

Unmanned Aircraft System Operations in UK Airspace – Operating Safety Cases

CAP 722A



Published by the Civil Aviation Authority, 2019

Civil Aviation Authority
Aviation House
Gatwick Airport South
West Sussex
RH6 0YR

All rights reserved. Copies of this publication may be reproduced for personal use, or for use within a company or organisation, but may not otherwise be reproduced for publication.

To use or reference CAA publications for any other purpose, for example within training material for students, please contact the CAA at the address above for formal agreement.

Previously published as Appendices B, C and D of CAP722, Unmanned Aircraft System Operations in UK Airspace – Guidance, March 2015

First edition of CAP 722A, July 2019

Contents

Contents	3
Revision History	4
Foreword.....	5
Abbreviations and Glossary of Terms	8
Section 1: UAS OSC Volume 1 - Operations Manual Template	17
Section 2: UAS OSC Volume 2 – UAS System(s) Template	28
Section 3: UAS OSC Volume 3- Safety Risk Assessment Guidance and Template.....	33
Appendix A: Operational and Technical Factors for UAS Operations.....	44

Revision History

First Edition

July 2019

Initial issue. Information has been extracted from Appendices B, C and D of CAP 722 Sixth Edition March 2015, and updated where appropriate to reflect the evolving best practice concerning risk assessment processes, and in order to capture the regulatory changes within ANO 2016 and its subsequent amendments.

Foreword

Aim

CAP 722A, Unmanned Aircraft System Operations in UK Airspace - Operating Safety Cases is intended to assist those involved in the production of an Operating Safety Case (OSC) which will be used as supporting evidence to an application to the CAA for operation of an Unmanned Aircraft System (UAS). The intent is to ensure that the required operational safety requirements have been met and best practice is adopted by all UAS operators before a UAS is authorised to operate in the UK.

The aim of the OSC is to present sufficient evidence that all relevant hazards and resultant safety risks have been identified within an operation and that these safety risks have been reduced to a Tolerable and As Low As Reasonably Practicable (ALARP) level¹.

In advance of further changes to this document, updated information is contained in the unmanned aircraft section of the CAA website www.caa.co.uk/uas

Content

CAP 722A does not replace existing civil aviation regulations but provides requirements and guidance for the preparation of a safety case/risk assessment as part of an application to the CAA for an operational authorisation, permission or exemption.

This document principally consists of 3 sections:

- OSC Volume 1 – Operations Manual Template;
- OSC Volume 2 – Systems Template;
- OSC Volume 3 – Safety Risk Assessment Guidance & Template.

The templates provide section headings detailing the minimum subject areas that need to be addressed when producing an OSC for the purposes of demonstrating that a UAS operation can be conducted safely. The template layouts as presented are not prescriptive, but the subject areas detailed must be included in the OSC documentation as required for the particular operation, in order to provide the minimum required information.

Policy

The UAS Operating Safety Case (UAS OSC) has been devised using the ConOps methodology to give a flexible method by which the applicant can provide the CAA with a safety argument for intended operations. Each application for an operational authorisation,

¹ See CAP 722A Glossary for definitions of relevant Safety Risk Management terms.

exemption or a permission (other than for a 'standard permission' for commercial operations and/or for operations within a congested area) must be accompanied by a UAS OSC.

Applicants wishing to apply to the CAA must produce an OSC, for assessment by the CAA. The individual OSC volumes that will be required is dependent on the relative complexity of the operation, based on the table below:

Further Policy and Guidance is contained in CAP 722.

Mass (kg)	Operating examples	Volume 1	Volume 2	Volume 3
20kg or less	'Standard Permission' (commercial ops and/or <150m of congested areas)	Required	Recommended	Recommended
	<50m from uninvolved people/properties; <150m from 'organised open-air assemblies of more than 1000 persons'; >400ft above the surface EVLOS BVLOS	Required	Required	Required
over 20kg	Low Complexity UAS and/or Rural Environment	Required	Required	Required
	Low Complexity UAS and/or Semi-rural	Required	Required	Required
	High Complexity UAS and/or Complex Airspace/ Congested Area	Required	Required	Required

Availability

The latest versions of CAP 722(Policy and Guidance), 722A(Operating Safety Cases) and 722B(National Qualified Entities) are available from the CAA website Publications section.

The CAA has a system for publishing further information and guidance and this can be found on the CAA website under the Skywise section, which can be filtered for information and subject matter relevant to UAS.

Point of Contact

Unless otherwise stated, all enquiries relating to this CAP should be made to:

UAS Unit
Civil Aviation Authority
Safety and Airspace Regulation Group
Aviation House
Gatwick Airport South
West Sussex
RH6 0YR

E-mail: uavenquiries@caa.co.uk

Abbreviations and Glossary of Terms

Terminology relating to UAS and their operation continues to evolve, therefore, this section contains non-exhaustive lists, which are a combination of emerging ICAO definitions and other 'common use' terms which are considered to be acceptable alternatives.

Abbreviations

A

AAIB	Air Accidents Investigation Branch
ACAS	Airborne Collision Avoidance System
ADS-B	Automatic Dependent Surveillance - Broadcast
AIP	Aeronautical Information Publication
AIS	Aeronautical Information Service
ALARP	As Low As Reasonably Practicable
ANO	Air Navigation Order
ANSP	Air Navigation Service Provider
ASTM	American Society for Testing and Materials
ATC	Air Traffic Control
ATM	Air Traffic Management
ATPL	Air Transport Pilot Licence
ATS	Air Traffic Service
ATSM	American Society for Testing and Materials
ATSU	Air Traffic Service (ATS) Unit
ATZ	Aerodrome Traffic Zone

B

BMFA	British Model Flying Association
BRLOS	Beyond Radio Line of Sight
BRS	Ballistic Recovery Systems

BSI British Standards Institute

BVLOS Beyond Visual Line of Sight

C

CAA Civil Aviation Authority

CAP Civil Aviation Publication

ConOps Concept of Operations

CPL Commercial Pilot Licence

CRM Crew Resource Management

C2 Link Command and Control Link

C3 Link Command, Control and Communication Link

D

DA Danger Area

DAA Detect and Avoid

E

EASA European Aviation Safety Agency

EC Electronic Conspicuity

ECCAIRS European Co-ordination Centre for Accident and Incident Reporting Systems

ERF Emergency Restriction of Flying

ERP Emergency Response Plan

EUROCAE European Organisation for Civil Aviation Equipment

EVLOS Extended Visual Line of Sight

F

FIR Flight Information Region

FPV First Person View

FRTOL Flight Radio Telephony Operators' Licence

FRZ Flight Restriction Zone

G

GCS Ground Control Station

H

HMI Human-Machine Interface

I

ICAO International Civil Aviation Organisation

ISO International Standards Organisation

M

MCC Multi Crew Cooperation

MOR Mandatory Occurrence Reporting

MTOM Maximum Take-off Mass

N

NAA National Aviation Authority

NOTAM Notice to Airmen

NQE National Qualified Entity

O

OSC Operating Safety Case

P

PPL Private Pilot Licence

Q

QMS Quality Management System

R

RA (T) Restricted Area (Temporary)

RLOS Radio Line of Sight

RPA Remotely Piloted Aircraft

RPAS Remotely Piloted Aircraft System

RPS Remote Pilot Station

RPZ Runway Protection Zone

RTCA Radio Technical Commission for Aeronautics

RTH Return To Home

S

SMS	Safety Management System
SPOF	Single Point of Failure
SRAP	Safety Risk Assessment Process
STANAG	Standardisation Agreement (NATO)

T

TCAS	Traffic Alert and Collision Avoidance System
TDA	Temporary Danger Area
TMZ	Transponder Mandatory Zone

U

UA	Unmanned Aircraft
UAS	Unmanned Aircraft System(s)
UAS OSC	Unmanned Aircraft System(s) Operating Safety Case

V

VLOS	Visual Line of Sight
------	----------------------

Glossary of Terms

A

Accountable Manager – Somebody who has the authority for ensuring that all activities are carried out in accordance with the applicable requirements and is responsible for establishing and maintaining an effective Management System.

Aircraft - Any machine that can derive support in the atmosphere from the reactions of the air other than the reactions of the air against the Earth's surface.

Air Navigation Order (ANO) - The legal document, established as a UK Statutory Instrument (SI) that is made for the purposes of regulating air navigation within the United Kingdom.

As Low as Reasonably Practicable - Risk management term; see also 'Risk Tolerance'. A risk can be said to be reduced to a level that is ALARP when the sacrifice of further reduction is "grossly disproportionate" to the decrease in risk that would be achieved. An ALARP argument must balance the "sacrifice" (in time, money or trouble) of possible

further risk reduction measures against their expected safety benefit (incremental reduction in risk exposure). Essentially, the '*stopping condition*' for risk reduction due to practical, economic or other such reasons.

B

Beyond visual line-of-sight (BVLOS) operation. A type of UAS operation which is not conducted in visual line of sight of the remote pilot or competent observer. .

C

C2 Link - The data link between the remotely-piloted aircraft and the remote pilot station for the purposes of managing the flight.

Competent Observer – A trained, and competent person designated by the operator who, by visual observation of the remotely-piloted aircraft, assists the remote pilot in the safe conduct of the flight.

