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Test methods for civil multi-copter unmanned aircraft system

Méthodes d'essai pour les multicoptères civils télépilotés

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical 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

Multi-copter unmanned aircraft system (UAS) is the most popular UAS in the market at the time of publication of this document, but the quality of products can vary significantly. However, it is difficult to evaluate the function and performance of these products as there is no unified standard test method and means to evaluate and test the multi-copter UAS. Therefore, the development of test method standards for civil multi-copter UAS is intended to provide a basis for product testing, in order to improve the product quality of the multi-copter UAS as a whole.

Test methods for civil multi-copter unmanned aircraft system

1 Scope

This document specifies test methods for civil electric multi-copter unmanned aircraft systems (UAS). This document is intended to be a general standard for testing the overall UAS functionality with the support of subsystems.

It is applicable to the category of civil electric multi-copter UAS with maximum take-off mass (MTOM) level I to level V according to ISO 21895. The configuration control and subsystem (e.g. energy system and flight control system tests) test methods are out of the scope of this document. In addition, test methods for operations in snow and icing conditions are not included either, manufacturers have procedures identified to cope with flight in those conditions.

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*

ISO 21895, *Categorization and classification of civil unmanned aircraft systems*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 21384-4, ISO 21895 and the following 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/

3.1
mission profile
specified mission to be performed, including the event and the environment sequence that the test article experiences

3.2
multi-copter UAS
rotorcraft lifted by two or more power-driven rotors on a substantially vertical axis, capable of hovering, taking off and landing vertically

4 General principles

4.1 Test purpose

The purpose of the test is to:

a) check whether the functionality, performance of the UAS meets the design requirements;

b) make recommendations on design modifications and whether to conduct supplementary tests.

4.2 Test conditions and requirements

4.2.1 Technical document

The following documents should be prepared before the test:

a) the design documents, figures and interface file which are relevant to the test;

b) operator’s manual;

c) test plan

4.2.2 Test article

The test article shall fulfil the following requirements.

a) The test article shall conform to the product manuals.

b) The number of test article shall meet the test requirements.

c) The test article shall have quality inspection certificates such as the enterprise qualification certificate.

4.2.3 Equipment and instruments

Test instruments and equipment (including special equipment and auxiliary equipment) shall be verified and calibrated, and shall be qualified within the flight test limitations and within the validity period. All the test instruments used should meet the expected use requirements; and its measurement uncertainty or maximum allowable error should be less than the agreed allowable error range of the measured parameter. For test process management, refer to ISO/IEC 17025.

4.2.4 Personnel requirements

Testers shall be able to operate the test article and the test equipment proficiently. Testers shall have the corresponding competence and qualification, if required.

4.3 Test environmental requirements

Unless otherwise specified, all tests shall be performed by measuring and recording test conditions, including temperature, relative humidity, atmosphere pressure and wind speed.

4.4 Test interruption and recovery

Test interruption and recovery methods are specified as follows.

a) The test is terminated on one of the following conditions.

  1) Key indicator(s) of the test article is (are) unqualified.

  2) The test article cannot work normally due to a malfunction and cannot be repaired.

b) When the following situations occur during the test, supplementary tests should be carried out as appropriate.

  1) Individual test article failed, the cause has been identified and corrected.

  2) The original design or test article configuration was changed.

3) The test article is replaced with the components or devices that affect the technical performance.

4.5 Test outline

The test plan shall include but not limited to the following:

a) mission profile description;

b) test purpose;

c) test time and location;

d) the number and technical status of the test article and test auxiliary;

e) test article, test classification methods;

f) test requirements;

g) test interruption and recovery;

h) acceptance criteria;

i) test organization;

j) test support;

k) test safety;

m) appendix (e.g. template of data record, collection of formulae).

4.6 Test report

The test report shall include but not limited to the following:

a) serial ID of the test article and pictures of the test article overview and the key components;

b) test general introduction;

c) test item, and necessary specification;

d) test acceptance criteria;

e) test safety (procedures and limitation, etc.);

f) test results;

g) main problems that have occurred in the test and the corresponding treatments;

h) conclusion;

i) issues and suggestions;

i) appendix (e.g. test data histories).

5 Test methods

5.1 Test item

UAS test items are shown in Table 1.

