RTCA DO-160 – Relevant validation of aviation equipment

Test requirements for electrical and electronic equipment in aerospace systems

RTCA DO-160 is the internationally leading environmental qualification standard for electrical and electronic equipment in aviation. It describes detailed test procedures to ensure that devices reliably withstand the extreme environmental conditions in aircraft, helicopters, eVTOLs, drones, and other aviation systems. This includes tests for temperature, humidity, altitude, pressure, vibration, shock, sand and dust, electromagnetic compatibility (EMI/EMC), lightning protection, power fluctuations, and many other influencing factors that can occur during the operation of an aircraft.

The standard is a fundamental prerequisite for the certification of avionics and onboard electronic components in both civil and military applications. Devices that pass DO-160 are considered robust, reliable, and airworthy—an essential quality criterion for manufacturers, authorities, and operators. In practice, DO-160 serves as a universal reference to standardise development processes, reduce risks in early project phases, and ensure interoperability between different manufacturers. It is particularly important as modern aircraft become increasingly complex, more interconnected and more electrified.

Through continuous updates, most recently DO-160G, the standard is continuously being adapted to new technologies such as electric propulsion systems, highly integrated cockpit systems, autonomous flight, or data-intensive communication systems.

weisstechnik can offer the right solution with a wide range of test chambers and test systems for thermal cycling, humidity, vibration tests and many other test methods..

Key Facts:

- RTCA DO-160 was developed by RTCA and EUROCAE.
- Objective: uniform set of rules in aviation.
- Use in electrical and electronic equipment in aviation.
- Consists of 13 environmental influences and 10 electrical and electromagnetic (EMI) influences.
- **weiss**technik can offer the right solution for 8 of the 13 environmental influences.

Origin and development

The RTCA (Radio Technical Commission for Aeronautics) and EUROCAE collaborated to develop the RTCA DO-160 standard in the 1970s. The aim was to create a uniform, binding set of test regulations, since differing national or manufacturer-specific requirements had previously led to compatibility and safety issues. Since then, the committees have revised the standard several times and expanded it from version A to the current version DO-160G. Each revision takes into account new technologies, changing environmental conditions and updated regulatory requirements. Today, the standard is a central component of global aviation standards, used by authorities such as the FAA and EASA as well as manufacturers and test laboratories worldwide.

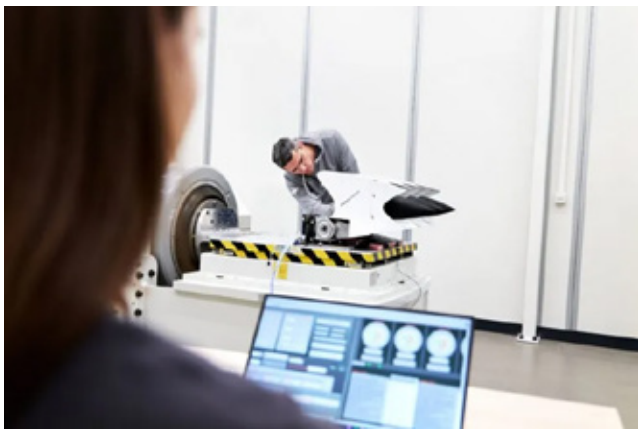

Figure 1: Testing eVTOL components

Structure of RTCA DO-160

RTCA DO-160 begins with general chapters. These are followed by the technical test chapters, which form the core of the standard: 13 environmental influences and 10 electrical and electromagnetic (EMI) influences. Each of these sections defines test procedures, measurement methods, and qualification categories that a device must meet depending on its installation location in the aircraft. The sections are modular in structure, allowing manufacturers to select only those areas that are relevant to their test specimens. This makes the RCTA DO-160 universally applicable for large airliners, helicopters, eVTOLs or UAVs.

Thermal and climatic (section 4-6):
temperature, altitude, temperature changes and humidity. These tests check whether electronic and mechanical components can withstand extreme environmental conditions.

Mechanical stresses (section 7-10):
vibration, shock, acceleration, as well as exposure to water and particles such as dripping and spraying water, sand, and dust.

Chemical and corrosive influences (section 11-14):
fungal growth, salt fog, fluid susceptibility, and other material related risks.

Acoustic and structural influences (section 15-16):
noise and resonance effects, which occur in particular in engine or rotor areas.

