Testing reliability of airborne electronics

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Environmental Test Chambers · Space Simulation Systems

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A major problem is checking radar, flight control and other systems to be sure that they will function properly–despite severe environmental changes. A test chamber has helped solve the problem

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The demand for greater reliability in airborne electronic equipment has produced a test chamber temperature control system that has the ability to drop cooling air temperature from −40 to −65 F in 2.8 minutes. In addition, the system features automatic proportioning of mass air flow to temperature, completely automatic operation controlled by a tape programmer, and a traveling alarm system that is actuated if the temperature goes out of tolerance.

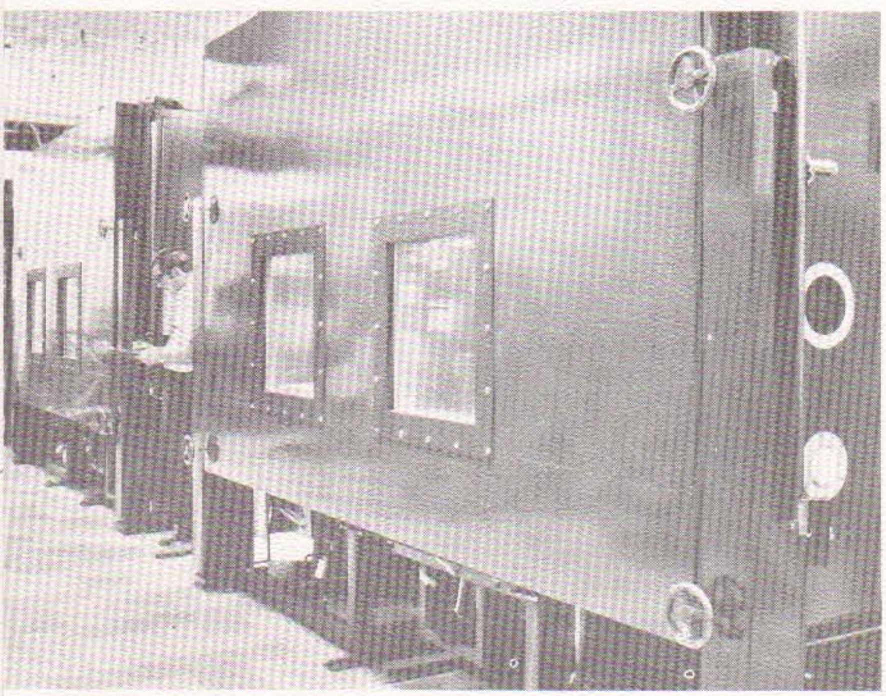
The automatic proportioning of air flow as a function of its temperature is of particular importance as it can prevent accidental damage to the very expensive packages being tested. As a result of refrigeration failure, for example, the mass flow is automatically increased to give the same cooling effect as the air temperature increases.

Five of these chambers (manufactured by Bemco Inc.) are being used to test entire airplane radar systems, complete with antenna. This reliability test is concerned exclusively with the ambient temperature that surrounds the electronic gear and the cooling air temperature that simulates the cooling air encountered in flight.

With the exception of three one-hour power-off phases, the electronic gear in the chamber is operating and continually monitored throughout a 24 hour profile. Concurrently, the system is subjected to vibration for 10 minutes out of every hour. This is accomplished by means of a mechanical shaker built into the floor of the chamber.

The test chamber, which has a total volume of 315 cubic feet of usable space, is divided into two compartments—one for the antenna, the other for associated electronic equipment. A double-walled silicone impregnated fiberglass curtain between the two compartments simulates the partition in the aircraft between the antenna section in the nose and the electronic equipment section. Within the second compartment, three main sections require cooling air—the transmitter; the plenum, that diverts the flow to various smaller components; and the roll gimbal assembly, which also has electronic components that must be cooled during flight.

The chamber provides five different temperatures—two compartment temperatures and three cooling air temperatures—by using five different temperature controllers. Programming for all five temperatures has



RELIABILITY TESTS for aircraft radar systems are conducted in these test chambers that have ability to drop cooling air temperature from −40 to −65 F in 2.8 minutes.

a one degree resolution and covers from −100 to +300 F. A definite profile of temperature changes is provided for each of these five areas.

One of the most difficult parts of the profile was to drop the cooling air from −40 to −65 F in 2.8 minutes. Mass air flow at this point is low and would normally have to cool down the rigid and flexible ducting at the same time. To eliminate the load presented by the ducting, a guard air system was incorporated around the ducts.

The guard air is always maintained at a lower temperature than the specimen cooling air. This colder guard air is blown through coaxial type jackets that surround the cooling air ducts. It is blown counterflow to each duct that carries the actual incoming specimen cooling air.

