3 Furnace Overview

3.1 Terminology

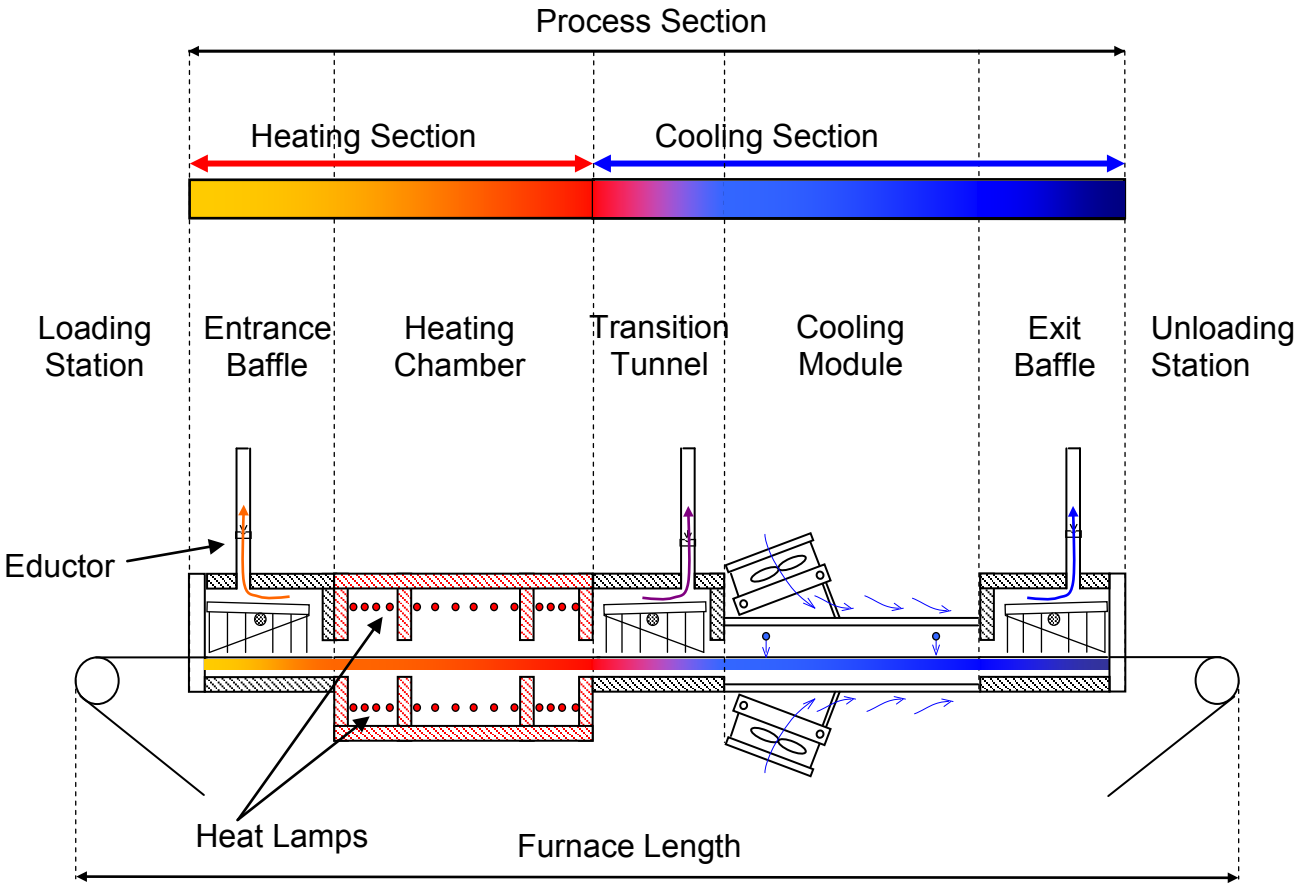

Figure 3-1: Furnace Nomenclature

Review the following terms in the glossary:

