EQUIPMENT OPERATION

Detailed steps for successful operation of the IR furnace. Includes operation of standard and optional equipment. Verify which options are installed before proceeding.

3.1 Power Controls and Indicators

3.1.1 Power Status Indicators

Figure 3-1 Control Console keyboard & monitor

A. MAIN POWER ON - Red Indicator

This lamp burns continuously when power is available to the furnace. The 3-phase disconnect switch and facility circuit breaker (optional) must be turned on and the EMO buttons and Safety Interlocks must be closed.

B. FURNACE CONTROLS POWER ON – Yellow Indicator

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

C. LAMPS ON – Green Indicator

The green lamp burns continuously when furnace lamps are energized, furnace is in warmup or ready status.

Figure 3-2 Control Console Furnace Power ON and OFF & Indicator Lights

D. COOLING – Fan Cooling Speed Control - (included option)

Turns on/off and adjusts the speed of the product/belt cooling fans at the furnace exit.

3.1.2 Power Console

Red lamp will remain on when power is connected to the furnace.

Press Green button to energize furnace control system.

Press red button to shut down furnace control system.

Figure 3-3 Power Buttons
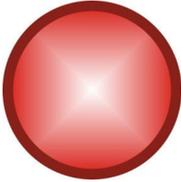**Main Power ON**

3.1.3 Main Furnace Power

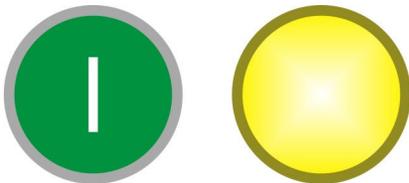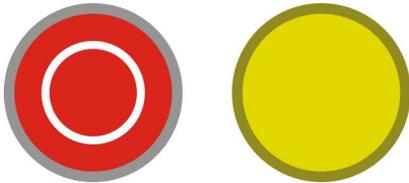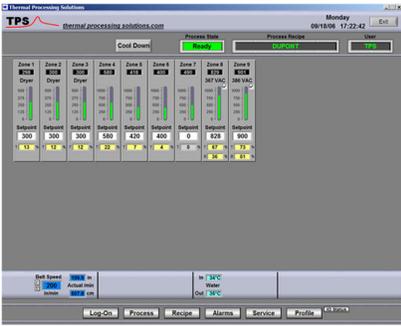| Table 3-1 Main Furnace Power		
MODE	**ON**	**OFF**
MAIN FACILITY CIRCUIT BREAKER	Power to furnace. Energize circuit breaker for power to furnace circuit breaker:	No power to furnace.
3-PHASE CIRCUIT BREAKER DISCONNECT	Lockable circuit breaker furnace disconnect switch. Switch must be turned ON to provide power to furnace. When both main facility circuit breaker and furnace disconnect are on: 1. MAIN POWER light (red) on	No power to furnace, computer or monitor
EMO SWITCHES **Standard (Vertical Mount) EMO**	Emergency Machine Stop	Operator activated Emergency Power Off switch located at furnace entrance and exit immediately cuts power to furnace. UPS keeps PLC, PC and monitor on for 5-6 minutes. 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 an interlocked lower panel is removed, emergency power interlocks will automatically cut power to furnace. UPS keeps PLC, PC and monitor on for 5-6 minutes. Replace panel or pull out exposed interlock switch to service position resume furnace operation.
MAIN POWER ON 	Lamp illuminates indicating that 3-phase power is connected to the furnace: facility main disconnect and the furnace circuit breaker are ON.	No power to furnace, computer or monitor
COMPUTER POWER	COMPUTER SWITCHED. The computer has been wired to start when the Furnace Controls ON is pressed. Although protected momentarily by the UPS, the computer should always be shut down via the Windows operating system before complete furnace shutdown. Otherwise, pressing the red Furnace Control power OFF button shuts down the computer or if Main Power is removed from the furnace.	The power button on the front of the computer must be pressed to start the computer if the computer does not start when the green Furnace Control ON button is pressed.

Table 3-1 Main Furnace Power		
MODE	**ON**	**OFF**
FURNACE CONTROLS ON FURNACE CONTROLS OFF	**Furnace Controls Power** lamp ON indicates power is supplied to the furnace control system. When F**urnace Controls Power** lamp is ON, pressing the red pushbutton instantly cuts power to the furnace control system, lamps and accessories, if the system has not been placed in Cool down. If the furnace has been placed in Cool down, pressing the red OFF button delays complete shutdown. IR lamps are turned off immediately. After all zones are below 100°C, the fans, transport belt, and other functions are shut down. In any event, the UPS will keep the PLC, PC and monitor on for 5-6 minutes after power is OFF to allow the user to properly shut down the furnace control software and PC.	**Furnace Controls Power** lamp OFF indicates furnace controller is OFF or in cool down. When **Furnace Controls Power** lamp is OFF, pressing the green pushbutton will power up the furnace control system and accessories if: a) All EMO and EPO interlock switches are closed; b) The UPS, PLC, PC and monitor are ON.
POWER FAILURE		A power failure will instantly cut power to the lamps. The UPS will keep key parts of the control system (PLC, PC, monitor, belt motor, fans) ON for 5-10 minutes after power is OFF to allow user to properly shut down the furnace control software and PC, and to remove as many parts as possible being processed within the furnace.

Table 3-2 Special Controls		
MODE	**ON**	**OFF**
Cooling Fan Speed Control Located on Control Console	Adjusts product/belt cooling fan speed. When furnace control system is ON, adjust switched knob clockwise to increase cooling section fan speed. To decrease cooling fan speed turn knob counterclockwise. Turn knob all the way counterclockwise to click at position 0 to turn OFF cooling fans completely. This is a 10-turn pot, a counter keeps track of the number of turns. Press tab to lock in position.	Turn knob full counterclockwise to turn fans OFF.

Chapter 3

Table 3-2 Special Controls		
MODE	**ON**	**OFF**
UPS POWER Switch Service On/Off switch - located behind the computer door on the front of the UPS	DEFAULT. Controls AC power to Computer and PLC 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.	Useful to cycle or service controller or control system analog and digital I/O devices. Shut down PLC after power disconnect of failure.

Table 3-3 Software – Furnace Control		
SOFTWARE MODE	**WARMUP**	**COOL DOWN**
PROCESS SCREEN 	If FURNACE POWER is ON, 1) energizes lamps and edge heaters via C1 lamp contactor, If FURNACE POWER is OFF, no effect	If furnace is in WARM UP or PROCESS READY modes, places furnace in COOL DOWN mode. Immediately shuts off lamps and edge heaters by opening C1 lamp contractor and furnace begins to cool. Unless the user enters AUTOMATIC SHUTDOWN mode, there is no other effect on the furnace, the furnace can be left in this standby mode indefinitely without harm. AUTOMATIC SHUT DOWN: When in COOL DOWN mode, user may enter AUTOMATIC SHUT DOWN mode by pressing the redo OFF pushbutton on the control console. In AUTOMATIC SHUT DOWN mode, when all furnace zones have called below 100C, power will be cut to the furnace control system and accessories. The user should properly shut down the PC via the Windows operating system before power is cut.

3.2   Software – Main screens

This section describes the main screens with a description of their use and the information presented on each. Detail regarding changing setpoint values can be found in 3.6 Modifying Control Strategies. Changing setpoint values requires level 3 access or higher.

3.2.1 Screen Menu bar

Located at the bottom of the main screens, the Menu bar allows operator to select a desired screen by moving the cursor and clicking on the chosen screen button. Note: Items on the Menu bar will vary according to furnace features and user log-in level. Typical screens and their functions are:

Lamps screen– polls heating elements and provides failure indication during furnace operation.

Log-On screen– log on to the furnace program and to view user access and furnace information

Process screen – Main operating screen. Display setpoints and values in the furnace controller.

Recipe screen – set, name, edit, store and retrieve operating parameters for each desired process to be run. Access gas flowmeter screen.

Alarm popup screen – view and silence/reset alerts and alarms and recent history.

Service screen – furnace tuning and calibration.

Profile shortcut – access profiling software, if present.

Auxiliary screens – quick access to Windows™ Calculator and Notepad and:

IO Status – status of input and output signals for troubleshooting.

Trends – current and historical operating levels for zone top/bottom power, temperature, temperature deviation as a function of time.

Figure 3-4 Screen Menu bar

3.2.2 Top Status bar

The top Status bar displays process state, recipe running in the furnace controller and name of the user that is currently logged-on. Use the Select button on the Status bar to initiate or kill the furnace process.


Figure 3-5 Top Status bar

A. Select (Process Action) button

The Process choices include Warm Up, Cool Down. Press the Warm Up button to introduce power to the heating lamps. The furnace remains in Warm Up until all zones are ±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.
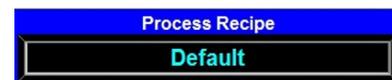

B. Process State indicator

Indicates the current state of the furnace: Warm Up, Process Ready, Cool Down, and Alarm.
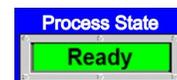
C. Recipe indicator

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

D. User indicator

The User indicator displays the name of the user currently logged on to the furnace software.

3.2.3 Furnace Log-On screen

[Log-On]

From the Menu Bar, select Log-On button to access the Log-On & User Information screen.

A. User and Furnace Information

From the Log-On screen, select User name to log-on. You can also select log-off, and depending on access level, add or delete users, and modify password and access codes. The Log-On screen also displays information about the furnace model and configuration.

B. Access Level Permissions

Level	Access Level Name	Permissions
0	Disabled	Cannot make any changes
1	Operator	Allows the operator to Start, Stop the furnace and Load and Run a Recipe and initiate a process.
2	Maintenance Engineer	Operator level plus Calibration and Test access.
3	Process Engineer	Maintenance Engineer level plus Operation Set-point, Recipe changes.
4	Supervisor	Operator level plus User management
5	Factory	Factory level. Restricted to Manufacturer's personnel only.

C. To Log-On, Select Access Level

The system is shipped with five (5) access levels enabling the Supervisor to add User Names (with designated Access levels) each with its own password. Select Access Level by clicking on the User Name, click Log-On and enter the appropriate password and select Ok.
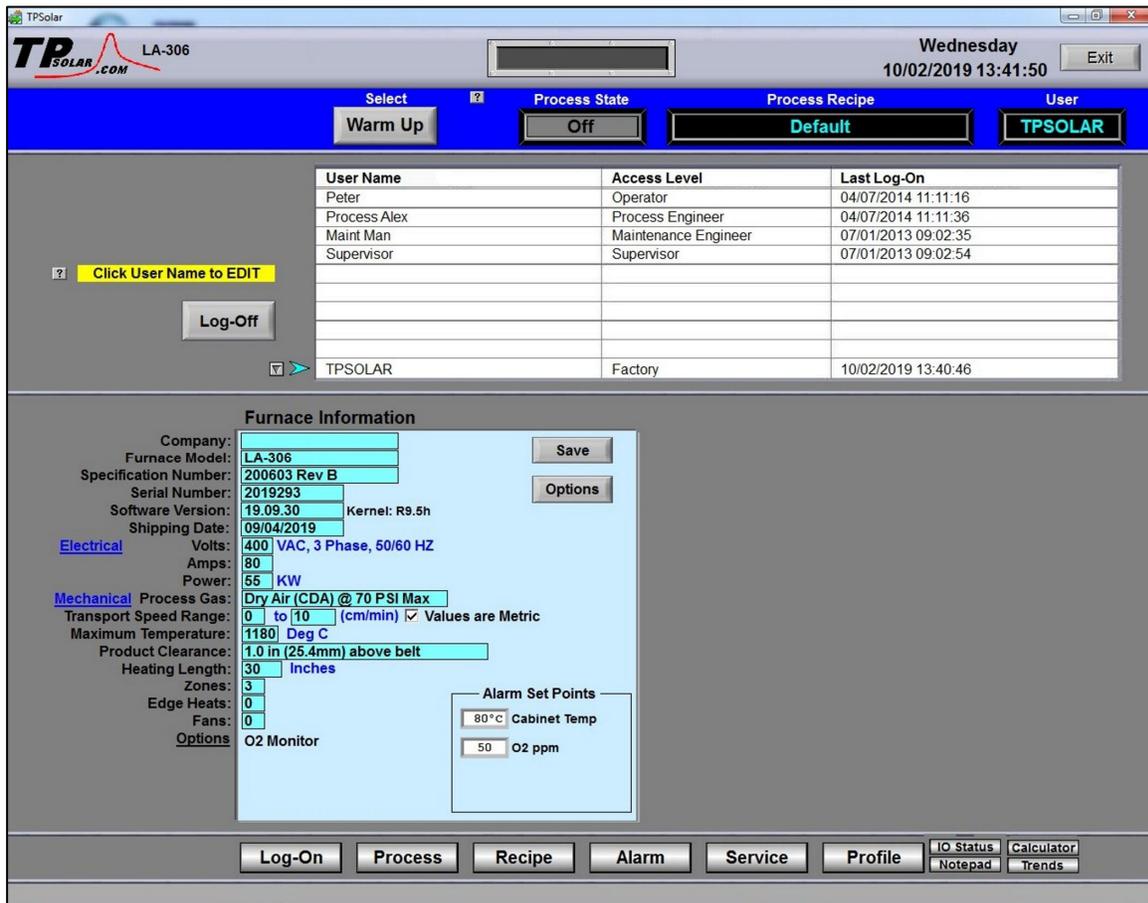

Figure 3-6 Log-On screen

D. Adding users (Supervisor level only)

Click on blank user name field. A User Edit window will open.

