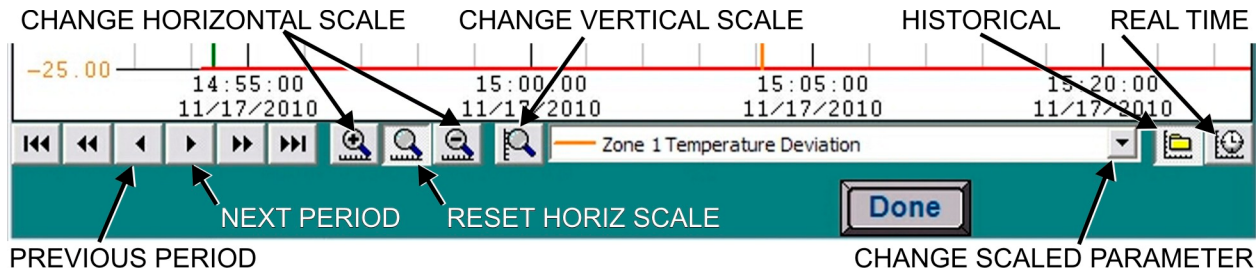


Figure 2-17 Super Trends Menu

Table 2-8 Super Trends Menu Buttons	
Button	Action
	<b>Real Time Mode</b> (default). Shows data currently being recorded for all 5 parameters.
	<b>Historical Mode</b> . Opens file from an earlier period. (See Figure 2-19). Activates Previous and Next buttons and Horiz scale buttons.
	<b>Select Pen</b> . Select a pen parameter and the vertical scale changes to match its set value
	<b>Zoom Pen</b> . Change vertical scale for selected parameter.
	<b>Zoom Normal</b> . Resets Horizontal scale to default (30 minutes per screen).
	<b>Zoom Hour</b> . Compresses horizontal scale (x-axis) to show more detail (one hour per screen).
	<b>Zoom Day</b> . Compresses horizontal scale (x-axis) to show longer time period in one view. (24 hours per screen)
	<b>Log Forward</b> (movement varies with Zoom) Zoom Normal: 5 minutes / 30 minutes / End of data Zoom In: 6 minutes / 1 hour / End of data Zoom Out: 30 minutes / 1 day / End of data
	<b>Log Back</b> (movement varies with Zoom) Zoom Normal: Start of data / 30 minutes / 5 minutes Zoom In: Start of data / 1 hour / 6 minutes Zoom Out: Start of data / 1 day / 30 minutes

Enter the Historical Log Mode by pressing . The Super Trend Historical Log file popup is shown in Figure 2-19. Once an historical file has been selected, the Zoom and Log Forward/Back buttons can be used to view different time periods of furnace activity.

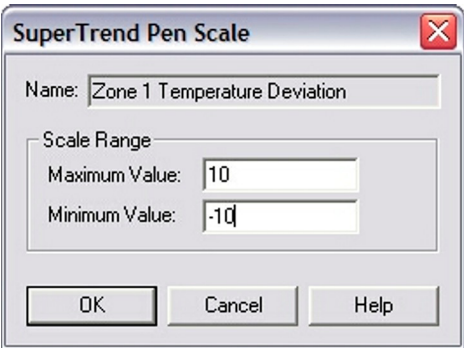


Figure 2-18 Change Vertical Scale

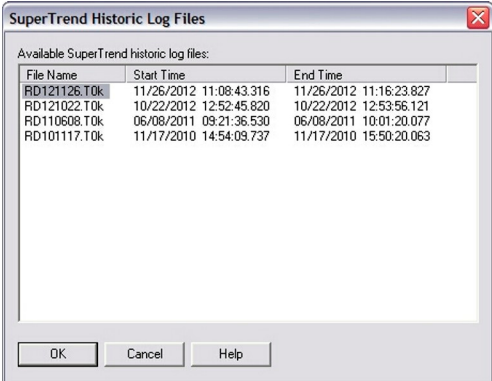


Figure 2-19 Load Historical Trend Data

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### 2.7 Alarm Status (All Access Levels)

This is a display only feature. Any existing alarm conditions, such as transport speed error, are highlighted on the Process screen. To clear or silence an alarm/alert, move the cursor to and click on “Acknowledge Events.” See Section 3 SERVICE & MAINTENANCE for further information.

### 2.8 Data Log/Alarms and Alerts

#### 2.8.1 Occurrence and Timed Logging Control (Access Levels 1 and 2)

Move the cursor to and click on “Logging” to see any occurrence.

