LCI LOCHABER CORNWALL INC

CONTINUOUS BELT IR BELT FURNACE

Model LA-309
Owner's Manual

Revision 1

MODEL:	LA- 309
SERIAL NUMBER:	13030913xx
FACTORY ORDER NUMBER:	13- 0xx

Infrared Furnace Setup, Operation, Theory & Troubleshooting Guide

This Owner's Manual contains product information specific to the newly installed equipment and software. In addition, this manual contains information regarding features and options which may or may not be included in your furnace system.

Use this Manual in conjunction with the Continuous Belt IR Furnace Reference Manual

Continuous Belt IR Furnace

Owner's Manual

Rev. 1

Model: LA-309

Serial Number: 13030913xx

Part No. 13-0xx - 676-110000-01 CD

Part No. 13-0xx - 676-110000-02 Loose Leaf

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Published by:

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TABLE OF REVISIONS

Rev	Sections	Description	Date
0	All	Initial Release	11/30/2012
1	3.12.1	Drive Train / Belt Alignment	3/20/2013

INTRODUCTION

This manual covers the LCI infrared high quality controlled atmosphere infrared belt furnace designed for industrial production and laboratory infrared thermal processing. If you have acquired an RTC IR furnace rebuilt by LCI, this manual describes its operation with few exceptions.

Achieving high performance and high yields is attainable with careful adjustment of the temperature and gas flow controls provided on the furnace. Infrared furnaces are highly responsive to critical temperature settings. With lamps as the primary heat source, the equipment is literally heating with the speed of light. The unique gas management system provides an extremely even distribution and well regulated flow of gas throughout the process chambers. Understanding how to control both the heat and gas flow is essential to the effective operation of the furnace. When the interaction and performance of the control elements are well managed the tool can achieve its potential. For many, our furnaces become regarded more than just an effective tool; they are viewed as a fine instrument that can produce results over a variety of thermal processing situations.

There are many features in your equipment to help assure your success in achieving your goals. Many "firsts" involving the application of near infrared heating include: the first high temperature furnace capable of operating at 1000°C with extremely tight temperature control; the first thick film furnace; the first controlled atmosphere furnace capable of <5 ppm O2; and the first hydrogen furnace.

WHAT IS IN THIS MANUAL

This manual explains furnace equipment installation and setup, operation and troubleshooting of LCI IR series furnaces as well as RTC IR furnaces refurbished by LCI. Some equipment described in this manual is optional or may not apply to your model as configured. The manual also covers aspects of infrared processing theory and techniques to assist you in achieving highly repeatable and reliable thermal processes.

Study this manual carefully. Experience has shown that clients who thoughtfully master the contents of this manual can become expert in understanding the process system capabilities of our infrared furnaces. In doing so, many are able to push the initial process performance envelope and thus achieve higher degrees in both process reliability and throughput than previously anticipated.

Note that throughout this Owner's Manual the equipment is generally referred to as a furnace. A dryer is a furnace with only the top lamp elements installed.

FORMATTING CONVENTIONS

This manual uses the following formatting conventions.

DANGER: This signifies a potential threat to human safety.

Warning: This signifies a potential threat to equipment damage or product loss.

Note: This signifies an important fact that could affect process control.

Examples are shown in italic text.

Bold text words or phrases embedded in this document, are terms with definitions in the glossary.

Bold Underlined text is used for pop-up windows, button descriptions & selector button/box choices.

Cross-references to "Section Titles" are bound with quotes.

(Optional ❒) accessories will be shown in parenthesis with a checkbox. If supplied, please check the box as appropriate.

ABOUT LCI

LCI Furnaces specializes in the manufacture and sales of high quality near infrared (0.5-5.5 µm) wavelength continuous belt dryers, ovens and furnaces worldwide. To improve our equipment design and performance, LCI encourages users to suggest ideas for improving designs and service. Additionally, we will discuss, in confidence, new thermal processing requirements, however difficult or routine they may be. If needed, LCI can design new equipment and features to meet the special and challenging needs our partners require. Should you have a furnace operating question, contact LCI Furnaces or FurnacePros Technical Support.

WHERE TO GET HELP

Corporate Offices & Factory

Address: 675 N Eckhoff St, Ste D, Orange, California 92868 USA
Phone: +1 (714) 935-0302
Fax: +1 (714) 935-9809

Technical Support & Service

Department: Aftermarket
e-mail: service@furnacepros.com
Phone: +1 (714) 935-0302 x220

Aftermarket Parts Ordering

Department: Aftermarket
e-mail: parts@furnacepros.com
Phone: +1 (714) 935-0302 x220

Equipment Sales, Upgrades & Factory Reconditioning

Department: Sales & Marketing
e-mail: info@lcifurnaces.com
Phone: +1 (714) 935-0302 x210

Websites

New Furnaces: www.LCIfurnaces.com
Aftermarket Support: www.FurnacePros.com

EQUIPMENT LIST

Verify that the following equipment was received.

Qty	Unit	Description	Part Number
(1)	ea	LA-309 Furnace	13-0xx-LA-309
(1)	ea	Monitor, Dell P170 17” LCD Professional Flat Panel	
(1)	Length	Belt segment with splice wire	-
(1)	ea	Latch and Key, Flowmeter (alt to installed twist latch)	-
(1)	ea	Mouse, USB Optical	2MOUSEU2L

In addition verify that you received the following, shipped separately.

