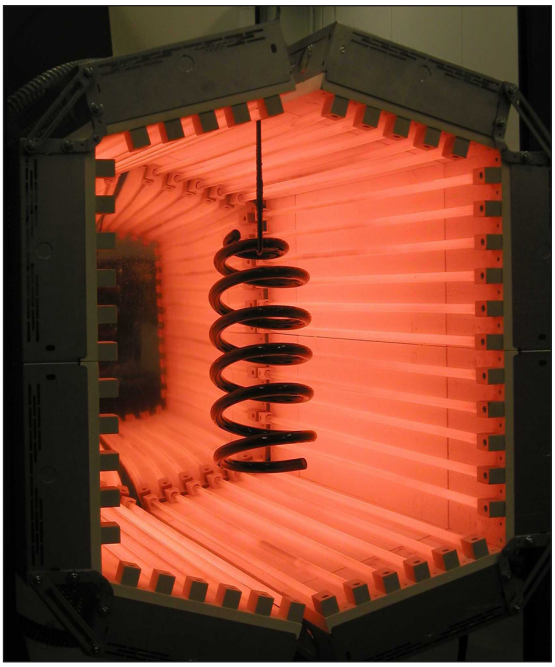
Please select from the Table of Contents

Process Heat Ovens

Process Heat Ovens

A Guide To Selecting Your Process Heating Needs

Need a new Oven or Heat Bank and don't know where to start? Infrared? Convection? Short-wave? Long-wave? Medium-wave? Gas? Electric? For most people, specifying and purchasing a new Heat Bank or Oven is not an everyday task, and sorting through the hype and conflicting advice to select and specify the heating equipment for an application can be the most difficult part of your process. But it can be easy if you start by giving us the information we need.



Fostoria Sales Engineers can help determine what you need, but usually we won't know your processes and production needs like you do. Rather than first selecting the heat bank or oven type and then trying to fit it to your application, we start by defining what needs to be done and then look for the heating system that will do your process. In most cases, when your process requirements are described in sufficient detail, your heating selection will be obvious.

Step 1: COLLECT INFORMATION

The first step is to clearly define all the products that will be processed in the heat bank or oven, including dimensions, shapes, materials, weights and your part's temperature limits.

Second, identify the heating category that best describes your process - each has its own requirements and characteristics that will dictate a specific type of heat bank or oven. Some of the major categories are:

- **Drying** – Removing water or solvent from a material, product or coating.
- **Curing** – Bringing a product or coating up to a specified temperature to cause a chemical reaction.
- **Preheating** – Raising the temperature of a product prior to another operation such as forming, coating, laminating, pressing or welding.
- **Annealing** – Heating a metal or plastic part through a specific time/temperature profile to achieve better material properties.
- **Shrinking** – Applying heat to plastic parts such as tubing to cause them to shrink around another part.

Many heat-processing applications involve a coating or adhesive that is dried or cured. The amount of coating or adhesive being used and its specific temperature characteristics impact oven selection, so the customer must find out what product will be used, along with its processing requirements. Solvent-based, water-based, powder, high solids, plastisol and catalyzed coatings have different heating requirements that the oven designer must consider. Also, we need to know the coating thickness, solvent or water content, and the amount and types of emitted vapors.

Step 2: TEMPERATURE PROFILE

The process time/temperature profile needed, required temperature tolerances and how the temperature will be measured during actual processing also affect heating equipment choice. In many cases you may be working with a new process and may not know the time/temperature profile or tolerances required to produce a consistent, quality product. Fostoria Process Equipment will provide testing with different heating parameters. For example, the time temperature profile to cure a coating when tested in a convection oven will vary from a profile generated in an infrared oven. And, a profile generated in a short-wave infrared oven will be different from that generated in a medium or long-wave oven. The only way to determine these differences is to test your product in these various conditions.

Step 3: ACCEPTANCE CRITERIA

When the final process is defined, we will test for optimum methods to achieve the desired results. The parameters to be monitored will include:

- Final temperature
- Time and temperature
- Test for dryness
- Test for cure
- Test for appearance
- Test for physical properties

FOSTORIA INDUSTRIES application engineers will be glad to work with you on your process, whether it is new or existing. Please fill out the Application Data Form and e-mail or fax directly to Fostoria Process Equipment, and an application sales engineer will contact you for scheduling the tests in our state-of-the-art test facilities, and arranging for shipment of your product samples and finishes, etc. (or click on the Laboratory Test Box and complete the Lab Test Request Sheet).

Medium and Hi-Velocity Transco (Convection) Ovens

All objects are surrounded by a relatively still layer of air which acts as an insulator around the object. This layer of air is known as the boundary layer. When drying a finish on the surface of an object the vapors pass from the finish to the surrounding boundary layer of air which becomes heavily saturated with the vapors.

The principle behind Fostoria-Transco high velocity air drying is to impinge high velocity heated air against the finish to be dried through a series of slot nozzles at velocities up to 13,500 fpm. The high velocity air continuously removes the stagnant boundary layer of air surrounding the finish and replaces it with fresh heated air to dry the finish. This reduces the insulating effect of the boundary layer to an absolute minimum and enhances the transfer of heat into the finish. Because the finish is dried faster, the substrate is heated less, reducing the energy required and minimizing a variety of undesirable effects caused by heating the substrate.

In a Fostoria-Transco high velocity dryer heat is added only in quantities enough to pace the curing reaction of the finish. Air temperatures are generally in the 400° to 500°F range resulting in product temperatures in the 200°F range. It should be understood that Fostoria-Transco dryers are not ovens. Temperatures outside the direct path of the nozzle flow are moderate. Thus, the dryers provide drying or curing, but not cooking or baking.

To facilitate the large volumes of air being moved in the dryer, an exhaust plenum and blower are provided to draw the air away after impingement. Frequently, the exhaust air can be ducted to another drying stage for additional energy savings. The exhaust air may also be returned to the heat source and recirculated with only a small percentage being exhausted and most of the heat reclaimed.

For high velocity air drying to be effective, nozzle velocities should exceed 6,000 fpm. Fostoria-Transco high velocity dryers are available with velocities up to 13,500 fpm and our medium velocity dryers are in the 6,000to 9,000 fpm range. The key to obtaining these air velocity levels lies with the horsepower of the fan motors as well as the design of the dryer air floe system and slot nozzles. There are some drying applications which may require lower velocities such as thick coatings, skinning and blistering problems and special shaped parts. Whatever the application may be, it is important to match the dryer velocity with the particular drying requirements of the applications.

Advantages of High Velocity Air Drying

- **Energy Efficient**
  Energy is the key element in most industrial processes. Fostoria-Transco dryers inherently minimize the energy required to dry a finish. Unlike conventional convection dryers which require heating up an entire chamber, the heat in high velocity dryers is directly impinged onto the finish. This enhances the transfer of heat into the finish and significantly reduces the amount if heat required. The temperature outside the direct path of the nozzle flow is moderate. Also, high velocity dryers utilize only enough heat to pace the curing reaction of the finish, relying instead on continuous air impingement for drying.
- **Any Energy Source**
  Fostoria-Transco dryers can utilize gas, oil, high and low pressure steam, electric and electric infrared as heat sources. Steam, in some cases, can be provided by waste-fueled boilers
- **Faster Drying ... Less Floor Space**
  High velocity air drying is one of the fastest methods for drying a finish. Fostoria-Transco dryers will allow faster line speeds than conventional dryers

for the same finish drying requirement. If the line speed is fixed, then a Fostoria-Transco dryer will occupy less space (line length) than a conventional dryer for the same finish.