Cooling Section	**Heated Length**	**SCR**
Drip Trays	**Heating Chamber**	**Stack**
Eductor	**Heating Section**	**Thermocouple**
Entrance Baffle	**Plenum**	**Throat**
Flow Meter	**Plenum Box**	**Transition Tunnel**
Furnace Length	**Process Environment**	**Zone**
Gate	**Process Gas**	
Heat lamp	**Process Section**	

3.1.1 General Area Descriptions

Control Panel

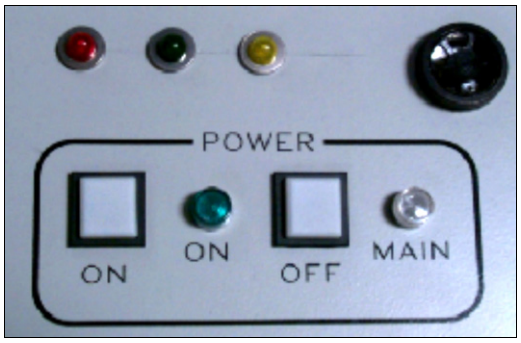

Figure 3-2: Control Panel

The control panel is the central location of main power control, alarm speaker, and if so equipped, ultrasonic cleaner/dryer power lights, as well as any cooling fan power dials. The PC keyboard/mouse pad and USB port are also here.

Safety Enclosure

The safety enclosure contains the system components that supply lamp and control panel power. Useable 110 VAC power for the computer is also provided here.

Figure 3-3: Safety Enclosure

Lower Electric Panel

The lower electric panel houses additional transformers to provide DC power throughout the furnace including any of the installed options such as an ultrasonic dryer or a light tower.

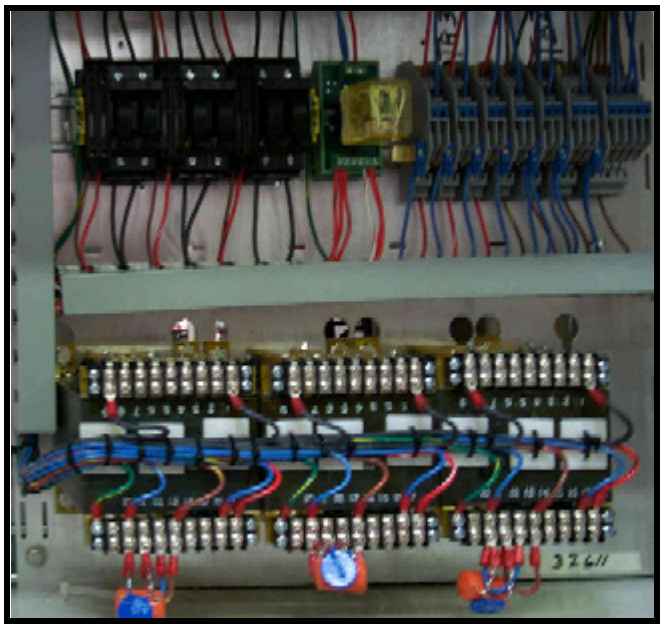

Figure 3-4: Lower Electrical Panel

SCR Panel

The SCR panel regulates the actual power applied to the heat lamps in response to signals from the PLC controller. The number of fuse relays and SCR control blocks varies based upon the furnace configuration and owner/user processes and requirements.

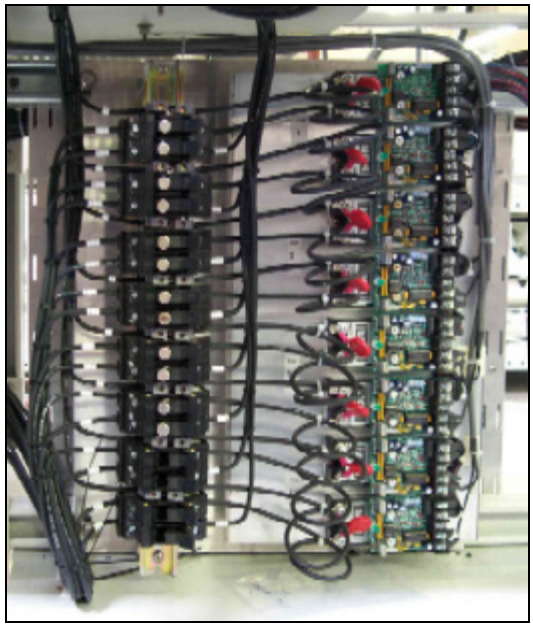

Figure 3-5: SCR Panel and Fuses

3.1.2 Element Monitor

A panel containing the element monitor boards and controller interface hardware is typically installed on the front of the furnace next to the PLC controller. Depending upon the number of heat lamps installed, each panel can have a different number of monitor boards and control modules.