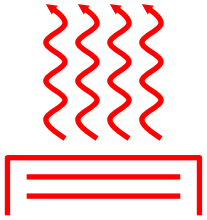
Qty	Unit	Description	Part Number
(2)	ea	Manual, Owner’s, 3-Ring Bound	13-0xx-676-110000-02
(2)	ea	Manual, Reference, Perfect Bound	675-110000-02
(1)	ea	CD Media, Reinstallation, ProControl™ Furnace software, including - Owner’s Manual, P/N 13-0xx-676-110000-01 - Reference Manual, P/N 675-110000-01	13-0xx-677-110000-01
(1)	ea	CD Media, Reinstallation, Windows®7 operating system	SERVICE TAG 0x0xxx0 OS KEY: xx0x-xxx0-xx0xx-xxxx-xxxxx
(1)	ea	CD, Drivers and Utilities, Dell Optiplex 990	

GENERAL SAFETY GUIDELINES

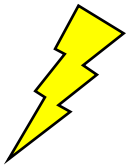
The following set of guidelines is intended to create awareness of potential health and safety hazards.

Normal Good Laboratory Practice

Normal good laboratory practices apply to the operation of IR furnaces. Do not use the space above the furnace as storage. Do not block the cabinet doors preventing the cooling of the electronic equipment inside. Do not operate with side covers off as this will prevent normal cooling of the electronic equipment thus voiding the warranty. Tuck electrical cords out of the way. Do not store flammables in the vicinity of the furnace and especially while operating the furnace with an oxygen atmosphere.

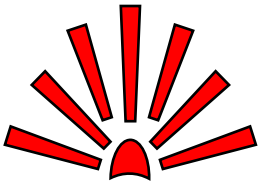


HIGH TEMPERATURES. In general, the operation of any furnace may expose operators or maintenance technicians to the risk of burns. After being processed in an infrared furnace, customer product may still be dangerous to handle. Each owner is responsible for providing a safe work environment and proper training in the handling of material being processed in a furnace.



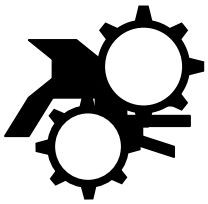
ELECTRICAL SHOCK HAZARD. IR furnaces operate at high voltages. Operation with side covers off constitutes a safety hazard. Ensure that main power is off while side covers are removed.

Electrical shock hazards exist for those technicians who service the furnace. High voltages are required to operate the furnace and precautions must be taken to reduce the exposure to these elements. Again, it is the responsibility of the furnace owner to assure that only properly trained service technicians, familiar with high voltage operations be allowed to service the equipment

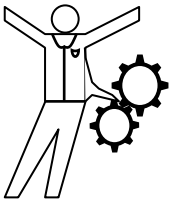


EXPLOSION Explosive dangers may exist in the high temperature process environment of the furnace. If the furnace operates with process gas containing hydrogen, measures must be taken to avoid the dangers of explosion. Furthermore, improper gas flow balance may draw oxygen rich air into the furnace, mixing with effluent gases and material from products, also creating a hazardous environment.

HAZARDOUS MATERIALS. Persons performing maintenance tasks such as replacement of lamps may become exposed to silica fiber compounds. Such tasks should be performed by qualified persons wearing gloves, eye protection and a facemask to prevent inhalation of particulates.



ROTATING EQUIPMENT. Roller dangers exist when working around the conveyor belt of the furnace. Care should be taken not to place hands on or near the belt drive mechanisms when the conveyor system is operating as roller crush may occur. Operators should avoid walking near the open ends of the conveyor belt. Those who must be near the moving parts should wear close fitting clothing.



SAFETY EQUIPMENT

EMO Buttons

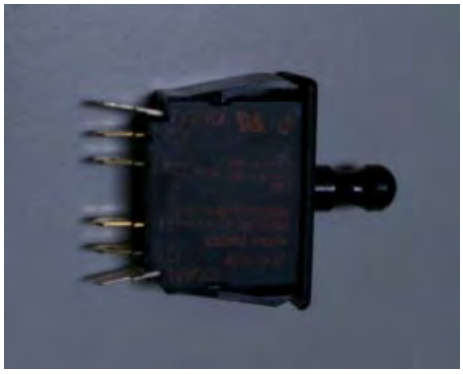
Each infrared furnace is fitted with at least two SEMI S2 compliant Emergency Machine Off buttons (EMO's), one located at each end of the furnace. Locate and insure their proper function prior to regular furnace operation.

Each Emergency Machine Off button (EMO) is attached directly to a switch that automatically shuts down all furnace electrical systems. In many cases, process gas flow will remain on after power is shut off.

Panel Interlock Switches

The furnace is equipped with a number of interlock switches located to prevent operation of the furnace with high voltage panel covers removed. One is located on the control enclosure hinged access panel, and one on each of the upper side panels closest to the furnace entrance safeguarding access to the high voltage at the chamber lamps.

Bypass this switch to allow furnace operation with the panels removed. Grasp the protruding switch and pull it out (See Figures) to override the switch. Setting the panel switches in bypass mode is useful during SCR calibration and other troubleshooting.



Panel Switches Showing Normal Operation Position

Panel Switch Installed - Bypass Mode Position

DANGER: Bypassing the panel interlock switches increases maintenance personnel exposure to electrical hazards. The user must ensure that any interlock switches placed in override mode are returned to normal operation following any inspection or adjustment..

Dual Gas - Forming Gas: Nitrogen/Hydrogen Premix (Option, ❒ not supplied)

The dual gas option provides for use of forming gas (FG) as a process gas. Use of FG is generally safe provided the concentration of hydrogen in the mixture is lower than the lower flammable limit of hydrogen. Hydrogen is flammable in concentrations of 4-74% in air; explosive range is 18-59% in air. Dual gas furnaces are equipped with an audible alarm to indicate low nitrogen and forming gas supply pressure.