- **Versatile ... Any Finish Requirement**
  Fostoria-Transco dryers are custom designed to insure that the ideal temperature, nozzle spacing and air velocity are used based on the characteristics of the particular finish and substrate. The dryers can be used on a variety of solvent based coatings as well as high solids and catalyzed coatings. They are especially well suited for drying waterborne coatings. The dryer controls are fully adjustable, so in many cases the same dryer can be used for a variety of different coatings. Among the primary products for which Fostoria-Transco dryers are successfully used are: hardboard, wood, paperboard, metal, paper and fabric. These may be webs, sheets, or flat or shaped parts.
- **Safer ... Lower Operating Temperatures**
  Since Fostoria-Transco dryers evaporate solvents at lower temperatures than conventional dryers, they are safer to operate. The high volume air flow which is characteristic of the dryer's operation continuously removes solvents from the dryer to maintain a safe atmosphere.
- **Better Quality Finishes**
  The high volume, low temperature air drying in Fostoria-Transco dryers completely removes solvents from a coating for a superior finish. The solvents are removed before the coating surface hardens resulting in an extremely durable, blister-free finish. Also, all inlet and recirculated air is filtered prior to being heated and impinged on the surface finish. All of the air in the dryer enclosure then is free from dust and dirt particles to Insure clean, quality finishes.
- **Lower Operating Costs ... Low Maintenance**
  High velocity air drying has proven to be among the fastest, most efficient methods for removing solvents from a coating. By shortening time cycles and line lengths while reducing the energy required for operation, Fostoria-Transco dryers reduce operating costs. Maintenance costs are kept minimal since the dryers are designed to permit easy access and service of component parts.

Design Features

While each Fostoria-Transco dryer is individually designed to meet the drying requirements of a particular application, all of the dryers are equipped with certain standard design features which assure their operating efficiency and dependable performance.

- The dryer enclosure is constructed of heavy duty aluminized steel panels which are insulated with up to 6" of high temperature insulation. This insures that the heated air is confined within the dryer enclosure and directed to the product.
- Optimum design slot nozzles impinge the heated air onto the product. The spacing and sizing of these nozzles is dependent on the air velocity requirements of the application. The nozzles are designed to impinge an even, direct path of air flow onto the product to provide thorough, uniform product drying.
- Access doors extend the full length of both sides of the dryer to permit easy access to the dryer chamber for maintenance purposes. The access doors on one side of the dryer are hinged in such a way that they serve as explosion relief panels for safety purposes.
- Negative pressure is always maintained within the dryer enclosure to eliminate the possibility of any of the heated air escaping through the dryer entrance and exit openings

- A heat recirculation system continuously recycles the heated air after it is impinged onto the product. Only a small percentage of the air is exhausted and most of the heat is reclaimed. The heat recirculation system insures that Fostoria-Transco dryers provide maximum energy efficiency.
- A complete closed-loop control system to maintain the continuous, efficient operation of the dryer is provided. This system operates by monitoring the temperature of the heated inlet air and automatically modulating the temperature of this air to maintain a given set temperature within the dryer. Additional controls usually provided with the control system include interlock disconnect switches, purge timer, automatic ignition, overload protection and flame proof. Other special control devices can be incorporated with the dryer control system as required.

Laboratory Testing Facilities

Complete laboratory testing facilities are maintained at our Fostoria, Ohio headquarters. Here, customers are invited to send in or bring their product samples and finishing materials for testing on our laboratory equipment. Our testing laboratory is fully equipped with both high velocity air drying equipment and gas and electric infrared equipment along with accurate control and measuring devices. This makes it possible for us to determine the best solution for our customer's application problem and make sound heating equipment recommendations based on the results of the tests.

Electric Infrared Ovens

Electricity is the energy of choice for many industrial infrared applications. There are many reasons for its popularity, such as: installation cost, controllability, ability to produce high temperatures quickly, and it is a clean form of heat.

Electric infrared emitters provide flexibility in producing the desired wavelength for a particular application. Fostoria offers a wide selection of electric infrared heat sources to meet the various requirements of industrial applications. Each of the different types of heat sources has particular characteristics which determine the suitability of the heat source for a particular application.

For most applications, it is sufficient to know that short wavelength, tungsten filament sources (quartz lamps) provide high radiant efficiency, deep penetration and a fast rate of response. Medium and longer wavelength nickel chrome filament sources (quartz tubes and metal rods) are less radiant efficient, but are more rugged, less expensive, and in some cases provide the best wave length for the application.

Powder Coating Applications

As the coatings industry changes from solvent based coatings to newer, more durable and ecologically friendly powder coatings, the role of infrared heat becomes more pronounced.

Curing solutions that were once obtainable using a single curing source are no longer the best when dealing with powders. The use of a convection only cure system will have many disadvantages:

- Uses more energy for heat up, curing and cool down
- Requires longer curing times, slower line speed
- Much larger footprint in your facility
- Unresponsive to the flexibility needed to adjust heat zones for reduced energy consumption and processing different parts
- Convection air movement and by-products can create contaminates on coated parts.

By implementing an electric infrared booster oven prior to final curing, the surface can be flashed off quickly, initiating the gel (polymerization) of the powder. This will reduce inconsistencies in color, contamination and keep powder from being blown off of the part.

There are hundreds of powder formulations in use today. Film thicknesses range from under 1 mil to over 15 mil and the range of colors, gloss and applications is equally as vast. What these diverse powder formulations do have in common, is near-perfect compatibility with infrared radiation as a method of curing.

New technologies are continually improving finish chemistry. Precise, reproducible oven temperature control characteristics are needed to assure the potential of today's' new powder formulas are met. This is the custom control you get with electric infrared curing systems.

High Density Board - New BT Series

Fostoria has designed infrared modular sections that incorporate a custom hi-density refractory board, composed of aluminum silicate and other non-organic binders. These reflector boards are

especially useful in higher watt density
applications such as for curing powder coatings, and are self-cleaning in many operations.

High-density boards are capable of withstanding up to 100 watts per square inch and act also as a generator of medium wavelength infrared.

This greatly benefits the powder finishing and curing process. As the coating continues to cure, it in turn heats the product being coated, aiding in the acceleration of the curing process.

A wash cycle always precedes the application of a coating, and removal of residual water is essential before coatings are applied. A Fostoria oven rapidly brings parts to 225 degrees F (or higher if desired), and evaporates all moisture. Fostoria ovens can also combine drying and preheating cycles into a single process when necessary, giving manufacturers the option of a complete powder cure system using only electric infrared. This greatly reduces the system footprint and cost.

Liquid Finishes

Infrared provides the heat, the cure, the bond, and the catalyst for a wide variety of industrial processes. Its most important role, however, is one in which it first found widespread use: the curing of liquid coatings.

Whether solvent-based, waterborne or non-reduced, infrared is the curing technology of choice among manufacturers of metal, plastic, and composite parts.

Fostoria Industries is an acknowledged leader in the design and development of high-efficiency infrared ovens for finish curing. We were the first to demonstrate infrared's effectiveness in high speed production curing, the first to introduce energy-saving zone control, and the first with virtually every development now regarded as standard in our industry.

Inks

Fostoria Infrared Systems provide high-speed drying of printing inks. Systems are infinitely adjustable, so pressmen can fine-tune drying cycles to accommodate the specific stock, coverage, pile temperature, and ink formula. Advanced cooling technology is provided through Fostoria's exclusive reflector/heat-sink design. When combined with high-velocity/high-pressure blowers, the result is the highest degree of control and repeatability.

Today, what distinguishes Fostoria is our ability to engineer systems with the power and wavelength, as well as the flexibility and control, to complement specific coatings systems. Where there is flexibility in the selection of a coating, Fostoria can also prepare recommendations and documentation for a finish and curing combination that best matches the application.

Most ferrous, and virtually all non-ferrous metal surfaces and composites that are coated with paint, can be cured using electric infrared systems. The ability to precisely control and zone infrared heat provides advantages over other curing methods. Additionally, infrared penetrates the coating and heats from the substrate out, preventing blisters that can result from trapped solvents.

Automotive & OEM Applications

Paints & Finishes, Plastics, Glass, Fabrics & Adhesives

Interior Trim & Seating

Fostoria has designed and manufactured OEM curing systems for use world wide. Just a few of our repeat customers are: GM, Boeing, Lear and Ford. We've handled many different materials for everything from window glass to headliners to varied interior parts and components. Our experience doesn't stop with just ovens. OEMs have also asked us to supply material handling systems.

Fostoria infrared ovens are designed to process seating components for relaxing fabric, removing moisture and de-wrinkling vinyl, cloth and leather for seat fabrication; drying coatings on plastic parts, and packaging finished parts for shipping. Infrared is also the process of choice for interior parts ranging from seatbelts to carpet.