Concept of Operations - describes the characteristics of the organisation, system, operations and the objectives of the user.

Congested Area – in relation to a city, town or settlement, means any area which is substantially used for residential, industrial, commercial or recreational purposes.

Controlled airspace – airspace which has been notified as Class A airspace, Class B airspace, Class C airspace, Class D airspace or Class E airspace;

Controlled Ground Area – The ground area where the UAS is operated and within which the UAS operator can ensure that only involved persons are present

D

Detect and Avoid - The capability to sense or detect conflicting traffic or other hazards and take the appropriate action.

E

Electronic Conspicuity - Electronic Conspicuity (EC) is an umbrella term for a range of technologies that can help airspace users to be more aware of other aircraft in the same airspace.

Emergency Response Plan – Plan of actions to be carried out by the operator/ remote pilot in the event of an emergency situation while conducting UAS operations.

Exemption – A document issued by the CAA which is used to allow an exception to the established regulations as listed within the Air Navigation Order.

F

Flight Restriction Zone (FRZ)- Airspace of defined dimensions around a protected aerodrome within which the permission of the relevant ATS unit or aerodrome operator, as appropriate, is required before a small unmanned aircraft flight can take place.

G

Ground Control Station (GCS) - See 'Remote Pilot Station'.

Note: RPS is the preferred term as it enables the consistent use of one term with the same meaning irrespective of its location (e.g. on a ship or in another aircraft).

H

Handover - The act of passing piloting control from one remote pilot station to another.

Hazard - A condition or object with the potential of causing injuries to personnel, damage to equipment or structures, loss of material, or reduction of ability to perform a prescribed function (*ICAO Doc 9859, Safety Management Manual (SMM)*)

High Authority - those systems that can evaluate data, select a course of action and implement that action without the need for human input.

Highly Automated - those systems that still require inputs from a human operator (e.g. confirmation of a proposed action) but which can implement the action without further human interaction once the initial input has been provided.

L

Lost C2 Link - The loss of C2 Link with the unmanned aircraft such that the remote pilot can no longer manage the aircraft's flight.

N

National Qualified Entity – A person or organisation approved by the CAA to submit reports relating to pilot competence in operating a small unmanned aircraft.

O

Operating Safety Case – Methodology used to apply to the CAA for a Permission or Exemption to operate a UAS within the UK.

Operational Authorisation – A document issued by the CAA that authorises the operation of an unmanned aircraft system, subject to the conditions outlined within the authorisation, having taken into account the operational risks involved.

P

Permission – Authorisation issued by the CAA to allow flights within the UK subject to the conditions and limitations specified.

R

Radio Line-Of-Sight (RLOS) - A direct radio link point-to-point contact between a transmitter and a receiver.

Redundancy - The presence of more than one independent means for accomplishing a given function or flight operation.

Remote Pilot - A natural person responsible for safely conducting the flight of an unmanned aircraft by operating its flight controls, either manually or, when the unmanned aircraft flies automatically, by monitoring its course and remaining able to intervene and change the course at any time. Regulation (EU) 2018/1139

Note: Within ANO 2016, article 94G the “remote pilot”, in relation to a small unmanned aircraft, is an individual who—

- (i) operates the flight controls of the small unmanned aircraft by manual use of remote controls, or*
- (ii) when the small unmanned aircraft is flying automatically, monitors its course and is able to intervene and change its course by operating its flight controls*

In this document, the term ‘remote pilot’ is used for all sizes of unmanned aircraft, hence the first definition is applicable.

Remote Pilot Station (RPS) - The component of the remotely-piloted aircraft system containing the equipment used to pilot the remotely-piloted aircraft.

Remotely-Piloted Aircraft (RPA) - An unmanned aircraft which is piloted from a remote pilot station.

Runway Protection Zone – Airspace of defined dimensions, which comprises part of the UAS Flight Restriction Zone, which is established for the protection of aircraft operating along the extended runway centreline.

S

Safety - The state in which the possibility of harm to persons or of property damage is reduced to, and maintained at or below, an acceptable level through a continuing process of hazard identification and safety risk management. (*ICAO Doc 9859, Safety Management Manual (SMM)*)

Safety Management System (SMS) - A systematic approach to managing safety, including the necessary organizational structures, accountabilities, policies and procedures.

Safety Risk Level – The combined estimation of likelihood and severity of harm to people when they encounter aviation.

Small Unmanned Aircraft - Any unmanned aircraft, other than a balloon or a kite, having a mass of not more than 20 kg without its fuel but including any articles or equipment installed in or attached to the aircraft at the commencement of its flight.

Small Unmanned Surveillance Aircraft - A small unmanned aircraft which is equipped to undertake any form of surveillance or data acquisition.

SUA Operator – In relation to a small unmanned aircraft, the SUA operator is the person who has the management of the small unmanned aircraft.

Swarming – Operation of more than one UAS, which are controlled collectively rather than individually.

T

Temporary Danger Area – A Danger Area that has been established on a short term (temporary) basis.

Tethered Unmanned Aircraft - An unmanned aircraft that remains securely attached (tethered) via a physical link to a person, the ground or an object all the time it is flying. The tether normally takes the form of a flexible wire or a cable and may also include the power supply to the aircraft as well.

Tolerable – Risk management term; see also ALARP. The threshold levels of risk appetite that can be accepted. The Health and Safety Executive defines Tolerable as a “willingness by society as a whole to live with a risk so as to secure certain benefits and in the confidence that the risk is one that is worth taking and that it is being properly controlled”

Transponder Mandatory Zone - Airspace of defined dimensions wherein the carriage and operation of pressure-altitude reporting transponders is mandatory

U

Unmanned Aircraft (UA) - Any aircraft operating or designed to operate autonomously or to be piloted remotely without a pilot on board.

Note: RPA is considered a subset of UA.

Unmanned Aircraft System (UAS) – An unmanned aircraft and the equipment to control it remotely.

Note: The UAS comprises individual 'System Elements' consisting of the Unmanned Aircraft (UA) and any other System Elements necessary to enable flight, such as a Remote Pilot Station, Communication Link and Launch and Recovery Element. There may be multiple UAs, RPS or Launch and Recovery Elements within a UAS.

Unmanned Aircraft System operator – Any legal or natural person operating or intending to operate one or more UAS.

V

Variation – A request to change the conditions within an already granted Permission, Exemption or other operational authorisation

Section 1: UAS OSC Volume 1 - Operations Manual Template

Conditions:

This document must be an original work completed and understood by the applicant (Operator). Applicants must take responsibility for their own safety case, whether the material originates from this template or otherwise.

Any significant changes to the Operator's OSC will require further assessment, by the CAA or approved organisation, prior to further operations being conducted and will necessitate application to the CAA for a variation. Examples of this could include: change to the ConOps or use of a different UAS to conduct operations.

All text in *italics* is guidance only and must not be included in the Company's UAS OSC

UAS OSC - Volume 1 - Operations Manual

The front cover of this manual should detail the following items

- Company name
- UAS Operating Safety Case
- Volume 1 – Operations Manual
- Version X Dated DD MM YYYY

The manual contents should be arranged with the following sections included:

Safety Statement

The person responsible² for the safe conduct of all the Company's operations must sign this statement; e.g. Accountable Manager, CEO, Company Director, etc. The statement must include, as a minimum, a statement that the company is safe to operate in the proposed environment, that the system(s) to be employed can be operated safely and a commitment to operate within the bounds of this UAS OSC, the Operations Manual and any CAA permission granted. Where necessary it must also include a commitment to conduct further mitigation actions detailed within this UAS OSC. A commitment to safety, as a priority, must be detailed.

² Accountable Manager, CEO or other suitable Director of the organisation.

*This must be signed and dated by the accountable person in this regard. *failure to sign and date this statement will result in the application being returned and will delay the processing of the application*

Amendment Record

Include an amendment record at the beginning of the document to record changes and show how that the document is being controlled

This section is critical to ensure appropriate document control.

Amendment/ Revision/ Issue Number	Date	Amended by	Signed
<i>(a,b,c or 1, 2, 3 etc.)</i>	<i>DDMMYYYY</i>	<i>Name of Person</i>	<i>Signature of person carrying out the amendment/ revision/ issue number.</i>

Acronyms and Abbreviations

Detail all acronyms or abbreviations used throughout the document – there is no need to further expand any acronym or abbreviation within the document body.

Table of Contents

This should include all the sections of the document. Note, the sections listed below are all required.

1. Introduction

This section must be used to outline the scope of the document, its intent and the overarching operating strategy of the company.

2. Safety Policy

The company's safety policy, safety management system, safety targets, etc. must be detailed.

3. Organisation

This section must give full details of the organisation that is the subject of the application. All areas detailed below must be covered as a minimum. The examples provided do not outline the full requirement.

3.1 Structure of organisation and management lines

Provide an organogram/organisational diagram and brief description of the organisation, its activities, i.e. UAS related and any accreditations or approvals held that might be considered relevant.

3.2 Nominated personnel

This section may be scaled to the size of the organisation and its structure and should include for example, the Accountable Manager, Operations Manager, Technical Manager, Chief Pilot, Remote Pilots and Quality/ Safety Manager. Each role must be covered with a brief description and multiple functions may be filled by the same person.

