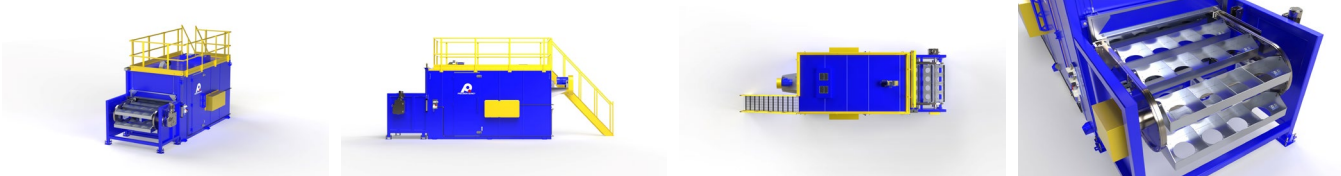




CASE STUDY

Conveyorized Electric Motor Stator Curing Oven for EV Motor Manufacturing

Conveyorized indexed electric Class A oven engineered for robotic loading of heavy motor stators within an automated EV-motor manufacturing cell — featuring 13 internal product stations at 20 in. index, 356°F operation, 126 kW electric resistance heating, 10,241 SCFM vertical bottom-up airflow, pneumatically actuated vertical guillotine doors, tray-centering clamps for repeatable robotic handoff, Allen-Bradley Kinetix 5500 servo-driven conveyor, CompactLogix PLC with PanelView Plus 7 HMI, and an approximately 25,000 lb structural-steel assembly.

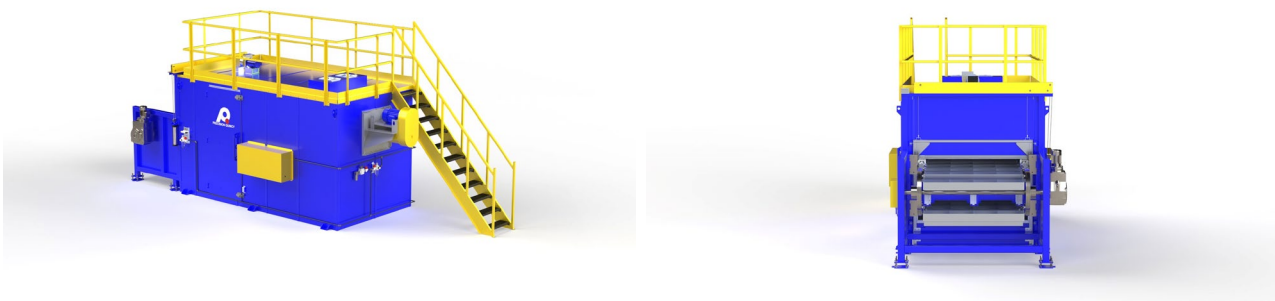


OVERVIEW

A conveyorized electric oven was engineered for integration into an automated electric-vehicle motor manufacturing cell. The process centered on stators used in EV motor production, with robotic loading and unloading as part of the overall cell architecture. Rather than serving as a conventional stand-alone heat-up oven, the intended concept was a controlled holding and curing chamber, with parts expected to arrive already preheated before entering the oven.

That process intent shaped the overall equipment strategy. The system was configured as an indexed conveyor oven with vertical bottom-up airflow, electric heat, and robotic tray presentation outside the heated chamber. The oven was built to hold a repeating stream of fixtures in known positions, maintain process temperature, and support integration with automated handling while preserving service access, thermal containment, and repeatable conveyor positioning.

The resulting system combined a single heated chamber with 13 internal index positions, a servo-driven conveyor with Allen-Bradley Kinetix 5500 drive, pneumatically actuated vertical guillotine entrance and exit doors, and a remote-mounted CompactLogix-based controls architecture. The design emphasized repeatable motion control, controlled airflow through the work zone, and automation-ready integration rather than manual batch loading.



