INTERNATIONAL STANDARD

ISO 21384-3

First edition
2019-11

Unmanned aircraft systems —

Part 3: Operational procedures

Aéronefs sans pilote —

Partie 3: Modes opératoires

Reference number
ISO 21384-3:2019(E)

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Published in Switzerland

Contents

Page

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 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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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

This document outlines requirements for unmanned aircraft (UA) operational procedures which, when applied together with any other current and future standard on unmanned aircraft systems (UAS) form a robust UA safety and quality standard. This document applies to all commercial UAS regardless of size, categorization, application or location and represents the international best practice for the safe operation of all commercial UAS. This document is structured in a way to provide a logical pathway from core principles to specific requirements, and the detail has been espoused in Annex A for reference.

Unmanned aircraft systems —

Part 3:
Operational procedures

1 Scope

This document specifies the requirements for safe commercial UAS operations.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

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

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

3.1
crew resource management
CRM
utilisation of all resources available to the crew to manage human error

3.2
remote pilot in command
RPIC
pilot designated by the operator as being in command and charged with the safe conduct of a flight

3.3
safety management system
SMS
systematic approach to managing safety, including the necessary organisational structures, accountabilities, policies and procedures

[SOURCE: ICAO Doc. 9859]

3.4
unmanned aircraft accident
occurrence associated with the operation of an unmanned aircraft which takes place between the time the aircraft is ready to move with the purpose of flight until it comes to rest at the end of the flight and the primary propulsion system is shut down, in which:

a) a person is fatally or seriously injured as a result of direct contact with any part or exposure to any emission of the UA or other component of the UAS, including parts which have become detached from the aircraft, or

b) the aircraft sustains damage or structural failure which prevents safe operation

3.5
unmanned aircraft incident
occurrence, other than an *unmanned aircraft accident* (3.4), associated with the operation of an aircraft which affects or could affect the safety of operation, including the loss of unmanned aircraft

4 Abbreviated terms

AIS	aeronautical information service
ATS	air traffic service
CofA	certificate of airworthiness
DAL	design assurance level
FW	firmware
FOD	foreign object debris
GNSS	global navigation satellite system
MCM	maintenance control manual
MEL	minimum equipment list
NOTAM	notice to airmen
OEM	original equipment manufacturer
PIC	pilot in command
RF	radio frequency
RPS	remote pilot station
SORA	specific operation risk assessment
SRM	safety risk management
SW	software
UA	unmanned aircraft
UAS	unmanned aircraft system
UTM	UAS traffic management
VO	visual observer

5 Safety and security

5.1 General

Operators shall implement a safety management system (SMS) as standard practice regardless of the type of unmanned aircraft systems (UAS) operated or size of operation. An SMS is a comprehensive, process-oriented approach to managing safety throughout an organization.

NOTE Safety management systems are defined in ISO 45001 and ICAO Doc. 9859.

5.2 Safety management system requirements

5.2.1 Safety policy

Management systems shall define policies, procedures, and organizational structures to accomplish their goals. Human error in unmanned aircraft (UA) operation and supporting system management can be controlled by a safety policy.

5.2.2 Safety risk management (SRM)

Safety risk management (SRM) uses task analysis, hazard identification, risk analysis, and risk assessment to develop risk controls.

SRM shall be performed on UA operation and supporting system management. ISO 12100 should be referred to for risk assessment.

NOTE Further guidance on risk assessment for UAS operations is given in the JARUS guidelines on specific operations risk assessment (SORA).

5.2.3 Safety assurance

Safety assurance provides for system monitoring, measuring, assessment, and corrective action to assure the effectiveness of risk controls.

Safety assurance shall be continuously performed throughout UA operation and supporting system management, including for functions executed by third-party service providers.

5.2.4 Safety promotion

Safety promotion provides guidance for training and communication to promote safety as a core value in the organization.

Safety promotion shall be performed throughout operation of UA and UA supporting system management.

All requirements in this document are indispensable to implement an SMS.

Operators should determine what evidence of SMS compliance is acceptable to the countries of intended operation.