**Any internal audit/quality function should be fulfilled by a separate person in complex organisations. **

3.3 Responsibility and duties of the UAS Operator, Remote Pilot and Support Personnel

The role and responsibilities for the person in charge of operating the unmanned aircraft should be detailed in this section. Articles 68, 69, 94, 94A-G, 95 and 241 of the ANO may provide some useful text for this section as deemed appropriate.

Additional ANO articles may also be appropriate if the platform has a mass greater than 20Kg.

Provide details of the composition of the flight team, for example, the commander, remote pilot(s), observers and other support staff as required, depending on type of operation, complexity and type of aircraft. Examples of support personnel include deployed observers, ground station operators, payload operators, radio operators etc:

- (a) *Describe the responsibilities and duties of personnel involved in the operation of UAS.*

3.4 Areas of operation

Provide a brief description of the expected operating areas for example, congested areas (urban), building sites, open countryside (rural), roads, marine environment (offshore), airport etc.

Include details of their geographic location, population density and any features considered important to the operation, such as roads, railways, tall obstacles and surrounding terrain. Include maps, diagrams and photographs for clarity.

3.5 Type of operation

Include details of the operations that are planned to be undertaken. Refer to the non-exhaustive list of examples detailed below:

- whether the flight(s) will be VLOS, EVLOS or BVLOS operation(s);
- the classification of the airspace the flight will be conducted in (Class A, C, D, E, or G);
- whether the flight will be performed during day or night;
- whether the flight is planned to be conducted in congested areas (Urban- high density population);
- the height above the surface for which the flight is planned;
- whether goods will be carried (this does not include dangerous goods) or articles will be dropped/dispensed;
- the type of operation being conducted, for example, filming, infrastructure inspections, agriculture, surveillance, test and development;
- whether operations involve swarming;
- if the flights involve operation at reduced distances from persons, vehicles, vessels or structures not involved in the operation of the unmanned aircraft;
- Whether the flight involves flying over assemblies of people
- Whether the flight involves flying within an aerodrome Flight Restriction Zone

The description should contain all relevant information that demonstrates a detailed understanding of how and where the operation is to be undertaken and the limitations or conditions associated with it. Any other information helpful in explaining the intended operation should be included in this section such as diagrams or illustrations.

3.6 Flight Safety Programme

3.61 Emergency Response Plan

An Emergency Response is an action taken in response to an unexpected and dangerous event in an attempt to mitigate its impact on people, property or the environment. The Emergency Response Plan should reflect the size, nature and complexity of activities performed by the organisation. The ERP should:

- i) Contain the action to be taken by the operator or specified individuals in an emergency
- ii) Provide for a safe transition from normal to emergency operations and vice versa
- iii) Ensure coordination with the ERPs of other organisations, where appropriate
- iv) Describe emergency training/drills as appropriate.

3.62 Incident Reporting

Include details of how occurrence reporting requirements are complied with, for example, the organisation's accident and incident investigation and reporting policy including their Emergency Response Plan (ERP).

This also includes reporting of accidents to AAIB and process for incorporating recommendations as necessary.

EU 376/2014 for reporting, analysis and follow-up of occurrences in civil aviation:

Reportable occurrences involving a UAS should be reported in accordance with EU 376/2014 and IR 2015/1018. In addition to those occurrences listed in IR 2015/1018, consideration should be given to reportable occurrences that can be considered as UAS-specific, such as those resulting in events that potentially prejudice the safety of other airspace users or third parties as a result of, but not limited to any of the following causes:

- loss of control of the unmanned aircraft due to:
 - loss of the C2 link;
 - loss of navigation function;
 - GCS configuration changes/errors:
 - between Remote Pilot Stations;
 - transfer to/from launch control / mission control stations;
 - display failures.
 - functional failures of the UAS causing loss of situational awareness;
 - structural failures during any phase of flight that lead to control difficulties or loss of the aircraft;
 - mishandling by the pilot in command including mis-selection of flight parameters via the GCS
 - Loss of propulsion.
- Crew Resource Management (CRM) failures/confusion;
- Human failures (Expand)
- any incident that causes injury to a third party.

Details of potential safety risks identified by the operator should be submitted via the European ECCAIRS portal (<http://www.aviationreporting.eu/AviationReporting/>) within 30 days of the initial date of notification of the occurrence. This update should include preliminary analysis and the actions to be taken as a result of that analysis. Furthermore, the UAS operator should submit the final results of their internal investigation no later than three months from the date of initial notification of the occurrence.

3.7 Operation of multiple types of UAS

Any limitations considered appropriate to the types of UAS that a remote pilot may operate if appropriate, i.e. Class, Weight and manufacturer and model.

3.8 Competency and qualification requirements including role training and currency

Provide details of any certificates of competency, qualifications, experience or training necessary for the pilot or support crew for the types of UAS and the roles employed by the operator.

Detail any training undertaken, beyond basic NQE competency assessment or other suitable qualification that prepares the pilot for flying in a particular environment, for example, urban or densely populated areas, segregated airspace etc. Provide details of the minimum experience and currency requirements, skills tests or manufacturer courses required by the organisation that support the case for an appropriate level of competency and knowledge for the proposed operations. These may include in-house or outsourced training.

Describe the training and assessment requirements and methods for pilots and support crew as determined by the operator to cover initial, refresher and conversion syllabi. Include any independent assessment of pilot competency and currency requirements. Some elements could be specific to the operator. This should also cover the use of new pilots and how they are assessed as competent prior to operating.

Describe the processes and procedures that will be implemented to ensure that remote pilot(s), and other operational support staff acquire and maintain the necessary currency to execute their duties.

3.9 Logs and records

Describe the organisation's requirements for the completion and retention of aircraft and remote pilot flying logs and records and any other data considered useful for the tracking and monitoring of the flight activity.

The following information should be recorded for each flight as a minimum:

- UAS type;
- UAS registration (when applicable);
- date and time of take-off and landing;
- location of take-off, flight and landing; airspace class
- name(s) of remote pilots;
- flight duration;
- Nature of the flight (for example, VLOS, EVLOS, BVLOS, reduced distances from uninvolved third parties, vessels, vehicles and structures);
- details of any relevant observations and incidents, including the reporting of any occurrences.

Copies of any onsite assessments or particular risk assessments carried out by the crew prior to conducting the operation(s) should be included in the records for the flight.

Additional information to be recorded by the operator should include:

- (a) all relevant qualifications, experience and/or trainings completed by the remote crew;*
- (b) all relevant qualifications, experience and/or trainings completed by the maintenance staff;*
- (c) the maintenance activities conducted on the UAS;*

These records should be stored for a minimum of 3 years, if required for inspection by the competent authority or any statutory body. These records can be electronic or hard copy.

3.10 Crew health

Provide details of the organisation's policy on crew health requirements including any procedures, guidance or references to ensure that the flight team are appropriately fit, capable and able to conduct the planned operations.}

Note: There are currently no mandatory aeromedical examination requirements for remote pilots or support staff.

3.11 Security & Privacy

Both physical and cyber security aspects are required to address particular potential weaknesses to UAS such as employees, location, accessibility, technology, management structure and governance.

The following two points should be addressed:

- (i) Physical security of system elements and assets, e.g. ensuring adequate physical protection is afforded to system assets;*
- (ii) Security governance to ensure the secure and safe operation of the system, e.g. Security Operating Procedures are drafted, applied, reviewed and maintained. This should include cyber security considerations;*

Privacy issues are covered by the Information Commissioners Office (ICO) and will not be dealt with by the CAA, however operators must describe how they will comply with privacy requirements within the OSC.

3.12 Other documents

An operator may include additional related documents considered necessary to provide sufficient information and clarity on the planned activity could be included in an annex. these could include copies of insurance documents, evidence of remote pilot competency, CAA permission or exemption, forms and templates used for site assessments, flight logs, etc. This should also include the Operator Registration Certificate when applicable.

4. Operations

This section must be used to provide details of the operating environment and procedures associated with the subject application. All subject areas detailed below must be covered as a minimum. Where examples are given, they do not necessarily represent all the information to be detailed for that requirement.

4.1 Operating limitations and conditions

Detail the specific operating limitations and conditions appropriate to achieving compliance with the relevant articles of the ANO and the conditions of any CAA permission or exemption, for example, operating heights, lateral distances, conditions and limitations for

operating within the applicable class(es) of airspace etc. This information can also be portrayed graphically, detailing any applicable boundaries and buffer zones intended for safety.

4.2 Methods to determine the intended task feasibility and operating site planning and assessment.

Describe the process undertaken to determine the feasibility of each intended task, for example, how the relevant aspects associated with the operation are assessed and prioritised. The main factors to be considered are given below:

- The airspace classification of the intended operating environment and any necessary notification procedures to ATC or aerodromes and considerations when operating in close proximity to aerodromes or other aircraft.
- Operations near industrial sites or activities such as live firing, gas venting, high-intensity radio transmissions etc., considerations such as local byelaws and physical obstructions (wires, masts, buildings, etc).
- Extraordinary restrictions such as prohibited airspace around prisons, nuclear establishments, habitation and recreational activities, public access, permission from landowners, likely operating sites and alternative sites, weather considerations, etc.