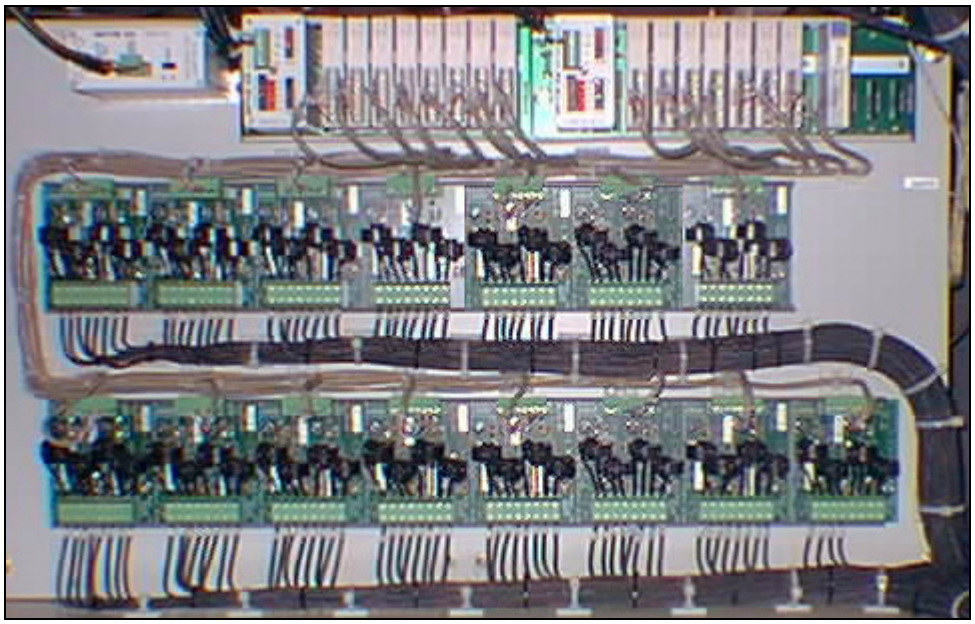

Figure 3-6: Element Monitor Installation

3.1.3 Motor

The 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 3-7: Conveyor Belt Motor.

