CIVIL AVIATION DIRECTIVE – 6011 PART (V)

UNMANNED AIRCRAFT SYSTEM

SPECIAL UAS PROJECT

CIVIL AVIATION AUTHORITY OF MALAYSIA

ISSUE 01
REVISION 01 – 15TH NOVEMBER 2022

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Introduction

In exercise of the powers conferred by section 24O of the Civil Aviation Act 1969 [Act 3], the Chief Executive Officer makes this Civil Aviation Directive 6011 Part (V) – Unmanned Aircraft System Special UAS Project – ("CAD 6011 Part (V) – UAS SUP"), pursuant to Regulation 140, 141, 142, 143,144, 189 and 193 of the Malaysian Civil Aviation Regulations (MCAR 2016).

This CAD contains the standards, requirements and procedures to individuals and operators in Malaysia seeking approval for operations categorised as 'Special UAS Project'.

This Civil Aviation Directive 6011 Part (V) – Unmanned Aircraft System Special UAS Project – ("CAD 6011 (V) – UAS SUP") is published by the Chief Executive Officer under Section 24O of the Civil Aviation Act 1969 [Act 3] and come into operation on 15 November 2022.

Non-compliance with this CAD

Any person who contravenes any provision in this CAD commits an offence and shall on conviction be liable to the punishments under section 24O of the Civil Aviation Act 1969 [Act 3] and/or under Malaysian Civil Aviation Regulation 2016.

(Datuk Captain Chester Voo Chee Soon)
Chief Executive Officer
Civil Aviation Authority of Malaysia

Civil Aviation Directive components and Editorial practices

This Civil Aviation Directive is made up of the following components and are defined as follows:

Standards: Usually preceded by words such as *"shall"* or *"must"*, are any specification for physical characteristics, configuration, performance, personnel or procedure, where uniform application is necessary for the safety or regularity of air navigation and to which Operators must conform. In the event of impossibility of compliance, notification to the CAAM is compulsory.

Recommended Practices: Usually preceded by the words such as "*should"* or "*may*", are any specification for physical characteristics, configuration, performance, personnel or procedure, where the uniform application is desirable in the interest of safety, regularity or efficiency of air navigation, and to which Operators will endeavour to conform.

Appendices: Material grouped separately for convenience but forms part of the Standards and Recommended Practices stipulated by the CAAM.

Definitions: Terms used in the Standards and Recommended Practices which are not self-explanatory in that they do not have accepted dictionary meanings. A definition does not have an independent status but is an essential part of each Standard and Recommended Practice in which the term is used, since a change in the meaning of the term would affect the specification.

Tables and Figures: These add to or illustrate a Standard or Recommended Practice and which are referred to therein, form part of the associated Standard or Recommended Practice and have the same status.

Notes: Included in the text, where appropriate, Notes give factual information or references bearing on the Standards or Recommended Practices in question but not constituting part of the Standards or Recommended Practices;

Attachments: Material supplementary to the Standards and Recommended Practices or included as a guide to their application.

It is to be noted that some Standards in this Civil Aviation Directive incorporates, by reference, other specifications having the status of Recommended Practices. In such cases, the text of the Recommended Practice becomes part of the Standard.

The units of measurement used in this document are in accordance with the International System of Units (SI) as specified in CAD 5. Where CAD 5 permits the use of non-SI alternative units, these are shown in parentheses following the basic units. Where two sets of units are quoted it must not be assumed that the pairs of values are equal and interchangeable. It may, however, be inferred that an equivalent level of safety is achieved when either set of units is used exclusively.

A common unit of measurements used within this document are expressed in accordance with those used in normal aviation practise within Malaysia:

a) Vertical distances of aircraft (heights, altitudes) are expressed in ***feet (ft)***
b) Heights of obstructions are expressed in ***metres (m)***
c) Distances for navigation, airspace reservation plotting, and ATC separation are expressed in ***nautical miles (nm)***
d) Shorter distances are expressed in ***metres (m)*** and ***kilometres (km)*** when at or over 5000 metres

e) Mass is expressed in ***kilogrammes (kg)*** and ***grammes (g)*** when less than 1 kg
f) Speed is expressed in ***knots (kt)***
*Note. - Speeds below 50 kts may also be expressed in **metres per second (m/s)***

Where appropriate, conversions will be provided with the text with the alternative value shows in brackets e.g., 400 feet (120 metres).

Other typical conversions that are used are:

a) Distance

10 feet	= 3 metres
50 feet	= 15 metres
500 feet	= 150 metres

b) Mass

250 g	= 0.55 lb (pounds)
25 kg	= 55 lb

Any reference to a portion of this document, which is identified by a number and/or title, includes all subdivisions of that portion.

Throughout this Civil Aviation Directive, the use of the male gender should be understood to include male and female persons.

CAD 6011 (II) is a subset of the 'CAD 6011 series', which includes:

CAD 6011	:	Unmanned Aircraft System (General)
CAGM 6011	:	Unmanned Aircraft System (General)
CAD 6011 (I)	:	Remote Pilot Training Organisation
CAD 6011 (II)	:	Agricultural UAS Operations
CAD 6011 (III)	:	UAS Rotary Wing Swarm Operations
CAD 6011 (IV)	:	Standard Scenarios (STSs)
CAD 6011 (V)	:	Special UAS Project

Note. - Work is currently being done to develop a CAD 6011 (II) in a 'Bahasa Malaysia' Edition. CAD 6011, CAGM 6011, CAD 6011 (III) and CAD 6011 (IV) will be introduced at a later stage.

Enquiries related to CAD 6011 (II) can be made to the UAS Unit via drone@caam.gov.my

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Record of Revisions

Revisions to this handbook shall be made by authorised personnel only. After inserting the revision, enter the required data in the revision sheet below. The *'Initials'* has to be signed off by the personnel responsible for the change.

Rev No.	Revision Date	Revision Details	Initials
ISS 01/REV 01	15 November 2022	Refer to Summary of Changes	CAAM

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Summary of Changes

ISS/REV no.	Item no.	Revision Details
ISS 01/REV 01	Para 1.2.1	Inserted note to make clear scope that this CAD is intended for domestic operations only
	Para 3.1.1	Revised approval process requirements for SUP Approval
	Para 3.1.1.1	Added evaluation process requirements for SAIL III onwards
	Para 3.1.1.2	Added evaluation process requirements for applicants that are exempted from full five phases certification process
	Para 3.2.2	Added SUP email address for SUP Approval application
	Para 3.2.5	Revised term for The Committee to Jawatankuasa UAS (JAKUAS)
	Para 3.2.6	Revised term for The Committee to Jawatankuasa UAS (JAKUAS)
	Para 5.2.7 (a)	Added word “to” after the “CAAM” sentence
	Para 5.7.3.2 (d)	Revised numbering
	Para 5.7.3.2 (e)	Revised numbering
	Para 6.4.1	Added ‘;and’ to the end of the sentence.
	Para 6.4.1 (b)(2)	Added ‘;and’ to the end of the sentence.
	Para 6.4.1 (b) (3)	Added ‘;and’ to the end of the sentence.
	Para 7.2 (a)(1)	revised term services to service.
	Para 7.2.(a)(2)	revised term services to service.
	Para 9.9.1	revised sentence Appendix 18 to the Convention on International civil Aviation to Annex 18 of the International Civil Aviation Organisation (ICAO). Removed footnote in term “aircraft operations[1]
	Para 9.3.4.(a).(1)	Revised embedded link
	Para 9.3.4.(a).(3)	Revised embedded link
	Appendix 1 Para 1.5	Added more information on the UAS design compliance requirements (OSO’s), M1 mitigation (tethered operation), verification of the system to contain the UAS within operational volume. Added more information on the CAAM’s validation approach for SAIL V onwards.
	Appendix 1 Figure 3	Revised the information in The SORA process flow
	Appendix 1 Para 2.3.1.c)	Added the term area of operation
	Appendix 1 Para 2.3.1.d)	Revised the sentence ‘in case of’ to ‘if there is’
	Appendix 1 Para 2.3.1.e)	Added more information on the use of qualitative or quantitative criteria in the determination of intrinsic GRC
	Appendix 1 Para 2.3.1.f)	Added more information on the qualitative assessment, guidance on the definitions of assemblies of people and conditions to classify an operation as taking place over a populated area
	Appendix 1 Para 2.3.1.g)	Added more information to determine EVLOS operation are to be considered as BVLOS

	Appendix 1 Para 2.3.1.h)	Added more information on controlled ground area
	Appendix 1 Table 2	Revised Operational scenarios and Intrinsic UAS ground risk class values
	Appendix 1 Para 2.3.2.c)	Revised the term Appendix 2 to Appendix 3
	Appendix 1 Para 2.3.2.g)	Added more information on the qualitative approach in reducing the intrinsic GRC
	Appendix 1 Table 3	Revised the footnote number 6 to 5 and footnote number 7 to 6
	Appendix 1 Para 2.5.2	Added the sentence "that issue the operational authorisation" to the paragraph
	Appendix 1 Table 6	Revised the letter O to L for SAIL III OSO#04
	Appendix 1 Para 2.5.3.b)	Revised the footnote number 9 to 8 and footnote number 10 to 9
	Appendix 1 Para 2.5.3.c)	Added the sentence "enhanced containment, which consists in the" and "applies to" to the paragraph
	Appendix 1 Para 2.5.3.c).2)	Added sentence "where the operational volume is" and revised the sentence "in populated environment" to "in a populated area"
	Appendix 1 Para 2.5.3.c).2).a)	Added more information on UAS designed standards
	Appendix 1 Footnote 4	Removed footnote 4 the intrinsic ground risk class for BVLOS operations in populated environment or over gathering of people will be developed in a future edition of the SORA.
	Appendix 6 Para 1.2 OSO #02	Revised Level of Integrity High and Level of Assurance Low, Medium and High criteria
	Appendix 6 Para 1.2 OSO #04	Revised Level of Integrity comments and added Level of Assurance Low, Medium and High comments.
	Appendix 6 Para 1.2 OSO #05	Revised Level of Assurance Low, Medium and High criteria
	Appendix 6 Para 1.2 OSO #06	Revised Level of Assurance Low, Medium and High criteria
	Appendix 6 Para 1.5 OSO #10 & OSO #12	Revised Level of Assurance Medium and High criteria
	Appendix 6 Para 1.7 OSO #18	Revised Level of Assurance Low and Medium criteria
	Appendix 6 Para 1.7 OSO #19	Revised Criterion #3 Level of Assurance Low, Medium and High criteria and comments
	Appendix 6 Para 1.7 OSO #20	Revised Level of Assurance Low and Medium requirements and comments
	Appendix 6 Para 1.8 OSO #23	Revised the Criterion #1 Level of Assurance criteria
	Appendix 6 Para 1.8 OSO #24 b)	Added more information on the requirements of the UAS designed and qualified for adverse environmental conditions
	Appendix 6 Para 1.9 TECHNICAL OSO	Revised Level of Assurance Medium criteria and comments

	Appendix 7 Para 1.3	Revised embedded link
	Appendix 7 Para 1.3.3.1	Revised embedded link
	Appendix 7 Para 1.3.3.2.a)	Revised the numbering 1.3.3.2.b) to 1.3.3.2.a) Revised the embedded link
	Appendix 7 Para 1.3.4.d)	Revised embedded link
	Attachment D	revised sentence

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Table of Contents

1 General

1.1 Citation

1.1.1 These Directives are the Civil Aviation Directive 6011 (V) – Special UAS Project (CAD 6011 (V) – SUP), Issue 01/Revision 01, and comes into operation on 15 November 2022.

1.1.2 This CAD 6011 (V) - SUP, Issue 01/Revision 01 will remain current until withdrawn or superseded.

1.2 Applicability

1.2.1 This CAD is applicable to Special UAS Project operations utilising an Unmanned Aircraft System (UAS).

Note. - This CAD covers the standards and requirements for domestic Special UAS project requirements and does not cover international/ cross border operations of unmanned aircraft system.

1.2.2 CAAM classifies Special UAS Project if the operation involves:

a) Carriage of items, inclusive of carriage of Dangerous Goods;

b) BVLOS;

c) Research and Development;

d) Any other operations that require an additional operational support activity from the CAAM due to the additional risks it involves.

1.2.3 This CAD is not applicable if the operations are conducted in any of the following conditions:

a) It has a characteristic dimension of 3 m or more, and is designed to be operated over assemblies of people;

b) It is designed for transporting people;

c) It is designed for the purpose of transporting dangerous goods and requiring a high level of robustness to mitigate the risks for third parties in case of accident.

1.2.4 An applicant for Research and Development Testing are to adhere to this CAD requirements. However, if the Research and Development testing satisfies in full the requirements laid out in Pre-Defined Risk Assessment - PDRA 02. (Refer to Appendix 8) the requirements in this CAD may be exempted.

1.3 Revocation

1.3.1 This CAD revokes Civil Aviation Directive 6011 (V) – Special UAS Project (CAD 6011 (V) – SUP) Issue 01/Revision 00, dated 01 March 2021.

1.4 Purpose

1.4.1 This CAD is applicable to Special UAS Project operations utilising an Unmanned Aircraft System (UAS).

1.4.2 CAAM classifies Special UAS Project if the operation involves:

a) Carriage of items, inclusive of carriage of Dangerous Goods;

b) BVLOS;

c) Research and Development;

d) Any other operations that require an additional operational support activity from the CAAM due to the additional risks it involves.

1.4.3 The ability to employ beyond visual line of sight (BVLOS) operations greatly enhances the utility and flexibility in UAS operations. However, in BVLOS, the operator may not be able to ascertain the relative position of the UA to persons, vehicle, aircraft or property. This limitation brings additional risks, in particular, the operator's ability to take collision avoidance action during the UA operation.

1.4.4 Dangerous goods are articles or substances that are capable of posing a hazard to health, safety, property or the environment if not properly mitigated.

1.4.5 Therefore, it is apparent that an additional set of mitigation is required such as Unmanned Traffic Management (UTM) System service provider, proper training of competent personnel and robust organisation of operators to ensure Emergency Response Plan and Recovery Scheme (ERP) is implemented by the operators prior to operations.

1.4.6 For the purposes of the civil UAS Regulation, the term 'operation of unmanned aircraft systems' does not include indoor UAS operations. Indoor operations are operations that occur in or into a house or a building (dictionary definition) or, more generally, in or into a closed space such as a fuel tank, a silo, a cave or a mine where the likelihood of a UA escaping into the outside airspace is very low.

1.5 Policy

1.5.1 UAS operating in Malaysia must meet at least the same safety and operational standards as manned aircraft when conducting the same type of operation in the same airspace.

1.5.2 As a result, when compared to the operations of manned aircraft of an equivalent class or category, UAS operations must not present or create a greater hazard to persons, property vehicles or vessels, either in the air or on the ground.

1.5.3 However, with unmanned aviation, the primary consideration is the type of operation being conducted, rather than who or what is conducting it, or why it is being done. Because there is ‘no person on board’ the aircraft, the consequences of an incident or accident are purely dependent on where that incident/accident takes place. The CAAM’s focus therefore on the risk that the UAS operation presents to third parties, which means that more effort or proof is required where the risk is greater.

1.5.4 For the purpose of UAS operations, the ‘See and Avoid’ principle employed in manned aircraft is referred to as ‘Detect and Avoid’.

1.6 Unmanned aircraft – clarification of terms

1.6.1 The following term are reproduced here:

a) ‘unmanned aircraft’ means an aircraft and its associated elements which are operated with no pilot on board.

b) ‘aircraft’ means a machine that can derive support in the atmosphere from reactions of the air, other than reactions of the air against the surface of the earth.

c) For clarification, the CAAM considers the following as flying ‘objects’ rather than flying ‘machines’ and so are not considered to be unmanned aircraft:

1) Paper aeroplane
2) Hand launched glider, but only those with no moveable control surfaces or remote control link
3) Frisbees, darts and other thrown toys.

d) For the purpose of electrically powered unmanned aircraft, the batteries are considered as part of the aircraft, and the ‘charge’ is considered as the fuel.

1.7 ICAO Annexes

1.7.1 The 19 Annexes to the Chicago convention contain the International Standards and Recommended Practices (SARPS), upon which every ICAO member State then uses to create its own national regulations.

1.7.2 ICAO is currently in the process of developing international SARPS covering Remotely Piloted Aircraft Systems which are conducting international Instrument Flight Rules (IFR) operations within controlled airspace and from aerodromes. These SARPS fit into the Certified category of UAS operations and the appropriate regulations will be adapted in accordance with these SARPS when they are completed.

1.7.3 ICAO is not currently developing SARPS for any other types of UAS operations.

1.8 Civil and Military regulations

1.8.1 Any aircraft which is not 'military aircraft' must, under Civil Aviation Act 1969 [Act 3] comply with civil requirements. 'Military aircraft' means a military aircraft as defined in item 2. (1) of Civil Aviation Act 1969 [Act 3].

1.9 Personal Data Protection Act (PDPA Act 709)

1.9.1 UAS Operators and remote pilots should be aware that the collection of images of identifiable individuals, even inadvertently, when using surveillance cameras mounted on an unmanned aircraft, may be subject to the Malaysian Personal Data Protection Act 2010 [Act 709] which regulates the processing of personal data in commercial transaction with the implementation of the 7 Personal Data Protection Principles on the protection of individual with regard to the processing of personal data and on the free movement of such data.

1.9.2 UAS 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. They must ensure that they observe the relevant trespass laws and do not unwittingly commit a trespass whilst conducting a flight.

1.9.3 Guidance below can be used with regards to PDPA before conducting the operation.

No	Item	Reference
1	For guidance regarding the identification of the privacy risks of your operation	The Malaysian Personal Data Protection Act 2010 [Act 709].
2	Definition of personal data	Act 709 Section 4 – Any information that can identify a person.
3	Role as Data User and Data Processor	Data User - any person who has the control over or authorizes the processing of personal data must comply with the 7 Principles of PDP and other related provisions under Act 708 and other subsidiary legislation related Act 709). Data Processor – Processes personal data on behalf of a Data User. Under section 9(2) of Act 709, Data user must ensure that the Data processor provides sufficient guarantees in respect of technical and organisational security measures governing the processing of personal data and take reasonable steps to ensure compliance with those measures.
4	How to inform data subjects about the UAS Activities	Act 709 Section 7 – Notice and Choice Principle.
5	Information on data minimisation principle	Act 709 Section 6(3) states that data processes by a data user must be for a lawful purpose, necessary and directly related to that lawful purpose and is adequate but not excessive in relation to that purpose.
6	Rights of data subjects	There are 5 rights of data subject under Act 709 as follows: i. **Section 30** (Right to access); ii. **Section 43** (right to correct); iii. **Section 38** (withdrawal of consent to process personal data); iv. **Section 42** (right to prevent processing likely to cause damage or distress); and v. **Section 43** (right to prevent processing for purposes of direct marketing).

Note. - These are only guidelines, please refer to Ministry of Communications and Multimedia for the updated and accurate information.

1.10 Insurance

1.10.1 Each holder of a Special UAS Project Approval shall maintain a valid insurance to cover its liability towards a third party.

1.11 Enforcement

1.11.1 The CAAM takes breaches of aviation legislation seriously and will seek to prosecute in cases where dangerous and illegal flying has taken place.

1.11.2 Please report any misuse of UAS to CAAM and the Royal Malaysian Police.

1.11.3 The CAAM's remit is limited to safety and also to investigate where someone is operating, or has operated, in a manner that is not in accordance with their Special UAS Project Approval. This does not include concerns over privacy or broadcast rights. Breaches of Aviation Regulation legislation pertaining to UAS must be reported directly to: drone.enforcement@caam.gov.my

2 Definition and Abbreviation

2.1 Definition

a) For the purposes of this CAD, the definitions in Malaysia Civil Aviation Regulation 2016 apply.

b) The following definitions also apply:

1) **‘unmanned aircraft system’ (UAS)** means an aircraft and its associated elements which are operated with no pilot on board;

2) **‘unmanned aircraft system operator’ (‘UAS operator’)** means any legal or natural person operating or intending to operate one or more UAS;

3) **‘assemblies of people’** means gatherings where persons are unable to move away due to the density of the people present;

Note. - Assemblies of people have been defined by an objective criterion related to the possibility for an individual to move around in order to limit the consequences of an out-of-control UA. It was indeed difficult to propose a number of people above which this group of people would turn into an assembly of people: numbers were indeed proposed, but they showed quite a large variation. Qualitative examples of assemblies of people are:

a) sport, cultural, religious or political events;

b) beaches or parks on a sunny day;

c) commercial streets during the opening hours of the shops; and

d) ski resorts/tracks/lanes

4) **‘UAS geographical zone’** means a portion of airspace established by the competent authorities that facilitates, restricts or excludes UAS operations in order to address risks pertaining to safety, privacy, protection of personal data, security or the environment, arising from UAS operations;

5) **‘robustness’** means the property of mitigation measures resulting from combining the safety **gain** provided by the mitigation measures and the level of assurance and integrity that the safety gain has been achieved;

6) ***RESERVED***

7) **‘visual line of sight operation’ (‘VLOS’)** means a type of UAS operation in which, the remote pilot is able to maintain continuous unaided visual contact with the unmanned aircraft, allowing the remote pilot to control the flight path of the unmanned aircraft in relation to other aircraft, people and obstacles for the purpose of avoiding collisions;

8) **‘beyond visual line of sight operation’ (‘BVLOS’)** means a type of UAS operation which is not conducted in VLOS;

9) ***RESERVED***

10) ***RESERVED***

11) **'dangerous goods'** means articles or substances, which are capable of posing a hazard to health, safety, property or the environment and which are shown in the list of dangerous goods in the Technical Instructions or which are classified to those instructions.

Note.1 - In the case of an incident or accident, that the unmanned aircraft is carrying as its payload, including in particular:

i) Explosives (mass explosion hazard, blast projection hazard, minor blast hazard, major fire hazard, blasting agents, extremely insensitive explosives);
ii) Gases (flammable gas, non-flammable gas, poisonous gas, oxygen, inhalation hazard);
iii) Flammable liquids (flammable liquids, combustible, fuel oil, gasoline);
iv) Flammable solids (flammable solids, spontaneously combustible solids, dangerous when wet);
v) Oxidising agents and organic peroxides;
vi) Toxic and infectious substances (poison, biohazard);
vii) Radioactive substances;
viii) Corrosive substances;

Note.2 - Under the definition of dangerous goods, blood may be considered to be capable of posing a hazard to health when it is contaminated or unchecked (potentially contaminated). In consideration of Chapter 9 of this CAD.

a) medical samples such as uncontaminated blood can be transported in either via 'Special UAS Project' approval or it must be 'certified' in accordance to this CAD;

b) unchecked or contaminated blood must be transported in the 'Special UAS Project' or the 'certified' category. If the transport may result in a high risk for third parties, the UAS operation belongs to the 'certified' category. If the blood is enclosed in a container such that in case of an accident, the blood will not be spilled, the UAS operation may belong to the 'Special UAS Project' if there are no other causes of high risk for third parties.

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

13) **'direct remote identification'** means a system that ensures the local broadcast of information about a unmanned aircraft in operation, including

the marking of the unmanned aircraft, so that this information can be obtained without physical access to the unmanned aircraft;

14) **‘follow-me mode’** means a mode of operation of a UAS where the unmanned aircraft constantly follows the remote pilot within a predetermined radius;

15) **‘geo-awareness’** means a function that, based on the data provided by the competent authorities, detects a potential breach of airspace limitations and alerts the remote pilots so that they can take immediate and effective action to prevent that breach;

16) **‘privately built UAS’** means a UAS assembled or manufactured for the builder's own use, not including UAS assembled from sets of parts placed on the market as a single ready-to-assemble kit;

17) **‘autonomous operation’** means an operation during which an unmanned aircraft operates without the remote pilot being able to intervene;

Note. - Flight phases during which the remote pilot has no ability to intervene in the course of the aircraft, either following the implementation of emergency procedures, or due to a loss of the command-and-control connection, are not considered autonomous operations.

An autonomous operation should not be confused with an automatic operation, which refers to an operation following pre-programmed instructions that the UAS executes while the remote pilot is able to intervene at any time.

18) **‘uninvolved persons’** means persons who are not participating in the UAS operation or who are not aware of the instructions and safety precautions given by the UAS operator;

Note. - Due to the huge variety of possible circumstances, general guidelines below may be used:

An uninvolved person is a person that does not take part in the UAS operation, either directly or indirectly.

A person may be considered to be ‘involved’ when they have:

a) given explicit consent to the UAS operator or to the remote pilot to be part of the UAS operation (even indirectly as a spectator or just accepting to be overflown by the UAS); and
b) received from the UAS operator or from the remote pilot clear instructions and safety precautions to follow in case the UAS exhibits any unplanned behaviour.

In principle, in order to be considered a ‘person involved’, one:

a) is able to decide whether or not to participate in the UAS operation;
b) broadly understands the risks involved;
c) has reasonable safeguards during the UAS operations, introduced by the site manager and the aircraft operator; and

d) is not restricted from taking part in the event or activity if they decide not to participate in the UAS operation.

The person involved is expected to follow the directions and safety precautions provided, and the UAS operator or remote pilot should check by asking simple questions to make sure that the directions and safety precautions have been properly understood.

Spectators or any other people gathered for sport activities or other mass public events for which the UAS operation is not the primary focus are generally considered to be 'uninvolved persons'.

People sitting at a beach or in a park or walking on a street or on a road are also generally considered to be uninvolved persons.

An example: when filming with a UAS at a large music festival or public event, it is not sufficient to inform the audience or anyone present via a public address system, or via a statement on the ticket, or in advance by email or text message. Those types of communication channels do not satisfy the points above. In order to be considered a person involved, each person should be asked for their permission and be made aware of the possible risk(s). This type of operation does not fall into the 'open' category and may be classified as 'specific' or 'certified', according to the risk.

19) **'making available on the market'** means any supply of a product for distribution, consumption or use on the Malaysian market in the course of a commercial activity, whether in exchange of payment or free of charge;

20) **'placing on the market'** means the first making available of a product on the Malaysian market;

21) **'controlled ground area'** means the ground area where the UAS is operated and within which the UAS operator can ensure that only involved persons are present;

22) **'maximum take-off mass' ('MTOM')** means the maximum Unmanned Aircraft mass, including payload and fuel, as defined by the manufacturer or the builder, at which the Unmanned Aircraft can be operated;

Note. - This MTOM is the maximum mass defined by the manufacturer or the builder, in the case of privately built UAS, which ensures the controllability and mechanical resistance of the UA when flying within the operational limits.

The MTOM should include all the elements on board the UA:

a) all the structural elements of the UA;
b) the motors;
c) the propellers, if installed;
d) all the electronic equipment and antennas;
e) the batteries and the maximum capacity of fuel, oil and all fluids; and
f) the heaviest payload allowed by the manufacturer, including sensors and their ancillary equipment.

23) **‘unmanned sailplane**’ means an unmanned aircraft that is supported in flight by the dynamic reaction of the air against its fixed lifting surfaces, the free flight of which does not depend on an engine. It may be equipped with an engine to be used in case of emergency.

24) **‘unmanned aircraft observer’** means a person, positioned alongside the remote pilot, who, by unaided visual observation of the unmanned aircraft, assists the remote pilot in keeping the unmanned aircraft in VLOS and safely conducting the flight;

25) **‘aircraft observer’** means a person who assist the remote pilot by performing unaided visual scanning of the airspace in which the unmanned aircraft is operating for any potential hazard in the air;

26) **‘command unit’ (“CU”)** means the equipment to control unmanned aircraft remotely as defined in point 32 of Article 3 of Regulation (EU) 2018/1139 which supports the control or the monitoring of the unmanned aircraft during any phase of flight, with the exception of any infrastructure supporting the command and control (C2) link service;

27) **‘C2 link service’** means a communication service supplied by a third party, providing command and control between the unmanned aircraft and the CU;

28) **‘flight geography’** means the volume(s) of airspace defined spatially and temporarily in which the UAS operator plans to conduct the operation under normal procedures;

29) **‘flight geography area’** means the projection of the flight geography on the surface of the earth;

30) **‘contingency volume’** means the volume of airspace outside the flight geography where contingency procedures are applied;

31) **‘contingency area’** means the projection of the contingency volume on the surface of the earth;

32) **‘operational volume’** is the combination of the flight geography and the contingency volume;

33) **‘ground risk buffer’** is an area over the surface of the earth, which surrounds the operational volume and that is specified in order to minimise the risk to third parties on the surface in the event of the unmanned aircraft leaving the operational volume;

34) **‘night’** means the time between 20 minutes after sunset and 20 minutes before sunrise, excluding both the times, determined at surface level;

36) **‘Agricultural UAS operations**’ is the operations of a UAS for the purpose of:

  i) Dispensing any ‘agricultural payload’ intended for plant nourishment, soil treatment, propagation of plant life, or pest control; or
  ii) Engaging in dispensing ‘agricultural payload’ and surveillance activities directly affecting agriculture, horticulture, or forest preservation, but not including the dispensing of live insects.

37) **‘Agricultural Payload’** means any dispensing materials such as pesticides and any other substances as permitted by Department of Agriculture (DOA). (Refer to DOA website for approved Agricultural Payload List)

38) **‘Pesticides’** means, subject to subsection (2) of Pesticides Act 1974 means:

  i) Any substance that contains an active ingredient; or
  ii) Any preparation, mixture or material that contains any one or more of the active ingredients as one of its constituents, but does not include contaminated food or any article listed in the Second Schedule of Pesticides Act 1974.

2.2 Abbreviation

AEC	Airspace Encounter Category
AEH	Airborne Electronic Hardware
ANSP	Air Navigation Service Provider
ARC	Air Risk Class
AGL	Above Ground Level
AM	Accountable Manager
AMC	Acceptable Means of Compliance
AO	Airspace Observer
ATC	Air Traffic Control
ATO	Approved Training Organisation
ATP	Authorised Technical Personnel
AWC	Aerial Work Certificate
BVLOS	Beyond Visual Line of Sight
CAAM	Civil Aviation Authority of Malaysia
CEO	Chief Executive Officer (CAAM, unless stated otherwise)
CG	Centre of Gravity
CGSO	Chief Government Security Office
COA	Certificate of Approval
CRP	Chief Remote Pilot
C2	Command and Control
C3	Command, Control and Communication
ConOps	Concept of Operations
DAA	Detect and Avoid
DOA	Department of Agriculture
ERP	Emergency Response Plan
FHSS	Frequency-Hopping Spread Spectrum
FOM	Flight Operations Manager
GRC	Ground Risk Class

GM	Guidance Material
GNSS	Global Navigation Satellite System
HMI	Human Machine Interface
ISM	Industrial, Scientific and Medical
JARUS	Joint Authorities for Rulemaking on Unmanned Systems
JUPEM	Jabatan Ukur dan Pemetaan Malaysia
LRMP	Lembaga Racun Makhluk Perosak
MAFI	Ministry of Agriculture and Food Industries
METAR	Aviation Routine Weather Report (in (aeronautical) meteorological code)
MC	Maintenance Controller
MCC	Multi-Crew Cooperation
MCAR	Civil Aviation Regulation 2016
MCMC	Malaysian Communications and Multimedia Commission
MTOM	Maximum Take-Off Mass
OM	Operations Manual
OSO	Operational Safety Objective
PDRA	Pre-Defined Risk Assessment
PtF	Permit to Fly
RBO	Risk-Based Oversight
RCoC	Remote Pilot Certificate of Competency
RCP	Required Communication Performance
RF	Radio Frequency
RFI	Remote Pilot Flight Instructor
RGI	Remote Pilot Ground Instructor
RLP	Required C2 Link Performance
RP	Remote Pilot
RPS	Remote Pilot Station
RPTO	Remote Pilot Training Organisation
SAIL	Specific Assurance and Integrity Level
SIRIM	Standard and Industrial Research Institute of Malaysia

SM	Safety Manager
SMSM	Safety Management System Manual
SOE	Schedule of Events
SORA	Specific Operations Risk Assessment
SPECI	Aviation Selected Special Weather code (in (aeronautical) meteorological code)
STS	Standard Scenario
SW	Software
TAF	Terminal Area Forecast
TCAS	Traffic Collision Avoidance System
TMPR	Tactical Mitigation Performance Requirement
TPM	Training and Procedure Manual
UA	Unmanned Aircraft
UAS	Unmanned Aircraft System
UAS Regulation	MCAR 2016 Part XVI and its legislations pertaining to UAS, including CAD 6011 and its subseries
VLL	Very Low Level
VLOS	Visual Line Of Sight
VO	Visual Observer

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3 Certification Process

3.1 Applying to conduct Special UAS Project Operations

3.1.1 This Chapter describes the process of applying for a Special UAS Project Approval in order to conduct a Special UAS Project. The CAAM has established a methodological approach for evaluating and determining an applicant's ability to comply with the Regulations. Depending on the operational risk the applicant presents, the applicants must successfully satisfy some or all of the phases in the evaluation process to receive the Special UAS Project Operations approval: The phases are:

a) Pre-application Phase;

b) Formal application Phase;

c) Documents Evaluation Phase;

d) Demonstration and Inspection Phase; and

e) Certification Phase.

3.1.1.1 With reference to 3.1.1, the applicants that will be required to satisfy in full all five (5) phases will be as following:

a) Operational risk with Safety Assurance Integrity Level (SAIL) amounting to three (III) onwards will be required

b) As stated by the Civil Aviation Authority of Malaysia (CAAM).

3.1.1.2 The applicants that are exempted from the full five phases certification process will still be subjected to:

a) a pre-application phase,

b) formal application phase,

c) documents evaluation phase (as applicable) and

d) certification phase.

Note. - Depending on the size and complexity of the Operation, the Demonstration and Inspection phase will either be conducted together with the Document evaluation phase, exempted or conducted specifically on its own phase on case by case basis by the CAAM.

3.2 Pre-application Phase

3.2.1 The pre-application meeting is an informal meeting to provide applicants with an overview of the certification process and identify the necessary resources to assist them in becoming certificated.

3.2.2 In addition to understanding the MCAR 2016, this CAD and its related documents, the CAAM strongly advices initial new applicants to book a pre-application meeting before preparing an application. To book a meeting, send an email to **drone.specific@caam.gov.my** in the subject field, put a **"request for Special UAS Project Approval pre-application meeting".** Within the body of the e-mail, indicate your preference for face-to-face or teleconference, and include your contact details.

3.2.3 The CAAM will advise the prospective applicant on the approximate period of time that will be required to conduct the certification process, subsequent to the receipt of a complete and properly executed application. This advice is particularly important in the case of new operators so that such applicants may avoid undue financial outlays during the certification period.

3.2.4 If an applicant is familiar with all the requirements of the certification process and the required documentation, they may not need a pre-application meeting (e.g., if they have previous experience as a Special UAS Project Approval holder approved by CAAM). In such cases, the CAAM eliminates the pre-application phase and the applicant proceeds to the formal application phase.

3.2.5 Depending on applicability, Jawatankuasa UAS (JAKUAS) may be called to join during the pre-application phase. JAKUAS may comprise of:

a) CAAM UAS Unit and other related divisions;

b) SIRIM;

c) MCMC;

d) JUPEM; and

e) CGSO; and

f) Other Agencies as required.

Note. - A representative of CAAM UAS Unit will act as chairman of JAKUAS.

3.2.6 The establishment of JAKUAS is required for the applicant to determine the applicability and compliance with all other UAS regulations set by other agencies; and if required, for the certification/approval process to work parallel.

3.2.7 Sequence of Events for Pre-application Phase

3.2.7.1 The sequence of events from the submission of application for issue of Special UAS Project Approval shall be as follows

a) Applicant will be required to establish contact with CAAM to understand procedures and gather information relevant to the Special UAS Project;

b) The name and Place of business of the applicant;

c) A description of the applicant's business organisation, corporate structure, and names and addresses of those entities and individuals having a major financial interest;

d) The nature or the proposed operations or activities;

e) A description of the applicant's business organisation.

3.2.7.1.1 In order to present to CAAM the items listed in 3.2.7.1, the applicant shall submit to CAAM:

a) For SORA Applicant: a drafted/cursory work SORA; The template provided in Appendix 1-6 details subject areas that should be addressed when producing the SORA.

b) For PDRA applicant: Compliance Declaration and its associated Documentations/Manuals alongside with the Application Form.

Note. - The reason why the drafted SORA is required at an early stage is to determine the feasibility of the operation to be conducted in Special UAS Project. The CAAM will only conduct a cursory view of the SORA during the application phase and the detailed assessment will only be conducted during the Document Evaluation Phase. CAAM will not be held liable and certification costs will not be refunded if during the Document Evaluation Phase, the operation intended cannot be continued via the Special UAS Project. (e.g., the mitigations and objectives proposed by the operator and required by the SORA does not meet sufficient level of confidence).

3.2.7.2 During the meeting, the CAAM will ensure that applicants meet the eligibility requirements for obtaining a Special UAS Project Approval by conducting a general inquiry. Be prepared to provide the CAAM with the following information:

a) Location of home base of operations;

b) Location of probable satellite sites;

c) Location(s) of the proposed operation(s) in .kmz/.kml file;

d) Operating as individual, corporation, or partnership;

e) Category and class of UAS; and

f) Qualifications and experience of Flight Operations Manager (FOM).

3.3 Formal application Phase

3.3.1 During this phase, the applicant is expected to submit:

a) For SORA applicant: the complete SORA to CAAM together, with the proposed Schedule of Event, the Application Form and the cost of certification established during the previous phase and relevant documents to support the intended operation.

b) For PDRA applicant: the Schedule of Event and the cost of certification established during the previous phase and relevant documents (if not already) to support the intended operation.

Note.1 - The application will not be processed in the event the applicant fails to make payment within 14 working days. Where application contains significant deficiencies, the CAAM will advise the applicant of this and provide an opportunity to withdraw and amend their application. Note that this will suspend the application process to a maximum of 30 calendar days after which, if revised information has not been received, the applicant will be cancelled, and all the monies will not be refunded to the applicant.

Note.2 - The applicant should be sure before submitting to CAAM for a formal application Phase that his intended operation may fall into the Special UAS Project. If applicant's risks are not properly mitigated via the SORA, and fall into the 'certified' category, all monies will not be refunded to the applicant, and a different certification for 'certified' category shall take place.

3.3.2 The CAAM will review the application within 21 working days of receiving the items required as listed in paragraph 3.3.1.

3.3.3 Applicants are notified, in writing, whether the formal application is accepted or rejected. If the application is inaccurate or not completed properly, the CAAM returns the application to the applicant outlining the items that are unsatisfactory. Applicants must take the appropriate action to correct the items before the certification process can continue. The CAAM may determine that a formal application meeting is necessary to resolve the issues with the application. Typically, the pre-application phase covers these items or specific discrepancies found with the application.

3.3.4 The CAAM's acceptance of a formal application phase does not constitute approval or acceptance of individual attached documents. The documents are thoroughly evaluated during subsequent phases of the certification process. This phase ends upon the CAAM's acceptance of the application, and the Document Evaluation Phase begins.

3.3.5 At this stage, the applicant and the UAS Unit certification team will likely know if the requirement of 'The Committee' is still required. The applicant is required to follow through with the approval process with the other relevant agencies if required. The approvals of other agencies are pertinent to be completed prior to the conduct of demonstration and inspection phase.