Include templates of checklists used to document task and operating site assessments and describe how these are evaluated, by whom and how it is determined that the task is considered feasible. Describe how these records are held and retrieved when necessary

4.3 Pre-notification to relevant third parties

If a flight is to be undertaken within an aerodrome's flight restriction zone or within another zone that restricts the flight of UAS, then the appropriate parties must be contacted, and notification of the intended operation provided and agreed prior to take-off, and permission obtained where necessary

This may include the publication of a NOTAM, the use of a TDA or any other appropriate method of notification and airspace segregation.

It may be necessary to inform the local police of the intended operation to avoid interruption to or concerns from the public.

4.4 Communications

Describe communication methods between airspace users, aircraft operators and air traffic service providers, and any other relevant agencies and emergency services where necessary. This should also include communications between the operator's personnel involved with the support of the UAS operation, as well as any back up communications to be used in the event of failure of the primary communication system.

Describe the methods used to achieve this, such as two-way radio, telephone, flight notification apps or other suitable methods.

4.5 Site permissions

Document the procedures describing how the landowner's permission to conduct the intended operation shall be obtained.

Operators must be aware of their responsibilities regarding operations from private land and any requirements to obtain the appropriate permission before operating from a particular site. In particular, they must ensure that they observe the relevant trespass laws and do not unwittingly commit a trespass whilst conducting a flight.

4.6 Weather

Detail the methods of obtaining weather forecasts and conditions and therefore the applicable UAS operating limitations due to weather conditions

4.7 On site procedures

Document the procedures associated with operating from the main and alternate sites. These details should include aspects such as the following:

- Site Survey: include methods of surveying the operating areas, identifying hazards and conducting any additional risk assessments;
- Selection of main and alternate operating sites: include methods of identifying and selecting the operating areas, including the size, shape, surroundings, surface, slope and suitability of the landing zone for an automatic return to home (RTH) and how this will be kept clear;
- Crew briefing: the procedures for briefing the flight and ground crew in connection with the task, responsibilities, duties, handling of emergencies, etc.;
- Cordon Procedure: include the processes used to separate the UAS operation from uninvolved persons and assets, such as establishing buffer zones, use and positioning of barriers, marshals etc.;
- Communications: outline the procedures for maintaining contact between flight and ground crew members and adjacent air operations if applicable;
- Refuelling: include the procedures and precautions associated with changing and/or charging of batteries, replenishment of liquid fuels, etc.;
- Loading of equipment: describe the precautions to be taken to ensure the security of loaded equipment.

4.8 Assembly and functional checks

Detail the checks that need to be conducted following completion of assembly of the system. These could include, but are not limited to:

- a visual inspection of the platform and its structure to ensure security of objects such as access panels, engines/motors, propellers/rotors, landing gear and external loads;
- that any batteries have been correctly installed;
- that the C2 Link is functioning;
- that all electrical and avionics equipment is serviceable and functioning;
- the correct operation of flight controls and engines/motors;
- the correct operation of payload release mechanisms;
- any items detailed by the UAS manufacturer.

4.9 Pre-flight checks

Detail the checks that need to be conducted immediately prior to flight. These could include, but are not limited to:

- a visual inspection of the platform and its structure;
- that the reported and actual battery/fuel capacity is sufficient for the flight;
- that the C2 Link and any functions associated with the loss of the C2 Link operate correctly;
- that the GNSS is receiving sufficient satellites in order to commence the flight;
- that the navigation system or RPS are programmed with correct route information;
- the correct operation of flight controls and engines/motors;
- verification that the weather conditions and GNSS coverage will be suitable for the flight;
- ensure that any flight termination system used is functioning;
- verification that there are no airspace restrictions in place using a flight notification app or similar method.

4.10 Flight Procedures

Detail the normal procedures to be performed by the crew associated with engine/motor starting, take-off, in-flight, landing and shutdown.

4.11 Post flight and between flight checks

Detail the checks or inspections to be conducted both after flight and between consecutive flights. Describe the process for reporting defects and maintenance actions.

4.12 Emergency Procedures

Detail any abnormal and emergency procedures applicable to conditions such as engine/motor, electrical or system failure or malfunction. Include loss of functions such as

C2 Link, navigation or RPS, flyaway, fire (in UA and/or RPS), airspace incursion, loss of separation distances to uninvolved third parties and infrastructure or any abnormal environmental conditions. Describe any applicable normal and failure indications provided to the remote pilot and include appropriate checklists. Applicable preventative measures should also be detailed.

4.13 Additional information

Provide details of any additional safety, training or operational requirements that may be required by the proposed operation(s). This may be covered under paragraph 3.12 if the operator prefers.

4.14 Radio Licensing requirements (if applicable)

It is the responsibility of the operator to ensure that the radio spectrum used for the command and control link and for any payload communications complies with the relevant Ofcom requirements and that any licenses required for its operation have been obtained. It is also the responsibility of the applicant to ensure that the appropriate aircraft radio licence has been obtained for any transmitting radio equipment that is installed or carried on the aircraft, or that is used in connection with the conduct of the flight and that operates in an aeronautical band, e.g. EC devices. Any radio licences required for the operation may be included in the additional information provided under paragraph 3.12 or 4.13.

Section 2: UAS OSC Volume 2 – UAS System(s) Template

Conditions

This document must be an original work representing the applicant Company. The Company must take responsibility for its own safety case, whether the material originates from this template or otherwise.

Any significant changes to the Company's UAS OSC will require further assessment, by the CAA or approved organisation, prior to further operations being conducted and will necessitate application to the CAA for a variation in this regard.

All text in *italics* is guidance only and must not be included in the Company's UAS OSC

UAS OSC - Volume 2 – UAS System(s) Template

The front cover of this manual should detail the following items:

- Company Name
- UAS Operating Safety Case
- Volume 2 – Systems
- Version X. Dated DD MM YYYY

The manual contents should be arranged with the following sections included

Amendment Record

Include an amendment record at the beginning of the document to record changes and show how that the document is being controlled

Amendment Number	Date	Amended by	Signed
<i>(a,b,c or 1, 2, 3 etc.)</i>	<i>DDMMYYYY</i>	<i>Name of Person</i>	<i>Signature of person carrying out the amendment.</i>

Acronyms and Abbreviations

Detail all acronyms or abbreviations used throughout the document; there is no need to further expand any acronym or abbreviation within the document body. If an Acronyms and

Abbreviations list has been provided in Volume 1 and covers the subjects in Volume 2, then there is no need to provide another one.

Table of Contents

The applicant may include in the Table of Contents the sections of the document as they see fit. It is recommended that the items listed below be included as a minimum

- Title Page
- Amendment Record
- Acronyms and Abbreviations (unless already covered in Volume 1)

1. Aircraft and Systems

This section must be used to identify the name and type of the unmanned aircraft to be used and to provide technical descriptions and details of the systems used by the unmanned aircraft in connection with the flights that are covered by the application. All areas detailed below must be covered as a minimum. Where examples are given they do not outline the full requirement.

1.1 Details of design and manufacturing organisation(s)

Provide details of the designer and manufacturer of the unmanned aircraft including any technical and design standards adopted, that may or may not be aviation related and that may add to the safety argument. Where possible, this should include evidence of test and evaluation if available.

Provide details of any recognised standards to which equipment relevant to the application has been designed, built and tested, for example, aeronautical standards such as EUROCAE and RTCA, or product standards such as ISO, ASTM, STANAG and BSI.

1.2 The design flight envelope (UAS performance characteristics)

Provide a full description of the flight envelope including, but not limited to:

- *the aircraft's flight duration/endurance and maximum range;*
- *the maximum radio range of the C2 Link;*
- *the service ceiling/maximum achievable operating height;*
- *the minimum airspeed required to maintain safe flight, i.e. the minimum manoeuvring speed or stall speed (if applicable);*
- *the available glide distances (where appropriate);*
- *the environmental and weather limitations;*
- *the effects of differing payloads on the flight envelope.*

1.3 UAS characteristics and design features

Provide specifications and characteristics of the unmanned aircraft, including, but not limited to:

- *the aircraft type, i.e. multicopter, fixed wing etc.;*
- *its overall dimensions;*

- *its mass with and without fuel;*
- *the maximum payload that can be carried;*
- *the kinetic energy impact value;*
- *Indication of sound power level if available.*

Photographs and detailed or schematic diagrams may be included

1.4 Construction

Detail the method of construction of the unmanned aircraft and materials used, for example, composite, metallic or combinations of materials including the frangibility of the aircraft structure

1.5 Electrical power provision and distribution

Detail the electrical power provision and distribution arrangement, including the number, type and arrangement of installed batteries, details and specification of any generator used, electrical loads and load shedding arrangements and alternative power supplies where appropriate. Inclusion of an electrical system schematic diagram is recommended.

1.6 Propulsion system

Detail the propulsion system(s) used, power output, type of propeller/rotor, type and number of engines/motors etc.

1.7 Fuel System

Detail the fuel system arrangement, type of fuel, i.e. electrical, liquid, hybrid, solar etc., as well as the fuel delivery system if applicable

1.8 Flight Control and/or Autopilot System

Details of how the UA is controlled, such as a description of the flight control units, actuators and control linkages, etc. Include details of any automatic functions, such as automatic take-off and landing, stabilisation and RTH functions.