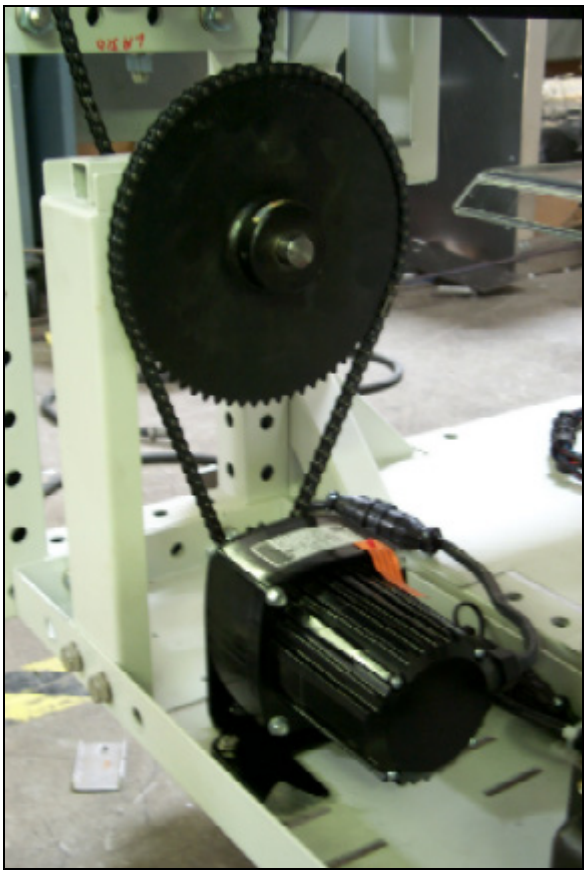

Figure 3-7: Conveyor Belt Motor

3.2 General Furnace Layout

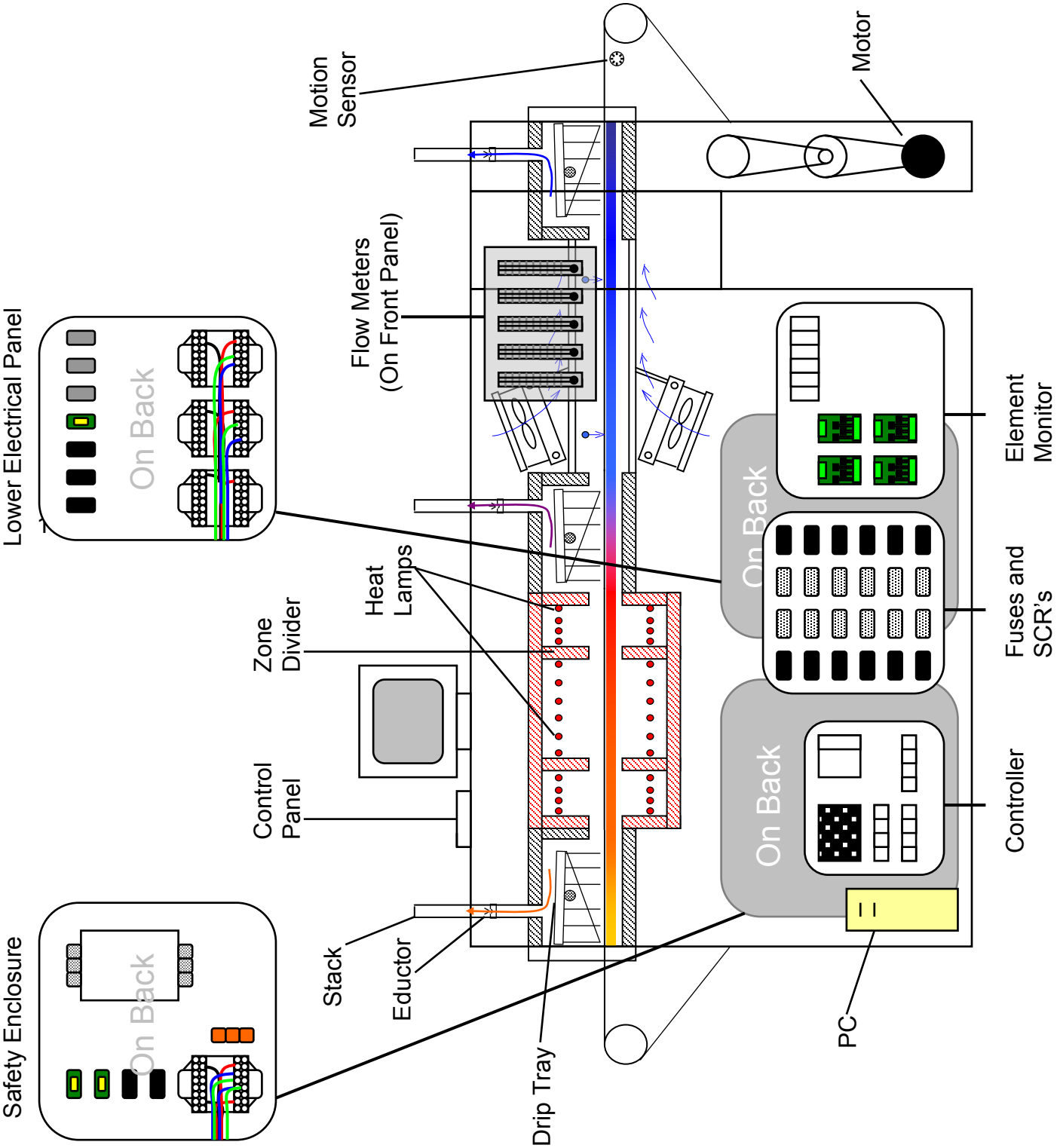

Figure 3-8: Furnace Layout

3.3 Thermal Process

3.3.1 Temperature Profile

A temperature profile represents multiple temperature measurements taken at close intervals over a period of time through the length of the furnace. Figure 3-9 below shows an example temperature profile inside the furnace.