3.3.6 Sequence of Events for Formal Application Phase

3.3.6.1 On receipt of acceptance of a Formal application, an applicant must fulfil the following requirements towards achieving a sound status as assessed by CAAM for issuance of Special UAS Project Approval:

a) Set up main base and operations base as applicable with a principal place of business, the registered office located in Malaysia. Such bases may be subjected to inspection by Inspectors of CAAM consistent with the type of operations sought;

b) Recruit adequately Key Management Officials commensurate with the type of operations (administrative, operational, maintenance, financial, etc.). Only the competence of the Flight Operations Manager, Safety Manager, Authorised Technical Personnel and the Accountable Manager shall be subjected to verification of the CAAM;

c) Submit the required documents as stated in paragraph 3.3.1 (as applicable) for the CAAM's review followed by acceptance/approval. The review of the documents is likely to be repeated for several times;

d) Obtain information on the UA(s) as well as the UA(s) purchase/lease documents for onward submission to the CAAM. The purchase/lease documents at this stage could be provisional one;

e) Initiate training of Remote Pilot and other personnel as applicable;

f) Prepare the company for inspection/evaluation by the CAAM;

g) Arrange for inspection of UA by the CAAM UAS Unit (either brought in to CAAM or at UA location);

h) Prepare for UA inspection, emergency response plan procedure and demonstration;

i) Prepare for demonstration flights as applicable;

j) Complies with MCAR 2016 and all the applicability of this CAD and CAD 6011 (when it becomes effective), as applicable;

k) Any other additional requirements that are deemed necessary by CAAM;

l) Any other additional requirements that are deemed necessary by The Committee;

m) Submit application form with relevant documents for issuance of SUP Approval.

Note.1 - The applicant must submit schedule of events (refer Attachment B) to the CAAM which are agreeable to both parties to demonstrate that the applicant has the capability and competency to comply with all requirements for the issuance of the SUP Approval. The dates shall be logical in sequence and provide time for review, inspection and approval of each item.

Note.2 - CAAM will determine if the inspection will be carried out for item (f), (g), (h) and (i) of this paragraph. Nonetheless, the applicant must be ready if an inspection by the CAAM takes place.

3.3.6.2 The criteria for a formal application for issue of an SUP Approval shall depend upon the applicant having been assessed by the CAAM to have attained satisfactory standard as regards to the sequence of events observed and the requirements mentioned in paragraph 3.3.6.1 duly complied with. At this stage, applicant shall submit application along with the required fees to the CEO in a prescribed form for issuance of SUP Approval.

3.3.6.3 For a renewal of the SUP Approval, the process will start from the Formal Application Phase as mentioned in 3.3.6.1. For all other applicants the process will start from Pre-application Phase.

3.4 Documents Evaluation Phase

3.4.1 During this phase, CAAM will undertake a detailed study of the applicant's SORA, compliance declaration for PDRA, manuals (if applicable) and other documents, as applicable which accompanied the formal application. The documentation must be complete, accurate and current to satisfy the CAAM's requirements before the inspection phase (if required) commences. There will be series of discussions between the CAAM and the applicant at this stage with regards to establishing the validity/acceptability of the applicant's proposals. It must be understood that the documents shall precisely reflect the mode and manner which the applicant intends to conduct the proposed operations and once approved; they shall form a part of understanding between the CAAM and the operator with regards to future functions of the operator.

3.4.2 Sequence of Events for Submission of Documents

3.4.2.1 In pursuant to item 3.4.1, After reviewing/correcting, applicant will submit two final copies of the manuals for CAAM approval.

3.5 Demonstration and Inspection Phase

3.5.1 During this phase, the applicant needs to demonstrate to the CAAM that the applicant is in a position to conduct the proposed operations in accordance with the procedures detailed in the SORA/documents/manuals reviewed during the previous phase utilising the personnel/facilities/equipment identified in the formal application. Qualifications and experience of the nominees for Nominated Post Holder(s) will be evaluated. Aircraft, maintenance facilities and arrangements will be inspected. Training facilities (on job training programme), and training personnel will be evaluated.

3.5.2 Operator's organisational structure, channels of communication, delegation of powers, financial strength and sources of funding will be subjected to detailed scrutiny to ensure that the operator has sufficient resources, effective arrangements and control to satisfy its obligations.

3.5.3 Nominated Post Holder(s), Flight Operations, Remote Pilot(s) and as required by the CAAM will also be assessed according to the operations during this phase.

3.5.4 If CAAM is satisfied with the above arrangements, demonstration flight(s) as applicable will be conducted, as determined by the CAAM. This phase may reveal the need for some operational changes, which in turn may require the applicant to make amendments to the documents originally submitted. All elements must be satisfactorily completed before proceeding to the certification phase.

3.6 Certification Phase

3.6.1 Once all the Demonstration and Inspection Phase is complete, the CAAM will discuss the outcome of the assessment with the applicant. At this point, the two possible outcomes are:

a) **Application is not yet complete:** If there are any deficiencies that cannot be remediated during the previous phase, the CAAM will indicate in writing the areas that need rework. The report will cover all aspect of the assessment phase, including course content, facilities and personnel. It should be noted that reports may contain constructive criticism.

b) **Application accepted:** If there are no deficiencies and once the CAAM has determined that all requirements, operational have been completed in a satisfactory manner, and that the applicant will comply with the applicable regulations and is fully capable of fulfilling its responsibilities and conducting a safe and efficient operation.

3.6.2 When all the previous phases have been **satisfactorily** completed, CAAM will take the necessary administrative action to accept formally the nominees for Key Personnel (if not already), the UA (if required), facilities and procedures specified in the ConOps, Operations Manual, applicable documents and formally issue the Special UAS Project Approval.

3.6.3 The culmination of this phase is the issuance of the SUP Approval to the applicant.

3.6.4 Subsequent to the issuance of a SUP Approval, the CAAM inspector will be responsible for conducting periodic inspections, to ensure the SUP Approval Holder's continued compliance with the CAAM regulations, authorisation, limitations and provisions of its SUP Approval.

3.6.5 The entire Certification for SUP Approval process flow chart can be found in Attachment D.

4 Special UAS Project

4.1 Scope of SUP Approval

4.1.1 No person shall engage in SUP activities unless in possession of valid SUP Approval issued by the CAAM, and in accordance with this CAD.

4.1.2 Each person having operational control for an SUP operation shall hold, and comply with the SUP Approval, issued by the CAAM.

4.1.3 For the purpose of paragraph 4.1.2, a person has responsibility for operational control if the person has any of the following functions as part of his responsibilities:

a) Assigning personnel for the operation and determining whether the operation may be operated safely;

b) Employing, contracting or otherwise engaging crew members for the operation;

c) Making a decision to vary the operation, other than a decision by the Remote Pilot taken on the grounds regarding safety.

4.1.4 If required by the CAAM, the applicant shall, upon an application for the issuance of the SUP Approval, cause the CAAM inspector to be trained and rated on the type of the UA listed in the application form.

4.1.5 If required by the CAAM, the operator shall, upon application for the variation of the SUP Approval to include additional type of UA, cause the CAAM inspector to be trained and rated on the type of aircraft listed in the application form.

4.2 Criteria for the issuance of SUP Approval

4.2.1 An applicant is entitled to a SUP Approval if it is approved by the CEO and is satisfied that:

a) Each applicant has demonstrated and meets the applicable requirements of this CAD; and

b) The granting of SUP Approval is not contrary to the interest of aviation safety.

4.2.2 The application for a SUP Approval shall be based on the risk assessment referred to in Chapter 6 of this CAD and shall include in addition the following information:

a) an operations manual when required by the risk and complexity of the operation;

b) a confirmation that an appropriate insurance cover will be in place at the start of the UAS operations;

c) contracted or own UTM system services to be used during the operation as required by Chapter 7 of this CAD.

4.2.3 The UAS operator shall submit an application for an updated Special UAS Project Approval if there are any significant changes to the operation or to the mitigation measures listed in the Special UAS Project Approval.

4.3 Significant Changes to the SUP Approval

4.3.1 Any non-editorial change that affects the SUP Approval, or affects any associated documentation that is submitted to demonstrate compliance with the requirements established for the authorisation, should be considered to be a significant change.

4.3.2 With regard to the information and documentation associated with the approval, changes should be considered to be significant when they involve, for example:

a) changes in the operations that affect the assumptions of the risk assessment;

b) changes that relate to the management system of the UAS operator (including changes of key personnel), its ownership or its principal place of business;

c) non-editorial changes that affect the operational risk assessment report;

d) non-editorial changes that affect the policies and procedures of the UAS operator; and

e) non-editorial changes that affect the OM (when required).

4.4 Transferability of a SUP Approval

4.4.1 A SUP Approval is not transferable.

4.5 Validity, suspension and revocation of SUP Approval

4.5.1 Depending on the competence of the SUP Approval Holder and its organisation, a SUP Approval may be valid up to a maximum of one (1) year. The date of issuance and expiry date is to be entered on the SUP Approval.

4.5.2 A SUP Approval will remain in force during the validity period until it is suspended or revoked by the CEO in accordance with the Regulation 193 of the MCAR 2016.

4.5.3 Any approval that is suspended or revoked must be surrendered forthwith to the CEO.

4.5.4 The certificate that expires shall forthwith be deposited by the holder to the CEO.

4.6 Oversight of SUP Approval

4.6.1 SUP Approval Holder shall be subjected to an annual desktop review of the operations, manuals, facilities, remote pilot currency logs and other relevant information when UAS operator apply to renew their SUP Approval. In addition, some UAS Operators will be selected for an 'on-site' audit on a random basis.

4.6.1.1 The application required by paragraph 4.6.1 shall be submitted to the CEO at least four (4) months prior to the expiry date of the SUP Approval, along with a statement in the application regarding the current capability and competency of the Operator.

4.6.2 Depending on the complexity of the organisation or the operations being conducted by the UAS operator, performance-based oversight principles may dictate that the CAAM's level of oversight is increased. This may mean more frequent audits of some UAS operators, or variations in the scope and manpower employed to conduct the audit.

4.6.3 On-site audits will be normally be scheduled with the UAS operator, although the CAAM reserves the right to conduct audits at 'no notice' if such an action is considered necessary. Audits will be conducted by the UAS Unit and may be carried out at the UAS operator's 'base' and/or at an operating location while carrying out an operating task.

Note. - For the purpose of demonstrating compliance with the UAS Regulation, a SUP Approval Holder shall grant to any person, that is duly authorised by the CAAM, an access to any facility, UAS, document, records, data, procedures or to any other material relevant to its activity.

4.6.4 Any findings or observations will be discussed during the audit and a timescale for their rectification will be agreed.

4.6.5 Oversight reports will be distributed to UAS operators within 28 working days of completion of an audit. The UAS operator will be expected to respond within the allocated timescale detailing the actions it intends to take to rectify any identified issues. Further communication will continue as considered necessary by the CAAM until the oversight report and associated findings/observations are closed.

4.6.6 Renewal of SUP Approval will be denied in case the SUP Approval Holder fails to come up with adequate corrective actions to a satisfactory level. Lack of timely corrective action or non-conformance with the regulatory requirements may result in enforcement action whenever applicable.

4.6.7 Finding and observations

4.6.7.1 When objective evidence is found by the CAAM during an audit or inspection that shows non-compliance with the applicable requirements, a finding will be notified to the UAS operator. In extreme cases, the UAS operator's operational authorisation or operating certificate may be limited, suspended or even revoked immediately.

4.6.7.2 Findings are classified as follows:

a) A level-one finding is any non-compliance with these requirements that could lead to uncontrolled non-compliances and which could affect the safety of a UAS operation;

b) A level-two finding is any non-compliance with these requirements that is not classified as level-one.

An observation may be raised where there is potential for future non-compliance if no action is taken, or where the CAAM wishes to indicate an opportunity for safety improvement or indicate something that is not considered good practice.

5 Requirement for the Issuance of SUP Approval

Operational Requirements

5.1 Responsibilities of the UAS operator

5.1.1 The UAS operator shall comply with all of the following:

5.1.1.1 Establish procedures and limitations adapted to the type of the intended operation and the risk involved, including:

a) Operational procedures to ensure the safety of the operations;

b) Procedures to ensure that security requirements applicable to the area of operations are complied with the intended operation;

c) Measures to protect against unlawful interference and unauthorised access;

d) Procedures to ensure that all operations are in respect of Protection Data Personal Act 2010. (Refer to paragraph 1.9 of this CAD for further guidance);

e) Guidelines for its remote pilots to plan UAS operations in a manner that minimises nuisances, including noise and other emissions-related nuisances, to people and animals.

5.1.1.1.1 Operational Procedures

a) In addition to 5.1.1.1 (a), if a UAS Operator employs more than one remote pilot, the UAS operator should:

1) Develop procedures for UAS Operations in order to coordinate the activities between its employees; and

2) Compile and maintain a list of their personnel and their assigned duties.

b) The UAS Operator should allocate functions and responsibilities in accordance with the level of autonomy of the UAS during the operation.

Note. - The UAS operator should develop operational procedures based on manufacturer's recommendations, if available.

5.1.1.2 Ensure that all operations effectively use and support the efficient use of radio spectrum in order to avoid harmful interference.

5.1.1.3 Ensure that before conducting operations, remote pilots comply with all of the following conditions:

a) Have the competency to perform their tasks in line with the applicable training identified by the Special UAS Project Approval;

b) Follow remote pilot training which shall be competency-based and include the competencies set out in CAD 6011 (I) Remote Pilot Training Organisation;

c) Have been informed about the UAS operator's operations manual or operations procedure.

5.1.1.4 Ensure that personnel in charge of duties essential to the UAS operation, other than the remote pilot itself, comply with all of the following conditions:

a) Have completed the on-the-job training developed by the operator;

b) Have been informed about the UAS operator's operations manual, if required by the risk assessment.

5.1.1.5 Carry out each operation within the limitations, conditions and mitigation measures defined in the Special UAS Project Approval.

5.1.1.6 Keep a record of the information on UAS operations. (Refer to paragraph 5.1.2 for additional guidance)

5.1.1.7 Keep and maintain an up-to-date record of:

a) All the relevant qualifications and training courses completed by the remote pilot and the other personnel in charge of duties essential to the UAS operation and by the maintenance staff, for at least 3 years after those persons have ceased employment with the organisation or have changed their position in the organisation;

b) The maintenance activities conducted on the UAs for a minimum of 3 years;

c) The information on UAS operations, including any unusual technical or operational occurrences and other data as required by the declaration for a minimum of 3 years.

5.1.1.8 Use UAS which, as a minimum, is designed in such a manner that a possible failure will not lead the UAS to fly outside the operation volume or to cause a fatality. In addition, Man-Machine interfaces shall be such to minimise the risk of pilot error and shall not cause reasonable fatigue.

5.1.1.9 Maintain the UAS in a suitable condition for safe operation by:

a) As a minimum, defining maintenance instructions and employing an adequately trained and qualified maintenance staff (Authorised Technical Personnel); and

b) Complying with paragraph 5.4, if required;

c) Using an unmanned aircraft which is designed to minimise noise and other emissions, taking into account the type of the intended operations and geographical areas where the aircraft noise and other emissions are of concern.

5.1.1.10 Ensure that the RPs employed are at least 18 years old and meets the currency requirements as below:

a) a requirement to practise all manoeuvres that are relevant to the Special UAS Project Approval;

b) A requirement to practice responses to abnormal conditions and in-flight failures on a regular basis, such as:

1) The ability to identify a deteriorating situation and react accordingly;

2) Taking manual control after a failure of any automated systems

3) Practice flight in ‘manual’ modes

4) Identification of the potential for GNSS and compass loss or degradation.

5.1.1.11 Submit to the CAAM an end report of the operational activity every quarterly and at the end of the SUP Approval indicating:

a) The activity performed and its objectives;

b) Any significant incident or accident that occurred during the operation;

c) Total economic savings if using UA operations versus not using UA (if available);

d) Total time savings if using UA operations versus not using UA (if available);

e) Reports on test data and its findings/conclusion (if applicable);

f) Unmentioned/Latent risk that appeared during the operations;

g) Operators suggestions on operational or technical improvements; and

h) Areas where CAAM may improve.

5.1.2 Logging of Flight Activities and Record Keeping

a) In pursuant to paragraph 5.1.1.6, an acceptable means to log and record the flight activities is to use a logbook, which may be electronic.

b) The information to be recorded should be indicated in the Special UAS Project Approval, which may include the following:

1) the identification of the UAS (manufacturer, model/variant (e.g., serial number);
Note. - if the UAS is not subject to registration, the identification of the UAS may be done using the serial number of the UAS.
2) the date, time, and location of the take-off and landing;
3) the duration of each flight;
4) the total number of flight hours/cycles;
5) in the case of a remotely piloted operation, the name of the remote pilot responsible for the flight;
6) the activity performed;
7) any significant incident or accident that occurred during the operation;
8) a completed pre-flight inspection;
9) any defects and rectifications;
10) any repairs and changes to the UAS configuration; and
11) the information required to comply with paragraph 5.4.

c) Records should be stored for 3 years in a manner that ensures their protection from unauthorised access, damage, alteration, and theft.

d) The logbook can be generated in one of the following formats: electronic or paper. If the paper format is used, it should contain, in a single volume, all the pages needed to log the holder’s flight time. When one volume is completed, a new one will be started based on the cumulative data from the previous one.

5.2 Management System

5.2.1 The operator shall establish, implement and maintain a management system corresponding to the size of the organisation, to the nature and complexity of its activities, taking into account the hazards and associated risks inherent in these activities.

5.2.2 The UAS operator shall comply with all the following:

a) Nominate an Accountable Manager with authority for ensuring that within the organisation all activities are performed in accordance with the applicable standards and that the organisation is continuously in compliance with the requirements of the management system;

b) Organisation structure acceptable to the CAAM with define lines of responsibility and accountability throughout the operator, including a direct safety accountability of the Accountable Manager;

c) A description of the overall philosophies and principles of the operator with regard to safety, referred to as the safety policy;

Note. - Guidance on SMS can be found in Chapter 8 of this CAD.

d) Appoint Nominated Post Holder(s) to execute the safety policy;

e) The identification of aviation safety hazards entailed by the activities of the operator, their evaluation and the management of associated risks, including taking actions to mitigate the risk and verify their effectiveness;

f) Maintaining trained and competent personnel to perform their tasks;

g) A function to monitor compliance of the operator with the relevant requirements. Compliance monitoring shall include a feedback system of finding to the AM to ensure effective implementation of corrective actions as necessary;

h) Any additional requirements as directed by the Chief Executive Officer.

5.2.3 The management system shall correspond to the size of the operator and the nature and complexity of its activities, taking into account the hazards and associated risks inherent in these activities.

a) The minimum Nominated Post Holder(s) that must be accepted by CAAM for the SUP Approval are:

1) Safety Manager (SM);
2) Flight Operations Manager (FOM); and
3) Authorised Technical Personnel (ATP).

Note. - The application form for nomination of an Accountable Manager or the Nominated Post Holder(s) can be found on the CAAM website, under UAS Section.

5.2.3.1 The acceptability of a single person holding several posts, possibly in combination with being the AM as well, will depend upon the nature and scale of the operation. The two main areas of concern are competency and an individual’s capacity to meet his responsibilities.

5.2.3.2 The Nominated Post Holder(s) shall be Malaysian citizens unless local expertise is not available for the safety of its operation. In cases where foreign expertise is required, approval shall be granted in accordance with the local employment terms and conditions and approved by CAAM.

5.2.4 Accountable Manager (AM)

a) The operator shall appoint AM as accepted by the CAAM who has the corporate authority for ensuring that all operations and maintenance activities can be financed and carried out to the standard required by the CAAM and any additional requirements defined by the UAS operator.

b) The AM is an essential part of the SUP Approval holder's management organisation. The term 'AM' is intended to mean the Chief Executive/Executive Chairman/Managing Director/CEO/General Manager, etc. of the operator's organisation, who by virtue of his position has overall responsibility (including finance) for managing the organisation.

5.2.5 Safety Manager (SM)

a) The operator shall appoint a SM accepted by the CAAM to ensure that the implementation and maintenance of an effective SMS. (Refer to Chapter 8 for further guidance). The SM shall:

   1) Have extensive applicable and adequate knowledge and experience commensurate with the Operator's planned operations, MCAR 2016, UAS Regulations and SMS.

Note. - Depending on the size and complexity of the organisation, the SM may be required to have undergone SMS Implementation Course.

b) The Safety Manager should:

   1) facilitate hazard identification, risk analysis, and risk management;
   2) monitor the implementation of risk mitigation measures;
   3) provide periodic reports on safety performance;
   4) ensure maintenance of the safety management documentation;
   5) ensure that there is safety management training available and that it meets acceptable standards;
   6) provide all the personnel involved with advice on safety matters; and
   7) ensure the initiation and follow-up of internal occurrence investigations.

5.2.6 Flight Operations Manager (FOM)

a) The operator shall appoint FOM as accepted by the CAAM to ensure that the operations are in compliance with the standards required by the CAAM, and any additional requirements defined by the UAS operator.

b) The qualifications of the FOM are:

   1) Has extensive applicable and acceptable experience to the type of operation conducted in the Special UAS Approval;
   2) Possess sound managerial capability.

5.2.7 Authorised Technical Personnel (ATP)

a) The operator shall nominate an authorise ATP and accepted by the CAAM to ensure that the technical requirements are in compliance with the standards required by the CAAM, and any additional technical requirements defined by the UAS operator.

b) Refer to paragraph 5.5 for more information on ATP.

5.3 Level of Autonomy and Guidelines for Human-autonomy Interaction

5.3.1 The concept of autonomy, its levels and human-autonomous system interactions are currently being discussed in various domains (not only in aviation), and no common understanding has yet been reached. Guidance will therefore be provided once this concept is mature and globally accepted.

5.3.2 Autonomous operations are **not allowed** by CAAM at this moment.

Note.1 - 'autonomous operation' means an operation during which an unmanned aircraft operates without the remote pilot being able to intervene.

Note.2 - Flight phases during which the remote pilot has no ability to intervene in the course of the aircraft, either following the implementation of emergency procedures, or due to a loss of the command-and-control connection, are not considered autonomous operations.

An autonomous operation should not be confused with an automatic operation, which refers to an operation following pre-programmed instructions that the UAS executes while the remote pilot is able to intervene at any time.

5.4 Use of certified equipment and certified unmanned aircraft

5.4.1 If the UAS operation is using an unmanned aircraft for which a certificate of airworthiness or a restricted certificate of airworthiness have been issued, or using certified equipment, the UAS operator shall record the operation or service time in accordance either with the instructions and procedures applicable to the certified equipment, or with the organisational approval or authorisation.

5.4.2 The UAS operator shall follow the instructions referred to in the unmanned aircraft certificate or equipment certificate, and also comply with any airworthiness or operational directives issued by the Authority.

5.4.3 General

a) In pursuant to item 5.4, **'certified equipment'** is considered to be any equipment for which the relevant design organisation has demonstrated compliance with the applicable certification specifications and received a form of recognition from CAAM that attests such compliance (e.g., a TSO authorisation).

b) The use of certified equipment or certified UA in the 'Special UAS Project Approval' operations does not imply a transfer of the flight activities into the 'certified' category of operation. However, the use of certified equipment or certified UA in the 'Special UAS Project Approval' operations should be considered as a risk reduction and/or mitigation measure in the SORA.

Technical Requirements

5.5 Airworthiness Requirement for SUP Approval UAS

5.5.1 In accordance with MCAR 2016, a UA having a mass of more than 20 kilogrammes without its fuel is required to have an authorisation from the Chief Executive Officer.

5.5.2 In pursuant to paragraph 5.4.1, all UAS in the Special UAS Approval may be subjected to the following requirements:

a) The UAS shall be designed as its intended operation set by the manufacturer and has been evaluated and acceptable by the CAAM;

b) The UAS shall have Technical Data Specification or equivalent set by the manufacturer and any other supporting documents shall be submitted to the CAAM as required;

c) The UAS shall have a proper Flight Manual, Maintenance Manual and Operating Manual from the UAS Manufacturer;

d) The UAS shall be maintained in accordance with the UAS maintenance manual provided by the UAS manufacturer;

e) The UAS Maintenance and inspections programme shall be developed by the UAS operator in accordance with the UAS manufacturer instructions and recommendations and shall be approved by the CAAM;

f) The UAS shall be maintained by authorised technical personnel (ATP) nominated by the organisation and shall be accepted by the CAAM;

g) The ATP shall carry out maintenance in accordance with the approved maintenance and inspections programme;

h) Pre-flight inspections shall be performed by the ATP prior any flight. However, pre-flight inspections can also be authorized to be performed by duly trained personnel (e.g., Remote Pilot or Ground Crew) provided:

   1) It is documented in the operations manual;
   2) Personnel are trained; and
   3) Accepted by the CAAM.

i) The ATP shall have relevant qualification, competent and must be trained by the UAS manufacturer;

j) Any modifications, repairs and replacement of parts and components on the UAS shall be as per manufacturer instructions and recommendations;

k) The modifications, repairs and replacement of parts and components shall only be performed by the ATP;

l) All the maintenance, modifications, repairs and replacement of UAS parts and components shall be recorded;

m) All the records shall be kept in a secure manner;

n) The records shall be retained for a minimum of 3 years;

o) Any other requirements prescribed by the CAAM if necessary; and

p) The UAS and all the relevant documentation shall be inspected and verified by the CAAM prior the authorisation to be granted.

5.6 Registration and marking of UA above 20 kilogrammes

5.6.1 If required by the CAAM, a UA of more than 20 kilogrammes without its fuel shall be registered as per following:

a) The UAS operator must display on the UAS marks consisting of Roman capital letters “CAAM-UAS-XXXX” followed by the four (4) digits registration number of the aircraft assigned by the CAAM. For example, CAAM-UAS-1234.

b) The registration markings must be readable and weatherproof;

c) The size of the marking may be determined by the operator and acceptable by the CAAM.

Note. - If the size of the UA does not allow the mark to be displayed in a visible way on the fuselage, or the UA represents a real aircraft where affixing the marking on the UA would spoil the realism of the representation, a marking inside the battery compartment is acceptable if the compartment is accessible.

Personnel Requirements

5.7 Responsibilities of the remote pilot

5.7.1 The remote pilot shall:

a) Not perform duties under the influence of psychoactive substance or alcohol or when it is unfit to perform its task due to injury, fatigue, medication, sickness or other causes;

b) Have the appropriate remote pilot competency as defined in the Special UAS Project Approval and carry a proof of competency while operating the UAS.

5.7.2 Before starting a UAS operation, the remote pilot shall comply with all of the following:

a) Obtain updated NOTAM in regards to the area of operations;

b) ensure that the operating environment is compatible with the authorised or declared limitations and conditions; (Refer to paragraph 5.7.3.1 for further detail)

c) ensure that the UAS is in a safe condition to complete the intended flight safely, and if applicable, check if the direct remote identification works properly; (Refer to paragraph 5.7.3.2 for further detail)

d) ensure that the information about the operation has been made available to the relevant air traffic service (ATS) unit, other airspace users and relevant stakeholders, as required by the Special UAS Project Approval or by the conditions published by the CAAM.

5.7.3 During the flight, the remote pilot shall:

a) Comply with the authorised limitations and conditions;

b) avoid any risk of collision with any manned aircraft and discontinue a flight when continuing it may pose a risk to other aircraft, people, animals, environment or property;

c) comply with the operational limitations in geographical zones stated in the Special UAS Project Approval;

d) comply with the operator’s procedures;

e) not fly close to or inside areas where an emergency response effort is ongoing unless they have permission to do so from the responsible emergency response services.

5.7.3.1 Operating Environment

a) The remote pilot should check any conditions that might affect the UAS operation, such as the locations of people, property, vehicles, public roads, obstacles, aerodromes, critical infrastructure, and any other elements that may pose a risk to the safety of the UAS operation.

b) Familiarisation with the environment and obstacles should be conducted through a survey of the area where the operation is intended to be performed.

c) It should be verified that the weather conditions at the time when the operation starts and those that are expected for the entire period of the operation are compatible with those defined in the manufacturer's manual, as well as with the Special UAS Project Approval, as applicable.

d) The remote pilot should be familiar with the flight conditions and make a reasonable effort to identify potential sources of electromagnetic energy, which may cause undesirable effects, such as EMI or physical damage to the operational equipment of the UAS.

5.7.3.2 To ensure that the UAS is in a safe condition to complete the intended flight, the remote pilot should:

a) update the UAS with data for the geo-awareness function if one is available on the UA;

b) ensure that the UAS is fit to fly and complies with the instructions and limitations provided by the manufacturer;

c) ensure that any payload carried is properly secured and installed, respecting the limits for the mass and CG of the UA;

d) ensure that the UA has enough propulsion energy for the intended operation based on:

   1) the planned operation; and

   2) the need for extra energy in case of unpredictable events; and

e) for a UAS equipped with a loss-of-data-link recovery function, ensure that the recovery function allows a safe recovery of the UAS for the envisaged operation; for programmable loss-of-data- link recovery functions, the remote pilot may have to set up the parameters of this function to adapt it to the envisaged operation.

6 Rules for Conducting an Operational Assessment

6.1 Operational Risk Assessment

6.1.1 An operational risk assessment shall:

a) Describe the characteristics of the UAS operation;

b) Propose adequate operational safety objectives;

c) Identify the risks of the operation on the ground and in the air considering all of the below:

1) the extent to which third parties or property on the ground could be endangered by the activity;
2) the complexity, performance and operational characteristics of the unmanned aircraft involved;
3) the purpose of the flight, the type of UAS, the probability of collision with other aircraft and class of airspace used;
4) the type, scale, and complexity of the UAS operation or activity, including, where relevant, the size and type of the traffic handled by the responsible organisation or person;
5) the extent to which the persons affected by the risks involved in the UAS operation are able to assess and exercise control over those risks.

d) Identify a range of possible risk mitigating measures;

e) Determine the necessary level of robustness of the selected mitigating measures in such a way that the operation can be conducted safely.

6.2 UAS Operation Description

6.2.1 The description of the UAS operation shall include at least the following:

a) The nature of the activities performed;

b) The operational environment and geographical area for the intended operation, in particular overflown population, orography, types of airspace, airspace volume where the operation will take place and which airspace volume is kept as necessary risk buffers, including the operational requirements for geographical zones;

c) The complexity of the operation, in particular which planning and execution, personnel competencies, experience and composition, required technical means are planned to conduct the operation;

d) The technical features of the UAS, including its performance in view of the conditions of the planned operation and, where applicable, its registration number;

e) The competence of the personnel for conducting the operation including their composition, role, responsibilities, training and recent experience.

6.3 Target Level of Safety Assessment

6.3.1 The assessment shall propose a target level of safety, which shall be equivalent to the safety level in manned aviation, in view of the specific characteristics of UAS operation.

6.4 Risks Identification

6.4.1 The identification of the risks shall include the determination of all of the below:

a) The unmitigated ground risk of the operation taking into account the type of operation and the conditions under which the operation takes place, including at least the following criteria:

1) VLOS or BVLOS;
2) population density of the overflown areas;
3) flying over an assembly of people; and
4) the dimension characteristics of the unmanned aircraft.

b) The unmitigated air risk of the operation taking into account all of the below:

1) the exact airspace volume where the operation will take place, extended by a volume of airspace necessary for contingency procedures;
2) the class of the airspace; and
3) the impact on other air traffic and air traffic management (ATM) and in particular:

i) the altitude of the operation;
ii) controlled versus uncontrolled airspace;
iii) aerodrome versus non-aerodrome environment;
iv) airspace over urban versus rural environment; and
v) separation from other traffic.

6.5 Mitigation Measures Identification

6.5.1 The identification of the possible mitigation measures necessary to meet the proposed target level of safety shall consider the following possibilities:

a) Containment measures for people on the ground;

b) Strategic operational limitations to the UAS operation, in particular:

1) restricting the geographical volumes where the operation takes place;
2) restricting the duration or schedule of the time slot in which the operation takes place;

c) Strategic mitigation by common flight rules or common airspace structure and services;

d) Capability to cope with possible adverse operating conditions;

e) Organisation factors such as operational and maintenance procedures elaborated by the UAS operator and maintenance procedures compliant with the manufacturer's user manual;

f) The level of competency and expertise of the personnel involved in the safety of the flight;

g) The risk of human error in the application of the operational procedures;

h) The design features and performance of the UAS in particular:

1) the availability of means to mitigate risks of collision;
2) the availability of systems limiting the energy at impact or the frangibility of the unmanned aircraft;
3) the design of the UAS to recognised standards and the fail-safe design.

6.6 Mitigation Measures Robustness

6.6.1 The robustness of the proposed mitigating measures shall be assessed in order to determine whether they are commensurate with the safety objectives and risks of the intended operation, particularly to make sure that every stage of the operation is safe.

6.7 Rules for Conducting an Operational Risk Assessment

6.7.1 General

a) The operational risk assessment required by Chapter 6 of this CAD may be conducted using the methodology described in Appendices of this CAD. This methodology is basically the specific operations risk assessment (SORA) developed by JARUS. Other methodologies might be used by the UAS operator as alternative means of compliance.

b) Aspects other than safety, such as security, privacy, environmental protection, the use of the radio frequency (RF) spectrum, etc., should be assessed in accordance with the applicable requirements established by other related government agencies in which the operation is intended to take place.

c) In accordance with Chapter 6 of this CAD, the applicant must collect and provide the relevant technical, operational and system information needed to assess the risk associated with the intended operation of the UAS, and the SORA (Appendix 1 of this CAD) provides a detailed framework for such data collection and presentation. The concept of operations (ConOps) description is the foundation for all other activities, and should be as accurate and detailed as possible. The ConOps should not only describe the operation, but also provide insight into the UAS operator's operational safety culture. It should also include how and when to interact with the air navigation service provider (ANSP) when applicable.

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7 Unmanned Aircraft Systems Traffic Management (UTM) Service

7.1 General

a) Apart from being a requirement for the Special UAS Project Approval, the UTM system can be considered as another strategy to mitigate risk, among other features, intended to ensure safe and efficient operations of UA within UTM-authorised volume of airspace and which is in compliance with regulatory requirements and is required to be accessible by the CAAM.

7.2 Minimum Requirement

a) The minimum requirement for a UTM system to conduct Special UAS Project, are the following:

1) **Activity reporting service:** a service that provides on-demand, periodic or event-driven information on UTM operations occurring within the subscribed airspace volume and time (e.g., density reports, intent information as well as status and monitoring information). Additional filtering may be performed as part of the service.

2) **Mapping service:** a service that provides terrain and obstacle data (e.g., GIS) appropriate and necessary for meeting the safety and mission needs of individual UAS operations or for supporting UTM system needs for the provisions of separation or flight planning services.

3) **Flight planning service:** a service that, prior to the flight arranges and optimizes intended operational volumes, routes and trajectories for safety, dynamic airspace management, airspace restrictions and mission needs.

4) **Tracking and location service:** a service that provides information to the UAS operator and the UTM system about the exact location of the UA, in real time.

5) **Weather service:** a service that provides forecast or real-time meteorological information to support operational decisions of individual UAS operators or services.

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8 Safety Management System

This section addresses general principles of an effective Safety Management System as described in ICAO Annex 19 – Safety Management System.

A safety management system (SMS) is a systematic approach to managing safety, including the necessary organisational structures, accountabilities, policies and procedures. (ICAO).

Even though the generic principles were initially focussed on manned aviation, it has been recognised that this system applies to many other industries and organisations for which their primary concern is the conservation of human life and property, reducing risks to a minimum tolerable level and as a result contributing to a safe, reliable and long-term operation.

8.1 The Four Pillars of an SMS

a) ICAO Annex 19 establishes Four basic pillars that form a complete Safety Management System. These are:

1) Policy

2) Risk management

3) Assurance

4) Promotion

Note. - The 4 pillars are outlined below.

8.1.1 Policy

a) Is the safety policy widely available and is the workforce fully engaged and supportive?

b) Does the workforce appreciate the importance of hazard identification and safety reporting?

c) Is adequate and timely feedback provided to the reporters?

These three questions apply across the entire organisation and are not confined to Flight Operations. This can only be achieved if management are likewise engaged and empowered to deliver the safety policy. What evidence is available to demonstrate your enterprise approach to safety management? Items such as an increase in voluntary reporting rates for all departments can be used. Furthermore, the establishment of a Just Culture must be evidenced and must be used by management at all levels.

8.1.1.1 The safety policy should:

a) Be endorsed by the accountable manager;

b) Reflect organisational commitments regarding safety, and its proactive and systematic management;

c) be communicated, with visible endorsement, throughout the organisation;

d) include internal reporting principles, and encourage personnel to report errors related to UAS operations, incidents and hazards; and

e) recognise the need for all personnel to cooperate with compliance monitoring and safety investigations.

8.1.1.2 The safety policy should include a commitment to:

a) improve towards the highest safety standards;

b) comply with all applicable legislation, meet all applicable standards, and consider best practices;

c) provide appropriate resources;

d) apply the human factors principles;

e) enforce safety as a primary responsibility of all managers; and

f) apply 'just culture' principles and, in particular, not to make available or use the information on occurrences:

g) to attribute blame or liability to someone for reporting something which would not have been otherwise detected; or

h) for any purpose other than the improvement of safety.

8.1.1.3 The senior management of the UAS operator should:

a) continually promote the UAS operator's safety policy to all personnel, and demonstrate their commitment to it;

b) provide the necessary human and financial resources for the implementation of the safety policy; and

c) establish safety objectives and associated performance standards.

8.1.1.4 The safety policy is the means whereby an organisation states its intention to maintain and, where practicable, improve safety levels in all its activities and to minimise its contribution to the risk of an accident or serious incident as far as is reasonably practicable. It reflects the management's commitment to safety, and should reflect the organisation's philosophy of safety management, as well as be the foundation on which the organisation's safety management system is built. It serves as a reminder of 'how we do business here'. The creation of a positive safety culture begins with the issuance of a clear, unequivocal direction.

8.1.1.5 The commitment to apply 'just culture' principles form the basis for the organisation's internal rules that describe how 'just culture' principles are guaranteed and implemented.

8.1.2 Risk Management

a) Does the safety reporting system allow employees to submit hazard reports easily? If the system is complex or not easily accessible, the workforce will be reluctant to submit reports.

b) Are the reports acted upon and is feedback provided to the reporters?

c) Are risk registers up to date and accessible to management?

d) How is the efficacy of risk controls/mitigations monitored?

e) Is there adequate resource in place to meet the requirements of implemented risk controls?

f) Are there processes in place to address both safety issue risk assessments and management of change?

g) Does the risk process recognise that safety is only one part of the risk picture? Are risks assessed in terms of their impact on financial, reputation and environmental factors?

h) Finally, how are risks communicated to the general workforce? Are diagrammatic representations such as Bow Tie visualisations used, that can be easily understood?

A primary objective of the risk control process should be to ensure that the appropriate resource is allocated to mitigate identified risks. Ideally, a register of all controls should be maintained alongside the risk register. All identified risks must be accepted by a responsible manager and high-level decisions should be made using risk-based analysis. Finally, there must be suitable processes in place to review and monitor all risks listed in the register as part of the assurance processes.

8.1.2.1 The UAS Operator should have a safety management system that is able to perform at least the following:

a) identify hazards through reactive, proactive, and predictive methodologies, using various data sources, including safety reporting and internal investigations;

b) collect, record, analyse, act on and generate feedback about hazards and the associated risks that affect the safety of the operational activities of the UAS operator;

c) develop an operational risk assessment as required by Chapter 6 of this CAD;

d) carry out internal safety investigations;

e) monitor and measure safety performance through safety reports, safety reviews, in particular during the introduction and deployment of new technologies, safety audits, including periodically assessing the status of safety risk controls, and safety surveys;

f) manage the safety risks related to a change, using a documented process to identify any external and internal change that may have an adverse effect on safety; the management of change should make use of the UAS operator's existing hazard identification, risk assessment, and mitigation processes;

g) manage the safety risks that stem from products or services delivered through subcontractors, by using its existing hazard identification, risk assessment, and mitigation processes, or by requiring that the subcontractors have an equivalent process for hazard identification and risk management; and

h) respond to emergencies using an ERP that reflects the size, nature, and complexity of the activities performed by the organisation. The ERP should:

    1) contain the action to be taken by the UAS operator or specified individuals in an emergency;

    2) provide for a safe transition from normal to emergency operations and vice versa;

    3) ensure coordination with the ERPs of other organisations, where appropriate; and

    4) describe emergency training/drills, as appropriate.