Shuttle Ovens

Infrared shuttle ovens condition vinyl in a fraction of the time required by air systems. Often purchased to improve productivity, they simplify handling by "shuttling" a warm sheet out with each cold sheet put in. The ovens feature continuous feed sensors to assure uniform temperatures, and a uniform result. Advanced oven modules incorporate an exclusive pneumatic "trap" to clamp the vinyl on four sides, thus preventing dimensional changes prior to forming. Common applications for shuttle ovens include: door panels, dashboards, steering wheel coverings and arm rests. Manufacturers of air bag compartments use these ovens for pre-heating vinyl prior to vacuum forming.

Storage Ovens

Re-engineered assembly systems for increased productivity have intensified the need for storage ovens, which heat parts such as wire harnesses, making them easier to assemble. These ovens are also used where pressure-sensitive adhesives perform more efficiently at higher temperatures (such as with body side moldings) and where pliability aids fit (such as with rubber bushings applied to door fittings).

We offer both infrared and convection storage ovens. We welcome the opportunity to consult with you regarding these applications, and to offer some case histories where the use of such systems has eliminated adhesive peel-off, reduced rework and eliminated related warranty claims.

Conveyor Ovens

Conveyorized Fostoria ovens are used for a wide variety of glass performance and

decorative effects. Systems are available for tempering and annealing and for pre-heating and tacking for lamination. Fostoria engineers specialty ovens to cure inks, ceramic paste and reflective coatings used on head and tail lights. Pre-heated vinyl sheets are used in the lamination of safety glass, without heating the glass. Paint on glass applications, including windshield "perimeter black-out" are common uses for our electric infrared ovens.

Total Systems and Specialty Systems -

Curing Plus Material Handling

Fully integrated systems can be engineered for applications in the automotive, electronics, appliance, and aerospace industries. They are also applicable to the manufacture of a wide variety of building products, from window grilles to press-formed panels made from log shavings.

For example, Fostoria offers a turnkey system for curing, cutting, and handling the "honeycomb" kraft paper used as a core material in garage doors, man doors, and office dividers. The system allows the manufacturer to purchase the honeycomb material in its unexpanded state and, using the Fostoria system, expand the product to the desired length, width, and cell size. The sequence of operation features:

- Expanding the honeycomb to the correct cell size by applying the proper tension to the product as it is conveyed.
- Setting the honeycomb to its expanded size by activating the heat-sensitive resins in the paper. Fostoria's Transco ovens provide the perfect solution to this step of the process.
- Cutting the panels to the exact width and length. The cuts in both directions are made while the web of honeycomb continues to move on the conveyor system.
- Curing the adhesive after application by a roll coater and prior to the exterior panels being attached.

The extension and adhesive curing of honeycomb is but one of many turnkey system approaches Fostoria's application and design engineers can provide to solve complex process and material handling problems. We can provide the benefit of total system responsibility through our expertise in both process heating and material handling.

Gas Infrared Ovens

Electricity is only one source for infrared heating. In many cases, industrial applications are better suited to the use of gas fired emitters as the infrared source.

There are many factors relevant to the decision to use electric or gas. Some practical considerations include:

- The cast of electricity versus natural gas or propane.
- The cost of upgrading electrical service to handle the load of an electric infrared oven.
- Process or temperature controllability.

While initial and operating costs are certainly a consideration in determining whether to install a gas or electric infrared oven, they should not overshadow the suitability of either for the particular application.

Gas Applications

Gas infrared systems are used in a variety of applications throughout industry. In many instances, gas is the fuel preference because of the size and scope of the operation. A generalization can be made that gas may be the fuel of choice in processes where high power density is required without close temperature control.

Examples of applications where gas infrared proves to be the preferred system include drying and broiling.

Drying - Applications requiring water dry off/moisture removal are ideally suited to gas infrared systems.

In many *paper mills* around the United States, the web of paper is run through gas infrared ovens to begin the moisture removal process. The process is completed as the paper web runs through a series of steam-heated calendars.

Textile mills utilize a similar process. Gas infrared ovens are incorporated into the process to remove moisture from the material as it passes through the web.

Foundries use gas infrared ovens to dry sand cores used to form castings.

In all these applications, incorporation of gas infrared ovens into the process have enabled companies to significantly reduce drying time and increase productivity.

Broiling - An application gas infrared is ideally suited for is broiling. Fostoria Industries engineers have modified standard gas infrared oven designs to accommodate the needs and regulations of the food processing industry.

Fostoria infrared broilers use a premix system due to the grease-laden air prevalent in food processing applications. In addition, infrared broilers are built out of stainless steel, and conform to NSF regulations.

Gas has several advantages over electricity in process broiling, with the primary being the tremendous BTU output required to meet the demands of most processing operations. An equivalent electric oven would in many cases be cost prohibitive in terms of operating costs and installed cost.

Additionally, and equally important, is the rugged design of the Fostoria broiler. *Burners are placed on top only, with the patty being flipped in the middle of the*

process to ensure even cook on both sides.

This design saves the burners from undue wear, and facilitates the removal of the tremendous amount of grease produced in the process.

Gas Infrared Burners

Specifications

The Fostoria 522 Series Gas Burner is designed for both atmospheric and premix systems where efficient use of the fuel and product temperature controllability are vital. These burners have an operating temperature range from 1400°F to 1650°F.

The 522 Series burner is suitable for applications requiring product temperatures up to 1200°F but is particularly adaptable for product temperatures up to 1000°F or less and where burner temperatures between 1200°F and 1600°F are preferred. This type burner is most efficient when operated at a color temperature of 1600°F. The 522 burner is rated to operate at 20,000 BTU/hour nominal.

Applications

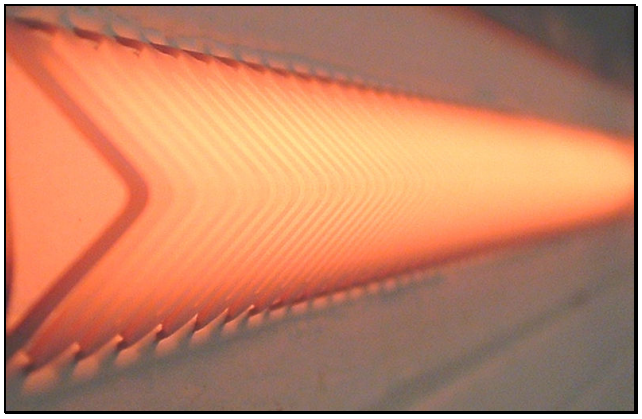
- Paint Curing
- Textile Dehydration
- Drying Textile Coatings
- Booster For Existing Ovens
- Drying Paper Coatings
- Food Broiling
- Water Dryoff
- Burn Off or Degreasing
- Adhesive Drying
- Water Dryoff
- Powder Coating
- Paper Drying

Operation

Response time is approximately 60 seconds to heat up to proper temperature for process operation and approximately 10-15 seconds response time for minor changes and adjustments. The 522 Series burner is ruggedly constructed to insure long burner life, low maintenance and protection from thermal shock.

The Fostoria line of gas infrared equipment is designed to give industrial processors all the desirable benefits of infrared heat from an efficient gas fired source.

V-Series
Fast Response Medium Wavelength Infrared Panel Heaters



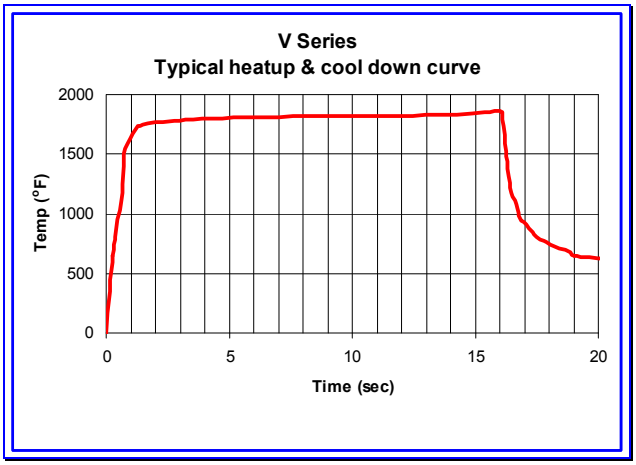
Introducing the revolutionary V-Series heater for industrial process heating applications. The V-series is perfect for applications that require high power, tight process control, and fast heat-up/cool-down.

