FINAL
DRAFT

INTERNATIONAL
STANDARD

**ISO/FDIS
5332**

ISO/TC **20**/SC **16**

Secretariat: **ANSI**

Voting begins on:
2023-08-02

Voting terminates on:
2023-09-27

Civil small and light unmanned aircraft systems (UAS) under low-pressure conditions — Test methods

Reference number
ISO/FDIS 5332:2023(E)

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Published in Switzerland

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Foreword

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This document was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 16, *Unmanned aircraft systems*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The market of civil unmanned aircraft systems (UAS) is developing rapidly. UAS are widely used not only by consumers, such as for aerial photography, but also for industrial purposes, for example, powerline inspection, vegetation protection, and environmental monitoring. In high-attitude areas, the demand for UAS is also increasing. However, there are currently no standards specifically for testing the functional performance of UAS under such environmental conditions. Therefore, it is necessary to propose a scientific method to test the UAS under low -air -pressure conditions.

Other elements of the UAS, for example personnel, can also adversely affect low-pressure performance. Although they are not addressed by this document, they should be taken into consideration when determining operational suitability.

Civil small and light unmanned aircraft systems (UAS) under low-pressure conditions — Test methods

1 Scope

This document specifies test method to determine the operation ability of unmanned aircraft systems (UAS) at low-air-pressure conditions.

This document is applicable to the category of civil small and light UAS, which applies to maximum take-off mass (MTOM) level II through V according to ISO 21895.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 21384-4, *Unmanned aircraft systems — Part 4: Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 21384-4 apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

4 Test description

4.1 General

UAS is introduced into the test chamber, where the temperature and air pressure are adjusted with reference to 4.2.2 and 4.2.3. Only certain functional items (see Annex A for reference) can be checked in the test chamber; the functional performance inspection before and after the test is checked according to relevant regulations, which is not included in this document due to the limitations of the test chamber.

4.2 Test conditions

4.2.1 Standard atmospheric conditions

The functional performance inspection before and after the test shall be carried out under the following conditions:

a) temperature: 15 °C to 35 °C;

b) air pressure: 84 kPa to 107 kPa;

c) relative humidity: ≤ 85 %.

4.2.2 Test with low temperature and low air pressure

The common low-temperature and low-air-pressure conditions should be selected from Table 1.

Table 1 — Conditions for tests with low temperature and low air pressure

Temperature °C	Air pressure kPa	Altitude m
–46	40	7 150
–32	55	4 850
–19	70	3 000

NOTE Unless otherwise specified, the temperature is calculated to reflect deviation of the international standard atmosphere (ISA), –15 °C colder than the ISA.

When the given air pressure in Table 1 is not applicable, it should be calculated according to Formula (1) as specified in IEC 60721-2-3 (for altitudes below 11 000 m):

$$p = p_0 \times \left((1 - (L \times h) f T_0)^{g f (R \times L)} \right) \quad (1)$$

where

p is the air pressure (kPa);

p_0 =101,325 kPa (standard pressure at sea level);

h is the altitude above the sea level (m);

L =0,006 5 K/m (temperature lapse rate);

T_0 =288,15 K (standard temperature at sea level);

g =9,806 65 m/ s^2 (Earth-surface gravitational acceleration);

R =287,053 J/(kg.K) (universal gas constant).

4.2.3 Test with high temperature and low air pressure

The common high-temperature and low-air-pressure conditions should be selected from Table 2.

Table 2 — Conditions for tests with high temperature and low air pressure

Temperature °C	Air pressure kPa	Altitude m
-16	40	7 150
-2	55	4 850
+11	70	3 000

NOTE Unless otherwise specified, the temperature is calculated to reflect deviation of the international standard atmosphere (ISA), +15 °C warmer than the ISA.

When the given air pressure in Table 2 is not applicable, it should be calculated according to Formula (1).

4.2.4 Allowed deviation

The following deviations shall be maintained:

a) temperature: ±2 °C;

b) air pressure: ±5 % of the specified value;

c) relative humidity: ±3 %.

4.2.5 Duration of exposure

The test duration shall be determined as the time required for functional inspections after the temperature and air pressure become stable as specified in 4.2.2 and 4.2.3, or the rated maximum operating time of UAS provided in relevant specifications (preferred).

4.2.6 Rate of temperature change

The rate of temperature change shall not exceed 3 °C/min.

4.2.7 Rate of pressure change

The rate of air pressure change shall not exceed 4,8 kPa/min.

4.3 Test article

The test article shall meet the following requirements.

a) The test article configuration shall be in accordance with the intended operation.

b) The quantity shall be adequate for the test, at least one article shall be provided.

4.4 Test apparatus

The test chamber shall comply with the following requirements.

a) The test chamber shall be within the valid period of calibration.

b) The test chamber shall be capable of maintaining the test conditions given in 4.2.

c) The inside of test chamber and test article shall not be contaminated by the air taken into the test chamber due to the change of pressure.

d) The test chamber shall be equipped with devices capable of continuously monitoring temperature and air pressure conditions.

5 Test procedures

5.1 Preconditioning

Unlike air pressure and humidity, it takes time for the temperature of the test article to stabilize. The temperature stabilization duration should be determined according to IEC 60068-2-39; when not applicable, it should be selected from the following:

a) mass of the test article ≤ 1,5 kg: 1 h;

b) 1,5 kg < mass of the test article ≤ 15 kg: 2 h;

c) 15 kg < mass of the test article ≤ 150 kg: 4 h.

5.2 Inspection before tests

Conduct functional performance testing at standard atmospheric conditions provided in 4.2.1; if the test article operates satisfactorily, proceed to the appropriate test procedure.

5.3 Conditioning

The sequence of tests shall be determined according to the relevant specification. Otherwise, high-temperature and low-air-pressure test should be performed first and then the low-temperature and low-air-pressure test.

a) Power on the test article; introduce it into the test chamber in an orientation, configuration and operational state as specified in the relevant specification.

b) Adjust the temperature to the required value and make sure that the temperature difference in different corners of the test chamber does not exceed 2 °C. The rate of temperature change should not exceed the value specified in 4.2.6. Maintain the temperature for the duration as determined in 5.1 so that the test article reaches temperature stabilization.

c) Adjust the air pressure to the required value; the rate of pressure change should not exceed the value specified in 4.2.7. After the air pressure becomes stable, conduct functional checkout, see Annex A for reference.

5.4 Recovery

Restore the air pressure to the standard atmospheric pressure (101,3 kPa) at the rate of change not exceeding the value specified in 4.2.7, and then restore the temperature to the standard atmospheric temperature at the rate of change not exceeding the value specified in 4.2.6. Maintain the temperature for the duration as determined in 5.1 so that the test article reaches temperature stabilization.

5.5 Inspection after tests

Conduct functional performance testing at standard atmospheric conditions provided in 4.2.1; record the test results, see Annex B for reference.

6 Test interruption and recovery

6.1 Interruption due to test chamber malfunction

Restart the test from the beginning.

6.2 Interruption due to test article operation failure

a) Replace the test article with a new one and restart the test.

b) Replace/repair the failed or non-functioning component or assembly with one that functions as intended and restart the entire test.

7 Test report

Unless otherwise specified, the test report shall include the following information as a minimum:

a) model, name, composition, quantity, and provider of the test article;

b) the International Standard used (including its year of publication);

d) Test methods and procedures;