8.1.2.2 In very broad terms, the objective of safety risk management is to eliminate risk, where practical, or reduced the risk (likelihood/severity) to acceptable levels, and to manage the remaining risk to avoid or mitigate any possible undesirable outcome. Safety risk management is, therefore, integral to the development and application of effective safety management.

8.1.2.3 Safety risk management can be applied at many levels in an organisation. It can be applied at the strategic level and at operational levels. The potential for human error, its influences and sources, should be identified and managed through the safety risk management process. Human factors risk management should allow the organisation to determine where it is vulnerable to human performance limitations.

8.1.3 Assurance

a) Are risk controls implemented and effective?

b) Are controls reviewed regularly?

c) Is the SMS improving continuously?

d) Is the SMS delivering stated safety objectives?

e) Has an Acceptable Level of Safety Performance (ALoSP) been agreed with the Regulator and can achievement of this be demonstrated?

Assurance is a key part of the SMS. Usually, the above requirements are met by the establishment of Safety Performance Indicators (SPIs) and Safety Performance Targets (SPTs). These items are discussed fully in Document 9859 (issue 4) and without these in place, any organisation will find it difficult to demonstrate an ALoSP and continuous improvement of the SMS.

8.1.4 Promotion

f) Unless the safety policy and its objectives are communicated widely and in a format that is designed to engage all employees, it is unlikely to be effective. Poster campaigns can be useful, but short-lived. Management must promote the safety policy continuously. This could be in the form of monthly safety newsletters by fleet managers (which could be a leading SPI if used). Again, this process should be adopted across all departments and whilst safety promotion is often positive in operational areas, the following questions should still be asked:

1) Is it applied in all areas?
2) How engaged are the other, non-operational, areas- for example, when did the commercial department last attend a risk assessment or a monthly safety meeting?

"Safety is no Accident. It Must be Planned"

8.2 SMS Regulatory Framework

b) The ICAO Standards and Recommended Practices (SARPS) promulgated in several Annexes to the Chicago Convention require the implementation of a safety management system by the following aviation service provider organisations:

1) Aircraft operators;

2) Aircraft maintenance organisations;

3) Air navigation services providers;

4) Airport operators;

5) training organisations;

6) aircraft manufacturers.

c) UAS operators are currently not included in the above list of service providers. However, the 3rd edition (Amendment 2) of Annex 19 is likely to introduce new SARPs requiring UAS operators to have an effective SMS. This amendment is still being drafted, with an applicability date around 2026.

Note. - Depending on the size and complexity of the operation, UAS operator in Special UAS Project may develop SMS Manual which must be acceptable to the CAAM.

8.3 General Safety Management System

Safety Risk

The predicted probability and severity of the consequence or outcomes of a hazard

Hazard

A condition that could cause or contribute to an aircraft incident or accident.

A series of defined, organisation-wide processes that provide for effective risk-based decision making related to a company's daily business.

8.4 Key Processes of an SMS

a) Hazard Identification

1) A method for identifying hazards related to the whole organisation (operational + systemic hazards)

b) Safety Reporting

1) A process for the acquisition of safety data not only related to product safety

c) Risk Management

1) A standard approach for assessing risks and for applying risk controls

d) Performance Measurement

1) Management tools for analysing how effectively the organisation's safety goals are being achieved

e) Safety Assurance

1) Processes based on quality management principles that support continual improvement of the organisation's safety performance

8.5 Implementation and Assessment

a) Many aspects of safety management may already exist within an organisation. In order to introduce an SMS a gap analysis is the suggested first step to establish what components already exist, (E.g., for writing a safety case or risk assessment). It is important that the SMS corresponds to the size and complexity of the organisation and takes into consideration the nature of its operations.

1) Implementation steps could include:

2) Obtain Senior Management buy-in;

3) Appointing a Safety Manager / Team / Board;

4) Undertake a gap analysis;

5) Develop an implementation plan;

6) Establish a risk assessment and control system;

7) Use for internal occurrence reports, audit findings, organisational changes;

8) Validate the matrix;

9) Establish and encourage a reporting system and a hazard log;

10) Produce a SMM or incorporate it into existing Exposition / Manuals;

11) Training of staff;

12) Ensure that all the SMS building blocks are in place;

13) Consider contracted and subcontracted services;

14) Proactively look for hazards;

15) Establish the most significant safety issues and start to measure and manage them;

16) Establish performance measures.

8.6 Applying an SMS for the UAS industry

8.6.1 The sensible and effective application of a Safety Management System to the different types of operations and categories is essential. These principles will help to contribute to the overall safety of the proposed operation and thus reduce the risk of it causing harm to persons or property. SMS principles can be applied from the basic Open Category all the way up to the Certified Category. A good understanding of these principles, and the employment of a risk-oriented approach, will help to ensure a safe and reliable UAS operation.

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9 Guidelines on Operations using Dangerous Goods

9.1 Dangerous Goods Categories

a) The operations using Dangerous Goods can be categories into two categories:

1) Agricultural UAS Operations; or

2) Carriage of Dangerous Goods.

9.2 Agricultural UAS Operations

a) Applicability

1) In pursuant to Regulation 136, 141 and 144 of the MCAR 2016, Aerial work means an aircraft operation in which an aircraft is used to provide specialized services in agriculture, construction, photography, surveying, observation and patrol, search and rescue, aerial advertisement and other similar activities. However, Agricultural UAS Operations is only applicable to agricultural work (Refer to Definition Item 35 of this CAD) utilizing an Unmanned Aircraft System (UAS).

2) The Directives for Agricultural UAS Operations is in a different CAD. Therefore, refer to CAD 6011 (II) – Agricultural UAS Operations where it prescribes the directives in relations to:

i) Agricultural UAS operations within Malaysia; and
ii) The issue of commercial and private agricultural UAS Aerial Work certificate for those operations.

b) Definition

1) ‘Agricultural UAS Operations’ is the operations of a UAS for the purpose of:

i) Dispensing any ‘agricultural payload’ intended for plant nourishment, soil treatment, propagation of plant life, or pest control; or
ii) Engaging in dispensing ‘agricultural payload’ and surveillance activities directly affecting agriculture, horticulture, or forest preservation, but not including the dispensing of live insects.

2) ‘Agricultural Payload’ means any dispensing materials such as pesticides and any other substances as permitted by Department of Agriculture (DOA). (Refer to DOA website for approved Agricultural Payload List)

3) ‘Pesticides’ means, subject to subsection (2) of Pesticides Act 1974 means:

i) any substance that contains an active ingredient; or
ii) any preparation, mixture or material that contains any one or more of the active ingredients as one of its constituents, but does not include contaminated food or any article listed in the Second Schedule of Pesticides Act 1974.

9.3 Carriage of Dangerous Goods Operations

9.3.1 The broad principles governing the international transport of dangerous goods by air are contained in Annex 18 of the International Civil Aviation Organisation (ICAO) – The Safe Transport of Dangerous Goods by Air. These broad provisions are amplified by detailed specifications contained in the Technical Instructions for the Safe Transport of Dangerous Goods by Air (Technical Instructions, Doc 9284). The UAS Operators intending to transport Dangerous Goods shall take the necessary measures to achieve compliance with these documents for international civil aircraft operations[1] and domestic civil operations.

9.3.2 Dangerous goods are articles or substances that are capable of posing a hazard to health, safety, property or the environment and which are shown in the list of dangerous goods (Table 3-1) provided in the Technical Instructions or which are classified according to nine classes based on their potential consequences. Identifying dangerous goods is the first step towards safety transporting them. Based on this, the safety risk posed can be reduced through proper packaging, communication, handling and stowage. The scope of dangerous goods needed for carriage abroad UA may be limited to specific items and classes. The UAS Operator shall identify these items and classes in their safety risk assessment. Dangerous goods classes and divisions as outlined in this CAD.

9.3.3 Application to carry dangerous goods are processed by a separate division from the UAS Unit, within the CAAM and a different process is followed. Therefore, UAS Operators must make a separate 'Dangerous Goods' application to their application for a Special UAS Project Approval.

9.3.4 Application for approval to carry dangerous goods:

a) UAS operators must refer to the CAAM dangerous goods approvals webpage for the most up-to-date information and to ensure all application requirements are met and then:

1) Complete the form in the National Transport of Dangerous Goods Programme (NTDGP) in this link.
2) Submit the appropriate fee
3) Details of cost can be found in the MCAR Fees and Charges which can be found on the CAAM website here.

9.3.5 General provisions

a) Dangerous goods transported by a UA shall comply with all the following conditions:

1) Operated in either ‘Special UAS Project’ or ‘certified’ category depending on risk assessment;
2) Submit an additional risk assessment clearly outlining the specific items and its classes;
3) Ensure that the UAS operator is competent in handling dangerous goods;
4) Develop a Dangerous Goods Standard Operating Procedures (DG SOP) as outlined in Item 9.3.8.

9.3.6 Examples of Dangerous Goods That May, Potentially, Be Carried On UA

a) The following are examples of dangerous goods that might be transported by UA:

1) Compressed gases such as aerosols and gas cartridges;
2) Flammable liquids, such as ethanol, ether;
3) Sterilization materials such as ethylene oxide;
4) Infectious substances such as certain medicines;
5) First aid kits;
6) Medical or clinical waste such as used needles and blood samples;
7) Safety devices;
8) Lithium batteries; and
9) Dry ice.

9.3.7 Safety Risk Assessment

a) The additional risk assessment[2] outlined in Item 9.3.5(a)(2) shall include at least the:

1) Identification of hazards associated with the dangerous goods;
2) Type of operations;
3) Containment characteristics of the UA;
4) Packing and packaging;
5) Quantity and type of dangerous goods to be transported; and
6) Level of competence of those handling the dangerous goods.

This list is not exhaustive. Provisions for identifying and classifying dangerous goods are contained in the Technical Instructions.

[1] International UAS operations/ Cross border operations are not allowed as of yet

[2] The Safety Management Manual (SMM) *(Doc 9859, 4th edition) contains general guidance on implementation of Annex 19 —* Safety Management, *including the conduct of safety risk assessments. A new manual entitled* Guidance for Safe Operations Involving Aeroplane Cargo Compartments *(Doc 10102) provides guidance on specific safety risk assessments on the transport of items in the cargo compartments of an aeroplane, including dangerous goods, which may be useful for UA operations.*

9.3.8 A safety risk assessment should be performed to address the potential consequences of identified hazards and associated mitigations should an unintentional release occur. The following are elements that should be included, at a minimum, in the safety risk assessment.

a) Risk associated with Dangerous Goods:

1) Infectious substances that are capable of causing permanent disability, life-threatening or fatal disease for which no vaccine or cure is available have the highest consequences. They could potentially affect multiple persons or animals.
2) Infectious pathogens that are spread by ingestion, for which prophylactic treatment or a cure is available will have moderate consequences.
3) Non-communicable pathogens for which prophylactic treatment or a cure is available will have low consequence.
4) Chemicals with high toxicity to human, animal or aquatic life have the highest consequences, and may affect multiple persons or animals.
5) Chemicals that are highly corrosive will have high consequences to package handlers or receivers.

b) Type of operation:

1) The safety risk assessment should consider the potential consequences to the transport over populated areas, remote areas or environmentally sensitive land and waters. Other normal flight risks such as those associated with operating routes, obstacles, altitudes, or take-off and landing areas should also be considered. Dropping of the dangerous goods from the UA also brings with it additional potential consequences for consideration.

c) Containment Characteristics of the UA (e.g., inside or outside of the UA)

1) The carriage of the dangerous goods inside or outside of the UA needs assessing. The securing of the dangerous goods within the UA, by attachment directly to the UA or slung from the UA, will have varying levels of risk.

d) Packing and packaging

1) Packaging methods used to contain dangerous goods may affect the likelihood of damage, leakages, spills or unintentional release of contents. In considering the packing and packaging requirements for dangerous goods, the provisions of the Technical Instructions should be followed to the extent possible.
2) If the provisions of the Technical Instructions cannot be followed, an equivalent or greater level of safety should be established in accordance with the level of risk. At minimum, the following should be taken into account:

i) The type of packaging should take into account the containment characteristics of the UA and damage that could be caused by exposure to airflow and weather such as rain or snow. The effects of temperature and pressure variations and vibrations which may be encountered during transport should be taken into account.

ii) Generally, dangerous goods should be packed in the lowest volume container necessary for the intended purpose.

iii) Measures to prevent leakage of liquid dangerous goods need to be taken into consideration. At minimum, the packaging should include a leak-proof liner or bag containing the dangerous goods surrounded by absorbent material and placed into a receptacle in a rigid outer packaging. Inner packaging should be placed so that the closure is upward within the package. Closures on inner packaging must be leak-proof and secured against loosening. Stoppers, corks or other such friction closures must be held in place by positive means.

iv) The contents of the packages should be documented and easily accessible in case of an incident or accident requiring emergency response. At a minimum, the UN number, container type, volume and number of items should be documented. In the case of biological substances, pathogen data sheets or information about the hazards to infectious substances, including deactivation and waste disposal, should be made available.

v) If the dangerous goods are to be dropped by the UA, additional consideration of the effects on the dangerous goods and packaging materials should be considered due to the forces and shocks encountered.

e) Quality and distribution of Dangerous goods to be transported:

1) The volume of dangerous goods to be carried coupled with packaging methods used may affect the likelihood of damage, leakages, spills or unintentional release of contents. For certain dangerous goods, the quantities may influence the severity of the identified consequence of a hazard. The potential for incompatible dangerous goods or non-dangerous goods to react dangerously when mixed needs to be taken into account.

f) Level of Competence of those handling the dangerous goods:

1) The level of competence of those handling the dangerous goods needs to be taken into account in relation to the level of responsibility and risk. Without appropriately qualified personnel, there is the potential of insufficiently implementing mitigating strategies or potentially introducing additional hazards or unintended consequences.

9.3.9 Dangerous Goods Standard Operating Procedure (DG SOP)

a) The UAS Operator shall establish a DG SOP approved by the CAAM for the safe transport of dangerous foods on the UA, including the conduct of a specific safety risk assessment.

b) The extend of the DG SOP will depend on the size of the organisation, the nature of the operation and the level of safety risk. At minimum, the DG SOP should include:

1) How to conduct a safety risk assessment; procedures to identify hazard, determine their potential consequences and ensure the risk can be managed to an acceptable level;
2) A training program and the level of competency achieved once training is completed; providing adequate instruction ensures that individuals handling dangerous goods are competent to perform their function commensurate with their responsibilities taking into account the level of safety risk;
3) Instructions for communicating information to relevant persons related to the dangerous goods being transported in case of an accident or incident;
4) Action to be taken in the event of emergencies involving dangerous goods; and
5) Instruction for the collection of safety data related to dangerous goods accidents and dangerous goods incidents.

c) Recommended elements to be included in the UAS Operator’s standard operating procedure manual for transport of dangerous goods (DG SOP)

1) **Policy of the Safe Transport of Dangerous Goods on UA -** The operator should establish a policy for the safe transport of dangerous goods on UA. The policy should include the practice of conducting a safety risk assessment.
2) **Procedures for carrying out responsibilities including mitigation measures to proactively manage risks -** The DG SOP should include measures taken and an indication of how these measures mitigate the potential consequences of identified hazards to an acceptable level. Procedures to mitigate hazards unique to UA operations should also be included to ensure the dangerous goods are capable of withstanding the normal conditions of transport involving the type of UA being used.
3) **Training program -** The DG SOP should include measures taken and an indication of how these measures mitigate the potential consequences of identified hazards to an acceptable level. Procedures to mitigate hazards unique to UA operations should also be included to ensure the dangerous goods are capable of withstanding the normal conditions of transport involving the type of UA being used.

4) **Instructions for communicating information related to the Dangerous goods carried by the UA in the case of an incident or accident** - The DG SOP should include measures taken and an indication of how these measures mitigate the potential consequences of identified hazards to an acceptable level. Procedures to mitigate hazards unique to UA operations should also be included to ensure the dangerous goods are capable of withstanding the normal conditions of transport involving the type of UA being used.
5) **Action to be taken in the event of emergencies involving dangerous goods -** Procedures should be established for an emergency response plan for dangerous goods incidents or dangerous goods accidents. A current list of contacts indicating whom should be notified if either event occurs, should be maintained.
6) **Instructions for collection of safety data –** Procedures should include instructions for collecting safety data related to dangerous goods accidents and dangerous goods incidents. Format to submit this data shall be emailed to the UAS Operator upon approval of carriage of dangerous goods.

9.4 Classes and Division of Dangerous Goods

a) The following classes and divisions are used to identify hazards associated with the transport of articles and substances by all modes of transport based on the product's specific chemical and physical properties. They are named in accordance with the United Nations Recommendations Transport of Dangerous Goods (Model Regulations). The classification of an article or substance for transport by air needs to be done by competently-trained individuals in accordance with the Technical Instructions. A good starting point for determining if your product might be dangerous is by obtaining a Safety Data Sheet (SDS) from the manufacturer and checking the "Transportation Information." This can provide valuable information on the transport risks related to your materials.

b) The numerical order of the classes and divisions is not that of the degree of danger.

1) **Class 1: Explosives**

i) Division 1.1: Substances and articles which have a mass explosion hazard
ii) Division 1.2: Substances and articles which have a projection hazard but not a mass explosion hazard
iii) Division 1.3: Substances and articles which have a fire hazard and either a minor blast hazard or a minor projection hazard or both, but not a mass explosion hazard
iv) Division 1.4: Substances and articles which present no significant hazard
v) Division 1.5: Very insensitive substances which have a mass explosion hazard

vi) Division 1.6: Extremely insensitive articles which do not have a mass explosion hazard

2) **Class 2: Gases**

i) Division 2.1: Flammable gases
ii) Division 2.2: Non-flammable, non-toxic gases Division 2.3: Toxic gases

3) **Class 3: Flammable liquids**
4) **Class 4: Flammable solids; substances liable to spontaneous combustion; substances which, on contact with water, emit flammable gases**

i) Division 4.1: Flammable solids, self-reactive and related substances and solid desensitized explosives and polymerizing substances
ii) Division 4.2: Substances liable to spontaneous combustion
iii) Division 4.3: Substances which, in contact with water, emit flammable gases

5) **Class 5: Oxidizing substances and organic peroxides**

i) Division 5.1: Oxidizing substances
ii) Division 5.2: Organic peroxides

6) **Class 6: Toxic and infectious substances**

i) Division 6.1: Toxic substances
ii) Division 6.2: Infectious substances

7) **Class 7: Radioactive material**
8) **Class 8: Corrosive substances**
9) **Class 9: Miscellaneous dangerous substances and articles, including environmentally hazardous substances**

10 Appendices

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Appendix 1

Rules for Conducting an Operational Risk Assessment

1 Introduction

1.1 Preface

a) This SORA is based on the document developed by JARUS, providing a vision on how to safely create, evaluate and conduct an unmanned aircraft system (UAS) operation. The SORA provides a methodology to guide both the UAS operator and the CAAM in determining whether a UAS operation can be conducted in a safe manner. The document should not be used as a checklist, nor be expected to provide answers to all the challenges related to the integration of the UAS in the airspace. The SORA is a tailoring guide that allows a UAS operator to find a best-fit mitigation means, and hence reduce the risk to an acceptable level. For this reason, it does not contain prescriptive requirements, but rather safety objectives to be met at various levels of robustness, commensurate with the risk.

b) The SORA is meant to inspire UAS operators and competent authorities and highlight the benefits of a harmonised risk assessment methodology. The feedback collected from real-life UAS operations will form the backbone of the updates in the upcoming revisions of the document.

1.2 Purpose of the document

a) The purpose of the SORA is to propose a methodology to be used as an acceptable means to demonstrate compliance with Chapter 6 of this CAD, that is to evaluate the risks and determine the acceptability of a proposed operation of a UAS within the Special UAS Project.

b) Due to the operational differences and the expanded level of risk, the 'Special UAS Project' category cannot automatically take credit for the safety and performance data demonstrated with the large number of UA operating in the 'lower risk/ normal authorisation to fly' category. Therefore, the SORA provides consistent approach to assess the additional risks associated with the expanded and new UAS operations that are not covered by the 'lower risk/normal authorisation to fly' category.

c) The SORA is not intended as a one-stop-shop for the full integration of all types of UAS in all classes of airspace.

d) This methodology may be applied where the traditional approach to aircraft certification (approving the design, issuing an airworthiness approval and type certificate) may not be appropriate due to an applicant's desire to operate a UAS in a limited or restricted manner. This methodology may also support the activities necessary to determine the associated airworthiness requirements.

This assumes that the safety objectives set forth in, or derived from, those applicable for the airworthiness certification, are consistent with the ones set forth or derived for the Special UAS Project Approval.

e) The methodology is based on the principle of a holistic/total system safety risk-based assessment model used to evaluate the risks related to a given UAS operation. The model considers the nature of all the threats associated with a specified hazard, the relevant design, and the proposed operational mitigations for a specific UAS operation. The SORA then helps to evaluate the risks systematically, and determine the boundaries required for a safe operation. This method allows the applicant to determine the acceptable risk levels, and to validate that those levels are complied with by the proposed operations. The CAAM may also apply this methodology to gain confidence that the UAS operator can conduct the operation safely.

f) To avoid repetitive individual approvals, CAAM has introduced 'predefined risk assessment' for the identified types of ConOps with known hazards and acceptable risk mitigations. A set of 'standard scenarios' will introduced as CAD 6011 (IV) at a later stage.

g) The methodology, related processes, and values proposed in this document are intended to guide the UAS operator when performing a risk assessment in accordance with Chapter 6 of this CAD.

1.3 Applicability

a) The methodology presented in this document is aimed at evaluating the safety risks involved with the operation of UAS of any class, size or type of operation (experimental, research and development and prototyping). It is particularly suited, but not limited to, SUP operations for which a hazard and a risk assessment are required.

b) The safety risks associated with collisions between UA and manned aircraft are in the scope of the methodology. The risk of a collision between two UA or between a UA and a UA carrying people will be addressed in future revisions of the document.

c) In the event of a mishap, the carriage of people or payloads on board the UAS (e.g., weapons) that present additional hazards are explicitly excluded from the scope of this methodology.

d) Security aspects are excluded from the applicability of this methodology when they are not limited to those confined by the airworthiness of the systems (e.g., the aspects relevant to protection from unlawful electromagnetic interference.)

e) Privacy and financial aspects are excluded from the applicability of this methodology.

f) The SORA can be used to support waiving the regulatory requirements applicable to the operation if it can be demonstrated that the operation can be conducted with an acceptable level of safety.

g) In addition to performing a SORA in accordance with this CAD, the UAS operator must also ensure compliance with all the other regulatory requirements applicable to the operation that are not necessarily addressed by the SORA.

1.4 Key concepts and definitions

1.4.1 Semantic model

a) To facilitate effective communication of all aspects of the SORA, the methodology requires the standardised use of terminology for the phases of operation, procedures, and operational volumes. The semantic model shown in Figure 1 provides a consistent use of the terms for all SORA users. Figure 2 provides a graphical representation of the model and a visual reference to further aid the reader in understanding the SORA terminology.

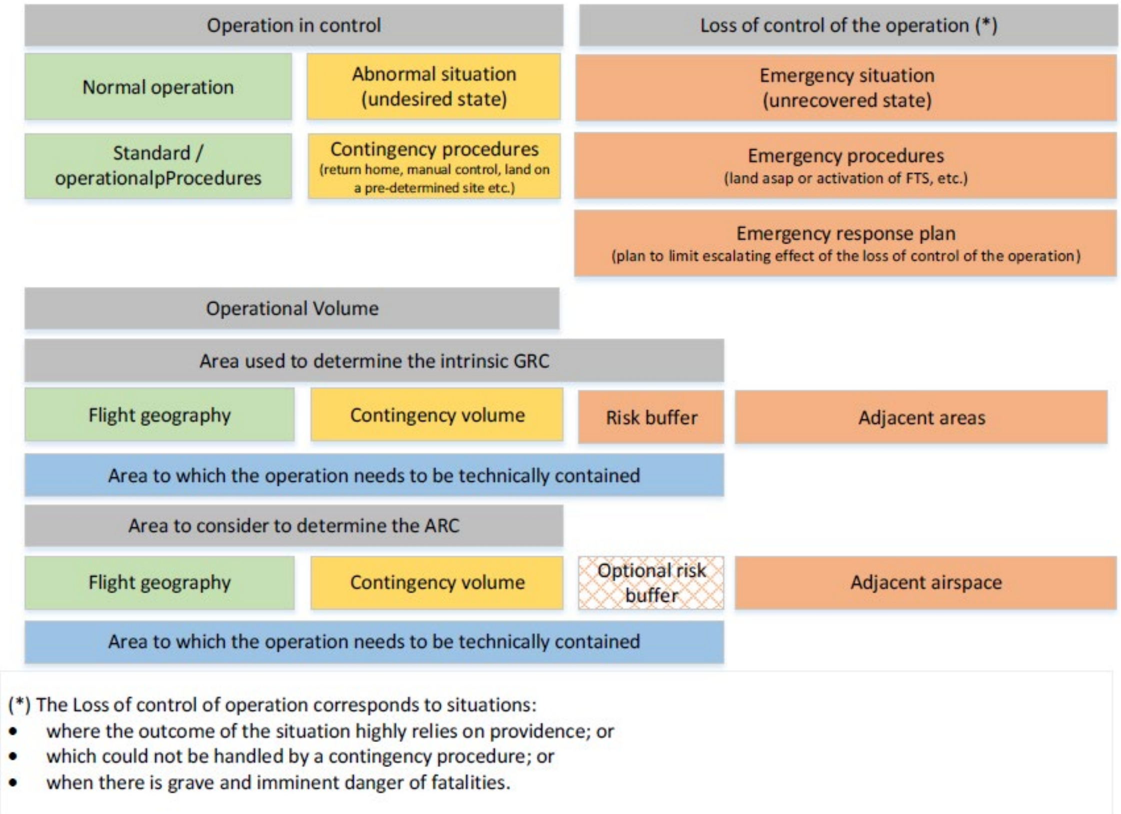

Figure 1 — SORA semantic model

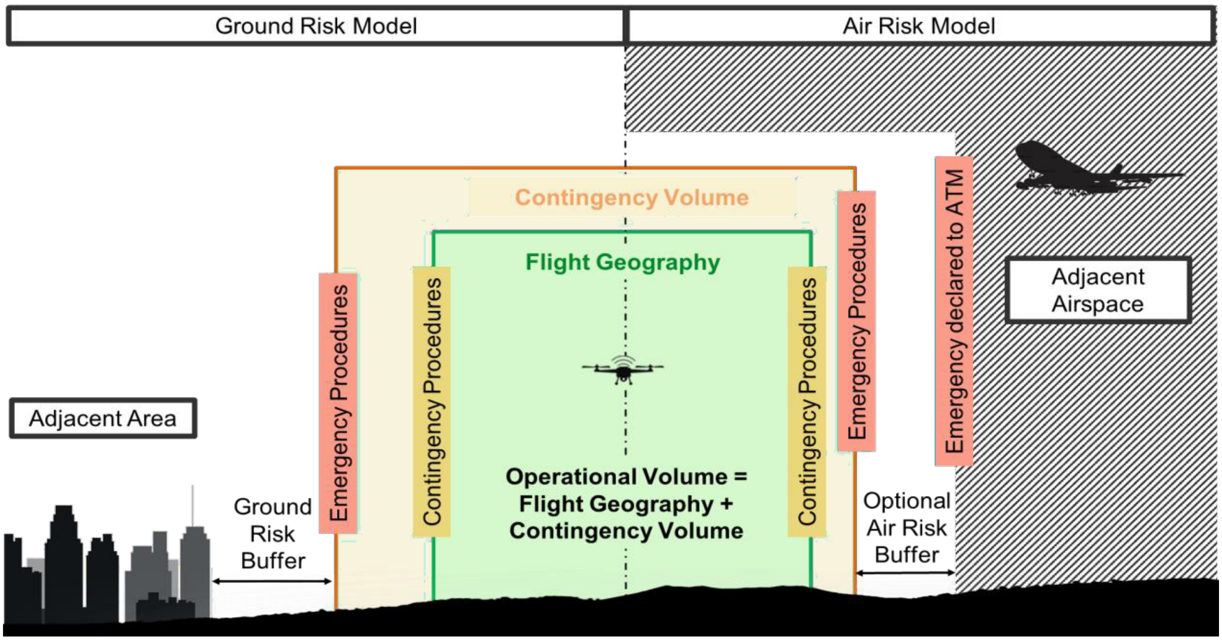

Figure 2 — Graphical representation of the SORA semantic model

1.4.2 Introduction to robustness

a) To properly understand the SORA process, it is important to introduce the key concept of robustness. Any given risk mitigation or operational safety objective (OSO) can be demonstrated at differing levels of robustness. The SORA process proposes three different levels of robustness: low, medium and high, commensurate with the risk.

b) The robustness designation is achieved using both the level of integrity (i.e., safety gain) provided by each mitigation, and the level of assurance (i.e., method of proof) that the claimed safety gain has been achieved. These are both risk-based.

c) The activities used to substantiate the level of integrity are detailed in Appendixes 3, 4, 5 and 6. Those appendixes provide either guidance material or reference industry standards and practices where applicable.

d) General guidance for the level of assurance is provided below:

1) A **low** level of assurance is where the applicant simply declares that the required level of integrity has been achieved.
2) A **medium** level of assurance is where the applicant provides supporting evidence that the required level of integrity has been achieved. This is typically achieved by means of testing (e.g., for technical mitigations) or by proof of experience (e.g., for human- related mitigations).
3) A **high** level of assurance is where the achieved integrity has been found to be acceptable by a competent third party.

Note. - CAAM has yet to approve any third party assessment body. Therefore, for now, CAAM acceptance is required to ensure high level assurances.

e) The specific criteria defined in the appendixes take precedence over the criteria defined in paragraph d.

f) Table 1 provides guidance to determine the level of robustness based on the level of integrity and the level of assurance:

	Low assurance	Medium assurance	High assurance
Low integrity	Low robustness	Low robustness	Low robustness
Medium integrity	Low robustness	Medium robustness	Medium robustness
High integrity	Low robustness	Medium robustness	High robustness

Table 1 — Determination of robustness level

g) For example, if an applicant demonstrates a medium level of integrity with a low level of assurance, the overall robustness will be considered to be low. In other words, the robustness will always be equal to the lowest level of either the integrity or the assurance.

1.5 Roles and responsibilities

a) While performing a SORA process and assessment, several key actors might be required to interact in different phases of the process. The main actors applicable to the SORA are described in this section.

b) UAS operator — The UAS operator is responsible for the safe operation of the UAS, and hence the safety risk analysis. The UAS operator must substantiate the safety of the operation by performing the specific operational and risk assessment, except for the cases defined such as operations in 'PDRA' or 'STS'. Supporting material for the assessment may be provided by third parties (e.g., the manufacturer of the UAS or equipment, UTM service providers, etc.). The UAS operator obtains a Special UAS Project Approval from the CAAM/ANSP.

Note. - Refer to Appendix 8 for additional information on PDRA. CAAM is in the midst of developing CAD 6011 (IV) which will cover standard scenarios.

c) Applicant — The applicant is the party seeking operational approval. The applicant becomes the UAS operator once the operation has been approved.

d) UAS manufacturer — For the purposes of the SORA, the UAS manufacturer is the party that designs and/or produces the UAS. The UAS manufacturer has unique design evidence (e.g., for the system performance, the system architecture, software/hardware development documentation, test/analysis documentation, etc.) that they may choose to make available to one or many UAS operator(s) or to the CAAM to help to substantiate the UAS operator's safety case. Alternatively, a potential UAS manufacturer may utilise the SORA to target design objectives for specific or generalised operations. To obtain airworthiness

e) approval(s), these design objectives could be complemented by the use of certification specifications (CS) or industry consensus standards if they are found to be acceptable by the CAAM.

f) Component manufacturer — The component manufacturer is the party that designs and/or produces components for use in UAS operations. The component manufacturer has unique design evidence (e.g., for the system performance, the system architecture, software/hardware development documentation, test/analysis documentation, etc.) that they may choose to make available to one or many UAS operator(s) to substantiate a safety case.

g) CAAM — The CAAM is the recognised national authority for approving the safety case of UAS operations, according to Chapter 6 of this CAD. The CAAM may accept an applicant's SORA submission in whole or in part. Through the SORA process, the applicant may need to consult with the CAAM to ensure the consistent application or interpretation of individual steps. The CAAM also provides the operational approval to the UAS operator. The CAAM is the competent authority in Malaysia to verify compliance of the UAS design and its components and to verify compliance with the operational requirements and compliance of the personnel's competency with the applicable rules. The following elements are related to the UAS design:

   - OSOs #02, #04, #05, #06, #10, #12, #18, #19 (limited to criterion #3), #20, and #24;- M1 mitigation (tethered operations): criterion #1 and M2 mitigation: criterion #1;

   - verification of the system to contain the UAS within the operational volume in accordance with Step #9 of the SORA process.

   When according to the SAIL or to the claimed mitigation means, the level of assurance of the above OSOs and or mitigation means is 'high' (i.e. SAIL V and VI), a verification by CAAM is required. For the other OSOs and mitigation means, the CAAM shall be the competent authority to verify the compliance with the UAS operator.

h) ANSP — The ANSP is the designated provider of air traffic service in a specific area of operation (airspace). The ANSP assesses whether the proposed flight can be safely conducted in the particular airspace that it covers, and if so, authorises the flight.

i) UTM service provider — As CAAM has not yet procured a "U-space" or similar service. A SUP applicant shall ensure that they either own or contract UTM service providers, who are entities that provide services to support the safe and efficient use of airspace. The requirements of the minimum standard of the UTM service is laid out in Chapter 7.

j) Remote pilot — The remote pilot is designated by the UAS operator, or, in the case of general aviation, the aircraft owner, as being charged with safely conducting the flight.

2 The SORA Process

2.1 Introduction to risk

a) Many definitions of the word ‘risk’ exist in the literature. One of the easiest and most understandable definitions is provided in SAE ARP 4754A / EUROCAE ED-79A: ‘the combination of the frequency (probability) of an occurrence and its associated level of severity’. This definition of ‘risk’ is retained in this document.

b) The consequence of an occurrence will be designated as harm of some type.

c) Many different categories of harm arise from any given occurrence. Various authors on this topic have collated these categories of harm as supported by the literature. This document will focus on occurrences of harm (e.g., a UAS crash) that are short-lived and usually give rise to a near loss of life. Chronic events (e.g., toxic emissions over a period of time) are explicitly excluded from this assessment. The categories of harm in this document are the potential for:

1) fatal injuries to third parties on the ground;

2) fatal injuries to third parties in the air; or

3) damage to critical infrastructure.

d) The CAAM, when appropriate, may consider additional categories of harm (e.g., the disruption of a community, environmental damage, financial loss, etc.). This methodology could also be used for those categories of harm.

e) Several studies have shown that the amount of energy needed to cause fatal injuries, in the case of a direct hit, is extremely low (i.e., in the region of few dozen Joules.) The energy levels of operations addressed within this document are likely to be significantly higher, and therefore the retained harm is the potential for fatal injuries. By application of the methodology, the applicant has the opportunity to claim lower lethality either on a case-by-case basis, or systematically if allowed by the competent authorities.

f) Fatal injury is a well-defined condition and, in most countries, is known by the authorities. Therefore, the risk of under-reporting fatalities is almost non-existent. The quantification of the associated risk of fatality is straightforward. The usual means to measure fatalities is by the number of deaths within a particular time interval (e.g., the fatal accident rate per million flying hours), or the number of deaths for a specified circumstance (e.g., the fatal accident rate per number of take- offs).

g) Damage to critical infrastructure is a more complex condition. Therefore, the quantification of the associated risks may be difficult and subject to cooperation with the organisation responsible for the infrastructure.

2.2 SORA process outline

a) The SORA methodology provides a logical process to analyse the proposed ConOps and establish an adequate level of confidence that the operation can be conducted with an acceptable level of risk. There are ten steps that support the SORA methodology and each of these steps is described in the following paragraphs and further detailed, when necessary, in the relevant appendixes.

b) The SORA focuses on the assessment of air and ground risks. In addition to air and ground risks, an additional risk assessment of critical infrastructure should also be performed. This should be done in cooperation with the organisation responsible for the infrastructure, as they are most knowledgeable of those threats. Figure 3 outlines the ten steps of the risk model, while Figure 4 provides an overall understanding of how to arrive at an air risk class (ARC) for a given operation.

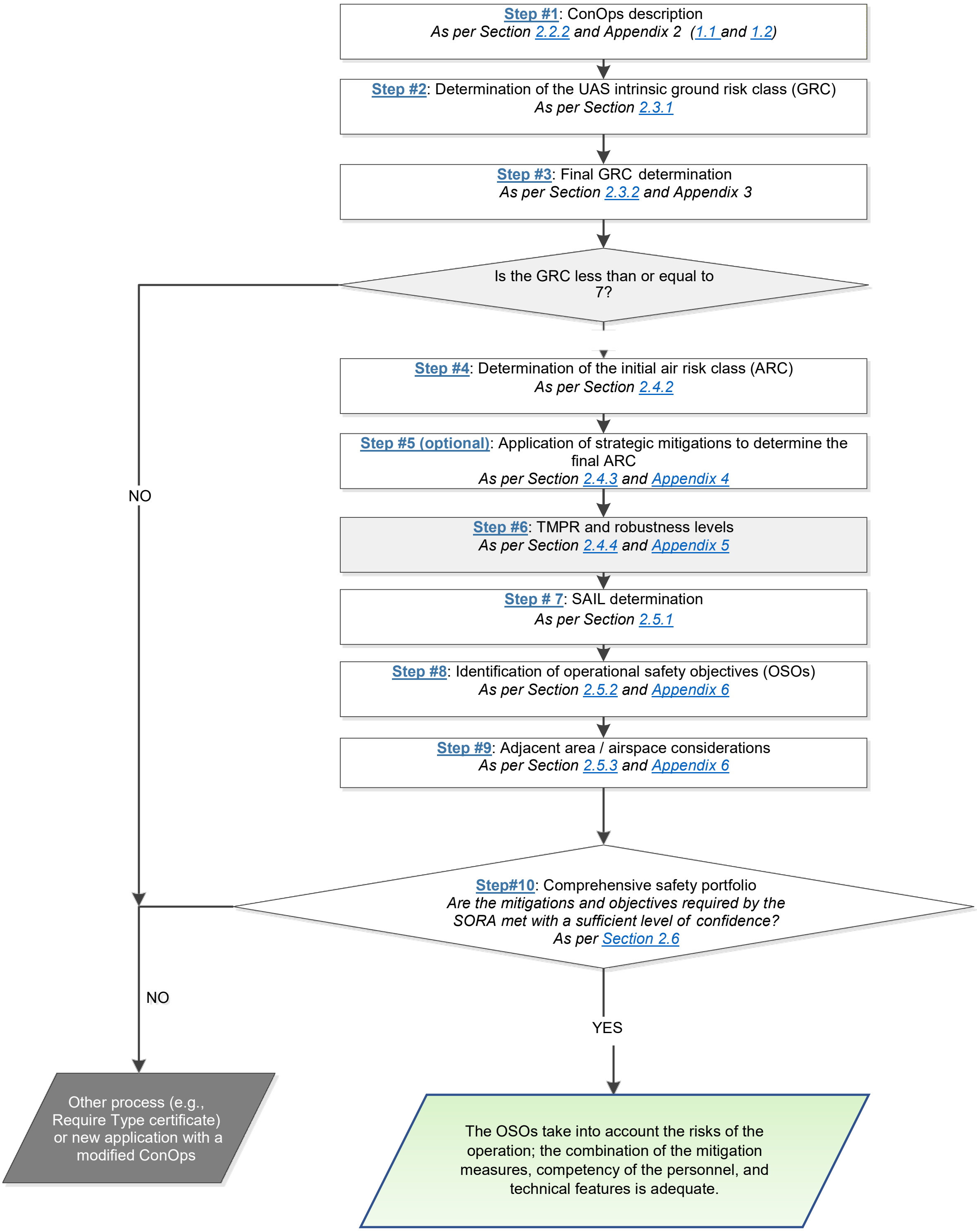

Figure 3 — The SORA process

Note. - *If operations are conducted across different environments, some steps may need to be repeated for each particular environment.*

2.2.1 Pre-application evaluation

a) Before starting the SORA process, the applicant should verify that the proposed operation is feasible (i.e., not subject to specific exclusions from the CAAM or from other related government agencies). Things to verify before beginning the SORA process are whether:

1) the operation falls within the 'lower risk/ normal authorisation to fly' category;
2) the operations are conducted in any of the conditions stated in paragraph 1.2.3 of Section 1 of this CAD;
3) the operation requires airworthiness certification; or
4) the operation is subject to a specific NO-GO from the CAAM or other related government agencies.