DANGER: Except for furnaces specifically equipped with the hydrogen option, combustible gas should NOT be connect to the furnace. Forming gas or other gas mixtures which have a combustible gas component can be safely introduced into furnace provided the delivered concentration is below its lower flammable limit (LFL) in air.

HNO - Hydrogen/Nitrogen Mixing (Option, ❒ not supplied)

Hydrogen/nitrogen mixing requires the addition of combustible gas sensors at key points on the furnace as well as additional flow and pressure sensors to assure the hydrogen introduced in an oxygen free furnace environment. Exhaust stack ignitors are also added to harmlessly flame any free hydrogen that maybe evacuated from the furnace. Use of Hydrogen (H_2) in the heating chamber requires special furnace owner safety considerations including:

1. Furnace installation ensuring proper ventilation and safe source gases,
2. Special warm up and cool down procedures must be followed.
3. Gas flow balance is critical to the safety of all personnel working near a infrared furnace operating with hydrogen process gas. Escaping hydrogen gas, or the admission of oxygenated gas into the process section is extremely hazardous.

These two events ensure that no additional H2 gas is allowed into the furnace and that the remaining H2 is diluted and removed as quickly as possible.

LIMITED WARRANTY

PURCHASER:	Customer	**PROJECT:**	13-0XX
PRODUCT:	LA-309 IR Furnace / Dell Optiplex 990	**SHIPMENT DATE:**	1/14/2013
SERIAL NUMBER:	13030913XX / 6Y0xxx0	**STARTUP DATE:**	2/17/2012

	EQUIPMENT	WARRANTY PERIOD
✓	IR Continuous Belt Furnaces & Dryers	Checkout/Startup by LCI: Twelve months (12) months from date of initial startup, in no event exceeding 15 months from date of shipment.
	Refurbished Equipment, Cooling systems & Controls Upgrades	Furnace Warranty Expires: **2/16/2014**. Checkout/Statup by others: Twelve months (12) months from date of shipment.
✓	Computer	Dell Next Business Day Support: Extended warranty expires **01/17/2015**
	Aftermarket Parts	Sixty (60) days from date of shipment.

Lochaber Cornwall Inc (LCI) warrants that the Equipment conforms to its specifications and is free from defects in workmanship and material under normal use and service, excluding chemical attack, wear and tear from abrasion or corrosion. During the Warranty Period LCI will at its option, repair or replace the defective part provided (1) PURCHASER promptly notifies LCI of any claimed defect, (2) PURCHASER receives return authorization and returns the product to LCI for inspection, and (3) the Product is determined by LCI to be defective and the remedy the responsibility of LCI. Minor deviations from the specifications shall not constitute defects or non-conformance. Consumables such as fuses, filters, lamps, thermocouples and lubricants are expressly excluded from this warranty.

No parts shall be received by LCI without LCI's prior written authorization. If LCI determines that the warranty does not apply, PURCHASER will be responsible for any repair or replacement costs and all associated freight charges.

LCI's LIABILITY IS LIMITED TO THE REPAIR OR REPLACEMENT OF THE EQUIPMENT FOUND TO BE DEFECTIVE AT SUCH LOCATION AS MAY BE DETERMINED IN THE SOLE DISCRETION OF LCI. ALL WORK UNDER THIS WARRANTY SHALL BE PERFORMED DURING NORMAL WORKING HOURS. ALL REPLACEMENT PARTS, WHETHER NEW OR REMANUFACTURED, ASSUME AS THEIR WARRANTY PERIOD ONLY THE REMAINING TIME PERIOD OF THIS WARRANTY.

PURCHASER shall bear the cost of return of any materials, components and equipment to LCI. LCI shall bear the cost of non-expedited shipping to PURCHASER of parts and materials replaced under this warranty. When a LCI representative visits PURCHASER's facility for warranty work, PURCHASER shall only reimburse related normal and customary travel and lodging expenses.

Unless otherwise specifically authorized in advance, payment of charges incurred by others shall not be borne by LCI. In any event, approved charges shall be limited to the cost LCI would have reasonably incurred had the equipment been returned to its plant for correction. LCI will not accept any backcharges for field corrections made without its prior written approval and instructions.

These warranties will not apply if the equipment or any components thereof have been subject to:

(1) operation, maintenance, overhaul, installation, storage or use which is improper or not in accordance with LCI's instructions;

(2) any alteration modification, or repair by anyone other than LCI or its authorized representative;

(3) any accident, misuse, neglect, or negligence after shipment; or

(4) damage due to uncontrollable external events or acts of God.

All payments must be made according to the agreement terms to activate this warranty. Warranties will commence for the remainder of the Warranty Period upon payment of any balance due LCI.

THE EXPRESS WARRANTIES MADE HEREIN ARE EXCLUSIVE AND ALL OTHER WARRANTIES, EXPRESS, STATUTORY OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE DISCLAIMED. IN NO EVENT SHALL LOCHABER CORNWALL, INC. OR ANY OF ITS SUBSIDERARIES BE LIABLE FOR ANY CONSEQUENTIAL DAMAGES (SUCH AS SPECIAL OR INDIRECT) NOR FOR ANY LOSS OF PRODUCTION OR OTHER LOSSES arising out of, resulting from, or in any way connected with its work, the performance of the Equipment, any failure of the Equipment or any breach of the agreement.

