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Unmanned aircraft systems —

Part 3: Operational procedures

Aéronefs sans pilote —

Partie 3: Modes opératoires

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

This second edition cancels and replaces the first edition (ISO 21384-3:2019), which has been technically revised.

The main changes are as follows:

— Clause 2: addition of normative references;

— Clause 3: addition of several terms and definitions;

— 5.1: addition of applicable management systems and equipment requirements;

— 5.2: major restructuring of the subclause, addition of requirements for operators under different preconditions and specified tasks for different personnel to be conducted;

— 9.1: designation of a remote pilot in control added;

— 9.4: addition of requirements for handovers of functions and responsibilities, precautions for the operation of multiple UA by one remote pilot, communication and airborne functions for UTM;

— 9.5: addition of new subclauses on organizational, operational and technical requirements for external service regarding UTM and C2CSP;

— Clause 11: new clause on conflict management including operational charts and descriptions.

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.

Unmanned aircraft systems —

Part 3:
Operational procedures

1 Scope

This document specifies the requirements for safe commercial unmanned aircraft system (UAS) operations, including the external safety-critical service providing command and control (C2) link.

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 12100, *Safety of machinery — General principles for design — Risk assessment and risk reduction*

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

ISO 23629-12:2022, *UAS traffic management (UTM) — Part 12: Requirements for UTM service providers*

ISO 23665, *Unmanned aircraft systems — Training for personnel involved in UAS operations*

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 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 https://www.electropedia.org/

3.1
C2 Link communications service provider
C2CSP
entity which provides a portion of or all of the *C2 Link* (3.4) service for operation of an UAS

Note 1 to entry: The definition is adapted from Reference [16].

3.2
designated operational coverage
DOC
volume where the C2 Link *QoSD* (3.9) meets the *C2 Link* (3.4) specified performances and supports the corresponding intended UAS operations

Note 1 to entry: The definition is adapted from Reference [16].

3.3
collision avoidance
third layer of conflict management which activates when the separation mode has been compromised

Note 1 to entry: The definition is adapted from Reference [17].

3.4
C2 Link
command and control link service
telecommunication service provided for the purpose of supporting command and control of the aircraft

Note 1 to entry: The definition is adapted from Reference [16].

3.5
crew resource management
CRM
utilization of all resources available to the crew to manage human error

3.6
DAA system
detect and avoid system
system that supports the remote pilot to see, sense or detect conflicting traffic or other hazards and take the appropriate action

3.7
external service
service and related provider, necessary for the safety of the UAS flight, encompassing:

a) *command and control link communication service provider (C2CSP)* (3.1);

b) other operation support services, whose purpose is to support a single flight but not to manage traffic;

c) UTM services

Note 1 to entry: The definition is adapted from Reference [20].

Note 2 to entry: Additional information on external services is provided in Annex B.

Note 3 to entry: Only the safety critical C2CSP is covered in this document.

Note 4 to entry: UTM services and non-safety-critical operation support services are covered in ISO 23629-12.

3.8
quality of service
QoS
totality of the characteristics of an entity that bear on its ability to satisfy stated and implied needs

Note 1 to entry: The definition is adapted from Reference [16].

3.9
quality of service delivered
QoSD
statement of the *QoS* (3.8) achieved or delivered to the UAS operator by the *C2 Link communications service provider (C2CSP)* (3.1)

Note 1 to entry: The definition is adapted from Reference [16].

3.10
quality of service experienced
QoSE
statement expressing the *QoS* (3.8) that remote pilots believe they have experienced

Note 1 to entry: The definition is adapted from Reference [16].

3.11
quality of service required
QoSR
statement of the *QoS* (3.8) requirements of the UAS operator to the *C2 Link communications service provider (C2CSP)* (3.1)

Note 1 to entry: The definition is adapted from Reference [16].

3.12
remain-well-clear
ability to detect, analyse and manoeuvre in order to ensure that a UA is not being operated in such proximity to other aircraft as to create a collision hazard

3.13
remote pilot in command
RPIC
pilot designated by the operator as being in command and charged with the safe conduct of a flight

3.14
safety assurance
set of activities providing for system monitoring, measuring, assessment, and corrective action to assure the effectiveness of risk controls

3.15
safety management system
SMS
systematic approach to managing safety, including the necessary organizational structures, accountabilities, policies and procedures

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

3.16
safety promotion
set of activities providing guidance for training and communication to promote safety as a core value in the organization

3.17
safety risk management
SRM
set of activities using task analysis, hazard identification, risk analysis, and risk assessment to develop risk controls

3.18
separation provision
second layer of conflict management and tactical process of keeping aircraft away from hazards by at least the appropriate separation minima which is only used when *strategic conflict management* (3.20) (i.e. airspace organization and management, demand and capacity balancing and traffic synchronization) cannot be used efficiently

Note 1 to entry: The definition is adapted from Reference [17].

3.19
service level agreement
SLA
enforceable agreement between the *C2 Link communications service provider (C2CSP)* (3.1) and the UAS operator covering the safety, performance, coverage and security of the *C2 Link* (3.4) provision as required for the RPAS operator's intended operations

Note 1 to entry: The definition is adapted from Reference [16].

