4.1 Service and Maintenance Access

PANELS NOT INTERLOCKED. The access panels are not equipped with interlock switches so power to the furnace must be cut and locked out before any panel is removed or opened to guard against electrical shock.

DANGER: Observe extreme caution when the furnace power is engaged while the access panels are removed. Dangerous levels of AC and DC voltages will be present.

Figure 4-1 Furnace Entrance Angle

UPPER PANELS. Gain access to the upper heating section (lamps and plenums, and zone thermocouples) and/or cooling sections by removing the Upper and Lower panels. Remove Upper Panels by unscrewing panel fasteners (see Figure 4-4) on the panel to be removed. Once all fasteners are unscrewed, lift the panel and pull away from the furnace. The Upper Panel must be removed before the corresponding Lower Panel can be removed.

When replacing the Upper panels carefully lower the top of the panel into the slot provided and insert the bottom of the panel so it is in line with the holes for the panel fasteners (see Figure 4-4). Reinstall panel fasteners. Usually Lower panels should be in place before Upper panels are installed.

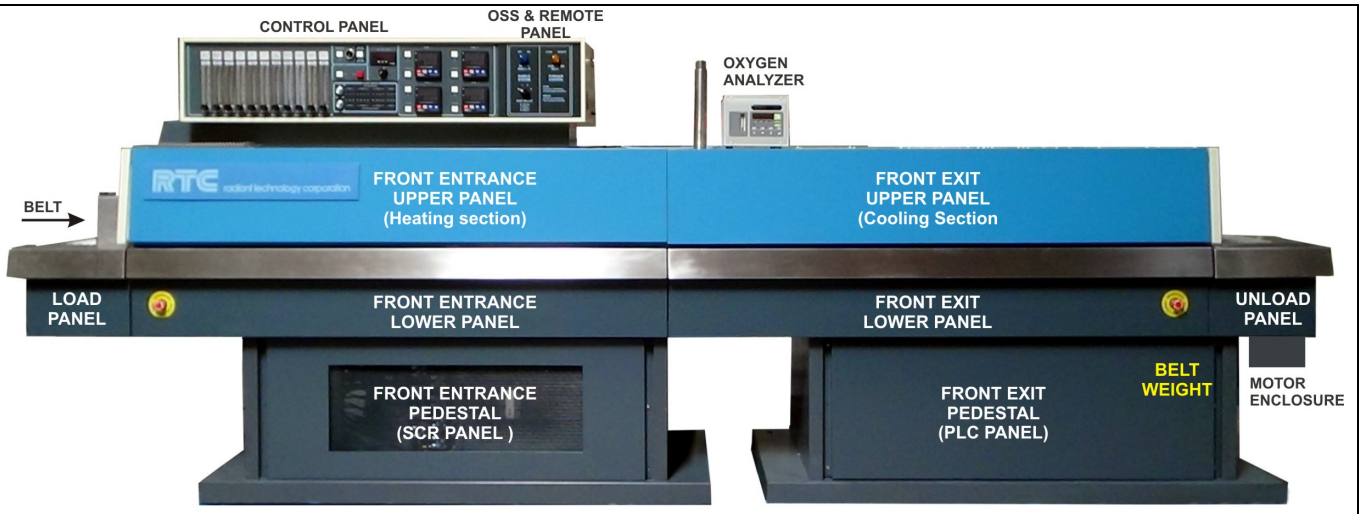


Figure 4-2 Front Access Panels

LOWER PANELS. To remove a Lower Panel: After the corresponding Upper Panel has been removed, lift the lower panel and pull toward you. Lower panels provide access to lower lamps, sample ports and/or bottom of cooling section.

When replacing the Lower panels, carefully lower the top of the panel onto the slots provided (see Figure 4-4).

LOAD PANEL. To gain access to the entrance roller, remove all fasteners on the lower flange of the Load Panel assembly. Stand at the entrance (in front of the belt) and carefully pull the entire Load Panel assembly away from the entrance of the furnace.

UNLOAD PANELS. Remove Unload panel to gain access to transport drive rollers and exit roller. To remove Unload panel assembly, remove all fasteners on the lower flange. Stand at the furnace exit (behind the belt) and carefully pull the entire Unload Panel assembly away from the exit of the furnace. .

CONTROL ENCLOSURE. To gain access to the furnace Control Panel components, remove fasteners on the top and back panel. Lift panel up and away.

Figure 4-3 Rear Access Panels

COOLING SYSTEM. Remove Front and/or Rear Exit Upper and Lower panels to access cooling system.

FURNACE DRIVE ENCLOSURE. Remove fasteners from Motor Enclosure access plate at exit to access transport drive motor, encoder and drive chain.

HEATING ELEMENTS. Remove Front and/or Rear Upper and Lower Entrance panels and plenum covers to access IR lamps.

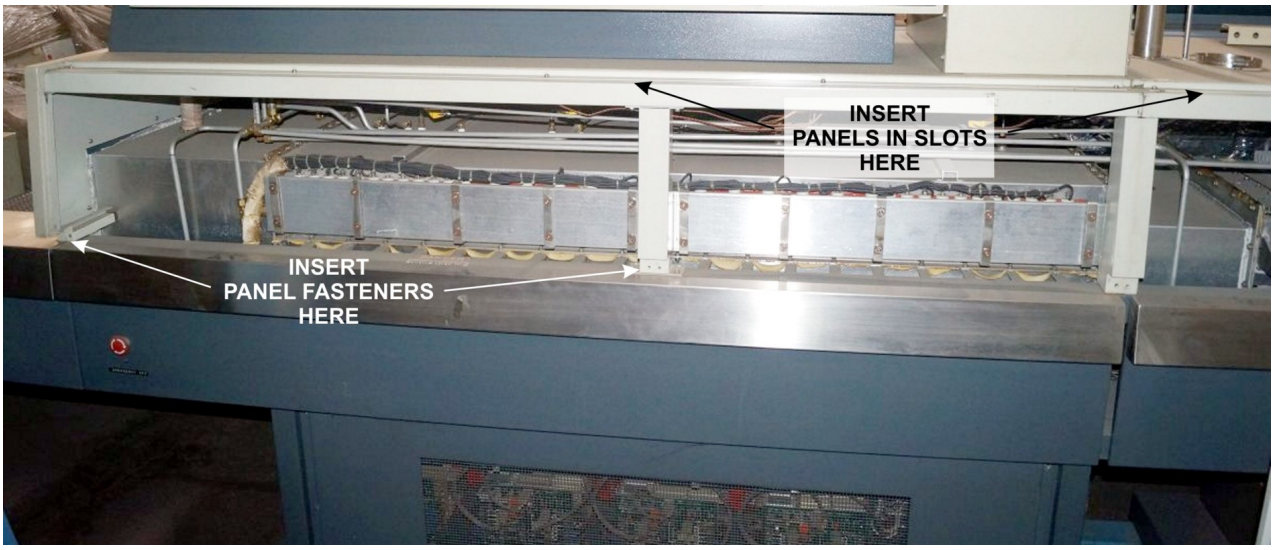


Figure 4-4 Upper Access Panel Installation

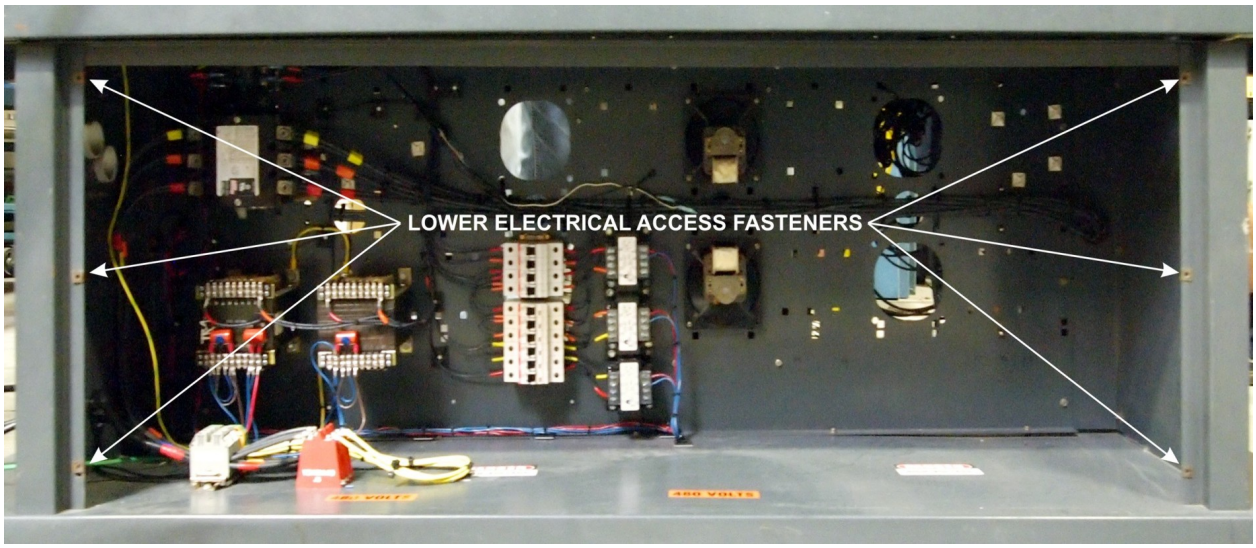


Figure 4-5 Lower Electrical Panel access

4.1.1 Electrical Panel Locations

There are 2 main electrical panels in the furnace plus the control console and auxiliary panels for optional items. The panels are located in the furnace in somewhat the same orientation as in Table 4-1 with the belt travelling from Left-to-Right.

Table 4-1 Electrical Panel Location (Plan View)

Belt 	• Safety & Power Distribution Panel	LOWER REAR SIDE	Storage	Motor
	• Control Console & • Motor Control Center	• Gas Sample System TOP FRONT SIDE • O2 Analyzer		
	• SCR Panel with • EM Sensors	LOWER FRONT SIDE	PLC and Remote interface panels	

Safety panel – Point where power enters the furnace. Contains main contactor and primary transformers. Located at furnace entrance, back side (Figure 4-7 and Figure 4-9).

PDP or Power Distribution Panel – Distributes power for 3 phases. Integrated with Safety panel on furnace rear side (Figure 4-7 and Figure 4-9).

SCR panel – Contains the SCR power controllers, solid state switches and firing boards, that manage power to the lamps using signals from the furnace controller. Located next to PLC panel on front side (Figure 4-6 and Figure 4-10).

EM Sensors – Element monitor sensors are current detection devices for determining integrity of lamp heater strings. These sensors and transfer current signal from sensors to EM display panel on Furnace Console. Located near SCR panel on return lines from lamp strings (Figure 4-6 and Figure 4-10).

PLC Panel / Remote Interface – located in the front lower exit enclosure. Install and connect PLC or other control equipment.

4.1.2 Control Interface

Furnace Control Console – Main human interface for controlling power to the furnace. On top of furnace near entrance (Figure 4-11 and **Error! Reference source not found.**).

Motor control center. Controls transport motor system. Located in Furnace Control Enclosure (Figure 4-11 and **Error! Reference source not found.**).

Transport Drive Motor and Encoder. Located below furnace exit, the transport drive motor is connected to the belt drive roller by chain. Motor shaft includes a 30 ppr (pulses per revolution) encoder that provides feedback to the belt speed rate meter (Figure 4-8).

OSS. Oxygen SAMPLE SYSTEM panel enables sample system and port selections for monitoring oxygen levels in the furnace. The SAMPLE SYSTEM panel is located on the right side of the Furnace Control Console (Figure 4-12 through Figure 4-14).

O2 Analyzer. Analyzer with integral sample pulls sample from selected port and displays detected sample line oxygen level. Provides contact closure for high O2 alarm. Located on top of furnace to the right of the Furnace Control Console. (Figure 4-12 through Figure 4-14).