LCI Furnaces
DIVISION OF LOCHABER CORNWALL INC

675 N. Eckhoff St., Ste D
Orange, CA, USA 92868
(714) 935-0302 x250
(714) 935-9809 Fax

EC CONFORMITY DECLARATION

We, Lochaber Cornwall, Inc., 675 North Eckhoff Street, Orange, California, USA, Ph:+ 1.714.935.0302, Fax +1.714.935.9809) declare that the

Product: Continuous Belt Infrared Furnace
Model LA-309N
s/n 1303091201

to which this declaration relates is in conformity with the following standard(s) or other normative document(s):

- Council Directive 2004/108/EC on Electromagnetic Compatibility (EMC)
  Annex I , 1 Protection & 2 Specific requirements for fixed installations
- Council Directive 2006/42/EC on Machinery Safety (MSD)
  - Annex I, Essential health and safety requirements relating to the design and construction of machinery, General Principles, sections 1.1.1 Definitions, 1.1.2 Integration, 1.2 Control systems, 1.3 Protection against mechanical hazards, 1.4 Required characteristics of guards and protective devices, 1.5 Risks due to other hazards, 1.6 Maintenance & 1.7 Information
- Council Directive 2006/95/EC on Low Voltage Equipment Safety (LVD)
  - Annex I Principal Elements of the Safety Objectives

The product complies with all safety relevant provision referring to:

- Controls
- Protection against mechanical hazards
- Required characteristics of guard and protection devices
- Protection against other hazards such as electrical, fire, noise and vibration

The Technical Construction File(s) required by this directive are maintained at the corporate headquarters of Lochaber Cornwall, Inc., 675-D North Eckhoff Street, Orange, California, USA.

The authorized representative located within the Community is:
Bita Electronique S.A., 45 Rte D'Arlon, LU-1140, Luxembourg Ville, Gr. D. Luxembourg,
Ph: +352.45.0010, Fax: +352.33.2343

The CE mark on the machine is affixed according to the EC directive 89/392/EEC. If the machine is modified without the agreement of the undersigned, this declaration becomes invalid.

Date of Issue: November 9, 2012

Place of Issue: Orange, CA, USA 92868

Lochaber Cornwall, Inc.

James Clark, President

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0.1 Furnace Description

The LA-309 is a computer controlled near-infrared, conveyor belt furnace for laboratory and production thermal processing in the range of 100-1000 ^{0}C in a controlled atmosphere, free of outside contamination. Your furnace may be configured for a maximum 600 ^{0}C temperature operation. Process gas may be CDA, N_2 or another inert gas. Dual gas furnaces may use Nitrogen and a second gas such as Forming Gas (pre-mixed N_2/H_2) or another type of reducing gas injected into the heating chamber.

Figure 0-1 Furnace Front Elevation

The LA-309 furnace transports product on a 240 mm (9.5-inch) wide belt. In the standard design the chamber clearance above the belt is 50 mm (2 inches). Optionally the furnace can be ordered with 25 mm (1-inch) or 100 mm (4-inch) vertical clearance above belt. LA-309 furnaces feature a hermetically sealed heating chamber permitting control of the furnace chamber process environment. Baffle sections before and after the heating section contain curtains that hang down to just above the belt to further isolate the furnace chamber from the room atmosphere and from the cooling section.

The LA-309 can process substrates, wafers, PCBs, metal, ceramic, glass or polycarbonate parts for electronic package sealing, thermo-setting polymer curing, reflow soldering, hybrid/thick film firing, brazing, annealing, tempering and metal sintering applications, or almost any kind of general thermal processing requiring repeatable precision temperature control in a controlled atmosphere environment.