Click on **User Name** to add the name.

Click on **Access Level** to set the access level, Click on **OK** to close the window.

The password is set by logging in as the new user and entering the password. The password can be set by the supervisor or by the new user. Once set, it can only be changed by a supervisor. See Editing Users below.

E. Editing users (Supervisor level only)

Click on the user name. A User Edit window will open.

Click on **Delete** to remove the user.

Click on **User Name** to change the name.

Click on **Access Level** to change the access level.

Click on **Reset Password** to erase the password. The password is set by logging in as the new user and entering the new password.

Click on **OK** to close the window.

3.2.4 Furnace Process Screen

Process

A. Process screen overview

Select the Process button on the menu bar to view the Process screen. The Process screen displays the zone temperature, setpoint temperature, the Process Recipe, Process State, Belt speed and setpoints, and other information such as percentage of power to elements and edge heater settings. Status of optional equipment such as Nitrogen Pre-Purge system, Oxygen and/or Moisture sample levels, selected sampling system port, Auto-OFF mode are also displayed

Figure 3-7 Process screen
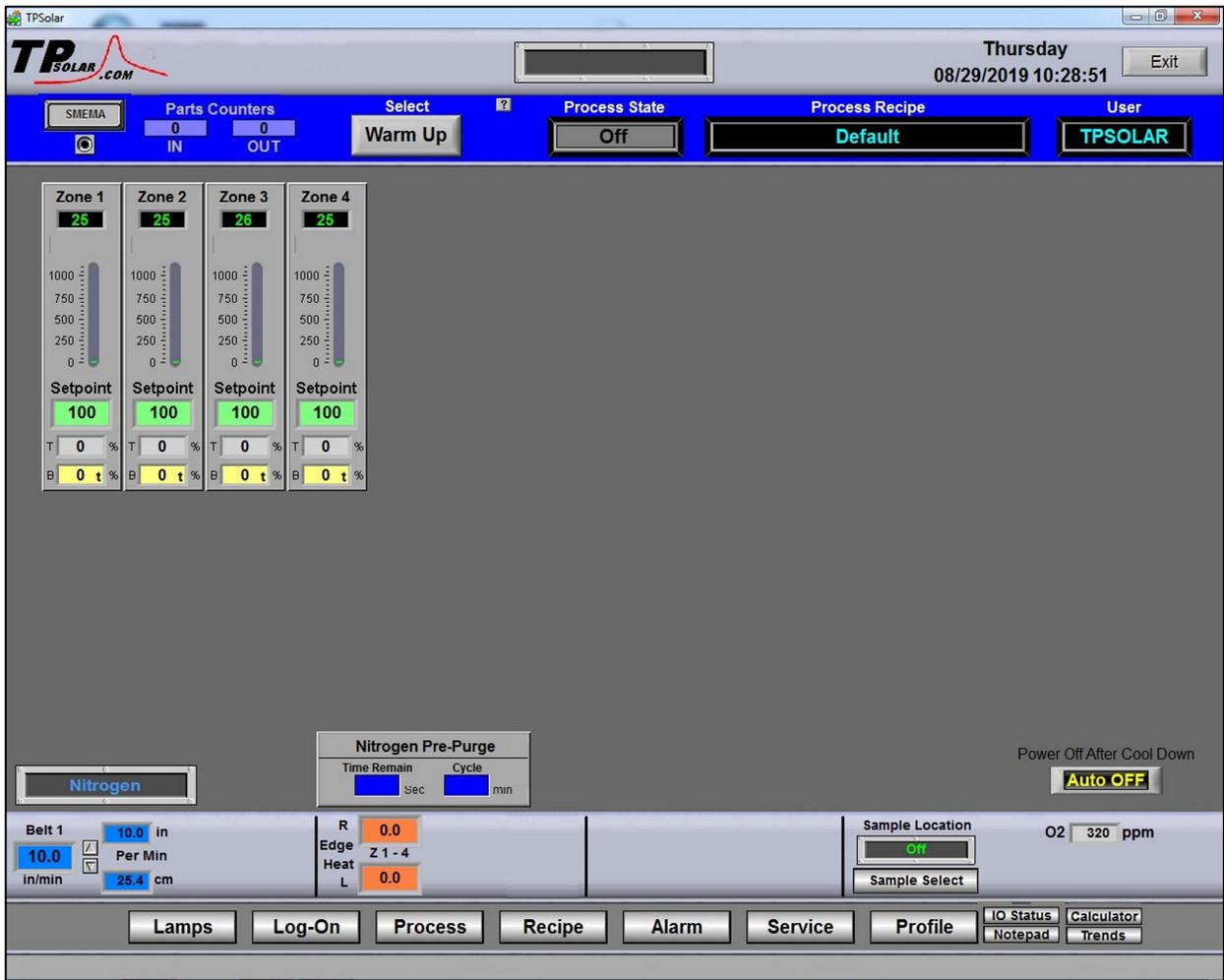
B. Zone Temperature display

Temperatures measured in each zone are title as shown in Figure 3-8.

displayed below each zone

Figure 3-8 Zone Temperature display

C. Zone Setpoint Temperature display

Setpoint Temperatures for each zone are label for each zone as shown in Figure 3-9. Click setpoint temperature. It will change immediately.

displayed below the Setpoint on the setpoint to enter a new

Figure 3-9 Zone Temperature setpoint

D. Temperature Deviation bar display

The actual zone temperature is displayed graphically using a vertical bar. The bar changes color based upon deviation from setpoint as set in the recipe running in the furnace. The bars are green for normal conditions, and change color independently as the deviation in a given zone changes. Scale is 0-1150 C of setpoint.

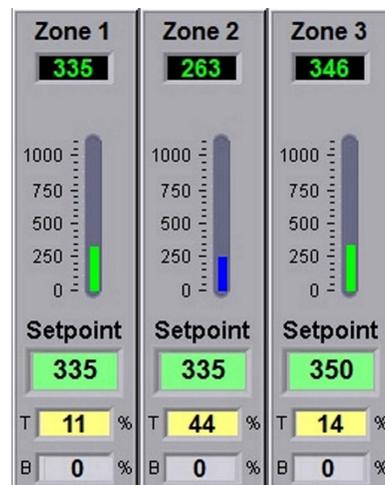| Color	Indicates zone is
Red	Hot
Yellow	Warm
Green	Normal
Light Blue	Cool
Blue	Cold

Figure 3-10 Zone Temperature display

E. Top and Bottom Power display

Real time zone top and bottom power applied to each zone is displayed below the Setpoint Field labeled T and B respectively. Click on any power display field to change setpoint. Changes will be sent to furnace immediately.

F. Belt Speed Display

The measured belt speed is displayed in English and metric units.

**Figure 3-11 Belt Speed display**

G. Edge Heater Setpoint display (option)

If equipped with Edge Heaters, the setpoint for each pair is displayed in the Right and Left fields as shown in the figure below. To change an edge heat value, click on the value and enter a new number from 0 – 100 percent. Changes will be sent to furnace immediately.


H. Nitrogen Pre-Purge status display (option)

Temperatures measured in each zone are displayed below each zone title as shown in the figure below. Click on the cycle time to change. Click on the Time remaining to reset to zero. Changes will be sent to furnace immediately.
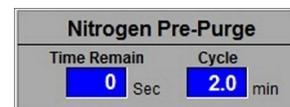
I. Oxygen Sampling System display (option)

Selected sampling port and measured oxygen level are displayed. When system is off, O2 level will read zero. When the Sample System is on, the Oxygen level for zone being sampled will be displayed in ppmv.
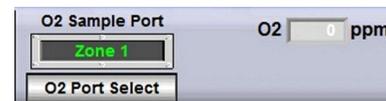
Click on the Sample Select or O2 Port Select button to select another port or change alert and alarm values. Changes will be sent to furnace immediately.

3.2.5 Recipe screen

Recipe

A. Recipe screen overview

The Recipe screen is used to create, edit and load a recipe into the furnace. A recipe can be created for each process (level 3+ access) that can save temperature zone setpoints, alert and alarm levels, PID Gain and Integral parameters, and top and bottom power levels for reuse every time the process is run. Recipes stored on the furnace computer can be accessed and sent to the furnace from the Recipe screen.

Editing. The Editing box displays the recipe currently loaded into the Recipe editor.
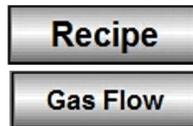
Editing
Default

Figure 3-12 Recipe Editing box

Figure 3-13 Get Recipe from Recipe screen

3.2.6 Recipe Gas Flow screen

Access the Gas Flow screen from the Recipe screen. Select Menu bar Recipe button and on the Recipe screen, select the Gas Flow button.

A. Recipe Gas Flow screen overview

This screen is used to record and display the flowmeter settings for each recipe. The Gas Flow screen will be shown similar to Figure 3-14 . Values may vary for each recipe loaded.
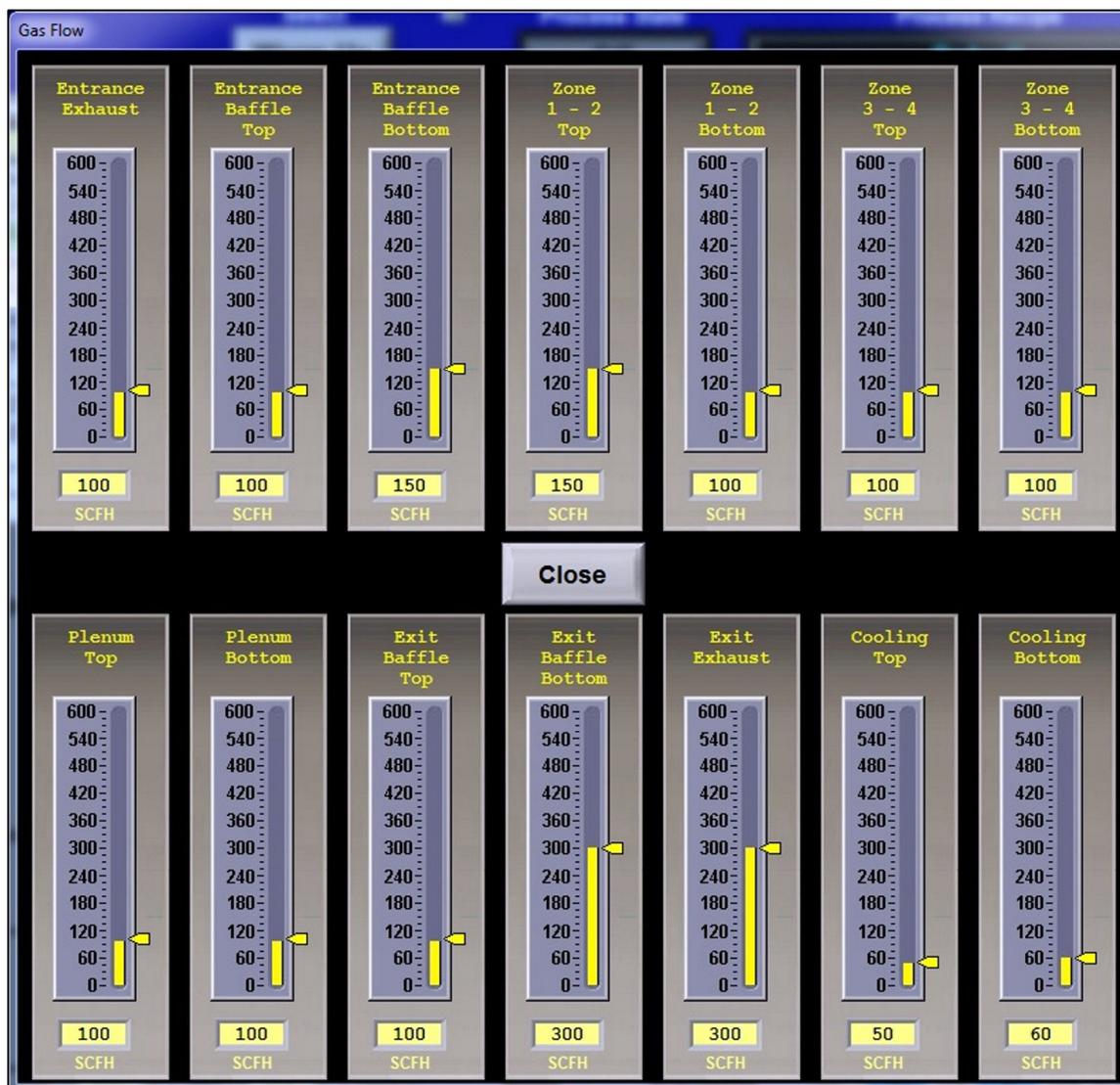
Figure 3-14 Recipe Gas Flow Screen

