International Standard

ISO 23665

Uncrewed aircraft systems — Training for personnel involved in UAS operations

Aéronefs sans pilote — Formation du personnel impliqué dans l'exploitation d'UAS

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Foreword

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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 document 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 Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 16, *Uncrewed aircraft system*.

This third edition cancels and replaces the second edition (ISO 23665:2023), which has been technically revised.

The main changes are as follows:

— alignment with three risk-based categories for uncrewed aircraft system (UAS) operations enshrined by the International Civil Aviation Organization (ICAO);

— addition of training requirements for pilot courses qualifying for beyond visual line-of-sight (BVLOS) operations in the specific category of UAS operations;

— addition of training requirements for visual observers (VO);

— addition of training requirements for fleet managers (FM).

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

Uncrewed aircraft (UA) have rapidly increased in number, applications and types within recent decades. UA are commonly utilized for filming, agricultural spraying, inspection, security activities and are expected to be also employed for transportation.

Because of the myriad of possible applications, several regulatory aviation authorities, starting with the International Civil Aviation Organization (ICAO), use a holistic taxonomy[8] of UAS operations based on safety risk perceived by the society.

These three risk-based categories of UAS operations are:

— low-risk open category, limited to visual line-of-sight operation (VLOS) operations;

— medium-risk specific category which permits also extended visual line-of-sight (EVLOS) and beyond visual line-of-sight (BVLOS) and entering controlled airspace;

— high-risk certified category which permits also long-range international flights under instrument flight rules (IFR) in controlled airspace.

In all categories, the UAS operator is responsible to train, qualify and maintain the competence of all personnel involved in the operations, including but not limited to remote pilots. In several jurisdictions, the aviation authorities promulgate rules on the competence of remote pilots (i.e. regulated profession, see Reference [11]). For other jobs (e.g. visual observers), no rules exist in several jurisdictions on any mandatory training. However, the UAS operator is still responsible for ensuring the competence of such personnel.

This document can help operators and training organizations to develop, purchase and deliver courses not only for the regulated professions, but even for other jobs related UAS operations. The resulting attestations can be useful for the career development and mobility of related personnel.

The required knowledge, attitude and skill levels for personnel who are involved in UAS operations must be clearly defined. When unskilled persons operate a UA, the risk of an accident or serious incident increases. Discrepancies in qualification criteria among countries or organizations also prevent the international exchange of workers.

This document helps to ensure that personnel who are involved in UAS operations receive appropriate education and obtain essential knowledge and skill. Training organizations and individuals qualified according to this document are internationally recognized. It enhances the international operation of UAS, enable personal exchange, and encourage international trade.

This document defines the procedures for the operation of a training organization, which is the entity that delivers training to UAS remote pilots.

This document provides requirements for the following specific courses:

— UAS remote pilot in the open category in Annex A;

— VLOS UAS remote pilot in the specific category in Annex B;

— EVLOS and BVLOS UAS remote pilot in Annex C;

— visual observers (VO) in Annex D;

— flight operations officer and fleet manager (FM) in Annex E.

Uncrewed aircraft systems — Training for personnel involved in UAS operations

1 Scope

This document specifies the procedures for training personnel who will be involved in the operation of uncrewed aircraft systems (UAS).

This document defines:

a) knowledge, skill, attitude and qualification criteria required for UAS remote pilots (RP), remote pilot in command (rPIC) and UAS training organizations (UTO) that provide training to UAS remote pilots and other personnel involved in UAS operations;

b) training curriculum and contents for specific learning courses;

c) qualification and criteria for verification of achieved competence by the training organizations;

d) general procedures for providing training of UAS personnel.

NOTE 1 An UTO can include additional topics or learning objectives, such as when required by legally binding rules in the applicable jurisdiction.

NOTE 2 A UAS operator can also act as the UTO, providing that possible conflict of interest between training and operations is properly managed.

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 5015-2, *Unmanned aircraft systems — Part 2: Operation of vertiports for vertical take-off and landing (VTOL) unmanned aircraft (UA)*

ISO 21384-3:2023, *Unmanned aircraft systems — Part 3: Operational procedures*

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

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

ISO 23629-12, *UAS traffic management (UTM) — Part 12: Requirements for UTM service providers*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 21384-4 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
airspace observer
AO
remote crew member who assists the *remote pilot* (3.7) by performing unaided visual scanning of the airspace in which the uncrewed aircraft is operating for any potential hazard in the air

Note 1 to entry: The definition is adapted from Reference [9].