V-shaped stamped elements have low mass for fast heating/cooling and minimal thermal lag for extremely tight process control. The elements are bonded to a high temperature insulation board having low thermal conductivity, low thermal mass, and low heat capacity to minimize stored heat so they can be switched on and off in seconds. This makes them ideal for processing heat sensitive products such as automotive components, carpeting, and other thermoforming applications.

V-Series heaters offer power densities and response times that rival those of short wavelength heaters, except they come in a very durable construction and have a medium wavelength output which is readily absorbed by most products. Therefore, they are ideally suited for drying applications, as well as heating plastics, carpet, and vinyl.

The unique V-shaped element provides numerous performance improvements over conventional stamped element heaters, including the following:

- Reduced cost
- Faster heat-up and cool-down
- Higher watt density
- Reduced thermal back-losses
- More robust construction (no need for special handling or shipping)
- More freely radiating design
- Longer life
- Elimination of hot spots
- Improved heating uniformity



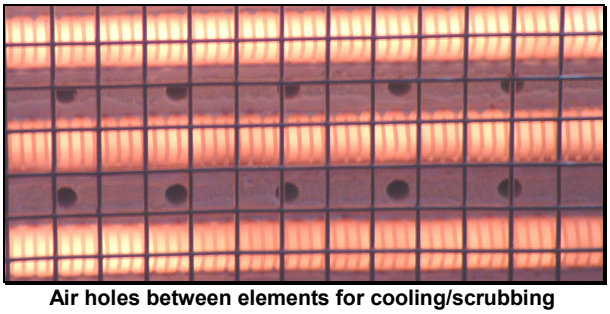
Standard Features

- Element temperatures up to 2,100 ° F (2 micron peak wavelength)
- Typical life expectancy of 12,000+ hrs. depending on temperature
- Heater wattages up to 100 watts per sq. in.
- Can be operated in any plane without any element sag or "coil creep"
- Stainless steel screen protects face
- Maintenance free
- Various voltages up to 600V
- Superior mechanical strength
- Rugged aluminized steel housing
- ¼-20 mounting studs
- Electrical junction box

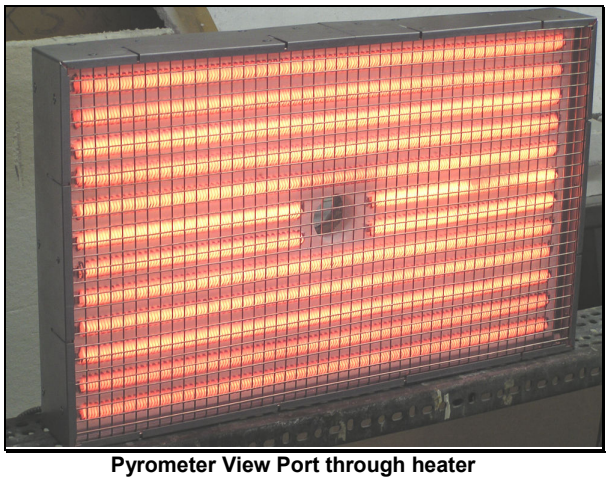
Optional Features

- Replaceable type K thermocouple
- Air holes for extremely fast cool down and/or to provide scrubbing action in drying applications
- Pre-mounted fans
- Multi-zone heaters
- Pyrometer view port through heater
- Stainless steel housing
- No housing (heater board only)
- Wire Leads

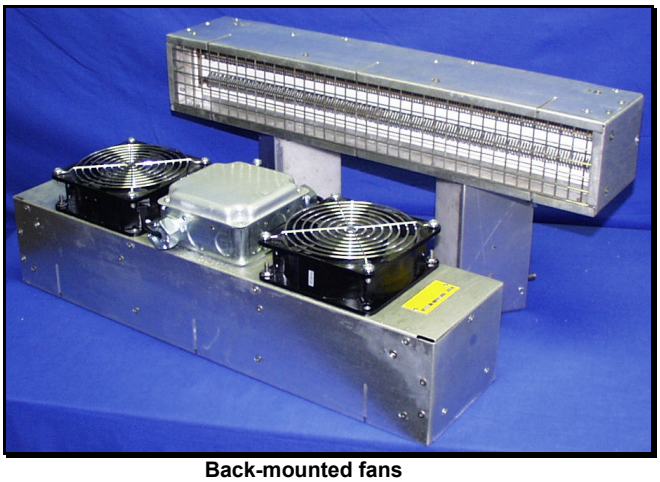
fostoria®
Quality Since 1917



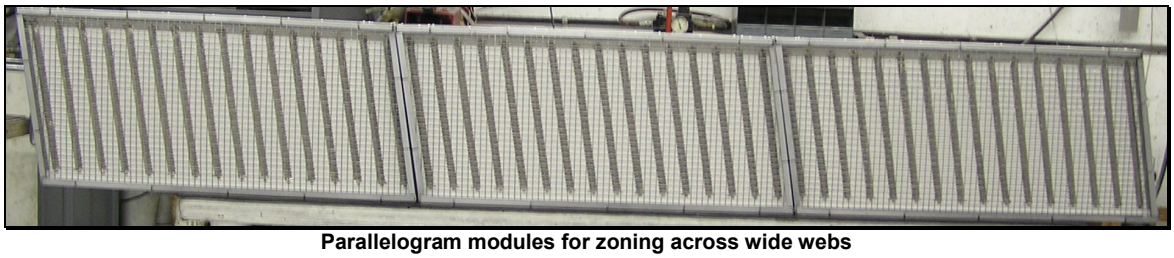
Air holes between elements for cooling/scrubbing



Pyrometer View Port through heater



Back-mounted fans



Parallelogram modules for zoning across wide webs

Fostoria Industries infrared heaters are used in many industries & applications including:

- Adhesives
- Annealing
- Automotive
- Carpeting
- Coatings
- Composites
- Curing
- Drying
- Electronics
- Extrusions
- Fiberglass
- Fiber Optics
- Films
- Filter Media
- Foil
- Glass
- Hose & Tubing
- Industrial Fabrics
- Medical
- Nonwovens
- Paint Finishing
- Paper
- Pipe/Conduit
- Plastics
- Powder Coating
- Printing
- Semiconductor
- Textiles
- Tubing
- Wire & Cable

Quality Since 1917

Industrial Control Panels

The Process Heat Division of Fostoria Industries, Inc. provides complete control panel systems that are engineered, fabricated, assembled, wired and programmed for the customer's specific machine or process.

Our 156,000 sq ft manufacturing facility includes state-of-the-art CNC metal fabricating equipment, automated turret presses with Jet-Cam programming, and equipment finishing. We can provide all panel related services, from design and layout; to sub-panel and panel assembly, low and high voltage wiring, component mounting, and programming with integration to your machine or system.

- **Fostoria can design panels to meet high assembly SCCR requirements**
- **Panels can be built to meet ESA/CSA requirements, and if specified, can be ESA or CSA labeled prior to shipment**
- **All equipment conforms to NFPA 70 (NEC) and NFPA 79 Electrical Standards**
- **We build panels to meet your safety needs, whether it is Category 2, 3, or 4**
- **We work with all major component manufacturers, including Allen-Bradley, Schneider, Mitsubishi, Fuji, etc . . .**
- **We provide:**
  - **o PLC Programming**
  - **o Operator Interface (HMI) design and programming**
  - **o Extensive CAD capability for design and documentation**
  - **o Variable Frequency Drive and Servo Motor design**
- **Fostoria will provide a complete set of drawings and PLC documentation**
- **We design and fabricate gas trains and associated controls for combustion systems**

Fostoria Industries has over 50 years of experience in industrial control panel engineering, fabrication and wiring, along with the associated programming, de-bug, installation and start-up of industrial panels and systems. We can fabricate from your design and specifications, or you can request we "turnkey" the entire panel, from specification through final assembly and installation.

fostoria®

Quality Since 1917

Industrial Controls

Fostoria Panels are designed and built for a variety of applications . . .