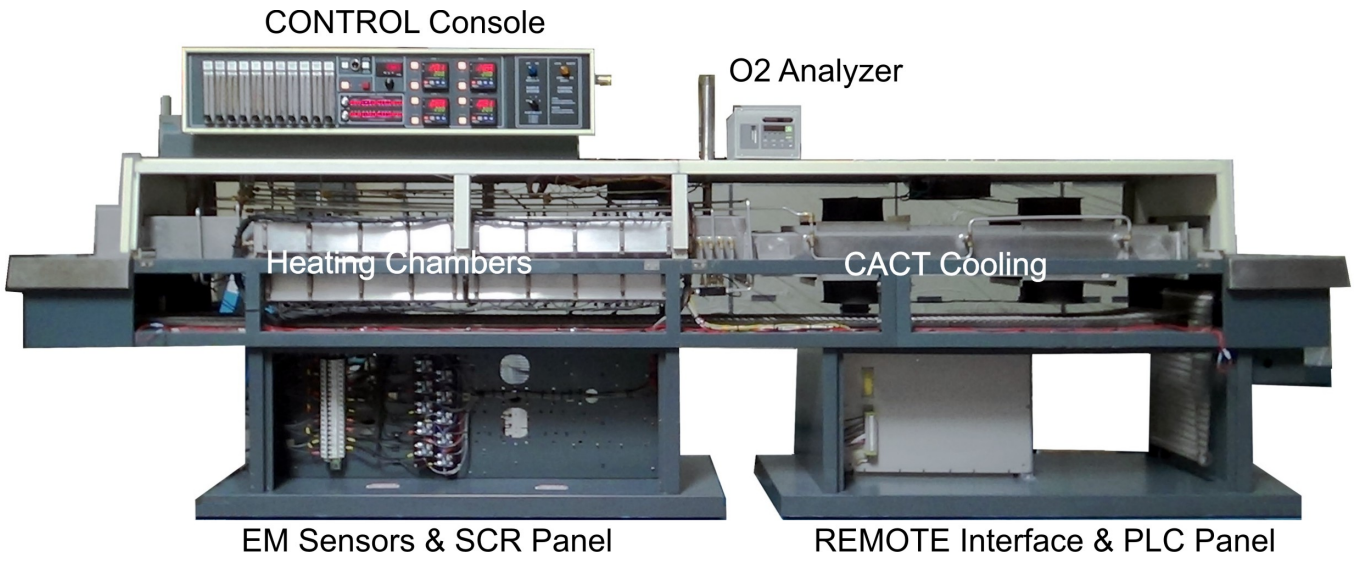


Figure 4-6 Front with Side Panels removed

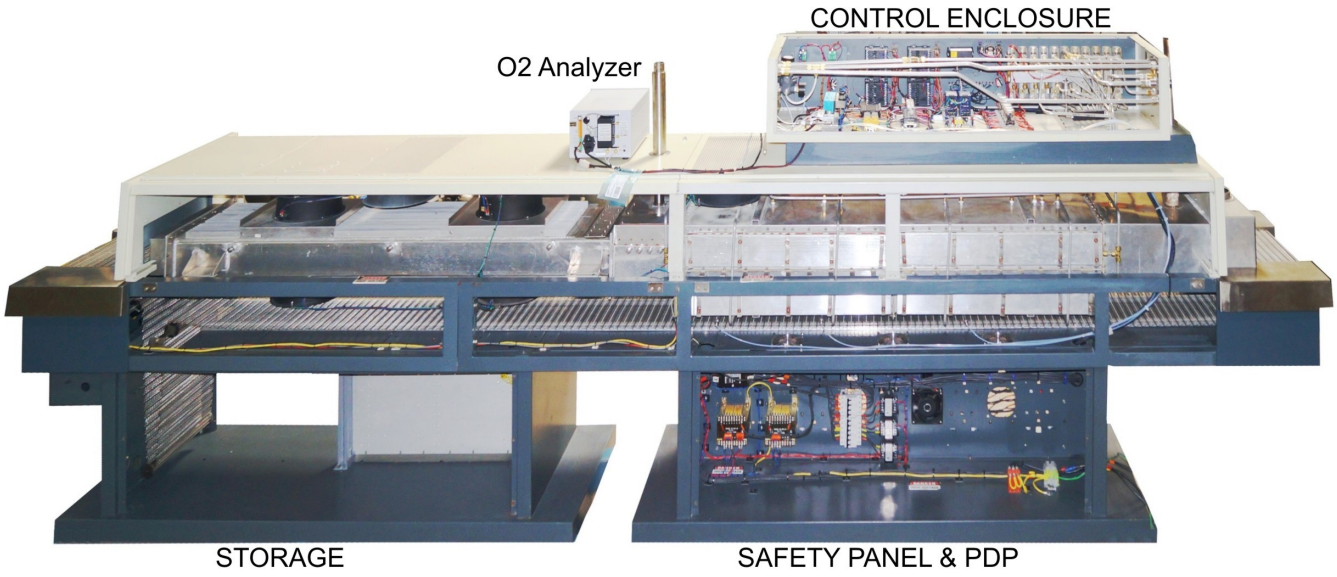


Figure 4-7 Rear with Side Panels removed

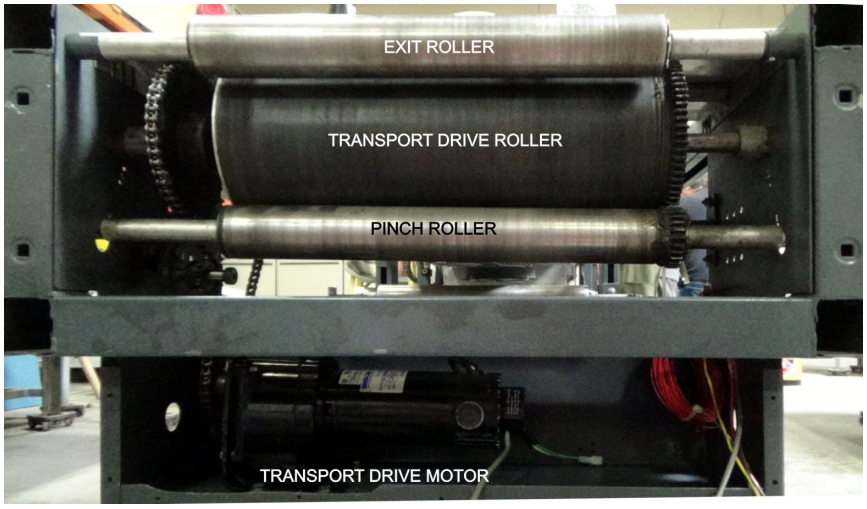


Figure 4-8 Exit End Transport Drive access

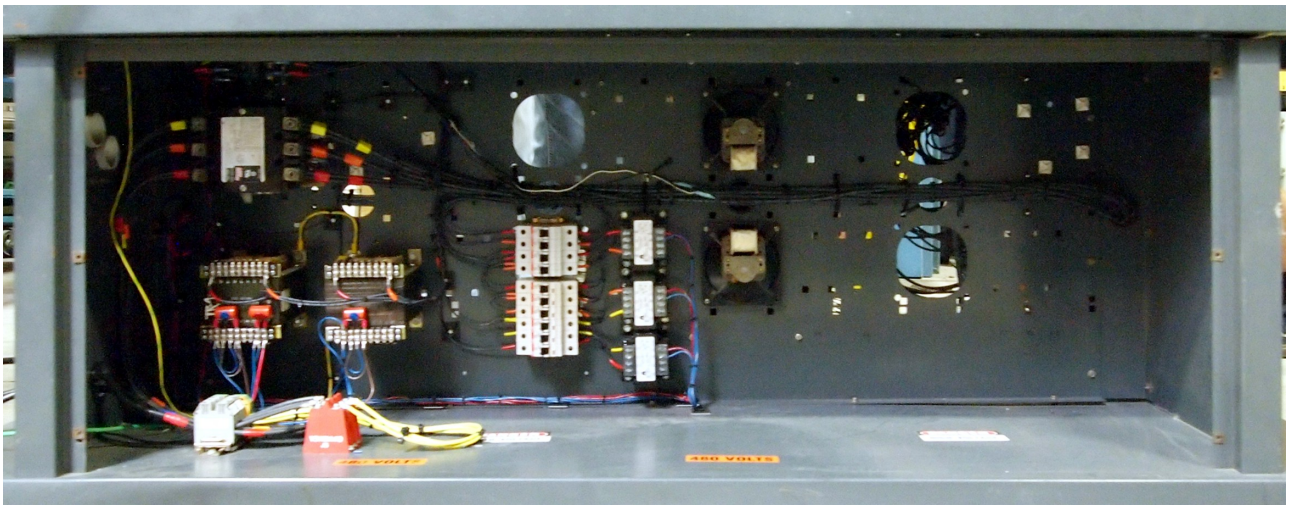


Figure 4-9 Power Distribution and Safety panels

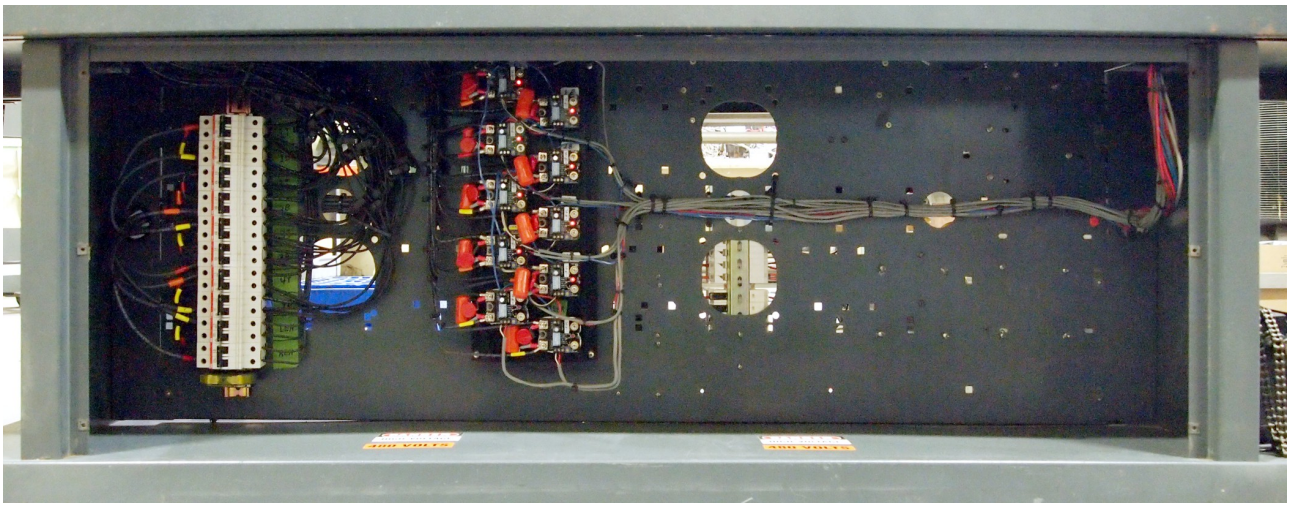


Figure 4-10 SCR Panel with EM sensors

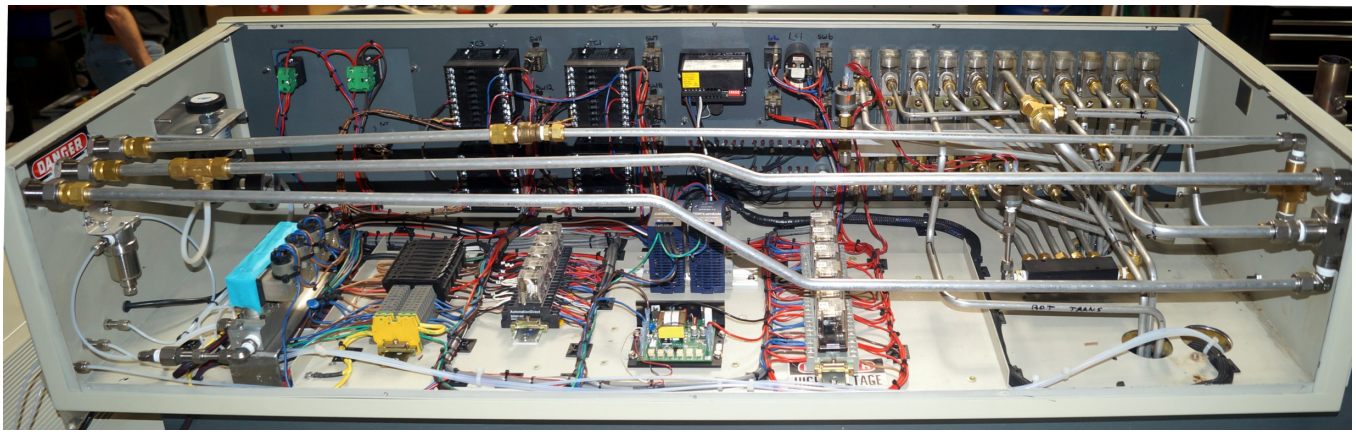


Figure 4-11 Control Enclosure – Rear View

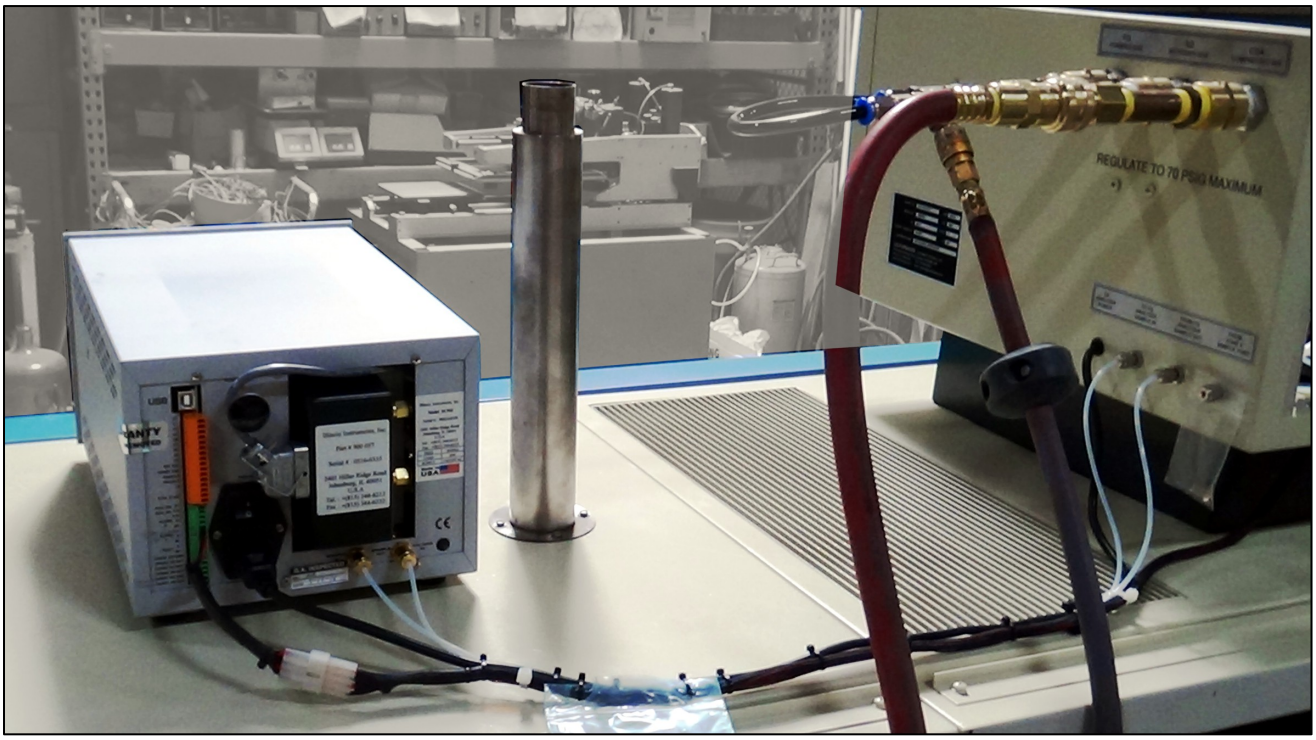


Figure 4-12 Oxygen Analyzer furnace connections

Figure 4-13 OSS & O2 Analyzer-front view

Figure 4-14 O2 Oxygen Analyzer & OSS encl-rear

4.1.3 Transport Drive at Entrance

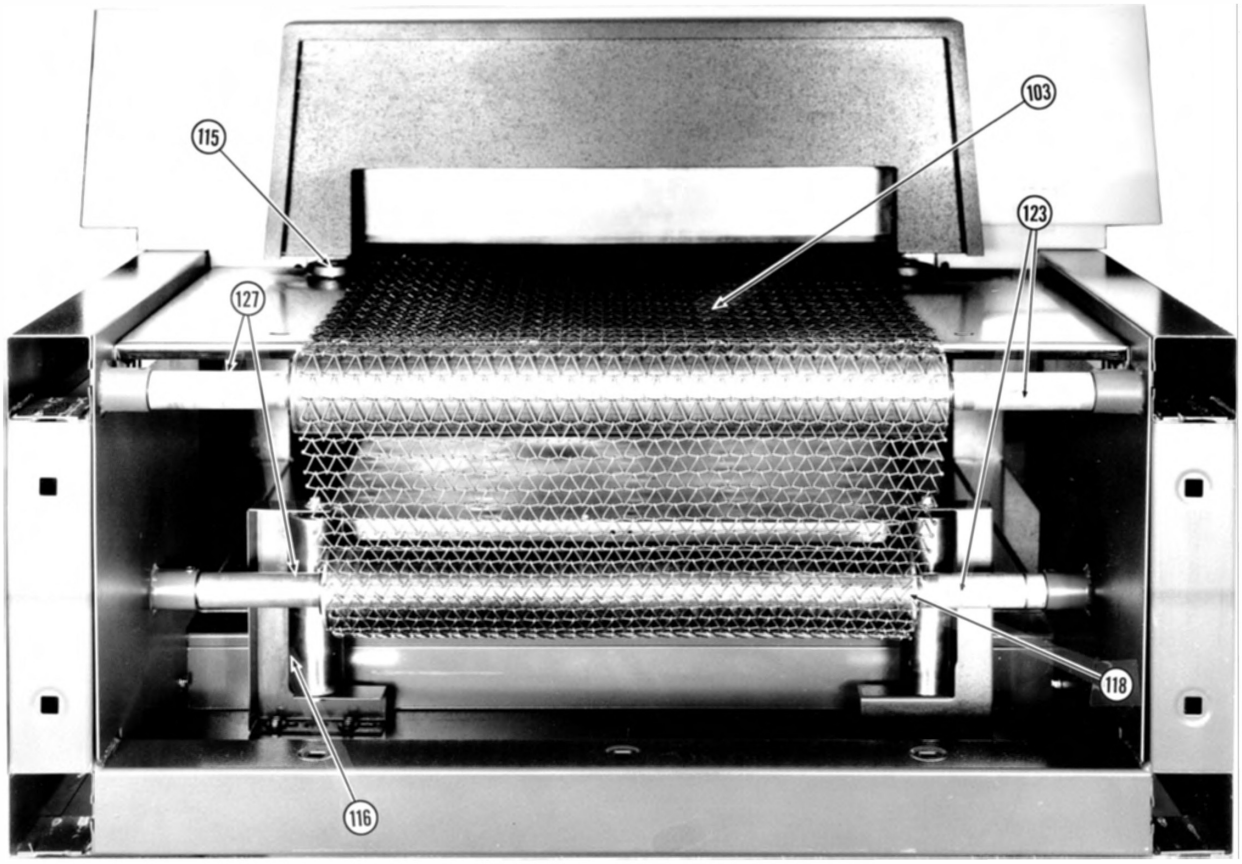


Figure 4-15 Transpord Drive at entrance

103 Belt, Conveyor, Balanced Weave, 15”	118 Roller, Idler, 2” dia (2 Entr, 1 Exit)
115 Roller Guide, Belt Drive (2 Entr, 2 Exit)	123 Shaft, Idler Roller (2 Entr, 1 Exit)
116 Roller Guide, Belt Return	127 Spacer, Idler Roller (4 Entr, 2 Exit)

4.1.4 Transport Drive at Exit

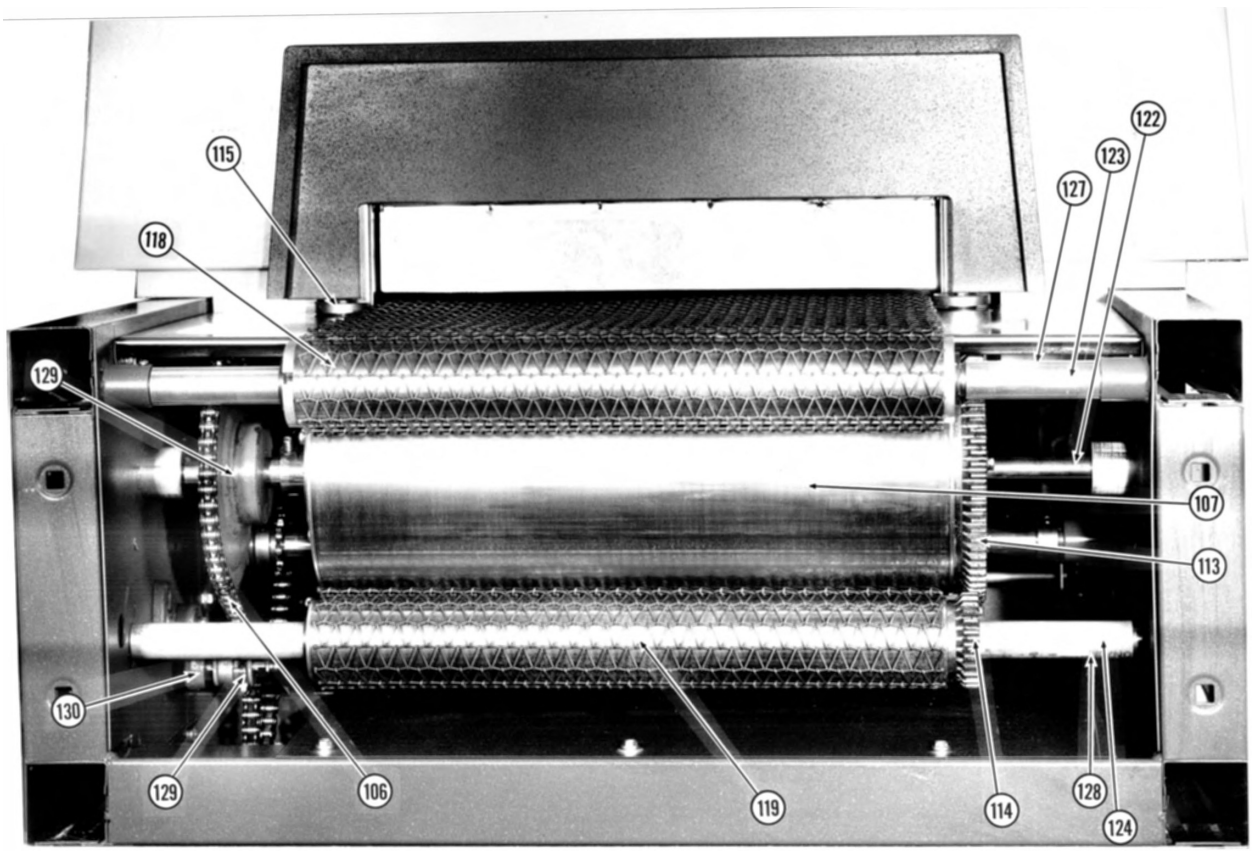


Figure 4-16 Transport Drive at exit

106 Chain, Conveyor Drive	123 Shaft, Idler Roller (2 Entr, 1 Exit)
107 Drum, Belt Drive Clutch Assy	124 Shaft, Pinch Roller
113 Gear, Drive Drum, 75T	127 Spacer, Idler Roller (4 Entr, 2 Exit)
115 Roller Guide, Belt Drive (2 Entr, 2 Exit)	128 Spacer, Pinch Roller (2)
118 Roller, Idler, 2” dia (2 Entr, 1 Exit)	129 Sprockets (Motor spkt, Drive spkt & Idler spkt)
119 Roller, Pinch, 2” dia	130 Tensioner, Chain Drive
122 Shaft, Drive Drum	

4.2 Routine Maintenance

4.2.1 General

Generally external cleaning is all that is required. The chambers are not to be touched or removed. If chamber cleaning is required, contact LCI FurnacePros.