*Notice that the green horizontal lines define the setpoint temperatures, yet the **thermocouple** (temperature recording devices) readings do not reach the actual setpoint temperature inside each zone. Also notice that the product peak temperature may be achieved well inside the cooling section.*

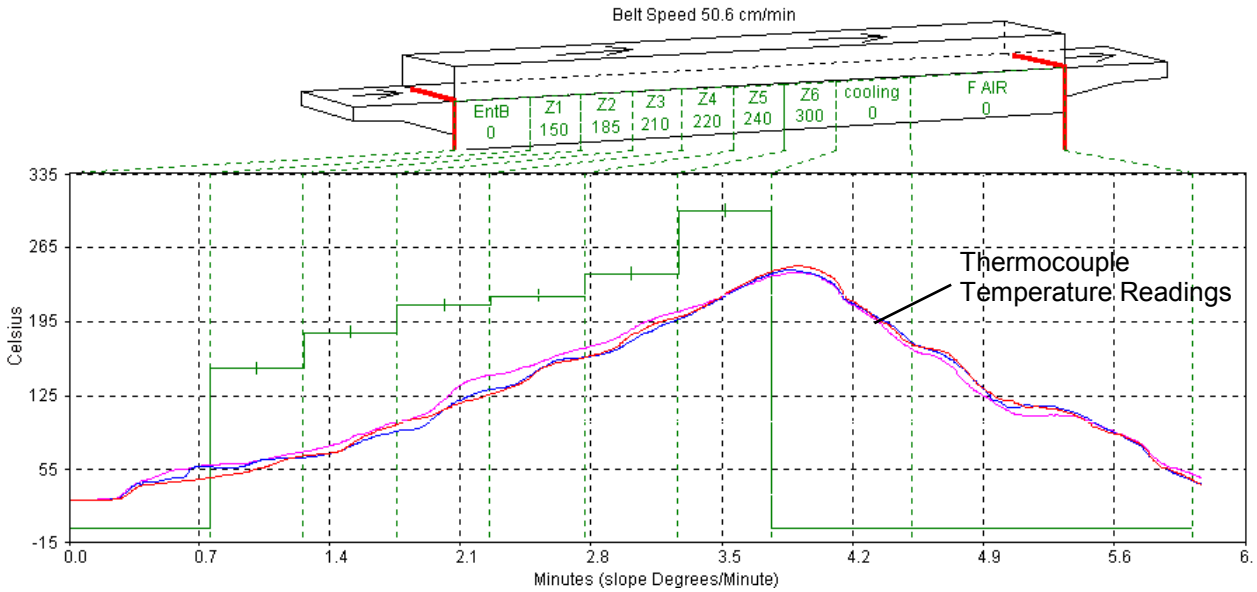

Figure 3-9: Temperature Profile Example

The temperature profile will be affected by the product material, mass and process gas. For example, a furnace with a controlled atmosphere cooling module installed can cool the product while in a pure nitrogen gas environment. The same temperature profile could be achieved with a forced-air cooling module, but could subject the product to a potentially hazardous oxidizing environment at elevated temperatures.

Prior to shipment, all furnaces undergo a temperature profile test. In this test, typically three thermocouples are sent through the furnace located on the conveyor belt at the center and each side. All furnace zones are programmed at the furnace owner's prescribed setpoint temperature and allowed to reach steady state. The thermocouple readings are expected to remain within 5% of one another. While this test is performed at the factory, it should also be performed at startup and periodically thereafter to assure that the desired temperature profile can be maintained.