0.2 Furnace Views

Figure 0-2 Furnace Rear Elevation

Figure 0-3 Entrance Elevation

Figure 0-4 Exit Elevation

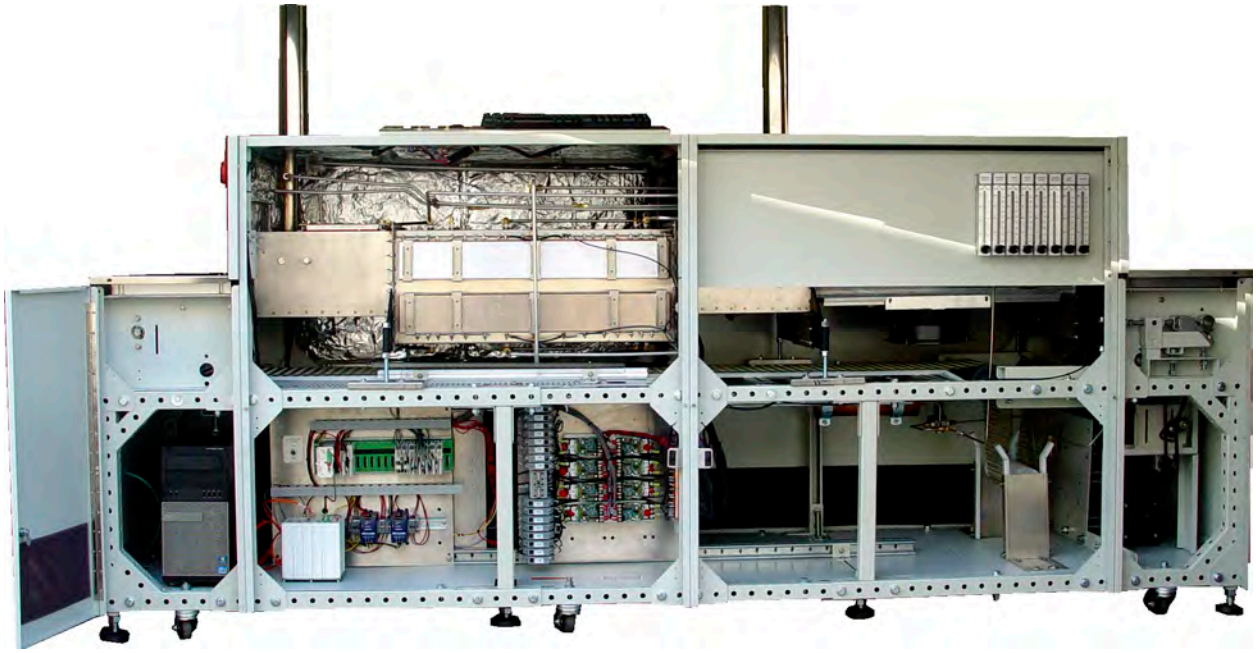

Figure 0-5 Front All Panels Off

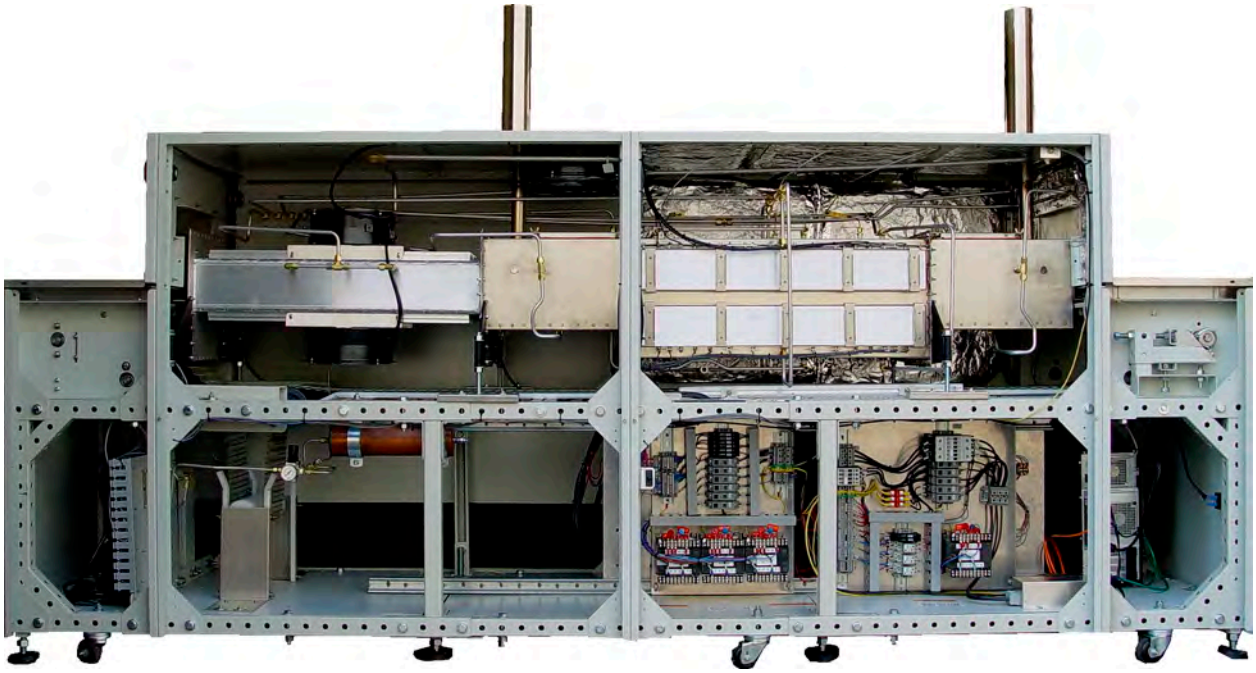

Figure 0-6 Rear All Panels Off

0.3 Furnace Elements

0.3.1 Furnace Arrangement

Parts are carried from the load station through the heating and cooling sections of the furnace to the unload station on a mesh belt driven by an adjustable speed motor.

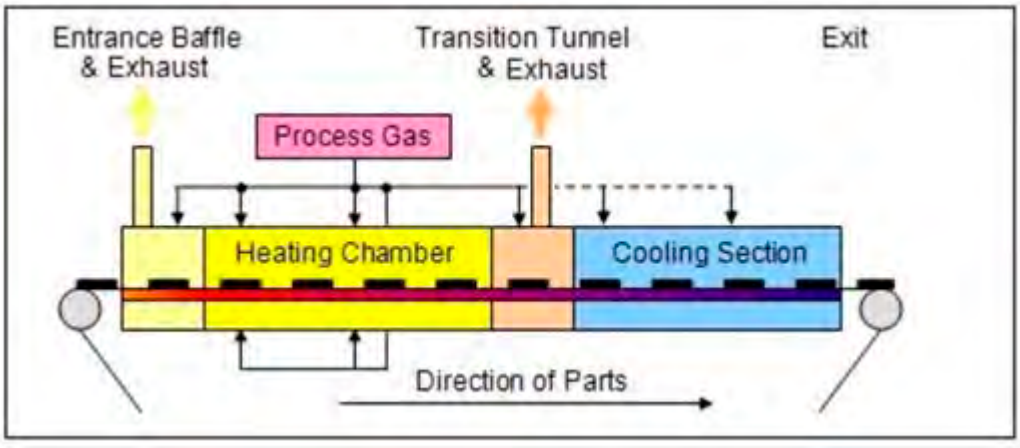

Figure 0-7 Process Sections

Process atmosphere is controlled much like a clean room: pressurized gas is pushed through the heating chamber insulation providing a pre-heated, laminar flow for a uniform, stable atmosphere.

The heating chamber is divided into zones separated by insulation dividers so that adjacent zones can have different setpoint temperatures if required. Control starts with K-type thermocouples in each zone quickly sensing changing conditions and feeding these signals to individual digital PID controllers for each zone. The PID loop controllers drive arrays of IR quartz heating lamps inside the heating chamber so as to maintain the desired temperature setpoint in each zone.

