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Aerospace series - Unmanned Aircraft Systems - Part 006: Means to terminate flight, requirements, and verification

Luft- und Raumfahrt - Unbemannte Luftfahrzeugsysteme - Teil 006: Mittel zum Flugabbruch, Anforderungen und Prüfverfahren

Série aérospatiale - Aéronefs télépilotés - Partie 006 : Moyens pour interrompre le vol, exigences et vérification

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Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
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Contents

Page

European foreword

This document (prEN 4709-006:2023) has been prepared by the Aerospace and Defence Industries Association of Europe — Standardization (ASD-STAN) and have been finalized by CEN/TC 471 “Aviation and aeronautics”, the secretariat of which is held by BNAE.

This document is currently submitted to the CEN Enquiry.

This document has been prepared under a Standardization Request given to CEN by the European Commission and the European Free Trade Association and supports essential requirements of EU Directive(s)/Regulation(s).

For relationship with EU Directive(s)/Regulation(s), see informative Annex ZA, which is an integral part of this document.

1 Scope

This document provides technical specification and verification methods to support compliance with Commission Delegated Regulation (EU) 2019/945 of 12 March 2019 on unmanned aircraft systems and on third-country operators of unmanned aircraft systems.

This part provides requirements, test methods and pass criteria for the means to terminate flight (flight termination) for unmanned aircraft systems, in particular addressing:

— safety related aspects of the architecture;

— descent performance;

— means to reduce the effects of impact on ground; and

— manufacturer's instructions.

Even if security, including IT security, may be useful from an operational point of view, it falls outside the scope of this document.

An activation of the means to terminate the flight by a visual observer is also outside the scope of this document.

This document provides voluntary means of demonstrating compliance with the requirements laid out in Regulation (EU) 2019/945.

Additional hazards that occur from the characteristics of the payload are excluded and are, conversely, under the responsibility of the UAS manufacturer and UAS operator.

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.

EN 4709-001:—,[1] *Aerospace series — Unmanned Aircraft Systems — Part 001: Product requirements and verification*

EN 4709-005:—,[2] *Aerospace series — Unmanned Aircraft Systems — Part 005: Verification Method for the Geocaging Function*

EN 62368-1:2014, *Audio/video, information and communication technology equipment - Part 1: Safety requirements (IEC 62368-1:2014, modified)*

[1] Under preparation. Stage at the time of publication: prEN 4709-001:2023.

[2] Under preparation. Stage at the time of publication: prEN 4709-005:2023.

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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
automatic flight control and guidance system
aggregation of items where the automatic flight control and guidance functions are allocated to

Note 1 to entry: for the assessment of independence and reliability, the automatic flight control and guidance system includes associated power supplies and protections (e.g. fuses, bridges).

3.2
configuration
basic design arrangement of the UA: fixed-wing, rotary wing, or multicopter

3.3
debris area
critical area from inert (non-explosive) debris defined as the sum of all areas on the ground where a person standing would be expected to be impacted by the UA during or after a loss of control event, and thus the area where a fatality is expected to occur if a person were within it

3.4
equipment to control unmanned aircraft remotely
any instrument, equipment, mechanism, apparatus, appurtenance, software, or accessory that is necessary for the safe operation of a UA, other than a part, and which is not carried on board that UA

[SOURCE: Commission Delegated Regulation (EU) 2019/945 of 12 March 2019 on unmanned aircraft systems and on third-country operators of unmanned aircraft systems, Article 3, No. (2)]

3.5
failure recognition time
time for the flight termination function to detect the issue

3.6
reaction time
time required to act

Note 1 to entry: For manual recovery, pilot reaction time includes the time for the remote pilot to detect the issue and to take appropriate action.

Note 2 to entry: Typically, failure recognition time and pilot reaction time together typically are 3 s.

3.7
flight termination (FT, means to terminate flight) (function)
allows the remote pilot to prevent the UA from exiting the controlled ground area by forcing the descent of the UA and preventing it from continuing its horizontal trajectory (e.g. by cutting the propulsion power)

Note 1 to entry: When an emergency situation is perceived as likely to lead to the UA outside the operational volume, the remote pilot is obliged to ensure that the flight termination function is triggered before the unmanned aircraft reaches the limits of the operational volume.

Note 2 to entry: Means for the remote pilot to terminate the flight of the UA can be provided by means for the remote pilot to manually terminate the flight of the UA or by programming an automatic activation of the flight termination function.