The screenshot displays the 'Recent Events' window in the FurnacePros software. The window title is 'FurnacePros'. The 'Recent Events' section contains a list of events with columns for 'Event Time' and 'Event'. The events are color-coded: blue for 'Furnace Ready', green for 'Opr Acknowledged Alarm', orange for 'ALERT-Zone' failures, and red for 'ALARM-FG Pres Switch' and 'ALARM-N2 Pres Switch'. The events listed are:

Event Time	Event
08/22/2010 15:18:54	Furnace Ready
08/22/2010 15:16:37	Opr Acknowledged Alarm
08/22/2010 15:16:35	ALERT-Zone 7 Ele 2 B FAIL
08/22/2010 15:16:35	ALERT-Zone 6 Ele 2 B FAIL
08/22/2010 15:16:35	ALERT-Zone 5 Ele 2 B FAIL
08/22/2010 15:16:34	ALERT-Zone 4 Ele 2 B FAIL
08/22/2010 15:16:34	ALERT-Zone 3 Ele 2 B FAIL
08/22/2010 15:16:34	ALERT-Zone 2 Ele 2 B FAIL
08/22/2010 15:16:34	ALERT-Zone 1 Ele 3 B FAIL
08/22/2010 15:15:44	Furnace Warm Up
08/22/2010 15:14:13	Opr Acknowledged Alarm
08/22/2010 15:14:07	Furnace Cool Down
08/22/2010 15:14:07	ALARM-FG Pres Switch
08/22/2010 15:13:25	Furnace Warm Up
08/22/2010 15:12:48	Opr Acknowledged Alarm
08/22/2010 15:12:38	ALARM-FG Pres Switch
08/22/2010 15:12:32	Opr Acknowledged Alarm
08/22/2010 15:12:18	Furnace Cool Down
08/22/2010 15:12:18	ALARM-N2 Pres Switch
08/22/2010 15:12:07	Furnace Ready

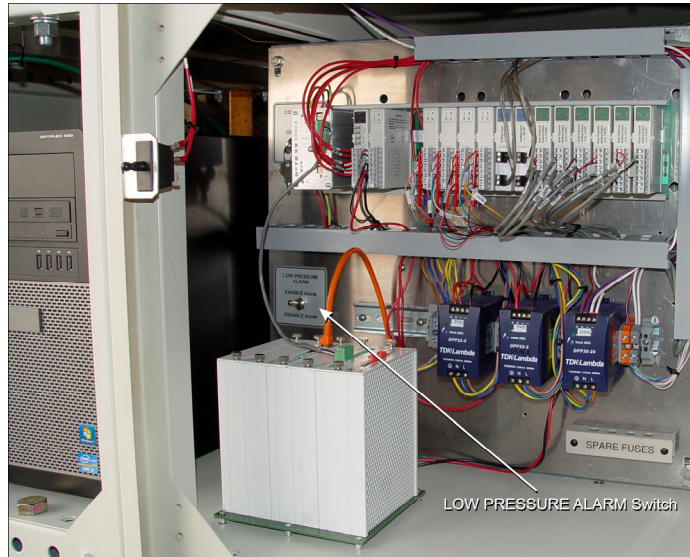
Below the event list is a 'Color Legend' bar with buttons for 'Alarm' (red), 'Alert' (orange), 'Acknowledgement' (green), 'Message' (blue), and 'Other' (grey). To the right of the event list are 'Prev' and 'Next' navigation buttons. At the bottom of the window, there is a navigation bar with buttons for 'ALARM', 'ALERT', 'MAINT', 'ACK ALMS', and 'User : Factory'. Below this bar are icons for 'Security', 'Process', 'Recipe', 'Monitor', 'Maint.', 'Logging', and 'Gas Flow'. The bottom left corner shows the date and time: 'Sunday 08/22/2010 15:20:47'.

Figure 2-20 Event Logging



## 2.8.2 IPS Low Gas Pressure Alarms

MAKE SURE THE LOW PRESSURE ALARM bypass switch on the PLC panel is in the ENABLE ALARM position. The IPS switch signals can be bypassed for service and testing using the LOW PRESSURE ALARM switch on the PLC panel. However, all alarms should be enabled during normal furnace operation.



**Figure 2-21 Low Pressure Alarm bypass switch location**

An Inlet Pressure Switch is installed on each process gas manifold. These switches are normally open. They close when proper pressure is present in the process gas supply lines.