3.20
strategic conflict management
first layer of conflict management that is achieved through the airspace organization and management, demand and capacity balancing and traffic synchronization components

Note 1 to entry: The definition is adapted from Reference [17].

3.21
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

3.22
unmanned aircraft incident
occurrence, other than an *unmanned aircraft accident* (3.21), associated with the operation of an aircraft which affects or can affect the safety of operation, including the loss of unmanned aircraft

3.23
VLL
very low level
airspace below the minimum heights for VFR traffic as established by the competent authority

4 Abbreviated terms

AIS	aeronautical information service
ANSP	air navigation service provider
ATS	air traffic service
BVLOS	beyond visual line-of-sight
CofA	certificate of airworthiness
COMO	compliance monitoring officer
DAL	design assurance level
EVLOS	extended visual line-of-sight
FW	firmware
FOD	foreign object debris
GNSS	global navigation satellite system
IFR	instrument flight rules
ISMS	information security management 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
SAFO	safety officer
SECO	security officer
SW	software
UA	unmanned aircraft
UAS	unmanned aircraft system
UTM	UAS traffic management
VLOS	visual line-of-sight
VO	visual observer

5 Safety and security

5.1 General

UAS operators and providers of safety critical external services shall implement an SMS and an ISMS as standard practice regardless of the type of UAS operated or size of operation. Both SMS and ISMS are comprehensive, process-oriented approaches to managing safety and security throughout an organization.

Any machine or equipment used at the UAS operator's or service provider's premises, facilities or workshops, shall be designed according to ISO 12100 or equivalent, to be safe for their intended use by involved personnel.

NOTE 1 Safety management systems for occupational health and safety of the personnel are defined in ISO 45001.

NOTE 2 Information security management systems are described in ISO/IEC 27001.

NOTE 3 Aviation safety management, as defined in Reference [12], has instead the purpose of protecting the safety of third parties, in the air or on the ground, during UAS operations.

5.2 Safety

5.2.1 Safety policy

A safety policy shall be defined for UAS operators and providers of external services to accomplish their goals. Human error in UA operation and supporting system management can be controlled by a safety policy.

The policy shall be complemented by procedures and organizational structures for safety risk management, safety assurance and safety promotion.

5.2.2 Requirements for operators conducting UAS operations in VLOS or EVLOS

All operators conducting UAS operations in VLOS or EVLOS shall:

a) address the structure, responsibilities, processes and procedures that promote and establish an environment and culture of continuing improvement and enhancement of safety;

b) appoint a person as COMO;

c) appoint a person as SAFO;

d) designate the COMO and the SAFO based on professional qualities and expert knowledge of laws, regulations and practices on safety of unmanned aviation and the ability to fulfil tasks respectively referred to in 5.2.5 and 5.2.6;

e) train and qualify personnel on safety management related to intended operations;

f) establish procedures for prescriptive safety including as a minimum:

   1) monitor and assess changes to regulations which can affect operations;

   2) establish evidence that all applicable regulations are complied with;

g) establish procedures to support reactive safety through:

   1) maintain records of any operational activity for at least three months (can be longer if required by regulations or because the State authority competent for the matter has opened an accident or incident investigation);

   2) provide in a timely manner any information required by the authority;

h) establish procedures for proactive safety including as a minimum:

   1) the possibility for staff, customers, subcontractors or other partner SPs to report any relevant and perceived safety occurrence;

   2) mandatory reporting of safety occurrences to the competent authority, based on applicable regulations;

   3) voluntary reporting to the competent authority of any additional and relevant observed safety occurrence, in a manner that would allow a further safety analysis by the authority, if deemed appropriate by the latter;

   4) collection of received or originated safety occurrence reports;

   5) timely feedback to originators of the report;

   6) storage of received or originated safety occurrence reports;

   7) protection of related information, in particular identity of the author of the report, in accordance with Annex A;

   8) dissemination of safety information to involved personnel and affected stakeholders;

   9) taking decisions, implementing and monitoring effect of corrective actions originated by received reports;

i) establish procedures for interorganizational safety management, allowing exchange of safety information with affected stakeholders.

NOTE 1 The COMO or SAFO can be or not be employees of the UAS operator.

NOTE 2 A single COMO or single SAFO can perform such a function on behalf of several organizations, providing that no conflict of interest arises.

NOTE 3 A single physical person can perform both the function of COMO and of SAFO.

5.2.3 Additional requirements for operators conducting UAS operations in BVLOS at VLL

In addition to 5.2.1 and 5.2.2, all operators conducting UAS operations in BVLOS at VLL shall:

a) not change configuration of the systems used for respective operations or the procedures thereof, without prior evaluation of the related hazards, considering safety, security and privacy, and emerging risks, complemented by verified implementation of the mitigations stemming from the evaluation;

b) control system configuration and operational procedures and manage changes, demonstrate and document their compliance with applicable regulations, monitor actual application of such procedures and maintain related records for at least two years;

c) establish procedures for predictive safety including as a minimum, safety assessment of any change affecting operations; such safety assessment should include:

   1) identification of the scope of the change;

   2) verification that the foreseen change is compliant with applicable regulations;

   3) identification of related hazards;

   4) determination of the safety criteria applicable to the change;

   5) risk analysis in relation to the harmful effects or improvements in safety related to the change;

   6) risk evaluation and, if required, risk mitigation for the change to meet the applicable safety criteria;

   7) verification that the change is in accordance with the scope that was subject to safety assessment, and meets the safety criteria, before the change is put into operation;

   8) acquisition of prior approval to implement the change, from the competent authority, when required by regulations;

   9) specification of the monitoring requirements necessary to ensure that the operations will continue to meet the safety criteria after the change has been implemented.