Note 3 to entry: The automatic flight termination, where implemented, would reflect the relevant part of the Geocaging standard to ensure coherence between the automatic means to terminate flight and the Geocaging function

Note 4 to entry: The flight termination function will be triggered:

— manually by the remote pilot and/or

— automatically in response to an imminent or actual loss of containment in coherence with EN 4709-005[2]

3.8
hazard
any condition or object with the potential to cause injuries, damage, loss of material or a reduction of the ability to perform a prescribed function

3.9
independence
concept that minimizes the likelihood of common mode errors and cascade failures between aircraft/system functions or items

Note 1 to entry: in the context of this standard – relates to the means to terminate the flight: a characteristic of the UAS architecture implemented to avoid having a failure outside or in common with the means to terminate the flight that would require flight termination as a mitigation but that inhibits proper execution of the flight termination function.

3.10
major impact damage
any damage resulting from impact dynamics that cannot be repaired and requires the replacement of the UA

3.11
maximum operational distance
in the context of this standard, the maximum range permitted by the standard scenario for which compliance is declared to, or the maximum range declared by the manufacturer, whichever is less

3.12
means for the remote pilot to terminate the flight of the UA (means to terminate flight)
technical means as part of a UAS that provide a flight termination function

3.13
means to reduce the effect of the UA impact dynamics
technical means as part of a UAS that prevent *major impact damage* to mitigate the risk that the remote pilot does not activate the means to terminate the flight in time, fearing the damage and the potential destruction of the UA

Note 1 to entry: Experience with this type of UAS operations has shown that human factors (e.g. fear of losing the UA) may play a role in reducing the effectiveness of the means to terminate the flight.

[SOURCE: European Union Aviation Safety Agency, Opinion No. 05/2019, Standard scenarios for UAS operations in the 'specific' category, section 2.3.1.9, page 12]

3.14
operational volume
volume of airspace, defined in space and time, to which the operation of the UA is restricted

3.15
payload
means instrument, mechanism, equipment, part, apparatus, appurtenance, or accessory, including communications equipment, that is installed in or attached to the aircraft and is not used or intended to be used in operating or controlling an aircraft in flight, and is not part of an airframe, engine, or propeller

[SOURCE: Commission Delegated Regulation (EU) 2019/945 of 12 March 2019 on unmanned aircraft systems and on third-country operators of unmanned aircraft systems, Article 3, No. (29)]

3.16
predictability
in the context of this document, the assurance that the UAS performs the procedures as described in the manufacturer's instructions

3.17
reliability
in the context of this document, the probability of proper execution of flight termination; relates to safe operation and does not take spurious/inadvertent activation into account

3.18
remote pilot
natural person responsible for safely conducting the flight of a UA by operating its flight controls, either manually or, when the UA flies automatically, by programming and monitoring its course, and remaining able to intervene and change its course at any time

[SOURCE: Commission Delegated Regulation (EU) 2019/945 of 12 March 2019 on unmanned aircraft systems and on third-country operators of unmanned aircraft systems, Article 3, No. (27)]

3.19
unmanned aircraft
UA
aircraft operating or designed to operate autonomously or to be piloted remotely without a pilot on board

[SOURCE: Commission Delegated Regulation (EU) 2019/945 of 12 March 2019 on unmanned aircraft systems and on third-country operators of unmanned aircraft systems, Article 3, No. (1)]

3.20
unmanned aircraft system
UAS
unmanned aircraft and the equipment to control it remotely

[SOURCE: Commission Delegated Regulation (EU) 2019/945 of 12 March 2019 on unmanned aircraft systems and on third-country operators of unmanned aircraft systems, Article 3, No. (3)]

3.21
tether
in the sense of this standard, a mechanical device for the purpose of effectively restraining the UA within the range permitted by the length of the tether as its primary function

3.22
untethered UA
UA that is not mechanically restraint in its movement by a tether

Note 1 to entry: not all cables linking the UA to the ground are considered as tether in the sense of this document e.g. an electric cable powering the UA, even if it was the only source of power and a loss of connection would inevitably lead to a loss of flight is not considered as a tether. Nonetheless, a tether may be used to transmit electrical power to the UA as its secondary function.

4 Product requirements and compliance of means to terminate the flight for Class 5 UAS

4.1 Reliability, predictability, and independence

4.1.1 Performance requirements

The UAS shall provide means for the remote pilot to terminate the flight of the UA, which shall:

(1) demonstrate that the probability of a failure to correctly activate the operation of the flight termination system is acceptable (reliability);

(2) ensure that the UAS performs the procedures as described in the manufacturer's instructions (predictability); and

(3) avoid having a failure in the automatic flight control and guidance function, the geocaging function or the flight termination function which by itself inhibits proper execution of the flight termination function when mitigation of that failure depends on flight termination (independence).

4.1.2 Verification method

4.1.2.1 Requirement (1) – Reliability

4.1.2.1.1 General

Reliability shall be shown by application of both methods provided in the following subclauses.