Table 1 — Test item information table

No.	Test items		Subclause number
1	Basic inspection	Completeness	5.2.1
2		Appearance	5.2.2
3		Size	5.2.3
4		Weight and centre of gravity	5.2.4
5		Moving and rotating parts check	5.2.5
6		Connectors	5.2.6
7	Functional inspection and testing	Identification	5.3.1
8		Route loading	5.3.2
8		Self-test	5.3.3
10		Information display	5.3.4
11		Data record	5.3.5
12		Return to home	5.3.6
13		Automatic obstacle avoidance	5.3.7
14		Typical failure protection	5.3.8
15		Take-off/launch and landing/recovery	5.3.9
16		Warning	5.3.10
17		Locking and starting of motor	5.3.11
18		Control mode switching	5.3.12
19	Flight performance test	Maximum take-off mass	5.4.1
20		Maximum flight range	5.4.2
21		Maximum flight altitude	5.4.3
22		Maximum horizontal flight speed	5.4.4
23		Maximum steady climb rate	5.4.5
24		Altitude hold performance	5.4.6
25		Speed hold performance	5.4.7
26		Flight endurance	5.4.8
27		Fixed-point hovering	5.4.9
28		Positioning navigation	5.4.10
29		Trajectory tracking accuracy	5.4.11
30		Capability of wind resistance	5.4.12
31	Navigation system test	Static attitude accuracy	5.5.1
32		Static positioning accuracy	5.5.2
33	Data link system test	Remote control distance and telemetry distance	5.6.1
34		Information transmission distance	5.6.2
35	Environmental test	High temperature	5.7.1
36		Low temperature	5.7.2
37		Rainfall	5.7.3
38		Humidity and heat	5.7.4
39		Vibration	5.7.5
40		Shock	5.7.6

Table 1 *(continued)*

No.	Test items		Subclause number
41	Electromagnetic compatibility test	Conductive emission	5.8.2.1
42		Radiation emission	5.8.2.2
43		Radiated, radio-frequency, electromagnetic field immunity	5.8.3.1
44		Power frequency magnetic field immunity	5.8.3.2
45		Electrostatic discharge immunity	5.8.3.3
46		Electrical fast transient/burst immunity	5.8.3.4
47		Surge immunity	5.8.3.5
48		Immunity to conducted disturbances, induced by radio-frequency fields	5.8.3.6
49		Voltage sag and short supply Interruption	5.8.3.7

5.2 Basic inspection

5.2.1 Completeness

Visual inspection should be adopted for completeness checking. The test article shall be inspected and recorded item by item by following product lists.

5.2.2 Appearance

Visual inspection shall be applied for appearance checking. The inspected items generally include:

a) the uniformity of equipment coating, the correctness and clarity of product identities (brand, size, type, model, weight, etc.), and the robustness of stickers (no curl or erase);

b) the completeness of label or mark for connectors, switches, control sticks;

c) damages such as cracks, scratches, corrosions.

5.2.3 Size

The characteristic size of UA and its components (e.g. length, width, height, wheelbase, propeller/rotor radius) shall be measured and recorded referring to product specifications with size error range.

5.2.4 Weight and centre of gravity

The weight of the UA and its components shall be measured. The centre of gravity shall be within the allowable range specified by the manufacturer. Measurement methods generally include the following.

a) Mass measurement tools shall be employed for measuring the weight of the UA and its components (unit: gram). The measurement should include conditions in which the UA is equipped with different mission loads.

b) The position of centre of gravity is estimated; and it shall be checked with the designed position.

c) Tests shall be performed with the most critical centre of gravity.

5.2.5 Moving and rotating parts check

Visual inspection shall be employed for checking moving parts such as switches, buttons, foldable arms and control surfaces; and for rotating parts of the vertical lifting elements (hub, blades, blade dumpers, pitch control mechanism, and all other parts that rotate with the assembly). Mechanical movement

is supposed to be smooth and reliable, without the occurrence of looseness, stagnation, shortage, deformation, etc.

5.2.6 Connectors

Connectors of the UAS shall be inspected according to indicators; results shall be recorded accordingly. Inspected items are specified by the manufacturer and may generally include:

a) fool-proofing and locking design, in-place indication;

b) operating friendliness, firm installation and connection robustness;

c) protective design for exposed connecters;

d) skewed, retracted and damaged pins;

e) non-sparking design of power connectors.

5.3 Functional inspection and testing

5.3.1 Identification

While in flight, the identification function of UAS shall be inspected through UAS surveillance system or a simulated surveillance system. The checked items include:

a) the accuracy of current flight data;

b) whether the identification of UAS and operator meet the requirements of the authority;

c) whether the reporting frequency meets the requirement of the authority.

5.3.2 Route loading

A route of typical flight mission shall be loaded to the UA prior to flight. In this loading process, the status report shall be examined. Then, how the UA follows the route shall be investigated.

5.3.3 Self-test

Once the power of UAS is engaged, visual inspection shall be used to check the voice or light indications of self-test results.

5.3.4 Information display

When UAS is powered on at the ground, the display of remote pilot station shall be examined through visual inspection. Inspected contents should be checked according to the manufacturer's specification.

5.3.5 Data record

The UAS shall be flown in a typical flight mission. After the flight, the recorded data should be read and inspected. The check items include the integrity of recorded data, the correctness of flight data and mission data. Both onboard and remote pilot station data record shall be tested.

5.3.6 Return to home

The activation and the manual intervention for abandoning mission shall be checked to confirm that it can be performed according to the manufacturer's intention.