3.2.7 Service screen

The Service screen is used to access furnace tuning and calibration features. Figure 3-15
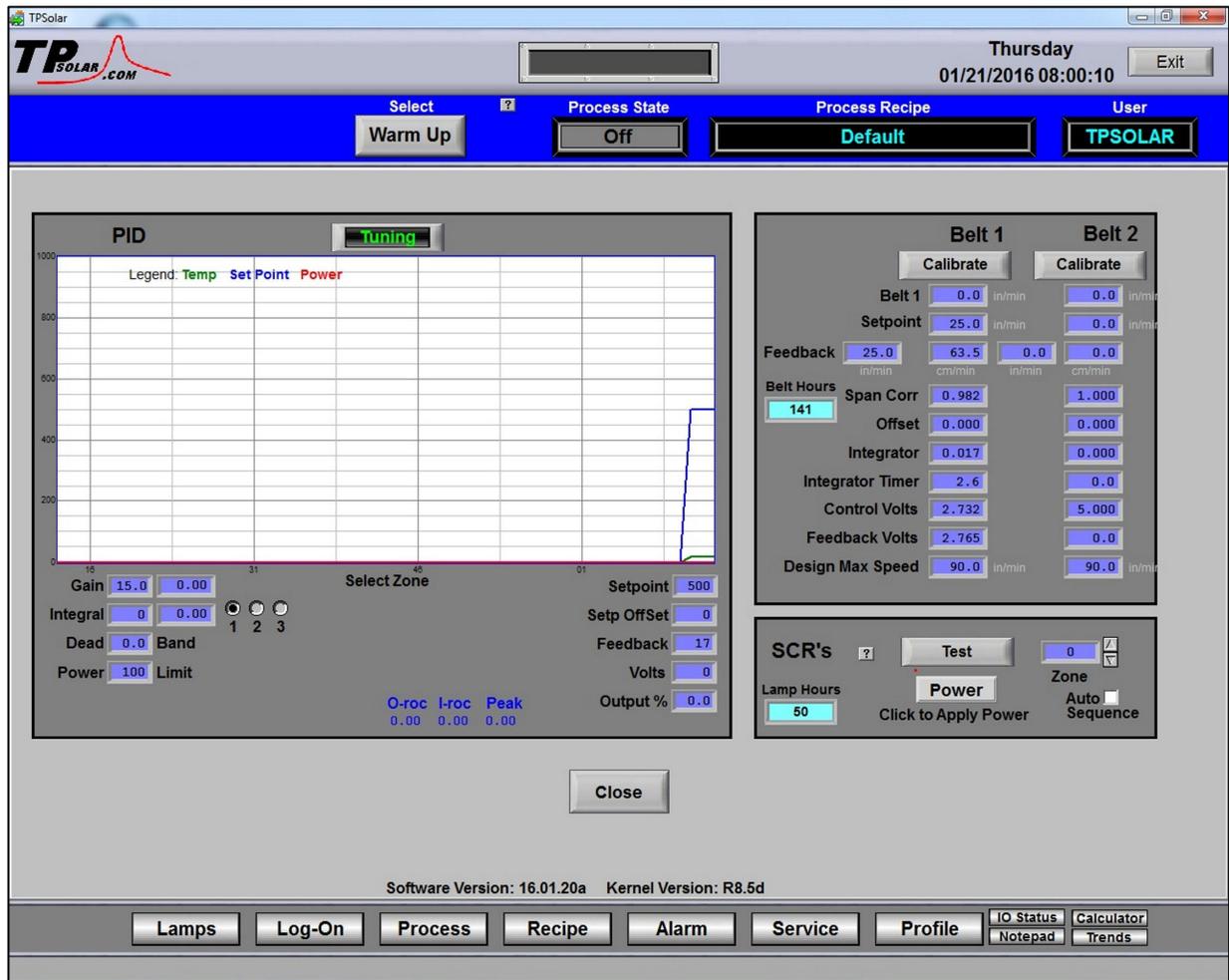
Figure 3-15 Service screen

3.2.8 Profile program

The Profile button is an optional feature that, if present, can be used to load a 3rd party profiling program. The profiling program will run independently of the furnace program. Once activated the profiling program must be closed separately from the furnace program.

3.2.9 Lamps screen (EM option)

Lamps

If the Element Monitoring system (EM) is enabled, the Lamps screen displays the status of
the heating elements by providing lamp string failure indication, Figure 3-16. The system checks for current
flowing as power is applied and reports the integrity of each string polled. Status for each string remains blank
until elements are polled. Strings indicating Fail mut be examined further to determine the nature of the failure.
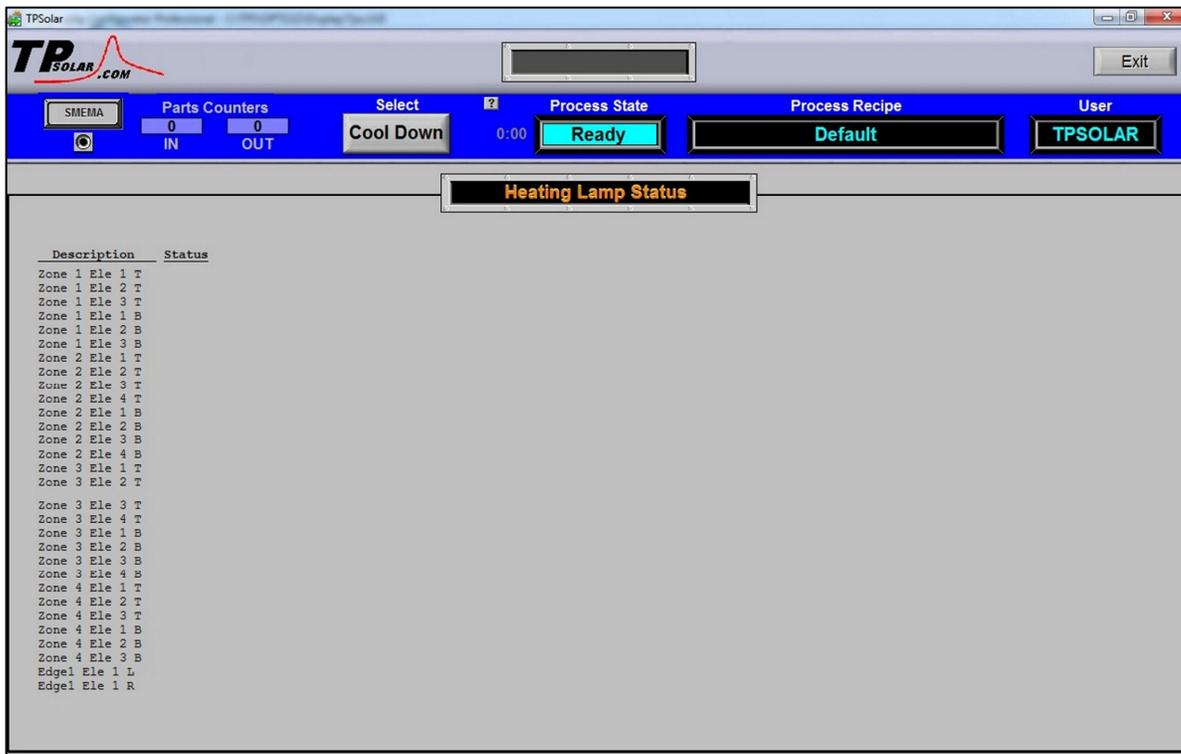
**Figure 3-16 Lamps screen**

3.2.10 Auxiliary screens and programs

IO Status **Calculator**
Notepad **Trends**

Four quick access buttons are provided in the Menu bar:

Windows™ Calculator program

Windows™ Notepad text editor program

IO Status popup screen: status of input and output signals for troubleshooting, Figure 3-17.

Trends screen: current and historical operating levels for zone top/bottom power, temperature, temperature deviation as a function of time, Figure 3-18.

Figure 3-18 Trends screen

Figure 3-17 I/O Status

3.3   Starting the Furnace

3.3.1 Main Power Indicator (red)

The red MAIN POWER indicator must be lit to make sure facility power is provided to the furnace and the furnace disconnect switch has been energized.

3.3.2 Process Gas Pressure

Assure that clean dry compressed process gas is supplied to the furnace at a minimum of 5.2 bar (75 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.

3.3.3 Flowmeters

Assure that flowmeters are adjusted to proper volumes for the recipe to be run.

3.3.4 Power On/Startup

Follow the steps in the STARTUP table to start the furnace.

Table 3-4 Starting the Furnace	
1. Main Power	Verify the red Main Power ON button is lit. Furnace Disconnect switch should be ON, all panels in place and EMO switches reset.
2. Furnace ON	Press green Furnace ON button. Yellow Furnace Controls Power light illuminates. Power is provided to the furnace controller.
3. Computer ON	Computer starts when Furnace ON is pressed. The computer boots up and the logo screen is displayed. Furnace software starts. Computer and PLC begin to communicate.
4. Monitor ON	Press the power button on the monitor if you do not see the logo screen.
5. Start Program **6. Log-In**	If the furnace program does not start automatically, press Furnace program icon to initialize communication with the PLC and start the furnace program. Log in to furnace software. Log-in is only possible when PLC and Computer are communicating.
7. Select Recipe **8. Warmup**	Select recipe and press Warmup to energize lamps. Green lamp will remain lit while lamps are energized.

3.3.5 Fans

Check that all cabinet cooling exhaust fans, cooling tunnel exterior fans and product cooling fans, if supplied, are turning. Verify facility exhaust system is enabled and working properly.

3.3.6 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 4.

3.3.7 Check Optional Equipment

Verify all optional equipment if functioning properly including, but not limited to:

MCL. Verify motorized chamber lift system is disabled and chamber is securely closed. (See Section 4.1)

O2 & OSS Systems. Verify Analyzer is enabled, if required. (See section 3.6.1G)

SMEMA. Verify sensors are in place and unobscured (See section 3.6.1K).

3.3.8 Verify Process Parameters or Get Recipe

Verify correct recipe is loaded: On the Process screen, the Process Recipe box in the top status bar displays the recipe currently running in the furnace controller. If the wrong recipe is displayed, either change the parameters on the process screen or load the correct recipe.
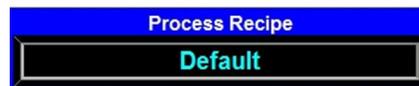

Figure 3-19 Default Recipe in Furnace

To Change Process parameters: On the Process screen 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.

To Load a Different Recipe: Click on the Menu bar **Recipe** button to access the **Recipe** screen. If the correct recipe is already displayed in the Recipe Editing box, click on **Send Recipe To: Process**. Otherwise get and send desired recipe to furnace as follows:

Figure 3-20 Default Recipe in Editor

> **Get Recipe from Computer.** To load a different recipe into the Recipe editor, select **Get Recipe From: Disk**. A dialog box will open, select from the list of furnace recipes stored on the furnace computer.

> **Send Recipe to Furnace.** Send the recipe to the furnace to replace the parameters running in the furnace controller. Select **Send Recipe To: Process**. Furnace will start using the values just loaded and these values will be shown on the Process screen.
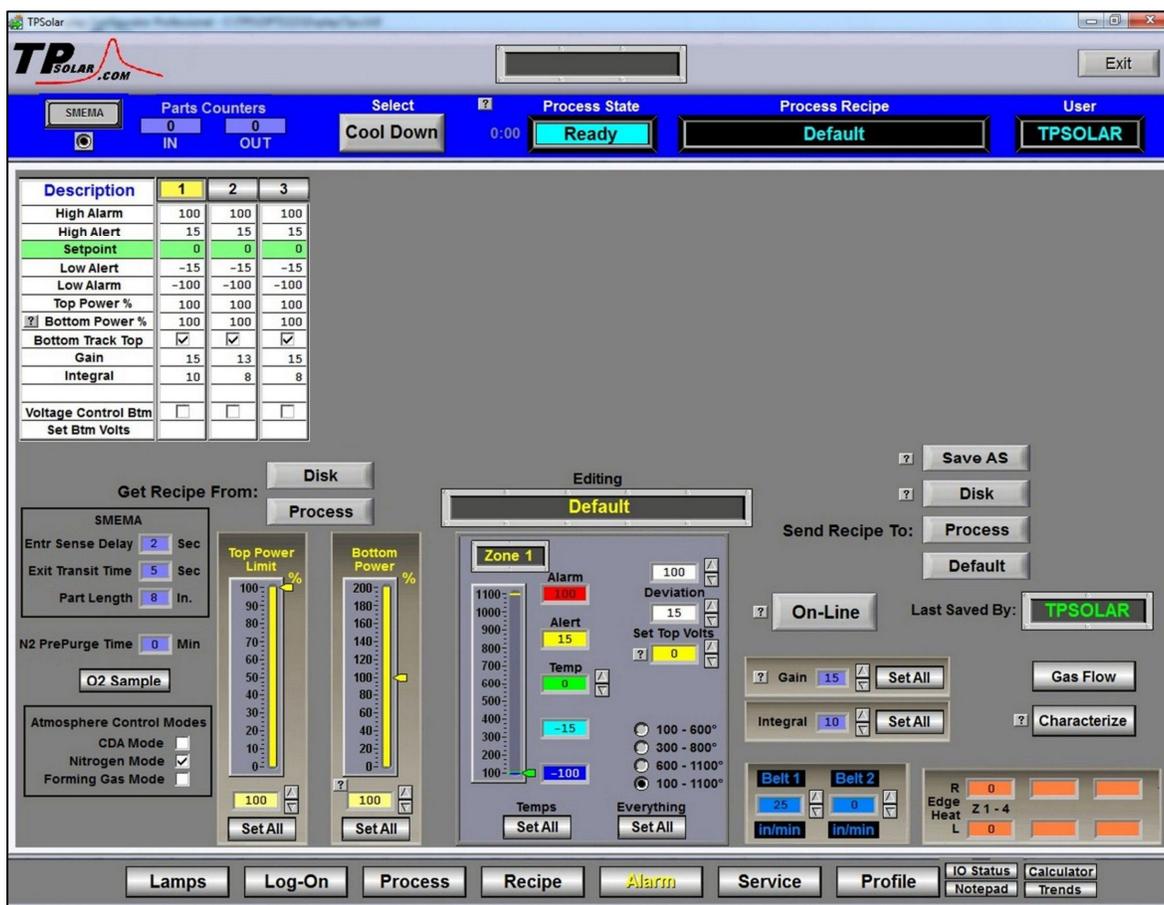

Figure 3-21 Get Recipe from Recipe screen

3.3.9 Warmup

Once correct recipe is loaded, gas flow settings are correct, and alarms are not present, go to the Process Screen to begin furnace Warmup.