The current switches are set to open when pressure falls below set points in the following table:

Table 2-9 Initial Alarm Settings			
Port	Manifold	Pressure	
		Gas 1	CDA or Nitrogen
Gas 2	Nitrogen Forming Gas, or other (Option)	55-60 psig	3.8-4 Bar

The pressure switch set points can be adjusted manually. Locate the switch in the process gas supply line. To increase the set point turn the wheel clockwise. Turn the top of the switch counter clockwise to decrease the pressure set point so the alarm will not occur until the pressure drops to a lower point.



**Figure 2.8.22 IPS Inlet Pressure Switch**

## 2.8.3 Auto Gas Shutoff (option not supplied)

This furnace may be equipped with Auto Gas Shutoff. The Auto Gas Shutoff feature consists of solenoid valves on the process gas supply lines integrated with the furnace. These valves open and allow Process Gas to flow when Furnace ON is pressed. This feature is designed to conserve process gas. To shut down the furnace the operator need only put the system into Cool Down and press Furnace OFF. When all furnace zones reach 100°C or lower for at least one minute, the furnace shuts down and the process gas valves close.

The Auto Gas Shutoff valves fail in the closed position.

### 2.9 Element Monitoring System

The Element Monitoring system consists of a panel of 6-channel circuit boards which detect the location of a failed heating element. The circuit boards monitor the current to the lamps and activate an audible alarm and visible alarm upon sensing an element failure. The display shows the specific location of the lamp or lamp string (multiple lamps wired in series make up a string) containing the failed lamp. The audible alarm alerts the operator immediately if a lamp fails and allows him to discern its location and determine if process results will be appreciably affected.

Access the Monitor screen in the software to view the status of the heating element strings. Communication failure or individual lamp failure of itself will not shut down the process. The process will only shut down if a lamp failure adversely impacts the furnace ability to maintain set point temperatures.

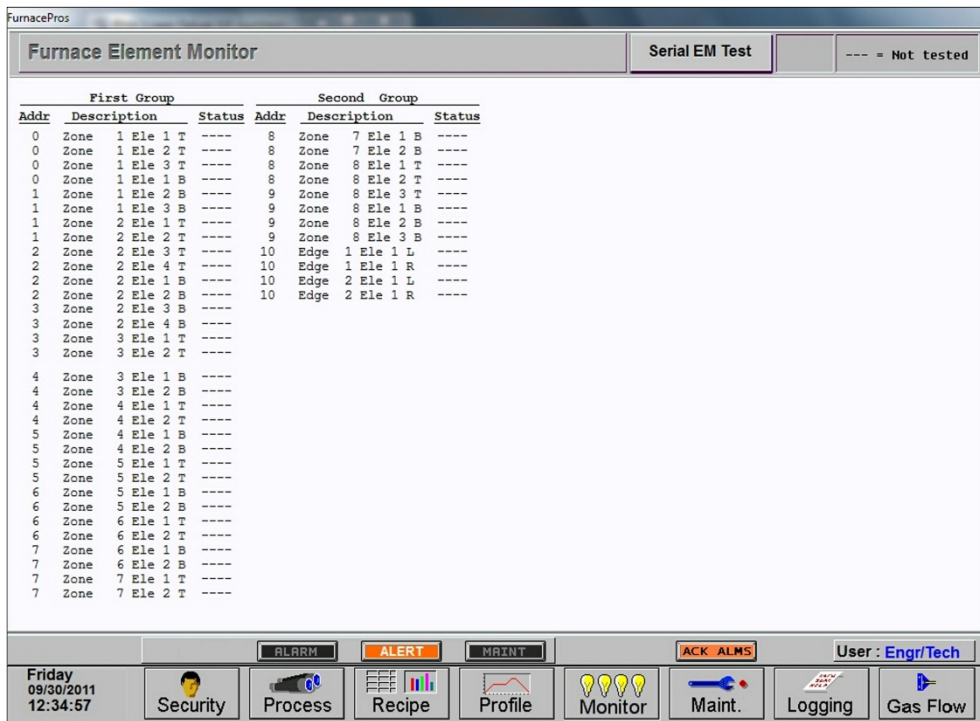


Figure 2-23 Element Monitor screen

#### 2.9.1 EM Signal Polling

On 2013 furnace models and later, the element monitor signals are collected from a current switch located each serial string. Visual indication of the status of each switch can be seen on the PLC digital modules assigned to the EM strings (see Figure 3-17 Furnace Controller EM I/O modules).

On pre-2013 models, the software polls the element monitor cards via a serial string. The signal sent from each channel can be viewed on the Serial EM Test popup screen (**Error! Reference source not found.**). Click on the Serial EM Test button to determine if all boards are communicating properly with the PLC controller. Each board contains a dip switch which determines the digital address of a given board and the software checks each board in sequence. Boards are addressed from 0 to nn.