NOTE 1 Further guidance on risk assessment for UAS operations is given in Reference [20].

NOTE 2 Procedures for managing changes can include analysis, calculations, simulation, laboratory testing, regression testing for software or testing in real environment, as well as distribution of necessary information to stakeholders and additional training for staff.

5.2.4 Additional requirements for operators conducting UAS operations in controlled airspace, above VLL and under IFR and for C2CSP

In addition to 5.2.1, 5.2.2 and 5.2.3, all operators conducting UAS operations in controlled airspace, above VLL and under IFR and all C2CSP, shall:

a) establish a manual containing all safety management procedures and reporting lines;

b) in the context of prescriptive safety, establish a system of periodical internal audits to demonstrate and document compliance with applicable regulations and organizational procedures;

c) in the context of reactive safety, establish procedures for internal safety investigations on significant safety occurrences;

d) as part of the inter-organizational processes for safety management, establish arrangements with other relevant organizations (e.g. other aircraft operators, vertiport operators, UTM service providers) to ensure continuous improvement of the safety of operations.

The arrangements with other organizations may include inter-organizational teams for joint safety investigation, safety analysis and development of joint corrective action plans.

NOTE The safety management manual cannot be combined with other manuals of the organization.

5.2.5 Tasks of the COMO

The UAS operator or C2CSP shall ensure that the COMO receives any instructions regarding the exercise of the tasks in this subclause only from the SP top management or from the competent State authorities.

The COMO shall not be dismissed or penalized by the organization for performing her/his tasks.

The COMO shall directly report to the highest management level of the operator or C2CSP organization.

The COMO shall be bound by secrecy or confidentiality concerning the performance of his or her tasks, taking into account applicable legislation.

The COMO may fulfil other tasks and duties in the integrated management system, providing that any such tasks and duties do not result in a conflict of interests. Therefore, the COMO may be responsible, for example, for data protection or safety management, but not for operations or service provision, maintenance or other activities related to production.

The COMO shall have at least the following tasks:

a) inform and advise the organization's top management and the employees who carry out tasks with regulatory compliance implications of their obligations pursuant to applicable regulatory provisions;

b) monitor compliance with applicable legislation, with this document and with the policies of the operator or C2CSP in relation to regulatory provisions, in the context of prescriptive safety management and including the assignment of responsibilities, awareness-raising and training of staff involved in relevant operations;

c) manage the related internal audits, if applicable, report the findings to the highest management level in the organization, advice on corrective action plans and monitor implementation of corrective actions;

d) support possible audits or inspections by competent authorities and prepare responses to respective protocol questions;

e) provide advice to the organization's top management where requested as regards regulatory compliance;

f) act as the contact point for the authorities on issues relating to regulatory compliance;

g) to systematize and analyse working information, keep the necessary documentation and draw up reports.

5.2.6 Tasks of the SAFO

The UAS operator or C2CSP shall ensure that the SAFO receives any instructions regarding the exercise of the tasks in this subclause only from the organization's top management or from the competent State authorities.

The SAFO shall not be dismissed or penalized by the organization for performing her/his tasks.

The SAFO shall directly report to the highest management level of the organization.

The SAFO shall be bound by secrecy or confidentiality concerning the performance of his or her tasks, taking into account applicable legislation.

The SAFO may fulfil other tasks and duties in the integrated management system, providing that any such tasks and duties do not result in a conflict of interests. Therefore, the SAFO may be responsible, for example, for data protection, compliance monitoring or security management, but not for operations, service provision, maintenance or other activities related to production.

The SAFO shall have at least the following tasks:

a) compile, update and control the configuration of the safety management manual, if applicable;

b) inform and advise the organization top management and the employees who carry out tasks having safety implications of their obligations pursuant to applicable safety provisions;

c) monitor all activities for reactive, proactive, predictive and inter-organizational safety management, taking into account applicable legislation, with this standard and with the policies of the organization in relation to safety, including the assignment of responsibilities, awareness-raising and training of staff involved in safety relevant tasks;

d) participate to joint safety teams, where established;

e) provide advice to the organization's top management where requested as regards any safety matters;

f) cooperate with the national authorities on safety matters, where applicable;

g) act as the contact point for the authorities on issues relating to safety.

5.3 Security

5.3.1 Requirements for operators conducting UAS operations in VLOS or EVLOS

Taking relevant security regulation into consideration, all operators conducting UAS operations in VLOS or EVLOS shall:

a) ensure that their facilities, systems and procedures take into account applicable security legislation, including that covering good repute of personnel;

b) ensure that all operated UA are registered and identified based on applicable legislation and related standards;

c) ensure physical security of their facilities and systems used for respective operations as far as reasonably practicable;

d) ensure that suitable procedures are in place to securely store, exchange and dispose of all data gathered during operations;

e) ensure that data is not distributed to non-eligible entities;

f) equip the premises, compartment or room where the UAS or other systems for operation are located, with suitable security to prevent access of unauthorized persons;

g) ensure that this door be closed and locked during operation, except when necessary to permit access and egress by authorized persons;

h) establish means to reasonably prevent unauthorized access, comprising as a minimum means for monitoring the area outside the door to identify persons requesting entry and to detect suspicious behaviour or potential threat;

i) ensure the physical protection of the systems used for provisions of respective services when no personnel are inside the premises, room or compartment;

j) released portable equipment for operations, including UA and their station, only for use to authorized personnel and only for the time necessary;

k) ensure that portable equipment for operations, including UAS, when not in use, is stored in a secure place.