3.4   Normal Furnace Operation

3.4.1 Process screen - Warmup

Click on Process **Select** button to start the furnace in Warm Up (Figure 3-22). Process State indicator will display **Warmup** (Figure 3-23). In the "WARM UP" mode, the heating elements are energized. After 20 minutes, check the system for instability or cycling, and correct if necessary.

| Figure 3-22 Select Warmup | Figure 3-23 In Warmup |

3.4.2 Process Screen - Process Start

When the furnace has stabilized the Process State indicator will display **Ready** (Figure 3-24). Although another 15-30 minutes at Ready state is often optimal, product may now be placed on the belt for processing.

Figure 3-24   Process Ready

NOTE: Allow the system to stabilize and to enter the Process READY mode as indicated by a Process State indicator on the screen before processing any product.

3.4.3 Load Product

Load product on the belt to provide as even a load as practical. Try to leave at least ½ inch on either edge of the belt free to assure parts move freely through the furnace and are properly processed. Often a leading and lagging dummy load can improve results. Dummy loads are sacrificial parts or an empty carrier placed before the first part and/or after the last part in a production run to assure all key parts are processed under similar conditions.

3.5   Furnace Shut Down

3.5.1 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 3.5.6 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.

3.5.2 Shut Down Modes

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

1.   EMO – Emergency Machine Off

2.   Control System Off

3.   Cool Down

4.   Auto Shut Down

5.   Complete Shut Down

3.5.3 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.

3.5.4 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.

3.5.5 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.

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

3.5.6 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. This furnace is equipped with Auto Gas Valve Shutdown, process gas will not be flowing to the furnace upon final shutdown. The furnace can be left in this state indefinitely without harm to the furnace. For complete shutdown of the furnace see section 3.5.7.

3.5.7 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 0, subsection 0.

FURNACE POWER OFF. See section 0 , 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. 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.

3.5.8 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.

3.5.9 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 PAC-controller, the furnace program will freeze. To exit any frozen Windows® program, Press Alt-F4 on the keyboard.

3.5.10 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.

Table 3-5 Restarting the Furnace after Auto Shut Down	
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.	
1. Close Furnace program	Click in the center of the furnace program screen and use Alt-F4 to close the furnace program. 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.
2. Main Power	Verify the Main Power ON button is lit. Disconnect switch should be on, all panels in place and EMO switches reset.
3. Furnace ON	Press Furnace Power ON button. Furnace ON light illuminates. **Wait 2-3 minutes for the Opto22 PLC to sync with the Furnace computer.**
4. Start Furnace Program	Press Furnace program icon to initialize communication with the PLC and start the furnace program.
5. Log-in	Log in to the 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!

3.6   Modifying Control Strategies On-line

Primary means of changing the way the furnace operates is covered in this section.

Process

3.6.1 On-Line Changes to Setpoints via the Process screen

On-Line Modifications. The Process screen displays the primary operating parameters running in the furnace controller. Many of these parameters can be modified in real time by level 3 and above users. On-Line changes are not saved. See section 3.7 to change and store a recipe instead of On-Line changes.
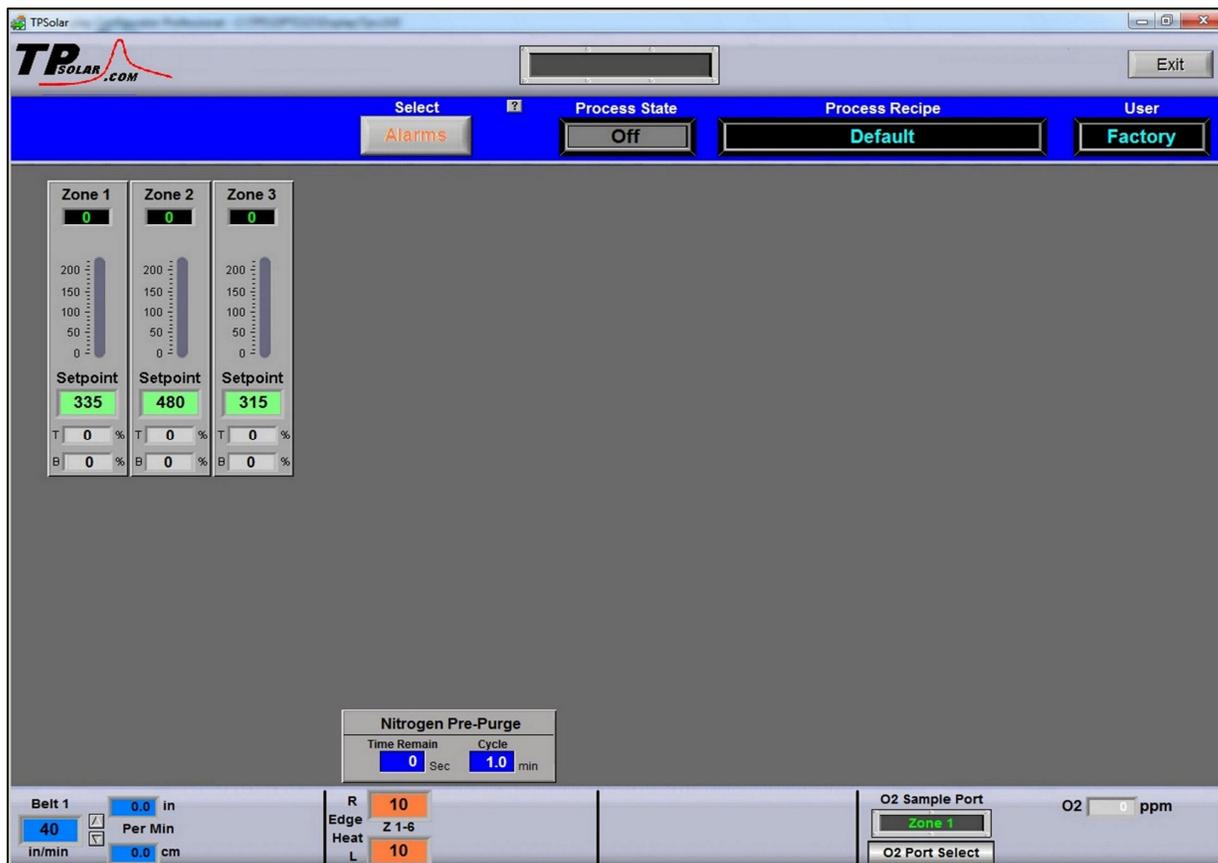

Figure 3-25 Process screen

A. Temperature Indicator and bar display

Measured Temperature, Top and Bottom Power (% applied) are displayed for each zone. Deviation of measured zone temperature from setpoint for each zone is displayed graphically using a colored vertical bar. Each bar changes color independently as the deviation in an individual zone changes. Temperature is in degrees C. Bar scale is 0-200% of setpoint. Power is in percent.

Color	Indicates zone is	Type
Red	Hot	Alarm
Yellow	Warm	Alert
Green	Normal	Setpoint
Light Blue	Cool	Alert
Blue	Cold	Alarm

To change the alarm and alert setpoints, go the Recipe screen and make the changes to Deviation values.
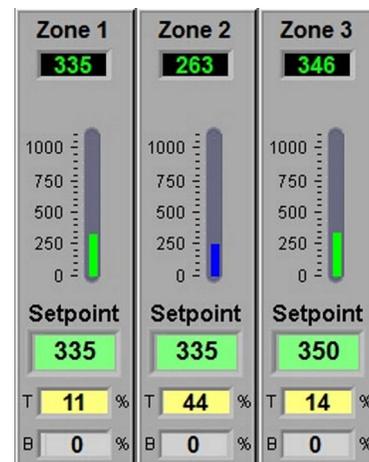
Figure 3-26 Zone Temperature & Power setpoints

B. Change Zone Temperature setpoint

To enter or change zone setpoint temperatures, click on the Setpoint field and enter the new temperature in degrees Celsius. Click Ok to send value to the furnace.
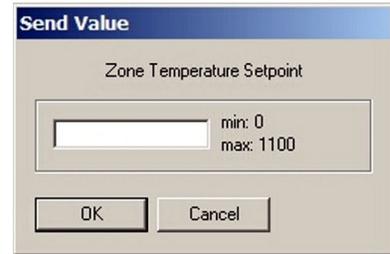The setpoint in the furnace will change immediately.

Figure 3-27 Zone Temperature Setpoint

C. Change Top and Bottom Power setpoints

 Real time zone top and bottom power applied to each zone is displayed below the Setpoint field. The T% and B% are Power fields that display the percent power used by each zone by the lamps above (T) and below (B) the belt.

Change the maximum 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.

Changes will be sent to furnace immediately.

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

Figure 3-28 Zone Temperature & Power

D. Change Belt Speed setpoint

The measured belt speed is displayed in English and metric units.

Click on the small setpoint fields to enter a new belt speed in either English or metric units. The larger Belt field displays the current belt speed and its units as determined by feedback from the motor speed as calibrated.
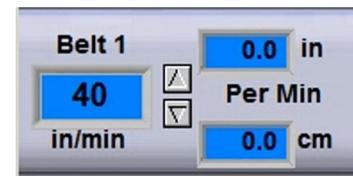
Figure 3-29 Belt Speed fields

E. Change Edge Heater setpoints (option)

If equipped with Edge Heaters, the setpoint and Left fields as shown in the figure below. the edge of the furnace belt.

Figure 3-30 Edge Heater setpoints

for each pair is displayed in the Right Edge heaters apply linear heat along

To change an edge heat value, click on the – 100 percent. Since edge heaters only apply entire length, the lowest acceptable value distribution of heat across the belt. Click on the field to change the value in the furnace. Changes will be sent to

value and enter a new number from 0 the preset amount of heat to their should be used to achieve even

furnace immediately.

F. Change N2 Pre-Purge system setpoint (option)

Nitrogen purge time remaining and total cycle time are displayed. Click on the cycle time to change. Click on the Time remaining to reset to zero. Changes will be sent to furnace immediately.

Figure 3-31 N₂ Pre-

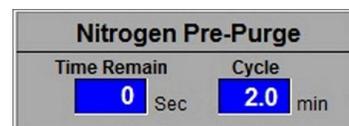### G. Oxygen Analyzer (option)

The O2 analyzer measures the concentration of oxygen in the sample line and displays the result in percent or parts per million by volume on the front of the analyzer. Three horizontal bars to the right of the led display indicate whether reading is in % or ppm, Figure 3-32. Regardless of the display, the analyzer output to the furnace program is always in ppm. The furnace program averages sample readings so the screen display will often differ slightly from the analyzer's real time display.

The oxygen power switch at the rear of the analyzer must be enabled for the analyzer to operate with the furnace.

Current zone sampling port and measured oxygen level are displayed on the furnace computer Process screen, Figure 3-33. When system is OFF, O2 level will read zero. When system is ON, O2 window will read 1-1000 ppm. For levels above 1000 ppmv, the software will display 1000. For values above 1000 ppm view the display on the analyzer itself, Figure 3-32.
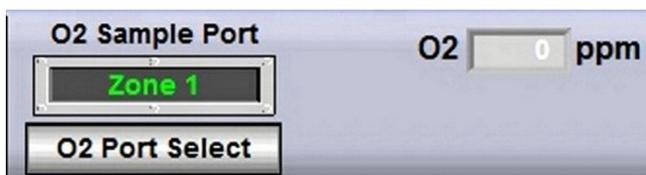

Figure 3-32 O2 Analyzer Display

Figure 3-33 O₂ ppm, Port Select button

H. Sample System Port Select

To enable sampling system, select a different sample port or change alert and alarm values in real time, on the Process screen, click **O2 Port Select** (Figure 3-33) to open O2 Sampling popup.