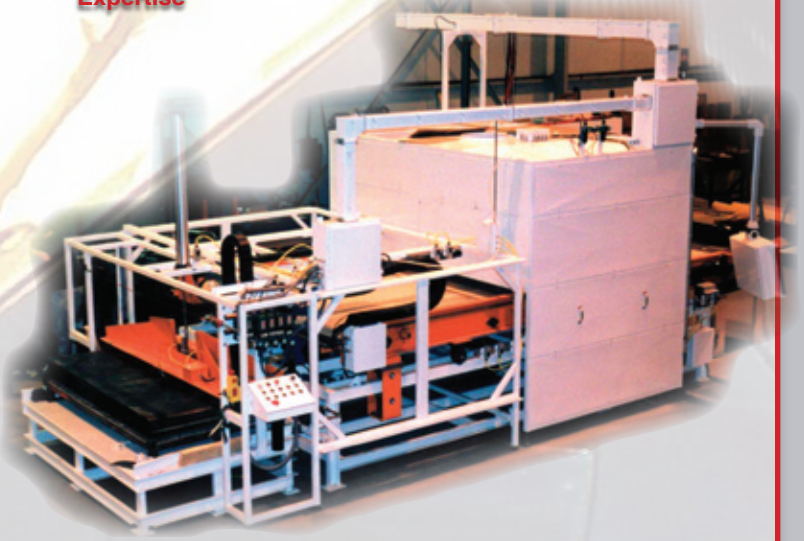
Control panel for chillers

- UL 508A Shop

Panel for a batch burn-off oven

- ISO 9001
- Skilled and Experienced Panel builders
- Engineering and Programming Expertise

Mezzanine mounted control panel for thermoforming ovens



PLC panels for material handling with remote operator stations

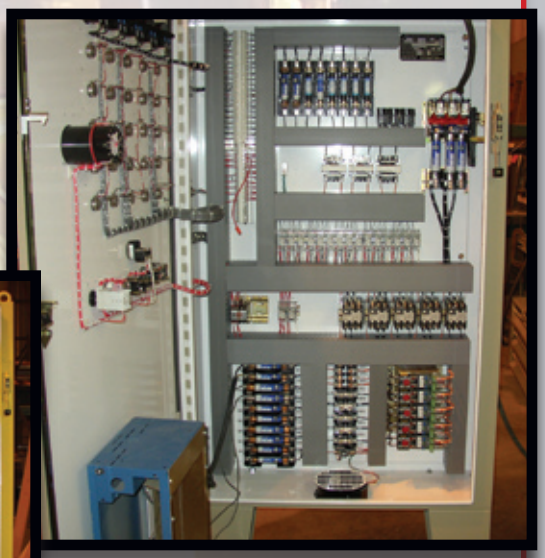
Gas trains and controls

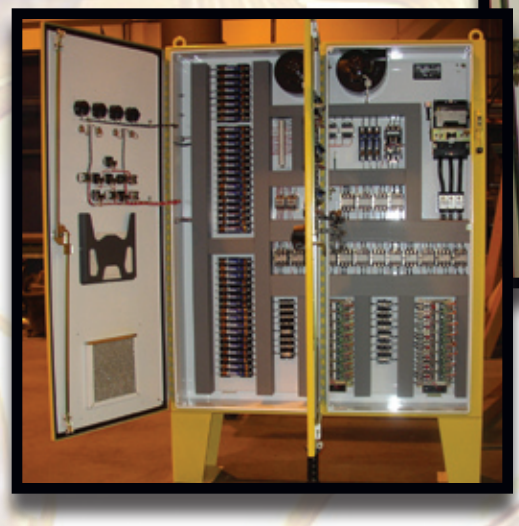
Fostoria Industries is firmly committed to *Quality & Value, Quick Turnaround, and Excellent Customer Service . . .*

We have maintained this reputation for decades. Our company began operations in 1917, producing fabricated automotive replacement parts, such as bumpers and running boards. Fostoria pioneered the application of infrared technology in the 1930s, for curing paint on automobiles, and our Process Heat Division today remains a leader in this industry.

Control panel building has always been an integral part of this business. Fostoria has provided oven systems and control panels for many Fortune 500 companies, as well as hundreds of other companies.

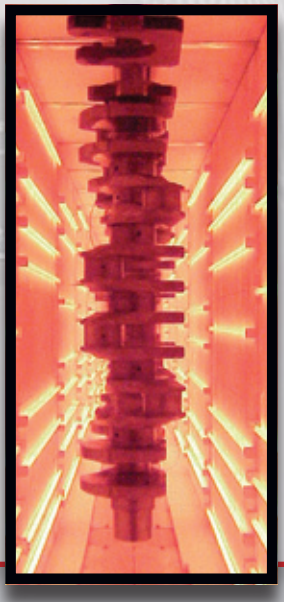
Some of our repeat customers:
Ford Motor Co.
GM
Delphi
Whirlpool Corp.
Lear Corp.
Collins & Aikman
Owens-Corning
Guardian
Daimler-Chrysler
Boeing
Lockheed
Marathon Products
Honda of America
Johnson Controls
Raytheon
General Mills
Harley Davidson
(your company here)





Pictured at left and above are examples of Fostoria's layout and wiring expertise, indicating the meticulous attention paid to every detail. Several of Fostoria's skilled panel builders have over 35 years of experience.

Pictured at right is an electric infrared oven controlled by Fostoria panels. This crankshaft annealing oven requires exact temperature control, achieved through PLC controlled zoning in the oven.



Pictured at left are examples of remote operator panel stations used for a variety of applications.

The photo at right shows a Fostoria portable panel used in a paint repair shop.

ELECTRIC

INFRARED

MAINTENANCE

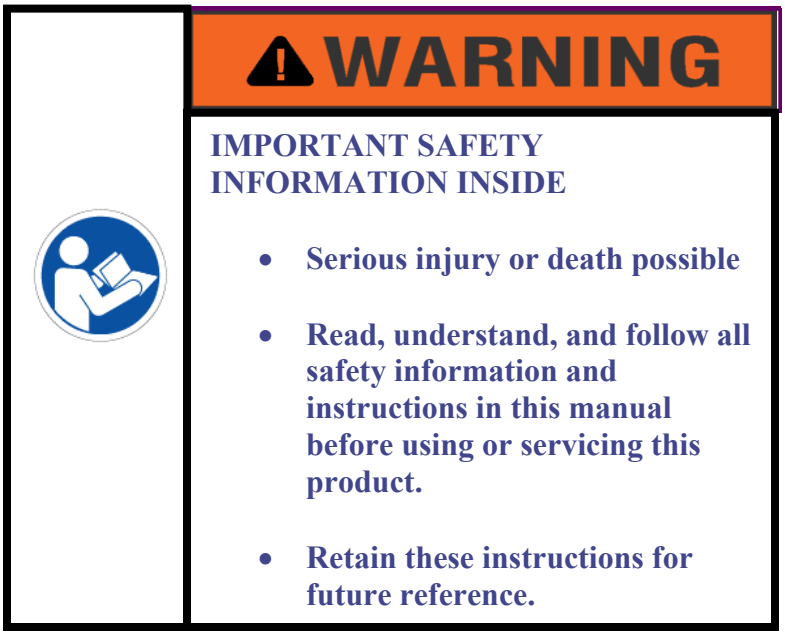
MANUAL

Fostoria Process Equipment Division of TPI Corporation
114 Roscoe Fitz Rd., Gray, TN 37615 (800) 495-4525 Fax (800) 477-0084

Web Site: www.fostoriaindustries.com

50-681-09 Rev. Date 5-09

TABLE OF CONTENTS



NOTICE: RECEIVING EQUIPMENT

The Transportation Company has acknowledged receipt in Good Condition of the material packed herein, as evidenced by the Bill-of-Lading.

YOUR RESPONSIBILITY FOR THIS SHIPMENT

If the shipment is not delivered to you in good order and in accordance with the quantity shown on the Bill-of-Lading, have the shortage or damage noted by the delivering carrier on both the delivery receipt and freight bill.

The delivering carrier should also be called for an inspection.

If bundles and crates are in apparent good order, but on opening, contents are found to be damaged, call the delivering carrier at once for inspection.
A copy of the inspection report must be retained in both cases.

CLAIMS MUST BE HANDLED PROMPTLY

We will assist you in every possible manner in the handling of a claim for loss or damage. Claims for loss or damage on shipments must not be deducted from our invoice, nor payment of the invoice withheld awaiting adjustment of such claims.

IMPORTANT
DO NOT RETURN GOODS WITHOUT WRITTEN AUTHORITY

Returned goods will not be accepted by us from transportation company unless return goods authorization has been issued by the home office at TPI Corp., Gray, TN.