3.3.2 Process Overview

Thermal Process

The **thermal process** is the idealized process description for a particular product as it passes through the process section, including the product temperature profile and process environment. When establishing the thermal process, a consistent temperature profile is just as important as establishing the correct process environment.

Each dissimilar product that passes through a FurnacePros furnace will likely utilize a different thermal process. Engineering design and empirical testing are the best methods of achieving the best thermal process.

Recipes

Once a specific thermal process has been established with correct zone setpoint temperatures, gas flow rates and conveyor belt speed, they can be stored in a recipe. The recipe is a set of instructions that can be stored in the computer and sent to the controller to achieve the predetermined process. The recipe also defines alert and alarm conditions based on furnace owner operator requirements to maintain product quality. The uncomplicated furnace software interface on the PC facilitates changes between recipe settings as well as modifying and saving them easily.

Recipes and how they are managed is covered in more detail in Section 5.5.3 p.47.

3.3.3 Controlled Atmosphere (Option ❒)

Many 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.

Controlled atmosphere is discussed further in Section 4.5 p. 29 as well as presented in a detailed approach in Chapter 9: Process Engineering.

3.4 Furnace Options Listing

3.4.1 Board Transfer Systems

SMEMA (Option ❒)

This option incorporates special protocol as outlined by the Surface Mount Equipment Manufacturers Association. The mechanical specifications outlined by this specification are consistent with standard furnace equipment. Additional wiring for SMEMA electrical equipment interface standard is added to transmit signals to loading and unloading systems. Product sensors are required to perform this function.

Product Sensor (Option ❒)

An overhead sensor determines if a product is present. This sensor can be used in conjunction with the SMEMA standard option or with product tracking monitoring up to three lanes, as discussed in Section 5.7.4, p.54.

Figure 3-10: Photoelectric Product Sensor

3.4.2 Brush Belt Cleaning System (Option ❒)

This option adds a passive brush cleaner. The belt drive pulls the belt through several planar brushes to remove loose particles.

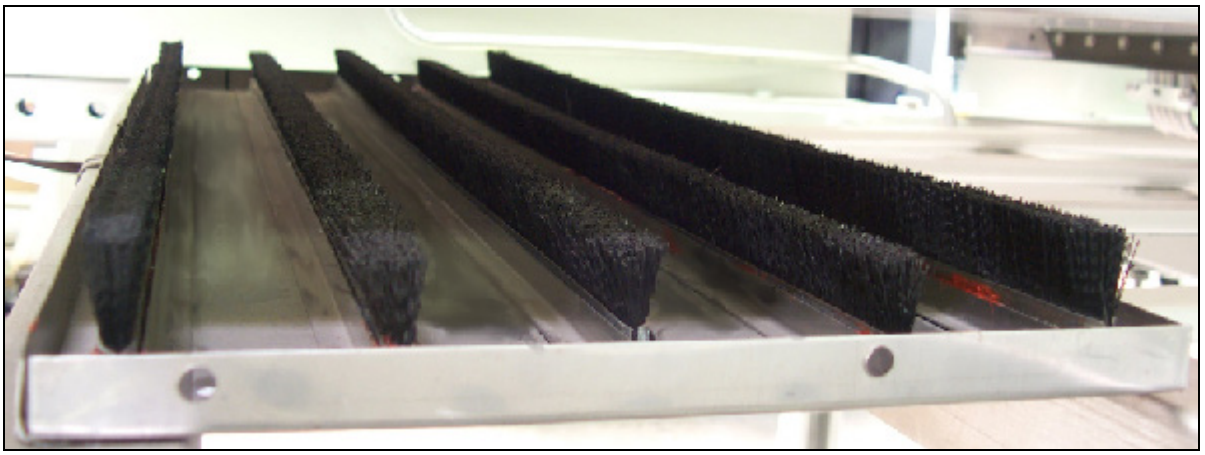

Figure 3-11: Brush Belt Cleaning System

3.4.3 Cabinet Temperature

Figure 3-12: Circuit Breaker Option

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

3.4.4 Circuit Breaker (Option ❒)

A special high-power circuit breaker is inserted in the supply power lines with access at the front of the furnace near the PC installation. Only the switch is visible from the front panel, with protective sheet metal guards surrounding it.