If the process requires gas sampling, click on the radio button until the label displays **On**. Select desired sampling port.

Verify sample system integrity (see 3.6.1I).

Select Zone to be sampled during recipe processing. To assure integrity of the measurements, make sure to allow sufficient time for the system to stabilize on a given port before again changing the ports.

Click Close, changes will be sent to furnace immediately. Figure 3-34

If the process does NOT require gas sampling, click on the radio button until the label displays **Off**. Close popup.

I. Sample System Integrity

Verify the quality of sample line or purge analyzer and lines, by sampling the nitrogen gas supply. Select Source and operate system until the measured ppm reaches expected values. On source the analyzer is reading the moisture content of the source nitrogen and any residual oxygen in the sample line.

Care should be taken to not let air or moisture to enter the analyzer. Once the sample lines become wet it can take many hours to several day for the oxygen value to equilibrate.
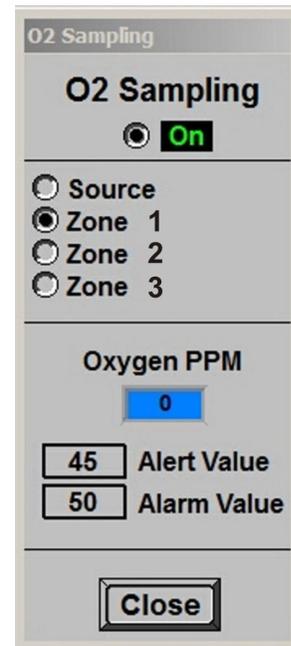
Figure 3-34 O₂ Port Sampling popup

J.   O2 Alert and Alarm Values

On the O2 Sampling popup, click on their respective boxed-in values to change Recipe Oxygen Alert and Alarm limits. While the oxygen system is enabled and the furnace status is ready, an Alert or Alarm will sound if the Sampling Analyzer detects oxygen levels above either the setpoint limits. Range of values is 1-1000 in ppmv.

K.   SMEMA Product Alert (option)

The SMEMA product alert system tracks parts as they enter and exit the furnace, Figure 3-35. This system can be designed for one, two or three product lanes. See 1.8.16 and 4.11 for more details on details on the SMEMA system hardware.
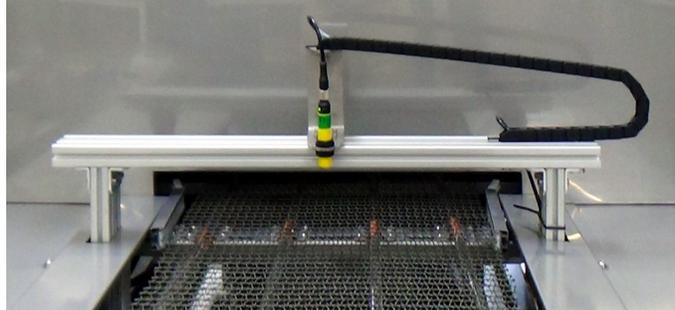
Figure 3-35 SMEMA sensor above belt

Activate the SMEMA product sensing system by clicking on the radio button below SMEMA button on the furnace software title bar to turn the system ON or OFF, Figure 3-36. Each time product passes under the entrance sensor, the Parts IN counter will increment. Each time product passes under the exit sensor, the parts OUT counter will increment. Running totals for each are shown on the title bar.

Figure 3-36 SMEMA setup

3.7   Managing Control Strategies with Recipes

3.7.1 Managing Recipes

The Recipe screen is used to create, edit and load a recipe into the furnace. A recipe can be created for each process (level 3+ access) containing temperature zone setpoints, alert and alarm levels, PID Gain and Integral parameters, and top and bottom power levels for reuse every time the process is run. Parameters for option al equipment such as Edge Heaters, O2 sampling system and SMEMA product tracking can be saved also.

Recipes stored on the furnace computer can be accessed and sent to the furnace from the Recipe screen.

Editing. The Editing box displays the recipe currently loaded into the Recipe editor, Figure 3-37.

Figure 3-37 Recipe Editing display
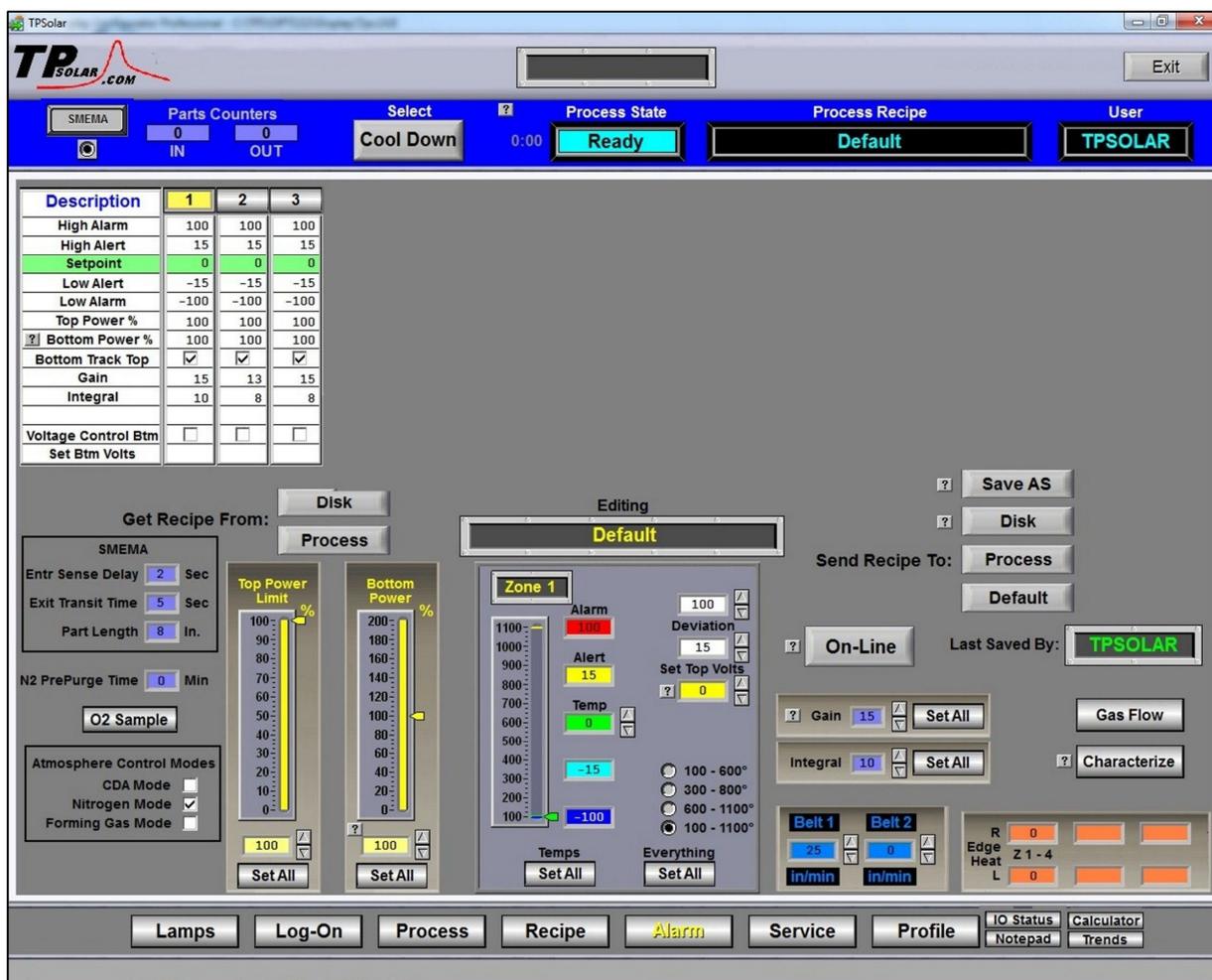
Figure 3-38 Recipe Screen

A. Get Recipe From:

Disk. To load a different recipe into the Recipe editor, select **Get Recipe From: Disk** . A dialog box will open with a list of the furnace recipes stored on the furnace computer.

Furnace. To load the recipe running in the furnace controller into the Recipe editor, select **Get Recipe From: Process**. The values from the recipe running in the furnace controller will be loaded into the editor.

B. Send Recipe To:

Save As a New Recipe**.** The recipe in the Recipe editor can be saved on the computer as a new recipe. Select **Send Recipe To: Save AS** . Click on existing name and enter a new recipe name and click **OK**. The new recipe will be stored in the RECIPES directory. **Save AS** will save the recipe in the Editor with the existing name or

new name. The Recipe name is imbedded in the Recipe file which means that no matter what '*file name'* is used, the '*Recipe name'* will always be as shown on screen.

Disk. To store a new or edited recipe in Recipe editor to the computer hard disk, select **Send Recipe To:** Disk . A dialog box will open. Enter the recipe name and recipe file name, click **OK**. The Recipe name typed gets imbedded in the Recipe File which means that the Recipe Name and the File Name will always be the same.

Process. Once edited a recipe can be sent to the furnace to replace the values running in the furnace controller. Select **Send Recipe To:** Process . The furnace will start using the values just loaded and these values will be shown on the Process screen.

3.7.2 Editing Recipes

A. Recipe Belt Speed Editor

Edit the values for the recipe belt speed. Multiple pairs will appear if furnace is equipped with more than one belt, Figure 3-39.

Range of values is minimum belt to maximum furnace belt speed in displayed units.

B. View Recipe and Zone Select

The Description box shows the recipe values for each zone. To make changes, click on the number of the Zone to be edited. In Figure 3-40 zone 2 is selected.

Figure 3-39 Recipe Belt Speed Editor

Description	1	2	3	4
High Alarm	100	100	100	100
High Alert	15	15	15	15
Setpoint	0	0	0	0
Low Alert	-15	-15	-15	-15
Low Alarm	-100	-100	-100	-100
Top Power %	100	100	100	100
? Bottom Power %	100	100	100	100
Bottom Track Top	☑	☑	☑	☑
Gain	15	13	15	15
Integral	10	8	8	10
Voltage Control Btm	☐	☐	☐	☐
Set Btm Volts				

Figure 3-40 Recipe Description & Zone Select

C. Edit Recipe Zone Temperatures

Once a zone is selected, edit the values in the Recipe Zone Editor fields. Figure 3-41 shows an example of using the Recipe Zone Editor to edit parameters for Zone 1. Setpoint fields and colors are defined in Table 3-6.

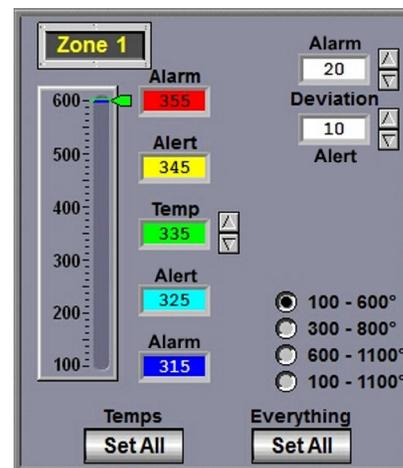| Table 3-6 Recipe Zone Editor Temperature Fields		
Type	Color	Description
Alarm	Red	Hot, high temperature Alarm setpoint
Alert	Yellow	Warm, high temperature Alert setpoint
Setpoint	Green	Normal
Alert	Light Blue	Cool, low temperature Alert setpoint
Alarm	Blue	Cold, low temperature Alarm setpoint

Figure 3-41 Recipe Zone Editor

Changes can be made to the setpoint temperature, alarm and alert levels, as follows:

Enter the new zone temperature setpoint in the green Temp field.

Adjust the top Deviation value to determine the Alarm bandwidth.

Adjust the bottom Deviation value to set the Alert bandwidth.

The high and low colored Alert and Alarm fields will update automatically using the bandwidth settings for each. For example, setting top Deviation to 20 will cause the high and low temperature alarm fields to update to 20 C above and below the zone temperature setpoint (green). Similarly setting the Alert Deviation field to 10 changes the high and low Alert fields to 10 C above and below the zone temperature setpoint.

The vertical temperature bar will change color when the actual zone temperature deviates in excess of the deviation amounts from setpoint.

Use Temps Set All button to enter the Recipe Zone Editor temperature setpoints in all zones in the recipe. Use Everything Set All button to enter the Recipe Zone Editor setpoints in all zones in the recipe.

D. Edit Recipe PID values

Once a zone is selected, edit the PID Gain and Integral values using the Recipe PID.

Click on the spinner or enter a new value in the field next to the PID Editor value you want to change.

Figure 3-42 Recipe PID Editor

Gain values can range from 5 to 20 with 5 being slow to warm-up and slow to react to temperature setpoint changes. An aggressive value of 10 will warm-up quickly and respond quickly to changes. Values above 10 are increasingly aggressive with 20 being extremely aggressive. The amount of correction is proportional to the rate of change of temperature deviation from Setpoint. Gain is an independent parameter.