WARNING. DO NOT ATTEMPT TO OPEN OR MANUALLY CLEAN THE CHAMBERS OR THE FURNACE MAY BE INOPERABLE DUE TO DAMAGE TO THE INSULATION. Contact the manufacturer if cleaning is required.

4.2.2 Daily Maintenance

Daily maintenance consists of a simple series of functional checks that will alert maintenance personnel to any signs of developing problems. The importance of regularly checking the machine cannot be over stressed to prevent not only damage to the machine, but also loss of productive time and product. Whenever the furnace is started the failure alarms should be checked for signs of trouble. An intermittent exhaust failure indicates system exhaust fan, and possibly exhaust ductwork must be checked and corrected as necessary. Other alarm functions should be monitored, such as the lamp failure indicator, to see if corrective action is required. As the machine is being started, each control and switch should be briefly checked to ensure that all functions are working properly. Any controls that do not respond as expected, or alarms that do not clear should be checked out and corrected before putting the machine into operation.

4.2.3 Monthly Maintenance

Monthly maintenance, in general, means four weeks of operation for one eight-hour shift per day. This period of operation is not an absolute number, and it is possible that some of the tasks are needed more or less often. Experience with the machine and process being performed should dictate the need.

Note: Run a temperature profile, no less often than monthly, on machines that are used for sensitive processes.

On machines that are used for a variety of products, it is advisable to set up a profiling schedule so that each process can be checked periodically. The most sensitive profiles should be checked at least monthly, while less sensitive profiles could be checked every 2-6 months.

4.3 Other Preventive Maintenance

4.3.1 Recommended Maintenance and Frequency

The following table lists furnace equipment and maintenance tasks and recommended intervals. Many of these items are optional equipment and may not be found on your furnace. In many cases visual inspection can determine whether any preventative maintenance is required. Often maintenance intervals are determined by the process and furnace use.

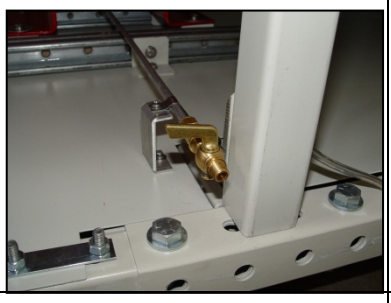
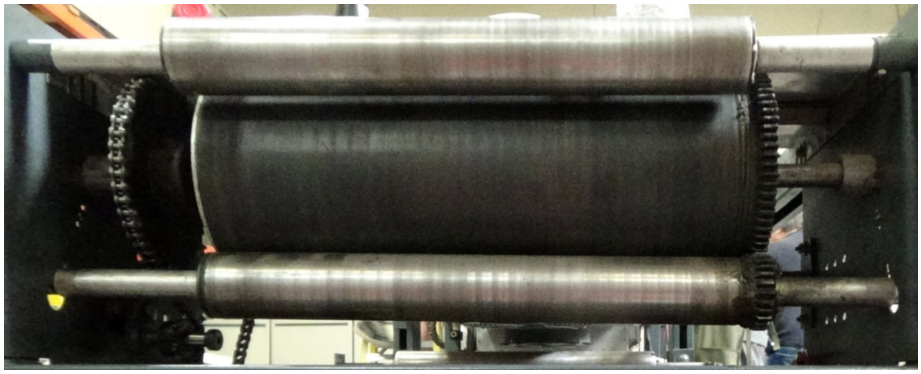
Table 4-2 Recommended Maintenance & Frequency		
Equipment	**Recommended Maintenance**	**Recommended Interval**
Air Filters, Compressed air	Remove the door panel below the flowmeters and replace filter set in the compressed air line to assure furnace receives clean dry air.  	6 months or as required.
Compressed Air Tank (optional)	With air pressure still on the furnace system, remove the door panel below and to the left of the flowmeters. Open the small valve for the air compressor reservoir drain. Purge the tank until the condensate has been removed. 	Monthly or as required.
Belt Shaft Bearings-perm	To gain access to the belt shaft bearings remove the end covers from both ends of the machine. Located at both ends of each belt shaft are permanently-lubricated bearings. These bearings should not be lubricated.	None
Belt Shaft Bearings with grease fittings	Bearings with grease fittings should be lubricated with a general multipurpose bearing grease. Apply enough grease to the bearing block so that excess grease can be visually seen squirting out along the shaft of the device. Wipe off all excess grease that has squirted out to avoid dirt accumulation.	3 years
Belt Shaft Rollers	The belt shaft rollers should be inspected periodically to make sure that they are centered on their respective shafts. Remove the end covers to gain full access to the belt shaft rollers. On furnaces with adjustment, if a roller is misaligned, loosen the setscrews that hold the roller onto the shaft and use a rubber mallet to move the roller on its shaft. Use a scale to make sure the rollers are centered to within 0.125 inches on the belt shaft. 	After first 30 days, annually thereafter

Table 4-2 Recommended Maintenance & Frequency

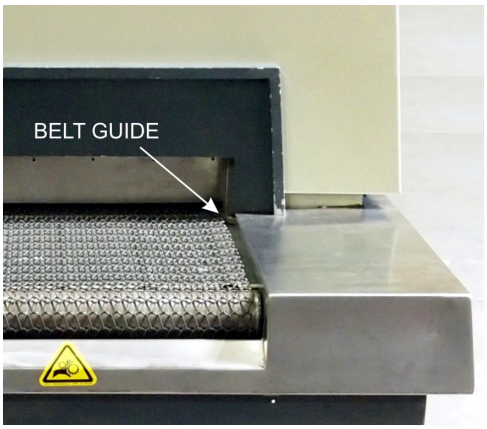
Equipment	Recommended Maintenance	Recommended Interval
Belt Tracking Adjustment	The belt should be checked periodically to make sure that it is tracking through the center of the oven. Belt tracking can be checked visually at the entrance and exit ends of the oven. The belt should be centered on the Load and the Unload decks and between the belt guides at the entrance and exit ends of the oven. If the belt tracks off-center: **On pre-1990** furnaces this problem can be only be rectified by pulling the belt to the center and/or adjusting the belt guides. To adjust the belt, stand at the furnace exit at the center of the belt. Grasp the belt on either side and gently pull toward you to lift the belt. Then pull belt to the center of the Unload station. If necessary loosen and adjust the belt guides. Using an open end wrench or socket wrench, loosen and move the guide wheels on either side of the belt at the entrance and exit to within an 1/8 to ¼ inch of either side of the belt when centered.  **On post-1990** furnaces this problem can be rectified by realigning the belt shafts. First, set the belt speed to zero and remove the end covers at the entrance and exit end of the machine to expose the frame ends and the belt shaft bearing mounts at the end of the belt shafts. The following procedure can be used to correct tracking problems at either end of the furnace.  Loosen the belt shaft bearing mount bolts at one end of the furnace (entrance or exit). While facing the end (entrance or exit) of the furnace, use the following procedure. If the belt is tracking to your left, pull the left side of the belt shaft forward and/or move the right side of the belt shaft rearward. If the belt is tracking to your right, pull the right side of the belt shaft forward and/or move the left side of the belt shaft rearward. Repeat this procedure at the other end of the furnace. It is best to make these adjustments in small increments. Adjustments that are too large will cause a belt tracking problem in the other direction. Now run the belt at its highest speed and observe how the belt is tracking. Repeat the adjustment procedure until the belt tracking is centered.	Weekly
Chamber	The chamber normally does not require maintenance. If a problem with the chamber is suspected, contact the manufacturer. Because the process gas is inserted through the insulation, the gas flow through the insulation generally prevents contamination from accumulating on the chamber walls. To reduce flux or other residue accumulated in the chamber, the zones can be set at 600°C to place the furnace into a self-cleaning cycle for about an hour to burn out organic residues.	Process dependent

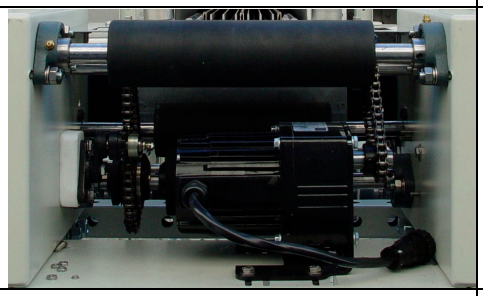
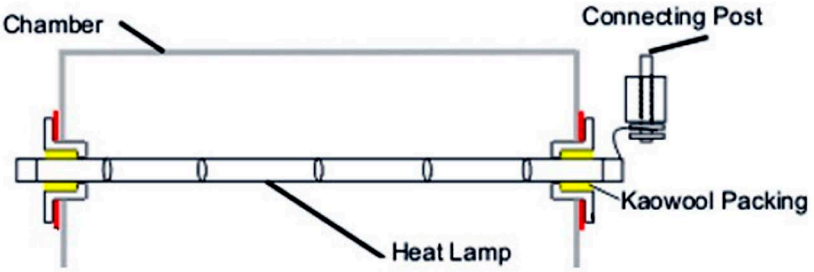
Table 4-2 Recommended Maintenance & Frequency		
Equipment	**Recommended Maintenance**	**Recommended Interval**
Cooling Fans	Inspect all system cooling fans for freedom of movement and proper operation.	1 year
Drip Trays	Remove and clean the drip tray, located under the process exhaust stack. Access to the tray is through the top removable section of the furnace chamber, located above the tray at the furnace entrance. Depending on the process, if very little buildup is found, cleaning may not be necessary more than once a year.	After the first 6 months of operation; as required thereafter.
Drive Chain	The chain drive system is contained in the motor enclosure at the exit end of the oven. Lubricate the drive chain with FurnacePros #100523 chain lube or a commercial quality non-dripping chain lube. 	Every 1 year of operation
Drive Chain Tensioner	**Post-1990 furnaces only.** The chain tensioner is equipped with a grease fitting for lubrication. The chain tensioner should be lubricated every 6 months with a general multipurpose bearing grease. Apply enough grease to the tensioner so that excess grease can be visually seen squirting out along the shaft of the device. Wipe off all excess grease that has squirted out to avoid dirt accumulation.	6 months
Drive Motor Mounts	The drive motor is contained in the enclosure at the exit end of the oven. The motor mount bolts must be checked periodically and tightened if necessary.	Annually, or as required.
Exhaust Stack	A visual inspection of the stack is recommended along with each drip tray cleaning. With a flashlight, look down the furnace stack. Check the exhaust stacks, after 6 months of operation, for possible buildup of materials generated from firing processes. The stacks should be cleaned, as necessary, with a brush and solvent to remove the buildup. A periodic inspection of the stacks is essential to establish a sensible maintenance cycle, since some processes will require frequent cleaning, and others require none at all. Contact LCI/FurnacePros if new gasket material is required to reattach the stack.	After the first 6 months, and thereafter as required.
Lamp Heating Elements	No maintenance is required for the heating elements other than replacement when one fails. Note that with low temperature operations, the lifetime of the heating element is in excess of 100,000 hours. At temperatures increase above 260C, the life of the lamps declines over time. Should failure occur, it will be sudden. When lamps are firing, the EM Top/Bottom Lamp String LED's on the control console will immediately reveal any lamp string with a failure. Use ohmmeter for best results (section **Error! Reference source not found.**), visual inspection is unreliable. Refer to section 4.6.12 for instructions for changing heating elements. Operating with sufficient process gas to the lamp seals (plenums) will greatly increase lamp life.	Inspect regularly; replace lamps as required.

Table 4-2 Recommended Maintenance & Frequency		
Equipment	**Recommended Maintenance**	**Recommended Interval**
Lamp Seals	Inspect the lamp seals (Kaowool packing around the ends of the infrared lamps) for loose, cracked or missing packing material. Once the side covers are removed, the lamp seals can be visually inspected. Inspect after first 6 months of operation.  	<500C operation, every 2-3 years; >500C operation, annually.
Sprocket Alignment	The sprockets are contained in the motor enclosure at the exit end of the oven. Visually verify that the sprockets are aligned. Adjust according to section 4.6.5.	After first 30 days and annually thereafter.
Sprocket Shaft Bearing Block	The sprockets are contained in the motor enclosure at the exit end of the oven. The sprocket shaft bearing block is equipped with a grease fitting for lubrication. The bearing block should be lubricated with a general multipurpose bearing grease. Apply enough grease to the bearing block so that excess grease can be visually seen squirting out along the shaft of the device. Wipe off all excess grease that has squirted out to avoid dirt accumulation.	After first 6 months; annually thereafter.
Transport Belt Length	Check the length of the transport belt and shorten it if the gravity loop comes within 6 inches of the floor. A properly shortened belt should hang between 2 and 3 inches below the main frame.	Annually, or as required.
Transport Clutch	The clutch should be inspected periodically to insure proper tension on the belt. To adjust, a large hex nut at the chain sprocket end of the drive drum must be tightened until the drum turns. If the drum cannot be stopped by firm pressure with your hands, the clutch is too tight. Do not over tighten the clutch, as it is there for safety reasons and to protect the equipment.	Annually, or as required

4.4 TROUBLESHOOTING

To troubleshoot, follow all suggested remedies sequentially to determine source of the problem.

4.4.1 Transport Drive System

Items to check include:

a) Make sure the belt is not overloaded with heavy product.
b) Verify belt tensioning weight is free to move.
c) Verify belt is free to move without obstruction from product or objects penetrating belt.
d) Adjust belt tracking (see Belt Tracking Adjustment in Table 4-2).

See Table 4-3 for troubleshooting specific transport drive issues.

Also see Table 4-2 Recommended Maintenance and Frequency for information on other items which may be the root cause of transport drive problems including maintenance, lubrication and adjustment of Belt shaft rollers (if applicable), Belt Tracking Adjustment, Drive Chain, and Drive Chain Tensioner.

Table 4-3 Troubleshooting Transport System

Symptom	Cause	Remedy
Jerking or Vibrating of the belt	Belt is obstructed, load too great.	1. Make sure the belt is not overloaded with heavy product. 2. Verify belt tensioning weight is free to move. 3. Verify belt is free to move without obstruction from product or objects penetrating belt. 4. Adjust belt tracking (see Belt Tracking Adjustment in Table 4-2)
Conveyor belt does not move. Belt has little or no tension. Speed indicator is operational	Clutch needs adjustment. See 4.6.1F Clutch Adjustment	Tighten clutch so belt moves, but can be stopped by placing pressure on the entrance roller.
Conveyor belt does not move. Belt has a large amount of tension. Speed indicator is operational. Clutch is slipping.	Belt obstruction.	Check belt on top and below for obstruction and/or snag. Correct as necessary. Adjust side rollers if necessary.
Conveyor belt does not move. Speed indicator is dark.	1. Belt speed knob turned full CCW to zero. 2. TR0-A 117 Vac supply fuse FB burned out. 3. Motor fuse FD burned out.	1. Turn belt speed knob CW to desired speed. 2. Check fuse FB (4A, MDX) in Control Enclosure. 3. Check fuse FD (see note 3 on Control Enclosure Analog schematic for fuse value).
Conveyor runs only at full speed. Speed display is operation. Belt speed knob has no effect.	LOCAL-REMOTE switch is in Remote position without an active remote controller.	1. Turn LOCAL-REMOTE switch to Local position, or 2. Activate Remote controller.

4.4.2 Troubleshooting Power Issues

Note that remedial steps marked "*" require access to the controls enclosure and should be performed only by qualified maintenance personnel.