1.9 Positioning, Navigation and Guidance

Provide details on the system(s) and method(s) used for positioning, navigation and guidance, including the number and types of applicable sensors, telemetry links and any automatic flight control functions. Include information relevant to the safe conduct of the flight and describe how relevant data on the normal functioning or failure of positioning and navigation functions is presented to the remote pilot.

1.10 Other avionics

Detail any other avionics fitted to the system, such as electronic conspicuity. Include details of any equipment approval if applicable.

1.11 Take-off and landing aids

Detail the landing gear and any landing aids fitted to the aircraft if applicable, such as wheels, skids, rails, launchers etc.

1.12 Payloads

For each UA give a description of the payload expected to be installed or carried, such as data acquisition equipment or cargo. For equipment payloads, detail any electrical power or data connection to the platform or sensors and arrangements for transferring/transmitting data from the aircraft, such that it does not present a hazard to the aircraft or is a source of distraction to the remote pilot.

1.13 Emergency recovery or safety systems

Detail any systems fitted to the unmanned aircraft or ground control station that contribute to safe handling or recovery in the event of loss of control or situational awareness including their modes of operation, such as ballistic parachutes, propeller guards, RTH, flight termination function, tethering system, Geofencing or Geo-caging, airbags etc.

1.14 Change Management and Modifications to the system

Detail any modifications that have been made post initial design, for example, any changes made, additions to or removals from the platform or its equipment

Detail how the organisation/operator manages and records changes to the original design, this could include changes to software and firmware.

1.15 C2 Link

Detail how control instructions and telemetry data are relayed between the RPS and the UA. Detail the frequencies, power levels and transmission schemes of the radio transceivers or modems used to provide the C2 Link, including any methods for making the link secure, such as pairing or encryption.

1.16 Remote Pilot Station (RPS)

Detail what the RPS comprises, for example, fixed or mobile installation, laptop computer, tablet or other, similar portable device. Provide details of the operating system and other relevant technical specifications. The following additional information should also be provided:

- *details of firmware and software update processes;*
- *the functions and capabilities of the RPS;*
- *the information that the RPS provides to the remote pilot and how it is presented;*
- *the power supply arrangements for the RPS*

1.17 Whole system Single Points of Failure (SPOF)

For each element of the whole system, identify where SPOF may exist. Where SPOF are identified, it is expected that they will be appropriately addressed through suitable technical or operational mitigations in the OSC Volume 3 Safety Assessment.

1.18 Known failure modes

For the whole system, identify known failure modes and detail preventative strategies. It is expected that known failure modes will be appropriately addressed through suitable technical or operational mitigations in the OSC Volume 3 Safety Assessment.

1.19 Life Cycle, maintenance schedules, inspections and repair of UAS

Give full detail of the maintenance regime of the UAS, including a description of scheduled maintenance timescales and associated tasks, maintenance procedures and how scheduled and unscheduled maintenance actions are recorded.

Where repairs to the system are necessary describe the repair philosophy, for example, how the integrity of the repair will be assessed as conforming to and meeting or exceeding the requirements of the original design data.

1.20 Spares

Describe the process by which any spares are procured and validated, how suppliers are chosen and how parts suitability is determined.

1.21 External lighting

Provide details of any external lights installed on the system, such as those required to make the aircraft conspicuous during night operations.

1.22 Transportation requirements

Detail how the system is transported between sites, including use of transportation cases and any special transportation methods necessary due to equipment fragility.

Section 3: UAS OSC Volume 3- Safety Risk Assessment Guidance and Template

Safety Risk Management Guidance

This section explains some important aspects of SRM which are important to know before tackling the Safety Risk Assessment Template in the Section 3.2. Sections 3.1 and 3.2 are designed to be read together and will help applicants to identify and assess Safety Risks³ associated with the intended operation. This is important because applicants must provide confidence, with any supporting evidence, that Safety Risks are, after any mitigations have been applied, at a safe enough level to make the OSC acceptable to the CAA.

There is no transfer of ownership of Safety Risk when the CAA accepts an OSC. Accountable persons within the UAS operation will retain ownership and accountability should a Safety Risks lead to an incident or accident. Those accountable for the management of Safety Risks should regard Safety Risk Management as an ongoing task.

Each Safety Risk should be at a TOLERABLE and ALARP level to be acceptable to the CAA

There are 3 stages in the completion of the Safety Risk Assessment Template;

Stage 1 - Safety Risk Assessment Process (SRAP)

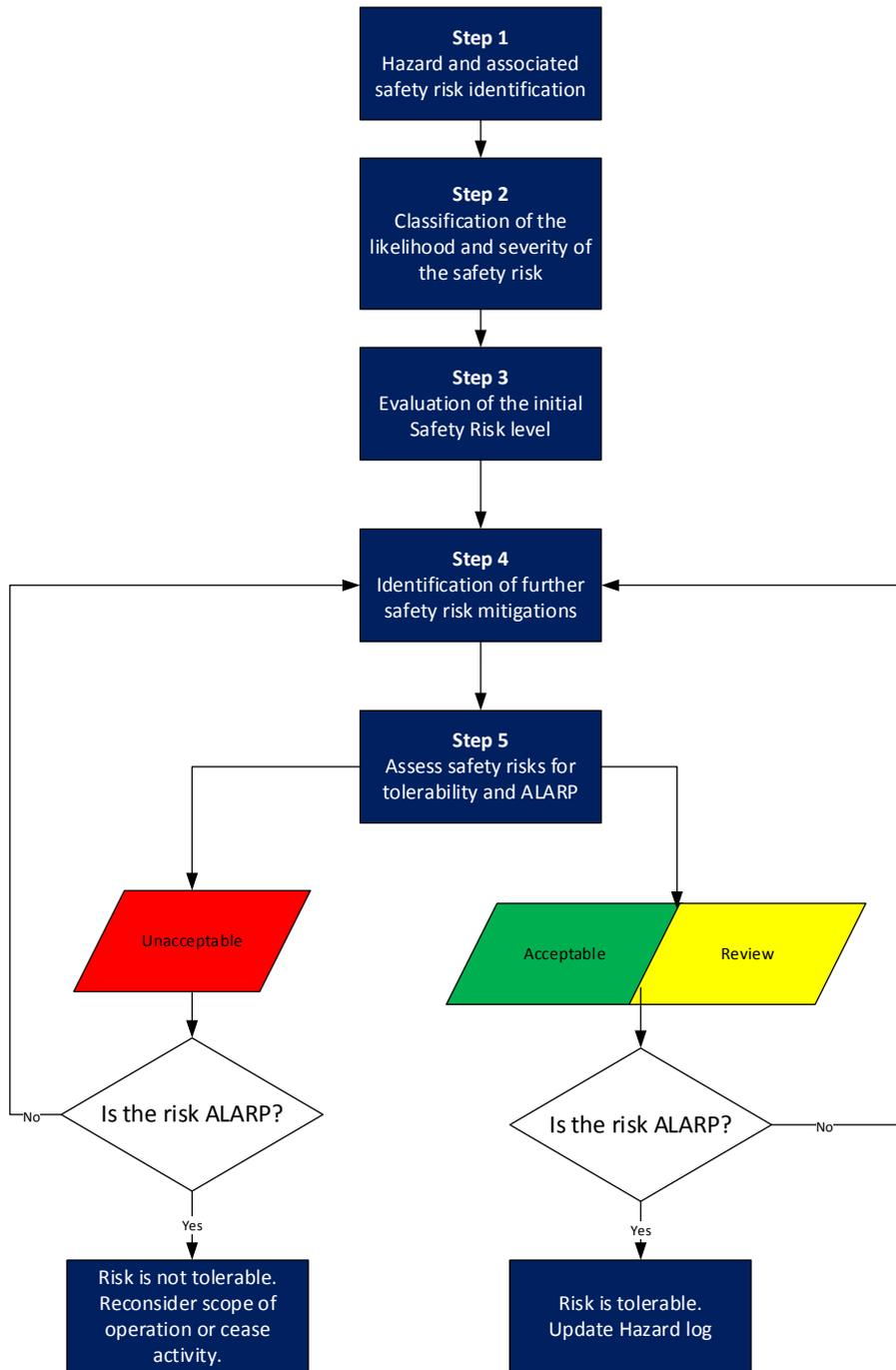
Stage 2 - Safety Risk Assurance

Stage 3 - Safety Risk Summary Statement

Overview of the Safety Risk Assessment Process

This stage contains the 5-step process, outlined below in flowchart figure 1.

³ The combined estimation of likelihood and severity of a particular aviation-related safety risk.



Types of Risk - Only Aviation Safety Risks are to be included in the SRAP. Health & Safety, financial or project completion risks are not in the scope of the OSC process. These types of risks are not to be submitted to the CAA as part of the OSC.

Hazard and Safety Risk Log - This is a table within which the progress through the SRAP is recorded. A blank example is at Table 1. The next section explains how it is populated.

Unique No	Identified Hazard	Associated Safety Risk	Existing Mitigation	Initial Safety Risk Level	Further Mitigation	Revised Safety Risk Level	ALARP Y/N	Tolerable Y/N	Owner
1	2	3	4	5	6	7	8	9	10

Table 1 – Hazard and Safety Risk Log

Safety Risk Level –The Safety Risk level is a combination of the **likelihood** of a Safety Risk occurring and the **severity** of harm to people, if that Safety Risk happens. Table 2 and table 3 below contain the definitions for likelihood and severity respectively.