5.3 Security

The following security precautions shall be taken when operating UA.

a) Operators shall implement all reasonably practicable cyber security measures in all aspects of UAS operations.

b) Operators shall ensure that all personnel with access to any part of the UAS are suitably vetted.

6 Data protection — Operator requirements

Taking relevant data protection regulation into consideration, operators shall ensure that:

a) systems in place to protect data gathered during UA operations as far as reasonably practicable;

b) suitable procedures are in place to securely store or dispose of all data gathered during UA operations;

c) personnel involved in the handling of sensitive data are suitably vetted.

Privacy etiquette shall be in accordance with Annex A.

7 Operator

7.1 Documentation

7.1.1 Documents held by the UAS operator

7.1.1.1 General

Operators shall hold documents, manuals and information specific to the UAS operator. Taking local regulations into consideration, operators shall ensure that the following documents are available:

a) details of the operator;

b) flight manual of each model of UA, or equivalent document issued by manufacturer;

c) registration and serial number of each UA;

d) operations manual;

e) maintenance control manual (MCM);

f) contracts and service level agreements with third parties providing safety related services;

g) insurance certificate(s) in accordance with 7.2;

h) copies of personnel licences or competence attestations issued by the operator or by a qualified entity;

i) certificates of airworthiness or, where existing, declarations of conformity by manufacturer or qualified entity.

7.1.1.2 Operations manual

The operator shall establish, maintain and apply an up-to-date operations manual. Taking local regulations into consideration, the operator shall ensure that an operations manual is in place, containing the following documents, policies and procedures:

a) a risk assessment is conducted for every type of operation;

b) all personnel involved in the operations are professionally competent and psychologically and medically fit;

c) all UAS are maintained in accordance with the maintenance programme consistent with the manufacturer's instructions;

d) all operations are conducted according to Clause 10;

e) manufacturer and manufacturer's designation for each UAS;

f) registration and serial number of each UAS;

g) duties of assigned pilot in command (PIC) and other crewmembers for each general mission type;

h) emergency actions/checklists;

i) minimum equipment list by mission type;

j) normal and abnormal checklists (to include pre-flight inspection);

k) standard operating procedures (SOPs), if any.

7.1.2 Documents to be available at the point of operations

The operator shall ensure that required documentsare available at the point of operations. Taking local regulations into consideration, the operator shall ensure that the following documents are available at the point of operations:

a) flight manual including predicted performance data;

b) journey log book;

c) current and suitable aeronautical charts for the route of flight and all routes along which it is reasonable to expect that the flight may be diverted, including departure, arrival and approach charts for all relevant aerodromes/heliports/any other location designated for take-off and landing of UAS, or electronic access to it;

d) details of the filed, current, air traffic service (ATS) and operational flight plans, if applicable;

e) notice to airmen (NOTAM) and aeronautical information service (AIS) briefing documentation or electronic access to it;

f) operations manual or pertinent subset thereof, including applicable checklists and the minimum equipment list (MEL);

g) meteorological information or electronic access to it;

h) mass and balance documentation;

i) for UA carrying cargo: a manifest, information on dangerous goods and detailed declarations of the cargo;

j) risk assessment and details of the mitigations from the risk assessment;

k) the operator's contact information;

l) remote pilot certificate (copy).

7.2 Insurance

Operators shall have insurance. Taking local regulations into consideration, operators shall ensure that they have insurance appropriate to their operations and covering health and safety of personnel and risks to third parties.

8 Airspace

8.1 Compliance with airspace regulations

UA operators shall establish procedures to ensure that applicable rules of the air and regulations defining airspace areas or special zones are followed.

These procedures shall also cover how to obtain permission by the local air traffic service provider(s) to access airspace, or alternative coordination procedures in the context of UAS traffic management (UTM).

It is presupposed that operators ensure that UAS comply with defined technical or performance specifications, including mandatory equipment or functions that enable easy identification or automatically limit the airspace they are allowed to enter (e.g. geo-limitations).