Table 4-4 Troubleshooting Power

Symptom	Cause	Remedy
Press POWER ON pushbutton, POWER ON pushbutton lamp stays OFF. All controls and displays are OFF.	Power is OFF to furnace.	1. Turn power back on at the circuit breaker. 2. Check EMOs (pull to reset) switches. 3. Check TR0-A circuit breakers CB1 and CB2. Reset as necessary. Refer to Drawing 802-101779-04 Safety Panel Analog schematic for details*. 4. Check 24 Vac supply fuse FA (5A, MDX). Refer to Drawing 802-101784-05 Control Enclosure Analog schematic for details*.
Press POWER ON pushbutton. POWER ON lamp is OFF. All controls and displays are ON.	POWER ON lamp is burned out.	1. Replace POWER ON pushbutton lamp.
POWER ON lamp is ON. All controls and displays are OFF.	POWER is OFF to the CONTROLS circuit.	1. Check operation of K2 and K6 relays. Refer to Drawing 802-101784-05 Control Enclosure Analog schematic for details*
POWER ON lamp is lit. All controls and displays are ON. Belt is not moving	1. Belt speed knob turned full CCW to zero. 2. TR0-A 117 Vac supply fuse FB burned out. 3. Motor fuse FD burned out	1. Turn belt speed knob CW to desired speed. 2. Check fuse FB (4A, MDX) in Control Enclosure. 3. Check fuse FD (see note 3 on Control Enclosure Analog schematic for fuse value).
POWER ON lamp is lit. Lamps, CACT cooling fans, cabinet exhaust fans and OA/OSS do not turn ON.	Fuse FC burned out or K3 Phase Power Contactor not working.	1. Check fuse FC (5A, MDX) in Control Enclosure. 2. Check K3 contactor operation in Safety Enclosure.
POWER ON lamp is lit. All controls and displays are ON. The fans and the belt are ON. A controller or the belt speed display are OFF.	117 Vac fuse blown.	1. Check following fuses*: FE – Zone 1 Controller (1A, MDX) FF – Zone 2 Controller (1A, MDX) FG – Zone 3 Controller (1A,MDX) FH – Zone 4 Controller (1A,MDX) FJ – Belt Speed Display (rebuilt RTC furnace: 0.5A, MDX). Refer to Drawing 802-101781 Frame Wiring Schematic for details.

Table 4-4 Troubleshooting Power		
Symptom	**Cause**	**Remedy**
POWER ON lamp is lit. All controls and displays are ON. The fans and the belt are ON. LAMPS pushbuttons are lit. LAMP STRINGS indicators are OFF and zone controller PV temperatures are falling or not changing. Note: In normal operation at lower setpoint temperatures, the LAMP STRINGS indicators will turn OFF whenever lamp power maintaining zone temperature falls below the threshold of the LAMP STRINGS current sensors. In that case, the reduced power to the lamps is still sufficient to keep zone controller PV temperatures at setpoint SV temperatures.	No power to the lamps.	1. Confirm there is no OVERTEMPERATURE Alarm active, preventing lamps from turning ON – refer to section 3.2.3 for details. 2. Confirm that desired TOP/BOTTOM zone switches are in ON position on the TEMPERATURE panel. 3. Confirm that zone controller setpoint temperatures have been set (SV display is bright and steady). 4. Confirm that zone controller OUT1 LED indicators are ON. 5. Check circuit breakers CB30 through CB44. Reset as necessary.

4.4.3 Troubleshooting Temperature Control

Table 4-5 Temperature Control Troubleshooting

Symptom	Cause	Remedy
A PV zone temperature is always higher than its SV setpoint temperature.	Turn zone switches for the affected zone OFF. If the PV temperature remains high or is increasing, heat is being added to the zone from outside the zone.	1. Increase gas flow into zone. 2. Change direction of gas flow. 3. Change setpoint to hold higher temperature. 4. Change setpoint of adjacent zone(s). 5. Troubleshoot problem zones. See section 4.5.2.
A PV zone temperature is unstable, with temperature varying up and down several degrees.	PID parameters may not be appropriate for the load.	1. Troubleshoot problem zones. See sections 4.5.2 and 4.5.3. 2. Modify zone PID parameters. See sections 3.9.1 and 3.9.2. 3. Auto Tune the zone. See sections 4.5.4 and 3.9.3.
Zone heat increasing rapidly toward an over-temperature condition and cannot be stopped	SCR output shorted	1. Replace the SCR*. See section 4.6.10 for more information. 2. Contact the LCI factory for properly configured replacement SCR controller.

4.4.4 Troubleshooting Element Failures

The element monitor LEDs on the Test panel indicate an open heating circuit or failed lamp heating elements. An LED turns ON when current is flowing through its respective lamp string. A lamp string is one or more lamps connected in series.

From a cool furnace press the POWER ON button to energize the lamps in the zones that are switched ON. Individual that LEDs fail to light in an energized zone indicate a failed lamp sting. See **Table 4-7 Zones, Lamp Strings and Lamps** to identify which strings should be ON when a zone is switched ON and heating.

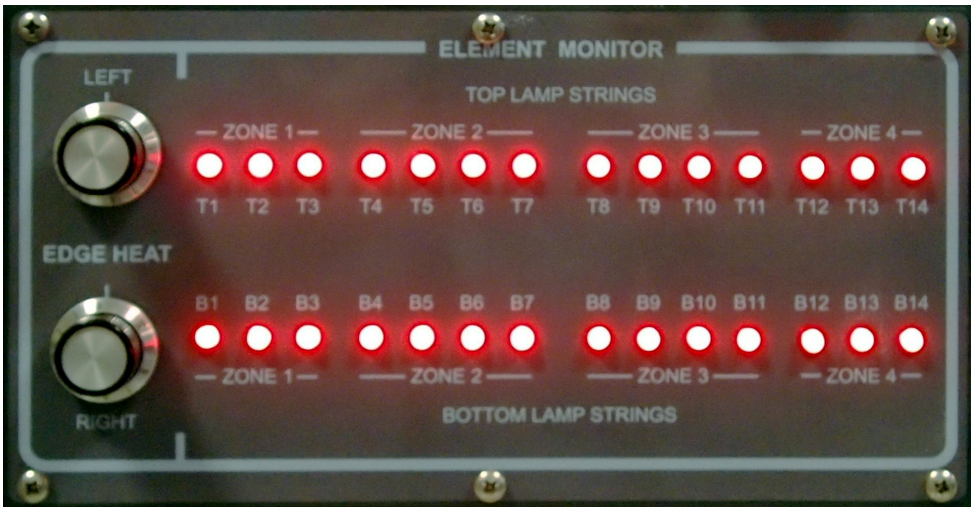


Figure 4-17 Test Panel: Lamp String Failure Indicator

If a lamp string LED does not light when operating, follow the procedure in Section Error! Reference source not found. Error! Reference source not found. to isolate the failed lamp.

Note: During normal operation at very low current levels, the LED lamps may not light.

Table 4-6 shows examples of EM screen readings and their meaning.

Table 4-6 Element Monitor panel

Ex	Zone	Str# T/B	Status	Description and Location
1	Zone 1	T1	If zone is firing, all Zone Top LED's should be lit.	If a single LED is not lit while zone 1 top lamps are firing, check integrity of corresponding lamp string corresponding. Lamp strings are counted from furnace entrance.
2	Zone 2	T2	If zone is firing, all Zone Top LED's should be lit.	If a single LED is not lit while zone 2 top lamps are firing, check integrity of corresponding lamp string corresponding. Lamp strings are counted from furnace entrance.
3	Zone 1	B1	If zone is firing, all Zone Bottom LED's should be lit.	If a single LED is not lit while zone 1 bottom lamps are firing, check integrity of corresponding lamp string corresponding. Lamp strings are counted from furnace entrance.

4.4.5 Heating Element Test Procedure

To simplify troubleshooting, the TOP LAMP STRINGS and BOTTOM LAMP STRINGS LED arrays display the specific location of a suspected failed lamp string during operation. For a more reliable check, the user should perform the Testing Lamps process in section **Error! Reference source not found.**.

Visual inspection of the lamps (either by looking down the entrance of the furnace or by removing the lamp covers) with the power on or off is not reliable. When adjacent lamps are on, reflected light will make a defective element appear okay. If the Testing Lamps process confirms that a string has failed, note the LAMP STRINGS indicator (T1, B1, etc.) that was OFF during the test, and use the following procedure to isolate which lamp in that identified string has failed.

This procedure is to be used to test for open heating or failed lamp heating elements.

B. Required Equipment

1. Ohmmeter (or Continuity Tester)
2. 3/8" Box or Open End Wrench
3. Control & Element Wiring Schematic 802-101814

C. Test Procedure

Remove all power from the furnace, and if a UPS or EPS is installed, locate and shut off the unit. Remove all side covers, completely exposing all lamp terminations.

Locate the identified failed string and the lamps in that string using this table:

Table 4-7 Zones, Lamp Strings and Lamps

Top Lamp Strings			Bottom Lamp Strings		
EM LED	Circuit Breaker	Lamps	EM LED	Circuit Breaker	Lamps
T1 – Zone 1	CB30	E1, E2	B1 – Zone 1	CB32	E1, E2
T2 – Zone 1	CB30	E3, E4	B2 – Zone 1	CB32	E3, E4
T3 – Zone 1	CB30	E5, E6	B3 – Zone 1	CB32	E5, E6
T4 – Zone 2	CB34	E1, E2	B4 – Zone 2	CB36	E1, E2
T5 – Zone 2	CB34	E3, E4	B5 – Zone 2	CB64	E3, E4
T6 – Zone 2	CB34	E5, E6	B6 – Zone 2	CB36	E5, E6
T7 – Zone 2	CB34	E7, E8	B7 – Zone 2	CB36	E7, E8
T8 – Zone 3	CB38	E1, E2	B8 – Zone 3	CB40	E1, E2
T9 – Zone 3	CB38	E3, E4	B9 – Zone 3	CB40	E3, E4
T10 – Zone 3	CB38	E5, E6	B10 – Zone 3	CB40	E5, E6
T11 – Zone 3	CB38	E7, E8	B11 – Zone 3	CB40	E7, E8
T12 – Zone 4	CB42	E1, E2	B12 – Zone 4	CB44	E1, E2
T13 – Zone 4	CB42	E3, E4	B13 – Zone 4	CB44	E3, E4
T14 – Zone 4	CB42	E5, E6	B14 – Zone 4	CB44	E5, E6

Within each zone, lamp E1 is nearest the entrance end of the furnace.

Disconnect one end of each of the 2 lamps in the suspect string and measure the resistance of each lamp. The resistance of a good lamp is <10 Ω. A higher reading identifies a defective lamp that should be replaced.

Refer to section 4.6.12 for lamp replacement instructions.

Once the elements have been completely tested, replace the covers on the furnace. Turn on the EPS/UPS (if so equipped) and power to the furnace. Bring the furnace up to temperature, and, next, run a profile verifying that no leaks occurred around the lamps that were replaced.

The procedure is now complete.

Note: See section 4.6.12 for instruction on Infrared Heat Lamp Replacement.

4.5 Troubleshooting Process Problems

4.5.1 Belt speed

Measure the belt speed with a stopwatch. If it differs from the value on the process screen by more than 5% (1 IPM off for each 20 IPM of belt speed), re-calibrate the belt speed. Follow the Belt Speed Calibration procedure in section **4.7.3 Belt Speed Calibration** of this manual.

4.5.2 Resolving zone control issues

Zone switches are useful for use in troubleshooting and resolving zone control issues, testing lamps (see section **Error! Bookmark not defined.**) and checking for blown lamp fuses (see Table 4-4 Troubleshooting Power).

Zone Control. If heat in any zone increases rapidly into a "runaway" condition even if the zone controller OUT1 LED indicator is dark (the controller output is OFF), but the heat can be stopped by shutting off the affected zone top and bottom switches, the zone SCR probably has failed with a shorted output and needs to be replaced.

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

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

4.5.3 Temperature or large power fluctuations

If the temperature is slow to respond to large deviations from setpoint temperature, it may be a problem with the PID settings. If you need to modify a particular zone, see the procedures in section **3.9 Controller PID Tuning**.

At low temperatures (<100°C) or near the maximum temperature, if there is an unacceptable deviation from setpoint, the SCR may need to be calibrated. If the SCR is out of calibration, most likely it will not be noticeable in the medium range of the temperature. If necessary, calibrate the SCR's using the procedure in section 4.7.1.

> NOTE: PID tuning should only be attempted by qualified personnel. Unreasonable PID parameters can stress the components of the system and cause premature failure of some electrical systems.

4.5.4 Unstable zone temperatures

If the temperature fluctuates by more than 5 degrees in less than 20 seconds after you reached ready state, it might be a problem with the PID settings. If you notice unstable behavior in a certain zone, you may need to modify the PID loop parameters for that particular zone. Follow the procedures in section **3.9 Controller PID Tuning** to retune the PID loop parameters.

> NOTE: PID tuning should only be attempted by qualified personnel. Unreasonable PID parameters can stress the components of the system and cause premature failure of some electrical systems.

4.5.5 Abnormal sensor behavior

There are numerous sensors (standard and optional) on the furnace, from thermocouples to an optional gas analyzer, and so on. If one particular sensor seems to behave erratically, you will need to look into the value reported by the control system and recalibrate or replace as necessary.

The errors could be

- a temperature with an erroneous or negative value,
- a gas analyzer readout that never changes value.

4.6 Service

4.6.1 Drive Train Adjustment / Belt Alignment

A. Sprocket Alignment

Unscrew the end cover at the exit end of the furnace to reveal the motor and drive mechanism. All sprockets should be perfectly aligned. Adjustments can be made by loosening the setscrews on the sprocket flanges. A straight edge can be useful for this operation.

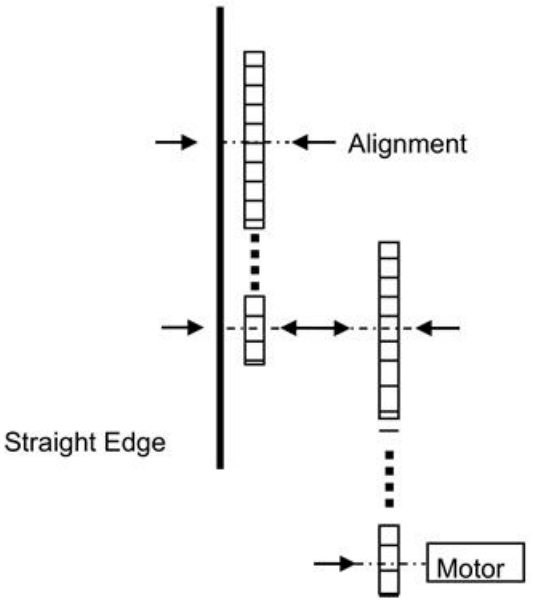


Figure 4-18 Sprocket Alignment

B. Motor Mount Bolts

Motor mount bolts must be checked periodically and tightened if necessary.

C. Sprocket Shaft Bearing Block Bolts

These shafts must be checked periodically. You will need to remove the end side covers to gain access to the bolts.

Sprocket shaft and roller shaft bearings are sealed units requiring no maintenance. The greasing points are redundant.

D. Chain Tension and Drive Chains

Pneumatic chain tensioners are equipped with a grease fitting for lubrication. Apply sufficient grease to the tensioner so that grease can be seen squirting out along the shaft. Remove excess grease.

If the tensioner is spring loaded, no adjustment is necessary. For other types of tensioners, slacken the mounting bolts and turn the tensioner towards the chain. Tighten the bolts. A correctly tensioned chain can just be lifted from the tensioner sprocket, but cannot be lifted clear of the sprocket teeth.

Drive chains should be lubricated with a non-dripping chain lubricant every 30 days.

E. Belt Roller Alignment

If a roller is misaligned on its shaft, loosen the setscrews that secure the roller on its shaft. Use a rubber mallet to move the roller. Rollers need to be centered within 0.125 inches so you will need a ruler or scale for this operation. Note: on pre-1990 furnaces some rollers may not be adjustable.

F. Clutch Adjustment

The clutch is a pressure plate assembly (Figure 4-19) that allows the friction transport drive system to move the belt and stop it there is an obstruction or other problem with the drive system.

With the motor running, the belt should be stoppable by manually placing firm pressure on the entrance roller. If the belt can be stopped too easily, tighten the three (3) Clutch Adjustment Bolts evenly, each by 1/4 turn until the desired tension is achieved and the drum turns smoothly.