3.4.5 European Certification CE (Option ❒)

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

CE Compliance to Machinery Directive Annex 1, 89/392/EEC
Safety of Machinery - Electrical Equipment of Machines Part 1-EN60204-1

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

Operation Manual in European Language
Circuit Breaker
Line Filter

3.4.6 Lexan Shields (Option ❒)

FurnacePros follows a strict implementation of CE requirements as outlined in the following documents:

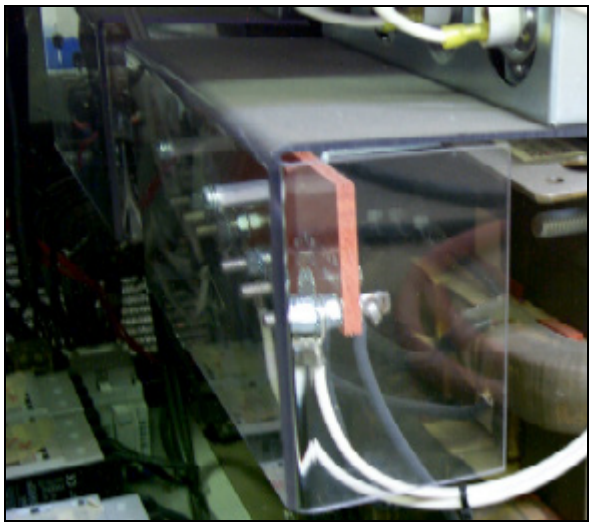

Figure 3-13: Lexan Shields

3.4.7 Line Filter (Option ❒)

An AC line filter reduces the electrical circuit noise by attenuating line voltage and limiting power fluctuations. This option is standard for European operators who purchased CE.

3.4.8 Low / High Belt Speed (Option ❒)

Specified special conveyor belt speeds require changes to motor speed, power and gearing for this option.

3.4.9 Light Tower

Basic (Option ❒)

Figure 3-14: Standard Light Tower Option

The light tower is supplied to provide a visible indicator of the condition of the furnace.

Green Light –	Process Ready
Amber Light –	Furnace Warming Up Furnace Cooling Down
Red Light –	Furnace Alert or Alarm
No Light –	Process Off

Process Gas Indicator (Option ❒)

A special light tower can be added to reflect N_2 gas operation.

White Light –	CDA
Blue Light –	N2 Gas

3.4.10 Quartz Standoffs (Option ❒)

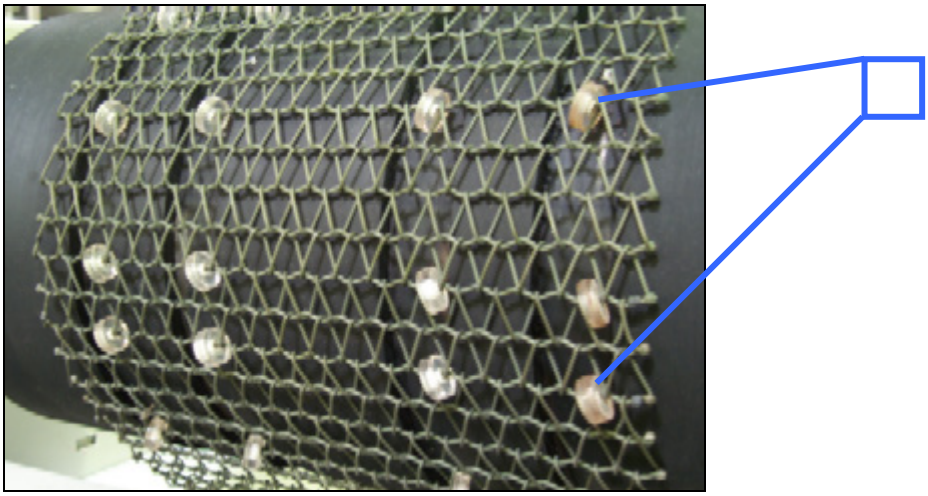

Figure 3-15: Conveyor Belt Shown with Quartz Rollers

Inset, Figure 3-15: Quartz Rollers – detail

The primary purpose of the quartz standoffs is to eliminate all contact between the customer product and the metal conveyor belt, as some substrates chemically react when in contact with metal at elevated temperatures. Additional polymer guides and rollers are added, and special, rubber coated entrance and exit drums are installed. This way, the outsides of the quartz standoffs do not contact any metal part while passing through the furnace, preventing indirect metal contamination. This option also increases belt life.