8.2 Airspace information

UA operators shall ensure that involved personnel have access to airspace information on prohibited, restricted, danger and special zones for UA operations in electronic format and, where applicable in

real time, and coming from relevant aeronautical information service providers authorised by the local aviation authority.

8.3 Operations above 500 ft (150 m)

It is presupposed that operations above 500 ft (150 m) above surface level are either under visual flight rules (VFR), instrument flight rules (IFR) or in temporary segregated airspace.

8.4 Special zones above flight level (FL) 600

UA operators shall organise additional specific training of the remote crew for operations at very high level (VHL) above FL 600, if applicable, in which one remote pilot in command (RPIC) through a single working position may have more than one UA under control.

9 Facility and equipment and requirements

9.1 Registration

UA shall be registered by the operator on a UA registration system.

9.2 UA identification

The UA shall be marked with:

a) the ID number when formally registered; or

b) the operator's contact information.

9.3 Compatibility

The following precautions shall be taken with regards to compatibility of elements when operating UA:

a) Payloads shall not adversely affect the safety of flight operations.

b) On board equipment shall not interfere with the command and control data link.

c) Remote pilot stations models shall be recognised as being compatible for use with the UA with which they are used based on information provided by the manufacturer of the aircraft and the manufacturer of the remote pilot station.

10 Operations

10.1 Flight operations

Flight operations refers to all activities pertaining to the flight cycle of a UA. All operations shall be conducted taking into consideration appropriate rules of the air.

The operator shall take into consideration the laws, regulations and procedures of those states in which operations are conducted. For each UA type, or variant thereof, in the operator’s fleet, the operator shall maintain the following information:

a) operational conditions and limitations;

b) authority contact details of the UA state of design;

c) area of operations;

d) special limitations and authorisations;

e) mandatory equipment, functionality and performance.

Operators shall define standard operating procedures following a comprehensive risk assessment for each type of operation which should then be included in the operations manual.

10.2 Operational plan — Flight planning

Operators shall ensure that flight planning is conducted and documented for every flight operation. Where the local aviation authority regulations for mission planning exist, it is presupposed that operators ensure that they follow or exceed these requirements. Operational plans shall, as a minimum, include the following:

a) weather and meteorological minimum;

b) fuel and energy requirements;

c) flight plan where required;

d) if a flight plan is not required, a route to be followed indicating:

   1) point of departure;

   2) landing point;

   3) cruising speeds;

   4) cruising levels;

e) airspace classification and restrictions;

f) risk assessment;

g) communications;

h) the actions of the pilot in the event of unforeseen situations;

i) program of autonomous flight of an aircraft in case of failure of the C2 Link;

j) notifications.

In the event an operation is affected by an unmanned aircraft incident or accident, operational plans shall be retained for a minimum of 12 months, taking into consideration requirements by the applicable regulation.

10.3 Flight preparation

10.3.1 Pre-flight inspections

Before each flight, the remote pilot (or appropriate crew member) shall conduct a pre-flight inspection according to the operations manual. This may include the following:

a) visual condition inspection of the UA components;

b) airframe structure;

c) all flight control surfaces and linkages;

d) registration markings, for proper display and legibility;

e) servo motor(s), including attachment point(s);

f) propulsion system;

g) rotor or fan shrouds, where used, are not damaged;

h) check all power systems;

i) avionics, including control link transceiver, communication/navigation equipment and antenna(s);

j) calibration of UA compass prior to any flight;

k) correct functioning of display panel, if used;

l) ground support equipment, including take-off and landing systems, for planned operation;

m) check that all C2 functions operate correctly;

n) correct movement of flight control surfaces;

o) flight termination system, if installed;

p) fuel and/or battery levels;

a) secure attachment of any payloads and ancillary equipment;

b) start of the UA propellers to inspect for any imbalance or irregular operation;

c) verification of all controller operations and proper function of heading and altitude sensors;

d) verification of any noted obstructions that may interfere with the UA;

e) assessment of the impact on the systems capability to maintain control where the potential exists for adverse radio interference during flight operations;

f) adequate fire extinguishing and first aid equipment is available.