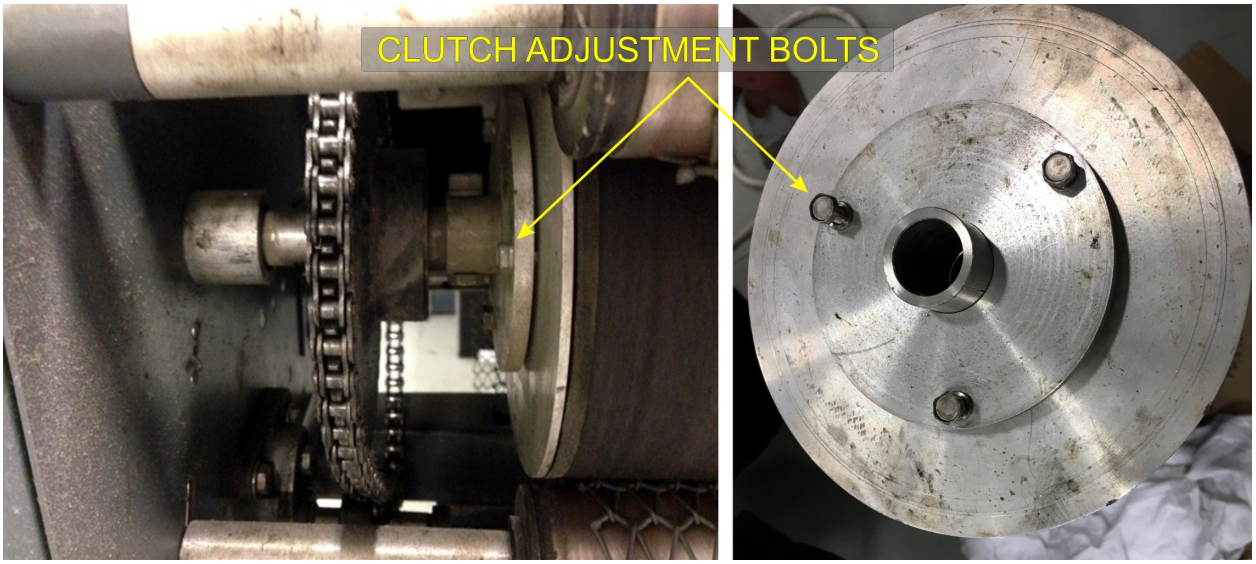


Figure 4-19 Clutch Adjustment

When the motor is running, if the belt cannot be stopped at all, slacken the clutch bolts evenly until yiou can stop the belt by putting pressure on the belt with you hand while the motor is running.

If the clutch does not appear to be functioning properly and cannot be adjusted, you can disassemble the clutch, make sure the parts are clean and free of burrs or other distortions, and reassemble. The clutch parts should be re-assembled in the order depicted in Figure 4-20 starting from the left-most nylon ring, insert this ring into the drive drum. Then install the rest of the clutch components from left to right so the final assembly resembles Figure 4-19

Figure 4-20 Clutch Components

Tighten the 3 bolts uniformly until the drum just turns.

G. Belt Tracking

To check belt position:

1. Stand at center of furnace exit.
2. Belt should be in center of Unload Station. If it is not in the center, adjust belt position.
3. When in center of Unload station, belt should be equal distant from belt guides. If not, adjust belt guides.

To check belt guides:

1. Furnace lamps should be off and belt must be cool. Set belt speed to zero,
2. Manually spin each belt guide to verify it moves freely. If not, remove and clean.
3. Belt guides should be equal distance (approx 1/8-1/4 inches from belt.

To check belt tracking:

1. Adjust belt speed to maximum.
2. Stand at the furnace exit or entrance and look along the length of the belt.
3. Moving belt should stay centered in Unload Station. If it does not stay in the center, adjust belt guides.
   - If the belt appears to stay the same distance from either sides of the Unload station, but not in the center, adjust the belt position.
   - If the belt appears to be running toward one side, adjust the belt position and adjust the belt guides.

To adjust belt position:

1. Furnace lamps should be off and belt must be cool.
2. Stand at center of furnace entrance, lift and pull belt to center of Load station.
3. Stand at center of furnace exit, grasp both sides of the belt, lift and pull the belt toward you and then pull the belt to the center of the Unload Station.

To adjust belt guides:

1. Furnace lamps should be off and belt must be cool.
2. Remove Unload Station or Load Station lower panel.
3. Center belt (see To adjust belt position).
4. Using a socket wrench, loosen belt guide. Move to guide to within 1/8 to 1/4 inch from edge of belt.
5. Tighten hex head machine screw. Guide should still turn freely.
6. Observe belt travel and determine if additional guide adjustments are required in order to keep the belt centered while it is moving.

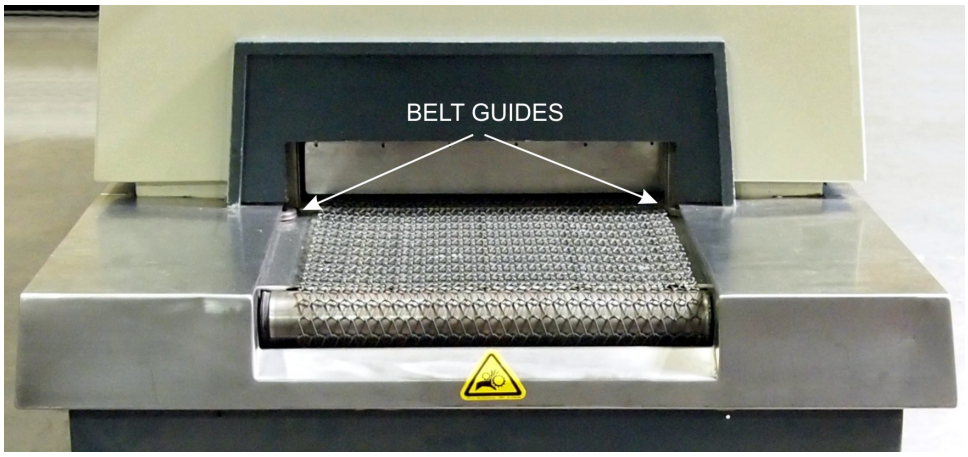


Figure 4-21 Belt Guides on Unload Station

4.6.2 Damaged Belt Options

If a section of the belt is damaged you can:

1. Straighten the wires in the section, or
2. Replace the section with a belt splice, or
3. Replace the belt.

4.6.3 Straightening the Belt

If the damage is not too severe the belt often can be straightened.

1. **Move bad section to Load or Unload station**

   Run the belt or pull the belt so the damaged section are accessible at entrance Load or exit Unload area.

2. **Manually straighten belt**

   Using a pair of long nose pliers gently bend the distorted wires to match the pattern of the undamaged portion of the belt.

3. **Verify**

   Use a straight edge to verify that any dips in the damaged section have been removed.

4. **Test**

   Turn on the compressed gas supply to tension the belt. Start the furnace and operate the belt without heat to verify alignment.

4.6.4 Replacing a Belt Section

If a section of the belt becomes damaged, but the rest of the belt is in good condition, a new section of belt can be installed.

Contact LCI FurnacePros to order a replacement belt that will meet your needs.

1. Determine the Portion of Belt to be Replaced

Mark off the section to be removed with a masking tape or permanent marking pen on either end of the damaged area of the belt. Note: compressed gas supply to furnace should be off.

Remove the weight tensioning bar from the holder. Lift the weight bar out to relieve the belt.

Take all the slack out of the belt by grasping the belt on either side of its width and pulling evenly and firmly.

The damaged belt section should then be located at the entrance load or exit unload area so you can work on the belt and splice it easily.

2. Removal of the Bad Section of Belt

Cut one of the cross-section wires travelling the width of the belt at the front of the damaged section. Make cut at ball joint on either side of the belt (see Figure 4-22 and Figure 4-23).

Remove the wire by pulling straight through the belt (Figure 4-24) and retain for later splicing.

Remove a second cross-section wire on the other end of the damaged section in the same manner.

Measure the length of the section removed and prepare a new section of belt the same size by removing one of the cross-section wires.

3. Install new section of the Transport Belt

Place the new belt section parallel and slightly overlapping the edge of the remaining belt on the furnace. Make sure to orient the belt as shown in Figure 4-25 by inserting one of the cross-section wires through the belt mesh across the width of the belt. Insert a second wire at the other end of the splice to the rest of the belt.

Both wires should be even and parallel and aligned with the belt edges. The cross-section wires will stay in place without any finishing at either end.

4. Reinsert Belt Weight

Reinsert belt weight as shown in. If necessary, pull belt to the left or right to align Belt so that Belt Weight is allowed to move freely as shown in Figure 4-30 and Figure 4-31.

5. Start Furnace

Turn on the compressed gas supply to tension the belt. Start the furnace and operate the belt without heat to verify alignment.

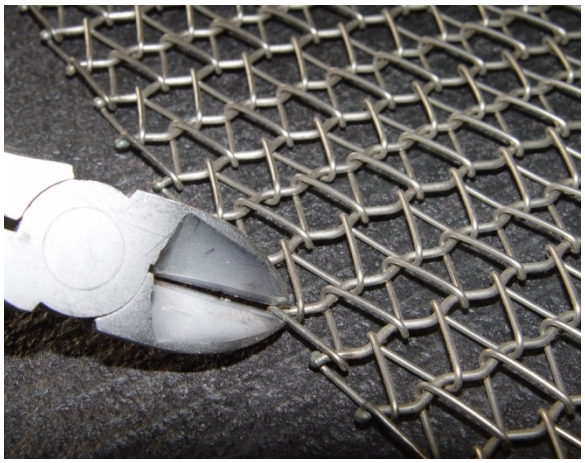


Figure 4-22 Cut wire at ball joint

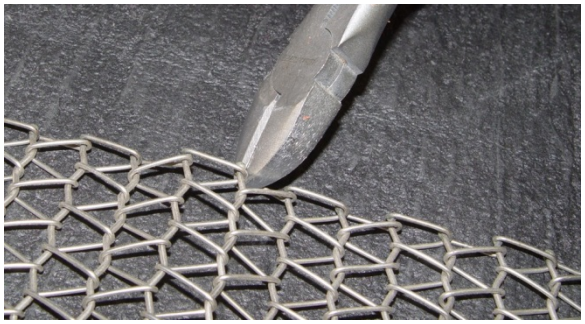


Figure 4-23 Second cut at opposite side

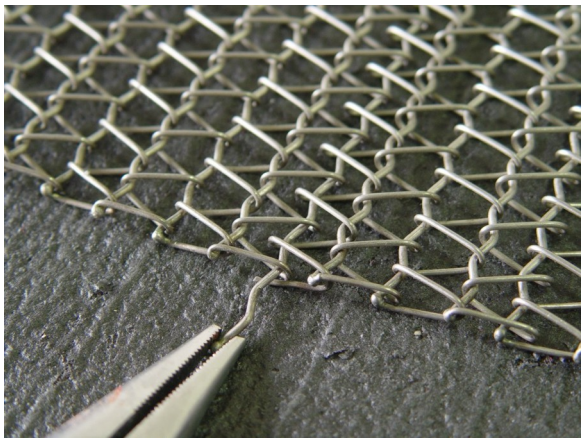


Figure 4-24 Remove belt wire

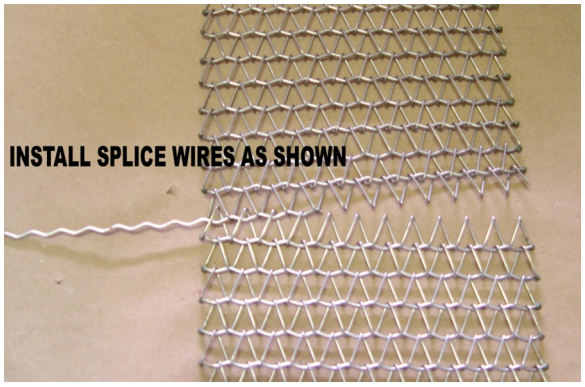


Figure 4-25 Insert splice wire

4.6.5 Transport Belt Replacement

If the belt becomes damaged, or too worn or dirty for continued satisfactory performance, a new belt can be installed. Contact FurnacePros to order a replacement belt that will meet your needs.

1. Removal of the Transport Belt

At the entrance of the furnace, cut one of the cross-section wires travelling the width of the belt Make cut at ball joint on either side of the belt (see Figure 4-22 and Figure 4-23).

Remove the wire by pulling straight through the belt (Figure 4-24) and retain for later splicing.

2. Installation of the Transport Belt

When installing the belt, have an assistant ready to help guide the belt into the furnace entrance. Position the new belt at the furnace entrance. Orient belt as shown in Figure 4-26.

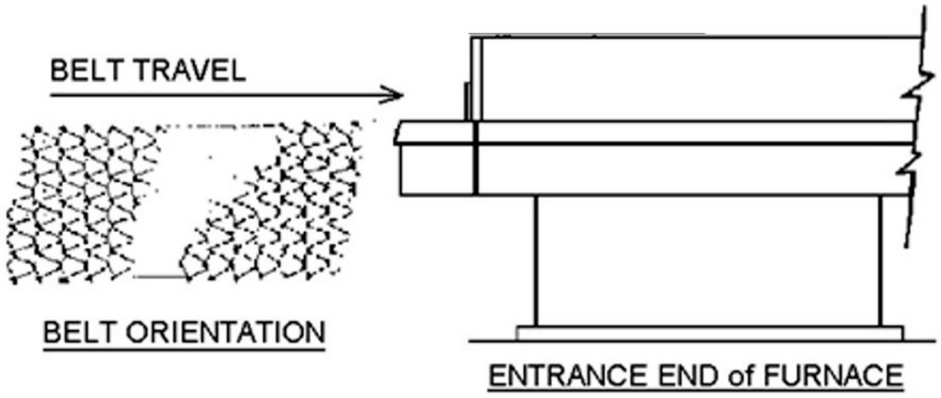


Figure 4-26 Belt Orientation

Attach the leading of the new belt to the end of the old belt as in Figure 4-25.

From the exit, carefully pull the belt through the furnace from the exit end, while an assistant at the entrance unrolls and guides the belt into the furnace.

When the belt has been pulled through the furnace chamber, detach it from the old belt and thread a pull wire through the rollers and drive drum, as shown in Figure 4-27. Pull the leading edge of the belt to the entrance and splice.

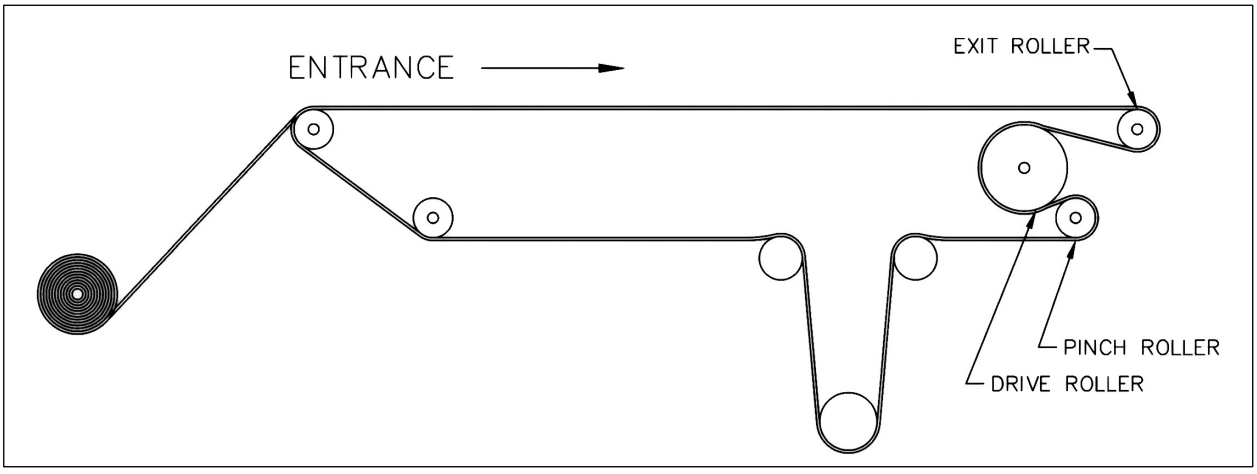


Figure 4-27 Belt Path

3. Splicing the Belt

Line up the ends of the belt so they are parallel and slightly overlapping as in Figure 4-28.

Splice the belt by inserting one of the cross-section wires through the belt mesh across the width of the belt as shown in Figure 4-28 and Figure 4-29.

The wire should be even and parallel and aligned with the belt edges. The cross-section wire will stay in place without any finishing at either end.

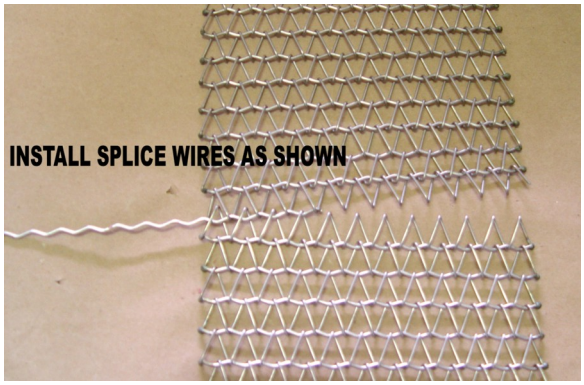


Figure 4-28 Align belt sections

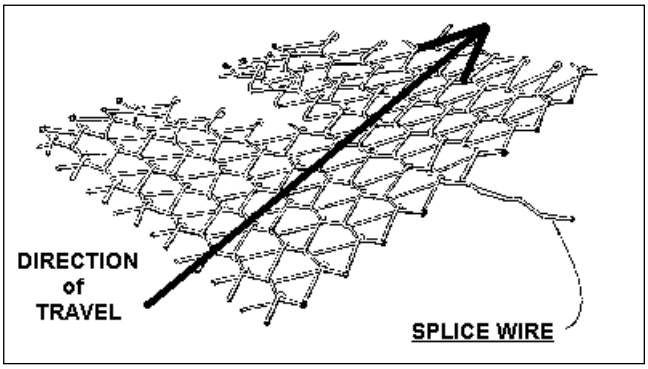


Figure 4-29 Insert splice wire

4. Install Belt Weight

Reinsert belt weight as shown in Figure 4-30. If necessary, pull belt to the left or right to align Belt so that Belt Weight is allowed to move freely as shown in Figure 4-31.