CUSTOMER PROCESS REQUIREMENTS

The process requirement was to cure electric-motor stators within an automated EV-motor manufacturing cell. Each stator weighed approximately 66 lb, and the system had to handle a total batch mass of approximately 4,752 lb. The oven had to function as one element within a robotic load/unload sequence, with all product handling automated rather than manual.

Application Requirement

- The equipment had to cure stators used in electric-vehicle motor production as part of an automated manufacturing cell.
- The process was designed around automated tray-based handling with robotic load and unload, requiring the oven to function as one integrated module within the broader cell architecture.
- Production rate basis: approximately 111 parts per hour.

Robotic Interface Requirement

- Repeatable robotic interaction at the load and unload position was a key requirement. Product trays had to present in a precisely known location outside the oven chamber so the robotic system could reliably place and remove parts.
- The conveyor position had to be mechanically repeatable, and the tray-holding arrangement had to center and secure the tray during robotic engagement.
- A pneumatic positioning system was required to push the customer tray into the correct location for robotic pickup and placement, creating a mechanically repeatable handoff point between the oven conveyor and the surrounding automated cell.

Process Concept Requirement

- The intended process concept was not to raise cold parts from ambient to cure temperature. Parts were expected to enter the oven already preheated, making the oven function as a heated holding and curing chamber within the broader production cell.
- The oven therefore had to maintain process temperature and controlled residence time across all internal stations rather than deliver aggressive heat-up from ambient.

Safety / Classification Requirement

- The oven was required to be designed as an NFPA 86 Class A unit to accommodate the VOC-bearing process conditions associated with the curing material system.
- VOC loading basis: approximately 164 grams per hour.

Utility Requirement

- Required electrical service: 480V / 3PH / 60Hz. Full load amperage: approximately 188 A.
- Required pneumatic supply: 60 PSI minimum.

THERMAL PROCESS REQUIREMENTS

The thermal process requirements were established from the need to cure electric-vehicle motor stators in a controlled indexed-conveyor holding chamber within an automated manufacturing cell.

Temperature Capability

- Operating temperature: 356°F. Maximum operating temperature: 450°F.
- Empty-chamber uniformity: $\pm 15^\circ\text{F}$ setpoint.

Process Basis

- The thermal process basis is curing and controlled thermal holding of preheated EV motor stators within an automated manufacturing cell.
- Because parts arrived preheated, the oven's thermal role was to maintain parts within the required curing environment across the full residence time rather than drive a cold-part heat-up from ambient.

Heat Input Requirement

- Heat source: electric resistance heat. Total installed heat: 126 kW across four heater banks.
- Heater bank distribution: Banks 1 and 2 at 27 kW each; Banks 3 and 4 at 36 kW each.

Airflow Delivery Requirements

- Airflow pattern: vertical bottom-up. Heated air driven upward through the product zone and tray structure.
- Total circulated air volume: approximately 10,241 SCFM.
- Recirculation fan: New York Blower 278 PLR plug fan — 10,250 CFM at 3.5 in. w.c.; 10 HP motor.
- Supply and return concept: pressurized supply plenum with adjustable air ports and matched return plenum system.

Exhaust / Ventilation Basis

- Exhaust fan: PQ1 exhauster — approximately 155 CFM at 1 in. w.c.; 0.75 HP motor. Exhaust opening: 3.5 in. × 7.5 in.
- Oven classification: NFPA 86 Class A. VOC loading basis: approximately 164 grams per hour.

EQUIPMENT CONCEPT & ARCHITECTURE

To deliver the process requirements for this EV motor stator curing application, the following equipment concept and architecture was developed.

Overall Concept

- One conveyorized indexed electric Class A oven with 13 internal product stations and a 20 in. product index, integrated into an automated EV-motor manufacturing cell with robotic load and unload.
- The design emphasized repeatable motion control, controlled bottom-up airflow, and automation-ready tray positioning rather than manual batch loading.