— Verify by ground tests as per 4.1.2.1.2 that the flight termination system as installed on the UAS can be activated properly and that the ability of the UA to continue powered horizontal displacement is inhibited.

— Verify by flight tests as per 4.1.2.1.3 that the flight termination system is able to reliably perform flight termination.

4.1.2.1.2 Ground tests

Ground tests may be conducted with the UAS used for flight tests as per 4.1.2.1.3 and can be performed along with the flight tests as pre-flight activities, or as flight tests.

Ground tests shall be conducted as end-to-end tests without any substitution as opposed to flight tests.

Where activated manually, the ground tests shall be performed at the *maximum operational distance* of the UA from the antenna(s) transmitting the flight termination command. The ground segment of the flight termination unit(s) should be connected to its antenna(s) as in the real operational case. Alternatively, in order to emulate the effects of distance, attenuation device(s) or a shielded environment equivalent to conditions whilst operating at maximum operational distance may be used.

Where activated automatically, correct activation of the termination signal shall be tested providing as input to the flight termination system those conditions which would cause its triggering in flight. In this case, the activation should be checked for a set of conditions covering uniformly the whole activation envelope, while limiting the granularity of such checks.

A single ground test is considered passed when upon activation the characteristics of the system indicate successful execution of flight termination:

a. for any configuration that performs flight termination in conjunction with deploying a parachute: the electrical current (amperage) of all motors is zero (off) and the parachute deployed; the opening of a parachute bay door is sufficient to indicate the successful deployment of a parachute where the parachute itself is deployed into the airstream;

b. for any configuration that performs flight termination by shutting off all motors: the electrical current (amperage) of all motors is zero (off) or negative (recuperating);

c. for any configuration that performs flight termination by moving actuators into a pre-defined position: the actuators are in the pre-defined position;

d. for any configuration that performs flight termination by powering off actuators: the electrical power (voltage) at the actuators is zero (off) or the actuator is in a mode where it does not draw current (amperage) and moves freely.

The test specimen shall be instrumented as required to show the characteristics of the system indicating successful execution of flight termination.

The UAS may be fitted with special firmware to trigger or simulate automatic activation conditions in order to enable compliance testing. Unless provided as dedicated software or firmware specific for the test, it shall be verified by review of the manufacturer's design that any means to trigger or simulate automatic activation conditions are not easily available and protected from unintended engagement by safeguards.

10 activations shall be performed consecutively.

Where the flight termination function can be activated both manually and automatically, the number of activations shall be evenly distributed across the entire ensemble but does not need to exceed the total number of activations specified above.

Ground tests are considered passed when the full set of tests is passed.

4.1.2.1.3 Flight Test

Flight tests may be combined with drop tests as per 4.2.2.

A total of **20** flight tests is required to demonstrate proper activation of the on-board segment of the flight termination system.

A representative non-destructive configuration may be arranged as a substitute if it can be ensured that the indicators used to monitor activation of the flight termination function are representative for the actual activation.

This may be accomplished by digital recording of the flight termination system signal, which would normally interrupt power connection to engines when flight termination system is actuated, avoiding that such signal actually commands power interruption during tests.

It shall be demonstrated that each manual activation from ground would result in flight termination.

In the following the terms 'maximum speed' and 'minimum speed' refer to the maximum and minimum speed as defined in the manufacturer's instructions, and in the same way 'minimum height' and 'maximum height' to minimum and maximum height as defined in the manufacturer's instructions.

— Where activated purely manually, the following scenarios shall be tested:

1. UA flying straight and level towards or away from the antenna(s) transmitting the flight termination signal, at the minimum and maximum height (excluding climb and descent segments). **10** activations shall be triggered:

    a. **5** at minimum height for maximum speed, **2** of which testing the *maximum operational distance* at that height, the other **3** within minimum and maximum speed (see NOTE 1 and NOTE 2) as shown in Figure 1,

    b. **5** at maximum height, **2** of which testing the *maximum operational distance* at that height, the other **3** within minimum and maximum speed (see NOTE 1 and NOTE 2) as given in 1.a.;

2. UA flying straight and level in a direction perpendicular to the one of the tests given in 1., same heights, same distribution. **10** activations shall be triggered:

    a. **5** at minimum height for maximum speed, **2** of which testing the *maximum operational distance* at that height, the other **3** within minimum and maximum speed (see NOTE 1 and NOTE 2) as shown in Figure 1,

    b. **5** at maximum height, **2** of which testing the *maximum operational distance* at that height, the other **3** within minimum and maximum speed (see NOTE 1 and NOTE 2) as given in 2.a..