Figure 4-30 Belt Weight in Place

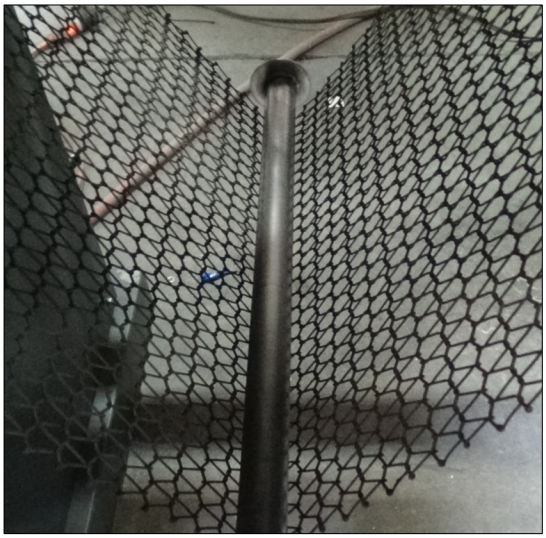


Figure 4-31 Proper Alignment of Belt Weight

5. Start Furnace

Turn on the compressed gas supply to tension the belt. Start the furnace and operate the belt without heat to verify alignment.

4.6.6 Drip Tray Cleaning

Drip trays are located in the furnace entrance baffle and transition tunnel baffle sections. Drip trays may collect condensate it the exit gas is not cool enough to keep the exhaust in a gaseous state.

The maintenance and period for drip trays depends very much on the processes being run. You may only have to use a vacuum to remove debris from the drip tray instead of removing the whole assembly. While some processes require drip trays to be cleaned every month, others processes may barely soil the drip trays.

1. Drip Tray Removal

Unscrew and remove the furnace side covers. If necessary, remove the cooling fan assembly.

Disconnect the T-pieces that connect the gas supply to the air-rake tubes. The T-pieces must be disconnected at the top and bottom but the connection to the air-rake tube may remain connected.

Undo the air-rake retaining nut.

Completely remove the air-rake tubes.

Undo the butterfly nuts holding the drip-tray inspection cover in place and remove the inspection cover.

Remove the drip tray being careful not to damage the attached baffle plates.

2. Clean Drip Tray

Wash or mechanically clean drip tray parts.

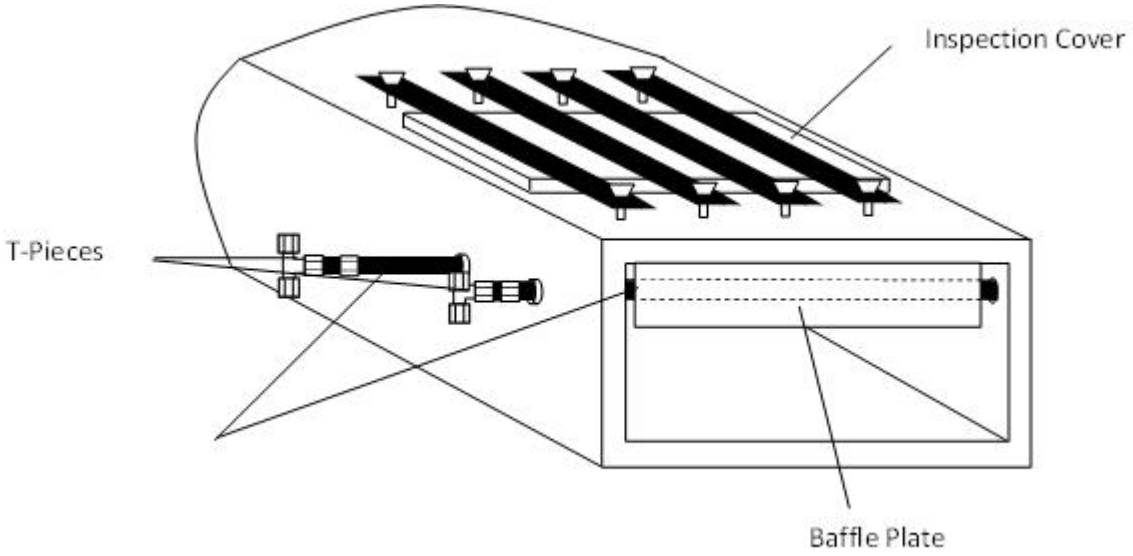


Figure 4-32 Drip Tray Cleaning

3. Drip Tray Installation

Re-installing the drip tray is easier if the baffle plates are tied flat against the drip tray. This is easily achieved by loosely wrapping a piece of wire around the drip tray and baffle plates.

Insert the drip tray and baffle assembly. Remove the wire.

Replace the inspection cover and reattach clamps. After several hours of operation, check the butterfly nuts on the inspection cover, and tighten if necessary.

Reinstall air rakes making sure that they are oriented as before with the notch on the alignment ring facing up.

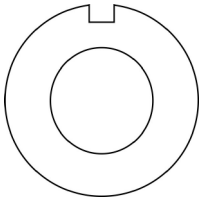


Figure 4-33 Air Rake Alignment Ring

4.6.7 Entrance and Exit Baffles

The Entrance and Exit Baffles aid in isolating the furnace atmosphere from the room atmosphere (Figure 4-34). To replace or repair the baffles, remove the baffle tray as follows:

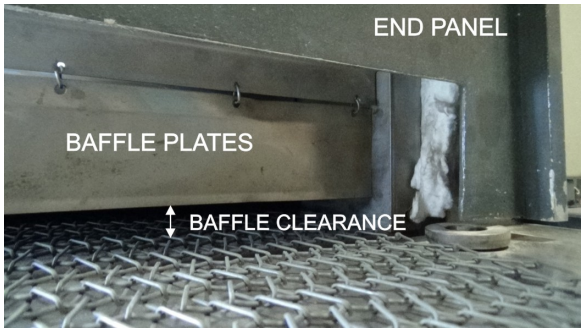


Figure 4-34 Entrance & Exit Baffles

A. Remove Front and Rear side access panels

Lift and remove the Upper and Lower Front and Rear Entrance side panels and Entrance Baffle, or

Lift and remove the Upper and Lower Front and Rear Exit side panels to expose End Panel fasteners and Exit Baffle.

See Section 4.1 Service and Maintenance Access.

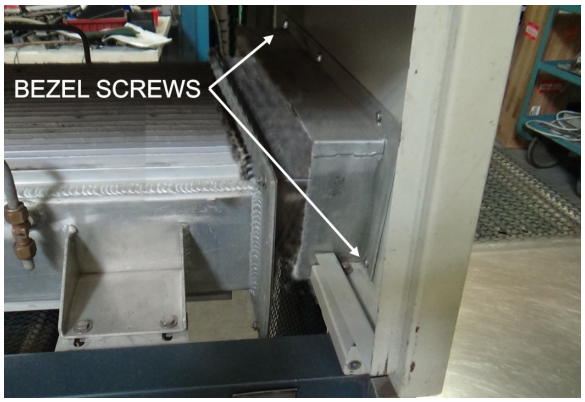


Figure 4-35 Bezel fasteners

B. Remove End Panel Bezel

Remove (5) fasteners holding Entrance or Exit End Panel Bezel

See Figure 4-35.

Figure 4-36 End Panel Bezel

C. Remove End Panel Bezel

Pull End Panel Bezel away from End Panel to expose end of Baffle. (Figure 4-36 and Figure 4-37).

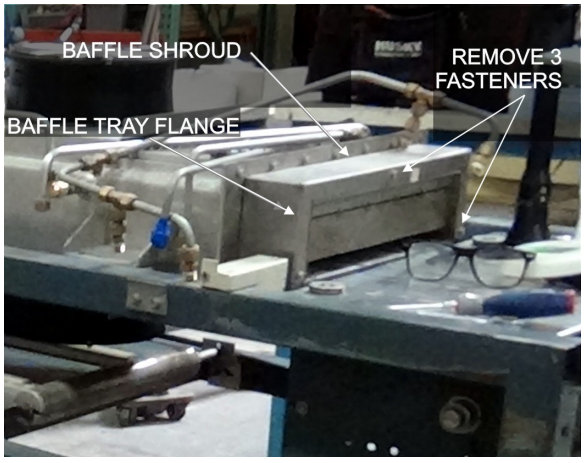


Figure 4-37 Exit Baffle Section Exposed

D. Remove 3 fasteners on exposed face of the baffle section)

Pull on Baffle Tray Flange to slide Baffle Tray out of Baffle Shroud at end of furnace and completely remove Baffle Tray. Figure 4-37 shows location of fasteners on Exit Baffle (shown with Top and End and Front and Rear side panels removed for clarity).

E. Baffle Replacement and Repair

Baffles are manufactured of 0.010” thick 304 stainless steel sheet and hang from stainless steel rings. When properly installed, baffle plates should swing freely with required clearance above the belt (typically 1/4 to 1/2 inch). See Figure 4-34.

4.6.8 Transition Tunnel Baffles

The Transition Tunnel Baffle section aids in isolating the furnace heating section atmosphere from the cooling section atmosphere (Figure 4-38). To replace or repair the baffles, remove the baffle tray as follows:

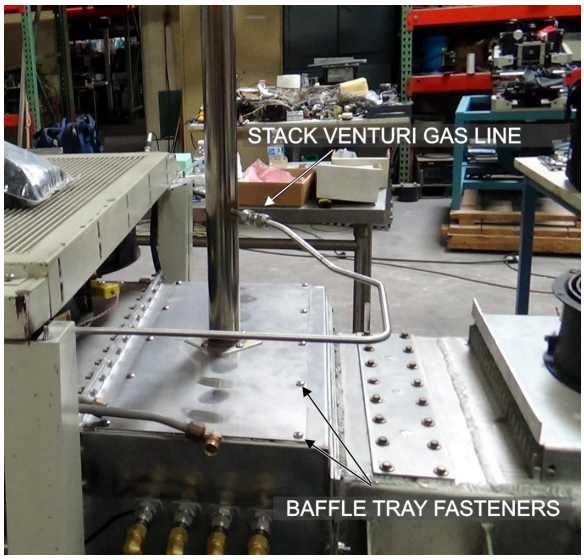


Figure 4-38 Transition Tunnel

A. Remove Exit side access panels

Lift and remove the Upper and Lower Front and Rear Exit side panels. See Section 4.1 Service and Maintenance Access.

B. Remove Exit Top Panel

Remove fasteners connecting Exit Top panel to Entrance Top Panel.

.

Disconnect Stack Venturi gas line.

C. Remove fasteners on baffle tray top plate

See Figure 4-39

Use screwdrivers or other flat tool to pry top plate from gasket.

INSTALLATION NOTE: Make sure high temperature gasket material is evenly applied on the flange surface of the baffle tray before inserting baffle tray into transition tunnel.

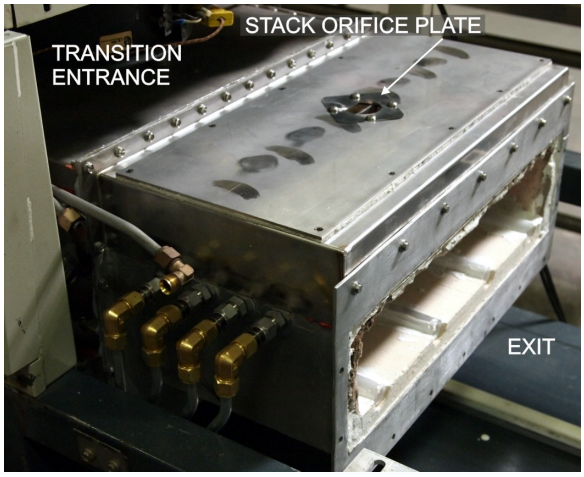


Figure 4-39 Exit Faceplate top fasteners

D. Stack Fasteners and Orifice Plate

The transition tunnel exhaust stack is held in place by four (4) machine screws. Remove stack and replace screws immediately to retain orifice plate.

INSTALLATION NOTE: If the stack machine screws are removed, please make sure the stack orifice plate is reinstalled with small opening toward furnace entrance (see Figure 4-40 for orientation of the stack orifice plate).

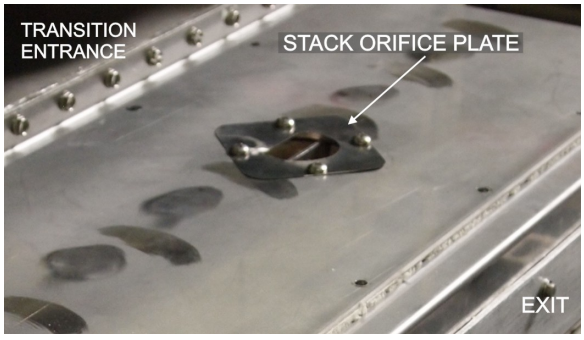


Figure 4-40 Transition Tunnel Stack Orifice Plate

E. Remove baffle tray

Gently lift baffle tray to clear baffle plates. See Figure 4-41

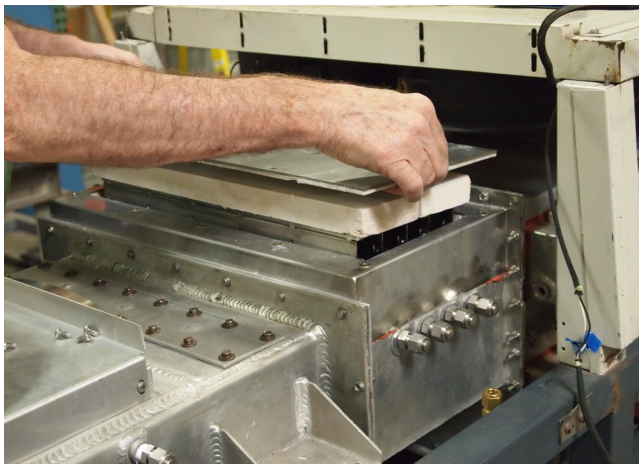


Figure 4-41 Baffle Tray in Transition Tunnel

F. Lift Baffle Tray to remove

Gently lift baffle tray to clear baffle plates.

INSTALLATION NOTE: There are (5) baffle plates and (4) air rakes in the rapid cool transition tunnel. When reinstalling the baffle tray, make sure the (5) baffle plates are inserted on either side of the corresponding air rake.

Figure 4-42 Baffle Tray

G. Baffle Section Exposed

Figure 4-43 shows the rapid cool transition tunnel with air rakes in place and baffle tray removed. Protect the top opening with a sheet of plastic, wood or metal while the baffle plate is being repaired to assure that the internals are not damaged

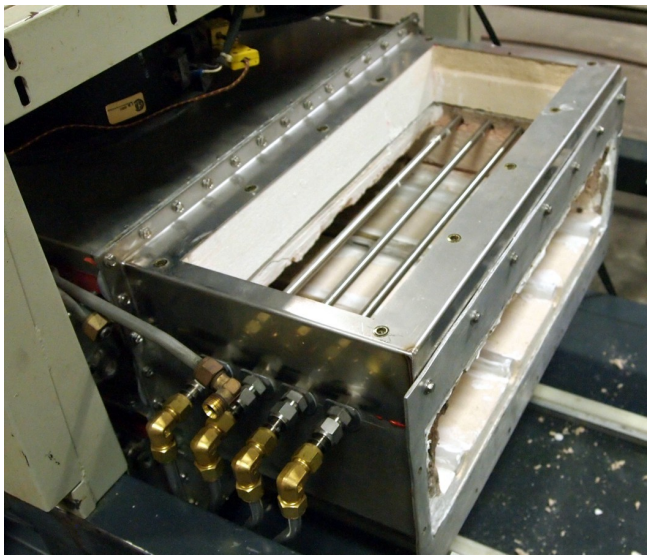


Figure 4-43 Transition Tunnel, Baffle Tray removed

H. Baffle Replacement or Repair

Baffles are manufactured of 22 gage 304 stainless steel sheet and hang from stainless steel rings. When properly installed, baffle plates should swing freely with required clearance above the belt (typically 1/4 to 1/2 inch).

4.6.9 CACT Baffle

The CACT Baffle aids in isolating the furnace transition section atmosphere from the cooling section atmosphere (Figure 4-34). To replace or repair the baffles, remove the baffle tray as follows:

A. CACT Baffle Access

Lift and remove the Upper and Lower Front and Rear Exit side panels. See Section 4.1 Service and Maintenance Access.

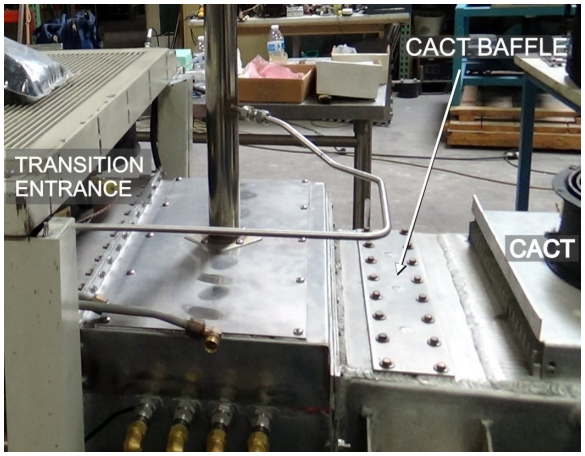


Figure 4-44 CACT baffle location

B. Exit Top Panel

You can remove the CACT baffle assembly without removing the top panel. However, for clarity, Figure 4-44 shows the location of the CACT baffle assembly with the top panel removed.