How air flow is measured

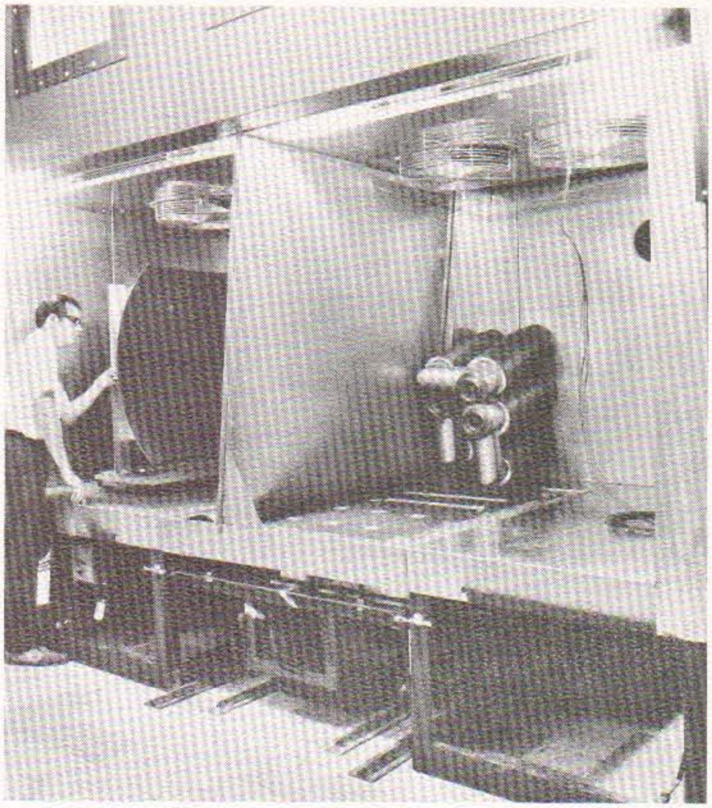
Laminar flow elements are used to provide a precise means of measuring mass air flow. This type of air flow measurement can be inaccurate because of air viscosity changes if there is any variation in the temperature of the mass air flow as it passes over the laminar flow elements. Also, at temperatures below freezing, moisture in the system will cause ice crystals to form and block the entrance of the laminar flow elements. These problems are avoided in the system by maintaining a constant 80 F temperature at the laminar flow elements—regardless of what happens upstream or downstream. All returning air is conditioned to 54 F. This air passes through an intake filter silencer and then enters a blower that boosts the pressure high enough to overcome all pressure drops in the system.

The heat of compression in the blower raises the conditioned air from 54 to 80 F. Regardless of the temperature of the return air, the air at the laminar flow measuring devices always ends up at 80. Downstream from these flow elements, the air is heated to as much as 120 F or cooled to as low as −65, as required. By maintaining this constant temperature at the laminar flow elements, the recorders always reflect the actual change of mass in the air flow.

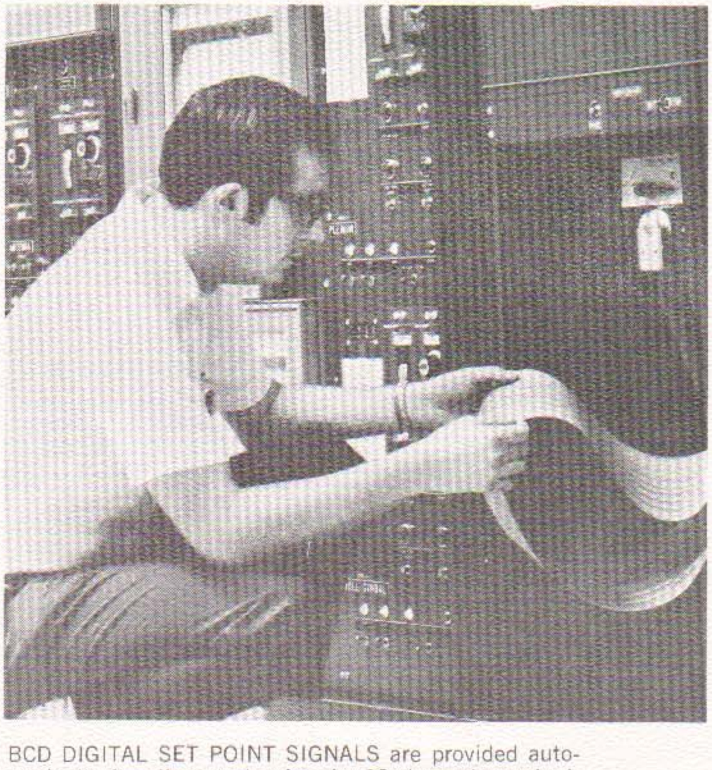
Instrumentation plays critical role

Cooling operations are controlled with solenoid valves, heating by SCR solid state devices. Both are energized at essentially zero potential. Control instruments are of the 3-mode type where the optimum proportional band, automatic reset, and rate of approach can be selected. These were chosen to meet the close tolerances required even though the amounts of cooling and heating that are controlled are very large (one compartment requires 100 horse power in refrigeration, the other 70). The average rate of change is 9 F per minute. The cascade type refrigeration system is capable of lowering the temperature to −100 F.

The chambers are equipped with a traveling alarm system that is actuated any time the temperature goes out of tolerance. The system is controlled by its own adjustable band width on each controller. During a normal temperature transition in the test profile, the alarms are automatically shut off until a new set point is reached. The alarm system is then automatically re-energized through the tape programmer. □



DUAL COMPARTMENTS INSIDE CHAMBER are separated by double-walled silicone-impregnated fiberglass curtain that simulates partition in aircraft between antenna section in nose and electronic equipment section.



BCD DIGITAL SET POINT SIGNALS are provided automatically for all control points by 82-channel punched-tape programmer.

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