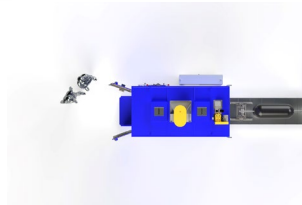




CASE STUDY

Specialized COPV Curing Oven with Motorized Rotating Cart System

Car-bottom batch curing oven with dual-spindle motorized rotation system for composite overwrapped pressure vessels—delivering $\pm 10^{\circ}\text{F}$ uniformity across a 110°F to 350°F operating range, Class-A NFPA 86 compliance, 54 KW electric heating, and Allen-Bradley PLC with up to 40 programmable ramp/soak cure profiles.



OVERVIEW

Precision Quincy engineered a specialized Class-A batch curing oven for composite overwrapped pressure vessels (COPV), featuring a motorized rotating cart with dual-spindle rotation system and car-bottom design. The oven maintains $\pm 10^{\circ}\text{F}$ temperature uniformity across a wide operating range from 110°F to 350°F , processing 200 lb batches of epoxy-coated cylindrical aerospace components requiring rotation and internal pressurization throughout the cure cycle.

The project combined the customer's need for simultaneous product rotation and vessel pressurization during curing with strict thermal uniformity requirements for critical aerospace composite structures. The final design integrates 54 KW electric heating with incoloy sheathed elements in multiple heater banks, a belt-driven 4,410 CFM recirculation fan delivering combination horizontal-vertical airflow, and a 580 CFM Class-A exhaust system. The car-bottom design uses a floor-mounted internal track with V-groove wheels so operators can load components outside the oven and the motorized cart drives the full assembly into position. An Allen-Bradley CompactLogix PLC with Watlow F4T ramp/soak controller manages up to 40 programmable cure profiles with integrated rotation control, pressure monitoring, and data collection.



CUSTOMER PROCESS REQUIREMENTS

A leading aerospace manufacturer required a precision thermal processing solution for curing composite overwrapped pressure vessels (COPV). The application imposed demanding requirements across product rotation, pressurization, temperature uniformity, safety compliance, and site constraints.

Application & product type

- Product: composite overwrapped pressure vessels (COPV) — large cylindrical aerospace components with epoxy resin coatings applied over carbon fiber composite structures.
- Process: batch curing in a controlled thermal environment to polymerize epoxy resin coatings and cure the composite matrix.
- COPVs are cylindrical; rotation during curing is required to ensure uniform epoxy distribution across the full part surface.
- Internal vessel pressurization must be maintained throughout the cure cycle to preserve structural integrity of the composite overwrap.

Load requirements

- Product weight: 200 lb per batch.
- Two vessels per batch, mounted on dual spindle stations at 29.5-inch centers; each vessel is 23.5 inches in diameter with a 6-inch gap between vessels.
- Loading method: car-bottom cart rolls out of the oven on the internal floor-mounted track; components are loaded onto spindles outside the oven with pressurization fittings connected, then the cart drives back in.

Thermal requirements

- Operating temperature range: 110°F to 350°F typical.

- Maximum temperature capability: 350°F.
- Temperature uniformity: $\pm 10^\circ\text{F}$ at operating setpoint across the full work area.
- Programmable ramp/soak profiles required to manage precise temperature ramp rates and soak periods critical to epoxy cure chemistry.

VOC / safety compliance requirement

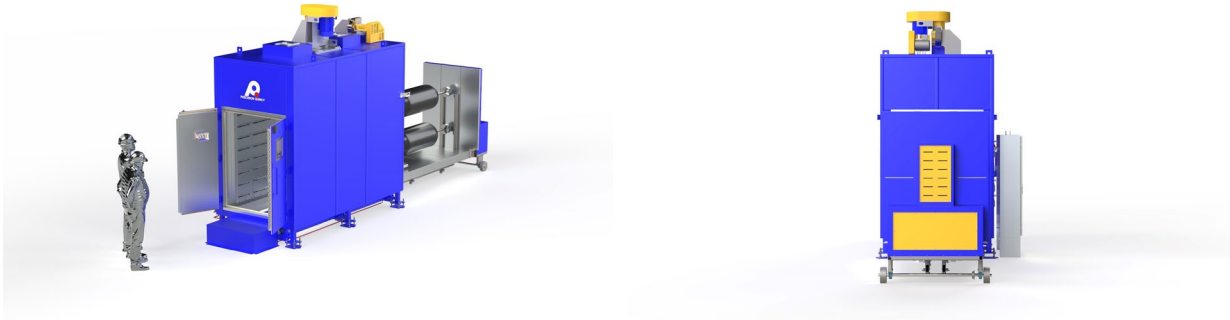
- VOC loading: 0.5 gallon per batch of standard solvent emitted during epoxy cure.
- Required: NFPA 86 Class-A oven compliance with appropriate exhaust, purge, and safety interlock systems.