Product cooling is by radiant cooling and CDA or N2 gas convective cooling in an enclosed tunnel, with exterior fan heat removal.

0.3.2 The Process Chamber

The process chamber contains an entrance baffle with an eductor equipped exhaust stack, an IR heating section, a transition tunnel with exhaust stack between the heating and cooling sections, and a closed atmosphere cooling tunnel, arranged as shown here:

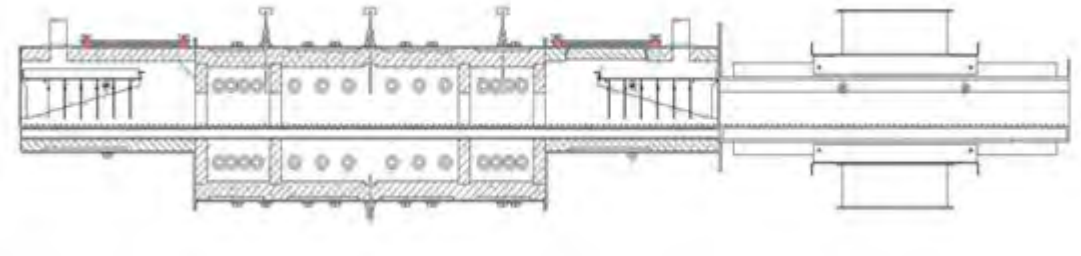

Figure 0-8 Furnace Internals

Together, the individual sections function as a unit to provide a carefully controlled gas atmosphere, precise temperature profile and two-stage controlled atmosphere cooling.

0.3.3 Entrance Baffle and Exhaust Stack

The entrance baffle isolates the heating section from the ambient air outside the furnace entrance. It is housed in a welded stainless steel shell lined with ceramic fiber insulation. An N_2 or CDA gas curtain and a series of hanging stainless steel baffle plates serve to act as a thermal barrier as well as purge the baffle and block ambient air from entering the furnace.

A venturi-assisted exhaust stack, known as an "eductor", draws furnace gases across a removable drip tray to prevent exhaust condensation from falling into the baffle section and contaminating the product.

0.3.4 Heating Chamber

The furnace chamber is similar in construction to the entrance baffle and may be hermetically sealed with plenum box covers over the lamp ends. Inside this section, arrays of tungsten filament quartz heating lamp tubes located above and below the belt, generate intense near-wave (sometimes called "short-wave") infrared light with a color temperature of 2500 K (peak wave length of 1.16 µm). These lamps are very efficient heaters with very fast response times, producing up to 600W per lamp at full power and capable of heating the furnace chamber to a state of equilibrium within minutes.

Lamp Arrangement. The lamps are arranged symmetrically above and below the belt. The top and bottom lamps may be used independently or together to provide the best possible heating configuration for any particular process. See 802-101500 Power and Current datasheet in Section 5 for the distribution of lamps and available power in each zone.

Chamber Process Gas. Process gas (CDA, N_2 , FG or other gas) is preheated before reaching the furnace interior by allowing it to permeate through the hot porous ceramic fiber insulation. This method of gas distribution does not affect the temperature profile and helps keep the furnace interior clean.

Zones. The heating chamber is partitioned into 3 separate zones using ceramic fiber dividers. The dividers are designed with the smallest possible opening consistent with the part parts clearance specifications. This partitioning assures very high thermal isolation between zones. Although the heating profile across the belt is extremely uniform, heat losses through the furnace side walls and at the belt edge supports produce a temperature drop near the edges of the transport belt. Away from the extreme edges of the belt, overall temperature uniformity across the belt will be $\pm 3\ ^{0}C$.

Temperature Measurement. Inside the furnace chamber, at the top center of each zone a type K thermocouple measures the temperature in that zone and provides feedback to each respective zone PID controller to determine the amount of power necessary to maintain setpoint temperatures. However useful these thermocouples are for controlling the temperature in each zone, the actual part is exposed to three heat transfer methods. As with any furnace, the most accurate way to determine what temperature product on the belt actually sees from these three methods of heat is to profile the furnace with a thermocouple placed directly on the product surface.

Heat Transfer Methods. Transfer of heat in the furnace is by three different methods: Radiation, Convection and Conduction. In order of their contribution to heating the product, these methods are:

A. Radiation

The furnace lamps emit infrared electromagnetic waves which, when striking and absorbed by product on the belt, cause its temperature to rise. This is the way "heat lamps" and microwave ovens work, and also the way the sun heats the Earth. The infrared radiation does not directly heat the process gas within the furnace.

B. Convection

During operation, lamp radiation heats the chamber top, bottom and side wall insulation. As the process gas enters the furnace through the porous ceramic insulation, it is heated to near the setpoint temperature of the zone. This flow of heated gas transfers heat to the product on the belt. This is how a hair dryer or home forced air heating works.

C. Conduction

Lamp radiation heats the transport belt which becomes a heat source for the product supported on the belt. This is how a hot plate heater works.

0.3.5 Controlled Atmosphere

LCI furnaces are equipped with the ability to supply constant streams of a supplied process gas. This feature allows the user to reduce product oxidation or contamination, remove process effluents or reduce other potentially negative effects of ambient air at high temperatures.

A controlled atmosphere also helps establish higher consistency in thermal processes. When a product travels through the process section, slight changes in the atmospheric conditions in a non-controlled atmosphere environment can affect the stability and consistency of the product temperature profile.

0.3.6 Transition Tunnel

The transition tunnel separates the furnace chamber from the closed atmosphere cooling tunnel. The transition tunnel is constructed using the same materials as the furnace section to minimize thermal stresses to the product caused by excessive cooling rates. Convective gas cooling of product is produced by the controlled flow of process gas into this tunnel. A series of hanging stainless steel baffle plates serve to act as a thermal barrier and help contain the furnace atmosphere. An eductor powered exhaust stack can aid in balancing the furnace.