If none of the above cases applies, the SORA process should be applied.

2.2.2 Step #1 — ConOps description

a) The first step of the SORA requires the applicant to collect and provide the relevant technical, operational and system information needed to assess the risk associated with the intended operation of the UAS. Appendix 2 to this document provides a detailed framework for data collection and presentation. The ConOps description is the foundation for all other activities, and it should be as accurate and detailed as possible. The ConOps should not only describe the operation, but also provide insight into the UAS operator's operational safety culture. It should also include how and when to interact with the CAAM/ANSP. Therefore, when defining the ConOps, the UAS operator should give due consideration to all the steps, mitigations and OSOs provided in Figure 3 and Figure 4.

b) Developing the ConOps can be an iterative process; therefore, as the SORA process is applied, additional mitigations and limitations may be identified, requiring additional associated technical details, procedures, and other information to be provided/updated in the ConOps. This should culminate in a comprehensive ConOps that fully and accurately describes the proposed operation as envisioned.

2.3 The ground risk process

2.3.1 Step #2 – Determination of the intrinsic UAS ground risk class (GRC)

a) The intrinsic UAS ground risk relates to the risk of a person being struck by the UAS (in the case of a loss of UAS control with a reasonable assumption of safety).

b) To establish the intrinsic GRC, the applicant needs the maximum UA characteristic dimension (e.g., the wingspan for a fixed-wing UAS, the blade diameter for rotorcraft, the maximum dimension for multi-copters, etc.) and the knowledge of the intended operational scenario.

c) The applicant needs to have defined the area at risk when conducting the operation (also called the 'area of operation') including:

1) the operational volume, which is composed of the flight geography and the contingency volume. To determine the operational volume, the applicant should consider the position-keeping capabilities of the UAS in 4D space (latitude, longitude, height and time). In particular, the accuracy of the navigation solution, the flight technical error[1] of the UAS and the path definition error (e.g., map errors), and latencies should be considered and addressed in this determination;
2) whether or not the area is a controlled ground area; and
3) the associated ground risk buffer with at least a 1:1 rule[2], or for rotary wing UA, defined using a ballistic methodology approach acceptable to the CAAM.

d) Table 2 illustrates how to determine the intrinsic ground risk class (GRC). The intrinsic GRC is found at the intersection of the applicable operational scenario and the maximum UA characteristic dimension that drives the UAS lethal area. If there is a mismatch between the maximum UAS characteristic dimension and the typical kinetic energy expected, the applicant should provide substantiation for the chosen column.

Intrinsic UAS ground risk class				
Max UAS characteristics dimension	1 m / approx. 3 ft	3 m / approx. 10 ft	8 m / approx. 25 ft	>8 m / approx. 25 ft
Typical kinetic energy expected	< 700 J (approx. 529 ft lb)	< 34 kJ (approx. 25 000 ft lb)	< 1 084 kJ (approx. 800 000 ft lb)	> 1 084 kJ (approx. 800 000 ft lb)
Operational scenarios				
VLOS/BVLOS over a controlled ground area[3]	1	2	3	4
VLOS over a sparsely populated area	2	3	4	5
BVLOS over a sparsely populated area	3	4	5	6
VLOS over a populated area	4	5	6	8
BVLOS over a populated area	5	6	8	10
VLOS over an assembly of people	7			
BVLOS over an assembly of people	8			

Table 2 – Determination of intrinsic GRC

1 The flight technical error is the error between the actual track and the desired track (sometimes referred to as 'the ability to fly the flight director').

2 If the UA is planned to operate at 120 m altitude, the ground risk buffer should at least be 120 m.

3 In line with Figure 1 and paragraph 2.3.1.(c), the controlled area should encompass the flight geography, the contingency volume and the ground risk buffer.

e) The operational scenarios describe an attempt to provide discrete categorisations of operations with increasing numbers of people at risk. In principle, it is possible to use either qualitative criteria (please refer to the next point (f) or quantitative criteria, or consider both criteria, to assess if an operation takes place over sparsely populated areas, populated areas or assemblies of people.

f) Qualitative assessment: the volume to be used by the operator to classify the operation includes the operational volume and the ground risk buffer (as defined by a semantic model), which determine the intrinsic GRC.

Section 2.1 Definition 'assemblies of people' provides guidance on when an operation is classified as taking place over assemblies of people.

An operation should be classified as taking place over a populated area if the volume that is used to determine the intrinsic GRC:

- does not include assemblies of people; and

- includes areas that are substantially used for residential, commercial or recreational purposes.

g) EVLOS[4] operations are to be considered to be BVLOS for the intrinsic GRC determination.

h) Controlled ground areas are a way to strategically mitigate the risk on ground (similar to flying in segregated airspace); the UAS operator should ensure, through appropriate procedures, that no uninvolved person is in the area of operation, as defined in Section 2.3.1(c).

i) An operation occurring in a populated environment cannot be intrinsically classified as being in a sparsely populated environment, even in cases where the footprint of the operation is completely within special risk areas (e.g., rivers, railways, and industrial estates). The applicant can make the claim for a lower density and/or shelter with Step #3 of the SORA process.

j) Operations that do not have a corresponding intrinsic GRC (i.e., grey cells on the table) are not supported by the SORA methodology.

k) When evaluating the typical kinetic energy expected for a given operation, the applicant should generally use the airspeed, in particular Vcruise 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.

l) The nominal size of the crash area for most UAS can be anticipated by considering both the size and the energy used in the ground risk

4 EVLOS — A UAS operation whereby the remote pilot maintains uninterrupted situational awareness of the airspace in which the UAS operation is being conducted via visual airspace surveillance through one or more human VOs, possibly aided by technological means. The remote pilot has direct control of the UAS at all times.

determination. There are certain cases or design aspects that are non-typical and will have a significant effect on the lethal area of the UAS, such as the amount of fuel, high-energy rotors/props, frangibility, material, etc. These may not have been considered in the intrinsic GRC determination table. These considerations may lead to a decrease/increase in the intrinsic GRC. The use of industry standards or dedicated research might provide a simplified path for this assessment.

2.3.2 Step #3 – Final GRC determination

a) The intrinsic risk of a person being struck by the UAS (in case of a loss of control of the operation) can be controlled and reduced by means of mitigation.

b) The mitigations used to modify the intrinsic GRC have a direct effect on the safety objectives associated with a particular operation, and therefore it is important to ensure their robustness. This has particular relevance for technical mitigations associated with the ground risk (e.g., an emergency parachute).

c) The final GRC determination (step #three) is based on the availability of these mitigations to the operation. Table 3 provides a list of potential mitigations and the associated relative correction factor. A positive number denotes an increase in the GRC, while a negative number results in a decrease in the GRC. All the mitigations should be applied in numeric sequence to perform the assessment. Appendix 3 provides additional details on how to estimate the robustness of each mitigation. Competent authorities may define additional mitigations and the relative correction factors.

		Robustness		
Mitigation Sequence	Mitigations for ground risk	Low/None	Medium	High
1	M1 — Strategic mitigations for ground risk[5]	0: None -1: Low	-2	-4
2	M2 — Effects of ground impact are reduced[6]	0	-1	-2
3	M3 — An emergency response plan (ERP) is in place, the UAS operator is validated and effective	1	0	-1

Table 3 — Mitigations for final GRC determination

d) When applying mitigation M1, the GRC cannot be reduced to a value lower than the lowest value in the applicable column in Table 2. This is because it is not possible to reduce the number of people at risk below that of a controlled area.

5 This mitigation is meant as a means to reduce the number of people at risk.

6 This mitigation is meant as a means to reduce the energy absorbed by the people on the ground upon impact.

e) For example, in the case of a 2.5 m UAS (second column in Table 2) flying in visual line-of-sight (VLOS) over a sparsely populated area, the intrinsic GRC is 3. Upon analysis of the ConOps, the applicant claims to reduce the ground risk by first applying M1 at medium robustness (a GRC reduction of 2). In this case, the result of applying M1 is a GRC of 2, because the GRC cannot be reduced any lower than the lowest value for that column. The applicant then applies M2 using a parachute system, resulting in a further reduction of 1 (i.e., a GRC of 1). Finally, M3 (the ERP) has been developed to medium robustness with no further reduction as per Table 3.

f) The final GRC is established by adding all the correction factors (i.e., -1-1-0=-2) and adapting the GRC by the resulting number (3-2=1).

g) If the final GRC is greater than 7, the operation is not supported by the SORA process.

h) In general, a quantitative approach to mitigation means allows to reduce the intrinsic GRC by 1 point if the mitigation means reduce the risk of operation by a factor of approximately 10 (90% reduction) compared to the risk that is assessed before the mitigation means are applied. Such quantitative criteria should be used to validate the risk reduction that is claimed when applying Appendix 3 of this CAD.

2.4 The air risk process

2.4.1 Air risk process overview

a) The SORA uses the operational airspace defined in the ConOps as the baseline to evaluate the intrinsic risk of a mid-air collision, and by determining the air risk category (ARC). The ARC may be modified/lowered by applying strategic and tactical mitigation means. The application of strategic mitigations may lower the ARC level. An example of strategic mitigations to reduce the risk of a collision may be by operating during certain time periods or within certain boundaries. After applying the strategic mitigations, any residual risk of a mid-air collision is addressed by means of tactical mitigations.

b) Tactical mitigations take the form of detect and avoid (DAA) systems or alternate means, such as ADS-B, FLARM, UTM services or operational procedures. Depending on the residual risk of a mid-air collision, the tactical mitigation performance requirement(s) (TMPR(s)) may vary.

c) As part of the SORA process, the UAS operator should cooperate with the relevant service provider for the airspace (e.g., the CAAM/ANSP or UTM service provider) and obtain the necessary authorisations.

d) Irrespective of the results of the risk assessment, the UAS operator should pay particular attention to all the features that may increase the detectability of the UA in the airspace. Therefore, technical solutions that improve the electronic conspicuousness or detectability of the UAS are recommended.

2.4.2 Step #4 - Determination of the initial air risk class (ARC)

a) The CAAM, ANSP, or UTM service provider, may elect to directly map the airspace collision risks using airspace characterisation studies. These maps would directly show the initial ARC for a particular volume of airspace. If the CAAM, ANSP, or UTM service provides an air collision risk map (static or dynamic), the applicant should use that service to determine the initial ARC, and go directly to Section 2.4.3 ‘Application of strategic mitigations’ to reduce the initial ARC.

b) As seen in Figure 4, the airspace is categorised into 13 aggregated collision risk categories. These categories were characterised by the altitude, controlled versus uncontrolled airspace, airport/heliport versus non-airport/non-heliport environments, airspace over urban versus rural environments, and lastly atypical (e.g., segregated) versus typical airspace.

c) To assign the proper ARC for the type of UAS operation, the applicant should use the decision tree found in Figure 4.

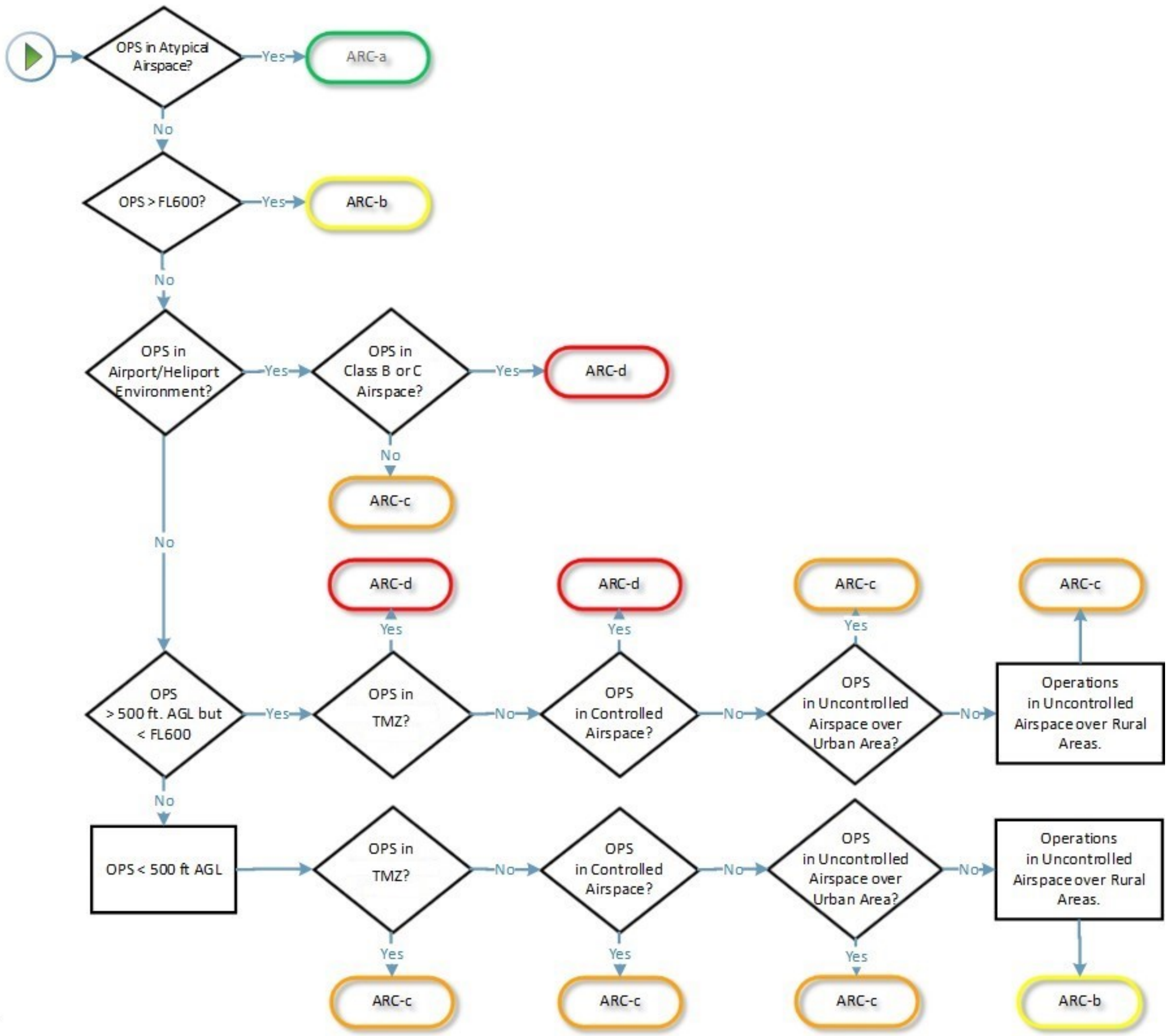

Figure 4 — ARC assignment process

d) The ARC is a qualitative classification of the rate at which a UAS would encounter a manned aircraft in typical generalised civil airspace. The ARC is an initial assignment of the aggregated collision risk for the airspace, before mitigations are applied. The actual collision risk of a specific local operational volume could be much different, and can be addressed with the application of strategic mitigations to reduce the ARC (this step is optional, see Section 2.4.3, Step #5).

e) Although the static generalised risk put forward by the ARC is conservative (i.e., it stays on the safe side), there may be situations where that conservative assessment may not suffice. It is important for both the CAAM and the UAS operator to take great care to understand the operational volume and under which circumstances the definitions in Figure 4 could be invalidated. In some situations, the CAAM may raise the operational volume ARC to a level which is greater than that advocated by Figure 4. The CAAM/ANSP should be consulted to ensure that the assumptions related to the operational volume are accurate.

f) ARC-a is generally defined as airspace where the risk of a collision between a UAS and a manned aircraft is acceptable without the addition of any tactical mitigation.

g) ARC-b, ARC-c, ARC-d generally define volumes of airspace with increasing risk of a collision between a UAS and a manned aircraft.

h) During the UAS operation, the operational volume may span many different airspace environments. The applicant needs to perform an air risk assessment for the entire range of the operational volume. An example scenario of operations in multiple airspace environments is provided at the end of Appendix 4.

2.4.3 Step #5 — Application of strategic mitigations to determine the residual ARC (optional)

a) As stated before, the ARC is a generalised qualitative classification of the rate at which a UAS would encounter a manned aircraft in the specific airspace environment. However, it is recognised that the UAS operational volume may have a different collision risk from the one that the generalised initial ARC assigned.

b) If an applicant considers that the generalised initial ARC assigned is too high for the condition in the local operational volume, then they should refer to Appendix 4 for the ARC reduction process.

c) If the applicant considers that the generalised initial ARC assignment is correct for the condition in the local operational volume, then that ARC becomes the residual ARC.

2.4.4 Step #6 — TMPR and robustness levels

a) Tactical mitigations are applied to mitigate any residual risk of a mid-air collision that is needed to achieve the applicable airspace safety objective. Tactical mitigations will take the form of either ‘see and avoid’ (i.e., operations under VLOS), or they may require a system which provides an alternate means of achieving the applicable airspace safety objective (operation using a DAA, or multiple DAA systems). Appendix 5 provides the method for applying tactical mitigations.

2.4.4.1 Operations under VLOS/EVLOS

a) VLOS is considered to be an acceptable tactical mitigation for collision risk for all ARC levels. Notwithstanding the above, the UAS operator is advised to consider additional means to increase the situational awareness with regard to air traffic operating in the vicinity of the operational volume.

b) Operational UAS flights under VLOS do not need to meet the TMPR, nor the TMPR robustness requirements. In the case of multiple segments of the flight, those segments conducted under VLOS do not have to meet the

TMPR, nor the TMPR robustness requirements, whereas those conducted under BVLOS do need to meet the TMPR and the TMPR robustness requirements.

c) In general, all VLOS requirements are applicable to EVLOS. EVLOS may have additional requirements over and above those of VLOS. The EVLOS verification and communication latency between the remote pilot and the observers should be less than 15 seconds.

d) Notwithstanding the above, the applicant should have a documented VLOS de-confliction scheme, in which the applicant explains which methods will be used for detection, and defines the associated criteria applied for the decision to avoid incoming traffic. If the remote pilot relies on detection by observers, the use of phraseology will have to be described as well.

e) For VLOS operations, it is assumed that an observer is not able to detect traffic beyond 2 NM. (Note that the 2 NM range is not a fixed value and it may largely depend on the atmospheric conditions, aircraft size, geometry, closing rate, etc.). Therefore, the UAS operator may have to adjust the operation and/or the procedures accordingly.

2.4.4.2 Operations under a DAA system — TMPR

a) For operations other than VLOS, the applicant will use the residual ARC and Table 4 below to determine the TMPR.

Residual ARC	TMPRs	TMPR level of robustness
ARC-d	High	High
ARC-c	Medium	Medium
ARC-b	Low	Low
ARC-a	No requirement	No requirement

Table 4 — TMPRs and TMPR level of robustness assignment

b) High TMPR (ARC-d): This is airspace where either the manned aircraft encounter rate is high, and/or the available strategic mitigations are low. Therefore, the resulting residual collision risk is high, and the TMPR is also high. In this airspace, the UAS may be operating in integrated airspace and will have to comply with the operating rules and procedures applicable to that airspace, without reducing the existing capacity, decreasing safety, negatively impacting current operations with manned aircraft, or increasing the risk to airspace users or persons and property on the ground. This is no different from the requirements for the integration of comparable new and novel technologies in manned aviation. The performance level(s) of those tactical mitigations and/or the required variety of tactical mitigations are generally higher than for the other ARCs. If operations in this airspace are conducted more routinely, the CAAM is expected to require the UAS operator to comply with the recognised DAA system standards (e.g., those developed by RTCA SC-228 and/or EUROCAE WG-105).

c) Medium TMPR (ARC-c): A medium TMPR will be required for operations in airspace where the chance of encountering manned aircraft is reasonable, and/or the strategic mitigations available are medium. Operations with a medium TMPR will likely be supported by the systems currently used in aviation to aid the remote pilot in the detection of other manned aircraft, or by systems designed to support aviation that are built to a corresponding level of robustness. Traffic avoidance manoeuvres could be more advanced than for a low TMPR.

d) Low TMPR (ARC-b): A low TMPR will be required for operations in airspace where the probability of encountering another manned aircraft is low, but not negligible, and/or where strategic mitigations address most of the risk, and the resulting residual collision risk is low. Operations with a low TMPR are supported by technology that is designed to aid the remote pilot in detecting other traffic, but which may be built to lower standards. For example, for operations below 120 m, the traffic avoidance manoeuvres are expected to mostly be based on a rapid descent to an altitude where manned aircraft are not expected to ever operate.

e) No performance requirement (ARC-a): This is airspace where the manned aircraft encounter rate is expected to be extremely low, and therefore there is no requirement for a TMPR. It is generally defined as airspace where the risk of a collision between a UAS and a manned aircraft is acceptable without the addition of any tactical mitigation. An example of this may be UAS flight operations in some parts of Alaska or northern Sweden, where the manned aircraft density is so low that the airspace safety threshold could be met without any tactical mitigation.

f) Appendix 5 provides information on how to satisfy the TMPR based on the available tactical mitigations and the TMPR level of robustness.

2.4.4.3 Consideration of additional airspace/operational requirements

a) Modifications to the initial and subsequent approvals may be required by the CAAM or the ANSP as safety and operational issues arise.

b) The UAS operator and the CAAM need to be cognisant that the ARCs are a generalised qualitative classification of the collision risk. Local circumstances could invalidate the aircraft density assumptions of the SORA, for example, due to special events. It is important for both the CAAM and the UAS operator to fully understand the airspace and air-traffic flows, and develop a system which can alert UAS operators to changes to the airspace on a local level. This will allow the UAS operator to safely address the increased risks associated with these events.

c) There are many airspace, operational and equipment requirements which have a direct impact on the collision risk of all aircraft in the airspace. Some of these requirements are general and apply to all volumes of airspace, while some are local and are required only for a particular volume of airspace. The SORA cannot possibly cover all the possible requirements for all the conditions in which the UAS operator may wish to operate. The applicant and the CAAM need to work closely together to define and address these additional requirements.

d) The SORA process should not be used to support operations of a UAS in a given airspace without the UAS being equipped with the required equipment for operations in that airspace (e.g., the equipment required to ensure interoperability with other airspace users). In these cases, specific exemptions may be granted by the CAAM. Those exemptions are outside the scope of the SORA.

e) Operations in controlled airspace, will likely require prior approval from the ANSP. The applicant should ensure that they involve the CAAM/ANSP prior to commencing operations in these environments.

2.5 Final assignment of specific assurance and integrity level (SAIL) and OSO

2.5.1 Step #7 - SAIL determination

a) The SAIL parameter consolidates the ground and air risk analyses, and drives the required activities. The SAIL represents the level of confidence that the UAS operation will remain under control.

b) After determining the final GRC and the residual ARC, it is then possible to derive the SAIL associated with the proposed ConOps.

c) The level of confidence that the operation will remain under control is represented by the SAIL. The SAIL is not quantitative, but instead corresponds to:

1) the OSO to be complied with (see Table 6);
2) the description of the activities that might support compliance with those objectives; and
3) the evidence that indicates that the objectives have been satisfied.

d) The SAIL assigned to a particular ConOps is determined using Table 5:

SAIL determination				
	Residual ARC			
Final GRC	a	b	c	d
≤2	I	II	IV	VI
3	II	II	IV	VI
4	III	III	IV	VI
5	IV	IV	IV	VI
6	V	V	V	VI
7	VI	VI	VI	VI
>7	Category C operation			

Table 5 - SAIL determination

2.5.2 Step #8 — Identification of the operational safety objectives (OSOs)

a) The last step of the SORA process is to use the SAIL to evaluate the defences within the operation in the form of OSOs, and to determine the associated level of robustness. Table 6 provides a qualitative methodology to make this determination. In this table, O is optional, L is recommended with low robustness, M is recommended with medium robustness, and H is recommended with high robustness. The various OSOs are grouped based on the threat they help to mitigate; hence, some OSOs may be repeated in the table.

b) Table 6 is a consolidated list of the common OSOs that historically have been used to ensure safe UAS operations. It represents the collected experience of many experts, and is therefore a solid starting point to determine the required safety objectives for a specific operation. The CAAM that issue the operational authorisation may define additional OSOs for a given SAIL and the associated level of robustness.

OSO number (in line with Appendix 6)		SAIL					
		I	II	III	IV	V	VI
	Technical issue with the UAS						
OSO#01	Ensure the UAS operator is competent and/or proven	O	L	M	H	H	H
OSO#02	UAS manufactured by competent and/or proven entity	O	O	L	M	H	H
OSO#03	UAS maintained by competent and/or proven entity	L	L	M	M	H	H
OSO#04	UAS developed to authority recognised design standards[7]	O	O	L	L	M	H
OSO#05	UAS is designed considering system safety and reliability	O	O	L	M	H	H
OSO#06	C3 link performance is appropriate for the operation	O	L	L	M	H	H
OSO#07	Inspection of the UAS (product inspection) to ensure consistency with the ConOps	L	L	M	M	H	H
OSO#08	Operational procedures are defined, validated and adhered to	L	M	H	H	H	H
OSO#09	Remote crew trained and current and able to control the abnormal situation	L	L	M	H	H	H
OSO#10	Safe recovery from a technical issue	L	L	M	H	H	H
	Deterioration of external systems supporting UAS operations						
OSO#11	Procedures are in-place to handle the deterioration of external systems supporting UAS operations	L	M	H	H	H	H
OSO#12	The UAS is designed to manage the deterioration of external systems supporting UAS operations	L	L	M	M	H	H
OSO#13	External services supporting UAS operations are adequate for the operation	L	L	M	H	H	H
	Human error						
OSO#14	Operational procedures are defined, validated and adhered to	L	M	H	H	H	H

[7]In case of experimental flight that investigate new technical solutions, the competent authority may accept that recognised standard are not met.

OSO#15	Remote crew trained and current and able to control the abnormal situation	L	L	M	M	H	H
OSO number (in line with Appendix 6)		SAIL					
		I	II	III	IV	V	VI
OSO#16	Multi-crew coordination	L	L	M	M	H	H
OSO#17	Remote crew is fit to operate	L	L	M	M	H	H
OSO#18	Automatic protection of the flight envelope from human error	O	O	L	M	H	H
OSO#19	Safe recovery from human error	O	O	L	M	M	H
OSO#20	A human factors evaluation has been performed and the human machine interface (HMI) found appropriate for the mission	O	L	L	M	M	H
	Adverse operating conditions						
OSO#21	Operational procedures are defined, validated and adhered to	L	M	H	H	H	H
OSO#22	The remote crew is trained to identify critical environmental conditions and to avoid them	L	L	M	M	M	H
OSO#23	Environmental conditions for safe operations are defined, measurable and adhered to	L	L	M	M	H	H
OSO#24	UAS is designed and qualified for adverse environmental conditions	O	O	M	H	H	H

Table 6 — Recommended OSOs

2.5.3 Step #9 – Adjacent area/airspace considerations

a) The objective of this section is to address the risk posed by a loss of control of the operation, resulting in an infringement of the adjacent areas on the ground and/or adjacent airspace. These areas may vary with different flight phases.

b) Safety requirements for containment are:

1) No probable[8] failure[9] of the UAS or any external system supporting the operation should lead to operation outside the operational volume.

2) Compliance with the requirement above shall be substantiated by a design and installation appraisal and shall include at least:

   i) the design and installation features (independence, separation and redundancy);

   ii) any relevant particular risk (e.g., hail, ice, snow, electro-magnetic interference, etc.) associated with the ConOps

[8] The term 'probable' needs to be understood in its qualitative interpretation, i.e., 'Anticipated to occur one or more times during the entire system/ operational life of an item'.

[9] The term 'failure' needs to be understood as an occurrence that affects the operation of a competent, part, or elements such that it can no longer function as intended. Errors may cause failures, but are not considered to be failures. Some structural or mechanical failures may be excluded from the criterion if it can be shown that these mechanical parts were designed according to aviation industry best practices.

c) The enhanced containment, which consists in the following three safety requirements, applies to operations conducted:

1) either where the adjacent areas:

i) contain assemblies of people unless the UAS is already approved for operations over assemblies of people; or

ii) are ARC-d unless the residual ARC of the airspace area intended to be flown within the operational volume is already ARC-d;

2) Or where the operational volume is in a populated area where:

i) M1 mitigation has been applied to lower the GRC; or

ii) operating in a controlled ground area.

a) The UAS is designed to standards that are considered adequate by the competent authority and/or in accordance with a means of compliance that is acceptable to that authority such that:

1) The probability of the UA leaving the operational volume should be less than 10-4/FH; and

2) No single failure of the UAS or any external system supporting the operation should lead to its operation outside the ground risk buffer.

Compliance with the requirements above should be substantiated by analysis and/or test data with supporting evidence.

b) Software (SW) and airborne electronic hardware (AEH) whose development error(s) could directly (refer to Note 2) lead to operations outside the ground risk buffer should be developed to an industry standard or methodology that is recognised as being adequate by the CAAM.

As it is not possible to anticipate all local situations, the UAS operator, the CAAM and the ANSP should use sound judgement with regard to the definition of the 'adjacent airspace' as well as the 'adjacent areas'. For example, for a small UAS with a limited range, these definitions are not intended to include busy airport/heliport environments 30 kilometres away. The airspace bordering the UAS volume of operation should be the starting point of the determination of the adjacent airspace. In exceptional cases, the airspace beyond those volumes that border the UAS volume of operation may also have to be considered.

Note 1: The safety requirements as proposed in this section cover both the integrity and assurance levels.

Note 2: The third safety requirement in Section 2.5.3(c) does not imply a systematic need to develop the SW and AEH according to an industry standard or methodology recognised as adequate by the CAAM. The use of the term 'directly' means that a development error in a software or an airborne electronic hardware would lead the UA outside the ground risk buffer without the possibility for another system to prevent the UA from exiting the operational volume.

2.6 Step #10 — comprehensive safety portfolio

a) The SORA process provides the applicant, the CAAM and the ANSP with a methodology which includes a series of mitigations and safety objectives to be considered to ensure an adequate level of confidence that the operation can be safely conducted. These are:

1) mitigations used to modify the intrinsic GRC;

2) strategic mitigations for the initial ARC;

3) tactical mitigations for the residual ARC;

4) adjacent area/airspace considerations; and

5) OSOs.

b) The satisfactory substantiation of the mitigations and objectives required by the SORA process provides a sufficient level of confidence that the proposed operation can be safely conducted.

c) The UAS operator should be sure to address any additional requirements that were not identified by the SORA process (e.g., for security, environmental protection, etc.) and identify the relevant stakeholders (e.g., environmental protection agencies, national security bodies, etc.). The activities performed within the SORA process will likely address those additional needs, but they may not be considered to be sufficient at all times.

d) The UAS operator should ensure the consistency between the SORA safety case and the actual operational conditions (i.e., at the time of the flight).

Appendix 2

1 ConOps: Guidelines on Collecting and Presenting System and Operational Information for Specific UAS Operations

1.1 General guidelines

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

1.2 Document control

Applicants should include an amendment record at the beginning of the document to record changes and show how that the document is controlled.

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

This section is critical to ensure appropriate document control.

Any significant changes to the ConOps may require further assessment and approval by the CAAM prior to further operations being conducted.

1.3 References

a) List all references (documents, URL, manuals, appendices) mentioned in the ConOps:

#	Title	Description	Amendment/ Revision/ Issue Number
[1]			
[2]			

1.4 Guidance for the collection and presentation of operationally relevant information

The template below provides section headings detailing the subject areas that should be addressed when producing the ConOps, 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 should be included in the ConOps documentation as required for the particular operation(s), in order to provide the minimum required information and evidence to perform the SORA.

1.4.1 Reserved

1.4.2 Organisation overview

a) This section describes how the organisation is defined, to support safe operations. It should include:

1) the structure of the organisation and its management, and
2) the responsibilities and duties of the UAS operator.

1.4.2.1 Safety

a) The ‘specific’ category covers operations where the operational risks are higher and therefore the management of safety is particularly important. The applicant should describe how safety is integrated in the organisation, and the safety management system that is in place, if applicable.

b) Any additional safety-related information should be provided.

1.4.2.2 Design and production

a) If the organisation is responsible for the design and/or production of the UAS, this section should describe the design and/or the production organisation.

b) It should provide information on the manufacturer of the UAS to be used if the UAS is not manufactured or produced by the operator, i.e., by a third-party manufacturer.

c) If required, information on the production organisation of the third-party organisation should be provided as evidence.

1.4.2.3 Training of staff involved in operations

a) This section should describe the training organisation or entity that qualifies all the staff involved in operations with respect to the ConOps.

1.4.2.4 Maintenance

This section should describe:

a) the general maintenance philosophy of the UAS;

b) the maintenance procedures for the UAS; and

c) the maintenance organisation, if required.

1.4.2.5 Crew

This section should describe:

a) the responsibilities and duties of personnel, including all the positions and people involved, for functions such as:

   1) the remote pilot (including the composition of the flight team according to the nature of the operation, its complexity, the type of UAS, etc.); and

   2) support personnel (e.g., visual observers (VOs), launch crew, and recovery crew);

b) the procedure for multi-crew coordination if more than one person is directly involved in the flight operations;

c) the operation of different types of UAS, including details of any limitations to the types of UAS that a remote pilot may operate, if appropriate; and

d) details of the operator'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.

1.4.2.6 UAS configuration management

a) This section should describe how the operator manages changes to the UAS configuration.

1.4.2.7 Other position(s) and other information

a) Any other position defined in the organisation, or any other relevant information, should be provided.

1.4.3 Operations

1.4.3.1 Type of operations

a) Detailed description of the ConOps: the applicant should describe what types of operations the UAS operator intends to carry out. The detailed description should contain all the information needed to obtain a detailed understanding of how, where and under which limitations or conditions the operations shall be performed. The operational volume, including the ground and air risk buffers, needs to be clearly defined. Relevant charts/diagrams, and any other information helpful to visualise and understand the intended operation(s) should be included in this section.

b) The applicant should provide specific details on the type of operations (e.g., VLOS, BVLOS), the population density to be overflown (e.g., away from people, sparsely populated, assemblies of people) and the type of airspace to be used (e.g., a segregated area, fully integrated).

c) The applicant should describe the level of involvement (LoI) of the crew and any automated or autonomous systems during each phase of the flight.

1.4.3.2 Normal operation strategy

a) The normal operation strategy should contain all the safety measures, such as technical or procedural measures, crew training, etc. that are put in place to ensure that the UAS can fulfil the operation within the approved limitations, and so that the operation remains in control.

b) Within this section, it should be assumed that all systems are working normally and as intended.

c) The intent of this chapter is to provide a clear understanding of how the operation takes place within the approved technical, environmental, and procedural limitations.

1.4.3.3 Standard operating procedures

a) This section should describe the standard operating procedures (SOP) applicable to all operations for which an approval is requested. A reference to the applicable operations manual (OM) is acceptable.

1.4.3.3.1 Normal operating procedures

a) This section should describe the normal operating procedures in place for the intended operations.

1.4.3.3.2 Contingency and emergency procedures

a) This section should describe the contingency procedures in place for any malfunction or abnormal operation, as well as an emergency.

1.4.3.3.3 Occurrence reporting procedures

UAS, like all aircraft, are subject to accident investigations and occurrence reporting schemes. Mandatory or voluntary reporting should be carried out using the reporting processes provided by the competent authorities. As a minimum, the SOP should contain:

a) reporting procedures in case of:

   1) damage to property;

   2) a collision with another aircraft; or

   3) a serious or fatal injury (third parties and own personnel); and

b) documentation and data logging procedures: describe how records and information are stored and made available, if required, to the AAIB, CAAM, and other government entities (e.g., police) as applicable.

Note. - Guidance can be found in Appendix 7 of this CAD.

1.4.3.4 Operational limits

This section should detail the specific operating limitations and conditions appropriate to the proposed operation(s); for example, operating heights, horizontal distances, weather conditions, the applicable flight performance envelope, times of operations (day and/or night) and any limitations for operating within the applicable class(es) of airspace, etc.

1.4.3.5 Emergency Response Plan (ERP)

The applicant should:

a) define a response plan for use in the event of a loss of control of the operation;

b) describe the procedures to limit the escalating effects of a crash; and

c) describe the procedures for use in the event of a loss of containment.

1.4.4 Remote crew training

1.4.4.1 General information

a) This section describes the processes and procedures that the UAS operator uses to develop and maintain the necessary competence for the remote crew (i.e., any person involved in the UAS operation).

1.4.4.2 Initial training and qualification

a) This section describes the processes and procedures that the UAS operator uses to ensure that the remote crew is suitably competent, and how the qualification of the remote crew is carried out.

Note. - Guidance can be found in CAD 6011 (I).

1.4.4.3 Procedures for maintenance of currency

a) This section describes the processes and procedures that the UAS operator uses to ensure that the remote crew acquire and maintain the required currency to execute the various types of duties.

1.4.4.4 Flight simulation training devices (FSTDs)

This section:

a) describes the use of FSTDs for acquiring and maintaining the practical skills of the remote pilots (if applicable); and

b) describes the conditions and restrictions in connection with such training (if applicable).

1.4.4.5 Training programme

a) This section provides a reference to the applicable training programme(s) for the remote crew.

1.5 Guidance for the collection and presentation of technical relevant information

The aim of this section is to collect all the necessary technical information about the UAS and its supporting systems. This information needs to be sufficient to address the required robustness levels of the mitigations and the OSOs of the SORA.

The list below is suggested guidance for items which may be relevant for this assessment, but the items may differ, depending on the specific UAS utilised in this ConOps.

1.5.1 *RESERVED*

1.5.2 UAS description

1.5.2.1 Unmanned aircraft (UA) segment

1.5.2.1.1 Airframe

This section should include the following:

a) A detailed description of the physical characteristics of the UA (mass, centre-of-mass, dimensions, etc.), including photos, diagrams and schematics, if appropriate to support the description of the UA.