Electrical power supply tests (section 16-25):
behaviour under voltage variations, transients, frequency changes, interruptions, and power network disturbances.

EMI/EMC testing (section 18-21):
emitted interference, interference immunity, radio-frequency exposure, ESD, magnetic fields, and HF influences. These tests ensure that devices do not interfere with one another.

Lightning and surge tests (section 22-23):
simulation of direct and indirect lightning currents, which are essential for safety-critical systems.

Further special tests (section 24-26):
icing, fire, radiation or RF emissions, depending on the application.

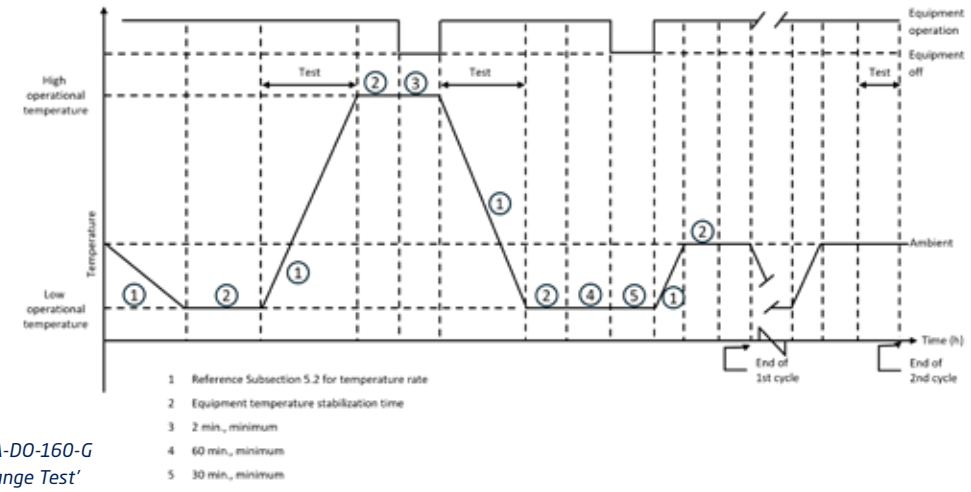

Figure 2: According to RTCA-DO-160-G Section 5 'Temperature Change Test'

Relevant industries & examples

The RTCA DO-160 is now one of the most important international standards for the environmental qualification of electronic and electrical equipment in the aerospace industry. Its application extends well beyond traditional commercial aircraft and covers numerous industries where reliability under extreme environmental conditions is essential.

Civil aviation

The largest user group consists of manufacturers of avionics and onboard electronics for commercial aircraft, business jets, and regional jets. DO-160 is a prerequisite for the certification of nearly all cockpit, navigation, communication, and cabin components. These include displays, transponders, sensors, lighting systems, and power supply modules.

Military aviation

DO-160 is also used for military aircraft, particularly when commercial or dual-use components are integrated. The standard enables a uniform qualification of mission systems, communication equipment, sensors, and power distribution units.

Helicopter industry

Helicopters place particularly high demands in terms of vibration, temperature changes, water and particle exposure. DO-160 is used here for avionics, rotor monitoring systems, external modules, emergency transmitters, and other components.

Urban air mobility and eVTOL systems

New aircraft concepts such as electric air taxis, autonomous aircraft, or hybrid propulsion systems require robust and lightweight electronics. DO-160 provides a reliable framework for this, for example for battery management systems, high-voltage control units, or autonomous flight control systems.

Professional drones (UAV/UAS)

As BVLOS (beyond visual line of sight) operations become more regulated, the importance of DO-160 is increasing. Manufacturers qualify flight controllers, navigation modules, data links and sensors according to specific sections in order to obtain operating approvals.

Space flight and NewSpace

Although primarily governed by their own standards, many space organizations use DO-160 tests for subsystems that are deployed both in aviation and in orbit, such as power distribution, communication modules, or electronics for small satellites.

weisstechnik can provide suitable solutions for a wide range of methods:

- Temperature and climatic testing
- Water and fluid testing
- Corrosion testing
- Particulate and atmospheric influences
- Altitude and pressure testing
- Combined tests and special methods

We offer the right solution for every test specimen! From compact bench-top models with a 16-litre test chamber volume to reach-in test chambers and drive-in systems for large-volume applications. In addition to our standard products, we work closely with our customers to develop bespoke solutions tailored precisely to their specific requirements.

