INTERNATIONAL STANDARD

ISO 5129

Third edition
2001-10-01

Acoustics — Measurement of sound pressure levels in the interior of aircraft during flight

Acoustique — Mesurage des niveaux de pression acoustique à l'intérieur des aéronefs en vol

Reference number
ISO 5129:2001(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.ch
Web www.iso.ch

Printed in Switzerland

Contents

Page

Annex

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 5129 was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 1, *Noise*.

This third edition cancels and replaces the second edition (ISO 5129:1987), which has been technically revised.

Annex A of this International Standard is for information only.

Acoustics — Measurement of sound pressure levels in the interior of aircraft during flight

1 Scope

1.1 This International Standard specifies requirements for instruments and test procedures for the measurement and reporting of sound pressure levels at crew and passenger locations in the interior of aircraft under steady flight conditions. The sound pressure levels may be used to determine various quantities for describing the acoustical environment in the interior of the aircraft. The procedures are intended to ensure uniformity in test results and to provide the basis for determination of measurement uncertainties.

1.2 This International Standard provides electroacoustical performance specifications for a complete measurement system from a microphone to the readout device. Various individual components of a measurement system may be selected so long as the total measurement system conforms to the specifications of this International Standard.

1.3 The preferred measurement procedure involves the recording of sound pressure signals with subsequent analysis into one-third-octave band sound pressure levels. Direct measurements may be made of one-third-octave-band sound pressure levels.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 31-7, *Quantities and units — Part 7: Acoustics*[1)]

ISO 266, *Acoustics — Preferred frequencies*

IEC 60942, *Electroacoustics — Sound calibrators*

IEC 61183, *Random-incidence and diffuse-field calibration of sound level meters*

IEC 61260, *Electroacoustics — Octave-band and fractional-octave-band filters*

IEC 61672-1, *Electroacoustics — Sound level meters — Part 1: Specifications* [2)]

3 Terms and definitions

For the purposes of this International Standard, in addition to the terms and definitions given in ISO 31-7, the following definitions apply. Definitions of other relevant quantities are given in IEC 61672-1.

1) To be revised as ISO/IEC 80000-8.

2) To be published.

3.1
aircraft
any machine that can derive support in the atmosphere from reactions of the air other than the reactions of the air against the earth's surface

3.2
beats
periodic variations in amplitude that result from the superposition of two simple harmonic quantities of different frequencies f_1 and f_2

NOTE Beats involve the periodic increase and decrease of amplitude at the beat frequency $|(f_1 - f_2)|$.

3.3
crew station
location intended to be occupied or used only by aircraft crew during flight operations

3.4
crew sleeping quarters
enclosed compartment for crew rest or sleep

NOTE Crew sleeping quarters are also known as crew rest quarters, crew rest modules, or crew rest areas.

3.5
passenger compartment
any area intended to be occupied by passengers during flight

3.6
synchrophaser
device to control the rotational speed and phase of propellers on multi-engine aircraft

3.7
steady flight
conditions under which aircraft parameters that significantly affect interior sound pressure levels are controlled so as to yield reproducible results

4 Instruments

4.1 General

A complete sound measurement system is composed of a microphone system, data recording and data analysis devices, a sound pressure level display device, and a sound calibrator to establish the overall acoustical sensitivity of the system. A measurement system may include multi-channel instruments and shall conform at least to the applicable class 2 performance specifications of IEC 61672-1. A measurement system, including a microphone system according to 4.2, that utilizes an integrating-averaging sound level meter or a conventional sound level meter with exponential time weighting shall conform at least to the applicable class 2 specifications of IEC 61672-1. One-third-octave-band time-averaged sound pressure levels shall be determined with spectrum analysers that conform at least to the class 2 specifications of IEC 61260.

4.2 Microphone system

The microphone system shall conform to the applicable specifications of IEC 61672-1 for random-incidence sounds. Random-incidence response of the microphone system shall be verified by a procedure from IEC 61183.