1) Dimensions: for fixed-wing UA, the wingspan, fuselage length, body diameter etc.; for a rotorcraft, the length, width and height, propeller diameter, etc.;

2) Mass: all the relevant masses such as the empty mass, MTOM, etc.; and

3) Centre of gravity: the centre of gravity and limits if necessary.

b) Materials: the main materials used and where they are used in the UA, highlighting in particular any new materials (new metal alloys or composites) or combinations of materials (composites 'tailored' to designs).

c) Load limits: the capability of the airframe structure to withstand expected flight load limits.

d) Sub-systems: any sub-systems such as a hydraulic system, environmental control system, parachute, brakes, etc.

1.5.2.1.2 UA performance characteristics

This section should include the following:

a) the performance of the UA within the proposed flight envelope, specifically addressing at least the following items:

1) Performance: the

i) maximum altitude;

ii) maximum endurance;

iii) maximum range;

iv) maximum rate of climb;

v) maximum rate of descent;

vi) maximum bank angle; and

vii) turn rate limits.

2) Airspeeds: the

i) slowest speed attainable;

ii) stall speed (if applicable);

iii) nominal cruise speed;

iv) max cruise speed; and

v) never-exceed airspeed.

b) Any performance limitations due to environmental and meteorological conditions, specifically addressing the following items:

1) wind speed limitations (headwind, crosswind, gusts);

2) turbulence restrictions;

3) rain, hail, snow, ash resistance or sensitivities;

4) the minimum visibility conditions, if applicable;

5) outside air temperature (OAT) limits; and

6) in-flight icing:

i) whether the proposed operating environment includes operations in icing conditions;

ii) whether the system has an icing detection capability, and if so, what indications, if any, the system provides to the remote pilot, and/or how the system responds; and

iii) any icing protection capability of the UA, including any test data that demonstrates the performance of the icing protection system.

1.5.2.1.3 Propulsion system

This section should include the following:

a) Principle

A description of the propulsion system and its ability to provide reliable and sufficient power to take off, climb, and maintain flight at the expected mission altitudes.

b) Fuel-powered propulsion systems

1) The type (manufacturer organisation and model) of engine that is used;

2) How many engines are installed;

3) The type and the capacity of fuel that is used;

4) How the engine performance is monitored;

5) The status indicators, alerts (such as warning, caution and advisory), messages that are provided to the remote pilot;

6) A description of the most critical propulsion-related failure modes/conditions and their impact on the operation of the system;

7) How the UA responds, and the safeguards that are in place to mitigate the risk of a loss of engine power for each of the following:

i) fuel starvation;

ii) fuel contamination;

iii) failed signal input from the remote pilot station (RPS); and

iv) engine controller failure;

8) The in-flight restart capabilities of the engine, if applicable, and if so, a description of the manual and/or automatic features of this capability;

9) The fuel system and how it allows for adequate control of the fuel delivery to the engine, and provides for aircrew determination of the fuel remaining. This includes a system level diagram showing the location of the system in the UA and the fuel flow path; and

10) How the fuel system is designed in terms of safety (fire detection and extinguishing, reduction of risk in case of impact, leak prevention, etc.).

c) Electric-powered propulsion systems

1) A high-level description of the electrical distribution architecture, including items such as regulators, switches, buses, and converters, as necessary;

2) The type of motor that is used;

3) The number of motors that are installed;

4) The maximum continuous power output of the motor in watts;

5) The maximum peak power output of the motor in watts;

6) The current range of the motor in amps;

7) Whether the propulsion system has a separate electrical source, and if not, how the power is managed with respect to the other systems of the UA;

8) A description of the electrical system and how it distributes adequate power to meet the requirements of the receiving systems. This should include a system level diagram showing the electrical power distribution throughout the UA;

9) How power is generated on board the UA (for example, generators, alternators, batteries).

10) If a limited life power source such as batteries is used, the useful life of the power source during normal and emergency conditions, and how this was determined;

11) How information on the battery status and the remaining battery capacity is provided to the remote pilot or the watchdog system;

12) If available, a description of the source(s) of backup power for use in the event of a loss of the primary power source. This should include:

    i) the systems that are powered during backup power operation;

    ii) a description of any automatic or manual load shedding; and

    iii) how much operational time the backup power source provides, including the assumptions used to make this determination;

13) How the performance of the propulsion system is monitored;

14) The status indicators and alert (such as warning, caution and advisory) messages that are provided to the remote pilot;

15) A description of the most critical propulsion-related failure modes/conditions and their impact on system operation;

16) How the UA responds, and the safeguards that are in place to mitigate the risk of a propulsion system loss for each of the following:

    i) Low battery charge;

    ii) A failed signal input from the RPS; and

    iii) A motor controller failure;

17) If the motor has in-flight reset capabilities, a description of the manual and/or automatic features of this capability.

d) Other propulsion systems

A description of these systems to a level of detail equivalent to the fuel and electrical propulsions sections above.

1.5.2.1.4 Flight control surfaces and actuators

This section should include the following:

a) A description of the design and operation of the flight control surfaces and servos/actuators, including a diagram showing the location of the control surfaces and the servos/actuators;

b) A description of any potential failure modes and the corresponding mitigations;

c) How the system responds to a servo/actuator failure; and

d) How the remote-pilot or watchdog system is alerted of a servo/actuator malfunction.

1.5.2.1.5 Sensors

This section should describe the non-payload sensor equipment on board the UA and its role.

1.5.2.1.6 Payloads

This section should describe the payload equipment on board the UA, including all the payload configurations that significantly change the weight and balance, electrical loads, or flight dynamics.

1.5.3 UAS control segment

This section should include the following:

1.5.3.1 General

An overall system architecture diagram of the avionics architecture, including the location of all air data sensors, antennas, radios, and navigation equipment. A description of any redundant systems, if available.

1.5.3.2 Navigation

a) How the UAS determines its location;

b) How the UAS navigates to its intended destination;

c) How the remote pilot responds to instructions from:

1) air traffic control;

2) UA observers or VOs (if applicable); and

3) other crew members (if applicable);

d) The procedures to test the altimeter navigation system (position, altitude);

e) How the system identifies and responds to a loss of the primary means of navigation;

f) A description of any backup means of navigation; and

g) How the system responds to a loss of the secondary means of navigation, if available.

1.5.3.3 Autopilot

a) How the autopilot system was developed, and the industry or regulatory standards that were used in the development process.

b) If the autopilot is a commercial off-the-shelf (COTS) product, the type/design and the production organisation, with the criteria that were used in selecting the COTS autopilot.

c) The procedures used to install the autopilot and how its correct installation is verified, with references to any documents or procedures provided by the manufacturer's organisation and/or developed by the UAS operator's organisation.

d) If the autopilot employs input limit parameters to keep the aircraft within defined limits (structural, performance, flight envelope, etc.), a list of those limits and a description of how these limits were defined and validated.

e) The type of testing and validation that was performed (software-in-the-loop (SITL) and hardware-in-the-loop (HITL) simulations).

1.5.3.4 Flight control system

a) How the control surfaces (if any) respond to commands from the flight control computer/autopilot.

b) A description of the flight modes (i.e., manual, artificial-stability, automatic, autonomous).

c) Flight control computer/autopilot:

1) If there are any auxiliary controls, how the flight control computer interfaces with the auxiliary controls, and how they are protected against unintended activation.

2) A description of the flight control computer interfaces required to determine the flight status and to issue appropriate commands.

3) The operating system on which the flight controls are based.

1.5.3.5 Remote pilot station (RPS)

a) A description or a diagram of the RPS configuration, including screen captures of the control station displays.

b) How accurately the remote pilot can determine the attitude, altitude (or height) and position of the UA.

c) The accuracy of the transmission of critical parameters to other airspace users/air traffic control (ATC).

d) The critical commands that are safeguarded from inadvertent activation and how that is achieved (for example, is there a two-step process to command ‘switch the engine off’). The kinds of inadvertent input that the remote pilot could enter to cause an undesirable outcome (for example, accidentally hitting the ‘kill engine’ control in flight).

e) Any other programmes that run concurrently on the ground control computer, and if there are any, the precautionary measures that are used to ensure that flight-critical processing will not be adversely affected.

f) The provisions that are made against an RPS display or interface lock-up.

g) The alerts (such as warning, caution and advisory) that the system provides to the remote pilot (e.g., low fuel or battery level, failure of critical systems, or operation out of control).

h) A description of the means to provide power to the RPS, and redundancies, if any.

1.5.3.6 Detect and avoid (DAA) system

a) Aircraft conflict avoidance

1) A description of the system/equipment that is installed for collaborative conflict avoidance (e.g., SSR, TCAS, ADS-B, FLARM, etc.).

2) If the equipment is qualified, details of the detailed qualification to the respective standard.

3) If the equipment is not qualified, the criteria that were used in selecting the system.

b) Non-collaborative conflict avoidance:

A description of the equipment that is installed (e.g., vision-based, PSR data, LIDAR, etc.).

c) Obstacle conflict avoidance

A description of the system/equipment that is installed, if any, for obstacle collision avoidance.

d) Avoidance of adverse weather conditions

A description of the system/equipment that is installed, if any, for the avoidance of adverse weather conditions.

e) Standard

1) If the equipment is qualified, a list of the detailed qualification to the respective standard.

2) If the equipment is not qualified, the criteria that were used in selecting the system.

f) A description of any interface between the conflict avoidance system and the flight control computer.

g) A description of the principles that govern the installed DAA system

h) A description of the role of the remote pilot or any other remote crew in the DAA system.

i) A description of the known limitations of the DAA system.

1.5.4 Containment system

a) A description of the principles of the system/equipment used to perform containment functions for:

1) avoidance of specific area(s) or volume(s); or
2) confinement in a given area or volume

b) The system information and, if applicable, supporting evidence that demonstrates the reliability of the containment system.

1.5.5 Ground support equipment (GSE) segment

a) A description of all the support equipment that is used on the ground, such as launch or recovery systems, generators, and power supplies.

b) A description of the standard equipment available, and the backup or emergency equipment.

c) A description of how the UAS is transported on the ground.

1.5.6 Command and control (C2) link segment

a) The standard(s) with which the system is compliant.

b) A detailed diagram that shows the system architecture of the C2 link, including informational or data flows and the performance of the subsystem, and values for the data rates and latencies, if known.

c) A description of the control link(s) connecting the UA to the RPS and any other ground systems or infrastructures, if applicable, specifically addressing the following items:

1) The spectrum that will be used for the control link and how the use of this spectrum has been coordinated. If approval of the spectrum is not required, the regulation that was used to authorise the frequency.
2) The type of signal processing and/or link security (i.e., encryption) that is employed.
3) The datalink margin in terms of the overall link bandwidth at the maximum anticipated distance from the RPS, and how it was determined.
4) If there is a radio signal strength and/or health indicator or similar display to the remote pilot, how the signal strength and health values were determined, and the threshold values that represent a critically degraded signal.
5) If the system employs redundant and/or independent control links, how different the design is, and the likely common failure modes.
6) For satellite links, an estimate of the latencies associated with using the satellite link for aircraft control and for air traffic control communications.
7) The design characteristics that prevent or mitigate the loss of the datalink due to the following:
   i) RF or other interference;
   ii) flight beyond the communications range;
   iii) antenna masking (during turns and/or at high attitude angles);
   iv) a loss of functionality of the RPS;
   v) a loss of functionality of the UA; and
   vi) atmospheric attenuation, including precipitation.

1.5.7 C2 link degradation

A description of the system functions in case of a C2 link degradation:

a) Whether the C2 link degradation status is available and in what form (e.g., degraded, critical, automatic messages).

b) How the status of the C2 link degradation is announced to the remote pilot (e.g., visual, haptic, or sound).

c) A description of the associated contingency procedures.

d) Other.

1.5.8 C2 link loss

a) The conditions that could lead to a loss of the C2 link.

b) The measures in case of a loss of the C2 link.

c) A description of the clear and distinct aural and visual alerts to the remote pilot for any case of a lost link.

d) A description of the established lost link strategy presented in the UAS operating manual, taking into account the emergency recovery capability.

e) A description of how the geo-awareness or geo-fencing system is used in this case, if available.

f) The lost link strategy, and, if incorporated, the re-acquisition process in order to try to re-establish the link in a reasonably short time.

1.5.9 Safety features

a) A description of the single failure modes and their recovery mode(s), if any.

b) A description of the emergency recovery capability to prevent risks to third-parties. This typically consists of:

   1) a flight termination system (FTS), procedure or function that aims to immediately end the flight; or
   2) an automatic recovery system (ARS) that is implemented through UAS crew command or by the on-board systems. This may include an automatic pre-programmed course of action to reach a predefined and unpopulated forced landing area; or
   3) any combination of the above, or other methods.

c) The applicant should provide both a functional and physical diagram of the global UA system with a clear depiction of its constituent components, and, where applicable, an indication of its peculiar features (e.g., independent power supplies, redundancies, etc.)

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Appendix 3

1 Integrity and Assurance Levels for the Mitigations Used to Reduce the Intrinsic Ground Risk Class (GRC)

1.1 How to use Appendix 3

The following Table 3.1 provides the basic principles to consider when using SORA Appendix 3.

	Principle description	Additional information
#1	Appendix 3 provides assessment criteria for the integrity (i.e., safety gain) and assurance (i.e., method of proof) of the applicant's proposed mitigations. The proposed mitigations are intended to reduce the intrinsic ground risk class (GRC) associated with a given operation.	The identification of mitigations is the responsibility of the applicant.
#2	Appendix 3 does not cover the (Letter of Intent). The LoI is based on the CAAM's assessment of the applicant's ability to perform the given operation.	
#3	A proposed mitigation may or may not have a positive effect in reducing the ground risk associated with a given operation. In the case where a mitigation is available but does not reduce the risk on the ground, its level of integrity should be considered equivalent to 'None'.	
#4	To achieve a given level of integrity/assurance, when more than one criterion exists for that level of integrity/assurance, all the applicable criteria need to be met.	
#5	Appendix 3 intentionally uses non-prescriptive terms (e.g., suitable, reasonably practicable) to provide flexibility to both the applicant and the competent authorities. This does not constrain the applicant in proposing mitigations, nor the CAAM in evaluating what is needed on a case-by-case basis.	
#6	This Appendix in its entirety also applies to single-person organisations.	

Table 3.1 – Basic principles

1.2 M1 - Strategic mitigations for ground risk

M1 mitigations are 'strategic mitigations' intended to <u>reduce the number of people at risk on the ground</u>. To assess the integrity levels of M1 mitigations, the following need to be considered:

a) the definition of the ground risk buffer and the resulting ground footprint; and

b) the evaluation of the people at risk.

With the exception of the specific case of a 'tether' provided in the following paragraph (2), the generic criteria to assess the level of integrity (Table 3.2) and level of assurance (Table 3.3) of the M1 type ground risk mitigations are provided in following paragraph (1).

1.2.1 Generic criteria

		Level of integrity		
		Low	**Medium**	**High**
M1 — Strategic mitigations for ground risk	Criterion #1 (Definition of the ground risk buffer)	A ground risk buffer with at least a 1:1 rule[1] or for rotary wing UA defined using a ballistic methodology approach acceptable to the CAAM.	The ground risk buffer takes into consideration: (a) improbable[2] single malfunctions or failures (including the projection of high energy parts such as rotors and propellers) which would lead to an operation outside the operational volume; (b) meteorological conditions (e.g., wind); (c) UAS latencies (e.g., latencies that affect the timely manoeuvrability of the UA); (d) UA behaviour when activating a technical containment measure; and (e) UA performance.	Same as medium[3]
	Comments	*[1] If the UA is planned to operate at an altitude of 150 m, the ground risk buffer should be a minimum of 150 m.*	*[2] For the purpose of this assessment, the term 'improbable' should be interpreted in a qualitative way as 'Unlikely to occur in each UAS during its total life, but which may occur several times when considering the total operational life of a number of UAS of this type'.* *[3] The distinction between a medium and a high level of robustness for this criterion is achieved through the level of assurance (Table 3 below).*	
	Criterion #2 (Evaluation of people at risk)	The applicant evaluates the area of operations by means of on-site inspections or appropriate appraisals to justify lowering the density of the people at risk (e.g., a residential area during daytime when some people may not be present or an industrial area at night time for the same reason).	The applicant evaluates the area of operations by use of authoritative density data (e.g., data from the UTM data service provider) relevant for the proposed area and time of operation to substantiate a lower density of people at risk. If the applicant claims a reduction, due to a sheltered operational environment, the applicant: (a) uses a UA of less than 25 kg and not flying above 174 knots[4], and (b) demonstrates that although the operation is conducted in a populated environment, it is reasonable to consider that most of the non-involved persons will be located within a building[5].	Same as medium.
	Comments	*N/A*	*[4] as per MITRE presentation given during the UAS Technical Analysis and Applications Center (TAAC) conference in 2016 titled 'UAS EXCOM Science and Research Panel (SARP) 2016 TAAC Update' - PR 16-3979* *[5] The consideration of this mitigation may vary based on the local conditions.*	*N/A*

Table 3.2 — Level of integrity assessment criteria for ground risk of non-tethered M1 mitigations

		Level of assurance		
		Low	Medium	High
M1 — Strategic mitigations for ground risk	Criterion #1 (Definition of the ground risk buffer)	The applicant declares that the required level of integrity is achieved[1].	The applicant has supporting evidence to claim that the required level of integrity has been achieved. This is typically done by means of testing, analysis, simulation[2], inspection, design review or through operational experience.	The claimed level of integrity is validated by a competent third party.
	Comments	*[1] Supporting evidence may or may not be available.*	*[2] When simulation is used, the validity of the targeted environment used in the simulation needs to be justified.*	*N/A*
	Criterion #2 (Evaluation of people at risk)	The applicant declares that the required level of integrity has been achieved[3].	The density data used for the claim of risk reduction is an average density map for the date/time of the operation from a static sourcing (e.g., census data for night time ops). In addition, for localised operations (e.g., intra-city delivery or infrastructure inspection), the applicant submits the proposed route/area of operation to the applicable authority (e.g., city police, office of civil protection, infrastructure owner etc.) to verify the claim of a reduced number of people at risk.	Same as medium; however, the density data used for the claim of risk reduction is a near-real time density map from a dynamic sourcing (e.g., cellular user data) and applicable for the date/time of the operation.
	Comments	*[3] Supporting evidence may or may not be available*	*N/A*	*N/A*

Table 3.3 — Level of assurance assessment criteria for ground risk of non-tethered M1 mitigations

1.2.2 Specific criteria in case of use of a tether to reduce people at risk

When an applicant wants to take credit for a tether to justify a reduction in the number of people at risk:

a) the tether needs to be considered part of the UAS and assessed based on the criteria below, and

b) potential hazards created by the tether itself should be addressed through the OSOs defined in Appendix 6.

The level of integrity criteria for a tethered mitigation is found in Table 3.4. The level of assurance for a tethered mitigation is found in Table 3.5.

		Level of integrity		
		Low	Medium	High
M1 — Tethered operation	Criterion #1 (Technical design)	Does not meet the 'medium' level criteria	(a) The length of the line is adequate to contain the UA in the operational volume and reduce the number of people at risk. (b) The strength of the line is compatible with the ultimate loads[1] expected during the operation. (c) The strength of the attachment points is compatible with the ultimate loads[1] expected during the operation. (d) The tether cannot be cut by the rotating propellers.	Same as medium[2]
	Comments	*N/A*	*[1] Ultimate loads are identified as the maximum loads to be expected in service, including all the possible nominal and failure scenarios multiplied by a 1.5 safety factor.* *[2] The distinction between a medium and a high level of robustness for this criterion is achieved through the level of assurance (Table 3.5 below).*	
	Criterion #2 (Procedures)	Does not meet the 'medium' level criteria	The applicant has procedures to install and periodically inspect the condition of the tether.	Same as medium[3]
	Comments	*N/A*	*[3] The distinction between a medium and a high level of robustness for this criterion is achieved through the level of assurance (Table 3.5 below).*	

Table 3.4 — Level of integrity assessment criteria for ground risk tethered M1 mitigations

		Level of assurance		
		Low	Medium	High
		(b) The adequacy of the procedures and checklists is declared.	intended purpose with positive results.	(b) The procedures, flight tests and simulations are validated by a competent third party.
	Comments	*N/A*	*N/A*	*N/A*
M1 — Tethered operation	Criterion #1 (Technical design)	Does not meet the 'medium' level criteria	The applicant has supporting evidence (including the specifications of the tether material) to claim that the required level of integrity is achieved. (a) This is typically achieved through testing or operational experience. (b) Tests can be based on simulations; however, the validity of the target environment used in the simulation needs to be justified.	The claimed level of integrity is validated by EASA.
	Comments	*N/A*	*N/A*	*N/A*

	Criterion #2 (Procedures)	(a) Procedures do not require validation against either a standard or a means of compliance considered adequate by the CAAM.	(a) Procedures are validated against standards considered adequate by the CAAM and/or in accordance with a means of compliance acceptable to that authority. (b) Adequacy of the procedures is proven through: (1) dedicated flight tests; or (2) simulation, provided the simulation is proven valid for the	Same as medium. In addition: (a) Flight tests performed to validate the procedures cover the complete flight envelope or are proven to be conservative.

Table 3.5 — Level of assurance assessment criteria for ground risk tethered M1 mitigations

1.3 M2 - Effects of ground impact are reduced

M2 mitigations are intended to reduce the effect of ground impact once the control of the operation is lost. This is done by reducing the effect of the UA impact dynamics (i.e., the area, energy, impulse, transfer energy, etc.). One example would be the use of a parachute.

		Level of integrity		
		Low/None	**Medium**	**High**
M2 — Effects of UA impact dynamics are reduced (e.g., parachute)	Criterion #1 (Technical design)	Does not meet the 'medium' level criterion	(a) Effects of impact dynamics and post impact hazards[1] are significantly reduced although it can be assumed that a fatality may still occur. (b) When applicable, in case of malfunctions, failures or any combinations thereof that may lead to a crash, the UAS contains all the elements required for the activation of the mitigation. (c) When applicable, any failure or malfunction of the proposed mitigation itself (e.g., inadvertent activation) does not adversely affect the safety of the operation.	Same as medium. In addition: (a) When applicable, the activation of the mitigation is automated[2]. (b) The effects of impact dynamics and post impact hazards are reduced to a level where it can be reasonably assumed that a fatality will not occur[3].
	Comments	*N/A*	*[1] Examples of post impact hazards include fires and the release of high- energy parts.*	*[2] The applicant retains the discretion to implement an additional manual activation function.* *[3] Emerging research and upcoming industry standards will help applicants to substantiate compliance with this integrity criterion.*
	Criterion #2 (Procedures, if applicable)	Any equipment used to reduce the effect of the UA impact dynamics is installed and maintained in accordance with the manufacturer's instructions.[4]		
	Comments / Notes	*[4] The distinction between a low, a medium and a high level of robustness for this criterion is achieved through the level of assurance (Table 3.7 below).*		
	Criterion #3 (Training, if applicable)	Personnel responsible for the installation and maintenance of the measures proposed to reduce the effect of the UA impact dynamics are identified and trained by the applicant.[5]		
	Comments / Notes	*[5] The distinction between a low, a medium and a high level of robustness for this criterion is achieved through the level of assurance (Table 3.7 below).*		

Table 3.6 — Level of integrity assessment criteria for M2 mitigations

		Level of assurance		
		Low/None	**Medium**	**High**
M2 — Effects of UA impact dynamics are reduced (e.g., parachute)	Criterion #1 (Technical design)	The applicant declares that the required level of integrity has been achieved[1].	The applicant has supporting evidence to claim that the required level of integrity is achieved. This is typically[2] done by means of testing, analysis, simulation[3], inspection, design review or through operational experience.	The claimed level of integrity is validated by CAAM against a standard considered adequate by CAAM and/or in accordance with means of compliance acceptable to CAAM (when applicable).
	Comments	*[1] Supporting evidence may or may not be available.*	*[2] The use of industry standards is encouraged when developing mitigations used to reduce the effect of ground impact.* *[3] When simulation is used, the validity of the targeted environment used in the simulation needs to be justified.*	
	Criterion #2 (Procedures, if applicable)	(a) Procedures do not require validation against either a standard or a means of compliance considered adequate by the CAAM. (b) The adequacy of the procedures and checklists is declared.	(a) Procedures are validated against standards considered adequate by the CAAM and/or in accordance with means of compliance acceptable to that authority. (b) The adequacy of the procedures is proven through: (1) dedicated flight tests; or (2) simulation, provided that the representativeness of the simulation means is proven for the intended purpose with positive results.	Same as medium. In addition: (a) Flight tests performed to validate the procedures cover the complete flight envelope or are proven to be conservative. (b) The procedures, flight tests and simulations are validated by a competent third party.
	Comments	*N/A*		*N/A*
	Criterion #3 (Training, if applicable)	Training is self-declared (with evidence available)	(a) Training syllabus is available. (b) The UAS operator provides competency-based, theoretical and practical training.	(a) Training syllabus is validated by a competent third party. (b) Remote crew competencies are verified by a competent third party.
	Comments	*N/A*	*N/A*	*N/A*

Table 3.7 - Level of assurance assessment criteria for M2 mitigations

1.4 M3 - An ERP is in place, UAS operator validated and effective

An ERP should be defined by the applicant in the event of a loss of control of the operation (*). These are emergency situations where the operation is in an unrecoverable state and in which:

a) the outcome of the situation relies highly on providence; or

b) it could not be handled by a contingency procedure; or

c) when there is a grave and imminent danger of fatalities.

The ERP proposed by an applicant is different from the emergency procedures. The ERP is expected to cover:

a) a plan to limit the escalating effect of a crash (e.g., to notify first responders), and

b) the conditions to alert ATM.

(*) Refer to the SORA semantic model (Figure 1) in the main body.

		Level of integrity		
		Low/None	**Medium**	**High**
M3 — An ERP is in place, UAS operator validated and effective	Criteria	No ERP is available, or the ERP does not cover the elements identified to meet a 'medium' or 'high' level of integrity	The ERP: (a) is suitable for the situation; (b) limits the escalating effects; (c) defines criteria to identify an emergency situation; (d) is practical to use; (e) clearly delineates the duties of remote crew member(s).	Same as medium. In addition, in case of a loss of control of the operation, the ERP is shown to significantly reduce the number of people at risk, although it can be assumed that a fatality may still occur.
	Comments	*N/A*	*N/A*	*N/A*

Table 3.8 — Level of integrity assessment criteria for M3 mitigations

		Level of assurance		
		Low/None	**Medium**	**High**
M3 — An ERP is in place, UAS operator validated and effective	Criterion #1 (Procedures)	(a) Procedures do not require validation against either a standard or a means of compliance considered adequate by the CAAM. (b) The adequacy of the procedures and checklists is declared.	(a) The ERP is developed to standards considered adequate by the CAAM and/or in accordance with means of compliance acceptable to that authority. (b) The ERP is validated through a representative tabletop exercise[1] consistent with the ERP training syllabus.	Same as medium. In addition: (a) The ERP and the effectiveness of the plan with respect to limiting the number of people at risk are validated by a competent third party. (b) The applicant has coordinated and agreed the ERP with all third parties identified in the plan. (c) The representativeness of the tabletop exercise is validated by a competent third party.
	Comments	*N/A*	*[1]The tabletop exercise may or may not involve all third parties identified in the ERP.*	*N/A*
	Criterion #2 (Training)	Does not meet the 'medium' level criterion	(a) An ERP training syllabus is available. (b) A record of the ERP training completed by the relevant staff is established and kept up to date.	Same as medium. In addition, competencies of the relevant staff are verified by a competent third party.
	Comments	*N/A*	*N/A*	*N/A*

Table 3.9 — Level of assurance assessment criteria for M3 mitigations

Appendix 4

1 Strategic Mitigation - Collision Risk Assessment

1.1 Introduction - air risk strategic mitigations

The target audience for Appendix 4 is the UAS operator who wishes to demonstrate to the CAAM that the risk of a mid-air collision in the operational volume is acceptably safe, and to obtain, with concurrence from the ANSP, approval to operate in the particular airspace.

More particularly, this Appendix 4 covers the process of how the UAS operator justifies lowering the initial assessment of the ARC.

The air risk model provides a holistic means to assess the risk of an encounter with manned aircraft. This provides guidance to both the UAS operator and the CAAM on determining whether an operation can be conducted in a safe manner. The model does not provide answers to all the air risk challenges, and should not be used as a checklist. This guidance provides the UAS operator with suitable mitigation means and thereby reduces the air risk to an acceptable level. This guidance does not contain prescriptive requirements, but rather a set of objectives at various levels of robustness.

1.2 Principles

The SORA is only used to establish an initial ARC for an operational volume when the CAAM has not already established one. The initial ARC is a generalised qualitative classification of the rate at which a UAS would encounter a manned aircraft in the operational volume. A residual ARC is the classification after mitigations are applied. The UAS operational volume may have collision risk levels that differ from the generalised initial ARC level. If this is assumed to be the case, this appendix provides a process to help the UAS operator and the CAAM work to lower the initial ARC through the application of strategic mitigations.

1.3 Air risk scope and assumptions

The scope of this air risk assessment is designed to help the UAS operator and the CAAM in determining the risk of a collision with manned aircraft which are operated for the Special UAS Project Approval. The scope of the air risk assessment does not include:

a) the probability of UAS-on-UAS encounters; or

b) risks due to wake turbulence, adverse weather, controlled flight into terrain, return-to- course functions, a lost link, or an automatic response.

1.3.1 SORA qualitative vs quantitative approach

This air risk assessment is qualitative in nature. Where possible, this assessment will use quantitative data to back up and support the qualitative assumptions. The SORA approach in general provides a balance between qualitative and quantitative approaches, as well as between known prescriptive and non-traditional methodologies.

1.3.2 SORA UTM Service provider assumptions

The SORA has used UTM service providers mitigations to a limited extent, because CAAM has not yet procured a UTM system service provider for and the UTM systems provides in Malaysia may be in the early stages of development. When UTM service provider provides adequate mitigations to limit the risk of UAS encounters with manned aircraft, a UAS operator can apply for, and obtain credit for these mitigations, whether they are tactical or strategic.

1.3.3 SORA flight rules assumptions

Today, UAS flight operations under the Special UAS Project cannot fully comply with the IFR and VFR rules as written. Although IFR infrastructures and mitigations are designed for manned aircraft operations (e.g., minimal safe altitudes, equipage requirements, operational restrictions, etc.), it may be possible for a UAS to comply with the IFR requirements. UAS operating at very low levels (e.g., 400 ft AGL and below) may technically comply with the IFR rules, but the IFR infrastructure was not designed with that airspace in mind; therefore, mitigations for this airspace would be derived, and highly impractical and inefficient. When operating BVLOS, a UAS cannot comply with VFR[1].

All aircraft must adhere to specific flight rules to mitigate the collision risk, in accordance with the Director General Directives - Rules of the Air. The implementation of procedures and guidelines appropriate to the airspace structure reduces the collision risk for all aircraft. For instance, there are equipment requirements established for the airspace requested and requirements associated with day-night operations, pilot training, airworthiness, lighting requirements, altimetry requirements, airspace restrictions, altitude restrictions, etc.

The SORA air risk model is a tool to assess the risks associated with UAS operations in a particular volume of airspace, and a method to determine whether those risks are within acceptable safety limits.

1.3.4 Regulatory requirements, safety requirements, and waivers

The ICAO Regulation requires all aircraft, manned and UAS, to 'remain well clear from and avoid collisions with' other manned aircraft. The UAS is unable to 'see and avoid', therefore, it must employ an alternate means of compliance to meet the intent of 'see and avoid', which will have to be defined in terms of safety and

[1] A UAS operating under VLOS may be able to comply with VFR.

performance for the UAS operation. When the risk of an encounter with manned aircraft is extremely low (i.e., in atypical/segregated airspace), an alternate means of compliance may not be required. For example, in areas where the manned airspace density is so low, (e.g., in the case of low-level operations in remote parts of Sarawak etc.), the airspace safety threshold could be met with no additional mitigation. UAS operators need to understand that although the airspace may be technically safe to fly in from an air collision risk standpoint, it does not fulfil the ICAO Annex 2, Section 3.2 'See and Avoid' requirements.

To operate a UAS in manned airspace, two requirements must be met:

a) A safety requirement that ensures that the operation is safe to conduct in the operational volume; and

b) A requirement for compliance with Section 3.2 of the ICAO Annex 2 to 'see and avoid'.

These requirements must be addressed to the CAAM through either:

a) demonstration of compliance with both requirements;

b) demonstration of an alternate means of compliance with the requirements; or

c) a waiver of the requirement(s) by the CAAM.

The SORA provides a means to assess whether the air risks associated with UAS operations is within acceptable limits.

1.3.5 SORA assumptions on threat aircraft

This air risk assessment does not consider the ability of the threat aircraft to remain well clear from or to avoid collisions with the UAS in any part of the safety assessment.

1.3.6 SORA assumptions on people-carrying UAS

This air risk model does not consider the notion of UAS carrying people, or urban mobility operations. The model and the assessment criteria are limited to the risk of an encounter with manned aircraft, i.e., an aircraft piloted by a human on board.

1.3.7 SORA assumptions on UAS lethality

This air risk assessment assumes that a mid-air collision between a UAS and manned aircraft is catastrophic. Frangibility is not considered.

1.3.8 SORA assertion on tactical mitigations

The SORA model makes no distinction between separation provision and collision avoidance but treats them as one dependent system performing a continuous function, whose goals and objectives change over time. This continuum starts with an encounter and progresses to a near mid-air collision objective as the pilot and/or the detect and avoid system of the UA negotiate(s) the encounter. The use of the term 'tactical mitigation' should therefore not be confused with the provisioning of (tactical) separation services referred to in ICAO Doc 9854.

1.4 General air-SORA mitigation overview

SORA classification of mitigations

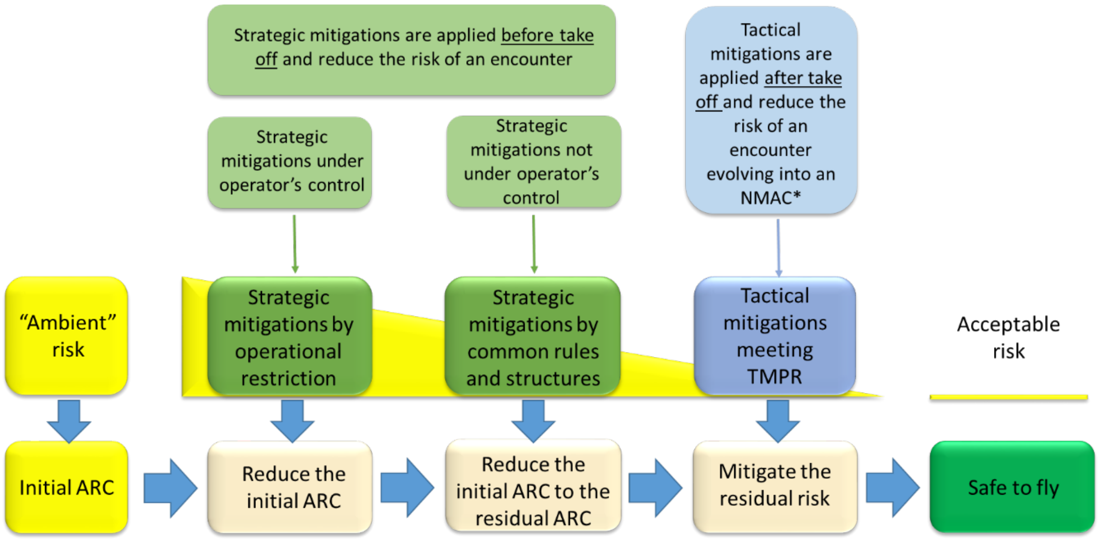
The SORA classifies mitigations to suit the operational needs of a UAS in the 'specific' class. These mitigations are classified as:

a) strategic mitigations by the application of operational restrictions;

b) strategic mitigations by the application of common structures and rules; and

c) tactical mitigations.

Figure 1 shows the alignment of the mitigation definitions between ICAO and the SORA.



* NMAC: near mid-air collision

Figure 1 — SORA air-conflict mitigation process

* The term 'failure' needs to be understood as an occurrence that affects the operation of a component, part, or element such that it can no longer function as intended. Errors may cause failures but are not considered to be failures. Some structural or mechanical failures may be excluded from the criterion if it can be shown that these mechanical parts were designed according to aviation industry best practices.

1.5 Air risk strategic mitigation

Strategic mitigation consists of procedures and operational restrictions intended to reduce the UAS encounter rates or the time of exposure, prior to take-off.

Strategic mitigations are further divided into:

a) mitigations by operational restrictions which are mitigations that are controlled[2] by the UAS operator; and

b) mitigations by common structures[3] and rules which are mitigations which cannot be controlled by the UAS operator.

1.5.1 Strategic mitigation by operational restrictions

Operational restrictions are controlled by the UAS operator and are intended to mitigate the risk of a collision prior to take-off. This section provides details on operational restrictions, and examples of how these can be applied to UAS operations.

Operational restrictions are the primary means that a UAS operator can apply to reduce the risk of collision using strategic mitigation(s). The most common mitigations by operational restriction are:

a) mitigation(s) that bound the geographical volume in which the UAS operates (e.g., certain boundaries or airspace volumes); and

b) mitigation(s) that bound the operational time frame (e.g., restricted to certain times of day, such as flying only at night).

In addition to the above, another approach to limit exposure to risk is to limit the exposure time. This is called 'mitigation by exposure'. Mitigation by exposure simply limits the time of exposure to the operational risk.

Mitigations that limit the flight time or the exposure time to risk may be more difficult to apply. With this said, there is some precedence for this mitigation, which has (in some cases) will be accepted by the CAAM. Therefore, even though it is considered to be difficult, this mitigation strategy may be considered.

One example is the minimum equipment list (MEL) system, which allows, in certain situations, a commercial airline to fly for three to ten days with an inoperative traffic collision avoidance system (TCAS). The safety argument is that three days is a very short exposure time compared with the total life-time risk exposure of the aircraft. This short time of elevated risk exposure is justified to allow the aircraft to return to a location where proper equipment maintenance can take place. While appreciating that this may be a difficult argument for the UAS operation to make, the UAS operator is still free to pursue this line of reasoning for a reduction in the risk of collision by applying a time of exposure argument.

[2] The usage of the word 'controlled' means that UAS operator is not reliant on the cooperation of other airspace users to implement an effective operational restriction mitigation strategy.

[3] This usage of the word 'structure' means air structure, airways, traffic procedures and the like.

1.5.1.1 Example of operational restriction by geographical boundary

The UAS operator intends to fly in a Class B airport airspace. The Class B airspace, as a whole, has a very high encounter rate. However, the UAS operator wishes to operate at a very low altitude and at the very outer reaches of the Class B airspace where manned aircraft do not routinely fly. The UAS operator draws up a new operational volume at the outer edge of the class B airspace and demonstrates that operations within the new Class B volume have very low encounter rates.

The UAS operator may approach this scenario by requesting the CAAM to more precisely define the airport environment from the SORA perspective. The UAS operator then considers the newly defined airport environment, and provides an operational restriction that allows the UAS operation to safely remain inside the class B airspace, but outside the newly defined SORA airport environment.

1.5.1.2 Example of operational restriction by time limitations

The UAS operator wishes to fly in a Class B airport airspace. The Class B airspace, as a whole, has a very high encounter rate. However, the UAS operator wishes to operate at a time of day when manned aircraft do not routinely fly. The UAS operator then restricts the time schedule of the UAS operation and demonstrates that the new time (e.g., 03:00 / 3 AM and still within Class B) has very low encounter rates and is safe for operation.