10.3.2 Communication planning

Operators shall ensure that a suitable communications plan is in place for all UA operations. The communications plan shall, as a minimum, include:

a) a list of the frequencies or bands that will be used appropriate to the C2 Link technical solution for radio line-of-sight and beyond radio-line-of-sight operation and the criteria for selecting them;

b) the C2 link(s) shall achieve the performance required to enable operation of the UAS consistent with the target level of safety appropriate to its class and type of operation; the performance requirements apply to any ATC communication, navigation and surveillance functions executed using the C2 Link in addition to the control functions necessary for the pilot or controlling function to manage the safe flight of the UA;

c) systems on the ground, including those used to provide some segments of communications network(s) supporting the C2 Link, ATC communications, navigation, surveillance and information services (e.g. to enhance situational awareness of traffic and weather) shall be verified to be operational with the performance required for the respective function categories.

10.4 In flight operations

10.4.1 Responsibilities of the remote pilot in command (RPIC)

The RPIC of a UA is directly responsible for, and is the final authority as to, the operation of that UA. The RPIC shall:

a) ensure that all control links between the controller and the UA are working properly;

b) ensure there is sufficient power/fuel to continue controlled flight operations to a normal landing;

c) ensure that any object attached to or carried by the UA is secure and does not adversely affect the flight characteristics or controllability of the aircraft;

d) ensure that all necessary documentation is available for inspection at the RPS, as required by 7.1;

e) ensure the mission execution is compliant with relevant operations manuals during all flight operations;

f) be adaptive and agile enough to make sound tactical decisions to avoid or mitigate unsafe conditions.

10.4.2 Operational limitations

The operator shall ensure that all personnel involved in the operations complies with the operational limitations contained in the flight manual and in the operations manual, including the following aspects.

Global navigation satellite system (GNSS) — operators shall ensure that all flight operations take account of the limitations on GNSS accuracy due to location, environment, space weather and restrictions during certain periods.

Geo-limitations — operators shall ensure that, where a geo-limitation database is being used, that it is from a reliable source and up-to date in order to maintain accuracy. This may be a CAA-approved AIS, if established.

Temperature — operators shall ensure that the effect of temperature is considered for all flight operations, e.g. reduced battery life.

Weather — operators shall ensure operations are only conducted in weather conditions (windspeed, rain, etc.) which are within the limitation defined by the manufacturer of the UA and any UTM service provider required in the approved airspace.

Operators shall ensure that the UA is flown at an adequate distance from natural or artificial obstacles so as to prevent any hazard of collision.

UA operators shall ensure that operations comply with specified environmental standards.

10.4.3 Handovers

Where handovers take place during the operation of a UA, all relevant personnel shall be competent in handover procedures in addition to the requirements detailed in Clause 7.

10.4.4 Multiple UA operation

10.4.4.1 General

The following precautions shall be taken when operating multiple UA with a single remote pilot:

a) operators shall ensure that operations are conducted only by remote pilots who are competent to operate multiple UA simultaneously;

b) UA on-board systems shall not interfere with those of other UA or aircraft (manned or UA) and with air or ground aviation aids (e.g. radar, navaids, …), including those under control by the same pilot; aircraft operations shall not create a mutual flight risk;

c) it is presupposed that operations are conducted in accordance with local aviation authority regulations.

10.4.4.2 Autonomous operation of multiple UA

Multiple UA autonomy is a continuum from complete human control of all decisions to situations where many functions are delegated to the computer with only high-level supervision or oversight from its operator. Allocation of cognitive functions may vary over the course of a flight based on such factors as environmental complexity and required response time. Operators shall account for these cognitive functions within the systems and are categorized as follows:

a) fault detection and vehicle health management;

b) situation awareness;

c) communications;

d) payload management;

e) guidance, navigation and control;

f) failure anticipation and reaction;

g) flight planning and decision making;

h) information/network management;

i) contingency management.

Where a multiple UA operation requires authorisation, this shall be obtained either from all relevant local authorities or accredited entities, and it is presupposed that the UA to be used in any operation complies with the relevant local regulations for multiple UA operations.