Definition	Meaning	Value
Frequent	Likely to occur many times	5
Occasional	Likely to occur sometimes	4
Remote	Unlikely to occur but possible	3
Improbable	Very unlikely to occur	2
Extremely Improbable	Almost inconceivable that the event will occur	1

Table 2 – Safety Risk Likelihood Classifications

Severity ⁴ of Safety Risk occurring		
Definition	Meaning	Value
Catastrophic	Results in fatality of one or more people	5
Hazardous	Very serious injury or serious injuries to multiple people	4
Major	Serious injury or minor injuries to multiple people	3
Minor	Results in minor injury to an individual	2
Negligible	Nuisance of little consequence	1

Table 3 – Safety Risk Severity Classifications

The likelihood and severity scores are placed into the axes of the Safety Risk Level matrix to establish the Safety Risk level. The purpose of this matrix is to establish if a Safety Risk is tolerable or not. This matrix is shown below in Table 4 with guidance on how to use it.

⁴ The potential for harm as the result of a stated risk happening – e.g. UAS colliding with a person.

	Severity of Safety Risk				
	Catastrophic	Hazardous	Major	Minor	Negligible
Likelihood of Safety Risk Occurring	5	4	3	2	1
Frequent 5	Unacceptable	Unacceptable	Unacceptable	Review	Review
Occasional 4	Unacceptable	Unacceptable	Review	Review	Acceptable
Remote 3	Unacceptable	Review	Review	Acceptable	Acceptable
Improbable 2	Review	Review	Acceptable	Acceptable	Acceptable
Extremely Improbable 1	Review	Acceptable	Acceptable	Acceptable	Acceptable

Table 4 – Safety Risk Level Matrix

Assessment of Safety Risk tolerability

For a particular safety risk identified in the Hazard Log in Table 1 then determine the level of safety risk likelihood using Table 2 and safety risk severity using Table 3, finally use the Safety Risk Level matrix in Table 4 to determine the corresponding risk level. The risk levels can be defined as follows:

Unacceptable – The Safety Risk is not tolerable and mitigation measures are required to reduce the Safety Risk to a tolerable level.

Review – The Safety Risk is tolerable, but only just. The risk should be reviewed with appropriate⁵ frequency to ensure that it remains so.

Acceptable – The safety Risk is tolerable and should be reviewed with appropriate frequency to ensure that it remains so.

⁵ The frequency of the reviews needs to be appropriate for the identified safety risks, and justified and evidenced by the applicant within Stage 2 – Safety Risk Assurance of the OSC Volume 3.

Assessing if a Safety Risk is ALARP

A Safety Risk is ALARP when it is considered that any further reduction in either likelihood or severity is not possible without expending a disproportionate amount of resource. Sufficient evidence and rationale must be presented for this assertion within an OSC to be acceptable to the CAA.

It is important to recognise that the assessment of ALARP is separate to the assessment of tolerability. This means that even when a Safety Risk has been assessed as Tolerable, it must **also** be assessed as ALARP.

All identified Safety Risks are to be TOLERABLE and ALARP

Using Safety Risk mitigations

Robustness of Safety Risk mitigations - Mitigations are measures to reduce the Safety Risk level. These mitigations are needed when a Safety Risk is either not TOLERABLE or not ALARP. Mitigations may be operational or technical⁶ in nature. The robustness of a mitigation is an expression of the confidence that it can and will reduce a Safety Risk's level. Robustness is assessed from two perspectives;

Performance – how well a Safety Risk level may be reduced by the mitigation.

Integrity – how reliably a reduction in Safety Risk level may be delivered.

The assessment of performance and integrity will typically be a combination of subjective⁷ and objective⁸ evidence to be presented within the OSC.

Safety Risk mitigations should be traceable throughout the OSC - OSC Volumes 1 and 2 should describe mitigations such as operational procedures and technical features, which are identified by the SRAP in the management of Safety Risks

⁶ Operational mitigations are typically revised or additional procedures to reduce the safety risk level. Technical mitigations are typically functions integrated within the UAS that reduce the safety risk level.

⁷ Subjective – when an argument is based or influenced on personal opinions.

⁸ Objective – when an argument is based on factual, actual, real and verifiable evidence.

UAS OSC - Volume 3 – Safety Risk Assessment Process (SRAP), Assurance and Summary - Template

Introduction

This document must be an original work completed by the operator. The Company must take responsibility for its own safety case, whether the material originates from this template or otherwise.

Any significant changes to the operator's UAS OSC will require further assessment, by the CAA or entity recognised by the CAA, prior to further operations being conducted and will necessitate application to the CAA for a variation in this regard.

All text in italics is guidance only and must not be included in the Operator's UAS OSC.

The Template

The front cover of Volume 3 should detail the following items

- Operator/organisation name
- UAS Operating Safety Case
- Volume 3 – Safety Risk Assessment
- Version X Dated DD MM YYYY

The manual contents should be arranged with the following sections included:

Amendment Record

Amendment or Issue Number	Date	Amended by	Signed
<i>(a,b,c or 1, 2, 3 etc.)</i>	<i>DDMMYYYY</i>	<i>Name of Person</i>	<i>Signature of person carrying out the amendment.</i>

An amendment record demonstrates control of the document

Acronyms and Abbreviations

Detail all acronyms or abbreviations used throughout the document- there is no need to further expand any acronym or abbreviation within the document body

Table of Contents

The table of contents must contain those items listed below as a minimum

Amendment Record

Acronyms and Abbreviations

Stage 1 Safety Risk Assessment Process

Stage 2 Safety Risk Assurance

Stage 3 Safety Risk Summary Statement

3.2.3 STAGE 1 – SAFETY RISK ASSESSMENT PROCESS (SRAP)

Any risk assessment and consequent application of(?) mitigations requires a systematic approach. OSC Volumes 1 and 2 should be used to support the assumptions and results of the analysis carried out in this document. For example, the technical details of the UAS, how it functions and the systems that provide technical mitigations against the identified risks will be detailed in Volume 2. The concept of operations, operational requirements and the environment the UAS will be flying in will be detailed in Volume 1 along with any operational mitigations that contribute to the safety arguments for the identified risks. The Safety Risk Assessment Process (SRAP) is used to identify, assess, manage and record Safety Risks associated with an operation. See section 3.1.1 for more guidance on the SRAP. The SRAP is divided into five steps, each of which are now described in more detail;

Step 1- Hazard and associated Safety Risk Identification

Identification and recording of the hazards and their associated Safety Risk specific to the operation(s) that are intended to be undertaken.

- a) *Create a Hazard and Safety Risk Log (see Table 1 below) This log has 10 columns and a single row for each hazard and associated Safety Risk.*

Unique No	Identified Hazard	Associated Safety Risk	Existing Mitigation	Initial Safety Risk Level	Further Mitigation	Revised Safety Risk Level	ALARP Y/N	Tolerable Y/N	Owner
1	2	3	4	5	6	7	8	9	10

Table 1 – Hazard and Safety Risk Log

- b) *Identify the hazards⁹ associated with the operation(s) that are intended to be undertaken and allocate a unique number for each.*
- c) *Identify any Safety Risks that each hazard may create. A single hazard may create more than a single safety risk.*
- d) *Update Hazard and Safety Risk Log columns (1) and (2) and (3) accordingly.*

Hazard identification includes consideration of Ground and Air environments and UAS technical failures and malfunctions. Some examples are;

- Ground
 - Obstacles, i.e. buildings, infrastructure etc.
 - Types of terrain.
 - Uninvolved 3rd parties.
- Air
 - Airspace class
 - Aerodrome boundaries/Flight Restriction Zones
 - Airspace incursion or excursion
 - Other airspace users
- Technical failures and malfunctions of the UAS
- Single Point of Failure leading to loss of control of UAS, e.g. loss of propulsion or loss of C2 Link.

Note: There is no mandatory requirement to use complex techniques (e.g. Goal Structured Notation or Bow Tie analysis) but these alternative risk assessment methodologies may be used; these will need to be presented and justified in Stage 2 – Safety Risk Assurance.

Step 2- Classification of the Likelihood and Severity of the Safety Risk

- a) *Make an assessment of the likelihood of the Safety Risk occurring (refer to the Safety Risk Likelihood Classifications in Table 2);*

- b) *Make an assessment of the severity of the Safety Risk (refer to the Safety Risk Severity Classifications in Table 3);*

⁹ **Hazard** - A condition or object with the potential of causing injuries to personnel, damage to equipment or structures, loss of material, or reduction of ability to perform a prescribed function (*ICAO Doc 9859, Safety Management Manual*)

Step 3 - Evaluation of the Initial Safety Risk Level

Combining Likelihood and Severity to determine overall initial Safety Risk level.