0.3.7 Closed Atmosphere Cooling Tunnel (CACT)

This section is constructed of extruded aluminum heat sink material and is not insulated. Inside, a carefully controlled atmosphere of CDA or N2 gas is maintained to cool the product to a safe temperature. Fans mounted on the exterior of the CACT transfer heat to the air inside of the furnace cabinet. This cabinet air is then exhausted by cabinet fan through an opening in the furnace top cover into the room or for removal by facility exhaust ducting.

To prevent drafts and ambient air from entering the CACT, a hanging stainless steel baffle plate is mounted directly to the CACT exit.

0.3.8 Control System

This control system is comprised of a programmable logic controller (PLC) and an computer interface (HMI) described in greater detail in Section 2.

0.3.9 Cabinet Fans

Cabinet Fan. The furnace is equipped with one (1) 10-inch diameter fan mounted on the underside of the top of the furnace cabinet. This fan exhausts heat emitted from the outside of the furnace chamber and cooling tunnel into the room or customer installed exhaust system.

Cooling System Fans. The CACT cooling tunnel is cooled by fans mounted outside the top and bottom of the tunnel. Cabinet air is forced over the cooling tunnel to remove heat transferred from the tunnel interior. This air is evacuated via the cabinet fan.

0.3.10 Transport Belt

The standard conveyor belt is of stainless steel. For high temperature applications (>450°C) the conveyor belt is a close weave Nichrome-V belt manufactured from high temperature wire comprised of 80% nickel and 20% chromium. This belt offers fast heat-up times, more uniform operating temperatures and excellent mechanical stability. This belt exhibits minimum shrinkage, growth, sag or distortion in use.

0.3.11 Motor

The transport drive motor assembly is typically mounted near the exit of the process section. Depending upon belt width, product mass, product number and belt speed, the motor-sprocket may appear different than the example shown in Figure 0-9 Transport Drive Motor.

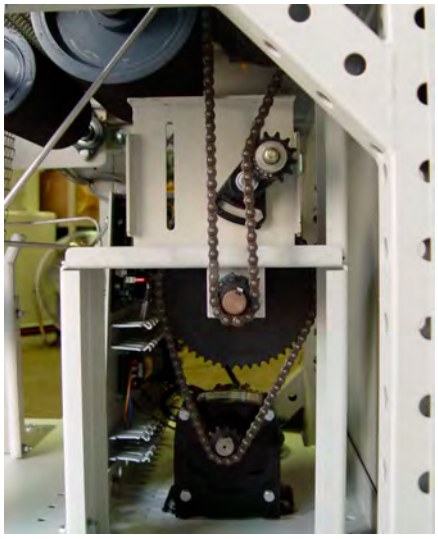

Figure 0-9 Transport Drive Motor

0.4 Advanced Features & Options

0.4.1 Low Pressure Alarms

Figure 0-10 Pressure Switch

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

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

Table 0-1 Initial Alarm Settings

Manifold	Process Gas	Pressure	
Gas 1	Nitrogen or CDA	55-60 psi	3.8-4.1 Bar
Gas 2	Nitrogen, Forming Gas or other (Dual Gas option only)	55-60 psi	3.8-4.1 Bar
Gas 2	Hydrogen (H_2 option only)	55-60 psi	3.8-4.1 Bar

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

0.4.2 Sample Ports

❒ **Option supplied: One port and connection on Zone 3**

This option includes control enclosure port connection to one or more of the sample ports located on the underside of each zone. Allows connection of an oxygen analyzer, moisture analyzer or other gas analyzer. Must be used with a sample pump (not included). Port connections are be located under chamber . Figure 0-11 shows a typical port location on a chamber.

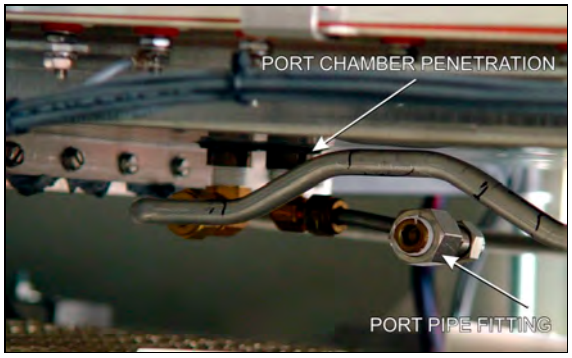

Figure 0-11 Sample Port Chamber Penetration

0.4.3 Oxygen Analyzer (option, not supplied)

Includes process oxygen analyzer with electrochemical RACE™ cell and internal sample pump (0.1-0.5 L/min sample rate). Measuring range: 0.1-1000 ppmv. Features microprocessor controlled functions, large auto-ranging LED display, and fast response. To avoid interference, must indicate if hydrogen gas will be present.

Figure 0-12 Oxygen Analyzer

Figure 0-13 O2 ppmv on Process screen

0.5 Options

0.5.1 CB-1 Circuit Breaker (option, ❒ not supplied)

A special high-power circuit breaker is inserted in the supply power lines with access at the rear of the furnace on the back or side of the Control Enclosure. See Figure 0-14.

Figure 0-14 Control Console showing 3 options: Circuit Breaker; Dual Process Gas; & Sample Port

Figure 0-15 Controls for Supply Gas Mixing System. (Only available on Dual Gas Furnaces)

0.5.2 Dual Gas (option, ❒ not supplied)

Includes separate manifold for supply of a separate gas to the furnace heating zones. Gas 1 can be CDA or nitrogen supplied to eductors, entrance baffle, transition tunnel, lamp seals, and the cooling system. Gas 2 is usually nitrogen, forming gas or other specialty gas. See Figure 0-14.