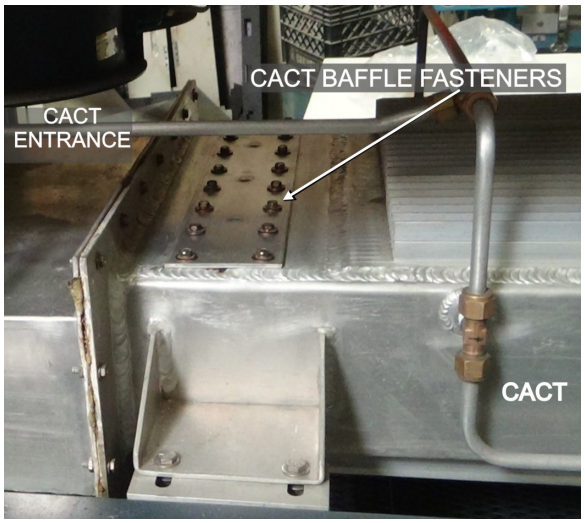


Figure 4-45 CACT Baffle fasteners

C. Remove CACT baffle fasteners

See Figure 4-45

Use screwdrivers or other flat tool to pry top plate from gasket.

INSTALLATION NOTE: When reinstalling make sure the flange mating surfaces are clean and smooth. Make sure fasteners are tightened evenly on Baffle Assy flange.

Figure 4-46 CACT Baffle assy

D. Lift Baffle Tray to remove

Gently lift CACT Baffle assembly and rotate baffle if necessary to clear CACT and furnace Top Panel.

Figure 4-46 shows CACT Baffle assembly removed from the CACT.

Figure 4-47 shows slot in CACT for inserting its Baffle assembly.

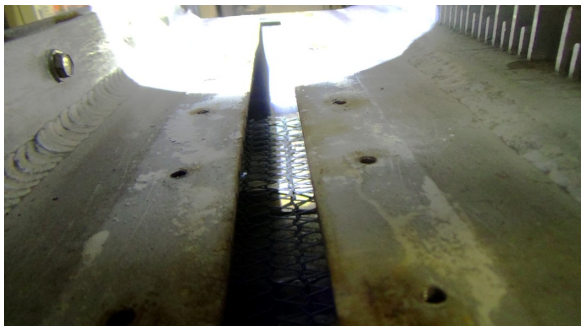


Figure 4-47 Transition Tunnel Stack Orifice Plate

E. Baffle Replacement and Repair

Baffles are manufactured of 22 gage 304 stainless steel sheet and hang from stainless steel rings. When properly installed, baffle plates should swing freely with required clearance above the belt (typically 1/4 to 1/2 inch).

4.6.10 Replacing SCR Control Modules

A. SCR REMOVAL

To remove the entire SCR assembly, disconnect the 10Vdc and the 24 Vac wire pairs. Unscrew the Line and Load wires. If you are only replacing the firing board, remove the (2) firing board screws. If you are removing the entire assembly, remove the (2) SCR Mounting screws. See Figure 4-48.

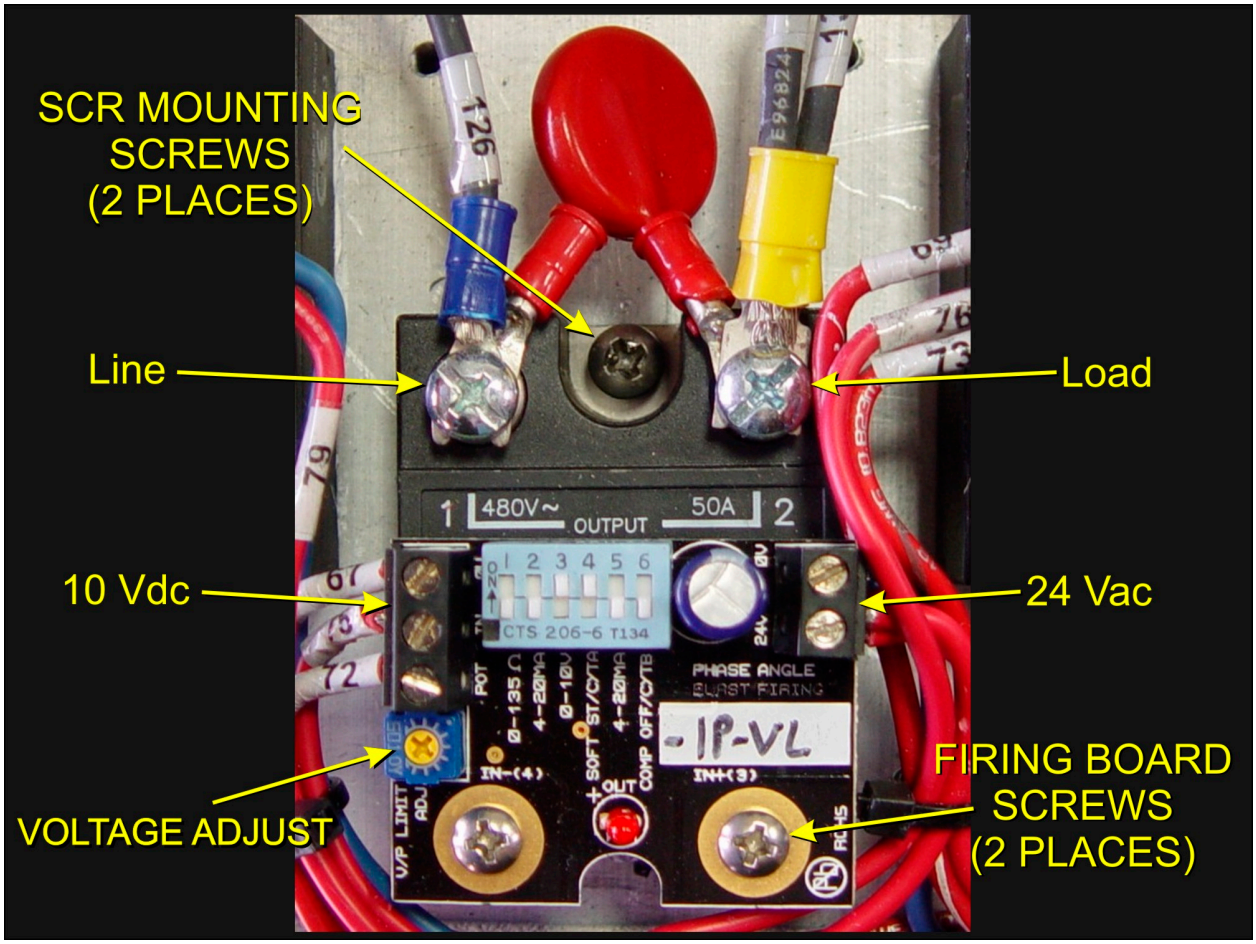


Figure 4-48 SCR installed

B. SCR INSTALLATION

Install an entire SCR assembly, by first checking that thermal paste is applied to the back of the SCR and the heat sink (aluminum plate) in the location where is will be mounted. Screw the assembly to the heat sink. Connect the 10 Vdc control wires, the 24 Vac control voltage wires and the Line and Load wires with red MOV in place. Also, re-connect R-C snubber assembly (not shown) between the Line and Load wires in parallel with the red MOV. Make sure the dip switch is set as shown in Table 4-8 Then follow the procedure on page 4-38, section **4.7.1 Calibrate SCRs** to calibrate the SCR.

Table 4-8 SCR Firing Board DIP Switch Settings

Dip Switch	1	2	3	4	5	6
Position	OFF	OFF	ON	ON	OFF	OFF

4.6.11 Replacing Console Indicator Lamps

Alarm LED's are pressed into the face of the control console. They can be removed by disconnecting the two leads and pushing from the inside. Alarm indicator lamps are 24Vdc LEDs and must be installed with the proper polarity to avoid damage to the LED.

The lamp indicator LEDs are inserted through the panel from the backside (see Figure 4-50 Lamp in Panel). To remove them from the control console, remove the LED rear retaining ring and press from the front of the Control Console. These parts are integral with the black current indicator. The whole single LED assembly should be replaced if damaged (see Figure 4-49 Lamp Indicator Installation).

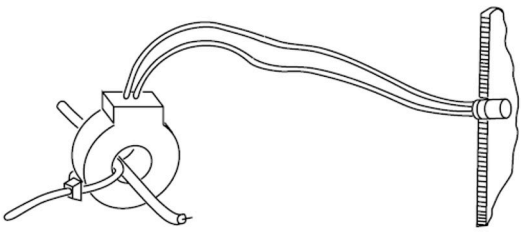


Figure 4-49 Lamp Indicator Installation

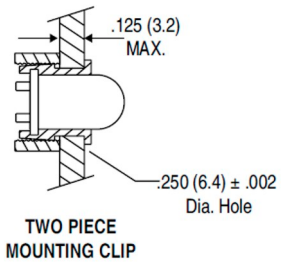


Figure 4-50 Lamp in Panel

4.6.12 Infrared Heat Lamp Replacement

A. Tools Required:

(2) 3/8 in. open ended wrenches	Replacement Kaowool packing material
Allen wrench	Lint free cloth or protective gloves
Flashlight	

B. Handling Heating Lamps

Warning: Whenever handling furnace heat lamps, special care must be taken not to touch the surface of the lamp. Leftover salt from handling the lamps can cause hot spots which can reduce lamp performance or cause failure.

If the cleanliness of a heat lamp is suspect, clean the lamp with isopropyl alcohol and wipe with a lint-free cloth prior to use.

C. Lamp Removal

All power should be removed from the furnace before replacing lamps.

1. If Plenum covers are supplied, remove the setscrews securing the plenum clamps and carefully remove plenum covers. Care must be taken not to damage the rubber seal between the plenum chamber and the chamber cover.
2. Short one lamp from each zone to the furnace frame to remove any charge residing in the lamps.
3. Taking care not to disturb the ceramic insulating blocks, use one of the 3/8" wrenches to hold the base nut while you loosen the fastening nut.

Warning: If the furnace is equipped with the hermetic seal (Option ❒), any cracks to the insulating block will result in furnace chamber leaks and should be replaced if broken.

4. Disconnect the element lead from the insulating terminal block. Repeat this step for the opposite side.
5. Remove lamp and old packing material.

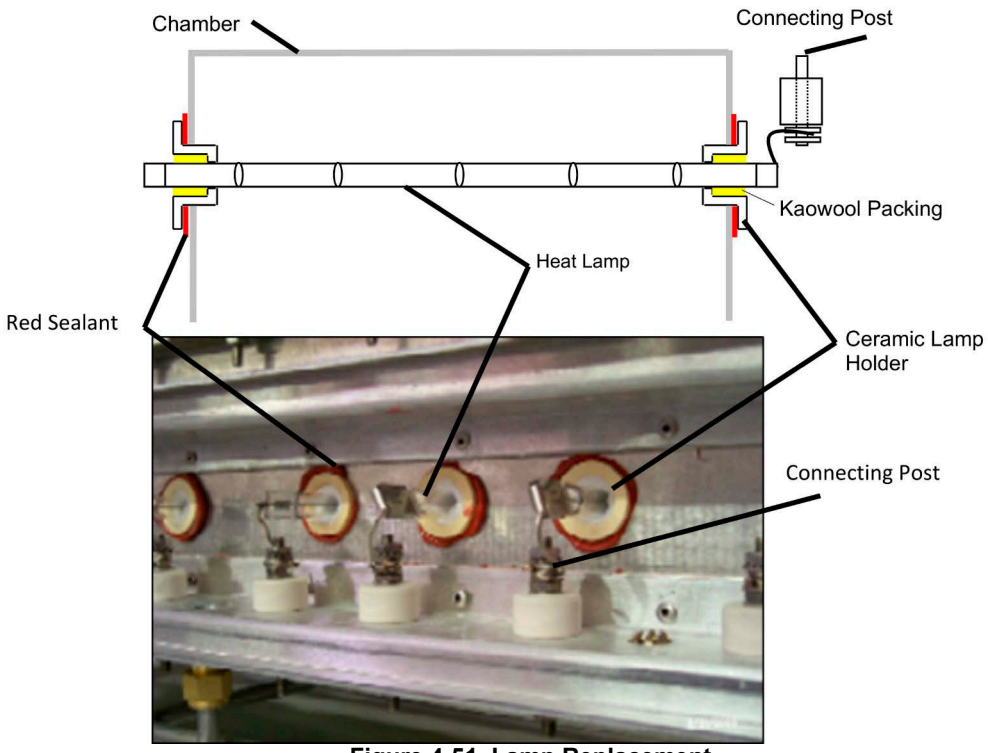


Figure 4-51 Lamp Replacement
Cross-section Across-the-Belt Diagram (top), End View Picture (bottom)

D. Lamp Installation

1. Make sure the red sealant securing the ceramic lamp holder is intact. Unsealed ceramic lamp holders may be resealed with Kaowool packing.
2. Using a lint free cloth or protective gloves, remove the lamp from its carton being very careful not to touch the glass with bare hands.
3. Straighten the connecting lead on one end of a new lamp and slide it into place. You may need the flashlight to locate the opposite side's ceramic holder. Once the lead appears from the ceramic holder, you may carefully pull the lamp through the furnace chamber.

   If threading the lamp is difficult. Thread a dowel or stiff wire through the furnace. Tape the lead to the dowel or wire and then pull the lamp into position.

5. Pack the ceramic holders on both sides with the Kaowool packing material.
6. Center the lamp to ±1/32-in. (±0.8-mm) and recheck the packing.
7. Wrap the connection leads around the connection terminals in the same direction as the nut will be tightened. Use two wrenches, as you did when removing the connection, to ensure the connection post is not disturbed.
8. Cut off excess connection wire.
9. Replace plenum covers being careful not to damage the rubber seal.

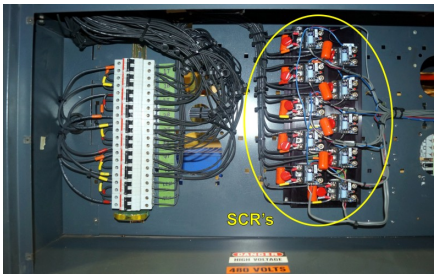
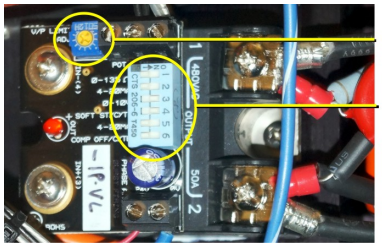
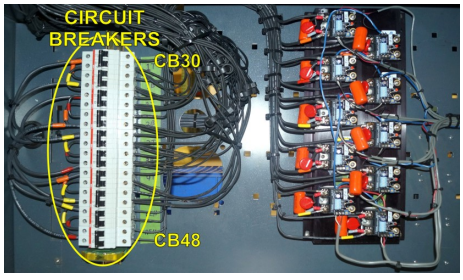
4.7 Calibration

4.7.1 Calibrate SCRs

Calibration of the SCRs is usually necessary only if an SCR or SCR controller is replaced. Good maintenance practice, however, is to check SCR calibration every 6 months or so, or if the furnace seems to be slower than usual to reach operating temperature.

This calibration procedure will require use of an RMS responding voltmeter/multimeter and a thin blade screwdriver, and will require that the access cover to the control enclosure be opened.

Caution: dangerous voltages and current will be present throughout the inside of the control enclosure, electrical enclosures, and on wire connections to the furnace lamps when the furnace is POWER ON is lit.

Action	Comments/Changes
1. Remove the Front Lower Electrical enclosure access panel.	Remove the screws along the sides of the access panel and place panel out of the way. **Caution**: Opening this cover will expose high voltage when furnace is connected to source power.
2. Locate SCRs on left side of enclosure.	
3. Identify DIP switch and maximum voltage potentiometer on SCR controllers. Note that DIP switch body may be a color other than blue, but the switches are always white.	
4. Locate lamp Circuit Breakers (CB30-CB48). The lamp returns are to be measured at terminal 2 of the breaker protecting each SCR.	 
5. Push OFF all lamp zone switches.	Turns OFF all lamps.

Action	Comments/Changes
6a. To calibrate a lamp SCR, set temperature controller for SCR to be calibrated to at least 400C; if controller current setpoint is higher, then use that higher setpoint temperature. **6b. To calibrate an edge heater SCR, no adjustment of temperature is necessary as they are controlled manually by adjusting their potentiometer knob**	Prepare to probe the SCR load terminal (#2) and the corresponding CB return terminal (#2) with an RMS-responding voltmeter: **Lamp SCR probe point** — **Return probe point** SCR1 (Zone 1 Top lamps) Load — CB30, terminal 2 SCR2 (Zone 1 Bot lamps) Load — CB32, terminal 2 SCR3 (Zone 2 Top lamps) Load — CB34, terminal 2 SCR4 (Zone 2 Bot lamps) Load — CB36, terminal 2 SCR5 (Zone 3 Top lamps) Load — CB38, terminal 2 SCR6 (Zone 3 Bot lamps) Load — CB40, terminal 2 SCR7 (Zone 4 Top lamps) Load — CB42, terminal 2 SCR8 (Zone 4 Bot lamps) Load — CB44, terminal 2 **Edge heater SCR probe point** — **Return probe point** SCR9 (EHL heater) Load — CB46, terminal 2 SCR10 (EHR heater) Load — CB48, terminal 2
7. If calibrating a lamp SCR, **a. Press appropriate zone switch ON.** **b. Wait 20 seconds for controller "soft-start" action to end.** **c. Probe appropriate points with RMS-responding voltmeter.** **d. Rotate yellow screw on SCR potentiometer CCW to the stop.** **e. Now, rotate yellow screw CW until meter reads 430 Vac or screw is fully CW, whichever comes first.** **f. Press zone switch OFF.** **If calibrating an edge heater SCR,** **a. Turn edge heater control pot fully CW to full ON.** **b. Wait 20 seconds for controller "soft-start" action to end.** **c. Probe appropriate points with RMS-responding voltmeter.** **d. Rotate yellow screw on SCR potentiometer CCW to the stop.** **e. Now, rotate yellow screw CW until meter reads 240 Vac or screw is fully CW, whichever comes first.** **f. Turn edge heater control pot fully CCW to OFF.**	Note: to maximize both power and lamp service life, DO NOT EXCEED 450 Vac on lamp SCRs.