10.4.5 Autonomous operations

Autonomous operation of UAS can be categorised in many ways but, essentially, they range from basic automatic flight systems which assist manual input and can hold altitude and position, avoid collision and conduct pre-programmed flight path operations to fully autonomous systems in which no human input is required for the system to complete its operation.

In order to ensure safety in autonomous UAS operations, the operator shall ensure that:

a) human intervention is possible during all such operations, regardless of the level of autonomous sophistication;

b) all such operations are monitored to ensure that human intervention is taken in the event of a safety critical failure which cannot be safely resolved by the autonomous system.

10.4.6 Communication

Where possible, during flight operations, the pilot shall coordinate with the appropriate authorities prior to executing divert procedures.

10.4.7 Operations at night

It is presupposed that where aviation authority regulations for night operations exist, operators ensure that they follow or exceed those requirements. Operators shall ensure that the following minimum considerations are taken when operating UA at night:

a) The takeoff/landing area is suitable for night operations.

b) The remote pilot shall be able to assess the wind direction to determine landing direction.

c) Lights shall not emit glare which endangers other aircraft.

d) A site suitability survey shall be carried out prior to the flight in daylight hours to assess any possible obstacles/hazards to the intended flight.

e) Lights fitted to attract attention to the UA shall not be used if they could be mistaken for lights indicating its relative path.

f) A method is in place for the remote pilot to see and avoid other aircraft, people on the ground, and ground-based structures and obstacles during darkness.

g) A method to increase the visibility of the UA is in place and the remote pilot is able to continuously monitor the position, altitude, attitude, and movement of the UA.

h) All personnel participating in the operation have knowledge to recognize and overcome visual illusions.

10.4.8 Surface/ground operations

Operators shall ensure that all surface/ground operations are conducted in a safe manner to avoid injury to third parties.

Operators shall ensure that procedures are in place to avoid risk of collision with other aircraft, vehicles or obstacles during movements of the aircraft on the surface.

10.4.9 Journey log

Operators shall ensure that journey logs:

a) are maintained for every UA in which particulars of the UA and its crew shall be entered at end of the duty period of each remote pilot in command.

b) contain at least the following information, taking into consideation local regulations:

   1) UA registration;

   2) a record of each control station used in the course of a flight;

   3) the duration of use and time of transfer for each control station;

   4) date of flight;

   5) remote crew member names and duty assignments;

   6) departure and arrival points and times;

   7) flight route;

   8) purpose and type of flight;

   9) observations regarding the flight;

   10) any maintenance concerns or abnormal occurrences during the flight; and

   11) signature of the remote pilot-in-command.

A journey log may also consist of a section dedicated to the UA control station.

10.4.10 Abnormal and contingency procedures

The operator shall ensure that normal, abnormal and emergency procedures are include in the operations manual, where necessary including also an emergency plan.

For instances when the air vehicle does not automatically shut down upon recovery or is unable to be remotely commanded to shut down, then a manual shutdown capability shall be safely accessible by ground personnel.

10.5 Additional operator responsibilities

10.5.1 Oversight of contracted service providers

Operators shall verify that the providers of any safety-critical services are capable of establishing and maintaining sufficient accuracy and integrity of the provided information and data, and sufficient safety, performance and quality of the services.

The provider of safety-critical services shall have a suitable organisational structure, appropriate documented procedures, and adequate resources and personnel.

Safety-critical services may include but are not limited to:

a) providing geographical data and limitations;

b) communication services supporting C2 link;

c) provision of services through RPS located anywhere in the world.

10.5.2 Personnel qualification and management

10.5.2.1 General

Operators shall appoint an accountable manager, who has the authority for ensuring that all activities are financed and carried out in accordance with applicable regulations.

Operators shall nominate a person or group of persons with management responsibilities (e.g. operations, continuing airworthiness, crew training, safety management, etc.) ensuring that the operator remains in compliance with the laws, regulations and procedures of those states in which operations are conducted. Such person(s) shall be ultimately responsible to the accountable manager.

Operators shall establish procedures for crew rostering.

Operators shall define the roles and task allocation of the remote crew for the operation of the UA.