Heating Architecture

- Heat source: electric resistance heat. Total installed heat: 126 kW across four heater banks (27 kW / 27 kW / 36 kW / 36 kW).
- Heat control: solid-state relay control per bank. Process controller: Watlow F4T. Overtemperature protection: Gefran controller.

Airflow / Recirculation Architecture

- Airflow pattern: vertical bottom-up.
- Recirculation fan: New York Blower 278 PLR plug fan — 10,250 CFM at 3.5 in. w.c.; 10 HP motor; Allen-Bradley PowerFlex 525 VFD.
- Exhaust: PQ1 exhauster — approximately 155 CFM at 1 in. w.c.; 0.75 HP motor.

Conveyor / Handling Architecture

- Conveyor type: double-pitch, oversized-roller, carbon-steel chain with positive-engagement sprockets and automatic pneumatic tensioning. Custom-built roller chain guides.
- Drive: Allen-Bradley VPL motor with Kinetix 5500 servo drive. Conveyor speed during index: 13 ft/min. Total index time: approximately 14.94 seconds. Belt return path inside the heated chamber.
- Load/unload position: 12 o'clock position of the drive sprocket, outside the oven chamber.
- Tray-centering concept: clamps/locking mechanisms with adjustable hard stops and pneumatic positioning to push the customer tray into the correct location for robotic pickup and placement.

Shell / Construction Architecture

- Work chamber dimensions: approximately 142 in. L × 76 in. W × 46 in. H.
- Overall exterior dimensions (oven body only): approximately 172 in. L × 88 in. W × 78 in. H. Overall system dimensions: approximately 250 in. L × 106 in. W × 110 in. H.
- Main wall construction: 6 in. thick with 6 in. of 6 lb mineral wool. Front wall: 4 in. thick with 4 in. of 6 lb mineral wool.
- Interior: aluminized steel. Exterior: carbon steel, Precision Quincy Blue finish. Approximate shipping weight: 25,000 lb.

Door / Access Architecture

- Entrance and exit doors: pneumatically actuated vertical guillotine doors.
- Two side access doors on the oven body with Allen-Bradley SensaGuard interlocks.
- Conveyor opening width: 68 in. each end. Conveyor height: 47.5 in. above finished floor.

Controls Architecture

- PLC: Allen-Bradley CompactLogix 5069-L330ER. HMI: Allen-Bradley PanelView Plus 7 Standard, 10 in.
- Temperature controller: Watlow F4T. Overtemperature control: Gefran. Fan drives: Allen-Bradley PowerFlex 525 VFDs.
- Conveyor servo drive: Allen-Bradley Kinetix 5500 with VPL motor.
- Controls architecture: remote-mounted NEMA 12 high-voltage and low-voltage control enclosures with separate oven junction box and external network-device mounting panel.
- Safety: Allen-Bradley SensaGuard interlocks on side access doors; exhaust and recirculation airflow switches; ATC purge timer; local E-stop affecting conveyor operation.
- Applicable standards basis: NFPA 79, NFPA 86, UL 508A.

TECHNICAL SPECIFICATIONS

Oven Configuration	
Type	Conveyorized indexed electric Class A oven
Application	EV motor stator curing within automated manufacturing cell
Internal Stations	13 stations inside oven
Product Index	20 in.
Product Chamber Dimensions	142 in. L × 76 in. W × 46 in. H
Exterior Dimensions (Oven Body)	Approx. 172 in. L × 88 in. W × 78 in. H
Overall System Dimensions	Approx. 250 in. L × 106 in. W × 110 in. H
Conveyor Opening Width	68 in. each end
Conveyor Height	47.5 in. above finished floor
Chain Spacing	63 in.
Approx. Shipping Weight	25,000 lb

Thermal Heat Power System	
Operating Temperature	356°F
Maximum Temperature	450°F

Empty-Chamber Uniformity	±15°F setpoint
Heat Source	Electric resistance heat
Total Heat Power	126 kW
Heater Bank Distribution	Banks 1 & 2: 27 kW each; Banks 3 & 4: 36 kW each
Oven Classification	NFPA 86 Class A
VOC Loading	Approx. 164 grams/hr