- a) *Apply the results of the assessment of Step 2 (Likelihood and Severity estimation) the Safety Risk Level Matrix in Table 4;*
 - *Identify any existing safety risk mitigations associated with the identified hazards that will reduce either likelihood or severity of the safety risk;*
- b) *Update Hazard and Safety Risk Log column (4) with details of what the existing mitigations are.*
- c) *Having considered the effect of any existing mitigations on the likelihood and severity, record the Initial Safety Risk level in column (5) of the Hazard and Safety Risk Log.*

Step 4 – Identification of further Safety Risk Mitigations

Determination and assessment of further Safety Risk mitigations to reduce the level of Safety Risk

- a) *Mitigation strategies may include:*
 - system design change;
 - incorporating technical features (BRS, electronic conspicuity, etc.)
 - amendment of operational procedures;
 - changes to crew composition;
 - training of personnel to deal with the hazard(s);
 - development of emergency and/or contingency arrangements and plans;
 - modifying or, ultimately, ceasing operation.

Following the application of mitigations, the safety risk should be re-evaluated

- a) *Identify and describe further mitigations in the Hazard and Safety Risk Log column (6)*
- b) *Re-assess Likelihood, Severity and Safety Risk level as per Steps 2 and 3. Insert the Revised Safety Risk level in column (7) of the Hazard and Safety Risk log.*

Step 5 – Assess Safety Risks for TOLERABILITY and ALARP

- a) Assess if the Revised Safety Risk Level is TOLERABLE.

If the Revised Safety Risk Level is in the Review or Acceptable region of the matrix, it is tolerable.

If the Revised Safety Risk Levels still remain in the Unacceptable region of the matrix it is not tolerable and further mitigations will be required to reduce the Safety Risk Level (Go immediately to SRAP Step 4)

b) Assess if the Revised Safety Risk Level is ALARP.

c) When a Safety Risk has been assessed as TOLERABLE and ALARP a ‘Y’ may be inserted into columns (8) and (9) of the Hazard and Safety Risk log.

3.2.4 STAGE 2 – SAFETY RISK ASSURANCE

*This is a self-assessment by the applicant of how effectively the SRAP has been carried out and why the applicant is confident that Safety Risks have been managed to a Tolerable and ALARP level. It is a holistic safety argument that is coherent across all 3 Volumes of the OSC and supports the applicant’s claim; **that all appropriate Safety Risks have been identified and are TOLERABLE and ALARP.***

Safety Risk Assurance shall include as a minimum:

- a. Explanation of the methodology and rationale of the Hazard and Safety Risk Identification and Assessment process described in the Stage 1: Safety Risk Assessment Process above. It is important to give the CAA confidence that the most concerning Safety Risks have been included in your assessment;*
- b. Explanation of the robustness of Safety Risk mitigations;*
- c. Reference to and explanation of how OSC Vol 1 processes and procedures mitigate identified Safety Risks;*
- d. Identification of owners for each Safety Risk and ensure their names are recorded in column (10) of the Hazard and Safety Risk log.¹⁰*
- e. Describes methodology and periodicity of review for Safety Risks*
- f. Explain how Safety Risk mitigations are:*
 - Appropriate*
 - Implemented*

¹⁰ This could be the Accountable person within the organisation.

- *Measured*
- *Assured*

Each individual Safety Risk should be listed in turn and evidence presented that demonstrates that it is at a TOLERABLE and ALARP level. This should be presented in a Claim, Argument, Evidence format – see below:

- **Claim** – Hazard and Safety Risk Log Number XXX is Tolerable and ALARP;
- **Argument** – Why the applicant considers the claim to be true. A suitable supporting statement for the claim, for example, the remote pilot holds a ‘xxxx’ remote pilot certificate, has been independently assessed in all modes of flight by ‘xxxx’ association, which may be an NQE, or another suitably competent organisation. Alternatively, the remote pilot may be the holder of another acceptable pilot licence/qualification (refer to CAP722 Policy and Guidance for Civil UAS pilot competency criteria) and has ‘xxx’ hours experience on this system, ‘xxx’ hours of which have been in the intended operating environment. Suitable operational and/or technical mitigations may be described here.
- **Evidence** – To support the argument. This may be the operator’s log book and copies of certificates or licences held. It is important that any referenced evidence is either already embedded in the UAS OSC, such as in OSC Volume 1, 3.12, or is attached to the UAS OSC application. If an operational mitigation requires a new procedure within the operations manual it should be referenced here as part of the evidence.

Note: *Only Safety Risks that have been identified within the SRAP should be included in Stage 2 – Safety Assurance. Do not include new Safety Risks that are not part of Stage 1 – Safety Risk Assessment Process.*

3.2.5 STAGE 3 – SAFETY RISK SUMMARY STATEMENT

The final stage is to summarise the whole Operating Safety Case. (i.e. all three volumes of the OSC) with two key statements;

- 1) A statement of intent to operate to the principles and guidelines given in this UAS OSC.**
- 2) A clear statement that Safety Risks are considered by the applicant to be TOLERABLE and ALARP and are owned by accountable individuals within the applicant’s organisation.**

This summary should directly support the Safety Statement made in Volume 1 of the UAS OSC.

Appendix A: Operational and Technical Factors for UAS Operations

This section contains guidance on factors that should be taken into account when preparing the Operating Safety Case for the operation.

Operational Factors

Type of Operation(s)

- VLOS: Surrounding buildings, vegetation or other obstructions may affect the maximum distances that the UA can be flown from the remote pilot while remaining in direct visual line of sight of the remote pilot. Consideration may need to be given to splitting an operation into a number of separate flights from different locations.
- EVLOS: This is a subset of VLOS where the requirement for the remote pilot to maintain direct visual contact with the UA is addressed by other methods or procedures, although the 'collision avoidance' element is still achieved through 'visual observation' by a human. When visual observers are used, they must be:
 - Fully briefed and aware of their responsibilities and the operational task
 - Appropriately positioned so that they can adequately monitor the area they are responsible for
 - Able to communicate continuously and effectively with the remote pilot and provide sufficient collision avoidance information to the remote pilot
 - Aware of the maximum operating range limits of the UA so that they can inform the remote pilot when the UA is approaching its limiting range.
- BVLOS: When operating BVLOS, the primary consideration is to be able to mitigate the risk of collision, both with other aircraft and with persons or objects on the ground. The three main capabilities that must be demonstrated are:
 - Positional awareness – The knowledge of where the UA is located at all times.

- Situational awareness – The knowledge of what is around the UA at all times.
- Command and control – The ability to effect the necessary control on the UA (in order to manoeuvre clear of collision threats) and to receive appropriate information from the UA in order to verify that those commands have been carried out.

Utilisation of other agencies. Liaising with the Police, local authorities and other controlling agencies/organisation to effect official road closures, traffic cessation or site access restrictions.

Note: These measures will ideally be proportionate to the risk posed by the UAS, bearing in mind the limited flight times and size and weight of the aircraft.

Temporary restrictions may suffice in some cases. Restrictions that would be suitable for a manned aircraft such as a helicopter would not, in most cases, be applicable to a UAS.

International Operations. UAS operators planning to operate beyond an international FIR/UIR boundary must comply with the regulatory and ATM requirements applicable to the territories over which the UAS is flown; these may differ from UK requirements. Whilst the CAA will provide guidance on cross border ATC procedures, including detailing the arrangements for those areas of airspace where ATS provision is delegated either to or by the UK, guidance on foreign national procedures is to be sought from the appropriate State National Aviation Authority (NAA).

Wind and turbulence. Taking account of changes of wind strength and direction at varying heights above the surface. Windshear, 'rotor' and 'curl-over' effects may be present at any point on the planned flight path caused by interactions between buildings and strong winds or when transitioning from flight over land to over water.

Emergency procedures. UAS emergency procedures planned to be implemented as a result of system failures must be able to be put into effect without breaching the minimum separation distances. For example, an automatic 'Return-to-Home' function must not cause a hazard to anyone off the nominal flight path;

Airspace. Although the airspace over congested areas at very low levels (e.g. 500ft and below) generally tends to have a much lower density of manned aircraft, those manned aircraft that are flying in the areas at low altitudes are likely to be there due to a specific tasking (e.g. Police or Air Ambulance helicopters), as opposed to being 'in transit' and so are likely to be over a specific location for a much longer period. UAS operators must be aware of any aviation restrictions that are in place, such as the Restricted Areas established over central London, and comply with their additional requirements. Many aerodromes are established within congested areas, hence the restrictions and the additional requirements associated with the published Flight Restriction Zones must also be observed.

Crew Communication. Operators should consider adequate means of communication between crew members, competent observers and any other relevant people when conducting operations, including any procedures that need to be implemented. Operators should also consider back up communication methods in case the primary means of communication fails

Technical Factors

Radio Frequency (RF) interference. Remote pilots must take account of possible performance reduction of the C2 link in urban environments due to multiple sources of RF emissions (mobile telephone, Wi-Fi, public service radio etc.). Mitigation against the consequences of GNSS signal disturbances due to the proximity of buildings and structures plus the deleterious effects of jamming and spoofing must be considered and incorporated. The use of a spectrum analyser is recommended to assist in assessing the level of local electromagnetic and RF congestion in the appropriate frequency ranges used by critical systems that are reliant on the transmission and reception of radio signals.

It is the responsibility of the operator to ensure that the radio spectrum used for the command and control link and for any payload communications complies with the relevant Ofcom requirements and that any licenses required for its operation have been obtained. It is also the responsibility of the operator to ensure that the appropriate aircraft radio licence has been obtained for any transmitting radio equipment that is installed or carried on the aircraft, or that is used in connection with the conduct of the flight and that operates in an aeronautical band.