5.3.2 Additional requirements for operators conducting UAS operations in BVLOS at VLL

In addition to 5.3.1, all operators conducting UAS operations in BVLOS at VLL, shall:

a) address the structure, responsibilities, processes and procedures that promote and establish an environment and culture of continuing improvement and enhancement of operation's security;

b) appoint a person as SECO;

c) designate the SECO based on professional qualities and expert knowledge of laws, regulations and practices on national security, aviation security and cyber-security and the ability to fulfil the tasks referred to in 5.3.4;

d) train and qualify personnel to effectively recognize and respond to possible acts of unlawful interference against operations;

e) ensure, directly or through service level agreements (SLA) with C2CSP and UTM communication SPs, that any communication link supporting operations, is secured and assured, in a way proportionate to the related safety, security and privacy risks;

f) establish procedures for checking identity of personnel before allowing them to access premises, UAS or other equipment;

g) deny to unauthorized persons the ability to access premises, UAS or equipment;

h) establish procedures to report to the competent authority any information on observed security occurrences, in a manner that would allow a further impact analysis by the authority, if appropriate;

i) consider, if established by the state, geographical zones within which operations of civil UAS are restricted or excluded to address risks pertaining to security.

NOTE 1 It is important to note that the registration process is different from the authorization process.

NOTE 2 The SECO can be or not be an employee of the UTM SP.

NOTE 3 A single SECO can perform such a function on behalf of several organizations, providing that no conflict of interest arises.

5.3.3 Additional requirements for operators conducting UAS operations in controlled airspace, above VLL and under IFR and for C2CSP

In addition to 5.2.1 and 5.2.2, all operators conducting UAS operations in controlled airspace, above VLL and under IFR and all C2CSP, shall:

a) conduct appropriate background checks on all personnel involved in operations or provision of safety critical services to confirm, for example, the validity of someone's identity, criminal record, education, and employment history;

b) establish a security management system comprising a threat-based, risk-managed approach under which to assess and manage their own security risks, threats and impacts;

c) ensure that the security management system includes a risk policy that is transparent, predictable and controllable, focused on the largest risks and equitable;

d) assess the information systems essential for operation or for provision of safety critical services, against any potential intentional unauthorized electronic interaction (IUEI) security threat and vulnerability that could result in an unsafe condition;

e) ensure that the assessment includes as a minimum:

   1) determination of the security environment for the information security of respective activities;

   2) identification of the relevant assets or systems;

   3) identification of the attack paths;

   4) assessment of the safety consequences of the security threat to the affected assets;

   5) evaluation, by considering the existing security protection means, of the level of threat that would have an impact on safety;

   6) determination of whether the risks, which are the result of the combination of the severities and the potentiality to attack (or, inversely, the difficulty of attacking), are acceptable:

      — If they are acceptable, preparation of a justification statement, including the means to maintain the risk at an acceptable level;

      — If they are not acceptable, analysis of the proposed means of mitigation to ensure an acceptable level of safety;

   7) implementation of means of mitigation,

   8) evaluation of the effectiveness of the means of mitigation with respect to the level of risk (combination of the level of threat and severity of the threat condition);

   9) iteration from point 6) until all the residual risks are acceptable.

f) establish procedures ensuring that the result of this assessment, after any necessary means of mitigation have been identified, lead to either to a statement that the systems have no identifiable vulnerabilities, or to documented implementation of sufficient mitigation measures;

g) provide, when mitigation measures were necessary, sufficient grounds for evaluating that the residual risk is acceptable;

h) establish procedure to make the documentation on the means of mitigation available in a timely manner to the competent authority when requested by the latter;

i) once the overall security risk has been deemed acceptable, if necessary, develop instructions for personnel and other users to maintain the information security risk of the systems or services at an acceptable level, after the entry into service of the system or service or modification thereof.

5.3.4 Tasks of the SECO

The operators conducting UAS operations in controlled airspace, above VLL and under IFR and the C2CSP shall ensure that the SECO receives any instructions regarding the exercise of the tasks in this subclause only from the organization's top management or from the competent State authorities.

The SECO shall not be dismissed or penalized by the organization for performing her/his tasks.

The SECO shall directly report to the highest management level of the organization.

The SECO shall be bound by secrecy or confidentiality concerning the performance of his or her tasks, taking into account applicable legislation.

The SECO may fulfil other tasks and duties in the integrated management system, providing that any such tasks and duties do not result in a conflict of interests. Therefore, the SECO may be responsible,

for example, for data protection or safety management, but not for operations, service provision, maintenance or other activities related to production.