Recirculation / Airflow System

Airflow Pattern	Vertical bottom-up
Total Circulated Air Volume	Approx. 10,241 SCFM
Recirculation Fan	New York Blower 278 PLR plug fan
Recirculation Fan Capacity	10,250 CFM at 3.5 in. w.c.
Recirculation Fan Motor	10 HP
Fan Drive	Allen-Bradley PowerFlex 525 VFD
Supply / Return Concept	Pressurized supply plenum with adjustable air ports and matched return plenum

Exhaust System

Exhaust Fan	PQ1 exhauster
Exhaust Volume	Approx. 155 CFM at 1 in. w.c.
Exhaust Fan Motor	0.75 HP
Exhaust Opening	3.5 in. × 7.5 in.

Conveyor / Handling System

Conveyor Type	Double-pitch, oversized-roller, carbon-steel chain
Conveying Motion	Indexed
Drive	Allen-Bradley VPL motor with Kinetix 5500 servo drive
Conveyor Speed	13 ft/min during index
Index Timing	Approx. 14.94 seconds total index time
Sprockets	Positive-engagement sprockets
Belt Tension	Automatic pneumatic tensioning
Chain Guides	Custom-built roller chain guides
Belt Return Path	Inside heated chamber
Load / Unload Position	12 o'clock position of drive sprocket, outside oven chamber
Tray Positioning	Tray-centering clamps / locking mechanisms with adjustable hard stops and pneumatic positioning for robotic loading and unloading

Construction Materials / Finish

Primary Structure	Carbon steel structural frame internal to insulated walls
Interior	Aluminized steel
Exterior	Carbon steel; Precision Quincy Blue finish
Main Wall Construction	6 in. thick with 6 in. of 6 lb mineral wool
Front Wall Construction	4 in. thick with 4 in. of 6 lb mineral wool
Door Type	Pneumatically actuated vertical guillotine doors (entrance and exit)

Safety & Compliance	
NFPA 86 Classification	Class A
Applicable Standards	NFPA 79, NFPA 86, UL 508A
Access Door Safety	Allen-Bradley SensaGuard interlocks on side access doors
Airflow Safety	Exhaust and recirculation airflow switches
Work-Area High Limit	Gefran overtemperature controller
Purge Control	ATC purge timer
Emergency Stop	Local control-enclosure E-stop affecting conveyor operation

Controls & Electrical	
Facility Voltage	480V / 3PH / 60Hz
Full Load Amperage	Approx. 188 A
Pneumatic Supply	60 PSI minimum
PLC	Allen-Bradley CompactLogix 5069-L330ER
HMI	Allen-Bradley PanelView Plus 7 Standard, 10 in.
Temperature Controller	Watlow F4T
Overtemperature Control	Gefran
Fan Drives	Allen-Bradley PowerFlex 525 VFDs
Conveyor Servo Drive	Allen-Bradley Kinetix 5500 with VPL motor
Controls Architecture	Remote-mounted NEMA 12 high-voltage and low-voltage enclosures with separate junction box and network-device panel

Process Summary	
Product	Electric-vehicle motor stators
Market / Application	EV motor manufacturing
Process Type	Indexed curing and controlled thermal holding within an automated manufacturing cell
Part Mass	66 lb per part; 4,752 lb total batch mass
Production Rate	Approx. 111.1 parts/hr
Fixture / Tray	Customer robotic fixtures with pneumatic tray-centering and positioning for robotic load/unload
Testing / Validation	Factory preassembly, wiring checkout, operational test, and chamber balancing / uniformity adjustment prior to shipment

Key Verification Concept

Repeatable servo-driven index timing, pneumatic tray-centering accuracy, bottom-up thermal delivery, and VOC-compliant Class A exhaust control within an automated cell



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