NOTE A microphone system includes those components of a measurement system that produce an electrical signal in response to a sound pressure. The components generally include one or more microphones with preamplifiers and extension cables, and other devices as necessary such as windscreens.

4.3 Sound calibrator

The sound calibrator shall conform at least to the class 1C requirements of IEC 60942. The nominal frequency of the sinusoidal sound signal produced by the sound calibrator shall be in the range from 200 Hz to 1 250 Hz.

4.4 Verification of conformance

The performance of the instruments in a measurement system should be verified to conform to the applicable requirements of IEC 61672-1, IEC 60942 and IEC 61260 within a year before conducting a test in accordance with this International Standard.

5 Test procedures

5.1 Measurement procedures

5.1.1 Measurement locations

5.1.1.1 Passenger compartments

Sound pressure signals shall be measured at the typical head position of a seated passenger or flight attendant, with the passenger or attendant not present. The microphone shall be located on the seat centreline, with the axis vertical and pointed upwards, a distance of 0,15 m ± 0,025 m from the headrest and 0,65 m ± 0,05 m above the unoccupied seat cushion. The number and distribution of measurement locations in a passenger compartment will depend on the aircraft's seating arrangements and the specific test objectives. Measurement locations shall be chosen so as to provide a representative description of the acoustical environment in the passenger compartment.

5.1.1.2 Crew stations

Sound pressure signals shall be measured at typical head positions of the crew. At flight crew locations, the microphone shall be placed at a representative seated head height and within 0,1 m of the typical ear position where speech communication is normally received, with the flight crewmember present and seated. Measurements at a cabin-crew-standing location shall be made with the microphone 1,65 m ± 0,1 m above the floor, and with the crewmember not present. Measurements at cabin-crew-seated locations not in the passenger compartment shall be made in accordance with the specifications in 5.1.1.1. Retractable seats shall be in the occupied configuration.

5.1.1.3 Crew sleeping quarters

Sound pressure signals shall be measured at the resting position of the crewmember's head, with the crewmember not present. The microphone shall be placed a distance of 0,15 m ± 0,025 m above the mattress, blanket or headrest, as appropriate. If the head position is close to a wall, the microphone shall be not less than 0,15 m from that wall.

5.1.1.4 Microphone mounting

The microphone shall be held in a fixed location with a bracket or extension rod as appropriate to minimize interference and shielding effects, including those that are caused by an operator holding the microphone extension rod or support device. A windscreen shall be fitted around the microphone if airflow impinges on the microphone during a test. The insertion loss of the windscreen as a function of frequency and angle of sound incidence, in the absence of wind, shall be known from manufacturer's data or other experimental evidence.

5.1.2 Acoustical sensitivity and background electrical noise

5.1.2.1 Acoustical sensitivity

The overall acoustical sensitivity of the measurement system shall be determined, while on the ground, prior to, and after, the measurements of sound pressure levels in the aircraft interior. Determination shall be by means of the sound calibrator or by a combination of the sound calibrator and a sinusoidal electrical signal inserted through the electrical input facility in place of the microphone output. Additional checks of acoustical sensitivity may be made during a test. Appropriate adjustments shall be applied to the indicated sensitivity levels to account for the effects of differences between the prevailing atmospheric pressure and air temperature and the reference atmospheric pressure and air temperature specified in IEC 60942.

5.1.2.2 Background electrical noise

The background electrical noise of the measurement system shall be determined in one-third-octave bands with the microphone(s) placed in a low-level sound field. Background electrical noise shall be determined for level ranges used for data acquisition. When recorded, the duration of the recording time shall be at least 30 s.

5.1.3 Acoustical data acquisition

5.1.3.1 Data recordings

For each measurement, the duration of the recording shall be at least 30 s. The level-range-control settings of the recording system shall be monitored to ensure that signals are recorded near the optimum record level, avoiding overload of input stages. If beats are noted to be present, the recording time at a measurement location shall include at least four beat periods, with a minimum recording time of 30 s.