The SECO shall have at least the following tasks:

a) inform and advise the organization's top management and the employees who carry out tasks having security implications of their obligations pursuant to applicable security provisions;

b) monitor compliance with applicable legislation, with this standard and with the policies of the organization in relation to security, including the assignment of responsibilities, awareness-raising and training of staff involved in security relevant services, and the related audits;

c) provide advice to the organization's top management where requested as regards the security assessment and monitor its performance;

d) cooperate with the national authorities on security matters, where applicable;

e) act as the contact point for the authorities on issues relating to security.

6 Data protection — Operator requirements

Taking relevant data protection regulation into consideration, operators and C2CSPs 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) operations manual;

d) maintenance control manual (MCM);

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

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

g) copies of personnel licenses or competence attestations issued by the operator or by a qualified entity;

h) 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 operation's 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 program consistent with the manufacturer's instructions;

d) all operations are conducted according to Clauses 9 and 11;

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

f) registration and serial number of each UA;

g) duties of assigned pilot in command (PIC) and other crew members 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

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

a) flight manual including UA performance data and limitations;

b) journey logbook;

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

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

j) the operator's contact information;

k) 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 demonstrate compliance 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 authorized 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 any other flight rules applicable to UAS operations or in temporary segregated airspace.

8.4 Special zones at very high flight levels (FL) 600

UA operators shall organize additional specific training of the remote crew for operations in higher airspace, if applicable, in which one remote pilot in command (RPIC) through a single working position may have more than one UA under control. This may also involve specific procedures in accordance with the ANSP's requirements to facilitate such operations.

8.5 Facility and equipment and requirements

8.6 Registration

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

8.7 UA identification

The UA shall be marked with:

a) the ID number when formally registered; or

b) the operator's contact information.

8.8 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 recognized 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.

9 Operations

9.1 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 demonstrate compliance with 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 and take into account 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 authorizations;

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.

Operators shall establish and maintain operational control on all operations, including designation of remote pilot(s) to act as remote PIC and of other operational staff, including observers and fleet managers.

Transfer of remote PIC responsibilities shall be affected in accordance with procedures established by the UAS operator.

The UAS operator shall establish appropriate policies and procedures for the transfer of remote PIC responsibilities.

9.2 Operational plan — Flight planning

Operators shall ensure that flight planning is conducted and documented by the fleet manager 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) navigation and surveillance;

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

j) program of autonomous flight of a UA;

k) 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.

9.3 Flight preparation

9.3.1 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) conspicuity measures such as high visibility markings or additional lighting appropriate to the operation;

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

g) propulsion system;

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

i) check all power systems;

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

k) calibration of UA compass prior to any flight;

l) correct functioning of display panel, if used;

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

n) check that all C2 functions operate correctly;

o) correct movement of flight control surfaces;

p) flight termination system, if installed;

q) fuel and/or battery levels;

r) secure attachment of any payloads and ancillary equipment;

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

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

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

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

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

9.3.2 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; and

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.

9.4 In flight operations

9.4.1 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 safe operation of that UA. Only one remote pilot shall be assigned to hold remote PIC responsibility at any given time.

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.

9.4.2 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.

a) 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.

b) 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 to maintain accuracy. This may be a CAA-approved AIS, if established.

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

d) 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 to prevent any hazard of collision.

UA operators shall ensure that operations are performed in consideration of with specified environmental standards.

9.4.3 Transfer of functions and responsibilities

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.

Written procedures shall identify when remote PIC authority is transferred during handover operations or when the UA is transferred to subsequent control elements.

The intended operation may require, under normal, contingency or emergency conditions:

— transfer of responsibility from one RPIC to another RPIC at same working position, at two different working position inside the same control station or in connection with handover from one station to a station in a different location; or

— switchover of the command-and-control data link to a different channel.

The operator shall ensure that procedures are included in the operations manual, as applicable and compatible with manufacturer's instructions, for:

a) transfer of RPIC responsibility at same working position;

b) change of work position by same RPIC in same control station;

c) transfer of RPIC responsibility from one work position to another person at a different working position in the same control station;

d) handover and parallel transfer of RPIC responsibility to a control station in a different location;

e) switchover of command-and-control data link channel.

f) the moment when responsibility is transferred is clearly identified;

g) any transfer of responsibility, change of position, handover or switchover is recorded;

h) all relevant personnel are competent in transfer, change of position, handover or switchover procedures in addition to the requirements detailed in Clause 7.

9.4.4 Multiple UA operation

9.4.4.1 General

The following precautions shall be taken when a single remote pilot operates multiple UA at any altitude:

a) It is presupposed that these operations are conducted in accordance with local aviation authority regulations.

b) Prior to undertaking these operations, the operator shall conduct a safety and security risk assessment, implement required mitigations to control the risks to an acceptable level and maintain records for such assessments and implementation of mitigations.

c) The safety risk assessment of these operations shall include assessment of the crew workload under normal, abnormal and emergency conditions.

d) Operators shall ensure that operations are conducted only by remote pilots who are competent to operate multiple UA simultaneously.

e) Having defined and implemented the required mitigations and having defined the required competencies for the personnel, operators shall ensure that related procedures and checklists are included in respective operation manual and applied in practice.

f) 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.

g) The operator shall ensure that no more than a single RPIC be assigned to an individual UA in flight.

NOTE 1 one RPIC can be responsible for a swarm of several UA.

NOTE 2 For long duration flights the RPIC responsibility can be transferred to another RPIC.