Note 2 to entry: Airspace observer is one of the possible qualifications of the generic term *visual observer* (3.11).

Note 3 to entry: One or more airspace observers are typically employed in extended visual line of sight (EVLOS) operations.

3.2
controlled ground area
ground area where the UAS is operated and within which the UAS operator can ensure that *uninvolved persons* (3.9) are not present

Note 1 to entry: The definition is adapted from Reference [9].

3.3
fleet manager
FM
person designated by the operator to execute specific functions associated with the operational control system of the UAS operator

Note 1 to entry: The definition is adapted from Reference [13].

Note 2 to entry: The tasks of the fleet manager are specified in ISO 21384-3, including planning, control and supervision of flight operations.

Note 3 to entry: FM qualification requires an initial *flight operations officer (FOO)* (3.4) qualification followed by an advanced role-specific training.

Note 4 to entry: If a *remote pilot* (3.7) in command is required for the operation, the fleet manager supports, either briefing or assisting the remote pilot in command, or both, in the safe conduct of the flight.

Note 5 to entry: In case of autonomous operations, as defined in Reference [10], for which the RP is not required, the fleet manager remains responsible to obtain the necessary authorization, to monitor the outcome of the mission and, should it be necessary, to activate the emergency response plan.

Note 6 to entry: The term flight dispatcher (FD) is traditionally used in crewed aviation. In some jurisdictions, the same term is also used in remotely piloted aircraft system (RPAS)/UAS operations.

3.4
flight operations officer
FOO
generic function or role associated with the operational control system of the UAS operator, supporting the preparation and execution of a flight

Note 1 to entry: The definition is adapted from Reference [13].

Note 2 to entry: FOO qualification does not require advanced role-specific training, an initial qualification is sufficient.

3.5
ground observer
remote crew member who assists the *remote pilot* (3.7) by contributing to maintaining the controlled area on the ground void of *uninvolved persons* (3.9) or monitoring the position and behaviour of such uninvolved persons, to minimize risks for them and to minimize the possibility that they would jeopardise safety of flight

Note 1 to entry: The definition is adapted from Reference [12].

Note 2 to entry: Ground observer is one of the possible qualifications of the generic term *visual observer* (3.11).

Note 3 to entry: The presence of the ground observer has no effect on the range of the operation.

3.6
national aviation authority
civil aviation authority
competent aviation authority
government statutory authority in each country that regulates and oversees safety of civil aviation

3.7
remote pilot
RP
person charged by the operator with duties essential to the operation of an uncrewed aircraft and who manipulates the flight controls, as appropriate, during flight time

Note 1 to entry: The definition is adapted from Reference [5].

3.8
uncrewed aircraft observer
remote crew member, positioned alongside the *remote pilot* (3.7), who, by unaided visual observation of the uncrewed aircraft, assists the remote pilot in keeping the uncrewed aircraft in *VLOS* (3.10) and safely conducting the flight

Note 1 to entry: The definition is adapted from Reference [9].

Note 2 to entry: Uncrewed aircraft observer is one of the possible qualifications of the generic term *visual observer* (3.11).

Note 3 to entry: UA observers do not enable extending the range of operations beyond VLOS.

3.9
uninvolved person
person who is not participating in the UAS operation or who is not aware of the instructions and safety precautions given by the UAS operator

Note 1 to entry: The definition is adapted from Reference [9].

3.10
visual line-of-sight operation
VLOS
operation in which the *remote pilot* (3.7) or *uncrewed aircraft observer* (3.8) maintains direct unaided visual contact with the uncrewed aircraft system

Note 1 to entry: The definition is adapted from Reference [4].

3.11
visual observer
remote crew member who, by visual observation of the remotely piloted aircraft, assists the *remote pilot* (3.7) in the safe conduct of the flight

Note 1 to entry: The definition is adapted from Reference [6].

Note 2 to entry: Visual observer is a generic term referring either to *airspace observer* (3.1), *ground observer* (3.5) or *uncrewed aircraft observer* (3.8).