1.5.1.3 Example of operational restriction by time of exposure

The UAS operator wishes to cut the corner of a Class B airspace for flight efficiency. The UAS operator demonstrates that even though the Class B airspace has a high encounter rate, the UAS is only exposed to that higher rate for a very short amount of time as it transitions the corner.

1.5.2 Strategic mitigation by common structures[4] and rules

Strategic mitigation by common structures and rules requires all aircraft within a certain class of airspace to follow the same structures and rules; these structures and rules work to lower the risk of collision within the airspace. In accordance with the ICAO Regulation, all aircraft in that airspace must participate, and only the competent authorities have the authority to set requirements for those aircraft, while the ANSP and ATCO provide instructions. The UAS operator does not have control[5] over the existence or level of participation of the airspace structure or the application of the flight rules. Therefore, strategic mitigation by common structures and rules is applied by the competent authorities.

For example, imagine the situation if individual drivers could create their own driving rules to cover their direction, lanes, boundaries and speed. If the driving

[4] This usage of the word 'structure' means air structure, airways, traffic procedures and the like.

[5] The usage of the words 'does not control' means that the UAS operator does not have control over the implementation of aviation structure and rules and is reliant on the CAAM to implement structures and rules.

rules were different from one driver to another, no safety benefit would be gained, even though they were all following rules (their own), and total chaos would ensue. However, if all drivers were compelled to follow the same set of rules, then the traffic flow would be orderly, with increased safety for all drivers. This is why a UAS operator cannot propose a mitigation schema requiring participation from other airspace users that differs from that required by the CAAM.

Most strategic mitigations by common structures and rules will take the form of:

a) common flight rules; and

b) common airspace structures.

Strategic mitigations by common flight rules is accomplished by setting a common set of rules which all airspace users must comply with. These rules reduce air conflicts and/or make conflict resolution easier. Examples of common flight rules that reduce the collision risk include right of way rules, implicit and explicit coordination schemes, compacity requirements, cooperative identification system, etc.

Strategic mitigation by using a common airspace structure is accomplished by controlling the airspace infrastructure through physical characteristics, procedures, and techniques that reduce conflicts or make conflict resolution easier. Examples of common flight airspace structures which reduce the risk of collision are airways, departure and approach procedures, airflow management, etc.

In the future, as U-space structures and rules become more readily defined and adopted, they will provide a source for the strategic mitigation of UAS operations by common structures and rules that UAS operators could more easily apply.

1.5.2.1 Example of mitigation by common flight rules

The UAS operator intends to fly in a volume of airspace in which the CAAM requires all UAS to be equipped with an electronic cooperative system[6] and anti-collision lighting. The rules further require the UAS operator to file a flight plan with the designated ANSP/UTM service providers, and check for potential hazards along the whole flight route. The operator complies with these requirements and installs anti- collision lights and a Mode-S Transponder. The operator further agrees to file a flight plan prior to each flight. These rules enhance the safety of the flight in the same way as a notice to airmen (NOTAM).

[6] The installation of an electronic cooperative system would make the UAS a cooperative aircraft in accordance with FAA Interim Operational Approval Guidance 08-01, ‘Unmanned Aircraft Systems operations in the U.S. National Airspace System,’ Federal Aviation Administration, FAA/AIR-160, 2008.

The UAS operator should also have a system in place to check for high airspace usage in the intended operational volume (e.g., a glider competition or a fly-in). In those situations where the UAS operator does not own the airspace in which the operational volume exists, the rules require the UAS operator to request permission prior to entering that airspace.

1.5.2.2 Examples of mitigation by common airspace structure

Example 1: The CAAM establishes a transit corridor through Class B airspace that keeps the UAS separated from other non-UAS airport traffic, and safely separates the corridor traffic in one direction from the traffic in the other direction. The UAS operator intends to fly through this Class B airport airspace, and hence must stay within the established transit corridor and adhere to the transit corridor rules.

Example 2: The UAS operator intends to fly a UAS from one location to another, and files a flight plan to CAAM/ANSP. As the UAS takes off, the UTM service provider then guarantees separation by procedural control of all the aircraft in the airspace. Procedural controls are the take-off windows, reporting points, assigned airways and altitudes, route clearances, etc. required for safe operation.

1.6 Reducing the initial air risk class (ARC) assignment (optional)

This section is intended for an applicant that intends to use strategic mitigations to reduce the collision risk (i.e., ARC). There are two types of ARC:

a) the initial ARC, which is a qualitative classification of a UAS operational collision risk within an operational volume before strategic mitigations are applied; and

b) the residual ARC, which is a qualitative classification of a UAS operational collision risk in an operational volume after all strategic mitigations are applied.

If a UAS operator agrees that the (generalised) initial ARC applicable to their operation and operational volume is correct, then this step is not necessary, and the assessment should continue at SORA Step #6 (assigning the DAA tactical performance requirement and robustness levels based on the residual collision risk).

If mitigations to reduce the ARC are relevant and are proposed, this section provides information and examples of how to use strategic mitigation(s) to lower the collision risk within the operational volume, and demonstrate the strategy to the CAAM. The examples within the SORA may or may not be applicable or acceptable to the CAAM; however, the SORA encourages an open dialogue between the applicant and the CAAM to determine what is acceptable evidence.

1.6.1 Lowering the initial ARC to the residual ARC-a in any operational volume (optional)

ARC-a is intended for operations in atypical/segregated airspace (see Table 4.1). Lowering the initial ARC to residual ARC-a requires a higher level of safety verification because it allows a UAS operator to operate without any tactical mitigation.

To demonstrate that an operation could be reduced to a residual ARC-a, the UAS operator should demonstrate:

a) that the operational volume can meet the requirements of SORA atypical/segregated airspace; and

b) compliance with any other requirements mandated by the CAAM for the intended operational volume.

A residual ARC-a assessment does necessarily exempt the UAS operator from the requirements to ‘see and avoid’ and to ‘remain well clear from’ other aircraft. If the CAAM allows the UAS operator a residual ARC-a assessment for the operational volume, in order to comply with the ICAO Regulation, the UAS operator must either provide a valid means and equipment as an alternate means of compliance for the ‘see and avoid’ requirement, or the CAAM must waive the requirement to ‘see and avoid’ and ‘remain well clear.’

1.6.2 Lowering the initial ARC using operational restrictions (optional)

There may be many methods by which a UAS operator may wish to demonstrate a suitable air risk and strategic mitigations. The SORA does not dictate how this is achieved, and instead, allows the applicant to propose and demonstrate the suitability and effectiveness of their strategic mitigations. It is important for both the UAS operator and the CAAM to understand that the assessment may be qualitative in nature, and where possible, augmented with quantitative data to support the qualitative assumptions and decisions. The UAS operator and the CAAM should understand there may not be a clear delineation of the decision points, so common sense and the safety of manned aircraft should be of paramount consideration.

The SORA provides a two-step method to reduce the air risk by operational mitigation. The first step is to determine the initial ARC by using the potential air risk encounter rate based on known airspace densities (as per Table 4.1). The second step is to reduce the initial risk through UAS operator-provided evidence that demonstrates that the intended operation is more indicative of another airspace volume and an encounter rate that corresponds to a lower risk classification (ARC); hence, reducing the initial ARC to a residual ARC (as per Table 4.2). This requires the agreement of the CAAM before the ARC may be reduced.

The SORA used expertise from subject matter experts to rate the airspace encounter category (AEC) and the variables that influence the encounter rates (i.e., proximity, geometry, and dynamics). The variables are not interdependent, nor do they influence the encounter outcome in the same manner. A small increase in one encounter rate variable can have major effects on the collision risk; conversely, a small increase in another variable could have limited effect on the collision risk. Hence, lowering the aircraft density of an AEC airspace does not equate to a direct and equal lowering of the ARC risk level. There is no direct correlation between an individual AEC variable and the ARC collision risk levels. In summary:

a) there are three inter-dependent variables that affect the ARC;

b) the contribution of each variable to the total collision risk is not the same; and

c) for simplicity, the SORA only allows the manipulation of one of the variables: the proximity, i.e., the aircraft density.

The first step to potentially lowering the ARC is to determine the AEC and the associated density rating using Table 4.1. 12 operational/airspace environments were considered for the SORA air risk classification, and they correspond to the 12 scenarios found in Figure 4 of the SORA main body (Appendix 1).

Operational environment, AEC and ARC			
Operations in:	**Initial generalised density rating**	**Corresponding AEC**	**Initial ARC**
Airport/heliport environment			
OPS in an airport/heliport environment in class B, or C airspace	5	AEC 1	ARC-d
OPS in an airport/heliport environment in class or G airspace	3	AEC 6	ARC-c
Operations above 400 ft AGL but below flight level 600			
OPS > 400 ft AGL but < FL 600 in a Mode-S Veil or transponder mandatory zone (TMZ)	5	AEC 2	ARC-d
OPS > 400 ft AGL but < FL 600 in controlled airspace	5	AEC 3	ARC-d
OPS > 400 ft AGL but < FL 600 in uncontrolled airspace over an urban area	3	AEC 4	ARC-c
OPS > 400 ft AGL but < FL 600 in uncontrolled airspace over a rural area	2	AEC 5	ARC-c
Operations below 400 ft AGL			
OPS < 400 ft AGL in a Mode-S Veil or TMZ	3	AEC 7	ARC-c
OPS < 400 ft AGL in controlled airspace	3	AEC 8	ARC-c
OPS < 400 ft AGL in uncontrolled airspace over an urban area	2	AEC 9	ARC-c
OPS < 400 ft AGL in uncontrolled airspace over a rural area	1	AEC 10	ARC-b
Operations above flight level 600			
OPS > FL 600	1	AEC 11	ARC-b
Operations in atypical or segregated airspace			
OPS in atypical/segregated airspace	1	AEC 12	ARC-a

Table 4.1 – Initial air risk category assessment

After determining the initial risk using Table 4.1, an applicant may choose to reduce that risk using Table 4.2. To understand Table 4.2, the first column shows the AEC in the environment in which the UAS operator wishes to operate. Column A shows the associated airspace density rating for that AEC rated from 5 to 1, with 5 being very high density, and 1 being very low density.

Column B shows the corresponding initial ARC.

Column C is key to lowering the initial ARC. This column shows the relative density ratings that a UAS operator should demonstrate to the CAAM in order to argue and justify that the actual local air density rating of the operational area is lower than the rating associated with the initial AEC (Column A) in Table 4.1. If this can be shown and accepted by the CAAM, then the new lower ARC level as shown in column D may be applicable.

As stated earlier, the UAS operator is responsible for collecting and analysing the airspace density and for demonstrating the effectiveness of their proposal for strategic mitigations by operational restrictions to the CAAM. In summary, the UAS operator should demonstrate that the restrictions imposed on the UAS operation can lower the risk of a collision by showing that the local airspace encounter rate, under the operational restrictions, is lower than the generalised AEC assessed encounter rate provided in Table 4.1.

The strategic mitigation reduction case should be modelled after a safety case. The size and complexity of the strategic mitigation reduction depends entirely on what the UAS operator is trying to do, and where/when they want to do it. The strategic mitigation case as a safety case has two advantages. Firstly, it provides the UAS operator with a structured approach to describe and capture the operation, the hazards identified, the risk analysed, and the threat(s) mitigated. Secondly, it provides a safety case structure that a CAAM is familiar with, which, in turn, helps the CAAM to understand the UAS operator's intended operation and their reasoning as to why a reduction in the ARC can be safely justified.

The UAS operator should propose to the CAAM and/or ANSP of the format and presentation of the strategic mitigation reduction case which shall be agreed upon by both parties.

The density rating of manned aircraft, assessed on a scale of 1 to 5, with 1 representing a very low density and 5 representing a very high density.				
Column	A	B	C	D
AEC	Initial generalised density rating for the environment	Initial ARC	If the local density can be demonstrated to be similar to:	New lowered (residual) ARC
AEC 1 or; AEC 2	5	ARC-d	4 or 3	ARC-c
			2 or 1 Note 1	ARC-b
AEC 3	4	ARC-d	3 or 2	ARC-c
			1 Note 1	ARC-b
AEC 4	3	ARC-c	1 Note 1	ARC-b
AEC 5	2	ARC-c	1 Note 1	ARC-b
AEC 6 or; AEC 7 or; AEC 8	3	ARC-c	1 Note 1	ARC-b
AEC 9	2	ARC-c	1 Note 1	ARC-b
Note 1: The reference environment for assessing density is AEC 10 (OPS < 400 ft AGL over rural areas).				
AEC10 and AEC 11 are not included in this table, as any ARC reduction would result in ARC-a. A UAS operator claiming a reduction to ARC-a should demonstrate that all the requirements that define atypical or segregated airspace have been met.				

Table 4.2

To fully understand the above, the SORA provides three examples.

Example 1:

A UAS operator is intending to operate in an airport/heliport environment, in class C airspace, which corresponds to AEC 1.

The UAS operator enters the initial ARC reduction table at Row AEC 1. Column A shows that the generalised airspace density of this environment is 5. Column B shows the associated initial ARC as ARC-d. Column C indicates that if a UAS operator can demonstrate that the actual, local airspace density corresponds to a generalised density rating of 3 or 4, then the ARC level may be reduced to a residual ARC-c (Column D). If a UAS operator demonstrates that the local airspace density corresponds more to scenarios with a density of 2 or 1, then the ARC level may be lowered to a residual ARC-b (Column D).

Example 2:

A UAS operator is intending to operate in an airport/heliport environment, in class G airspace, with a corresponding level of AEC 6.

The UAS operator enters the initial ARC reduction table at Row AEC 6. Column A shows that the generalised airspace density rating that corresponds with this environment is 3. Column B shows the associated initial ARC as ARC-c. Column C indicates that if a UAS operator can demonstrate that the actual, local, airspace density corresponds more to the reference scenario that has a generalised density rating of 1, namely AEC 10, then the residual ARC level may be reduced to ARC-b (Column D).

Example 3:

A UAS operator is intending to operate below 400 ft AGL, in a class G (uncontrolled) airspace, over an urbanised area, with a corresponding level of AEC 9.

The UAS operator enters the initial ARC reduction table at Row AEC 9. Column A indicates that the generalised airspace density rating corresponding with this environment is 2. Column B shows the associated initial ARC is ARC-c. Column C indicates that if a UAS operator demonstrates that the local airspace density corresponds more to a density rating of 1, namely AEC 10, then the residual ARC level may be reduced to ARC-b (Column D).

1.6.3 Lowering the initial ARC by common structures and rules (optional)

Today, aviation airspace rules and structures mitigate the risk of collision. As the airspace risk increases, more structures and rules are implemented to reduce the risk. In general, the higher the aircraft density, the higher the collision risk, and the more structures and rules are required to reduce the collision risk.

In general, manned aircraft do not use very low level (VLL) airspace, as it is below the minimum safe height to perform an emergency procedure, 'unless at such a height as will permit, in the event of an emergency arising, a landing to be made without undue hazard to persons or property on the surface' (Ref can be found in Rule of the Air under Chapter 4 – Visual Flight Rules). Subject to permission from the CAAM/ANSP, special flights may be granted permission to use this airspace. Every aircraft will cross VLL airspace in an airport environment for take-off and landing.

With the advent of UAS operations, VLL airspace is expected to soon become more crowded, requiring more common structures and rules to lower the collision risk. It is anticipated that U-space services will provide these risk mitigation measures. This will require mandatory participation by all aircraft in that airspace, similar to how the current flight rules apply to all manned aircraft operating in a particular airspace today.

The SORA does not allow the initial ARC to be lowered through strategic mitigation by common structures and rules for all operations in AEC 1, 2, 3, 4, 5, and 11.[7] Outside the scope of the SORA, a UAS operator may appeal to the CAAM to lower the ARC by strategic mitigation by using common structures. The determination of acceptability falls under the normal airspace rules, regulations and safety requirements for ATM/ANS providers.

[7]AEC 1, 2, 3, 4, and 5 already have manned airspace rules and structures defined in Director General Directives - Rules of the Air. Any UAS operating in these types of airspace shall comply with the applicable airspace rules, regulations and safety requirements. As such, no lowering of the ARC by common structures and rules is allowed, as those mitigations have already been accounted for in the assessment of those types of airspace. Lowering the ARC for rules and structures in AEC 1, 2, 3, 4, 5, and 11 would amount to double counting of the mitigations.

Similarly, the SORA does not allow for lowering the initial ARC through strategic mitigation by using common structures and rules for all operations in AEC 10[8].

The maximum amount of ARC reduction through strategic mitigation by using common structures and rules is by one ARC level.

The SORA does allow for lowering the initial ARC through strategic mitigation by structures and rules for all operations below 400 ft AGL within VLL airspace (AECs 7, 8, 9 and 10).

To claim an ARC reduction, the UAS operator should show the following:

a) the UA is equipped with an electronic cooperative system, and navigation and anti- collision lighting[9];

b) a procedure has been implemented to verify the presence of other traffic during the UAS flight operation (e.g., checking other aircraft's filed flight plans, NOTAMs[10], etc.);

c) a procedure has been implemented to notify other airspace users of the planned UAS operation (e.g., filing of the UAS flight plan, applying for a NOTAM from the service provider for UAS[11] operations, etc.);

d) permission has been obtained from the airspace owner to operate in that airspace (if applicable).

1.6.3.1 Demonstration of strategic mitigation by structures and rules

The UAS operator is responsible for collecting and analysing the data required to demonstrate the effectiveness of their strategic mitigations by structures and rules to the CAAM.

[8] AEC 10: the initial ARC is ARC-b. To lower the ARC in these volumes of airspace (to ARC-a) requires the operational volume to meet one of the requirements of atypical/segregated Airspace.
[9] Although the SORA takes into account the questionable effects of anti-collision lighting, it also takes into account that the installation of anti collision lights is often relatively simple and has a net positive effect in preventing collisions.
[10] Although NOTAMs are used here as an example, the us of a NOTAMs may not be acceptable unless they cover all operations in VLL airspace. It is envisioned that a separate system like that of NOTAMs, which is specifically addresses the concerns of VLL airspace, will fulfil this requirement.
[11] Although flight plans and posting NOTAMs are used here as examples, the use of flight plans and NOTAMs may not be acceptable unless they cover all operations in VLL airspace. It is envisioned that a separate system, which specifically addresses the concerns VLL airspace, will fulfil this requirements.

1.7 Determination of the residual ARC risk level by the CAAM

As stated before, the UAS operator is responsible for collecting and analysing the data required to demonstrate the effectiveness of all their strategic mitigations to the CAAM.

The CAAM makes the final determination of the airspace residual ARC level.

Caution: As the SORA breaks down collision mitigation into strategic and tactical parts, there can be some overlap between all these mitigations. The UAS operator and the CAAM need to be cognisant and to ensure that mitigations are not counted twice.

Although the static generalised risk (i.e., ARC) is conservative, there may be situations where that conservative assessment may be insufficient. In those situations, the CAAM may raise the ARC to a level that is higher than that advocated by the SORA.

For example, a UAS operator surveys a forest near an airport for beetle infestation, and the airspace was assessed as being ARC-b. The airport is hosting an air show. The CAAM informs the UAS operator that during the week of the air show, the ARC for that local airspace will be ARC-d. The UAS operator can either equip for ARC-d airspace or suspend operations until the air show is over.

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Appendix 5

1 Tactical Mitigation Collision Risk Assessment

1.1 Introduction-tactical mitigation

The target audience for Appendix 5 is the UAS operator who wishes to apply TMPR, robustness, integrity, and assurance levels for their operation.

Appendix 5 provides the tactical mitigation(s) used to reduce the risk of a mid-air collision. The TMPR is driven by the residual collision risk of the airspace. Some of these tactical mitigations may also provide means of compliance with Section 3.2 of the ICAO Regulation.

The air-risk model has been developed to provide a holistic method to assess the risk of an air encounter, and to mitigate the risk that an encounter develops into a mid-air collision. The SORA air-risk model guides the UAS operator, the CAAM, and/or ANSP in determining whether an operation can be conducted in a safe manner. This appendix is not intended to be used as a checklist, nor does it provide answers to all the challenges of DAA. The guidance allows a UAS operator to determine and apply a suitable means of mitigation to reduce the risk of a mid- air collision to an acceptable level. This guidance does not contain prescriptive requirements, but rather objectives to be met at various levels of robustness.

1.2 Principles

The mitigation of the risk that an encounter develops into a mid-air collision is a highly dynamic, variable, and complicated process. To simplify the process, the air-risk model takes a more qualitative approach to arrive at an initial aggregated airspace risk assessment. After an assessment of the initial, unmitigated risk of an encounter, and optional application of strategic mitigations, this appendix assigns a performance requirement on the UAS operation to mitigate the remaining collision hazard (i.e., the residual airspace risk).

1.3 Scope, assumptions and definitions

See Appendix 4 for the scope and assumptions

1.4 Knowledge of terms and definitions

To understand this section, the following SORA definitions need to be understood:

a) atypical/segregated vs other airspace;

b) AEC (see Appendix 4);

c) initial ARC (see Appendix 4);

d) residual ARC (see Appendix 4);

e) ICAO conflict management (see ICAO Doc 9854, Section 2.7);

f) strategic mitigation (see Appendix 4);

g) tactical mitigations and feedback loops; and

h) VLOS and BVLOS.

1.5 TMPR assignment

A tactical mitigation is a mitigation applied after take-off, and for the air risk model, it takes the form of a 'mitigating feedback loop'. This feedback loop is dynamic in that it reduces the rate of collision by modifying the geometry and dynamics of the aircraft in conflict, based on real-time aircraft conflict information.

SORA tactical mitigations are applied to cover the gap between the residual risk of an encounter (the residual ARC) and the airspace safety objectives. The residual risk is the remaining collision risk after all strategic mitigations are applied.

1.5.1 Two classifications of tactical mitigation

There are two classifications of tactical mitigations within the SORA, namely:

a) VLOS, whereby a pilot and/or observer uses (use) human vision to detect aircraft and take action to remain well clear from and avoid collisions with other aircraft.

b) BVLOS, whereby an alternate means of mitigation to human vision, as in machine or machine assistance[1], is applied to remain well clear from and avoid collisions with other aircraft (e.g., ATC separation services, TCAS, DAA, etc.).

1.5.2 TMPR using VLOS

Originally the regulations for 'see and avoid' and 'avoid collisions', defined in Section 3.2 of the ICAO Regulation, assumed that a pilot was on board the aircraft. With UA, this assumption is no longer valid, as the aircraft is piloted remotely.

Under VLOS, the pilot/UAS operator accomplishes 'see and avoid' by keeping the UAS within their VLOS. The UAS remains close enough to the remote pilot/observer to allow them to see and avoid another aircraft with human vision unaided by any device other than, perhaps, corrective lenses. VLOS is generally considered an acceptable means of compliance with the 'remain well clear from' and 'avoiding collisions' requirements of Section 3.2 of the ICAO Regulation.

VLOS generally provides sufficient mitigation for cases where the requirements for tactical mitigations are low, medium, and high. Different states may have other rules and restrictions for VLOS operations (e.g., altitudes, horizontal distances, times for relaying critical flight information, UAS operator/observer training, etc.). In some situations, the CAAM may decide that VLOS does not provide sufficient mitigation for the airspace risk, and may require compliance with additional rules

[1] For the purposes of this dissection, systems like ATC separation services would be considered to be machine assisted.

and/or requirements. It is the UAS operators' responsibility to comply with these rules and requirements.

The UAS operator should produce a documented VLOS de-confliction scheme, explaining the methods that will be applied for detection and the criteria used to avoid incoming traffic. If the remote pilot relies on detection by observers, the use of communication phraseology, procedures, and protocols should be described. Since the VLOS operation may be sufficiently complex, a requirement to document and approve the VLOS strategy is necessary before approval by the CAAM.

The use of VLOS as a mitigation does not exempt the UAS operator from performing the full SORA risk analysis.

1.5.3 TMPR using BVLOS

Since VLOS has operational limitations, there was a concerted effort to find an alternate means of compliance with the human 'see and avoid' requirements. This alternate means of mitigation is loosely described as 'detect and avoid (DAA)'. DAA can be achieved in several ways, e.g., through ground-based DAA systems, air-based DAA systems, or some combination of the two. DAA may incorporate the use of various sensors, architectures, and even involve many different systems, a human in the loop, on the loop, or no human involvement at all.

TMPR provides tactical mitigations to assist the pilot in detecting and avoiding traffic under BVLOS conditions. The TMPR is the amount of tactical mitigation required to further mitigate the risks that could not be mitigated through strategic mitigation (the residual risk). The amount of residual risk is dependent on the ARC. Hence, the higher the ARC, the greater the residual risk, and the greater the TMPR.

Since the TMPR is the total performance required by all tactical mitigation means, tactical mitigations may be combined. When combining multiple tactical mitigations, it is important to recognise that the mitigation means may interact with each other, depending on the level of interdependency. This may negatively affect the effectiveness of the overall mitigation. Care should be exercised not to underestimate the negative effects of interactions between mitigation systems. Regardless of whether mitigations or systems are dependent or independent, when they act on the same event, unintended consequences may occur.

1.5.3.1 TMPR assignment risk ratio

The SORA TMPR is based on the findings of several studies. These studies provide performance guidance using risk ratios. Table shows the SORA TMPR risk ratio requirements derived from those studies.

Air-Risk Class	TMPR	TMPR system risk ratio objectives
ARC-d	**high performance**	**system risk ratio ≤ 0.1**
ARC-c	medium performance	system risk ratio ≤ 0.33
ARC-b	low performance	system risk ratio ≤ 0.66
ARC-a	No performance requirement	No system risk ratio guidance; although the UAS operator/applicant may still need to show some form of mitigation as deemed necessary by the CAAM

Table 5.1 — TMPR risk ration requirements table

Table provides TMPR qualitative criteria as a qualitative means of compliance to help UAS operators translate the risk ratio quantitative values found in Table 5.1 into system qualitative functional requirements. Table 5.3 provides guidance for the TMPR integrity and assurance objectives for compliance with the objectives of Table 4.1.

For the purpose of this assessment, the objectives of Table 5.1 take precedence over the guidance provided in Tables 5.2 and 5.3.

1.5.3.2 TMPR qualitative criterion table

Table 5.2, below, shows more qualitative criteria for the different functions and levels of the TMPR. The qualitative criteria are divided into five sub-functions of DAA, namely: detect, decide, command, execute, and the feedback loop. Where reference is made to the detection of a percentage of all aircraft, this should be read as a detection rate of the overall mix of aircraft anticipated to be encountered in the detection volume, and not limited to the detection of just the subset of aircraft in the mix.

	Function	TMPR Level				
		VLOS	No Requirement (ARC-a)	Low (ARC-b)	Medium (ARC-c)	High (ARC-d)
Tactical mitigation performance requirements (TMPR)	Detect[1]	No Requirement	No Requirement	The expectation is for the applicant's DAA Plan to enable the operator to detect approximately 50 % of all aircraft in the detection volume[2]. This is the performance requirement in the absence of failures and defaults. It is required that the applicant has awareness of most of the traffic operating in the area in which the operator intends to fly, by relying on one or more of the following: • Use of (web-based) real time aircraft tracking services • Use Low Cost ADS-B In /UAT/FLARM[3]/Pilot Aware[3] aircraft trackers • Use of UTM/U-space Dynamic Geofencing[4] • Monitoring aeronautical radio communications (e.g., use of a scanner)[5]	The expectation is for the applicant's DAA Plan to enable the operator to detect approximately 90 % of all aircraft in the detection volume[2]. To accomplish this, the applicant will have to rely on one or a combination of the following systems or services: • Ground based DAA /RADAR • FLARM [3/6] • Pilot Aware [3/6] • ADS-B In/ UAT In Receiver[6] • ATC Separation Services[7] • UTM/U-space Surveillance Service[4] • UTM/U-space Early Conflict Detection and Resolution Service[4] • Active communication with ATC and other airspace users[5]. The operator provides an assessment of the effectiveness of the detection tools/methods chosen.	A system meeting RTCA SC-228 or EUROCAE WG- 105 MOPS/MASPS (or similar) and installed in accordance with applicable requirements.

[2]The detection volume is the volume of airspace (temporal or spatial measurement) which is required to avoid a collision (and remain well clear if required) with manned aircraft. It can be thought of as the last point at which a manned aircraft must be detected, so that the DAA system can performance all the DAA functions. The detection volume in not tied to the sensor(s) Field of View/Field of Regard. The size of the detection volume depends on the aggravated closing speed of traffic that may reasonably be encountered, the time required by the remote pilot to command the avoidance maneuver, the time required by the system to respond and the maneuverability and performance of the aircraft. The detection volume is proportionally larger than the alerting threshold.
[3]FLARM and PilotAware are commercially available (trademarked) products/brands. They are referenced here only as example technologies. The references do not imply an endorsement by the approval authority for the use of these products. Other products offering similar functions may also be used.
[4]These refer to possible future applications of automated traffic management systems for unmanned aircraft in an UTM/U-space environment. These applications may not exist as such today.
[5]If permitted by the authority. May require a Radio-License or Permit.
[6]The selection of systems to aid in electronic detection of traffic should be made considering the average equipment of the majority of aircraft operating in the area. For example: in areas where many gliders are known to operate, the use of FLARM or similar systems should be considered whereas for operations in the vicinity of large commercially operated aircraft, ADS-B IN is probably more appropriate. These refer to possible future applications of automated traffic management systems for unmanned aircraft in an UTM/U-space environment. These applications may not exist as such today. A subscription to these services may be required.
[7]The selection of systems to aid in electronic detection of traffic should be made considering the average equipment of the majority of aircraft operating in the area.

	Function	TMPR Level				
		VLOS	No Requirement (ARC-a)	Low (ARC-b)	Medium (ARC-c)	High (ARC-d)
Tactical mitigation performance requirements (TMPR)	Decide	No Requirement	No Requirement	The UAS operator should have a documented de-confliction scheme, in which the UAS operator explains which tools or methods will be used for detection and what the criteria are that will be applied for the decision to avoid incoming traffic. In case the remote pilot relies on detection by someone else, the use of phraseology will have to be described as well. Examples: • The operator will initiate a rapid descend if traffic is crossing an alert boundary and operating at less than 1000ft. • The observer monitoring traffic uses the phrase: 'DESCEND!, DESCEND!, DESCEND!'.	All requirements of ARC-b and in addition: 1. The operator provides an assessment of the human/machine interface factors that may affect the remote pilot's ability to make a timely and appropriate decision. 2. The UAS operator provides an assessment of the effectiveness of the tools and methods utilised for the timely detection and avoidance of traffic. In this context timely is defined as enabling the remote pilot to decide within 5 seconds after the indication of incoming traffic is provided. The UAS operator provides an assessment of the failure rate or availability of any tool or service the UAS operator intends to use.	A system meeting RTCA SC-228 or EUROCAE WG-105 MOPS/MASPS (or similar) and installed in accordance with applicable requirements.

	Function	TMPR Level				
		VLOS	No Requirement (ARC-a)	Low (ARC-b)	Medium (ARC-c)	High (ARC-d)
Tactical mitigation performance requirements (TMPR)	Command	No Requirement	No Requirement	The latency of the whole command (C2) link, i.e., the time between the moment that the remote pilot gives the command and the airplane executes the command should not exceed 5 seconds.	The latency of the whole command (C2) link, i.e., the time between the moment that the remote pilot gives the command and the airplane executes the command should not exceed 3 seconds.	A system meeting RTCA SC-228 or EUROCAE WG-105 MOPS/MASPS (or similar) and installed in accordance with applicable requirements.

	Function	TMPR Level				
		VLOS	No Requirement (ARC-a)	Low (ARC-b)	Medium (ARC-c)	High (ARC-d)
Tactical mitigation performance requirements (TMPR)	Execute	No Requirement	No Requirement	UAS descending to an altitude not higher than the nearest trees, buildings or infrastructure or ≤ 60 feet AGL is considered sufficient. The aircraft should be able to descend from its operating altitude to the 'safe altitude' in less than a minute.	Avoidance may rely on vertical and horizontal avoidance manoeuvring and is defined in standard procedures. Where horizontal manoeuvring is applied, the aircraft shall be demonstrated to have adequate performance, such as airspeed, acceleration rates, climb/descend rates and turn rates. The following are suggested minimum performance criteria:[10] • Airspeed: ≥ 50 knots • Rate of climb/descend: ≥500 ft/min • Turn rate: ≥ 3 degrees per second	A system meeting RTCA SC-228 or EUROCAE WG-105 MOPS/MASPS (or similar) and installed in accordance with applicable requirements.

[10]Low End Performance Representative (LEPR) performance requirements for RTCA SC-228 Study 5

	Function	TMPR Level				
		VLOS	No Requirement (ARC-a)	Low (ARC-b)	Medium (ARC-c)	High (ARC-d)
Tactical mitigation performance requirements (TMPR)	Feedback Loop	No Requirement	No Requirement	Where electronic means assist the remote pilot in detecting traffic, the information is provided with a latency and update rate for intruder data (e.g., position, speed, altitude, track) that support the decision criteria. For an assumed 3 NM threshold, a 5 second update rate and a latency of 10 seconds is considered adequate (see example below).	The information is provided to the remote pilot with a latency and update rate that support the decision criteria. The applicant provides an assessment of the aggravated closure rates considering traffic that could reasonably be expected to operate in the area, traffic information update rate and latency, C2 Link latency, aircraft manoeuvrability and performance and sets the detection thresholds accordingly. The following are suggested minimum criteria: • Intruder and ownship vector data update rates: ≤ 3 seconds.	A system meeting RTCA SC-228 or EUROCAE WG-105 MOPS/MASPS (or similar) and installed in accordance with applicable airworthiness requirements.

Table 5.2 — TMPR qualitative criteria table

1.5.3.3 Effects of aircraft equipment on tactical system performance

The performance of a tactical mitigation is affected by the equipment of both the UAS and threat aircraft, on an encounter-by-encounter basis. A tactical mitigation mitigates the encounter risk by using a set of sub-functions of the DAA routine, namely see/detect, decide, command, execute, and feedback loop. Equipment that aids these sub-functions increases the overall performance of the tactical mitigation system.

The following example illustrates how the equipment of both the UAS and threat aircraft affects the overall tactical performance. Given a threat aircraft equipped with a transponder, it is easier for other aircraft to detect and track the threat aircraft. In this case, the UAS can be equipped with a system that is able to detect and track transponders. However, a UAS that mitigates the risk by locating the threat aircraft by detecting their transponder (e.g., through ACAS-II V. 7.1) cannot use the same approach to mitigate the risks posed by an aircraft without a transponder.

Tactical mitigation equipment is not homogeneous within the airspace. Different classes of airspace have different mixes of equipment. General aviation aircraft tend to be less well-equipped than commercial aircraft. There will be differences in the mix of general aviation/commercial aircraft from one location/airspace to another. Based on the aircraft equipment, a specific tactical system (e.g., FLARM, ACAS, etc.) could mitigate the risk of a collision in some classes of airspace and not in others.

Therefore, the UAS operator needs to understand the effectiveness of their tactical mitigation systems within the context of the airspace in which they intend to operate, and select systems used for tactical mitigation accordingly. A TCAS II 7.1/ACAS-II equipped UAS will not mitigate all the encounter risks in an area where sailplanes equipped with FLARM are known to operate.

1.5.4 TMPR robustness (integrity and assurance) assignment

Table 5.3, below, lists the recommended requirements to comply with the TMPR integrity and assurance assignment.

		TMPR: N/A (ARC-a)	TMPR: Low (ARC-b)	TMPR: Medium (ARC-c)	TMPR: High (ARC-d)
Level of integrity	Criteria	Allowable loss of function and performance of the Tactical Mitigation System: < 1 per 100 Flight Hours (1E-2 Loss/FH)	Allowable loss of function and performance of the Tactical Mitigation System: < 1 per 100 Flight Hours (1E-2 Loss/FH)	Allowable loss of function and performance of the Tactical Mitigation System: < 1 per 1 000 Flight Hours (1E-3 Loss/FH)	Allowable loss of function and performance of the Tactical Mitigation System: < 1 per 100 000 Flight Hours (1E-5 Loss/FH)
	Comments / Notes	*The requirement is considered to be met by commercially available products. No quantitative analysis is required.*	*The requirement is considered to be met by commercially available products. No quantitative analysis is required.*	*This rate is commensurate with a probable failure condition. These failure conditions are anticipated to occur one or more times during the entire operational life of each aircraft.*	*A quantitative analysis is required.*
		TMPR: N/A (ARC-a)	**TMPR: Low (ARC-b)**	**TMPR: Medium (ARC-c)**	**TMPR: High (ARC-d)**
Level of assurance	Criteria	N/A	The operator declares that the tactical mitigation system and procedures will mitigate the risk of collisions with manned aircraft to an acceptable level.	The operator provides evidence that the tactical mitigation system will mitigate the risk of collisions with manned aircraft to an acceptable level.	The evidence that the tactical mitigation system will mitigate the risk of collisions with manned aircraft to an acceptable level is verified by a competent third party.
	Comments / Notes	*N/A*	*N/A*	*N/A*	*N/A*

Table 5.3 — TMPR integrity and assurance objectives

1.6 Maintenance and continued airworthiness

The DAA maintenance and continued airworthiness requirements are addressed in the SAIL requirements; please refer to Appendix 6.

Appendix 6

1 Integrity and Assurance Levels for the Operational Safety Objectives (OSOs)

1.1 How to use SORA Appendix 6

The following Table 6.1 provides the basic principles to consider when using SORA Appendix 6.

	Principle description	Additional information
#1	Appendix 6 provides assessment criteria for the integrity (i.e., safety gain) and assurance (i.e., method of proof) of OSOs proposed by an applicant.	The identification of OSOs for a given operation is the responsibility of the applicant.
#2	Appendix 6 does not cover the LoI of the CAAM. LoI is based on the competent authority's assessment of the applicant's ability to perform the given operation.	
#3	To achieve a given level of integrity/assurance, when more than one criterion exists for that level of integrity/assurance, all applicable criteria need to be met.	
#4	'Optional' cases defined in SORA main body Table 6 do not need to be defined in terms of integrity and assurance levels in Appendix 6.	All robustness levels are acceptable for OSOs for which an 'optional' level of robustness is defined in Table 6 'Recommended OSOs' of the SORA main body.
#5	When the criteria to assess the level of integrity or assurance of an OSO rely on 'standards' that are not yet available, the OSO needs to be developed in a manner acceptable to the competent authority.	
#6	Appendix 6 intentionally uses non-prescriptive terms (e.g., suitable, reasonably practicable) to provide flexibility to both the applicant and the competent authorities. This does not constrain the applicant in proposing mitigations, nor the CAAM in evaluating what is needed on a case-by-case basis.	
#7	This appendix in its entirety also applies to single-person organisations.	