3.4.11 Thermocouple Wheel Assembly (Option ❒)

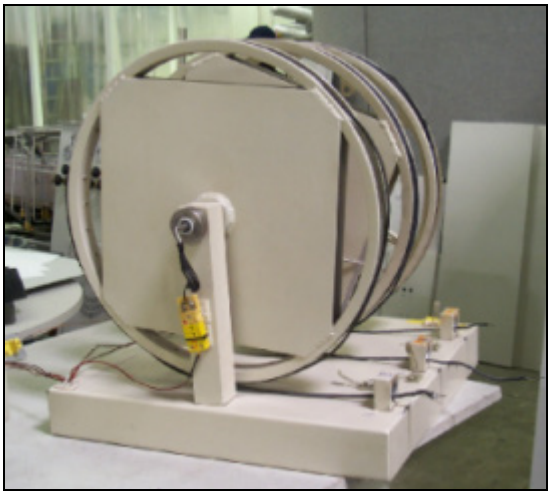

Figure 3-16: Thermocouple Wheel Assembly - 3 T/Cs

This option provides a quick and easy-to-use assembly of from 1 to 3 thermocouples for use in performing temperature and thermal process profile tests. The wheel assembly can be placed at the furnace entrance to enable thermocouples to be drawn through the furnace automatically. Once tests are completed, the thermocouples and heated wire cables can be retrieved safely.

3.4.12 Ultrasonic Cleaner/Dryer (Option ❒)

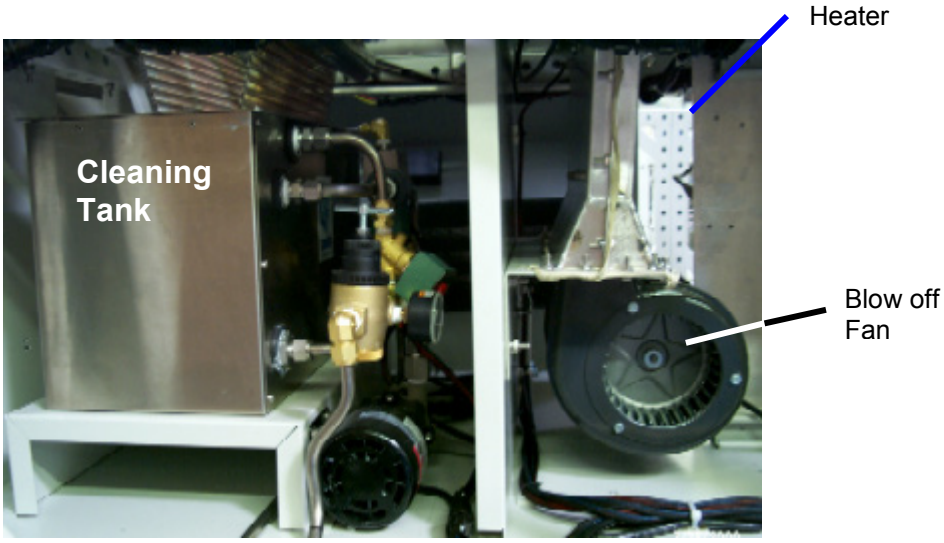

Figure 3-17: Ultrasonic Cleaner and Dryer installation

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.

3.4.13 UPS (Option ❒)

Figure 3-18: Uninterruptable Power Supply

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. The control software includes modification to add automatic reset without using the normal power up and screen menu selection process, so that immediate restart is available after power interruption.