4 Abbreviated terms

AICs	aeronautical information circulars
AIP	aeronautical information publication
AGL	above ground level
ARC	air risk class
ATC	air traffic control
ATS	air traffic service
ATZ	aerodrome traffic zone
Baro-VNAV	barometric-vertical navigation
BVLOS	beyond visual line-of-sight
CAE	control area extensions
CRM	crew resource management
CTR	control zone
CZ	control zones
DAA	detect and avoid
ERP	emergency response plan
EVLOS	extended visual line-of-sight
FD	flight dispatcher
FIR	flight information region
GNSS	global navigation satellite system
GPS	global positioning system
ICAO	International Civil Aviation Organization
IFR	instrument flight rules
MAC	mid-air collision
NOTAM	notice to airmen
OM	operations manual
PIC	pilot in command
RPA	remotely piloted aircraft
rPIC	remote pilot in command
RPS	remote pilot station
SD card	secure digital card

TCA	terminal control areas
TEM	threat and error management
UAS	uncrewed aircraft systems
UO	uncrewed aircraft observer
UTO	UAS training organization
UTM	UAS traffic management
VFR	visual flight rules
VLOS	visual line-of-sight
VO	visual observer
WIS	weather information system

5 Uncrewed aircraft systems (UAS) training organization (UTO)

5.1 Responsibilities

a) The UTO shall offer one or more of the following courses:

   1) courses covering one or more of the learning objectives related to theoretical knowledge listed in the annexes to this document;

   2) courses covering one or more of the learning objectives related to practical skill listed in the annexes to this document;

   3) courses covering learning objectives linked to a specific UAS model or use of specific equipment;

   4) the UTO may group the learning objectives in 1), 2) or 3) in one or more clearly identified modules or offered courses.

b) The training organization shall identify as a minimum the person(s) responsible for the following areas:

   1) training;

   2) assessment or examination;

   3) occupational health and safety, including when the UTO uses flight training devices (FTD);

   4) safety officer when the UTO provides practical skill training in the real environment with the UA in flight in the airspace.

   NOTE 1 ISO 21384-3 describes which function cannot be combined into a single person.

c) The UTO may contract elements of training to a third-party external provider, through procedures ensuring that the standard of training intended to be provided by the third party meets the requirements of this document.

NOTE 2 In case of c), the UTO retains responsibility for the whole course or module (e.g. instructor for a group of theoretical LOs), including for the elements contracted to a third party.

NOTE 3 In some jurisdictions, a possible third party can be a qualified entity (QE) providing only assessment or examination, with independence from training delivery.

5.2 Documentation for staff members

The training organization shall maintain, at least, the following documentation for all staff members delivering training services:

a) name, address and date of birth;

b) training or qualification, experience;

c) duties assigned to the individual staff member.

The training organization shall have documentary evidence that all staff members hold relevant and current qualifications for their duties. Proof of qualifications shall be updated at least every two years and made available to the clients upon request.

5.3 Records

The training organization shall retain, at least, the following records of trainee training and certification in paper or electronic format for a minimum of 7 years:

a) trainee name;

b) trainee address;

c) trainee email address;

d) trainee telephone number;

e) trainee date of birth;

f) course(s) taken;

g) pass or fail and date;

h) instructor details.

The training organization should follow the general protocols for data management outlined in ISO 15489-1 as far as possible.

5.4 Emergency procedures and equipment

For all locations where UAS are to be operated, the training organization shall ensure the availability of the following:

a) a first aid kit suitable for the planned activities;

b) a communication system suitable for alerting emergency services;

c) firefighting equipment;

d) identification of an evacuation location for personnel;

e) a means for contacting the appropriate air traffic control (ATC), e.g. telephone, radio.

5.5 Introductory information

The training organization shall provide the following information to trainees:

a) conditions regarding the responsibilities of each party related to commencement, delivery and termination of the service;

b) consequences for the training organization and the trainee should either party choose to cancel the service;

c) prerequisites and any qualification requirements to obtain the service (e.g. prerequisite certifications);

d) equipment requirements;

e) costs;

f) insurance requirements;

g) any legislation and legal requirements relevant to the specific kind of service;

h) limitations of eventual qualification;

i) scope of the training course;

j) course procedures;

k) means and methods for assessment and criteria for successful completion;

l) the fact that records of their personal data will be kept for 7 years, and that these records may be passed on to a central training authority or national aviation authority;

m) specification of duration, modules, matters and contents delivered in the course;

n) specification of language or languages of the course delivery.