Integral values are calculated in the Recipe Editor based on the Gain. Integral values may adjust automatically during Warm-up and will be saved to the Recipe file after Warm-up changes to Ready. The function of the Integral is to slowly reduce steady state temperature deviations from Setpoint to zero. Integral input range is 5-55.

Derivative is not used.

Use Gain Set All button to enter the Recipe Gain value in all zones in the recipe.

Use Integral Set All button to enter the Recipe Integral value in all zones in the recipe.

E. Apply Zone Characterization

Variations in Zone Chamber performance can be caused by thermocouple inaccuracies, thermocouple placement, insertion depth, gas flow, baffle placement/arrangement, etc. Although every effort is made to ensure repeatability at the Factory, some minor variations can occur. Changes in performance over time due to maintenance activities are likely to occur as well.

To compensate for variations in the Zone Chamber environment, a characterization value can be introduced that will raise or lower the feedback temperature. This allows the same recipe to be used across Furnaces by 'normalizing' each Furnace with individual characteristic settings for each zone. A positive value of say 10 degrees will increase the Zone Temperature by 10 degrees (in the chamber) but will not affect the displayed temperature or the Zone Setpoint.

Click on Characterize button to access Zone Character pop-up. Click on the zone field to apply a characterization factor. These settings are stored in the Furnace Setup file and apply to all Recipes. Range of values is -25 to + 25 in degrees C.

Figure 3-43 Zone Character pop-up

F. Edit Recipe Top and Bottom Power

Once a zone is selected, edit the values in the Top Bottom Power fields. Figure 3-44 shows an example of using the Recipe Top Bottom Power Editor to edit change the recipe parameters for the selected zone.

Click on the spinner or enter a new value in the field below the Power bar you want to change.

Range of top values is 0.5 to 100 in percent (%).

Bottom Power tracks Top Power and its setting is a percentage of Top Power applied. Range of top values is 0.5 to 200 in percent (%) of Top Power.

Use Top Power Set All button to enter the Recipe Top Power value in all zones in the recipe.

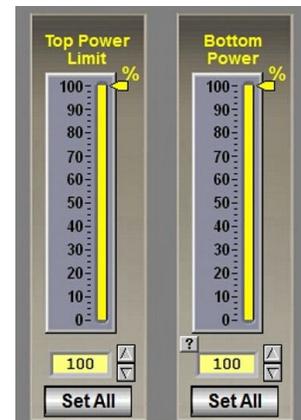Use Bottom Power Set All button to enter the Recipe Bottom Power value in all zones in the recipe.

Figure 3-44 Recipe Top Bottom Power editor

3.7.3 Managing Optional Equipment with Recipes

A. N2 Pre-Purge Recipe Editor

Upon initiating furnace warmup, if so equipped, the Nitrogen PrePurge system floods the furnace chambers with nitrogen for a period of time determined by each recipe. Enter the amount time for the purge in the N2 PrePurge time field, Figure 3-45.

Figure 3-45 Recipe N₂ Purge Editor

Range of values is 0-10 in minutes.

B. O2 Sampling Recipe Editor

Click [O2 Sample] to open O2 Sampling Recipe popup (Figure 3-46).

If the recipe does not require gas sampling, click on the radio button until the label displays Off . Close popup.

If the recipe requires gas sampling, click on the radio button until the label displays On .

Select Zone to be sampled during recipe processing.

Enter Recipe Oxygen Alert and Alarm limit values.

Click close. Parameters will be stored in recipe when recipe is next saved.

While recipe is running in the furnace, an Alert or Alarm will sound if the Sample System Analyzer detects an Oxygen level above one of the setpoint limits.

Range of values is 10-1000 in ppmv.
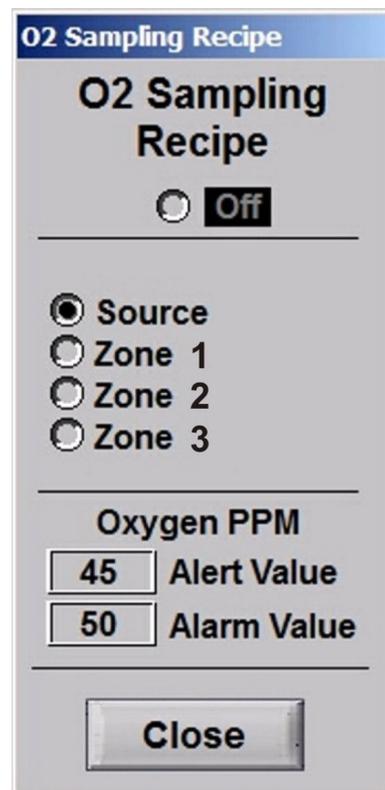
Figure 3-46 O2 Sampling Recipe popup

C. SMEMA Recipe Editor

On the Recipe screen enter the following parameters to be stored in the recipe.

Entr Sense Delay (seconds) is the time after the sensor detects the part to it being counted IN and the **Furnace_Ready** signal is sent to the upstream equipment HSK contacts.

Exit Transit Time is the time it takes a part to travel from the Exit sensor to the end of the belt where the next machine gets the part. The **Boat_Available** output signal is turned ON after the amount of time set in Exit Transit Time field as a signal to the next machine that there is a part ready to be acquired at the exit. Enter Exit Transit time in seconds.

Figure 3-47 SMEMA Recipe parameters

Part Length field on the Recipe screen is used to determine the time it takes for a part to pass the Exit Sensor. This time is 1.5 times the part length divided by the belt speed. This time is used to ignore false readings as the part passes by the sensor. Enter the part length in inches.

3.7.4 Gas Flow screen (access from Recipe screen)

Record flowmeter settings and store for each recipe using the Gas Flow screen. If stored with the recipe file, when a recipe is later opened, the operator can verify and adjust the flow meters to match each recipe. Access the Gas Flow screen from the Recipe screen.
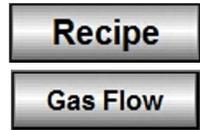
A. Recipe Gas Flow screen

Flow Meter Recipe Settings. Select Recipe button and on the Recipe screen, select the Gas Flow button. The Gas Flow screen (Figure 3-49) will displayed. The Gas Flow screen is provided as a record of the settings required for the recipe only. This screen displays the flowmeter setpoint values stored for the recipe in the editor. The flowmeters must be adjusted manually for each recipe loaded.
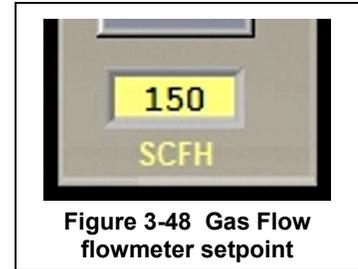
The labels as flowmeter ranges are entered at the factory. To change the recipe value for a flowmeter location, click on the setpoint field (Figure 3-49) and enter a new value.

See Owner's Manual, Specifications section for recommended settings. See section 5.5.5 for information on setting the flow meters to balance the system gas flow.

Figure 3-48 Gas Flow flowmeter setpoint

Figure 3-49 Gas Flow Screen

3.8 PID Zone Tuning

Service

(Access Level 3+) On the Service screen, click "Tuning" button to view the Tuning screen. Enter new values for Gain, Integral and Derivative and save in recipe file.

Table 3-7 PID Initial settings	
Parameter	Initial Values
Proportional Gain	15
Integral	25
Derivative	none

Click on the desired Zone radio button to monitor and Edit Zone PID Settings for that zone. Zone Tuning fields will display the PID parameters for that zone. Place the cursor on the value to be modified and click. Type the new setting and press enter from the keyboard.

See section 5.4 for Process Engineering considerations in establishing PID parameters. Also see section 4.14.1 to completely retune a zone.
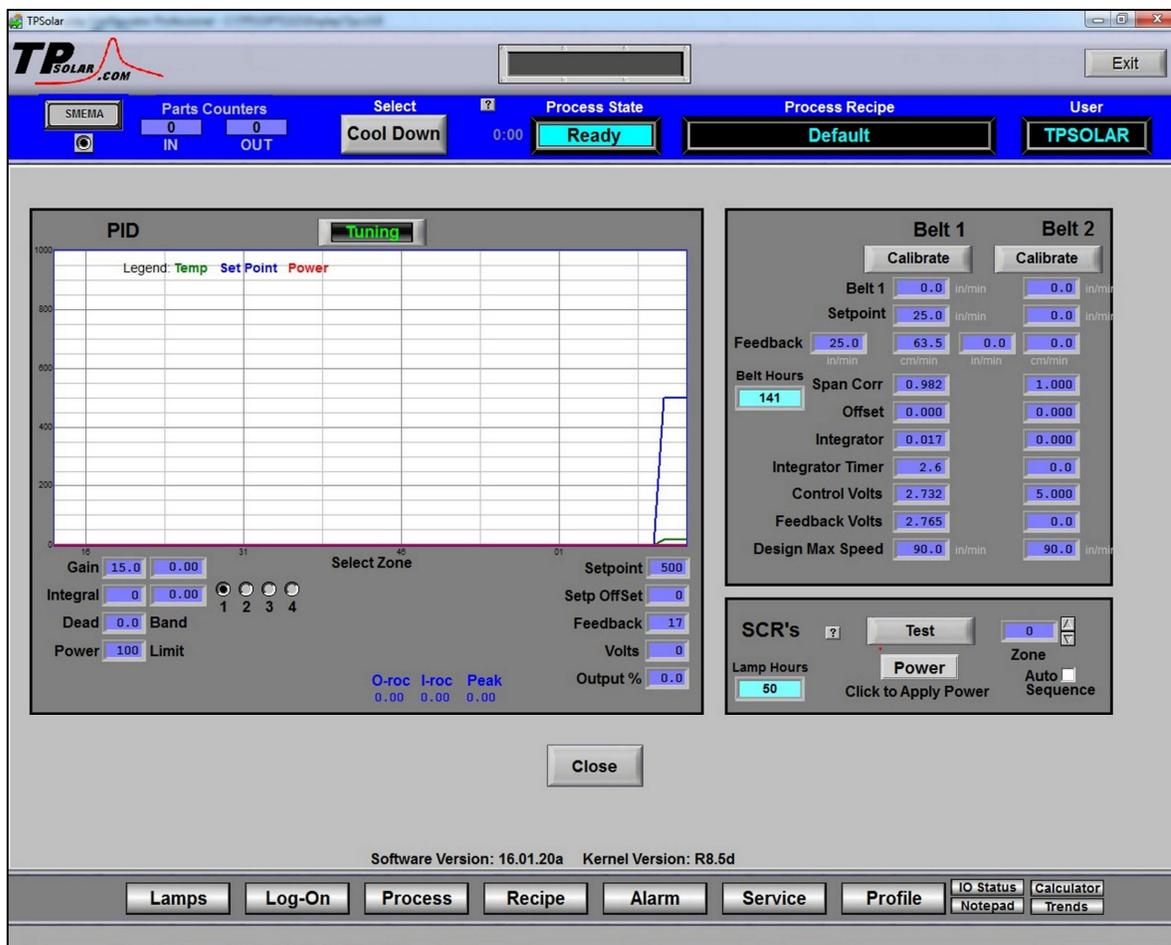
Figure 3-50 Service screen: Zone Tuning

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

The derivative is not used.

