



United Technologies
turn to the experts

Down to Earth Transport for Out of This World Cargo.



The Boeing Company Relies on Vector™ Units for Mission Critical Cross-country Satellite Transport.

Satellites made by Boeing's commercial satellite business typically travel over 900 million miles orbiting the Earth during their 15+ years of operational service. However, before a rocket blasts them into space, some make a critical 2,500-mile road trip from the manufacturing site in southern California to Cape Canaveral on Florida's Space Coast. After meticulous assembly in ultra-clean, climate-controlled conditions, the satellites are placed inside a custom-built container designed to maintain those conditions during transport. Boeing turned to Carrier Transicold dealers to fabricate the Transport Environmental Control System (TECS) that helps maintain temperature, humidity and a dust-free environment. Vector™ 8500 single-temperature refrigeration units provide the mission critical reliability necessary to protect space hardware.

Carrier Transicold Solution.

Engineered for high-capacity performance and reliability, the hybrid diesel-electric Vector platform provides the solution of choice for Boeing's satellite transporter.

Unlike traditional mechanical trailer refrigeration units that rely on belts and pulleys connected to a diesel engine, Vector units have an all-electric refrigeration system, called E-Drive™ technology. Although each Vector unit has a diesel engine, its sole purpose is to drive a high performance generator that produces electricity to run the compressor, fans, control system and other electronic components.

The absence of mechanical components improves reliability, and the platform's high capacities provide the ample cooling required when transporting through the extreme heat and humidity of the southern United States.



Each of the twin Vector units provides the high level of reliability and performance required by Boeing's satellite transport operations.

Location:
El Segundo, California

Customer:
Boeing Network & Space Systems, part of The Boeing Company, the world's largest aerospace company and leading manufacturer of commercial jetliners and defense, space and security systems.

Objectives:
Control interior environment of a transporter to keep satellite exposure well within specified design limits, even in the most extreme temperatures when transported over land from the manufacturing site to the launch facility.

Transporter Specification:
Approximately 15 feet wide, 13 feet tall and 40 feet long.

Decision Drivers:
Reliability, capacity and environmental compliance.

Carrier Transicold Equipment:
Two Vector 8500 single-temperature units with engine emissions systems.

Special Challenges:
Carrier dealerships worked together to help fabricate a custom-configured environmental control unit for Boeing's ground-based satellite transport operations.

For more information please visit www.transicold.carrier.com



Precious Cargo.

Commercial satellites are launched from a variety of locations around the world – notably French Guiana and Kazakhstan. Few cargo aircraft have the volume capacity to load the containerized spacecraft, and the transport costs can easily exceed \$1 million. Still, when a satellite only needed to make a one-mile trip from the El Segundo manufacturing site into a waiting aircraft at the nearby Los Angeles International Airport, maintaining ideal conditions within its transporter was less of a challenge. Onboard the plane, temperature and humidity were not an issue, and the trip duration was relatively short.

For launches from Cape Canaveral, the I-10 corridor offers an alternative to transporting the satellites by air – a direct land route from Boeing's West Coast operation to Florida. However, the route traverses western deserts, hot plains of Texas and the southern parts of the Gulf States, so a high-performance cooling system would be required for the transporter.

Mission Accomplished.

Production of the new TECS was a collaboration between Boeing and two Carrier Transicold Dealers – Carrier Transicold of Southern California and Midlands Carrier Transicold. In Midlands' fabrication shop in Omaha, Nebraska, two Vector units were mounted to a framework on opposite sides of a supply/return plenum. In operation, a single Vector does the work, and the other serves as a backup.

The TECS is positioned atop a "gooseneck" platform at the front of the transporter and connects to aluminum ductwork that runs along the top outer edges of the transporter lid. Chilled air is delivered to the rear of the container and pulled forward. Air is purified with activated carbon and HEPA filters. Dehumidifiers were added to maintain relative humidity of less than 60 percent inside the transporter.

Anticipating long-term use of the system, Boeing specified the Vector units with Carrier Transicold's optional engine emission system, providing future compliance with California Air Resources Board standards that require an additional 85 percent particulate emissions reduction from engines of the Vector unit's horsepower class after seven years use.

Upon completion of the unit, the Carrier Transicold dealers worked closely with Boeing on system testing at the peak of summer, 2015, in southern California's High Desert region. The system performed as expected.

By late August the transporter had its first mission with the new TECS, carrying a Boeing communications satellite. The Boeing team kept careful watch over the interior climate using telematics that enabled monitoring via computer and smart phone. Even with temperatures spiking at 107 degrees in Phoenix on the first day, humidity inside was held to 35 percent, and the Vector unit maintained a steady 70 degrees, data that stayed the course for the remainder of the successful trip.



The six-day trip a Boeing satellite makes from California to the Florida launch pad requires a convoy, including chase-cars and highway patrol escorts. The Vector must run around-the-clock for each day of the trip.



As the saying goes, failure is not an option in space missions. For that reason, Boeing requires redundant refrigeration units for its satellite transporter. The Vector 8500 units (blue) share a common supply/return plenum (white area with Boeing logo). The white ductwork carries supply air, which flows down both sides to the far end of the transporter.