9.4.4.2 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 authorization, 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.

9.4.5 Autonomous operations

Autonomous operation of UAS can be categorized 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.

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.

9.4.6 Communication and airborne functions for UTM

For coordination with ATS or UTM as applicable, remote crews shall use a standard phraseology.

Operators shall ensure that respective UAS are equipped with serviceable functions mandated by competent authorities to interact with ATS or UTM services in defined volumes of airspace.

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

NOTE Airborne functions can include mandatory VHF radiotelephony, ADS-B, ATC transponder, required navigation performance (RNP), electronic-ID, Geo-limitations, lights for night flight or else, depending on the category or class of the UA and on the volume of airspace where the operations are intended.

9.4.7 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 take-off/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 the UA to attract attention 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 can continuously monitor the position, altitude, attitude, and movement of the UA; and

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

9.4.8 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.

9.4.9 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 consideration local regulations;

c) UA registration;

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

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

f) date of flight;

g) remote crew member names and duty assignments;

h) departure and arrival points and times;

i) flight route;

j) purpose and type of flight;

k) observations regarding the flight;

l) any maintenance concerns or abnormal occurrences during the flight;

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

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

9.4.10 Abnormal and contingency procedures

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

9.5 External services

9.5.1 UAS functions interacting with UTM

Operators shall ensure that their UAS are equipped with the required functions to interact with ATS or UTM services, as in 9.4.6.

9.5.2 Oversight of contracted service providers

Operators shall verify that the providers of any safety-critical, safety-related or operation support services can establish and maintain sufficient accuracy and integrity of the provided information and data, and sufficient safety, security, performance and quality of the services.

The providers of safety critical UTM services, or of safety related UTM services or of operation support services shall have a suitable organizational structure, appropriate documented procedures, and adequate resources and personnel in accordance with ISO 23629-12.

Non-UTM safety-critical or safety related services may include but are not limited to:

a) training of remote crews;

b) communication services supporting C2 Link;

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

The operator shall ensure that organizations' training for its remote pilots conform to ISO 23665.

The operator shall ensure that providers of safety critical or safety related UTM services or providers of operation support services conform to ISO 23629-12.

NOTE 1 A list of possible UTM and operation support services is contained in ISO 23629-12:2022, Annexes A to C.

NOTE 2 C2 Link and RPS services are considered safety critical but linked to operations and not belonging to UTM.

NOTE 3 C2CSP are covered in this document.

9.5.3 C2 communication service provider (C2CSP)

9.5.3.1 General

The C2 Link communications provision is a service which may involve several C2 Link communications service providers (C2CSP) for a given flight.

This service may use several means of communications external to the unmanned aircraft and to its RPS.

The signal between the UA and RPS may either be an electromagnetic signal-in-space or an electronic signal in a physical device (wire, optical fiber, etc.).

The C2 Link is not a tangible product, therefore it cannot be subject to product verification procedures.

Specific C2 Link communications equipment installed on the aircraft or at the RPS (e.g. receiver(s), transmitter(S), antenna(s)) used for the C2 Link are subject to verification processes under the responsibility of the UAS manufactures or operator.

UAS design, under responsibility of the UAS designer, should define all approved C2 Links and the QoSR.

The C2CSP shall:

a) have at its disposal sufficient and suitable facilities and equipment, directly or through agreements with other C2CSPs;

b) establish a service level agreement (SLA) with each UAS operator contracting the services of the C2CSP, including the terms of quality of service required (QoSR) provision:

   1) transaction time from point of attachment with the RPS to the antenna on the UA flying inside the DOC;

   2) integrity;

   3) continuity; and

   4) availability of provided C2 Link service;

c) ensure that the quality of service delivered (QoSD) shall not be worse than the QoSR specified in the SLA with the operator;

d) establish and maintain a safety management system as in 5.2.4 and appoint a COMO and a SAFO as in 5.2.5 and 5.2.6;

e) establish and maintain a security management system as in 5.3.3 and appoint a SECO as in 5.3.4;

f) protect data and information as in Clause 6.

NOTE Parameters of QoSR can be influenced by the automation embedded on board for the purpose of detect and avoid.

9.5.3.2 Technical requirements

The C2CSP shall:

a) define and communicate to potential users the designated operational coverage (i.e. the geographical area) within which C2 Link services are available, taking into account possible regulatory requirements;

b) implement technical means and procedures with regards to:

   1) protocols to exchange information;

   2) control of the interfaces with UAS operators, UTM SPs and other service providers;

   3) radio transmitting equipment which shall not generate harmful interferences to other users of the electro-magnetic spectrum, and which shall take into account international and national regulations on the use of the electromagnetic spectrum, including for aeronautical purposes;

   4) sufficient robustness of the C2 Link to survive modest levels of interference that will be present from time to time;

   5) protection of the C2 Link by encryption using security keys, if required by the UAS operator through the SLA;

   6) verification that the performances of the C2 Link service, including transaction time from point of attachment with the RPS to the antenna on the UA flying inside the DOC, integrity, continuity and availability of provided service, are not worse than those specified in the SLA with the operator; in-flight change of components of C2 systems is acceptable, if it is done in accordance with procedures established in the UAS design, as referred in the SLA between the UAS operator and the C2CSP, and each component is in the appropriate configuration;

   7) continuous monitoring of functionalities and performances of the C2 Link.

c) control the accuracy and currency of information originated by the SPs or obtained from external providers, taking into account at least:

   1) applicable regulations on performances of C2 Link services;

   2) other suitable industry standards;

   3) procedures developed by the SP to complement a) and b).