0.5.3 Supply Gas Mixing (option, ❒ not supplied)

Includes two (2) pressure regulators with pressure gauges and flowmeters to allow switching between Gas 1 and Gas 2 supply to furnace heating zones. Users can adjust for 100% forming gas to the furnace for critical reducing operations and later switch to nitrogen to save higher cost specialty gas. User can also adjust flowmeters to increase amount of nitrogen in the forming gas mix. See Figure 0-15.

0.5.4 Auto Gas Shutoff (option, ❒ not supplied)

This furnace may be equipped with Auto Gas Shutoff. The Auto Gas Shutoff feature consists of solenoid valves on the process gas supply lines integrated with the furnace. These valves open and allow Process Gas to flow when Controls Green (ON) button 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 Controls red (OFF) button. When the Cool Down timer expires, the furnace shuts down and the process gas valves close.

The Auto Gas Shutoff valves fail in the closed position.

0.5.5 Independent Over Temperature Alarm Operation (option, ❒ not supplied)

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

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

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

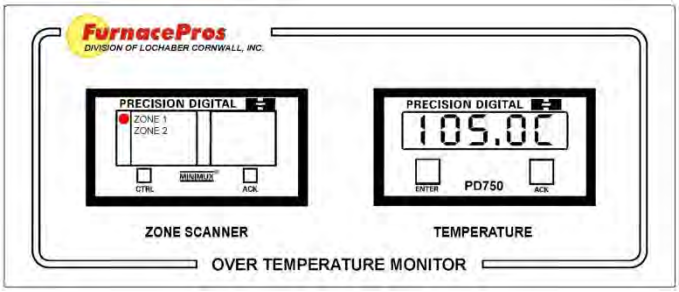

Figure 0-16 Over Temperature Monitor

0.5.6 Cabinet Temperature (option, ❒ not supplied)

A secondary thermocouple is attached near the center of the heating chamber between the chamber and the outside panel. The sensor is attached to and indicator to allow the user to monitor the cabinet temperature, which can reveal possible cabinet fan failure, or blocked air inlets or exits.

0.5.7 CE European Certification option, ❒ supplied)

A strict implementation of CE requirements is followed according to the following documents:

Directive 2004/EC on Electromagnetic Compatibility

Directive 2006/42/EC on Machinery Safety

Directive 2006/95/EC on Low Voltage Safety

The following supplemental options are also added to achieve the standard:

Line Filter

European standard wiring

0.5.8 Line Filter (option, ❒ supplied)

An AC line filter reduces the potential electrical interference generated by SCRs and motor controls within the furnace. Compliant with IEC 60950. This option is standard for European operators who purchased CE.

0.5.9 Low or High Belt Speed (option, ❒ standard supplied)

Standard belt speed is 5-500 mm/min. Alternate belt speeds can be offered increasing or decreasing the current min/max belt speed. Special conveyor belt speeds require changes to motor speed, power and gearing for this option.

0.5.10 Ultrasonic Cleaner/Dryer (option, ❒ not supplied)

The ultrasonic belt cleaning system removes contamination that accumulates on the belt during normal furnace operation. This system includes an ultrasonic tank, belt dryer and timer system to enable automatic cleaning of the belt. A fan-driven air blow-off removes water droplets and can be provided with an optional heater to further drive moisture from the belt. The belt is drawn through an ultrasonic tank that is automatically filled and drained by a timer and control circuitry. The cleaning/drying of the belt takes place when the furnace is off-line. This option requires connection to facility water source and water drain.

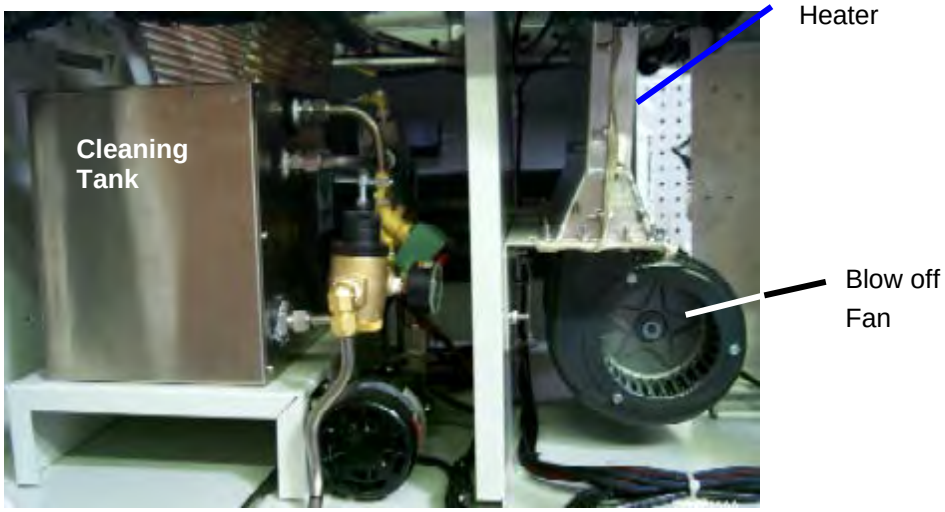

Figure 0-17 Ultrasonic Cleaner installation

0.5.11 UPS (option, ❒ not supplied)

This option adds an uninterruptable power supply to keep the belt, fans, and control system running for at least twenty minutes during a power outage. The transport belt continues to run at set speed which minimizes product loss during brief power failures. The unit automatically switches from standby to process start upon restoring power, whether provided by generator backup or city power.