Table 6.1 – Basic principles to consider when using SORA Appendix 6

1.2 OSOs related to technical issues with the UAS

OSO #01 — Ensure that the UAS operator is competent and/or proven

TECHNICAL ISSUE WITH THE UAS		Level of integrity		
		Low	**Medium**	**High**
OSO #01 Ensure that the UAS operator is competent and/or proven	Criteria	The applicant is knowledgeable of the UAS being used and as a minimum has the following relevant operational procedures: checklists, maintenance, training, responsibilities, and associated duties.	Same as low. In addition, the applicant has an organisation appropriate[1] for the intended operation. Also, the applicant has a method to identify, assess, and mitigate the risks associated with flight operations. These should be consistent with the nature and extent of the operations specified.	Same as medium.
	Comments	*N/A*	*[1] For the purpose of this assessment, 'appropriate' should be interpreted as commensurate with/proportionate to the size of the organisation and the complexity of the operation.*	*N/A*

TECHNICAL ISSUE WITH THE UAS		Level of assurance		
		Low	**Medium**	**High**
OSO #01 Ensure that the UAS operator is competent and/or proven	Criteria	The elements delineated in the level of integrity are addressed in the ConOps.	Prior to the first operation, a competent third party performs an audit of the organisation	The applicant holds an organisational operating certificate or has a recognised flight test organisation. In addition, a competent third party recurrently verifies the UAS operator's competences.
	Comments	*N/A*	*N/A*	*N/A*

OSO #02 — UAS manufactured by a competent and/or proven entity

TECHNICAL ISSUE WITH THE UAS		Level of integrity: Low	Level of integrity: Medium	Level of integrity: High
OSO #02 UAS manufactured by competent and/or proven entity	Criteria	As a minimum, manufacturing procedures cover: (a) the specification of materials; (b) the suitability and durability of materials used; and (c) the processes necessary to allow for repeatability in manufacturing, and conformity within acceptable tolerances.	Same as low. In addition, manufacturing procedures also cover: (a) configuration control; (b) the verification of incoming products, parts, materials, and equipment; (c) identification and traceability; (d) in-process and final inspections & testing; (e) the control and calibration of tools; (f) handling and storage; and (g) the control of non-conforming items.	The manufacturer complies with the organisational requirements defined in CAAM Part 21.
	Comments	*N/A*	*N/A*	*N/A*

TECHNICAL ISSUE WITH THE UAS		Level of assurance: Low	Level of assurance: Medium	Level of assurance: High
OSO #02 UAS manufactured by competent and/or proven entity	Criteria	The declared manufacturing procedures are developed to a standard considered adequate by the CAAM and/or in accordance with a means of compliance acceptable to that authority. CAAM validates the claimed level of integrity.	Same as low. In addition, evidence is available that the UAS has been manufactured in conformance to its design. CAAM validates the claimed level of integrity.	Same as medium, In addition: CAAM validates compliance with the organisational requirements that are defined in CAAM Part 21.
	Comments	*N/A*	*N/A*	*N/A*

OSO #03 — UAS maintained by competent and/or proven entity

TECHNICAL ISSUE WITH THE UAS		Level of integrity		
		Low	**Medium**	**High**
OSO #03 UAS maintained by competent and/or proven entity (e.g., industry standards)	Criteria	(a) The UAS maintenance instructions are defined, and, when applicable, cover the UAS designer's instructions and requirements. (b) The maintenance staff is competent and has received an authorisation to carry out UAS maintenance. (c) The maintenance staff use the UAS maintenance instructions while performing maintenance.	Same as low. In addition: (a) Scheduled maintenance of each UAS is organised and in accordance with a maintenance programme. (b) Upon completion, the maintenance log system is used to record all the maintenance conducted on the UAS, including releases. A maintenance release can only be accomplished by a staff member who has received a maintenance release authorisation for that particular UAS model/family.	Same as medium. In addition, the maintenance staff work in accordance with a maintenance procedure manual that provides information and procedures relevant to the maintenance facility, records, maintenance instructions, release, tools, material, components, defect deferral, etc.
	Comments	N/A	N/A	N/A

TECHNICAL ISSUE WITH THE UAS		Level of assurance		
		Low	**Medium**	**High**
OSO #03 UAS maintained by competent and/or proven entity (e.g., industry standards)	Criterion #1 (Procedure)	(a) The maintenance instructions are documented. (b) The maintenance conducted on the UAS is recorded in a maintenance log system[1/2]. (c) A list of the maintenance staff authorised to carry out maintenance is established and kept up to date.	Same as low. In addition: (a) The maintenance programme is developed in accordance with standards considered adequate by the CAAM and/or in accordance with a means of compliance acceptable to that authority. (b) A list of maintenance staff with maintenance release authorisation is established and kept up to date.	Same as medium. In addition, the maintenance programme and the maintenance procedures manual are validated by a competent third party.
	Comments	*[1] Objective is to record all the maintenance performed on the aircraft, and why it is performed (rectification of defects or malfunctions, modifications, scheduled maintenance, etc.)* *[2] The maintenance log may be requested for inspection/audit by the approving authority or an authorised representative.*	*N/A*	*N/A*
	Criterion #2 (Training)	A record of all the relevant qualifications, experience and/or training completed by the maintenance staff is established and kept up to date.	Same as low. In addition: (a) The initial training syllabus and training standard including theoretical/practical elements, duration, etc. is defined and is commensurate with the authorisation held by the maintenance staff. (b) For staff that hold a maintenance release authorisation, the initial training is specific to that particular UAS model/family. (c) All maintenance staff have undergone initial training.	Same as medium. In addition: (a) A programme for the a maintenance release authorisation is established; and (b) This programme is validated by a competent third party.recurrent training of staff holding
	Comments	*N/A*	*N/A*	*N/A*

OSO #04 — UAS developed to authority recognised design standards

TECHNICAL ISSUE WITH THE UAS		Level of integrity		
		Low	Medium	High
OSO #04 UAS developed to authority recognised design standards	Criteria	The UAS is designed to standards considered adequate by the competent authority and/or in accordance with a means of compliance acceptable to that authority. The standards and/or the means of compliance should be applicable to a low level of integrity and the intended operation.	The UAS is designed to standards considered adequate by the competent authority and/or in accordance with a means of compliance acceptable to that authority. The standards and/or the means of compliance should be applicable to a medium level of integrity and the intended operation.	The UAS is designed to standards considered adequate by the CAAM and/or in accordance with a means of compliance acceptable to that authority. The standards and/or the means of compliance should be applicable to a high level of integrity and the intended operation.
	Comments	*In case of experimental flights that investigate new technical solutions, the competent authority may accept that recognised standards are not met.*		

TECHNICAL ISSUE WITH THE UAS		Level of assurance		
		Low	Medium	High
OSO #04 UAS developed to authority recognised design standards	Criteria	Consider the criteria defined in section 1.0 of Appendix 6.		
	Comments	CAAM validates the claimed level of integrity.	CAAM validates the claimed level of integrity.	*N/A*

OSO #05 — UAS is designed considering system safety and reliability

This OSO complements:

a) the safety requirements for containment defined in the main body; and

b) OSO #10 and OSO #12, which only address the risk of a fatality while operating over populated areas or assemblies of people.

TECHNICAL ISSUE WITH THE UAS		Level of integrity		
		Low	**Medium**	**High**
OSO #05 UAS is designed considering system safety and reliability	Criteria	The equipment, systems, and installations are designed to minimise hazards[1] in the event of a probable[2] malfunction or failure of the UAS.	Same as low. In addition, the strategy for detection, alerting and management of any malfunction, failure or combination thereof, which would lead to a hazard, is available.	Same as medium. In addition: (a) Major failure conditions are not more frequent than remote[3]; (b) Hazardous failure conditions are not more frequent than extremely remote[3]; (c) Catastrophic failure conditions are not more frequent than extremely improbable[3]; and (d) SW and AEH whose development error(s) may cause or contribute to hazardous or catastrophic failure conditions are developed to an industry standard or a methodology considered adequate by the CAAM and/or in accordance with means of compliance acceptable to that authority[4].
	Comments	*[1] For the purpose of this assessment, the term 'hazard' should be interpreted as a failure condition that relates to major, hazardous, or catastrophic consequences.* *[2] For the purpose of this assessment, the term 'probable' should be interpreted in a qualitative way as 'anticipated to occur one or more times during the entire system/operational life of a UAS'.*	*N/A*	*[3] Safety objectives may be derived from JARUS AMC RPAS.1309 Issue 2 Table 3 depending on the kinetic energy assessment made in accordance with Section 6 of EASA policy E.Y013-01.* *[4] Development assurance levels (DALs) for SW/AEH may be derived from JARUS AMC RPAS.1309 Issue 2 Table 3 depending on the kinetic energy assessment made in accordance with paragraph 2.3.2 of Appendix 1.*

TECHNICAL ISSUE WITH THE UAS		Level of assurance		
		Low	**Medium**	**High**
OSO #05 UAS is designed considering system safety and reliability	Criteria	A functional hazard assessment[1] and a design and installation appraisal that shows hazards are minimised, are available. CAAM validates the claimed level of integrity.	Same as low. In addition: (a) Safety analyses are conducted in line with standards considered adequate by the CAAM and/or in accordance with a means of compliance acceptable to that authority. (b) A strategy for the detection of single failures of concern include pre-flight checks. CAAM validates the claimed level of integrity.	Same as medium. In addition, safety analyses and development assurance activities are validated by CAAM.
	Comments	*[1] The severity of failure conditions (no safety effect, minor, major, hazardous and catastrophic) should be determined according to the definitions provided in JARUS AMC RPAS.1309 Issue 2.*	*N/A*	*N/A*

OSO #06 — C3 link characteristics (e.g., performance, spectrum use) are appropriate for the operation

a) For the purpose of the SORA and this specific OSO, the term ‘C3 link’ encompasses:

1) the C2 link; and

2) any communication link required for the safety of the flight.

b) To correctly assess the integrity of this OSO, the applicant should identify the following:

1) The performance requirements for the C3 links necessary for the intended operation.

2) All the C3 links, together with their actual performance and RF spectrum usage.

Note.1 - The specification of the performance and RF spectrum for a C2 Link is typically documented by the UAS designer in the UAS manual.

Note.2 - The main parameters associated with the performance of a C2 link (RLP) and the performance parameters for other communication links (e.g., RCP for communication with ATC) include, but are not limited to, the following:

i) the transaction expiration time;
ii) the availability;
iii) the continuity; and
iv) the integrity.

Refer to the ICAO references for definitions.

3) The RF spectrum usage requirements for the intended operation (including the need for authorisation if required).

Note. - Usually, countries publish the allocation of RF spectrum bands applicable in their territories. This allocation stems mostly from the International Communication Union (ITU) Radio Regulations. However, the applicant should check the local requirements and request authorisation when needed since there may be national differences and specific allocations (e.g., national sub-divisions of ITU allocations). Some aeronautical bands (e.g., AM(R)S, AMS(R)S 5030-5091MHz) were allocated for potential use in UAS operations under the ICAO scope for UAS operations classified as cat. C (‘certified’), but their use may be authorised for operations under the ‘specific’ category. It is expected that the use of other licensed bands (e.g., those allocated to mobile networks) may also be authorised under the ‘specific’ category. Some un-licensed bands (e.g., industrial, scientific and medical (ISM) or short-range devices (SRDs)) may also be acceptable under the ‘specific’ category; for instance, for operations with lower integrity requirements.

4) Environmental conditions that might affect the performance of C3 links.

TECHNICAL ISSUE WITH THE UAS		Level of integrity		
		Low	**Medium**	**High**
OSO #06 C3 link characteristics (e.g., performance, spectrum use) are appropriate for the operation	Criteria	(a) The applicant determines that the performance, RF spectrum usage[1] and environmental conditions for C3 links are adequate to safely conduct the intended operation. (b) The remote pilot has the means to continuously monitor the C3 performance and ensures that the performance continues to meet the operational requirements[2].	Same as low[3].	Same as low. In addition, the use of licensed[4] frequency bands for C2 Links is required.
	Comments	*[1] For a low level of integrity, unlicensed frequency bands might be acceptable under certain conditions, e.g.,:* *(a) the applicant demonstrates compliance with other RF spectrum usage requirements (e.g., MCMC requirements), by showing that the UAS equipment is compliant with these requirements; and* *(b) the use of mechanisms to protect against interference (e.g., FHSS, frequency de-confliction by procedure).* *[2] The remote pilot has continual and timely access to the relevant C3 information that could affect the safety of flight. For operations requesting only a low level of integrity for this OSO, this could be achieved by monitoring the C2 link signal strength and receiving an alert from the UAS HMI if the signal strength becomes too low.*	*[3] Depending on the operation, the use of licensed frequency bands might be necessary. In some cases, the use of non-aeronautical bands (e.g., licensed bands for cellular network) may be acceptable.*	*[4] This ensures a minimum level of performance and is not limited to aeronautical licensed frequency bands (e.g., licensed bands for cellular network). Nevertheless, some operations may require the use of bands allocated to the aeronautical mobile service for the use of C2 Link (e.g., 5030 – 5091 MHz).* *In any case, the use of licensed frequency bands needs authorisation.*

TECHNICAL ISSUE WITH THE UAS		Level of assurance		
		Low	Medium	High
OSO #06 C3 link characteristics (e.g., performance, spectrum use) are appropriate for the operation	Criteria	Consider the assurance criteria defined in section 1.0 of Appendix 6. (low level of assurance) CAAM validates the claimed level of integrity.	Demonstration of the C3 link performance is in accordance with standards considered adequate by the CAAM and/or in accordance with means of compliance acceptable to that authority. CAAM validates the claimed level of integrity.	Same as medium. In addition, evidence is validated by CAAM.
	Comments	*N/A*	*N/A*	*N/A*

OSO #07 — Inspection of the UAS (product inspection) to ensure consistency with the ConOps

The intent of this OSO is to ensure that the UAS used for the operation conforms to the UAS data used to support the approval/authorisation of the operation.

TECHNICAL ISSUE WITH THE UAS		Level of integrity		
		Low	Medium	High
OSO #07 Inspection of the UAS (product inspection) to ensure consistency with the ConOps	Criteria	The remote crew ensures that the UAS is in a condition for safe operation and conforms to the approved ConOps.[1]		
	Comments	*[1] The distinction between a low, a medium and a high level of robustness for this criterion is achieved through the level of assurance (see the table below).*		

TECHNICAL ISSUE WITH THE UAS		Level of assurance		
		Low	Medium	High
OSO #07 Inspection of the UAS (product inspection) to ensure consistency with the ConOps	Criterion #1 (Procedures)	Product inspection is documented and accounts for the manufacturer's recommendations if available.	Same as low. In addition, the product inspection is documented using checklists.	Same as medium. In addition, the product inspection is validated by a competent third party.
	Comments	*N/A*	*N/A*	*N/A*
	Criterion #2 (Training)	The remote crew is trained to perform the product inspection, and that training is self-declared (with evidence available).	(a) A training syllabus including a product inspection procedure is available. (b) The UAS operator provides competency-based, theoretical and practical training.	A competent third party: (a) validates the training syllabus; and (b) verifies the remote crew competencies.
	Comments	*N/A*	*N/A*	*N/A*

1.3 OSOs related to operational procedures

OPERATIONAL PROCEDURES		Level of integrity		
		Low	Medium	High
OSO #08, OSO #11, OSO #14 and OSO #21	Criterion #1 (Procedure definition)	(a) Operational procedures[1] appropriate for the proposed operation are defined and, as a minimum, cover the following elements: (1) Flight planning; (2) Pre- and post-flight inspections; (3) Procedures to evaluate the environmental conditions before and during the mission (i.e., real-time evaluation); Procedures to cope with unexpected adverse operating conditions (e.g., when ice is encountered during an operation not approved for icing conditions); (5) Normal procedures; (6) Contingency procedures (to cope with abnormal situations); (7) Emergency procedures (to cope with emergency situations); (8) Occurrence reporting procedures; and Note: normal, contingency and emergency procedures are compiled in an OM. (b) The limitations of the external systems supporting UAS operation[2] are defined in an OM.		

	Comments	*[1] Operational procedures cover the deterioration3 of the UAS itself and any external system supporting UAS operation.* *[2] In the scope of this assessment, external systems supporting UAS operation are defined as systems that are not already part of the UAS but are used to:* *(a) launch/take-off the UA;* *(b) make pre-flight checks; or* *(c) keep the UA within its operational volume (e.g., GNSS, satellite systems, air traffic management, U-Space). External systems activated/used after a loss of control of the operation are excluded from this definition.* *[3] To properly address the deterioration of external systems required for the operation, it is recommended to:* *(a) identify these 'external systems';* *(b) identify the modes of deterioration of the 'external systems' (e.g., complete loss of GNSS, drift of the GNSS, latency issues, etc.) which would lead to a loss of control of the operation;* *(c) describe the means to detect these modes of deterioration of the external systems/facilities; and* *(d) describe the procedure(s) used when deterioration is detected (e.g., activation of the emergency recovery capability, switch to manual control, etc.).*		
	Criterion #2 (Procedure complexity)	Operational procedures are complex and may potentially jeopardise the crew's ability to respond by raising the remote crew's workload and/or the interactions with other entities (e.g., ATM, etc.).	Contingency/emergency procedures require manual control by the remote pilot[2] when the UAS is usually automatically controlled.	Operational procedures are simple.
	Comments	*N/A*	*[2] This is still under discussion since not all UAS have a mode where the pilot could directly control the surfaces; moreover, some people claim it requires significant skill not to make things worse.*	*N/A*
	Criterion #3 (Consideration of Potential Human Error)	At a minimum, operational procedures provide: (a) a clear distribution and assignment of tasks, and (b) an internal checklist to ensure staff are adequately performing their assigned tasks.	Operational procedures take human error into consideration.	Same as medium. In addition, the remote crew[3] receives crew resource management (CRM)[4] training.

	Comments	*N/A*	*N/A*	*[3] In the context of the SORA, the term 'remote crew' refers to any person involved in the mission.* *[4] CRM training focuses on the effective use of all the remote crew to ensure safe and efficient operation, reducing error, avoiding stress and increasing efficiency.*

OPERATIONAL PROCEDURES		**Level of assurance**		
		Low	**Medium**	**High**
OSO #08, OSO #11, OSO #14 and OSO #21	Criteria	(a) Operational procedures do not require validation against either a standard or a means of compliance considered adequate by the CAAM. (b) The adequacy of the operational procedures is declared, except for emergency procedures, which are tested.	(a) Operational procedures are validated against standards considered adequate by the CAAM and/or in accordance with a means of compliance acceptable to that authority. (b) Adequacy of the contingency and emergency procedures is proven through: (1) dedicated flight tests; or (2) simulation, provided the simulation is proven valid for the intended purpose with positive results.	Same as medium. In addition: (a) Flight tests performed to validate the procedures and checklists cover the complete flight envelope or are proven to be conservative. (b) The procedures, checklists, flight tests and simulations are validated by a competent third party.
	Comments	*N/A*	*N/A*	

1.4 OSOs related to remote crew training

a) The applicant needs to propose competency-based, theoretical and practical training that:

1) is appropriate for the operation to be approved; and

2) includes proficiency requirements and recurrent training.

b) The entire remote crew (i.e., any person involved in the operation) should undergo competency-based, theoretical and practical training specific to their duties (e.g., pre-flight inspection, ground equipment handling, evaluation of the meteorological conditions, etc.).

REMOTE CREW COMPETENCIES		Level of integrity		
		Low	Medium	High
OSO #09, OSO #15 and OSO #22	Criteria	The competency-based, theoretical and practical training is adequate for the operation[1] and ensures knowledge of: (a) the UAS Rules and Regulations; (b) airspace operating principles; (c) airmanship and aviation safety; (d) human performance limitations; (e) meteorology; (f) navigation/charts; (g) the UAS; and (h) operating procedures.		
	Comments	*[1] The distinction between a low, a medium and a high level of robustness for this criterion is achieved through the level of assurance (see table below).*		

REMOTE CREW COMPETENCIES		Level of assurance		
		Low	Medium	High
OSO #09, OSO #15 and OSO #22	Criteria	Training is self-declared (with evidence available).	(a) Training syllabus is available. (b) The UAS operator provides competency-based, theoretical and practical training.	A competent third party: (a) validates the training syllabus; and (b) verifies the remote crew competencies.
	Comments	*N/A*	*N/A*	*N/A*

1.5 OSOs related to safe design

a) The objectives of OSO#10 and OSO#12 are to complement the technical containment safety requirements by addressing the risk of a fatality while operating over populated areas or assemblies of people.

b) In the scope of this assessment, external systems supporting UAS operations are defined as systems that are not already part of the UAS but are used to:

1) launch/take off the UA;

2) make pre-flight checks; or

3) keep the UA within its operational volume (e.g., GNSS, satellite systems, air traffic management, U-space).

External systems activated/used after a loss of control of the operation are excluded from this definition.

		LEVEL of INTEGRITY		
		Low	**Medium**	**High**
OSO #10 & OSO #12	Criteria	When operating over populated areas or assemblies of people, it can be reasonably expected that a fatality will not occur from any probable[1] failure[2] of the UAS or any external system supporting the operation.	When operating over populated areas or assemblies of people, it can be reasonably expected that a fatality will not occur from any single failure[3] of the UAS or any external system supporting the operation. SW and AEH whose development error(s) could directly lead to a failure affecting the operation in such a way that it can be reasonably expected that a fatality will occur, are developed to a standard considered adequate by the CAAM and/or in accordance with means of compliance acceptable to that authority.	Same as medium
	Comments	*[1] For the purpose of this assessment, the term 'probable' should be interpreted in a qualitative way as, 'anticipated to occur one or more times during the entire system/operational life of a UAS'.* *[2] Some structural or mechanical failures may be excluded from the criterion if it can be shown that these mechanical parts were designed according to aviation industry best practices.*	*[3] Some structural or mechanical failures may be excluded from the no-single failure criterion if it can be shown that these mechanical parts were designed to a standard considered adequate by the CAAM and/or in accordance with a means of compliance acceptable to that authority*	

		LEVEL of ASSURANCE		
		Low	Medium	High
OSO #10 & OSO #12	Criteria	A design and installation appraisal is available. In particular, this appraisal shows that: (a) the design and installation features (independence, separation and redundancy) satisfy the low integrity criterion; and (b) particular risks relevant to the ConOps (e.g., heavy rain, monsoon season, haze, electromagnetic interference, etc.) do not violate the independence claims, if any.	Same as low. In addition, the level of integrity claimed is substantiated by analysis and/or test data with supporting evidence. CAAM validates the claimed level of integrity.	Same as medium. In addition, CAAM validates the level of integrity claimed.
	Comments	*N/A*	*N/A*	*N/A*

1.6 OSOs related to the deterioration of external systems supporting UAS operations

For the purpose of the SORA and this specific OSO, the term 'external services supporting UAS operations' encompasses any service providers necessary for the safety of the flight, such as communication service providers (CSPs) and U-space service providers.

DETERIORATION OF EXTERNAL SYSTEMS SUPPORTING UAS OPERATIONS BEYOND THE CONTROL OF THE UAS		Level of integrity		
		Low	Medium	High
OSO #13 External services supporting UAS operations are adequate for the operation	Criteria	The applicant ensures that the level of performance for any externally provided service necessary for the safety of the flight is adequate for the intended operation. If the externally provided service requires communication between the UAS operator and the service provider, the applicant ensures there is effective communication to support the service provision. Roles and responsibilities between the applicant and the external service provider are defined.		
	Comments	*N/A*	*N/A*	*Requirements for contracting services with the service provider may be derived from ICAO Standards and Recommended Practices (SARPs) that are currently under development.*

DETERIORATION OF EXTERNAL SYSTEMS SUPPORTING UAS OPERATION BEYOND THE CONTROL OF THE UAS		Level of assurance		
		Low	**Medium**	**High**
OSO #13 External services supporting UAS operations are adequate for the operation	Criteria	The applicant declares that the requested level of performance for any externally provided service necessary for the safety of the flight is achieved (without evidence being necessarily available).	The applicant has supporting evidence that the required level of performance for any externally provided service required for safety of the flight can be achieved for the full duration of the mission. This may take the form of a service-level agreement (SLA) or any official commitment that prevails between a service provider and the applicant on the relevant aspects of the service (including quality, availability, responsibilities). The applicant has a means to monitor externally provided services which affect flight critical systems and take appropriate actions if real-time performance could lead to the loss of control of the operation.	Same as medium. In addition: (a) the evidence of the performance of an externally provided service is achieved through demonstrations; and (b) a competent third party validates the claimed level of integrity.
	Comments	*N/A*	*N/A*	*N/A*

1.7 OSOs related to Human Error

OSO #16 — Multi-crew coordination

This OSO applies only to those personnel directly involved in the flight operation.

HUMAN ERROR		Level of integrity		
		Low	**Medium**	**High**
OSO #16 Multi crew coordination	Criterion #1 (Procedures)	Procedure(s) to ensure coordination between the crew members and robust and effective communication channels is (are) available and at a minimum cover: (a) assignment of tasks to the crew, and (b) establishment of step-by-step communications.[1]		
	Comments	*[1] The distinction between a low, a medium and a high level of robustness for this criterion is achieved through the level of assurance (see the table below).*		
	Criterion #2 (Training)	Remote crew training covers multi-crew coordination	Same as low. In addition, the remote crew[2] receives CRM[3] training.	Same as medium.
	Comments	*N/A*	*[2] In the context of the SORA, the term 'remote crew' refers to any person involved in the mission.* *[3] CRM training focuses on the effective use of all the remote crew to assure a safe and efficient operation, reducing error, avoiding stress and increasing efficiency.*	*N/A*
	Criterion #3 (Communication devices)	N/A	Communication devices comply with standards considered adequate by the CAAM and/or in accordance with a means of compliance acceptable to that authority.	Communication devices are redundant[4] and comply with standards considered adequate by the CAAM and/or in accordance with a means of compliance acceptable to that authority.
	Comments	*N/A*	*N/A*	*[4] This implies the provision of an extra device to cope with the failure of the first device.*

HUMAN ERROR		LEVEL of ASSURANCE		
		Low	Medium	High
OSO #16 Multi crew coordination	Criterion #1 (Procedures)	(a) Procedures do not require validation against either a standard or a means of compliance considered adequate by the CAAM. (b) The adequacy of the procedures and checklists is declared.	(a) Procedures are validated against standards considered adequate by the CAAM and/or in accordance with means of compliance acceptable to that authority. (b) Adequacy of the procedures is proven through: (1) dedicated flight tests; or (2) simulation, provided the simulation is proven valid for the intended purpose with positive results.	Same as medium. In addition: (a) flight tests performed to validate the procedures cover the complete flight envelope or are proven to be conservative; and (b) the procedures, flight tests and simulations are validated by a competent third party.
	Comments	*N/A*	*N/A*	*N/A*
	Criterion #2 (Training)	Training is self-declared (with evidence available)	(a) Training syllabus is available. (b) The UAS operator provides competency-based, theoretical and practical training.	A competent third party: (a) validates the training syllabus; and (b) verifies the remote crew competencies.
	Comments	*N/A*	*N/A*	*N/A*
	Criterion #3 (Communication devices)	Consider the criteria defined in section 1.0 of Appendix 6.		
	Comments	*N/A*	*N/A*	*N/A*

OSO #17 — Remote crew is fit to operate

a) For the purpose of this assessment, the expression ‘fit to operate’ should be interpreted as physically and mentally fit to perform their duties and safely discharge their responsibilities.

b) Fatigue and stress are contributory factors to human error. Therefore, to ensure that vigilance is maintained at a satisfactory level of safety, consideration may be given to the following:

1) remote crew duty times;

2) regular breaks;

3) rest periods; and

4) handover/takeover procedures.

HUMAN ERROR		Level of integrity		
		Low	Medium	High
OSO #17 Remote crew is fit to operate	Criteria	The applicant has a policy defining how the remote crew can declare themselves fit to operate before conducting any operation.	Same as low. In addition: — Duty, flight duty and resting times for the remote crew are defined by the applicant and adequate for the operation. — The UAS operator defines requirements appropriate for the remote crew to operate the UAS.	Same as Medium. In addition: — The remote crew is medically fit, — A fatigue risk management system (FRMS) is in place to manage any escalation in duty/flight duty times.
	Comments	*N/A*	*N/A*	*N/A*

HUMAN ERROR		LEVEL of ASSURANCE		
		Low	Medium	High
OSO #17 Remote crew is fit to operate	Criteria	The policy to define how the remote crew declares themselves fit to operate (before an operation) is documented. The remote crew declaration of fit to operate (before an operation) is based on policy defined by the applicant.	Same as Low. In addition: — Remote crew duty, flight duty and the resting times policy are documented. — Remote crew duty cycles are logged and cover at a minimum: — when the remote crew member's duty day commences, — when the remote crew members are free from duties, and — resting times within the duty cycle. — There is evidence that the remote crew is fit to operate the UAS.	Same as Medium. In addition: — Medical standards considered adequate by the CAAM and/or means of compliance acceptable to that authority are established and a competent third party verifies that the remote crew is medically fit. — A competent third party validates the duty/flight duty times. — If an FRMS is used, it is validated and monitored by a competent third party.
	Comments	*N/A*	*N/A*	*N/A*

OSO #18 — Automatic protection of the flight envelope from human errors

a) Each UA is designed with a flight envelope that describes its safe performance limits with regard to minimum and maximum operating speeds, and its operating structural strength.

b) Automatic protection of the flight envelope is intended to prevent the remote pilot from operating the UA outside its flight envelope. If the applicant demonstrates that the remote-pilot is not in the loop, this OSO is not applicable.

c) A UAS implementing such an automatic protection function will ensure that the UA is operated within an acceptable flight envelope margin even in the case of incorrect remote-pilot control inputs (human errors).

d) UAS without automatic protection functions are susceptible to incorrect remote-pilot control inputs (human errors), which can result in the loss of the UA if the designed performance limits of the aircraft are exceeded.

e) Failures or development errors of the flight envelope protection are addressed in OSOs #5, #10 and #12.

HUMAN ERROR		**LEVEL of INTEGRITY**		
		Low	**Medium**	**High**
OSO #18 Automatic protection of the flight envelope from human errors	Criteria	The UAS flight control system incorporates automatic protection of the flight envelope to prevent the remote pilot from making any single input under normal operating conditions that would cause the UA to exceed its flight envelope or prevent it from recovering in a timely fashion.	The UAS flight control system incorporates automatic protection of the flight envelope to ensure the UA remains within the flight envelope or ensures a timely recovery to the designed operational flight envelope following remote pilot error(s).[1]	
	Comments	*N/A*	*[1] The distinction between a medium and a high level of robustness for this criterion is achieved through the level of assurance (see table below).*	

HUMAN ERROR		LEVEL of ASSURANCE		
		Low	Medium	High
OSO #18 Automatic protection of the flight envelope from human errors	Criteria	The automatic protection of the flight envelope has been developed in-house or out of the box (e.g., using commercial off-the-shelf elements), without following specific standards. CAAM validates the claimed level of integrity.	The automatic protection of the flight envelope has been developed to standards considered adequate by the CAAM and/or in accordance with a means of compliance acceptable to that authority. CAAM validates the claimed level of integrity.	Same as Medium. In addition, evidence is validated by CAAM.
	Comments	*N/A*	*N/A*	*N/A*

OSO #19 — Safe recovery from human errors

a) This OSO addresses the risk of human errors which may affect the safety of the operation if not prevented or detected and recovered in a timely fashion.

1) Errors can be made by anyone involved in the operation.

2) An example could be a human error leading to the incorrect loading of the payload, with the risk of it falling off the UA during the operation.

3) Another example could be a human error not to extend the antenna mast, thus reducing the C2 link coverage.

Note. - the flight envelope protection is excluded from this OSO since it is specifically covered by OSO #18.

b) This OSO covers:

1) procedures and lists,

2) training, and

3) UAS design, i.e., systems detecting and/or recovering from human errors (e.g., safety pins, use of acknowledgment features, fuel or energy consumption monitoring functions …)

HUMAN ERROR		LEVEL of INTEGRITY		
		Low	Medium	High
OSO #19 Safe recovery from Human Error	Criterion #1 (Procedures and checklists)	Procedures and checklists that mitigate the risk of potential human errors from any person involved with the mission are defined and used. Procedures provide at a minimum: — a clear distribution and assignment of tasks, and — an internal checklist to ensure staff are adequately performing their assigned tasks.		
	Comments	*N/A*	*N/A*	*N/A*
	Criterion #2 (Training)	— The remote crew[1] is trained to use procedures and checklists. — The remote crew[1] receives CRM[2] training.[3]		
	Comments	*[1] In the context of SORA, the term 'remote crew' refers to any person involved in the mission.* *[2] CRM training focuses on the effective use of all the remote crew to ensure a safe and efficient operation, reducing error, avoiding stress and increasing efficiency.* *[3] The distinction between a low, a medium and a high level of robustness for this criterion is achieved through the level of assurance (see table below).*		
	Criterion #3 (UAS design)	Systems detecting and/or recovering from human errors are developed according to industry best practices.	Systems detecting and/or recovering from human errors are developed to standards considered adequate by the CAAM and/or in accordance with a means of compliance acceptable to that authority.	Same as medium.
	Comments	*N/A*	*N/A*	*N/A*

HUMAN ERROR		LEVEL of ASSURANCE		
		Low	Medium	High
OSO #19 Safe recovery from Human Error	Criterion #1 (Procedures and checklists)	— Procedures and checklists do not require validation against either a standard or a means of compliance considered adequate by the CAAM. — The adequacy of the procedures and checklists is declared.	— Procedures and checklists are validated against standards considered adequate by the CAAM and/or in accordance with a means of compliance acceptable to that authority. — Adequacy of the procedures and checklists is proven through:	Same as Medium. In addition: — Flight tests performed to validate the procedures and checklists cover the complete flight envelope or are proven to be conservative.
			— Dedicated flight tests, or — Simulation, provided the simulation is proven valid for the intended purpose with positive results.	— The procedures, checklists, flight tests and simulations are validated by a competent third party.
	Comments	*N/A*	*N/A*	*N/A*
	Criterion #2 (Training)	Consider the criteria defined for the level of assurance of the generic remote crew training OSO (i.e., OSO #09, OSO #15 and OSO #22) corresponding to the SAIL of the operation		
	Comments	*N/A*	*N/A*	*N/A*
	Criterion #3 (UAS design)	The applicant declares that the required level of integrity has been achieved[1]. CAAM validates the claimed level of integrity.	The applicant has supporting evidence that the required level of integrity is achieved. That evidence is provided through testing, analysis, simulation[2], inspection, design review or operational experience. CAAM validates the claimed level of integrity.	CAAM validates the claimed level of integrity
	Comments	*[1]Supporting evidence may or may not be available.*	*[2]When simulation is performed, the validity of the targeted environments that is used in the simulation needs to be justified.*	*N/A*

OSO #20 — A Human Factors evaluation has been performed and the HMI found appropriate for the mission

HUMAN ERROR		LEVEL of INTEGRITY		
		Low	**Medium**	**High**
OSO #20 A Human Factors evaluation has been performed and the HMI found appropriate for the mission	Criteria	The UAS information and control interfaces are clearly and succinctly presented and do not confuse, cause unreasonable fatigue, or contribute to remote crew errors that could adversely affect the safety of the operation.		
	Comments	*If an electronic means is used to support potential VOs in their role to maintain awareness of the position of the unmanned aircraft, its HMI:* — *is sufficient to allow the VOs to determine the position of the UA during operation; and* — *does not degrade the VO's ability to:* — *scan the airspace visually where the unmanned aircraft is operating for any potential collision hazard; and* — *maintain effective communication with the remote pilot at all times.*		

HUMAN ERROR		LEVEL of ASSURANCE		
		Low	**Medium**	**High**
OSO #20 A Human Factors evaluation has been performed and the HMI found appropriate for the mission	Criteria	The applicant conducts a human factors evaluation of the UAS to determine whether the HMI is appropriate for the mission. The HMI evaluation is based on inspection or analyses. CAAM witnesses the HMI evaluation of the UAS	Same as Low but the HMI evaluation is based on demonstrations or simulations.[1] CAAM witnesses the HMI evaluation of the UAS	Same as Medium. In addition, CAAM witnesses the HMI evaluation of the UAS and a competent third party witnesses the HMI evaluation of the possible electronic means used by the VO.
	Comments	N/A	[1] When simulation is performed, the validity of the targeted environment that is used in the simulation needs to be justified.	N/A

1.8 OSOs related to Adverse Operating Conditions

OSO #23 — Environmental conditions for safe operations are defined, measurable and adhered to

ADVERSE OPERATING CONDITIONS		LEVEL of INTEGRITY		
		Low	Medium	High
OSO #23 Environmental conditions for safe operations are defined, measurable and adhered to	Criterion #1 (Definition)	The environmental conditions for safe operations are defined and reflected in the flight manual or equivalent document.[1]		
	Comments	*[1] The distinction between a low, a medium and a high level of robustness for this criterion is achieved through the level of assurance (see table below).*		
	Criterion #2 (Procedures)	Procedures to evaluate environmental conditions before and during the mission (i.e., real-time evaluation) are available and include assessment of meteorological conditions (METAR, TAFOR, etc.) with a simple recording system.[2]		
	Comments	*[2] The distinction between a low, a medium and a high level of robustness for this criterion is achieved through the level of assurance (see table below).*		
	Criterion #3 (Training)	Training covers assessment of meteorological conditions.[3]		
	Comments	*[3] The distinction between a low, a medium and a high level of robustness for this criterion is achieved through the level of assurance (see table below).*		

<table>
<tr><th colspan="2">ADVERSE OPERATING CONDITIONS</th><th colspan="3">LEVEL of ASSURANCE</th></tr>
<tr><th colspan="2"></th><th>Low</th><th>Medium</th><th>High</th></tr>
<tr><td rowspan="7">OSO #23 Environmental conditions for safe operations defined, measurable and adhered to</td><td>Criterion #1 (Definition)</td><td colspan="3">Consider the criteria defined in Section 1.9 of Appendix 6</td></tr>
<tr><td>Comments</td><td colspan="3">N/A</td></tr>
<tr><td rowspan="2">Criterion #2 (Procedures)</td><td>— Procedures do not require validation against either a standard or a means of compliance considered adequate by the CAAM.</td><td>— Procedures are validated against standards considered adequate by the CAAM and/or in accordance with a means of compliance acceptable to that authority.</td><td>Same as Medium. In addition:
— Flight tests performed to validate the procedures cover the complete flight envelope or are proven to be conservative.</td></tr>
<tr><td>— The adequacy of the procedures and checklists is declared.</td><td>— The adequacy of the procedures is proved through:
— Dedicated flight tests, or
— Simulation, provided the simulation is proven valid for the intended purpose with positive results.</td><td>— The procedures, flight tests and simulations are validated by a competent third party.</td></tr>
<tr><td>Comments</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td>Criterion #3 (Training)</td><td>Training is self-declared (with evidence available).</td><td>— Training syllabus is available.
— The UAS operator provides competency-based, theoretical and practical training.</td><td>A competent third party:
— Validates the training syllabus.
— Verifies the remote crew competencies.</td></tr>
<tr><td>Comments</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
</table>

OSO #24 — UAS is designed and qualified for adverse environmental conditions (e.g., adequate sensors, DO-160 qualification)

a) To assess the integrity of this OSO, the applicant determines:

1) whether credit can be taken for the equipment environmental qualification tests / declarations, e.g., by answering the following questions:

i) is there a Declaration of Design and Performance (DDP) available to the applicant stating the environmental qualification levels to which the equipment was tested?

ii) Did the environmental qualification tests follow a standard considered adequate by the CAAM (e.g., DO-160)?

iii) Are the environmental qualification tests appropriate and sufficient to cover all the environmental conditions related to the ConOps?If the tests were not performed following a recognised standard, were the tests performed by an organisation/entity that is qualified or that has experience in performing DO-160 like tests?

2) Can the suitability of the equipment for the intended/expected UAS environmental conditions be determined from either in-service experience or relevant test results?

3) Any limitations which would affect the suitability of the equipment for the intended/expected UAS environmental conditions.

b) The lowest integrity level should be considered for those cases where a UAS equipment has only a partial environmental qualification and/or a partial demonstration by similarity and/or parts with no qualification at all.