Site conditions

- Heating: electric (54 KW specified).
- Site altitude: less than 1,000 feet above sea level.
- Electrical service: 460V / 3-phase / 60 Hz.

Accessibility constraints

- Equipment must enter facility through a 12' \times 16' dock door.



THERMAL PROCESS REQUIREMENTS

These thermal process requirements were developed to meet the customer's curing process needs for composite overwrapped pressure vessels, based on the application conditions and operating parameters.

Temperature requirements

- Operating temperature range: 110°F to 350°F.
- Maximum temperature capability: 350°F.

Load / product parameters

- Batch capacity: 200 lb per batch.
- Individual part geometry: cylindrical COPVs (23.5" diameter); rotation throughout the cure cycle ensures all surfaces receive consistent thermal exposure.
- Vessels are pressurized during cure; PLC-integrated pressure regulators maintain internal vessel pressure throughout the cycle.

Heat input requirement

- Required heat input: 54 KW electric.
- Incoloy sheathed heating elements arranged in multiple heater banks for precise zone-level control.

Airflow delivery

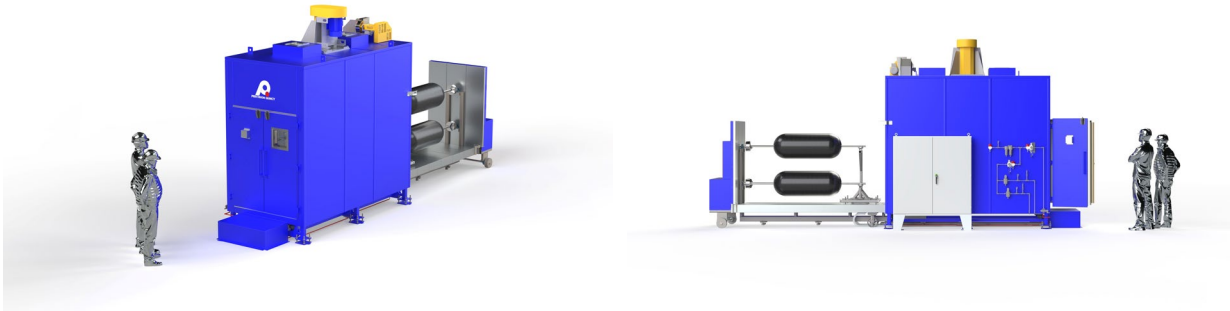
- Combination horizontal-vertical airflow through the 182 cubic foot oven chamber.
- Supply fan: 4,410 CFM at 2" WC static pressure, 5 HP TEFC motor, belt-driven.
- Supply ductwork: 16-gauge aluminized steel with adjustable slot nozzles for airflow balancing around rotating cylindrical parts.

Exhaust requirements (Class-A VOC removal)

- Class-A exhaust fan: 580 CFM at 1" WC static pressure, 0.75 HP ODP motor.
- Exhaust type: gravity port with adjustable damper for VOC removal control.
- Exhaust discharge: per applicable code (customer to vent outside building).

Temperature uniformity

- $\pm 10^{\circ}\text{F}$ from setpoint at operating temperature across the full 182 cubic foot work area, ensuring consistent and complete epoxy cure across the full load.



EQUIPMENT CONCEPT & ARCHITECTURE

To deliver the thermal process requirements (which deliver the customer process requirements), Precision Quincy settled on the following equipment concept and architecture for the COPV batch curing oven.

Overall concept

- Class-A, electrically heated, car-bottom batch curing oven with motorized rotating cart.
- Electric heating via 54 KW incoloy sheathed elements in multiple heater banks.
- Work area: 36" W \times 112" L \times 78" H (182 cu ft interior volume).
- Overall equipment dimensions: 75" W \times 257" L \times 143" H.
- Total equipment weight: approximately 9,500 lb.

Door system

- Front-end bi-parting pneumatic doors: 4-inch thick insulated construction.
- Safety devices: manual safety latches; limit switches on access doors monitored by PLC.
- Seal: door gaskets around full perimeter for optimal chamber sealing during cure cycle.

Product rotation system

- Two powered spindle stations on 29.5-inch centers.
- Drive side: three-jaw chucks. Driven side: V-rollers.
- Variable speed and acceleration control via PLC.
- Accommodates two 23.5-inch diameter cylindrical vessels with 6-inch gap between.