Return of special or non-stock items cannot be authorized. Credit for goods returned, under authority of a returned good authorization, will depend on value to us based on our selling price, less a fair charge to cover expense of shipping, re-handling, inspection, refinishing, etc., providing material is received in good condition, transportation charges prepaid. Credit rendered is to be used against future purchases.

GENERAL INSTRUCTIONS FOR THE INSTALLATION OF FOSTORIA ELECTRIC INFRARED OVENS

1) **Install and level oven so that proper "product" clearance is maintained through length of oven. Oven must be level within plus or minus 3 degrees unless heat sources are rated for vertical burning operation.**

2) **Each oven will consist of one or more banks. These banks will be numbered beginning with number one, and running to the final bank. Number one bank, which is the entrance bank, will be stamped "entrance end", and on each side, it will be stamped "bank one- right side" and "bank one-left side." The number two bank will be marked "entrance end- bank two," "right side-bank two," and "left side-bank two." Each of the following banks are marked in this sequence until the final bank. The last bank is marked the same, except it will be stamped "exit end." To determine which is the right and left side of the oven, face in the direction of the conveyor travel, and the right side is the right side of the bank and the left is the left side of the bank. Each bank will bolt to its mate by bolting through the holes in the frame.**

   In cases where there are top banks, they will be marked in the same manner.

3) **All ovens are wired with high temperature wire. This wire is usually terminated outside the oven in a wire-way or junction box. Wire rated for 90 degree C (194 degrees F) sized for load (to meet all wiring codes that apply) can be used to connect the oven to the control panel. Caution should be taken not to abuse any exposed wires during assembly, since it may require complete disassembly of the bank to repair. In most cases several banks can be spliced together in the wire way with the use of terminal blocks and only the proper circuit wire is needed to the control panel. All circuit numbers and letters are for identification. EXAMPLE: A circuit marked 1A2 would be "zone l" "phase A" and "circuit 2". All oven leads will have corresponding termination points in the control panel.**

4) **"TEMPERATURE SENSORS:**
   a. **It is crucial that polarity is observed when wiring any temperature sensor.**
   b. **For thermocouples, the proper type extension wire must be used.**
   c. **To splice a T/C, use porcelain wire nuts. If this is not possible, the wires may be twisted together and taped. We do not recommend using a common wire nut. The dissimilarity in the metals may cause erratic heat transfer causing incorrect temperature control.**
   d. **For radiometers, a two conductor shielded cable should be used.**
   e. **Never run sensor wires together with the power wires. FII recommends a separate conduit or wire way for the sensor wires.**

5) **When an exhaust system is supplied, it may be done by mounting several exhaust fans on the oven or by mounting one or more blowers away from the oven and connecting them to the oven by the use of duct. In either case, an airflow switch is usually required for each blower. The switch is usually mounted close to the blower and is installed for positive pressure. The airflow switch, when possible, is checked for proper operation before shipping. The electrical interlock leads are terminated in the control panel during installation. The air flow switch must always be mounted in the horizontal position, with the adjustment spring pointing UP. Plumb the bottom portion of the air flow switch to the pressure side of the blower. SEE Diagram # 1.**

6) **An over temperature device may be supplied to shut down the oven in case of over heating due to fire or line stoppage. It is usually mounted in the final exhaust stack on the discharge side. The electrical interlock wires are terminated in the control panel during installation.**

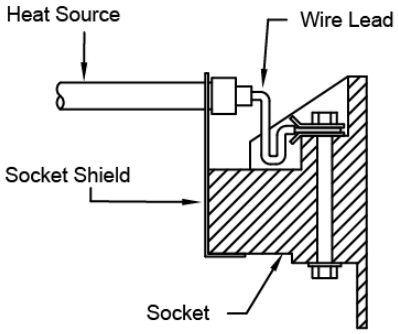
7) **It is always best to install the lamps and end caps just before the oven is to be energized. This reduces the possibility of lamp breakage. Before lamping an oven, circuit wires should be checked for grounds or cross-phasing by a continuity test or Mega-Ohm tester. Once the lamps have been installed, these tests are impossible. When lamping the oven, care should be taken not to touch the quartz with the bare hand. Installers should use soft cotton gloves. If an element should be handled or been in contact with the skin, simply wipe the tube off with alcohol or paint thinner. Reference Diagram #2 for the proper installation of the heat sources.**

8) **All control panels are energized and tested before shipping. Wire and wiring from the oven to vthe control panel, and service to the control panel, is provided by the customer; unless otherwise specifically negotiated.**

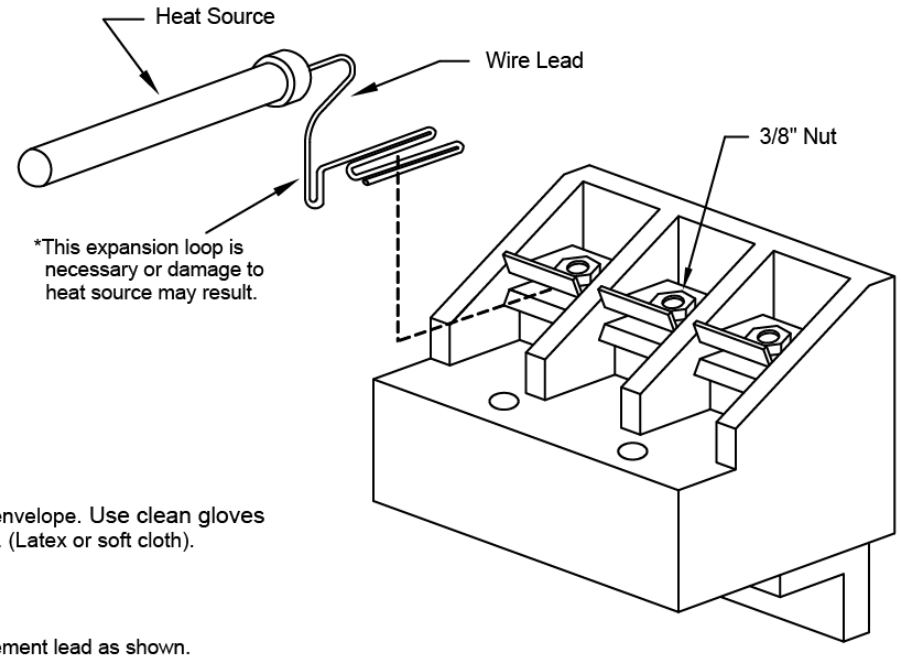
CAUTION

9) **Be sure to keep the interior components of the control panel free of metal shavings that may be generated during installation or maintenance. Shavings can cause malfunctions if left in or on control components.**

DIAGRAM #2



HEAT SOURCE INSTALLATION PROCEDURE (SO9 SOCKET):



NOTE: To avoid contamination of the Quartz envelope. Use clean gloves during the handling of the heat source. (Latex or soft cloth).