Action	Comments/Changes
8. Repeat step 7 for all SCR's being calibrated.	During the calibration process, the lamps selected to be ON will gradually heat the zones as can be seen from the PV display on each controller. If zone temperatures exceed 500 °C, let the zones cool down below 250 °C before continuing. It is a good idea to allow the transport belt to stay on during calibration to help remove any excess heat from the zones. When finished with calibration process, return all temperature controllers and edge heater pot knobs to their operational settings.
9. Replace the Front Lower Electrical enclosure access panel	Replace the screws along the sides of the access panel to seal enclosure. The SCR calibration process is now complete.

4.7.2 Belt Speed Measurement

The belt speed has been calibrated at the factory. The actual belt speed can be verified by the following procedure.

Tools Required: Tape Measure & Stop Watch.

❶ Measure the distance from the furnace entrance gate to the exit gate.

❷ Set the belt to the desired speed. (Set belt to the maximum speed if you plan to reprogram the Belt Speed Display meter.).

❸ Place an object on the belt to act as a marker

❹ Start the timer as the marker enters the entrance gate.

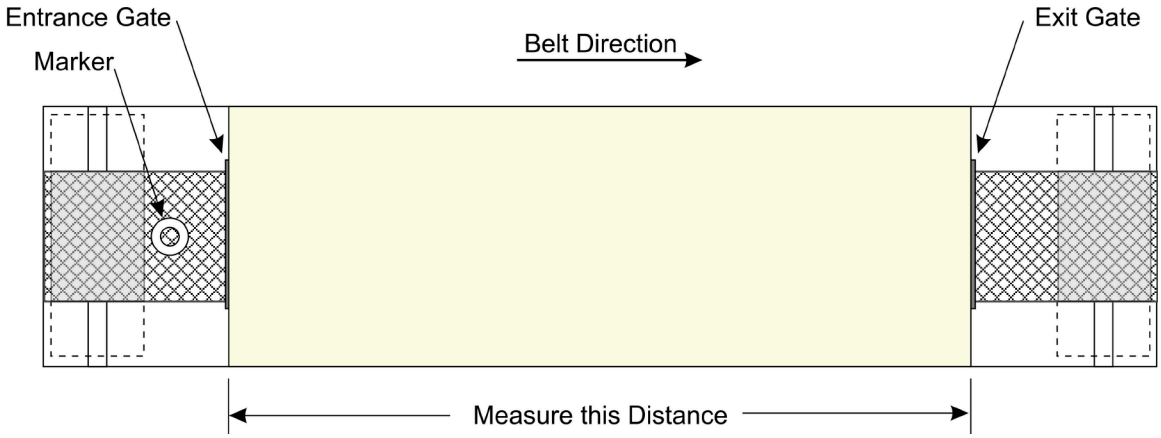


Figure 4-52 Belt Speed Calibration Diagram

❺ When the marker on the belt reaches the exit belt tray, stop the timer. Record the time in seconds.

CALCULATE ACTUAL BELT SPEED:

Convert the measured distance from **step ❶** above to inches.

Convert the time from **step ❺** to minutes.

Compute the actual belt speed according to the following equation:

$$\text{Speed} = \frac{\text{Distance (in.)}}{\text{Time (min.)}}$$

4.7.3 Belt Speed Calibration

If you need to reprogram the Belt Speed Display:

❶ Configure the Belt Speed display for PROGRAM Mode as described in section 0.1.1C.

❷ Follow the steps in section 4.7.2 at maximum Belt Speed.

❸ Enter the calculated ACTUAL BELT SPEED in the Belt Speed Display RATE SCALING DISPLAY field.

❹ Reset Display to OPERATOR Mode as described in 0.1.1J.

4.7.4 Belt Speed Display Meter Programming

A. OPERATOR MODE

The **Belt Speed** digital display meter shows the belt speed in inches per minute (ipm), or millimeters per minute (mm/m), or centimeters per minute (cm/min), or almost any other preferred units for speed.

In the Operator Mode the PAR, ▼ and ▲ are only used to change the display settings and should be disabled during normal furnace operation.

Figure 4-53 Belt Speed Display Meter

B. PROGRAMMABLE PARAMETERS

The Belt Speed display meter is a digital tachometer configured for the furnace ordered. To change the display units or any other parameter requires enabling the PROGRAM MODE to enable the display buttons: PAR, ▲ and ▼. The Belt Speed indicator has five programmable parameters which are entered in the sequence shown in Table 4-9.

Table 4-9 Belt Speed Tachometer Parameters

Parameter	Display	Value (default) mm/min	Value (default) cm/min	Value (default) in/min
Decimal Position	dEC.Pt	000	00.0	00.0
Low Update Time	LO-Udt	1	1	1
High Update Time	HI-Udt	2	2	2
Rate Scaling Display Value (Max Belt Speed)	At-dSP	measured max speed, mm/min	measured max speed, cm/min	Measured max speed, in/min
Rate Scaling Input Value (pulses per second)	At-inP	# of pulses at max speed	# of pulses at max speed	# of pulses at max speed
End	End			

C. CONFIGURE FOR PROGRAM MODE

The PAR, ▼ and ▲ are disabled during normal furnace operation. To reprogram the Belt Speed Display requires shutdown of the furnace and enabling the Program Mode via dip switch on the back of the display. This requires opening the Control Enclosure.

1. Shut off the furnace power and open the back of the control enclosure.
2. Find the 6-position dipswitch on the back of the digital tachometer. Move the program disable switch number 5 from OFF to ON to enable the display buttons.
3. Start the furnace.
4. Press the PAR key to enter Programming Mode. The meter briefly displays PAR followed by the first programming parameter described in the table below. Pressing the ▼ moves the selection to the right to select the digit position in the parameter value. Pressing ▲ increments the selected digit or parameter value.
5. Pressing the PAR key saves each entered value.

D. LOW UPDATE TIME - DISPLAY UPDATE (0.1 to 99.9 seconds)

The Low Update Time is the minimum amount of time between display updates. The factory setting of 2.0 allows a minimum of four seconds between updates. Low values below 0.3 will update the display correctly, but may cause the display to appear unsteady.

E. HIGH LOW UPDATE TIME - DISPLAY ZERO (0 to 99.9 seconds)

The High Update Time is the maximum amount of time before the display is forced to zero. The High Update Time must be higher than the Low Update Time and also higher than the desired slowest readable speed (one divided by pulses per second). The factory setting of 5.0 will force the display to zero for speeds below 0.2 Hz or one pulse every 5 seconds.

F. RATE SCALING DISPLAY VALUE (0 to 999999)

Enter the maximum Belt Speed value for the units selected.

G. RATE SCALING INPUT VALUE (0 to 99999.9)

The Rate Scaling Input Value is the number of pulses that corresponds to the maximum belt speed.

H. PROGRAM MODE END

The Belt Speed display meter exits the Programming Mode when the PAR key is pressed to save the Rate scaling value. The meter briefly displays End upon exiting Programming Mode. All programmed selections are now transferred to the non-volatile memory and the meter returns to the Belt Speed display. (If power loss occurs during Programming Mode, verify parameter changes and reprogram, if necessary, when power is restored.

I. PROGRAM MODE TIMEOUT

The Belt Speed display meter has an automatic time out feature. If no keypad activity is detected for approximately 60 seconds, the meter automatically exits the Programming Mode. The meter briefly displays End and returns to the Belt Speed display. When automatic timeout occurs, any changes that were made to the parameter currently being programmed will NOT be saved.

J. RESET DISPLAY TO OPERATOR MODE

To completely exit Programming Mode and return the Belt Speed display meter to Operator Mode, lockout the display buttons via the dip switch on the back of the display. This requires opening the Control Enclosure.

1. Shut off the furnace power and open the back of the control enclosure.
2. Find the 6-position dipswitch on the back of the digital tachometer. Move the program disable switch number 5 from ON to OFF to enable the display buttons.
3. Start the furnace

The PAR key, ▼ and ▲ are disabled during normal furnace operation.

4.7.5 Thermocouples

The thermocouples are type K and are pre-calibrated. They do not require any additional calibration.

4.7.6 Low Gas Pressure Switch Calibration

Inlet Pressure Switches are installed on the process gas manifolds. These switches are normally open. They close when proper pressure is present in the process gas supply lines.

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

Table 4-10 Initial Alarm Settings

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

The pressure switch set points can be adjusted manually (see 4.7.6B Calibration.).

A. Gas Supply Low Pressure Switch Calibration

The process gas pressure switch is located on the gas supply manifold for each gas supplied.

If a reservoir tank is supplied, the pressure switch is located at or near the compressed air receiver. See drawing 802-101780-01.

B. Calibration

To calibrate each switch:

1) Verify that the Low Pressure Alarm switch is enabled.
2) Close all flowmeter valves.
3) Set inlet air pressure to desired set point pressure. Read pressure on supply gage.
4) Locate the pressure switch to be adjusted.
5) To adjust, loosen the knurled lock nut at the top of the switch.
6) Rotate the Adjusting Wheel:

   CW –Turn the top of the switch clockwise to increase the pressure set point below which the alarm will trip.

   CCW – Turn the top of the switch counterclockwise to decrease the pressure set point so the pressure must drop to a lower value to trip the alarm.

   You can hear a faint click when the micro switch changes state. Below this point below which the switch will activate the alarm when enabled.

Figure 4-54 Gas Pressure sensor

7) Turn the knurled wheel clockwise to "lock in" the setpoint position
8) Start the furnace system without power to the lamps. Close the facility process gas valve to the furnace. Open the flowmeter valves and verify that the alarm trips when the pressure drops below the new set point.

Readjust as necessary and retest

4.7.7 OSS Sampling System

A. System Equipment.

The OSS Sampling system consists of a 4-port manifold with solenoid valves mounted on each port for Source gas, Port 1, Port 2 and Port 3. The sample ports are located on the bottom of the furnace chamber. During normal operation, when the Sampling System is energized the designated sample port is opened and gas flows from the process gas source (nitrogen) or from the furnace chamber piped to the selected port. Once the sample passes through the analyzer it is exhausted to one of the furnace exhaust stacks.

Figure 4-55 OSS Sample System Panel & Oxygen Analyzer

The analyzer includes a sample pump that pulls the sample from the furnace ports. The system includes a pressure regulator to control gas flow pressure to 3.5 psig from the Source process gas supply pressure. In addition, a 10 micron filter is provided to assure clean sample gas is delivered to the analyzer(s). The regulator and filter are located in the furnace Control Enclosure. See drawing 801-090776 GAS SAMPLING SYSTEM piping diagram. See 802-101873 MOISTURE & OXYGEN ANALYZER CONTROL schematic.

B. Troubleshooting the OSS

O2 Power. Verify the analyzer is ON when activated by the furnace POWER ON pushbutton. Make sure the black POWER button located on the back of the Oxygen analyzer is pressed ON and the blue OXYGEN ANALYZER ON switch on the SAMPLE SYSTEM control panel is ON.

Ports. When the Furnace POWER is ON and the blue OSS switch is ON, the lamp on the solenoid (inside the OSS Enclosure) for the selected port should be ON. Remove OSS enclosure rear access plate and rotate switch and verify that when each port is activated and the respective solenoid lamp is ON.

Source Gas. The source gas (usually nitrogen supply) can also be sampled to provide a reference measurement. The nitrogen supply pressure must be reduced from 70 psi at the furnace entrance to 0.5-1.0 psig for the sample system. This secondary pressure regulator located in the furnace Control Enclosure. Verify that it is properly adjusted to supply 0.5-1.0 psig.

Sample filter. The sample gas passes through a 0.5 micron particulate filter. If the system seems to have difficulty pulling a sample, the filter might need to be changed or the sample ports purged.

Air in the lines. The oxygen sampling system should only be operated when the furnace internals are “dry”. To prevent air from contaminating the sample lines and analyzer, always set PORT SELECT switch to SOURCE before starting the sample system and when stopping the system.

Leaking sample line connections. High O2 values may be a result of atmospheric in leakage. Verify connections on either side of the ANALYZER SAMPLE IN tubing are gas tight.

Moisture in the lines. The oxygen sampling system should only be operated when the furnace internals are “dry”. To prevent moisture from contaminating the sample lines and analyzer, always set PORT SELECT switch to SOURCE before starting the sample system and when stopping the system. If the lines become wet:

1. Turn the black power button on the back of the Oxygen Analyzer OFF.
2. At the furnace Control Enclosure, disconnect the tube connected TO O2 ANALYZER IN.
3. Remove the filter element from the sample system filter in the furnace Control Enclosure.
4. Connect a dry nitrogen source line (30 psig) to the TO O2 ANALYZER IN port on the furnace Control Enclosure.
5. Select Port 1 and turn the blue Oxygen Sample Switch ON.
6. Turn on the nitrogen supply. Nitrogen will now pass through the sample line connected to zone 1 port.
7. Select Ports 2 and then 3 and perform step 5 and 6 until all ports are dry.

   Note: Because the OA/OSS system is designed to measure oxygen levels in parts per million (ppmv), it may take from 30 minutes to several hours to completely free the lines of moisture.

C. High O2 Readings

High oxygen level readings may be a result of a number of factors:

Tuning furnace flowmeter settings. High O2 values may be a result of atmospheric in leakage into the furnace chambers. To reduce oxygen levels in the furnace, adjust flowmeters so that nitrogen/forming gas flow into the furnace exceeds 15 times the combined exhaust stack settings. This with assure a slightly positive pressure in the furnace. Also with the sampling system operating make the following adjustments to further reduce O2 levels.

1. Start the furnace with N2 only using recommend initial settings from the flowmeter datasheet in Section 6.
2. Set belt speed to process requirements.
3. Set O2 sampling system to SOURCE sampling and turn on O2 Power switch to purge the manifold and sample line.
4. After 30 minutes to 1 hour at stable temperatures, switch sampling to Port 3 (Zone 3).
5. Adjust knob on back of O2 Analyzer to about 0.1 to 0.15 on the Analyzer flowmeter to set sample flow rate.
6. After 10 minutes, O2 readings should have stabilized. Check O2 reading on Analyzer display.
7. To further lower O2 ppmv:
    a. Lower Entrance Stack and Transition Stack settings, wait minimum of 5 minutes. Then to improve further:
    b. Increase Z1 and Z2-4 flowmeter settings. Check settings.
8. Then check ports 1 and 2 for O2 levels. Adjust flowmeters to improve if necessary.

Generally when tuning for low O2, make small corrections to flowmeters, one at a time and wait until system stabilizes (5-10 minutes) and observe the result before changing another flowmeter.

Record settings and observations on a simple spreadsheet so you can go back to best configuration later if necessary. Once furnace temp, belt speed and flowmeter settings are optimized for a particular process, the furnace will perform in a repeatable fashion, provided the external environment is stable as well.

D. Lower Nitrogen Consumption

To reduce nitrogen consumption during low O2 operation.

1. Stabilize furnace or follow steps in section **4.7.7C High O2 Readings**.
2. Monitor Zone 1.
3. Lower Entrance Baffle flow in 5-10 SCFH increments waiting 5 minutes between adjustments until Oxygen level begins to rise.
4. Increase Entrance Baffle flow to level where lowest O2 value is observed.

Note: During adjustment watch furnace temperature stability. If Zone 1 temperatures begin to oscillate or the ELEMENT MONITOR panel indicated lamps are exhibiting increased OFF time, increase Entrance Baffle flow and/or Z1 flow to improve furnace stability. Some minimum flow in the Entrance Baffle may be required to isolate Z1 from the outside atmosphere and to assure Z1 lamps stay lit as much as possible.

5. Monitor Zone 3.
6. Lower Transition Tunnel Baffle flow in 5-10 SCFH increments waiting 5 minutes between adjustments until Oxygen level begins to rise.
7. Increase Transition Tunnel Baffle flow to level where lowest O2 value is observed.

Note: During adjustment watch furnace temperature stability. If Zone 4 temperatures begin to oscillate or the ELEMENT MONITOR panel indicated lamps are exhibiting increased OFF time, increase Transition Tunnel Baffle flow and/or Z4 flow to improve furnace stability. Some minimum flow in the Transition Tunnel Baffle may be required to isolate Z4 from the cooling section atmosphere and to assure Z4 lamps stay lit as much as possible. Also, monitor cooling rates to assure enough flow in the Transition Tunnel to promote adequate initial cooling before the CACT.