- Integrated pressurization: 1/4-20 fittings for vessel pressurization; pressure regulators integrated with PLC for continuous monitoring and control throughout the cure cycle.

Car-bottom / loading architecture

- Motorized car-bottom cart rolls out of oven on floor-mounted internal track with V-groove wheels and 12-inch raised base incorporating cart bottom seal and tracking roller system.
- Cart bottom seal and tracking roller system maintain chamber sealing integrity during operation.
- Snap-together cable carrier system with mounting brackets protects all wiring and hoses during cart movement.
- Cart-mounted E-stop; limit switches on cart and access doors for full-cycle safety monitoring.

Heating / airflow architecture

- 54 KW electric heating with incoloy sheathed elements arranged in multiple heater banks for efficient temperature control across the work area.
- Supply fan: belt-driven, 4,410 CFM at 2" WC static pressure, 5 HP TEFC motor.
- Airflow pattern: combination horizontal-vertical via 16-gauge aluminized steel supply ductwork with adjustable slot nozzles for optimal distribution around rotating cylindrical parts.
- Class-A exhaust fan: 580 CFM, 0.75 HP ODP motor, gravity port with adjustable damper for VOC removal.

Construction / shell architecture

- Structural steel frame; an extremely robust and stable platform.
- 16-gauge aluminized steel interior and exterior walls.
- Wall thickness: 4 inches with 6-pound density mineral wool insulation.
- Finish: Precision Quincy Blue industrial epoxy enamel on body and door; ANSI 61 gray control panel.

Controls architecture

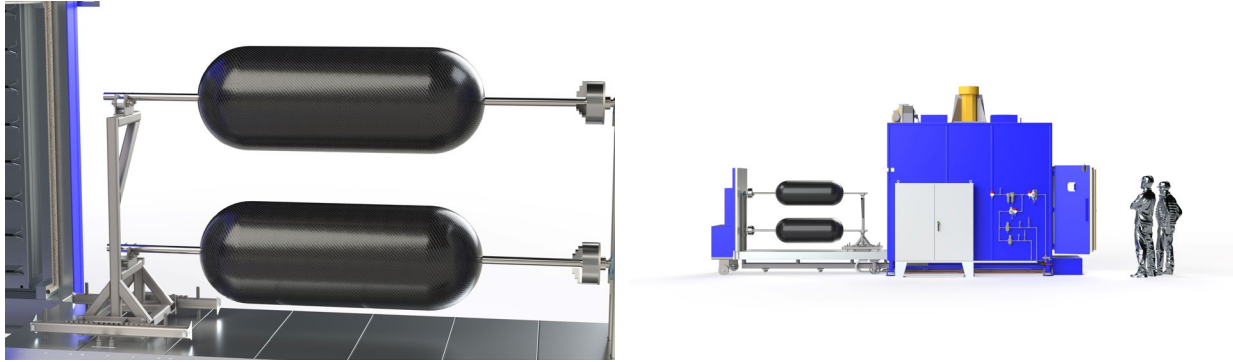
- PLC: Allen-Bradley CompactLogix.
- HMI: Allen-Bradley PanelView Plus 10-inch color touchscreen.
- Temperature controller: Watlow F4T ramp/soak with 4.3-inch color touchscreen; up to 40 programmable cure profiles.
- Thermocouple type: Type J.
- Rotation control: variable RPM and acceleration control via PLC.
- Pressure monitoring: integrated pressure regulator monitoring via PLC.
- Data collection framework included; battery backup.
- Panel rating: NEMA 1, UL 508A labeled.

Safety systems

- NFPA 86 and OSHA compliant.
- Class-A exhaust system for continuous VOC removal during cure cycle.
- Work area hi-limit controller (digital/manual reset).
- Adjustable mechanical motor-driven purge timer.
- Airflow switches on supply fan and exhaust fan as safety interlocks.
- Cart-mounted E-stop and additional emergency stop locations.
- Manual safety latches and door limit switches; safety chain monitored by PLC for diagnostics.

Other noted attributes

- Utilities: 460V / 3-phase / 60 Hz; 100 FLA estimated.
- IEC-type motor starters; disconnect included.
- Equipment dimensions designed to pass through a 12' × 16' dock door for installation.