Electronic Conspicuity: Electronic Conspicuity (EC) can help airspace users to be more aware of other aircraft in the same airspace. Operators who choose to utilise EC as a mitigation should refer to the guidance and requirements contained in CAP 1391.

Test flights. It is desirable to conduct limited test flights (hover controllability check) and other systems tests at the launch point before committing to the full flight profile. Where applicable, the integration and correct set-up of any camera and gimbaled-mount required for the operation should also be checked at this time to avoid unnecessary calibration flights.

Tethering. The use of a tethered unmanned aircraft may be appropriate to mitigate risks associated with an operation. Operators wishing to utilise a tether must ensure the tether remains securely attached (tethered) via a physical link to a person, the ground or an object at all times while it is flying. The tether normally takes the form of a flexible wire or a cable and may also include the power supply to the aircraft as well.

in the case of a tethered unmanned aircraft, the tether system should have a tensile mechanical strength that is no less than:

- for heavier-than-air aircraft, 10 times the weight of the aerodyne at maximum mass;
- for lighter-than-air aircraft, 4 times the force exerted by the combination of the maximum static thrust and the aerodynamic force of the maximum allowed wind speed in flight;

Operating in Congested Areas

In order to operate in congested areas, UAS operators must establish safety and operational control measures that prevent the UAS from endangering the general public. Operators are advised to ensure that their existing risk assessment and operating procedures address the enhanced measures required for congested areas. The procedures must address all relevant aspects of the congested areas they intend to operate within, taking into account any special circumstances or local conditions.

Segregation. Segregating the activities from public interference by placing physical barriers and cordons around the area of activity or using other built/natural features that effectively separate the UAS operation from the general public.

Crowd control. Marshalling or other active crowd control measures that restrict access to the area within which the UAS is operating.

Site Survey Assessment

The use of non-established sites for flying UA requires an assessment of the suitability of that site to be made prior to commencing operations. Such an assessment must be made using a site visit and available information from at least

the aeronautical charts, as well as other sources of information such as the UK Aeronautical Information Service (www.ais.org.uk), DroneSafe Website, digital imagery (Google Earth/ Maps etc.), Ordnance Survey maps etc.

Typical elements of an assessment that could affect the safety of the flight include:

- the class/ type of airspace and specific provisions (e.g. Controlled Airspace, Flight Restriction Zones etc);
- other aircraft operations (local aerodromes or operating sites);
- hazards associated with industrial sites or such activities as live firing, gas venting, high-intensity radio transmissions etc.;
- local by-laws;
- obstructions (wires, masts, buildings etc.);
- extraordinary restrictions such as segregated airspace around prisons, nuclear establishments etc. (suitable permission may be needed); habitation and recreational activities;
- public access;
- permission from landowner; Operators must be aware of their responsibilities regarding operations from private land and any requirements to obtain the appropriate permission before operating from a particular site. In particular they must ensure that they observe the relevant trespass laws and do not unwittingly commit a trespass whilst conducting a flight;
- likely operating site and alternative sites;
- weather conditions for the planned flight;
- minimum separation distances from persons, vessels, vehicles and structures not under control of the remote pilot, to include a buffer zone if necessary;

Site survey assessments may be carried out utilising check lists or other means the operator deems appropriate. These assessments will form part of the operators' record keeping in accordance with conditions imposed within any authorisation issued by the CAA.

Overflight of Uninvolved 3rd Parties

The overflight of persons not under the control of the remote pilot below certain heights is generally restricted and will be described in the conditions of the permission or exemption issued by the CAA.

For small unmanned aircraft (UAS of 20 kg and below), ANO 2016 article 95 defines the separation distances that must be applied and is backed up by article 94(2) with regard to the requirement for the remote pilot to be satisfied that the flight can be conducted safely. For UAS operations over 20 kg, the overflight of persons may be allowed subject to appropriate operational procedures and technical mitigations to prevent harm to uninvolved third parties and property such as Ballistic Recovery Systems (BRS) (e.g. parachutes), and independent flight termination systems.

When evaluating the typical kinetic energy expected for a given operation, the applicant should generally use airspeed, in particular V_{cruise} for fixed-wing aircraft and the terminal velocity for other aircraft. Specific designs (e.g. gyrocopters) might need additional considerations. Guidance useful in determining the terminal velocity can be found at <https://www.grc.nasa.gov/WWW/K-12/airplane/termv.html>

The safety case for the overflight of people must include an assessment of the Kinetic Energy Limits and the method of flight termination (e.g. BRS or other). Two crash scenarios must be considered in determining the impact kinetic energy of the UA, as follows:

- a free-fall from 400 ft for all UAS;
- additionally, for a UAS capable of high forward speed, a maximum impact speed (set as 1.4 x maximum achievable steady speed in level flight).

Assuming negligible aerodynamic drag, an object dropped from 400 ft will hit the surface at 95 knots and the kinetic energy at impact will be 95 kJ if the mass of the object is 80 kg. If the object exhibits significant aerodynamic drag (without reliance upon any on-board parachute deployment system), the impact velocity will be less, and a higher mass may be permissible without exceeding a calculated 95 kJ.

In the second scenario and with a maximum speed of 70 knots, 95 kJ equates to a mass of 75 kg. The mass can be increased, provided the maximum achievable steady level flight speed is sufficiently low that the energy limit is not exceeded (e.g. at 150 kg a maximum speed of 49 knots is permitted).

Operational Limitations

An operational authorisation, permission or exemption for UAS operations will normally include a number of operational limitations, dependant on the operational complexity and UAS being used.

For small unmanned aircraft, these limitations will normally include a prohibition on flight:

- within the flight restriction zone of a protected aerodrome, unless the permission of the relevant air traffic control unit, flight information service unit or aerodrome operator, as detailed in ANO 2016 article 94A, at that aerodrome has been obtained. For UAS above the 20Kg threshold the whole of the ANO applies and will require an exemption in this regard.
- at a height exceeding 400 feet above ground level;
- at a distance beyond the visual range of the Remote Pilot, or a maximum range of 500 metres;
- within 50 metres of any person, vessel, vehicle or structure not under the control of the remote pilot;
- unless it is equipped with a mechanism that will cause the UA to land in the event of disruption to or a failure of any of its control systems, including the radio link, and the remote pilot satisfied him/herself that such mechanism is in working order before the UA commences its flight;
- unless the remote pilot has reasonably satisfied himself that any load carried by the UA is properly secured, that the UA is in a flightworthy condition and that the flight can safely be made taking into account the wind and other significant weather conditions;
- unless the SUA operator maintains records of each flight made pursuant to the permission and makes such records available to the CAA on request;
- unless a site safety assessment has been completed by the operator and these site safety assessments are made available to the CAA on request;
- unless in accordance with the operations manual submitted to the CAA.
- Operators must also be aware of their responsibilities regarding operations from private land and any requirements to obtain the appropriate permission before operating from a particular site. In particular, they must ensure that they observe the relevant trespass laws and do not unwittingly commit a trespass whilst conducting a flight;

The CAA may also impose additional limitations for UAS as it deems fit; such limitations could include a prohibition on:

- flights that have not been notified to the local Police prior to the flights taking place;
- flights where the maximum achievable steady speed in level flight is greater than 70 knots. This will consider the kinetic energy of the platform;
- aerobatic flight;
- tasks that involve aerial inspection of, or flight close to, any object or installation that would present a risk to safety in the event of damage due to any impact by the UAS (e.g. chemical/gas storage areas);
- direct overflight of crowds or uninvolved persons;
- carriage of dangerous goods (<https://www.caa.co.uk/Commercial-industry/Aircraft/Dangerous-goods/Dangerous-goods-approvals-for-UK-and-foreign-registered-aircraft-operators/>);
- participation in any public flying display (except with the written permission of the CAA).

Examples of Operational and Technical Safety Risk Mitigations

The considerations in this example are not intended to be exhaustive or prescriptive. They illustrate how to approach the assessment of the performance and assurance of mitigations to Safety Risks.

- Safety Risk: A loss of C2 Link may cause the UAS to depart from the intended area of operation with consequent risk of mid-air collision with a manned aircraft.
- Mitigations:
 - Operational Mitigation – If the UAS flies away a mobile telephone call will be made to the local Air Traffic Service Unit (ATSU), so they may pass traffic information to other aircraft.
 - Performance - Making this telephone call will reduce likelihood of the loss of C2 link leading to a mid-air collision, but only with aircraft that the ATSU are in contact with.

- Assurance - This mitigation relies on mobile phone coverage being available and the ATSU answering the phone. Is there an agreed procedure in place with the ATSU and has a direct telephone number been provided for this? What is the mobile phone coverage like in the intended operational area?
- Technical Mitigation – The UAS is equipped with the facility for a primary and secondary C2 link that operates on different frequencies and is always available to the remote pilot.
- Performance – A backup to the C2 link will mean that if one fails the other will take over. It is much less likely that both systems will fail at once – this reduces likelihood of the safety risk happening.
- Assurance – How independent are the two C2 links - Are there any single points of failure that would mean both C2 links could fail at the same time?