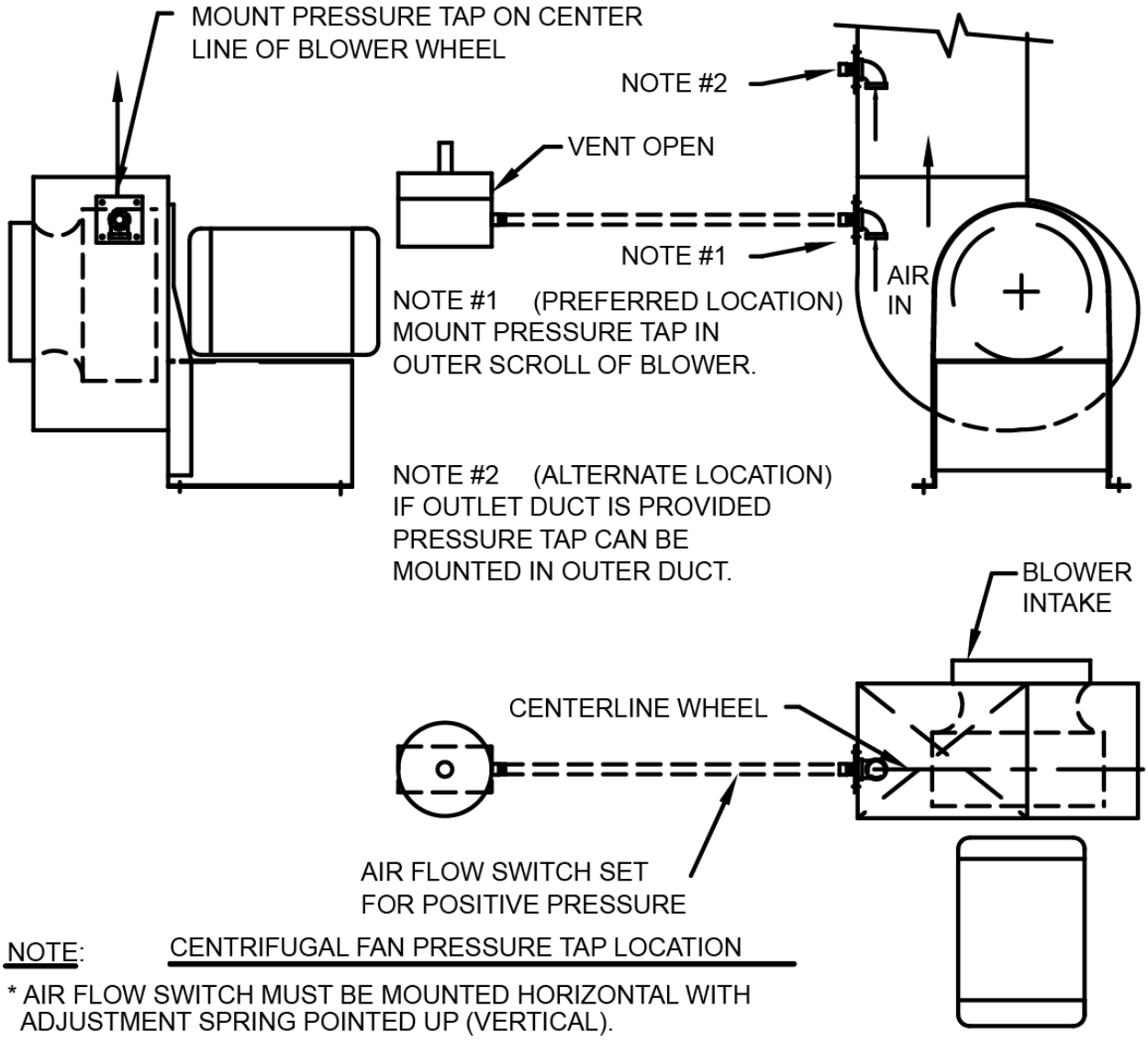
1. Remove end caps from both ends of fixture
2. Cut element lead to approx. 4" length.
3. Refer to above sketch. Bend and form the element lead as shown. Make sure to establish the expansion loop as shown.
4. Place element in fixture.
5. Insert the formed wire leads between lipped washers and tighten nuts. Test the expansion loop by moving the element back and forth in its long direction. Movement of approx. ¼" in both directions should be possible. If movement is not possible, the element is installed too tight and damage may occur. Correct if necessary.
6. Re - install end caps.

DO NOT SCALE

900 SERIES LAMPING PROCEDURE

DESIGN: RLH	DATE: 8/5/05	FILE: 900-13F.DWG	
CHECKED: JWH	APPROV'D: 8/5/05	DWG. NO. 900	REV.
Fostoria Industries, Inc. 1200 N. Main St., Fostoria, Ohio 44830		SIZE: 13F	SHEET

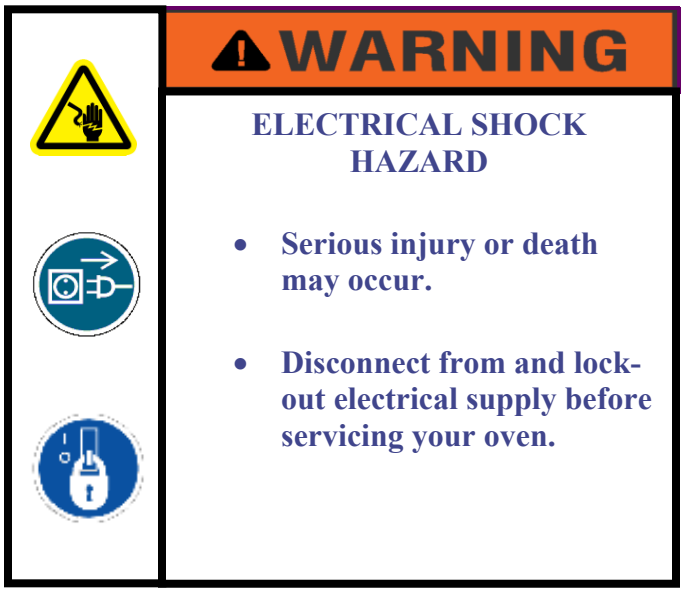
DIAGRAM #1 - AFS MOUNTING



NOTE: CENTRIFUGAL FAN PRESSURE TAP LOCATION

* AIR FLOW SWITCH MUST BE MOUNTED HORIZONTAL WITH ADJUSTMENT SPRING POINTED UP (VERTICAL).
* PLUMB BOTTOM PORT OF AIR FLOW SWITCH TO PRESSURE SIDE OF BLOWER.
* AIR FLOW SWITCH IS TO BE SET FOR POSITIVE PRESSURE.
* AIR FLOW SWITCHES ARE NOT TO BE MOUNTED WHERE AMBIENT TEMPERATURE WILL EXCEED 120° F.
* USE INSULATED SPADE TERMINALS FOR WIRING. WIRE SIZE #16-14 STUD SIZE #6
* MTW WIRE RATED AT 105°C. (211°F.) IS TO BE USED FOR WIRING OF AIR FLOW SW.
* AIR FLOW SW. WILL REQUIRE A GROUND WIRE.
* ALL MOTORS WILL REQUIRE A GROUND WIRE.
* VERIFY TUBING IS FREE OF OBSTRUCTIONS

TROUBLE SHOOTING



Symptom	Possible Cause	Corrective Action
Equipment cannot be energized	No voltage to main disconnect	Check incoming service
	Fuses blown at main or control panel	Replace fuse after corrective action taken
	Air flow switches not closing	Refer to Diagram #1; check blower rotation
	Over temperature device not properly set	Consult factory for correct setting
	Heat elements not properly installed	Refer to Diagram #2 (Heating Element Installation)
	Oven not purged	Check purge timer for proper setting and function
	Conveyor interlock (if supplied) not closed	Check connection to conveyor
	Wiring between panel and oven not correct	Check wiring diagram supplied with system
Equipment operates for a time, then shuts down	Drop in line voltage	Check incoming service
	Air flow switch failure	Refer to Diagram #1; replace AFS if needed
	Over temp. device failed, or set too low	Consult factory for proper setting
	Exhaust and/or pressure fans stop	Check motor overloads or drive belts (if supplied)
	Line, main or control fuses blown; or breaker tripped	Determine cause of blown fuse; replace after corrective action taken
Heating elements energize, but not to full intensity; or only some elements energize	Low input voltage	Check incoming service
	Improper elements installed	Compare specifications on elements to B/M
	Elements not properly installed	Refer to Diagram #2
	Loose connection on element socket	Refer to Diagram #2; tighten pigtail/socket connections
	Dirty elements and/or reflectors	Wipe off elements/reflectors (see Diagram #2)
	Incorrect wiring from control panel to oven	Check wiring diagram supplied with system
	Fuses blown (main, control or SCR fuses)	After corrective action, replace fuse(s)

Always remove fuses from the device before testing.

CLEANING AN INFRARED OVEN

To help maintain the system's efficiency, it is very important that all reflectors, end caps and heat sources be kept in good condition.