TECHNICAL SPECIFICATIONS

Note: The specifications below reflect the as-built configuration. Any fields not explicitly stated remain intentionally omitted.

| Oven Configuration | |
|--------------------|--|
| Type | Batch, car-bottom with motorized rotating cart |
| Work Area | 36" W × 112" L × 78" H (914 × 2,845 × 1,981 mm) |
| Interior Volume | 182 cubic feet |
| Overall Dimensions | 75" W × 257" L × 143" H (1,905 × 6,528 × 3,632 mm) |
| Equipment Weight | Approximately 9,500 lb |

| Thermal Performance | |
|------------------------|---|
| Operating Temperature | 110°F to 350°F (43°C to 177°C) |
| Maximum Temperature | 350°F (177°C) |
| Temperature Uniformity | ±10°F (±5.6°C) at operating setpoint |
| Heat Source | Electric, 54 KW |
| Heating Elements | Incoloy sheathed, multiple heater banks |
| Airflow Pattern | Combination horizontal-vertical |

| Airflow System | |
|-----------------|--|
| Supply Fan | 4,410 CFM @ 2" WC static pressure |
| Supply Motor | 5 HP, TEFC, belt-driven |
| Supply Ductwork | 16-gauge aluminized steel with adjustable slot nozzles |
| Exhaust Fan | 580 CFM @ 1" WC static pressure |
| Exhaust Motor | 0.75 HP, ODP |
| Exhaust Type | Gravity port with adjustable damper (Class-A) |

| Rotating Cart System | |
|-----------------------|--|
| Spindle Configuration | Dual powered spindles on 29.5" centers |
| Drive System | Three-jaw chucks (drive side), V-rollers (driven side) |
| Vessel Diameter / Gap | 23.5" diameter vessels; 6" gap between vessels |

| | |
|-------------------------|--|
| Pressurization | ¼-20 connections for vessel pressurization |
| Pressure Control | Regulators integrated with PLC |
| Cart Motion | Internal floor-mounted track with V-groove wheels; 12" raised base |
| Cable Management | Snap-together cable and hose carrier with mounting brackets |
| Safety | Cart-mounted E-stop, limit switches, cable carrier protection |

| Door System | |
|-----------------------|--|
| Type | 4-inch thick insulated bi-parting doors, front-loading |
| Operation | Pneumatically actuated bi-parting doors |
| Safety Devices | Manual safety latches; limit switches on access doors |
| Gasket | Door gaskets for optimal chamber sealing |

| Construction Materials / Finish | |
|--|---|
| Primary Structure | Structural steel frame |
| Interior Walls | 16-gauge aluminized steel |
| Exterior Walls | 16-gauge aluminized steel |
| Wall Thickness | 4 inches |
| Insulation | 6-pound density mineral wool (4-inch wall) |
| Finish | Precision Quincy Blue industrial epoxy enamel (body and door); ANSI 61 gray control panel |

| Controls & Automation | |
|----------------------------------|--|
| PLC | Allen-Bradley CompactLogix |
| HMI | Allen-Bradley PanelView Plus 10" color touchscreen |
| Temperature Controller | Watlow F4T ramp/soak with 4.3" color touchscreen |
| Profile Storage | Up to 40 programmable ramp/soak profiles |
| Thermocouple Type | Type J |
| Rotation Control | Variable RPM and acceleration control via PLC |
| Pressure Monitoring | Integrated pressure regulator monitoring |
| Data Collection | Data collection framework included |
| Battery Backup | Included |
| Panel Rating | NEMA 1, UL 508A labeled |

| Safety & Compliance | |
|--------------------------------|---|
| NFPA 86 Classification | Class-A |
| Work Area Hi-Limit | Digital / manual reset controller |
| Purge Timer | Adjustable mechanical motor-driven timer |
| Airflow Switches | (1) per supply fan, (1) per exhaust fan |
| Emergency Stops | Cart-mounted E-stop; additional locations as required |
| Door Safety | Manual safety latches, limit switches |
| Safety Chain | Monitored by PLC for diagnostics |

| | |
|------------------------|------------------|
| Code Compliance | NFPA 86 and OSHA |
|------------------------|------------------|

Utilities

| | |
|-----------------------|---|
| Electrical | 460V / 3-phase / 60 Hz; 100 FLA (estimated) |
| Motor Starters | IEC type |
| Disconnect | Included |
| Site Altitude | Less than 1,000 feet above sea level |

Process Specifications

| | |
|------------------------|--|
| Parts Processed | Composite Overwrapped Pressure Vessels (COPV) |
| Product Weight | 200 lb per batch |
| Process | Epoxy resin curing with rotation and vessel pressurization |
| VOC Loading | 0.5 gal/batch of standard solvent |



**MAKE BADASS
PRODUCTS**

pqovens.com