NOTE The C2 Link performances under responsibility of the C2CSP do not include performances of the avionics or equipment at the RPS.

9.5.3.3 Switchover

Switchover to another link or network shall be conducted in accordance with the procedures defined in the operations manual, to include confirming the QoSE (quality of service experienced) of the accepting link or network.

Contingency switchovers shall be performed in line with security measures and procedures that ensure that the accepting link or network is authenticated and authorized.

9.5.3.4 Maintenance

The C2CSP shall organize maintenance of the systems providing C2 Link according to ISO 23629-12:2022, 10.3.

9.5.3.5 Software safety assurance

The C2CSP shall assure safety of the software installed in the systems providing C2 Link according to ISO 23629-12:2022, 11.3.

9.5.3.6 Abnormal and contingency procedures

The C2CSP shall establish a contingency plan including, as a minimum:

a) a plan for handling a security incident including reporting and isolating compromised data or components;

b) a plan for handling a privacy breach including reporting and isolating compromised data or components;

c) a plan for monitoring and detection of service failure, malfunctions or anomalous behaviour which includes mechanism for immediate reporting to the involved UAS operators and UTM service providers;

d) a plan for handling external service malfunctions (e.g. power supply);

e) management of lost or degraded communications with connected SPs and operators.

f) an emergency management plan defining a process, ideally automated, to restore normal operating conditions in the event of a system failure or malfunction; estimated restoration times should be communicated to connected UTM SPs and to involved UAS operators.

NOTE 1 Plans can include methods of bandwidth reduction, buffering, or secondary communication paths.

NOTE 2 Contingency plans can involve procedural as well as automated steps.

NOTE 3 Contingency plans can involve third-party organizations, systems or services.

9.5.3.7 Manuals and documents

The following documents, manuals and information specific to the organization, shall be available, in the authentic form, at the location of the C2CSP operational management:

a) certificate of registration of the legal entity;

b) third-party liability insurance certificate(s);

c) any approval or certification by the competent authority, if applicable, and related terms of approval, specific authorizations and privileges;

d) radio station license(s), if applicable;

e) contracts and service level agreements (SLA) between the C2CSP and other organizations contributing to service provision or maintenance of the systems, as applicable;

f) contracts and service level agreements (SLA) between the C2CSP and served UAS operators, which shall include the required performance of the C2 Link services inside the DOC;

g) any certificate for privacy, cyber-security, quality, social responsibility, environment, if available;

h) declarations of conformity, verification or validation of systems and equipment, if applicable;

i) operations manual amended or revised as necessary to ensure that the information contained therein is kept up to date and containing operational procedures and related checklists;

j) the operations manual shall include procedures for:

   1) normal, abnormal and contingency procedures and related checklists;

   2) conducting risk assessment for every type of service or change thereto;

   3) competency and qualification of all personnel executing safety related tasks;

   4) maintenance of all systems necessary to provide C2CSP consistent with the manufacturer's instructions;

   5) separation provision and collision avoidance procedure considering the type of UA and operation;

   6) conflict management elements;

   7) safety management manual and related records;

   8) names, qualifications and duties of the person or persons required for service provision;

   9) training records and qualification of all personnel involved in service provision;

   10) records of regulatory compliance activities;

   11) operating manual(s) of such systems and equipment;

   12) maintenance instructions and procedures;

   13) system(s) maintenance logs, including configuration and software;

   14) information concerning search and rescue services in the DOC of the provided services;

   15) emergency response plan;

   16) occurrence or defect reports and related documents in the context of C2 Link performances, data protection, security and safety;

As a minimum, operating and maintenance manuals for systems providing C2 Link shall be those which were issued by the original equipment manufacturer.

The documents or parts of manuals or procedures shall be made available to all relevant staff or contractors, as a function of respective duties.

The C2CSP shall establish a system of record-keeping that allows adequate storage and reliable traceability of all activities developed, covering all the elements related to provided services.

The format of the documents or records (i.e. paper or electronic) shall be specified in the C2CSP's procedures.

Records shall be stored in a manner that ensures protection from damage, alteration and theft, for a period of three months, unless differently determined by the competent authority.

The C2CSP shall ensure, to the extent possible, in the event an aircraft using the provided services became involved in an accident or incident, the preservation of all related records and, if necessary, their retention in safe custody pending their disposition as determined by the competent authority.

9.5.3.8 Liability and insurance

All C2CSP, unless they can demonstrate that third-party liability is borne by public authorities, shall:

a) take into consideration relevant liability and insurance regulations applicable in the DOC of the service they provide;

b) hold valid insurance coverage, commensurate to their services as well as number of users and types of supported UAS operations and covering, as a minimum, risks for third parties in the air and on the ground;

c) ensure that the insured risks include terrorism, hijacking, acts of sabotage and intentional or inadvertent unauthorized electronic interaction;

d) ensure that appropriate insurance coverage always exists, for their provided service and inside the entire DOC.

9.6 Personnel qualification and management

9.6.1 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).