Operators shall establish a fatigue risk management programme appropriate for the UA operation environment including the UA and mission profiles.

Operators shall have facilities allowing the performance and management of all planned tasks and activities, considering the nature and complexity of such activities.

10.5.2.2 Competence

10.5.2.2.1 General

Operators shall establish a documented policy and procedures to ensure that all remote pilots and other personnel executing tasks relevant to the safety of operations within their organisation are competent to carry out flight operations within the limits of their remit. It is presupposed that such procedures meet or exceed appropriate aviation authority regulations where they exist.

10.5.2.2.2 Operations personnel

Operators shall ensure that all operational tasks are conducted by competent personnel. Taking relevant aviation authority regulation into consideration, operators should ensure that operations personnel are competent in the following areas:

a) aircraft components;

b) aircraft systems;

c) airspace;

d) aerodynamics;

e) civil aviation regulations;

f) flight operations;

g) flight basics;

h) emergency procedures;

i) mission scenarios;

j) planning organisations;

k) privacy;

l) safety management;

m) software;

n) visual observer (VO) responsibilities;

o) datalink/radio frequency (RF) communications;

p) weather.

10.5.2.2.3 Maintenance personnel

Operators shall ensure that all maintenance tasks are conducted by competent personnel. Taking the appropriate aviation authority regulation into consideration, operators should ensure that maintenance personnel are competent in the following areas:

a) procedures to replace components in accordance with the manufacturer's instructions and as appropriate to the flight operations being undertaken;

b) tool control procedures;

c) maintenance reporting procedures;

d) deferred defect procedures consistent with the minimum equipment list (MEL);

e) foreign object debris (FOD) prevention procedures.

10.5.2.2.4 Medical fitness

The operator shall ensure that all personnel are medically and mentally, taking into consideration applicable regulations. Remote crewmembers shall not participate in the operation of an UA if they know or have reason to know that they have a physical or mental condition that could interfere with the safe operation of the UA.

10.5.2.3 Currency

Operators shall establish a documented currency programme to ensure that all crewmembers within their organisation remain competent in accordance with their operations manual. The programme shall be appropriate to the complexity of the crewmember's remit.

Operators shall establish an evaluation procedure and a programme to evaluate the proficiency of all crewmembers within their organisation to ensure that they meet the standards set out in the operations manual.

10.5.2.4 Qualification and training

Operators shall have a sufficient quantity of competent and qualified personnel for each UA type that they operate.

Operators shall establish and maintain a training programme covering as a minimum the training standards for remote flight crew, key personnel including management system personnel, support personnel (dispatchers) and visual observers.

The training programme shall address operational procedures including handover, contingency and emergency procedures, dangerous goods, security and management system.

The operator shall ensure that remote pilots are certified or hold an attestation of competence and are appropriately rated, when required and taking into consideration local aviation authority regulations.

Training shall be approved by the local aviation authority or by an entity accredited by the relevant aviation authority when required and taking into consideation local aviation authority regulations.

Operators shall be responsible for qualifications and training of all remote flight crew and for the assignment of remote flight crew duties and responsibilities.

Operators shall establish a recurrent crew resource management (CRM) training programme for the remote flight crew.

The operator shall only designate a remote pilot to act as RPIC if the person has:

a) the minimum level of training, experience and currency as defined in the operations manual, taking into consideation local regulations;

b) adequate knowledge of the route or area to be flown and of any aerodromes, including alternate aerodromes, other operating sites, facilities and procedures to be used;

c) in the case of multi-crew operations, completed a command course appropriate for the envisaged operations.

Operators are responsible for qualifications and training of all support personnel necessary for the safe conduct of operation and for the assignment of related duties and responsibilities, including but not limited to dispatchers, visual observers, UA technicians and other ground support crew for launch and recovery, payload masters.

The training programme shall ensure that personnel remain competent through difference training, periodic proficiency checks and periodic refresher training.

The UA training organisation shall establish, implement and record training of all crewmembers, visual observers, maintenance staff and other safety relevant crews, taking into consideration local regulations.