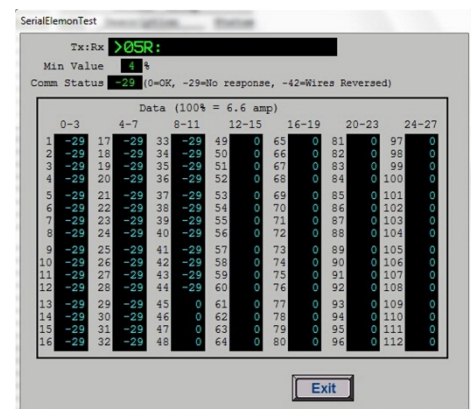


Figure 2-24 EM Serial Test screen

## 2.10 Over Temperature Alarm

### 2.10.1 Over Temperature Option (option not supplied)

The Over Temperature Alarm system consists of redundant zone thermocouples, a scanner/annunciator and digital panel meter hardware integrated into the furnace software. The scanner/annunciator and digital panel meter are mounted on top of the furnace near the flowmeter controls.

**NORMAL OPERATION.** The system scans each zone and passes a temperature signal to the digital panel meter. The operator can view the temperature on the panel meter and the respective zone being monitored will be indicated on the scanner

**ALARM.** If the temperature in any zone reaches the alarm set point, an alarm will sound in the scanner/annunciator and the furnace will go into Cool Down, the heating elements will be shut off by the controller. To silence the alarm, press ACK on the scanner/annunciator. The furnace cannot be restarted until the zone temperature drops below the alarm set point.

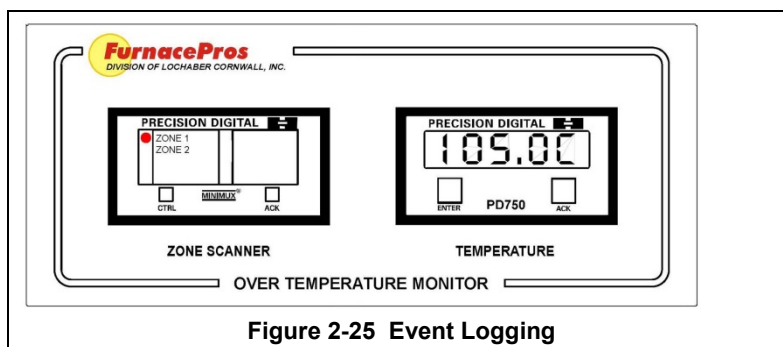


Figure 2-25 Event Logging

## 2.11 View Alternate Programs

To switch the viewing window between ProControl™ Furnace Process Software and another application (the WinKIC or DataPaq Windows Applications) press and hold down the ALT key, and then press TAB repeatedly. When the title of the desired Windows Application appears, release ALT. The new application will appear in the foreground. Repeat the procedure to return ProControl™ Furnace Process Software to the active window.

## 2.12 Exit Program in Windows

To exit an active program, click Alt-F4 and the program will either close immediately or present a dialog box asking if you are sure. Click yes to close the program.

## Section 2

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### 2.13 Remote Access

In order to allow for remote diagnostics of in-process furnace operations, a 2nd network interface card (NIC) is provided as well as a modem with communication software. The remote operator, in conjunction with on-site personnel, can simultaneously view the Process screen and have access to input and control features.

Remote access can be accomplished as follows:

- Broadband connection via internet access

#### 2.13.1 Network Connection

To connect furnace to the network:

Wired: Connect a Cat5 or higher TCP/P Cable to the RJ45 port below the entrance of the furnace. Set LAN Connection 2 to receive network signals.

Note LAN Connection 1 must be reserved for the furnace control system.
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Wireless: Connect a USB wireless transmitter such as D-Link DWA-140 RangeBooster Wireless-N network adapter to the control console USB port (behind the keyboard). Setup connections to receive network signal.

#### 2.13.2 LogMeIn

The preferred method for factory diagnostics is to use the LogMeIn.com internet service for remote diagnostics:

If the computer is LogMeIn enabled:

Make sure there is an internet connection to the local network connection 2 port

Click on the blue LogMeIn icon in the menu or next to clock on desktop menu bar.

Click Overview

Click TURN ON button.

Note: When TURN OFF button is shown, the system is already enabled for LogMeIn.

notify the factory the that system is enabled for LogMeIn and on-line.

If the computer is not LogMeIn enabled, contact FurnacePros for installation instructions.