It is presupposed that all activities are in accordance with applicable statutory and regulatory requirements 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.

NOTE Remote crew include remote pilots, observers, fleet managers and any other personnel involved in operations.

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 program 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.

9.6.2 Competence

9.6.2.1 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 organization 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.

9.6.2.2 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 organizations;

k) privacy;

l) safety management;

m) software;

n) visual observer (VO) responsibilities;

o) datalink/radio frequency (RF) communications;

p) weather.

9.6.2.3 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.

9.6.2.4 Medical fitness

The operator shall ensure that all personnel are physically and mentally fit to conduct flight operations, 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 impairment that could interfere with the safe operation of the UA.

9.6.3 Currency

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

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

9.6.4 Qualification and training

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

Operators shall ensure that all personnel involved in operations have the necessary training and experience for the tasks envisioned. Where relevant, ISO 23665 describes training requirements for specific roles.

Operators shall establish and maintain a training program 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 program 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 consideration 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 program 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 consideration 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 program shall ensure that personnel remain competent through difference training, periodic proficiency checks and periodic refresher training.

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

10 Maintenance

10.1 General

The operator shall ensure that all components of the UA are maintained in condition for safe flight and that the UA (or the multiple UA) and all other required UA components on the ground remain serviceable.

The operator shall ensure that only authorized or original equipment manufacturer (OEM) parts are used in the maintenance of UA.

The operator shall ensure that operational and emergency equipment necessary for the intended operation are serviceable.

Operators shall ensure that flights only take place when:

a) the UA is maintained in safe condition for flight;

b) the serviceability of the command-and-control link has been verified;

c) all other necessary UA components are serviceable;

d) any operational equipment fitted is correctly installed and serviceable or clearly identified as unserviceable;

e) any emergency equipment fitted is correctly installed and serviceable;

f) the maintenance of the UA is performed in accordance with manufacturer data;

g) the certificate of airworthiness (CofA), if applicable, is valid.

For each UA the operator shall establish and implement a maintenance program in accordance with the manufacturer's manuals and considering the results of the operational risk assessment.

Crewmembers shall not operate a UA unless it is maintained and released to service by an approved maintenance organization or under an equivalent system, either of which may be acceptable to the state of registry.

10.2 Hardware updates

Operators shall ensure that procedures are in place to implement all instructions issued by the manufacturer to ensure that all UAs being operated are kept updated and, where necessary returned where a recall order is active.

Operators shall implement all applicable airworthiness directives issued by the design authority.

10.3 Software updates

Operators shall check with manufacturers regularly to ensure that all software used in the operation of UA is kept up to date with all patches applied.

Updates should consider the effect on the entire system, and updates shall be made to multiple system elements at the same time as needed to maintain a supported configuration.

Where software is issued without design assurance level (DAL), the operator shall conduct tests to ensure that the software is safe for operational use.

10.4 Service release

Before any flight, the UA shall be released to service by a competent and responsible person. Any person signing a maintenance release shall be authorized by the operator.

10.5 Configuration management

Operators shall keep records of the current configuration of all system elements in the UA. Records should include serial numbers, lot numbers, versions, SW/FW version numbers for each major system element.

As a minimum, flight and maintenance manuals shall be those issued by the original equipment manufacturer.

The UA configuration shall not be changed from those specified by the manufacturer without appropriate evaluation.

11 Conflict management

11.1 General

This clause describes the conflict management procedure of all remote pilots and other personnel executing tasks relevant to the safety of operations.

Conflict management will be to limit, to an acceptable level, the risk of collision between aircraft, UA and other hazards.

11.2 Separation provision and collision avoidance

Conflict management consists of strategic conflict management, separation provision and collision avoidance according to Reference [17]. The conflict management procedure in 11.3 focuses separation provision phase and collision avoidance phase.

Separation provision and collision avoidance are applied in three levels, comprising:

a) Human-in-the-loop: UAS operators shall implement a separation provision and collision avoidance standard procedure to be followed by the remote pilot, using supporting information such as guidance of the DAA system.

b) Human-on-the-loop: UAS operators shall implement a standard procedure to monitor the separation provision function and collision avoidance function using supporting information such as guidance of the DAA system. The remote pilot shall have the option to intervene before the UA implements the standard procedures.

c) Human-out-Of-the-loop: UAS operators shall implement a standard procedure to monitor the separation provision function and collision avoidance function using supporting information such as guidance of the DAA system. The remote pilot shall have the option to intervene when the UA deviates from standard procedures.

NOTE 10 levels of automation are defined in Reference [5]. The levels of automation greater than 6 are considered as “Human-out-of-the-loop”. The levels 6 or less are considered as “Human-on-the-loop” or “Human-in-the-loop”.

11.3 Operational procedure

The following sequences depict standard operating procedure of the remote pilot detected objects.

The first sequence, Figure 1, shows the typical operation at VLL, supported by details about each operation in Table 1. Basically, this doesn't include ATC instruction and manoeuvre coordination.

The second sequence, Figure 2, shows the typical operation above VLL, supported by details about each operation in Table 2. This generally includes ATC instruction and manoeuvre coordination.

Each path in the procedure may occur simultaneously especially when multiple intruders appear.

Each sequence is followed by the table of operations conducted by remote pilot.