5.1.3.2 Direct measurements

An integrating-averaging sound level meter with a set of one-third-octave-band filters, or a spectrum analyser, is preferred for direct measurement of one-third-octave-band sound pressure levels. Averaging times shall be as specified in 6.1.

NOTE Time weighting S should be used if sound pressure levels are measured by a conventional sound level meter.

5.1.3.3 Crew sleeping quarters

Sound pressure signals shall be recorded for at least 30 s at locations noted in 5.1.1.3 and with minimal cabin and cockpit transient sounds (that is, no audible conversations, radio transmission, or transient operation of equipment). If measurement of transient sounds is required, sound pressure signals shall be recorded while the source of the transient sound is activated, for example, by flushing the toilet in a lavatory, opening and closing the door to a cockpit or lavatory, or operations in a galley. Five separate recordings of the sound pressure signal shall be made for each transient sound source.

5.2 Test conditions

5.2.1 Configuration of the aircraft interior

The interior of the aircraft shall be fully furnished with carpets, seats and curtains, and the configuration shall be noted. Factors that influence interior sound pressure levels, such as the location of partitions in the passenger compartments and the material used to cover the seats, shall be included in the description of the aircraft configuration. Seat backrests shall be set to their most upright position. The number of persons in the test aircraft shall be kept to the minimum required to conduct the tests. When feasible, no person shall be located so as to cause

a significant effect on the sound field at a measurement location. No person shall be seated or standing within 1 m of the microphone, except at flight crew stations. The positions of all persons shall be noted.

5.2.2 Configuration of aircraft systems

Pressurization and air-conditioning systems shall be operating normally or in automatic mode. For aircraft not equipped with an environmental control system that has an automatic mode, the system shall be set to deliver 100 % of maximum design airflow. For unpressurized aircraft or environmental control systems that are designed to deliver 100 % airflow only in the event of an emergency, the airflow rate shall be representative of that for normal operating conditions. All individual passenger or crew air outlets shall be closed, except where required for normal operation. The public address system shall not be operating. Noise and vibration control systems shall be operating normally.

5.2.3 Crew sleeping quarters

Crew sleeping quarters shall be in a deployed position representative of normal use and unoccupied, with the access door closed, mattresses and blankets installed, as appropriate, and the public address system turned off. The aircraft environmental control system shall be operating normally to maintain a comfortable air temperature in the sleeping quarters. Diffusers for the environmental control system shall be set according to the design airflow requirements for crew sleeping quarters. Bunks shall be unoccupied.

5.3 Aircraft flight conditions

5.3.1 General

Aircraft flight conditions shall be those for steady flight, with aircraft Mach number or indicated airspeed, or both, and engine power settings or shaft rotational speeds, or both, stabilized to specified values within specified tolerance limits.

5.3.2 Flight condition data

The following data shall be recorded at appropriate intervals while sound pressure signals are measured:

a) aircraft altitude or pressure altitude, as appropriate;

b) aircraft Mach number or indicated airspeed, or both;

c) engine power settings (for example, engine shaft rotational speed or pressure ratio and synchronizer setting, or propeller rotational speed and engine torque and synchrophaser setting);

d) rotorcraft main rotor and tail rotor rotational speeds;

e) nominal position of the aircraft center of gravity;

f) nominal quantity of fuel in the fuel tanks, as total fuel weight or as a percentage of maximum fuel load;

g) external ambient static air temperature (if static temperature is not given directly by aircraft instruments, record data appropriate for later calculation of static temperature);

h) cabin pressure differential (inside minus outside) or cabin pressure and nominal cabin air temperature;

i) environmental control system setting.

6 Data processing

6.1 Averaging time

The averaging time for determining one-third-octave-band sound pressure levels shall be at least 16 s. If beats are noted to be present, the averaging time shall include at least three beat periods with a minimum averaging time of 16 s.