Section 4: Temperature and Altitude

Electronic systems in aircraft must withstand extreme environmental conditions such as cold temperatures, low air density and rapid pressure changes, which can impair their function and stability. This section specifies comprehensive test procedures that realistically simulate temperature- and altitude-related stresses. The selection of tests depends on the installation location, operating altitude and expected pressure conditions. These include: low and high temperature tests as well as altitude testing

Products: laboratory test chambers LabEvent, temperature test chambers TempEvent (reach-in, walk-in, drive-in), customised solutions, altitude simulation chambers SkyEvent

Section 5: Temperature Variation

Equipment used in aviation often has to withstand rapid and repeated temperature changes. RTCA DO-160 Section 5 simulates these stresses through cyclic tests between defined temperature limits. Effects such as thermal stresses, material fatigue, crack formation, condensation and functional deviations are evaluated – especially in the case of rapid temperature changes, to which components react to varying degrees.

Product: temperature shock test chambers ShockEvent, temperature test chambers TempEvent (reach-in, walk-in) with 15...25K/min.

Section 6: Humidity

In terms of humidity, testing evaluates the moisture resistance of aviation-qualified equipment. Electronics and materials used in aviation can absorb moisture due to climatic conditions, condensation, or installation in unconditioned areas. This can lead to corrosion, insulation problems, leakage currents, chemical reactions, or thermal changes. The test therefore specifically assesses the electrical, chemical, and mechanical effects of humidity on the equipment.

Products: laboratory test chamber LabEvent, climate test chambers ClimeEvent (reach-in, walk-in, drive-in), and customer-specific solutions.

Section 9: Explosion Proofness

RTCA DO-160 Section 9 tests equipment used in areas with potentially flammable gases or vapours to ensure that it is not a source of ignition. The tests include verification of non-ignition, evaluation of the containment of a possible internal ignition, and confirmation that no surface temperatures exceed 204°C.

Equipment is classified into three categories:
Category A (hermetically sealed / explosion-proof)
Category E (not hermetically sealed but ignition-safe)
Category H (hot surfaces without spark generation)

Product: explosion-proof test chamber ExtremeEvent

Section 10: Waterproofness

Section 10, 'Waterproofness test', examines how aviation-approved devices react to water exposure such as condensation, dripping, spraying or jet water. The aim is to ensure that moisture does not lead to failures, corrosion or leaks.
Depending on the operating environment, testing is carried out in four categories:
Category Y (condensation)
Category W (dripping water)
Category R (spray water)
Category S (high-pressure water jets, e.g. for de-icing)

Product: climate test chamber ClimeEvent (reach-in, walk-in) with special equipment, spray water test chamber WaterEvent

Section 12: Sand & Dust

The sand and dust test, Section 12, assesses how well devices withstand the ingress and accumulation of fine particles. Sand and dust can block moving parts, form electrical bridges, promote corrosion or impair seals and bearings. The tests simulate realistic blowing conditions encountered during flight operations and are conducted in two categories:
Category D (dust in moderate air flow)
Category S (sand and coarse particles in high wind speeds)

Product: dust testing devices DustEvent

Section 14: Salt Fog

The DO-160 salt fog test evaluates how resistant aviation-related devices are to salty atmospheres, such as those often found near the sea or during de-icing. It simulates the corrosive effects of salt to investigate the impact on materials, coatings, seals and electrical connections. Risks include corrosion of metal surfaces and contacts, malfunctions due to salt deposits, and insulation faults or wiring problems.

The test is divided into two categories:
Category S (standard salt fog with alternating exposure and drying)
Category T (increased salt fog exposure with additional functional and insulation testing)

Product: Ascott cyclic corrosion chamber

Section 24: Icing

RTCA DO-160G Section 24 tests how well devices can withstand ice formation when installed on the exterior of aircraft or in non-air-conditioned areas. Icing can block mechanical movements, impair electrical functions or compromise structural stability. The tests ensure that devices remain functional even under ice loads or that existing de-icing measures are effective. The tests are carried out under varying climatic conditions, usually in separate climate chambers.

Three types of ice are simulated:
Category A (frost and condensation icing)
Category B (critical ice formation on moving parts due to freezing, melting and refreezing)
Category C (ice formation on cold surfaces with assessment of the maximum tolerated ice thickness)

Product: climate test chamber ClimeEvent with special equipment