6 Training resources

6.1 Teaching aids

The training organization shall provide the necessary resources for training such as instructors, trainee reference materials, facility equipment.

6.2 Instructor requirements

The instructor shall be capable of conducting training on the specific requirements detailed in Annex A, B, C, D or E.

6.3 Theoretical training

6.3.1 Theory knowledge delivery methods

Required theory knowledge can be introduced using instructor-delivered sessions, via internet, virtual reality, applications or any similar mechanisms if the trainee can subsequently prove mastery of the required information.

6.3.2 Theory presentations

In the case that theory teaching is conducted by training organization instructor-delivered sessions, it shall be conducted in an environment such as a dedicated classroom that is free from significant distractions to learning. This shall provide trainees with sufficient working facilities and training aids (e.g. writing surfaces, reference materials, computers, visual or audio materials) to ensure that trainees are able to understand the information being presented.

6.4 Flight training

6.4.1 Training environment

Where the training organization provides flight training with real UA, it shall secure an appropriate flight training airspace. The training environment shall be suitably designated and equipped for trainees. The airspace shall be designated as a reserved airspace for training, if possible.

The training organization shall ensure the training environment is appropriate and safe, including taking reasonable steps to consider such factors as:

a) potential conflict with other aircraft;

b) risk to third parties, including to members of the public;

c) ensuring the area is cleared of any unnecessary hazards to trainees, instructors and other personnel involved in the training operations.

Electromagnetic interference including from other communications and sources in the environment (e.g. other emitter, power lines) should be prevented as far as can be reasonably achieved.

NOTE Applicable radio interference assessment methods are described in Reference [2] and Reference [3].

6.4.2 Training aircraft

The training organization shall provide appropriate uncrewed aircraft of an appropriate kind, number and quality for the training courses being offered to trainees to ensure all trainees have sufficient experience and airtime with the necessary aircraft types. Dual control systems for training aircraft can be beneficial in some circumstances and may be used when appropriate.

6.4.3 Simulators

The training organization should use training simulators wherever possible and appropriate, particularly when demonstrating serious emergency actions.

6.4.4 Risk management

The training organization shall ensure that a risk assessment is conducted before each flight training activity and shall adopt procedures to ensure that all risks are controlled as far as is reasonably possible. All relevant factors shall be considered as part of this assessment including the capability of trainees, the weather conditions, likely air traffic movement and the available equipment.

7 Training content delivery

The training organization shall provide training covering the theoretical knowledge and practical skills as defined in Annex A, B, C, D or E. If trainees are taking multiple curricula such as those specified in Annex A and Annex B, the items already covered in Annex A may be omitted during the training as specified in Annex B. The quality and effectiveness of the training content shall be evaluated and maintained periodically.

Before a qualification is issued to a trainee, the training organization shall assess the trainee's knowledge and practical competence to ensure all the required competencies defined in this document have been met.

The training organization should meet the general requirements for learning services described in ISO 29993:2017, Clause 12 and ISO 29993:2017, Clause 13 as far as possible.

8 Final qualification

The training organization shall issue diplomas, or other means of recognition, to certify when trainees have met the requisite knowledge and practical skills as defined in Annex A, B, C, D or E. The diplomas shall include the following data:

a) trainee name;

b) serial number of the diploma, given by the training organization issuing the diploma;

c) course name and version information;

d) UAS classification or category covered by course;

e) issue date;

f) expiration date (where applicable);

g) training organization name;

h) qualifying instructor's name;

i) any special endorsements, e.g. including night operations.

9 Evaluation protocols

Trainees shall be evaluated in their theoretical and practical skills to demonstrate their competency according to this document before being issued with any qualification.

Prior to final evaluation, trainees shall either complete the training described in the applicable annex or Annexes A to E or, in the case of experienced but unqualified UAS pilots, demonstrate equivalent existing abilities.