3.9   Real-time and Historical Trends

To view current or historical performance by zone:

1. Press the Trends button at the top of the Process screen,
2. Select dropdown for the desired zone to view.
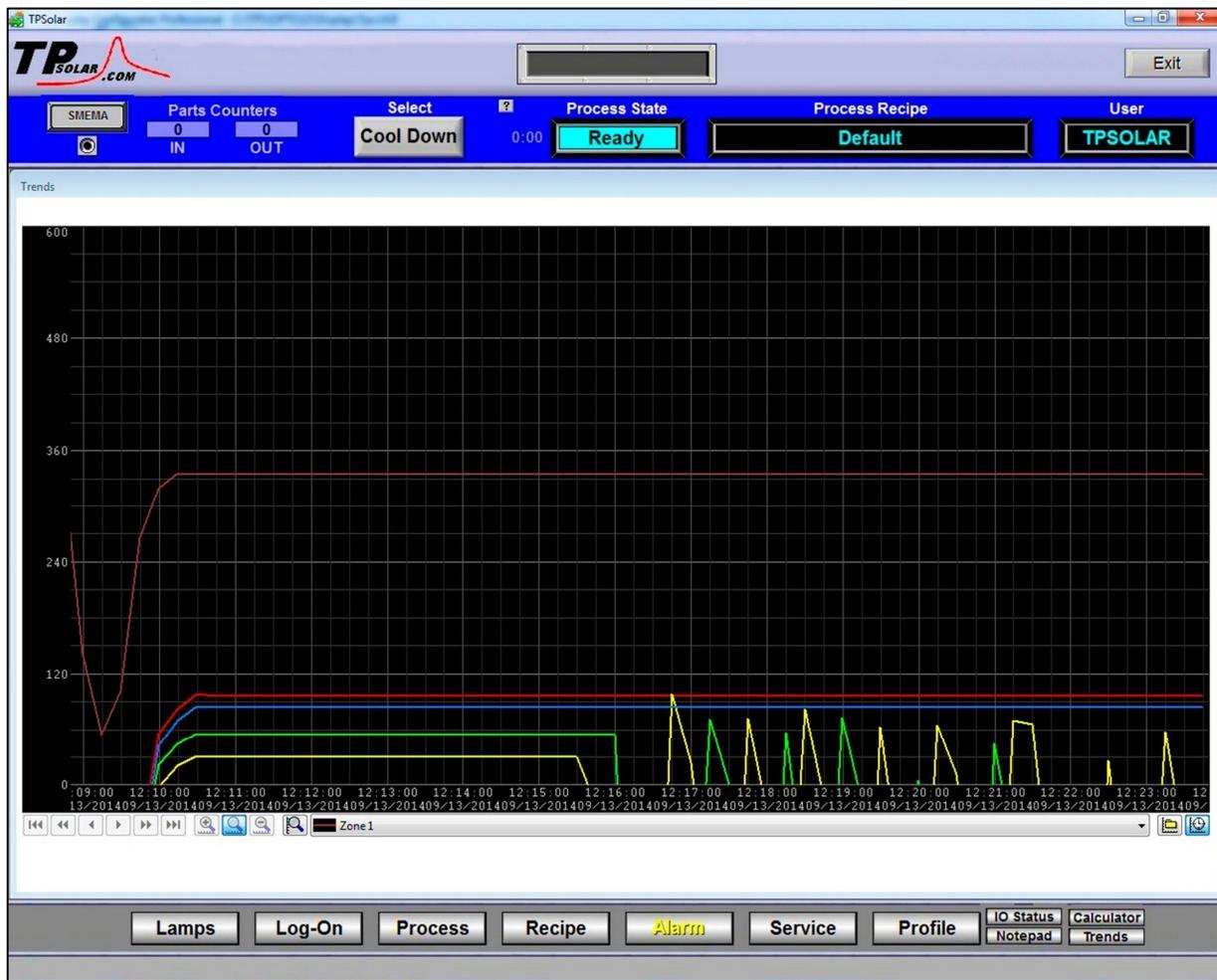
Figure 3-51 Trends graph

Once the trends graph appears (Figure 3-51) 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. All parameters are shown on the screen at all times, although the scale is adjusted for the selected parameter.
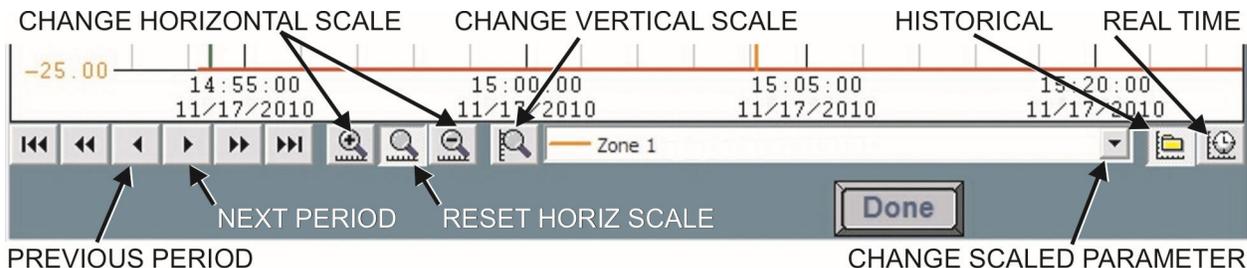
Figure 3-52 Trends Menu bar

<table>
<tr><td colspan="2" align="center">Table 3-8 Trends Menu Buttons</td></tr>
<tr><td>Button</td><td>Action</td></tr>
<tr><td></td><td>Real Time Mode (default). Shows data currently being recorded for all 5 parameters.</td></tr>
<tr><td></td><td>Historical Mode. Opens file from an earlier period. (See Figure 3-54). Activates Previous and Next buttons and Horiz scale buttons.</td></tr>
<tr><td>Zone 1 ▼
Zone 1
Zone 2
Zone 3
Zone 4
Zone 5
Zone 6</td><td>Select Zone. Select the zone you want to track.</td></tr>
<tr><td></td><td>Zoom Pen. Change vertical scale for selected parameter.</td></tr>
<tr><td></td><td>Zoom Normal. Resets Horizontal scale to default (30 minutes per screen).</td></tr>
<tr><td></td><td>Zoom Hour. Compresses horizontal scale (x-axis) to show more detail (one hour per screen).</td></tr>
<tr><td></td><td>Zoom Day. Compresses horizontal scale (x-axis) to show longer time period in one view. (24 hours per screen)</td></tr>
<tr><td>▶ ▶▶ ▶▶❘</td><td>Log Forward (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</td></tr>
<tr><td>❘◀◀ ◀◀ ◀</td><td>Log Back (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</td></tr>
</table>

Enter the Historical Log Mode by pressing ⬛. The Super Trend Historical Log file popup is shown in Figure 3-54.

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 3-53 Change Vertical Scale

Figure 3-54 Load Historical Trend Data

3.10 Alarm Status (All Access Levels)

`Alarm`

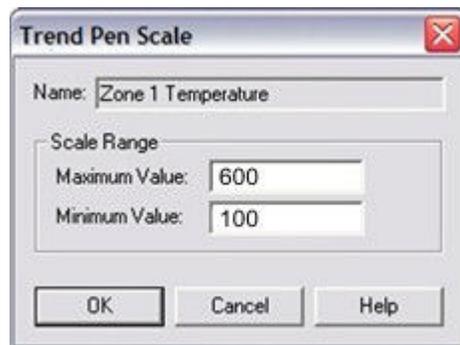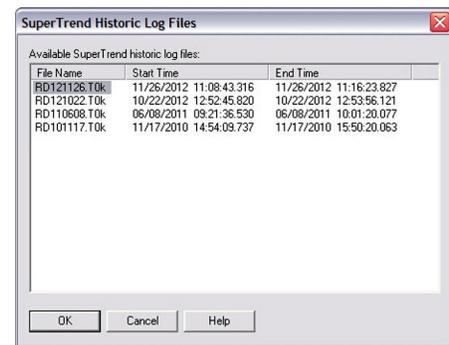During an Alarm condition, the Menu bar Alarm button turns red. Any existing alarm conditions, such as transport speed error, can be viewed on the Alarm popup screen. Click on the Alarm button on the Menu bar to access the Alarm pop-up. To clear or silence an alarm/alert, move the cursor on the Alarm pop-up screen and click on "Silence Reset" See Chapter 4 SERVICE & MAINTENANCE for further information.
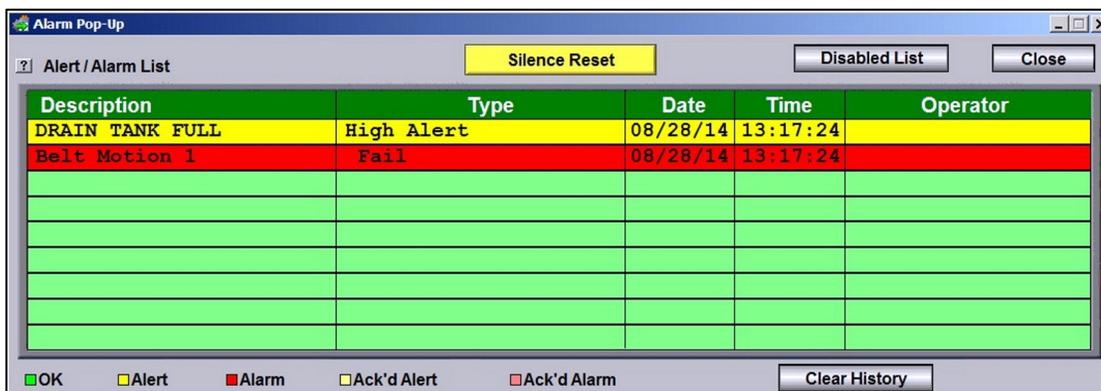
Figure 3-55 Alarm pop up screen

A. Silence Reset button

Pressing the Silence Reset 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).

B. Alarm Definitions

Table 3-9 Typical Alarms			
Message	**Type**	**Description**	**Enabled**
Zone Temps	Alarm/Alert	High or Low temperature after setpoint is reached	Yes
Cabinet Temperature	Alarm	High temperature in Furnace Enclosure	No
Water In Temperature	Alarm	High Inlet water temperature	No
Water Out Temperature	Alarm	High Outlet water temperature	No
Water Flow Switch	Alarm	No Cooling Water flow	No
Process Air Flow Switch	Alarm	No Process Air flow	No
Exhaust Air Flow Switch	Alarm	No Exhaust Air flow	No
Cooling Air Flow Switch	Alarm	No Cooling Air flow	No
Cooling Exhaust Flow Switch	Alarm	No Cooling Exhaust Air flow	No
Belt Speed	Alarm	High or Low Belt Speed feedback	Yes
Transport Motion	Alarm	Belt not moving.	Yes
I/O Rack Offline	Alarm	Communication failure to Acromag I/O module	Yes
Zone x Lamp Fail	Alert	Lamp Failure in specified Zone.	Yes
Nitrogen Pressure	Alarm	Low process gas supply pressure	Yes

<table>
<tr><th colspan="4" align="center">Table 3-9 Typical Alarms</th></tr>
<tr><th>Message</th><th>Type</th><th>Description</th><th>Enabled</th></tr>
<tr><td>O2 Level</td><td>Alert</td><td>Oxygen level in furnace above Alert setpoint</td><td>Yes</td></tr>
<tr><td>O2 Level</td><td>Alarm</td><td>Oxygen level in furnace above Alarm setpoint</td><td>Yes</td></tr>
</table>

3.10.2 IPS Low Gas Pressure Alarms

A Inlet Pressure Switches is installed on the GAS 2 process gas manifold. These switches are normally open when gas is disconnected from the furnace. They close when proper pressure is present in the process gas supply line(s).

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

<table>
<tr><th colspan="4" align="center">Table 3-10 Initial Alarm Settings</th></tr>
<tr><th>Port</th><th>Manifold</th><th colspan="2" align="center">Pressure</th></tr>
<tr><td>Gas 1</td><td>CDA or Nitrogen</td><td colspan="2">No alarm</td></tr>
<tr><td>Gas 2</td><td>Nitrogen Forming Gas, or other (Option)</td><td>55-60 psig</td><td>3.8-4 Bar</td></tr>
</table>

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. See section 4.14.7 for instructions on adjustment and calibration.

Figure 3-56 IPS Inlet Pressure Switch

3.10.3 Auto Gas Shutoff

This furnace is 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.

3.12 Element Monitoring System (EM option)

The Element Monitoring system consists of single channel circuit boards installed on each string which detect the location of a failed heating element. The circuit boards monitor the current to the lamp string 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 **Lamps** 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.
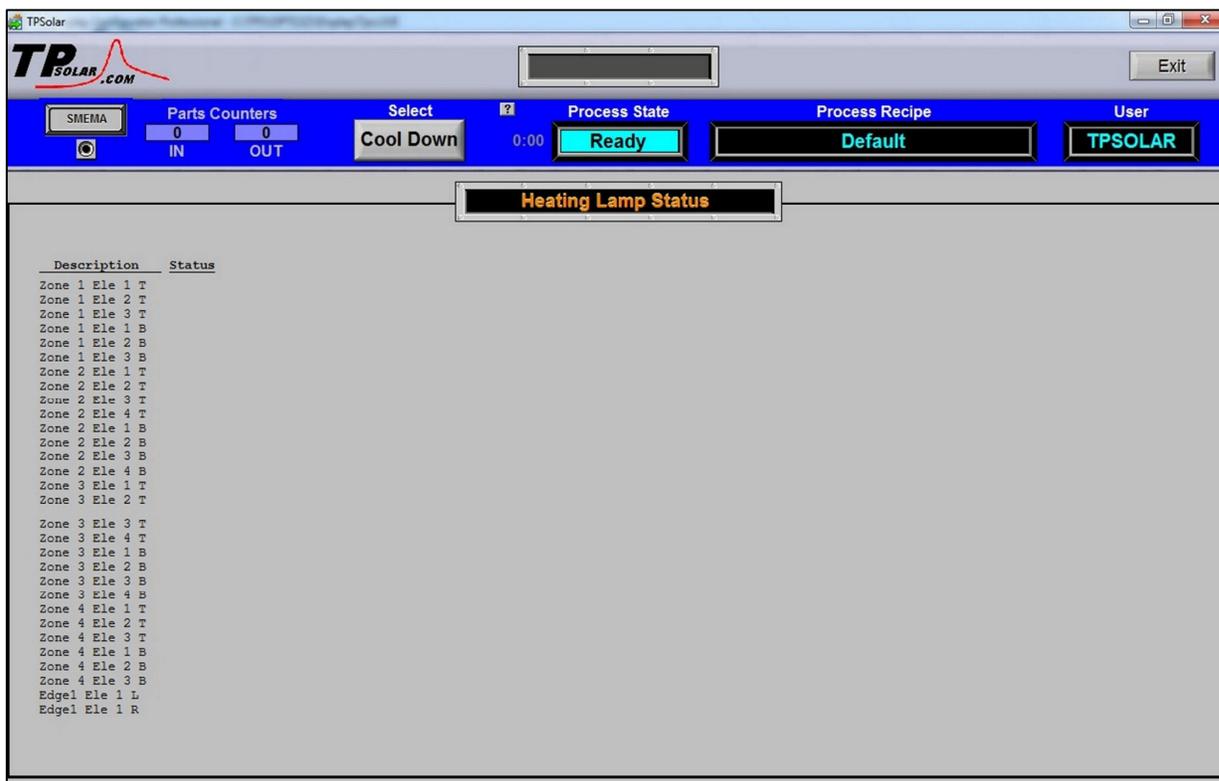
Figure 3-57 Lamps Element Monitor screen

Status is Blank. Polling has yet to occur. System will not poll element strings until power levels indicate enough current is demanded to prevent false readings. Element poling is best performed during warmup to assure adequate current should be flowing.