HOW TO MAINTAIN INFRARED OVENS

1) **Keep all dust, dirt and paint over-spray out of and away from the opening of the oven.**

2) **Check the operation of all heat sources, blow off loose dust and wipe all reflective sources with a clean soft cloth.**

3) **When cleaning the reflective surfaces, use a clean cloth dampened with a non-abrasive detergent.**

4) **Heat Sources should be kept as clean as the reflective areas of the equipment. If the heat sources become dirty, this will cause over heating and reduce their efficiency and reduce their expected life.**

5) **To clean the quartz envelope, it is suggested it be wiped off with a cloth dampened with alcohol, then follow with a soft dry cloth. Do not touch with bare hands after cleaning.**

6) **Occasionally, heat sources will fail and become broken; they should be replaced at the earliest possible time.**

7) **Some ovens and control panels are equipped with filters. Filters should be periodically checked and changed as soon as they become dirty.**

8) **Determining how often the oven should be cleaned will depend on shop conditions.**

9) **Replacement reflectors, end caps and heating elements for all Fostoria equipment are readily available from stock.**

ELECTRICAL PREVENTIVE MAINTENANCE

To insure continuous trouble-free operation of the Fostoria Control System, the following procedures should be followed:

1) **POWER CONNECTIONS**

   Tighten all main power connections at ---

   A) **Main circuit breaker (or disconnect switch).**

   B) **All connections on power controllers and/or contactors.**

   C) **All line and lead branch connectors; I.E. branch fuses, circuit breakers or terminals.**

   The above should be accomplished after the first two weeks of operation and quarterly thereafter.

2) **AIR COOLING**

   A weekly visual inspection of air filters is recommended with cleaning of same as indicated by inspection.

3) **GENERAL INSPECTION**

   A general visual inspection of the interior and exterior of the control enclosure should be made weekly. This inspection should cover such items as:

   EXTERIOR - -

   A) **Inoperative and/or damaged pilot lights, push buttons, and any other door mounted devices.**

   B) **Excessive dirt, oil, water or other possibly harmful accumulations of foreign matter on equipment and enclosure.**

   INTERIOR - -

   A) **Accumulation of foreign matter on relays and other components.**

   B) **Unusual wear or burning of contacts on relays, contactors and other components.**

   C) **General inspection of equipment mounting hardware.**

   Corrective action should be taken immediately if a visual inspection reveals any problems relating to this equipment.

REFLECTOR MAINTENANCE IN ELECTRIC INFRARED OVENS

Many electric infrared ovens rely on quartz medium wave or short-wave IR emitters to impinge heat on the product. Reflectors installed behind the emitters are therefore necessary to direct the IR energy in the most efficient manner possible to the product, and their reflectors may vary in patterns or composition. All reflectors, however, are designed to allow for ease of maintenance and cleanliness.

To understand the importance of reflector cleanliness, we need to look at what reflector maintenance means to the overall efficiency of the electric infrared oven:

Most industrial infrared ovens are designed around the customer's specific needs and application. This makes it difficult to define "Oven Efficiency" in generalized terms that can be applied to every situation. However, the following can be of some assistance.

An industry-wide accepted definition for oven efficiency is:

Eff = Energy absorbed by the product / total energy consumed by the oven.

Efficiencies measured on various IR ovens will vary in the range of 10% to 70%. The main factors that affect IR oven efficiency are:

1. Oven design.
2. Product (surface characteristic, geometry and position to IR).
3. Reflectors.
4. Exhaust and cooling.

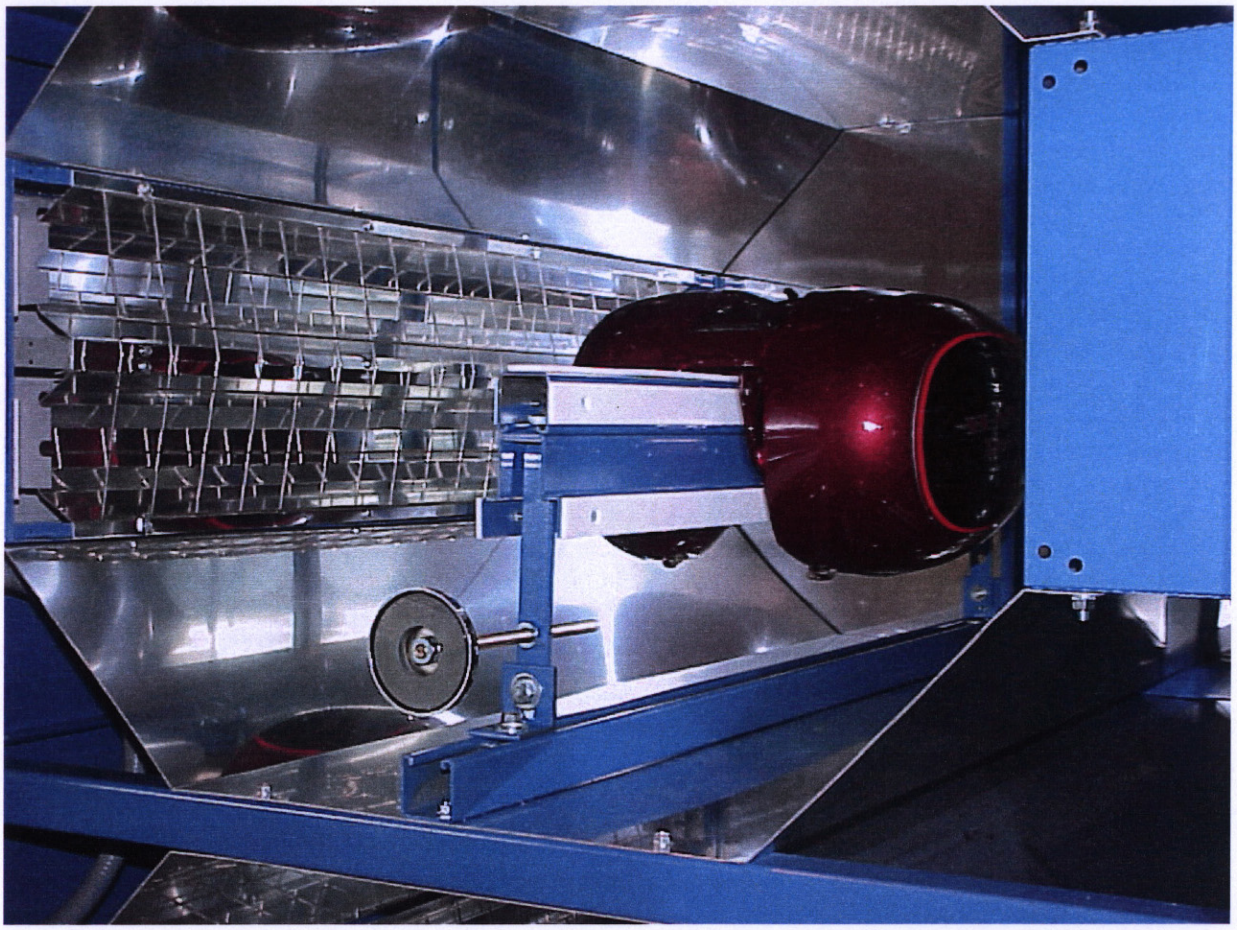
To illustrate the importance of reflector maintenance, let us look at the following example:

Let's assume a typical, well-designed, well-maintained IR oven operates with efficiencies in the 25% range. (This means that in order to put 1 kWh of energy into the product, you will have to buy 4 kWh of electricity). With dirty or damaged reflectors, the oven efficiency could possibly fall to 20%. (This means that in order to do the same job as before, you now have to buy 5 kWh of electricity – assuming the oven has the capability). Therefore, what appears to be a slight reduction in efficiency (only 5%) causes a significant increase in power consumption (25%). This is why regular maintenance and cleaning of an infrared oven is extremely important.

CHECK LIST:

- Keep all dust, dirt, and paint over-spray away from the oven openings.
- Develop a maintenance schedule to check the operation of all heat sources, blow off loose dust and wipe reflectors with a clean soft cloth. Determining how often the oven should be cleaned will depend on shop conditions.
- When cleaning any reflective surface, dust away all loose dirt and dust; then clean with a non-abrasive material.

- Heat Sources should be kept as clean as the reflective areas of the oven. If heat sources become dirty, they may overheat and experience a reduction in operating efficiency.
- To clean a quartz tube or quartz lamp heat source, they should be wiped off with a cloth dampened in alcohol, then followed with a soft dry cloth. Do not touch the emitters with bare hands after cleaning.



Harley Davidson

Application: Relax Decal
Oven: Duplicated Harley Oven
Voltage: 480 1-Qtz Lamp/5.5" refl

Product: Silver Metallic Tank
Note: Power On For 30 Seconds