Cincinnati Sub-Zero

Case Study

Custom Altitude, Temperature & Humidity Chamber Enables Environmental Validation of Advanced Satellite Antenna Systems

CHALLENGE

An advanced technology organization developing next-generation satellite communication systems required validation of large, flat antenna assemblies for low Earth orbit deployment. These metamaterial antennas enable continuous horizon-to-horizon tracking without mechanical movement, requiring consistent performance across varying environmental conditions.

Because space-based systems cannot be serviced after deployment, the customer required simulation of combined temperature, humidity, and altitude conditions representative of real-world operation.

At reduced pressure, maintaining thermal stability and humidity control becomes more difficult due to limited air density and convective heat transfer, requiring a system capable of delivering stable, repeatable environmental control across these combined conditions.

SYSTEM HIGHLIGHTS

- Integrated Environmental Simulation: Temperature, humidity, and altitude testing in a single system
- Temperature & Humidity Range: -55°C to +100°C; 10% to 95% RH
- Altitude Capability: Stable operation at 55,000 ft with configurable temperature conditions:
  - 10°C to +35°C at altitude
  - -55°C to +50°C at altitude

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SOLUTION

CSZ delivered a 64 cu. ft. Altitude/Temperature/Humidity Chamber configured to meet the customer's specific testing requirements.

The system integrates temperature, humidity, and altitude simulation into a single platform, enabling repeatable validation of antenna performance under combined environmental conditions. The chamber maintains stable operation across a wide temperature and humidity range while sustaining altitude simulation at 55,000 ft.

Specialized configurations support operation across multiple temperature ranges at altitude, including extended low-temperature performance not achievable with conventional designs.

Built for consistent performance, the chamber utilizes heavy-duty, high-capacity vacuum pumps to ensure reliable altitude simulation. Automated control of altitude setpoints enables precise regulation of ascent and descent rates, while a dive valve allows for rapid altitude reduction.

The chamber also incorporates custom access ports with flanged, sealed interfaces, allowing instrumentation and communication connections to be routed into the workspace without compromising environmental integrity.

This integrated approach reduces setup variability while ensuring consistent, repeatable environmental testing within a single system.

SYSTEM HIGHLIGHTS

- Cascade Refrigeration System: for reliable low-temperature performance
- Custom Access Ports (Flanged & Sealed):
  - One (1) 4" port (left-hand side)
  - One (1) 6" port (right-hand side)
- Chamber Construction: Heavy-duty interior and safety latching for durability and long-term use
- Visibility Features: Viewing window and interior lighting for test monitoring
- Sensing & Control: Solid-state humidity and altitude sensors for precise environmental control