Status is OK. Each individual element string with status **OK** has been polled and no failure found.

Status is Fail. Specific lamp string with Fail indicates insufficient current flow was detected and the elements (lamps) may not be heating properly, if at all. See **sections 4.9 Element Failure Indication** through **4.9.4 Lamp Replacement** for element troubleshooting and replacement.

EM Signal polling. The software polls the element monitor cards via a serial string received by the controller. See section **4.9.2 EM Serial** Polling for troubleshooting heating element strings.

3.13 Over Temperature (OT option)

The Over Temperature Alarm (OT) option provides a scanner to monitor each zone and respond to overtemperature conditions. Normally the furnace software puts the furnace into Cooldown if the temperature deviation in any zone reaches the user's alarm setpoint. The OT alarm setpoints are set higher than those in the furnace recipe in case the initial trigger is ignored.

Figure 3-58 OT Display

The OT system consists of redundant zone thermocouples, an Automatic Temperature Scanner/LCD display integrated into the furnace software. The Automatic Temperature Scanner display (Figure 3-58) is mounted on the front side of the furnace near the control console.

The Automatic Temperature Scanner scans each zone in succession. The operator can view the temperature of the zone being scanned on the LCD panel display. The active channel (zone) being monitored will be indicated on the scanner, Figure 3-59.
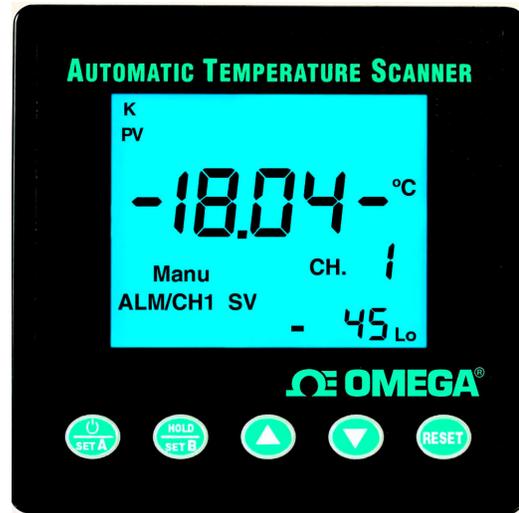
ALARMS. Each channel has individual, independent and programmable alarm setpoints with alarm indicator. If the temperature in any zone reaches the user set alarm set point, an alarm will sound in the Automatic Temperature Scanner and trigger the furnace into Cool Down. The heating elements will immediately be shut off by the controller. The furnace cannot be restarted until the zone temperature drops below the alarm set point.
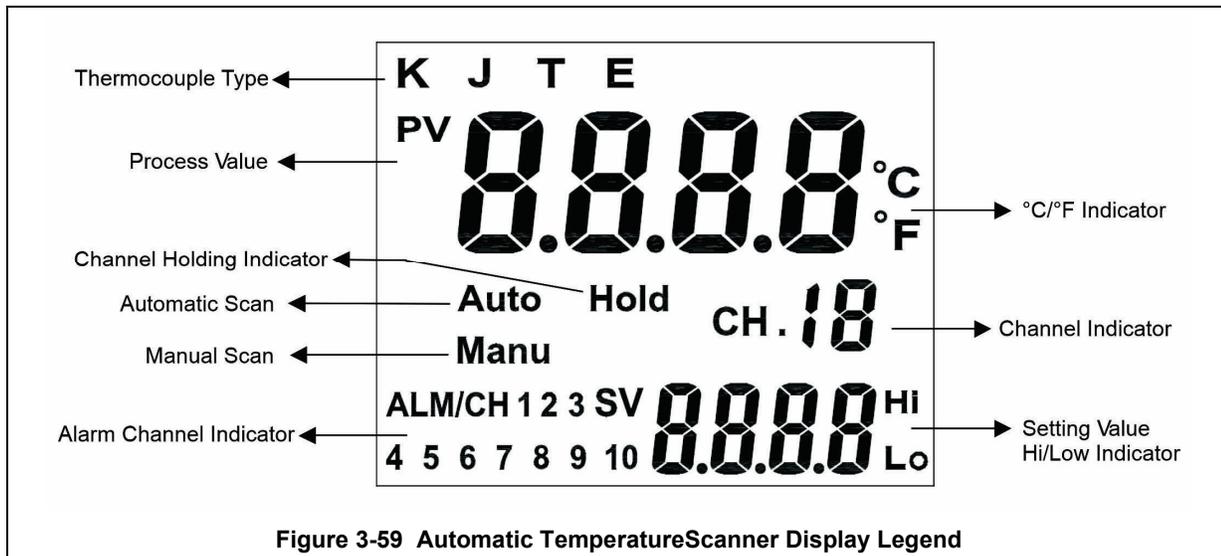
Figure 3-59 Automatic TemperatureScanner Display Legend

3.13.1 Button Functions

(SET A)	1. Press to turn on or off the power. 2. Press and hold to enter Basic Setting.
(HOLD SET B)	1. Press to keep monitoring the specific channel under automatic scan mode. 2. Press and hold to enter Hi/Low Setting.
(▲) (▼)	1. Switch channels under manually scan mode. 2. Adjust values in Basic and HI / Lo Setting.
(RESET)	1. Press to turn ON backlight for 10 minutes under backlight-OFF mode. 2. Press and hold to reset the alarm of each channel.

3.13.2 Basic Settings (SET A)

Press and hold (⏻ SET A) for 3 seconds to enter Basic Setting.

Use (▲) and (▼) to adjust setting values.

Press (⏻ SET A) to confirm setting values and enter next setting.

```
          ┌─────────────────────────────┐
          │    Set K, J, T, or E type    │
          └─────────────────────────────┘
                        │
                        ▼
          ┌─────────────────────────────┐
          │        Set °C or °F          │
          └─────────────────────────────┘
                        │
                        ▼
       ┌───────────────────────────────────┐
       │  Set how many channels will be used.│
       └───────────────────────────────────┘
                        │
                        ▼
          ┌─────────────────────────────┐
          │   Turn backlight on or off   │
          └─────────────────────────────┘
                        │
                        ▼
          ┌─────────────────────────────┐
          │  Set manual or automatic scan │
          └─────────────────────────────┘
               │                    │
            Manual              Automatic
               │                    ▼
               │      ┌───────────────────────────────┐
               │      │ Set Scan interval from 2 to 60 sec.│
               │      └───────────────────────────────┘
               │                    │
               ▼                    ▼
          ┌─────────────────────────────┐
          │       Set off-set value      │
          └─────────────────────────────┘
                        │
                        ▼
          ┌─────────────────────────────┐
          │             End             │
          └─────────────────────────────┘
```
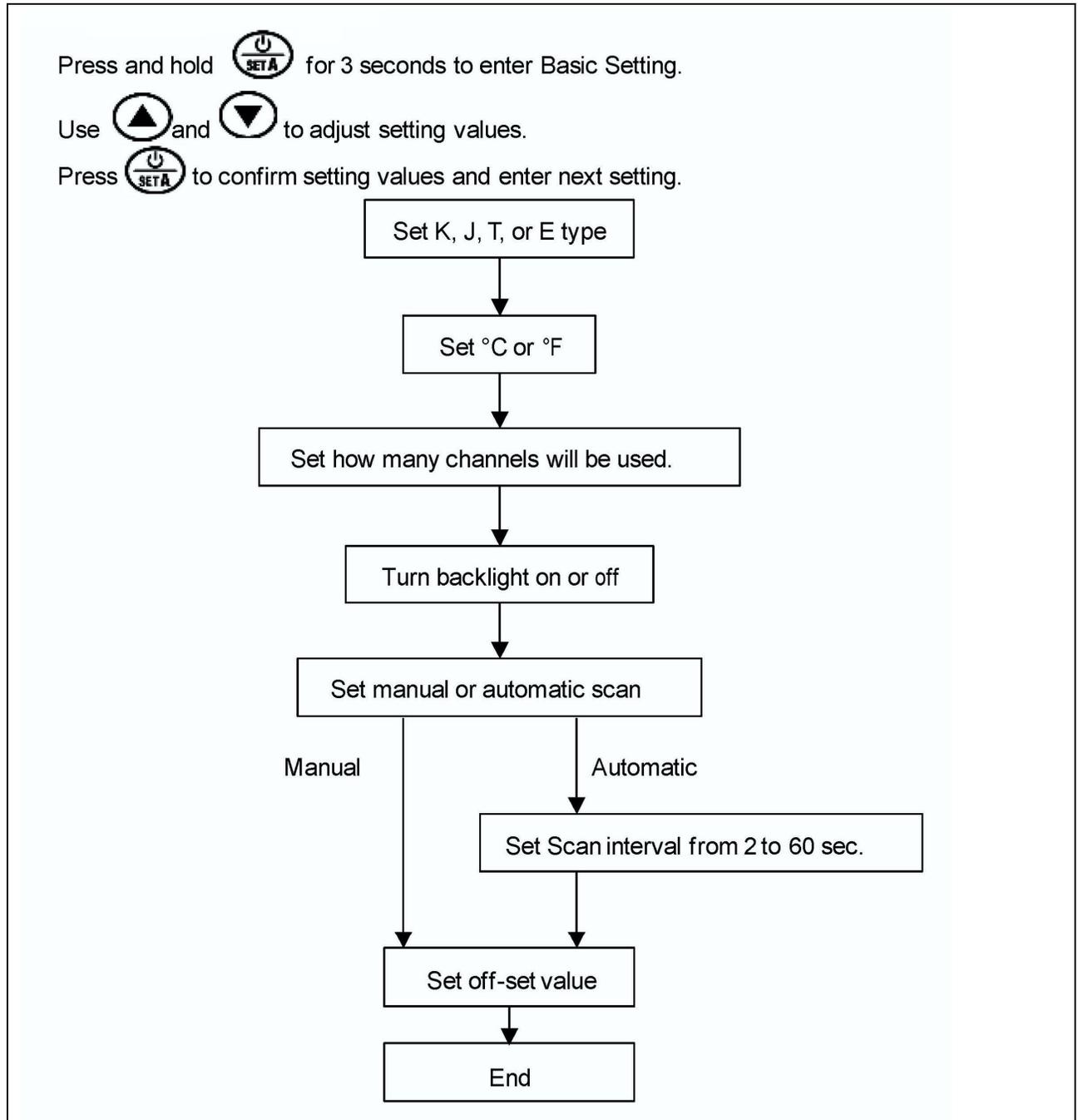
3.13.3 OT Hi Low Settings (SET B):

Press and hold (HOLD SET B) for 3 seconds to enter Hi/Low Setting.

Use (▲) and (▼) to set **HI** or **Lo** and adjust the setting values for each channel.

Press (HOLD SET B) to confirm and enter next setting.
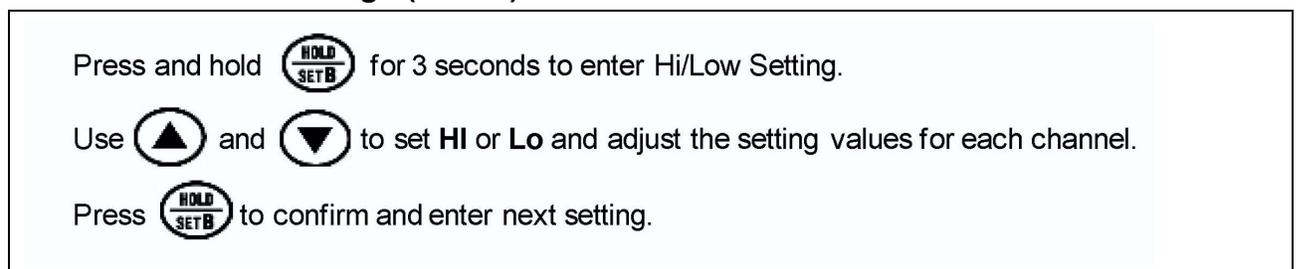
Memory and setpoints are retained when power is OFF.

3.14 View Alternate Programs

To switch the viewing window between the TPS Furnace Process Software and another application (the Mole, 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 Furnace Process Software to the active window.

3.15 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.