ADVERSE OPERATING CONDITIONS		**LEVEL of INTEGRITY**		
		N/A	**Medium**	**High**
OSO #24 UAS is designed and qualified for adverse environmental conditions	Criteria	N/A	The UAS is designed to limit the effect of environmental conditions.	The UAS is designed using environmental standards considered adequate by the competent authority and/or in accordance with a means of compliance acceptable to that authority.
	Comments	*N/A*	*N/A*	*N/A*

ADVERSE OPERATING CONDITIONS		LEVEL of ASSURANCE		
		N/A	Medium	High
OSO #24 UAS is designed and qualified for adverse environmental conditions	Criteria	N/A	Consider the criteria defined in Section 1.9 of Appendix 6	
	Comments	*N/A*	*N/A*	

1.9 Assurance level criteria for technical OSO

		LEVEL of ASSURANCE		
		Low	Medium	High
TECHNICAL OSO	Criteria	The applicant declares that the required level of integrity has been achieved[1].	The applicant has supporting evidence that the required level of integrity is achieved. This is typically done by testing, analysis, simulation[2], inspection, design review or through operational experience. EASA validates the claimed level of integrity.	EASA validates the claimed level of integrity.
	Comments	*[1] Supporting evidence may or may not be available.*	*[2] When simulation performed, the validity of the targeted environment that is used in the simulation needs to be justified.*	*N/A*

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Appendix 7

1 Occurrence Reporting

1.1 UAS Occurrence reporting

1.1.1 UAS occurrences- what you need to do

a) This section will walk you through the actions you need to take if there has been an occurrence involving an unmanned aircraft and you are wondering if you need to report it, who you need to report to and how you report it.

1.1.2 Have you got the most up-to-date information?

a) UAS occurrence reporting is evolving and the CAAM may need to make changes to occurrence reporting policy and guidance. To ensure you have the most up-to-date information, you must also check on the CAAM website in addition to the information in this document.

1.1.3 The purpose of occurrence reporting

a) Occurrence reporting systems are not established to attribute blame or liability.

b) Occurrence reporting systems are established to learn from occurrences, improve aviation safety and prevent recurrence.

c) The purpose of occurrence reporting is to improve aviation safety by ensuring that relevant safety information is reported, collected, stored, protected, exchanged, disseminated and analysed. Organisations and individuals with a good air safety culture will report effectively and consistently. Every occurrence report is an opportunity to identify root causes and prevent them from contributing to accidents where people are harmed.

d) The safe operation of UAS is as important as that of manned aircraft. Injuries to third parties, or damage to property, can be just as severe. Proper investigation of each accident, serious incident or other occurrence is necessary to identify causal factors and to prevent repetition. Similarly, the sharing of safety-related information via good reporting is critical in reducing the number of future occurrences.

1.1.4 What organisations in Malaysia have a reporting requirement?

a) The Air Accidents Investigation Branch (AAIB) and the Civil Aviation Authority of Malaysia (CAAM) have separate reporting requirements. It may be necessary to report to one or both. The regulations that describe these requirements are explained, below.

1.1.5 Occurrence reporting regulations

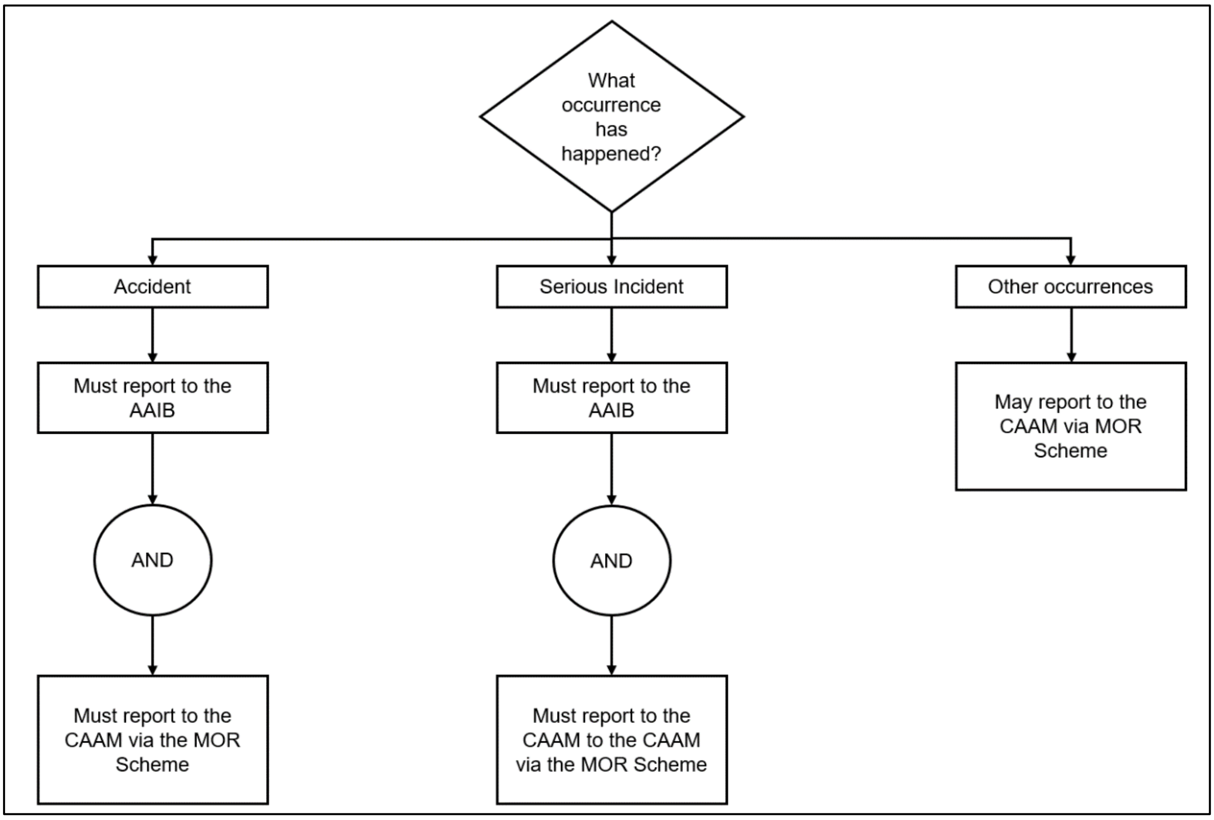
a) MCAR 2016 Regulation 165 on Mandatory Occurrence Reporting.

1.1.6 Occurrence reporting flowchart

a) The flowcharts below will help you find out three things:

1) What occurrences you need to report
2) Who you need to report to
3) Mandatory and voluntary reporting

Note. - Voluntary reporting is useful to provide opportunity for safety lessons to be learned more widely from an occurrence. More engaged air safety cultures tend to do more voluntary reporting.



Occurrence Reporting Flowchart

1.2 Definitions

1.2.1 A **reportable occurrence** in relation as defined in MCAR Regulation 165 (1) means:

a) Any incident relating to such an aircraft or any defect in or malfunctioning of such an aircraft or any part of equipment or such an aircraft, being an incident, malfunctioning or defect endangering, or which if not corrected would endanger the aircraft, its occupants or any other person.

b) Any defect in or malfunctioning of any facility, on the ground used or intended to be used for purposes of or in connection with the operation of such an aircraft, being a defect or malfunctioning endangering, or which if not corrected would endanger such an aircraft or its occupants.

Note. - Accidents and serious incidents are classifications of reportable occurrence which needs to be reported to CAAM under the Occurrence Reporting Scheme.

1.2.2 An **accident** as defined in ICAO Annex 13 means:

a) An occurrence associated with the operation of an aircraft which, in the case of a manned aircraft, takes place between the time any person boards the aircraft with the intention of flight until such time as all such persons have disembarked, or in the case of an unmanned aircraft, takes place between the time the aircraft is ready to move with the purpose of flight until such time as it comes to rest at the end of the flight and the primary propulsion system is shut down, in which:

1) A person is fatally or seriously injured as a result of:

i) Being in the aircraft; or
ii) Direct contact with any part of the aircraft, including parts which have become detached from the aircraft, or
iii) Direct exposure to jet blast,

except when the injuries are from natural causes, self-inflicted or inflicted by other persons, or when the injuries are to stowaways hiding outside the areas normally available to the passengers and crew; or

2) The aircraft sustains damage or structural failure which:

i) adversely affects the structural strength, performance or flight characteristics of the aircraft, and
ii) would normally require major repair or replacement of the affected component,

except for engine failure or damage, when the damage is limited to a single engine, (including its cowlings or accessories), to propellers, wing tips, antennas, probes, vanes, tires, brakes, wheels, fairings, panels, landing gear doors, windscreens, the aircraft skin (such as small dents or puncture holes) or minor damages to main rotor blades, tail rotor blades, landing gear, and those resulting from hail or bird strike, (including holes in the radome); or

3) The aircraft is missing or is completely inaccessible.

1.2.3 A **serious incident** as defined in ICAO Annex 13 means:

a) An accident involving circumstances indicating that there was a high probability of an accident and is associated with the operation of an aircraft, which in the case of a manned aircraft, takes place between the time any person boards the aircraft with the intention of flight until such time as all such persons have disembarked, or in the case of an unmanned aircraft, takes place between the time the aircraft is ready to move with the purpose of flight until such time it comes to rest at the end of the flight and the primary propulsion system is shut down.

1.2.4 A **fatal injury** as defined in ICAO Annex 13 means:

b) An injury which is sustained by a person in an accident and which results in his or her death within 30 days of the date of the accident.

Note.1 - Serious injury or death to flight crew or passenger which directly results from the operation of the aircraft or its equipment (e.g., abrupt manoeuvres, turbulence, propeller or jet blast) is required to be reported as Reportable Accident.

Note.2 - Any significant injury to any person, which directly results from the operation of the aircraft or its equipment, but which is not considered to constitute a Reportable Accident.

1.3 Occurrence

1.3.1 The regulations:

a) Occurrences must be reported in accordance with the requirements of MCAR Regulation 165.

b) The means of reporting is via the Mandatory Occurrence Reporting (MOR) Scheme. Which can be found on the CAAM website here.

c) Some of the occurrences MOR Scheme clearly applies to manned aircraft, however, many equally apply to unmanned aircraft.

1.3.2 Additional UAS Occurrences that must be reported:

a) In addition to those listed in the regulations above, other, more UAS specific occurrences must also be reported should they or a similar occurrence be experienced or observed by you. These occurrences are listed below but the list is not exhaustive.

b) When you are considering whether an occurrence is reportable, you should also take into account other situations where the same thing could have happened. For example, the actual occurrence may have been 'benign' as it happened in a remote area. However, if the full scope of how the aircraft could be operated is taken into account, for example over people, could the same occurrence in a different situation result in a more serious outcome?

1) <u>Operation of the aircraft</u>
   i) Unintentional loss of control
   ii) Loss of control authority over the aircraft
   iii) Aircraft landed outside the designated area
   iv) Aircraft operated beyond the limitations established in the relevant operating category or operational authorisation
   v) Aircraft operated without required licencing, registration or operational authorisation
   vi) Aircraft operated in an unairworthy or unflightworthy condition

2) <u>Technical malfunction/failure of the aircraft or command unit</u>
   i) Loss of command and control link (C2 link)
   ii) Battery failure/malfunction
   iii) Powerplant failure
   iv) Aircraft structural failure (for example, part of the aircraft detaches during operation)
   v) Errors in the configuration of the command unit
   vi) Display failures
   vii) Flight programming errors
   viii) Navigation failures

3) <u>Confusion/liaison errors between flight crew members (human factors)</u>
   i) Inter crew communication
   ii) Briefing
   iii) Competency oversights

4) <u>Interaction with other airspace users and the public</u>
   i) Conflict with another aircraft, such that a risk of collision may have existed
   ii) Infringement of restricted/reserved airspace (Inc. Flight restriction zones [FRZ] around aerodromes)
   iii) Inadvertent flight within close proximity of uninvolved persons (i.e., within the prescribed separation distances

5) Other emergencies

i) Any occurrence where the safety of the aircraft, operator, other airspace users or members of the public is compromised or reduced to a level whereby potential for harm or damage is likely to occur (or only prevented through luck)

1.3.3 Reporting an UAS occurrence to the AAIB

a) The AAIB

1) The purpose of the AAIB is to improve aviation safety by determining the circumstances and causes of air accidents and serious incidents and promoting action to prevent recurrence.

b) What UAS occurrences must be reported to the AAIB?

1) All UAS **accident and serious incidents** are required to be reported to the AAIB, regardless of weight or whether they are being used for commercial purposes.

c) Who must report UAS occurrences to the AAIB?

1) 'Any person involved' who has knowledge of an aircraft accident or serious incident in the Malaysia must report it to the AAIB. 'Any person' includes (but it is not limited to) the owner, operator, and remote pilot of a UAS.

d) A more detailed list can be found on the AAIB website.

e) Regulations

1) The applicable regulations for investigation of aircraft accident and incident are stated in the MCAR 2016 Part XXVI

i) Regulation 185 on notification of accident and incident.
ii) Regulation 187 on conduct of investigation.
iii) Regulation 187 on notice, circular, direction and information.

Note. - The regulations stated above apply at publication date of this CAD and you should refer to the AAIB website for up-to-date information.

1.3.3.1 How to report a UAS accident or serious incident to the AAIB?

a) Aircraft accidents or serious incidents should be reported by using the 'AAIB (Malaysia) Accident/Incident Notification Form' to the AAIB via email to yahaya@mot.gov.my or fax to 03-888 0163.

1.3.3.2 Any questions?

a) Contact the AAIB if you have any questions about reporting occurrences to the AAIB.

1.3.4 Reporting a UAS occurrence to the CAAM

a) What UAS occurrences must be reported to the CAAM?

1) UAS occurrences must be reported to the CAAM in accordance with the occurrence reporting flowcharts in this document.
2) Using the flowcharts will help you find out whether the occurrence need to be reported to the CAAM.

b) Who must report UAS occurrences to the CAAM?

1) A UAS operator, remote pilot or member of a UAS support crew that experiences or observes an occurrence.

c) How to report a UAS occurrence to the CAAM?

1) Reports are submitted using the Mandatory Occurrence Reporting (MOR) Scheme.

d) The MOR Scheme can be found here.

e) Guidance on how to use the MOR Scheme can be found within the Scheme itself.

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Appendix 8

Pre-Defined Risk Assessment – PDRA 02

CAAM/BOP/UAS/SUP/PDRA02-01

PRE-DEFINED RISK ASSESSMENT - PDRA02

Flights for Research and Development Testing of UAS with a Maximum Take-Off Mass (MTOM) up to 150kg

WHAT?

☐ This PDRA is designed to enable short term initial research and development flights to be conducted, within a sterile area away from people and property. It allows a UAS manufacturer/developer to conduct initial 'proof of concept' flight tests without the need to produce a full risk assessment for a product that may not prove to be feasible for further development.

WHEN?

PDRA02 enables the following operations:

☐ UA Operations for the purpose of research and development

☐ Flights must be conducted within a sterile area free of any uninvolved persons

☐ No flight within 50 metres horizontally from any uninvolved persons

☐ Maximum height not to exceed 400 feet above the surface of the earth

☐ Flights must be conducted at least 150 metres horizontally from a Designated Area i.e., Residential, Commercial, Industrial or Recreational Area

☐ Daytime operations ONLY and within VLOS

☐ Maximum horizontal distance from the remote pilot must not exceed 250 metres, unless a lesser control link radio range has been specified by the manufacturer. Direct unaided visual contact with the said UA must be maintained, sufficient to monitor its flight path for the purposes of avoiding collisions

☐ Maximum speed:
  a) 35 knots in any direction where MTOM is less than 75kg
  b) 25 knots in any direction where MTOM is between 75kg and 150kg
  c) Where the speed cannot be measured, the Unmanned Aircraft is not to be operated at a speed that is greater than a fast walking pace

☐ Articles may be picked up by, raised to, and dropped or lowered from the UA provided that the activity is confined to a sterile area defined for this purpose, and is conducted in a way that will not endanger persons or property

☐ Operations must not be conducted in controlled airspace, except with the permission of the appropriate Air Traffic Control Unit

☐ Operations must not be conducted within Aerodrome Traffic Zones (ATZ), Restricted Areas or Danger Areas unless the requirements for access to such airspace has been complied with

☐ Carriage of persons is not permitted

☐ Dangerous Goods permitted are only agricultural payload as listed by DOA or Pesticides registered under Pesticides Act 1974

WITH?

☐ UAS maximum take-off mass (MTOM) between up to 150kg

☐ UAS equipped with a mechanism that makes it land in the event of loss of disruption of C2 Link

☐ Insurance cover to meet insurance requirements

☐ Either a contracted or own UTM system will be used

HOW?

☐ UAS Operators must produce an Operations Manual which details how the flight will be conducted. (only the ConOps element of the operations manual is required for this PDRA)
For Agricultural PDRA, refer to CAD 6011 (II) item 4.7; for all other PDRA, Refer to Appendix 2 of CAD 6011 (V).

☐ SMS and ERP Manual

☐ All Remote Pilot involved in the Operation must be in possession of a valid and applicable RCoC.

RCoC-B may be sufficient for VLOS operations
RCoC-B + Module 2 is required if dispensation of Agricultural Payload is involved.

DOCUMENTS TO BE INCLUDED IN THE APPLICATION

☐ Operations Manual

☐ SMS and ERP Manual

☐ Copy of Certification of SMS Manager having attended SMS Implementation course

☐ Copy of RCoC all Remote Pilots intending to fly under the authorisation

11 Attachments

Attachment A (1)	:	Application Form for the Special UAS Project Approval
Attachment A (2)	:	Technical Characteristics of the UA
Attachment A (3)	:	Compliance Declaration for PDRA Applicant
Attachment B	:	Schedule of Events
Attachment C	:	Operations Manual Template
Attachment D	:	Special UAS Project Approval process flow chart
Attachment E	:	Layout of Special UAS Project Approval

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Application Form for the Special UAS Project Approval

CAAM/BOP/UAS/SUP/01-01

	CIVIL AVIATION AUTHORITY OF MALAYSIA **Application for Special UAS Project Approval**

APPLICATION FOR	**OPERATIONS**		☐	Initial
	☐	PDRA	☐	Renewal
	☐	SORA	☐	Renewal

UAS OPERATOR DATA			
1.1	**UAS Operator registration number**		
1.2	**UAS Operator Name**		
1.3	**Place of Business**		
1.4	**Email**		
1.5	**Telephone Number**		**Fax Number**

UAS DATA					
2.0 Configuration	**Aeroplane ☐**	**Helicopter ☐**	**Multirotor ☐**	**Hybrid/VTOL ☐**	**Other ☐**

2.1 Manufacturer	**2.2 Model**	**2.3 Max characteristic dimension**	**2.4 Total Number of UA operated**	**2.5 MTOM**	**2.6 Serial Number**

3.0 NOMINATED POST HOLDERS

Personnel	Name & Designation	Contact Number & Email Address
Accountable Manager (AM)		
Safety Manager (SM)		
Flight Operations Manager (FOM)		
Authorised Technical Personnel (ATP)		
OPERATION		
4.0 Proposed date for the commencement of operations		
4.1 Unmanned Traffic Management (UTM)	**Own ☐**	**Contracted ☐**
4.2 Description on UTM Capabilities		
4.3 ConOps		

4.4 Mitigation and operational safety objectives (OSOs) **(only applicable for SORA applicant)**	

CHECKLIST		
Supporting documents to be submitted:	**Yes**	**No**
Cheque attached for application fee	☐	☐
Insurance cover will be in place at the start of the UAS Operations	☐	☐
Technical Characteristics of the UAS	☐	☐
Specific Operations Risk Assessment (only applicable for SORA applicant)	☐	☐
Operations Manual (if required by the SORA)	☐	☐
Location(s) of the proposed operation(s) in .kmz/.kml file	☐	☐
Leasing contracts for the UA	☐	☐
Qualification of the Nominated Post Holder(s)	☐	☐
Qualification of the Remote Pilot Certificate of Competency (RCoC)	☐	☐
PDRA Declaration Form (applicable to PDRA applicant)	☐	☐
Operations Manual (applicable to PDRA applicant)	☐	☐
SMS and ERP Manual (applicable to PDRA applicant)	☐	☐

5.0 I, the undersigned, hereby declared that:

- ✓ **The information provided in this application form is true and correct.**
- ✓ **That the information provided in this application will allow CAAM to calculate an estimate for service for processing this application.**
- ✓ **That the cost estimate may change, and processing the application may be delayed, if:**
  - **The application does not accurately and completely identified my requirements; or**
  - **The details in the application are subsequently changed; or**
  - **Adequate supporting documentation has not been provided.**

- ✓ **For the CAAM to proceed with this application, I must:**
  - **Accept the cost estimate; and**
  - **Forward the prescribed payment; and**
  - **Forward all supporting documentations to the CAAM.**

I, the undersigned, hereby declared that the UAS operation will comply with:

- ✓ **Any applicable UAS Regulations and rules related to privacy, data protection, liability, insurance, security and environmental protection;**
- ✓ **The applicable requirements of MCAR and its legislation pertaining UAS; and**
- ✓ **The limitations and conditions defined in the Special UAS Project Approval provided by the CAAM.**

Note: I am aware of, and accept, the risk that information sent via email may be intercepted and read during transmission, not delivered or modified. (If you do not accept, material will be sent by post).

____ ________________________

Name, Signature of Accountable Manager & Company Stamp   Date (Day / Month / Year)

CAAM USE	
REMARKS:	
Signature:	Date:
Accepted by UASI:	
Signature:	Date:
Director of Flight Operations:	

FOR CAAM USE ONLY

UASI Name ____________________________

☐ ACCEPT ☐ REJECT

Remarks ____________________________

UASI Signature ____________________________

Date ____________________________

Application Fee:	
Receipt No:	
Cheque / P.O:	
Initial:	
Date:	

Instructions for filling in the form

1.1 UAS Operator Registration number issued by the CAAM (not applicable for first time applicant)

1.2 UAS Operator Name

1.3 Place of Business of operations, if SUP Approval Holder changes the address of their operations, they must notify in writing to the CAAM before the change becomes effective

1.4 Email address of the person to be contacted (preferably the Accountable Manager)

1.5 Telephone number and Fax number of UAS Operator

2.0 Configuration of UA

2.1 The name of the manufacturer of the UAS

2.2 The model of the UAS as defined by the manufacturer

2.3 The maximum characteristic dimension of the UA in metres

- for aeroplanes: the length of the wingspan;
- for helicopters: the diameter of the propellers;
- for multi-rotors: the maximum distance between the tips of 2 opposite propellers

2.4 The total number of UA operated for each type

2.5 UA MTOM in kilogrammes (refer to definition 22 for guidance)

2.6 The serial number of the UA defined by the manufacturer (if any) and the approved MCMC label serial number, SIRIM Type Approval / Certificate of Conformity (serial Number) or SIRIM Special Approval Certificate (serial number). The serial numbers shall be separated by (/) in between

3.0 Names and contact details of the Nominated Post Holders

4.0 The proposed date for the commencement of operations

4.1 Will a contracted or own UTM system will be used to meet the compliance of Chapter 7 of CAD 6011 (V)

4.2 Description of the UTM system meeting the minimum requirement listed in Chapter 7 of this CAD 6011 (V) and any additional capabilities (if any)

4.3 The description of the intended operation characterizing the area where it will take place (i.e., urban, sparsely populated, industrial, etc.) and the airspace

4.4 A list of the mitigation measures and the OSOs put in place, proposed by the UAS Operator. Sufficient information should be provided to the CAAM to assess the robustness of the measures

5.0 Declaration by AM

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Technical Characteristics of the UA

CAAM/BOP/UAS/SUP/02-01

CAAM Civil Aviation Authority of Malaysia	**CIVIL AVIATION AUTHORITY OF MALAYSIA** **Application for Special UAS Project** **Technical Characteristics of the UAS**

LANDING GEAR			Yes ☐	No ☐
Type	Fixed ☐	Retractable ☐		Other ☐
Characteristics	Wheels ☐	Skids ☐	Legs ☐	Other ☐

CONSPICUITY CHARACTERISTICS				
Paint [1]				
Lights [2]	Yes ☐	No ☐	Intensity	
Aircraft Visibility Lights:				
Control lights (flight mode or alert indicators, etc.):				

PROPULSION [3]							
Electrical	☐	Combustion	☐	Hybrid	☐	Other	☐
Description:							
Note: Provide a brief description (for example, push/pull systems, coaxial systems in the case of multirotor, combined systems, etc.)							

SYSTEMS					
Propellors	☐	Turbines	☐	Other	☐
Description:					

CONTROL AND/ OR POSITIONING SYSTEM [4]			
FLIGHT CONTROLLER [5]			
Manufacturer		Model	
Description:			
FLIGHT TERMINATION SYSTEM [6]			
Description:			
FLIGHT MODES [7]			
Description:			
GROUND CONTROL STATION [8]			
• Radio emitter			
Manufacturer		Model	
• Mobile/Computer application			

Manufacturer		Model			
• Other					
Manufacturer		Model			
CONTROL COMMUNICATION LINK					
Description (frequency):					
TELEMETRY COMMUNICATION LINK		yes	☐	no	☐
Description (frequency):					
VIDEO SYSTEM COMMUNICATION LINK (FPV)		yes	☐	no	☐
Description (frequency):					
PAYLOAD COMMUNICATION LINK		yes	☐	no	☐
Description (frequency):					
PAYLOAD [9]		yes	☐	no	☐
TYPE		fixed	☐	intercha-ngeable	☐
Description:					
OPERATION LIMITS [10]					
Maximum operating height					
Maximum airspeed					
Weather conditions					
SAFETY SYSTEMS/SAFETY NETS AND AWARENESS [11]					
Detect and Avoid		yes	☐	no	☐
Description:					
Geo-fencing or Geo-caging		yes	☐	no	☐
Description:					
Transponder		yes	☐	no	☐
Description:					
Systems for Limiting Impact Energy		yes	☐	no	☐
Description:					
Other:					
Description:					

Note to Applicant:

(1) Paint

Describe any painted elements that are visible (marks) and significant (colour, shape, etc.)

(2) Lights

Describe the lights, including their colours and locations.

(3) Propulsion

Mark the type of propulsion used, indicating (in the space provided) the manufacturer and model, and detailing relevant information such as the number of motors/engines, the configuration, etc. Powerplant design diagrams may be attached if necessary.

(4) Control and/or Positioning System

As a general instruction for this section, in addition to the description and information deemed necessary to define these systems, the operator shall provide any certification and rating for the systems. Such as those related to electromagnetic compatibility or SIRIM Type Approval / Special Approval satisfied by the equipment installed on the aircraft for consideration during the specific risk assessment conducted using the specific operations risk assessment (SORA) or any other SMS methodology to evaluate and authorise operations.

(5) Flight Controller

Indicate the manufacturer and model of the flight controller. Describe the relevant aspects affecting flight safety.

(6) Flight Termination System

Describe and include the technical characteristics of the system, its modes of operation, system activation and any certification and rating for the components, as well as proof of its electromagnetic compatibility for consideration during the SORA or any other SMS methodology that is followed to evaluate and authorise operations.

(7) Flight Modes

Describe the flight modes (i.e., manual, artificial stability with controller, automatic, autonomous). For each flight mode, describe the variable that controls the aircraft: increments in position, speed control, attitude control, type of altitude control (which sensor is used for this purpose), etc.

(8) Ground Control Station

For ‘encrypted’ links, describe the encryption system used, if any.

(9) Payload

Describe each of the different payload configurations that affect the mission or that, without changing it, impact the weight and balance, the electrical charge or the flight dynamics. Include all relevant technical details. If needed, you may use other documents that provide the specified details.

(10) Operation Limits

Describe in this section the maximum operating height, the maximum airspeed (including Vmax ascent, Vmax descent and Vmax horizontal), and, in addition, the meteorological limit conditions in which the UAS can operate (e.g., rain, maximum wind, etc.)

(11) Safety Systems/Safety Nets and Awareness

Describe the systems or equipment installed on the aircraft to mitigate potential safety risks, whether included in the form or not.

Compliance Declaration for PDRA Applicant

CAAM/BOP/UAS/SUP/03-01

<u>Note to Operator:</u>
This document should be completed with reference to CAD 6011 (V) – Special UAS Project.

The compliance declaration shall be used to ensure that all information is inserted in Manuals or present during the certification phase. These information provided to the CAAM will also assist the CAAM in processing the Special UAS Project Approval for PDRA applicant, in a more expedient manner. Operator should submit as early as possible, a point-by point reply to the applicable requirement. Additional requirement may be specified by the CAAM when deemed necessary.

Applicants are expected to complete the checklist in a clear manner by crossing the appropriate checkbox on the compliance status and indicate the location of the relevant supporting document. An example is as shown below:

Criteria Code	**Criteria Compliance status**			**Remarks** (Include reference to documentation or reason for non compliance/ non-applicability)
	Yes	**No**	**N/A**	
	☐	☐	☐	Document XX – Chapter X, item X.X; Document YY, - Chapter Y, item Y.Y

ORGANISATION DETAILS					
Name of Operator:					
Organisation:					
OPERATION DETAILS					
I, the undersigned, hereby declare that the UAS operation falls in PDRA operations and will be in compliance with the items below:		**Requirement compliance status**			**Remarks**
		Yes	**No**	**N/A**	
OPERATIONAL MATTERS					
1	**UA Operations for the purpose of Research and Development**	☐	☐	☐	

<table>
<tr><th colspan="6">OPERATION DETAILS</th></tr>
<tr><th colspan="2" rowspan="2">I, the undersigned, hereby declare that the UAS operation falls in PDRA operations and will be in compliance with the items below:</th><th colspan="3">Requirement compliance status</th><th rowspan="2">Remarks</th></tr>
<tr><th>Yes</th><th>No</th><th>N/A</th></tr>
<tr><th colspan="6">OPERATIONAL MATTERS</th></tr>
<tr><td rowspan="5">2</td><td>Location of intended operation is within a sterile area free of any uninvolved person</td><td>☐</td><td>☐</td><td>☐</td><td></td></tr>
<tr><td>• No flight within 50 metres horizontally from any uninvolved person</td><td>☐</td><td>☐</td><td>☐</td><td></td></tr>
<tr><td>• Flight conducted at least 150 metres horizontally from a designated Area i.e., Residential, Commercial, Industrial or Recreational Area</td><td>☐</td><td>☐</td><td>☐</td><td></td></tr>
<tr><td>• Operations are not conducted in controlled airspace, unless permitted by appropriate Air Traffic Control Unit</td><td>☐</td><td>☐</td><td>☐</td><td></td></tr>
<tr><td>• Operations are not conducted within Aerodrome Traffic Zone (ATZ), Restricted Areas or Danger Areas unless requirements for access to such airspace have been complied with</td><td>☐</td><td>☐</td><td>☐</td><td></td></tr>
<tr><td>3</td><td>Maximum height of intended operation shall not exceed 400 feet above the surface of the earth</td><td>☐</td><td>☐</td><td>☐</td><td></td></tr>
</table>

I, the undersigned, hereby declare that the UAS operation falls in PDRA operations and will be in compliance with the items below:		Requirement compliance status			Remarks
		Yes	No	N/A	
OPERATIONAL MATTERS					
4	**Operations will only be conducted during daytime ONLY and within VLOS**	☐	☐	☐	
	• Maximum horizontal distance from the remote pilot must not exceed 250 metres, unless a lesser control link radio range has been specified by the manufacturer	☐	☐	☐	
	• Direct unaided visual control with the said UA must be maintained, sufficient to monitor its flight path for the purposes of avoiding collisions	☐	☐	☐	
5	**Maximum speed**				
	• For UA less than 75 kg MTOM – maximum wind speed of not greater than 35 knots in any direction	☐	☐	☐	
	• For UA with MTOM of 75 kg – 150 kg – maximum wind speed of not greater than 25 knots in any direction	☐	☐	☐	
	• Where the speed cannot be measure, the Unmanned Aircraft is not to be operated at a speed that is greater than a fast-walking pace	☐	☐	☐	

I, the undersigned, hereby declare that the UAS operation falls in PDRA operations and will be in compliance with the items below:		Requirement compliance status			Remarks
		Yes	No	N/A	
OPERATIONAL MATTERS					
6	**Carriage of Articles**				
	• Articles may be picked up by, raised to, and dropped or lowered from the UA provided that the activity is confined to a sterile area defined for this purpose, and is conducted in a way that will not endanger persons or property	☐	☐	☐	
	• Operations will not involve carriage of persons	☐	☐	☐	
	• Operations will not involve carriage of Dangerous Goods except for Agricultural Payload as listed by DOA or Pesticides registered under Pesticides Act 1974.	☐	☐	☐	
TECHNICAL MATTERS					
7	**Maximum Take Off Mass**				
	• The UA used in the operation is below MTOM of 150 kg	☐	☐	☐	
	• The UAS is equipped with a mechanism that makes it land in the event of loss of disruption of C2 Link	☐	☐	☐	
OTHER					
8	• There is a valid insurance in place to cover a third party liability	☐	☐	☐	
	• There is a UTM system in place capable to track the operation activities and meets the requirements listed in CAD 6011 (V)	☐	☐	☐	

<table>
<tr><th colspan="2" rowspan="2">I am aware that it is an offence to make, with intent to deceive, any false representation for the purpose of procuring the grant, issue, renewal or variation of any certificate, licence, approval permission authorisation or other document.

I hereby submit:</th><th colspan="3">Requirement compliance status</th><th rowspan="2">Remarks</th></tr>
<tr><th>Yes</th><th>No</th><th>N/A</th></tr>
<tr><td colspan="6">REMOTE PILOT COMPETENCY EVIDENCE</td></tr>
<tr><td colspan="6">For remote pilots, the evidence the CAAM requires for the submission of the application depends on the number of current RP in the operations:
▪ Where the number of RP is five or less, the application will require of all remote pilots
▪ Where the number of RP exceeds five, the application must be supported by evidence in respect of the CRP(for Agricultural PDRA), FOM (for other than Agricultural PDRA) plus four other remote pilots selected by the applicant.

Evidence of RP competency is required as follows:</td></tr>
<tr><td rowspan="3">9</td><td>• <u>Initial applications</u> –
Appropriate Certificates as set out in the PDRA</td><td>☐</td><td>☐</td><td>☐</td><td></td></tr>
<tr><td>• <u>Renewal applications</u> –
individual log books with 2 hours flight time within the last three months. The documentation supplied must as a minimum include the name of the nominated pilot, the date of flight (including year) and duration of the flight. Please note flights must be entered as individual flights and not combined flight times.</td><td></td><td></td><td></td><td></td></tr>
<tr><td>• <u>Variation</u>
Appropriate certificates as set out in the PDRA documentation</td><td></td><td></td><td></td><td></td></tr>
</table>

I am aware that it is an offence to make, with intent to deceive, any false representation for the purpose of procuring the grant, issue, renewal or variation of any certificate, licence, approval permission authorisation or other document. **I hereby submit:**		**Requirement compliance status**			**Remarks**
		Yes	**No**	**N/A**	
OPERATIONS MANUAL					
10	• I confirm that the Operations Manual supplied shows a signature of the Accountable Manager	☐	☐	☐	
	• I confirm the Operations Manual supplied includes a section on the policy relating to accidents or serious incidents to the AAIB and for operating other occurrences in accordance with Mandatory Occurrence Reporting Procedures	☐	☐	☐	
	• I confirm the operations manual meets the requirements detailed: ○ For Agricultural PDRA: item 4.7 of CAD 6011 (II); ○ For other than Agricultural PDRA: Appendix 2 of CAD 6011 (V).	☐	☐	☐	
	• I confirm all UAS used are listed in the supplied current Operations Manual (including Manufacturer, Type, Model, MTOM, Command and Control Frequencies)	☐	☐	☐	

I am aware that it is an offence to make, with intent to deceive, any false representation for the purpose of procuring the grant, issue, renewal or variation of any certificate, licence, approval permission authorisation or other document. **I hereby submit:**		**Requirement compliance status**			**Remarks**
		Yes	**No**	**N/A**	
SMS AND ERP MANUAL					
11	• I confirm that the SMS and ERP Manual supplied shows a signature of the Accountable Manager	☐	☐	☐	
	• I confirm the SMS and ERP manual supplied includes a robust ERP applicable to my Research and Development Operation	☐	☐	☐	

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Schedule of Events

CAAM/BOP/UAS/SUP/04-01

ORGANISATION DETAILS			
Name of Operator:		Place of Business:	
Accountable Manager:		Mailing Address (if different from Place of Business)	
AM email address		Pre-Certification Number: (CAAM UAS Unit to insert)	
AM contact number			
Desired Date for the operations to commence			

Necessary document, action or event		**Proposed Date**	**Date received/ Accomplished**	**Date returned for changes**	**Reference**
Description: 1) Items in yellow will be completed by the CAAM; 2) Items marked as “SA” are for SORA applicant; 3) Items marked as PDRA are for PDRA applicant; 4) Items marked as B are applicable to both SORA and PDRA applicant.					
1.0	**PRE-APPLICATION PHASE**				
SORA	Submission of Draft SORA				
PDRA	Submission of Compliance Declaration				
PDRA	Submission of Declaration Form for PDRA applicant				
PDRA	Submission of Operations Manual				
PDRA	Submission of SMS and ERP Manual				
SORA	Cursory review of the ConOps and Draft SORA				

Necessary document, action or event		Proposed Date	Date received/ Accomplished	Date returned for changes	Reference
Note: Items in yellow will be completed by the CAAM					
PDRA	Submission of Compliance Declaration				
PDRA	Submission of Declaration Form for PDRA applicant				
PDRA	Submission of Operations Manual				
PDRA	Submission of SMS and ERP Manual				
B	Assignment of Certification Team by CAAM				
					Project Manager
					BOP
					BAW
					ATC
					Other
					Other
B	Establishment of The Committee				
					SIRIM
					MCMC
					JUPEM
					CGSO
B	Pre-application meeting				

Necessary document, action or event		Proposed Date	Date received/ Accomplished	Date returned for changes	Reference
Note: Items in yellow will be completed by the CAAM					
2.0	**FORMAL APPLICATION PHASE**				
SORA	Application Form				
SORA	Schedule of Events				
SORA	Payment of cost of certification				
SORA	SORA				
PDRA	Schedule of Events				
PDRA	Payment of cost of certification				
SORA	Review of Application				
SORA	Review of Schedule of Events				
SORA	Review of SORA				
PDRA	Review of Schedule of Events				
PDRA	Formal Application meeting				
3.0	**DOCUMENTS EVALUATION PHASE**				
SORA	Review of SORA				
SORA	Review of Operations Manual (if required by the SORA)				
B	Review of the Insurance Cover				
SORA	Review of the Technical Characteristics of the UAS				
B	Review of the proposed location				
B	Review of leasing/owned documents of UA(s)				
B	Review of any other documents applicable				
B	Review of Maintenance Manual (or equivalent)				
PDRA	Review of SMS/ERP Manual				

Necessary document, action or event		Proposed Date	Date received/ Accomplished	Date returned for changes	Reference
Note: Items in yellow will be completed by the CAAM					
B	**Nominated Post Holder/Key Personnel**				
B	Application for interview of AM				
B	Application for interview of SM				
B	Application for interview of FOM				
B	Application for interview of ATP				
B	Interview of AM				
B	Interview of SM				
B	Interview of FOM				
B	Interview of ATP				
	OTHER				
B	Approval from other agencies (if applicable)				
4.0	**DEMONSTRATION AND INSPECTION PHASE** (may be exempted, combined with Document evaluation phase, or on its own)				
B	On site assessment				
B	Evaluation of on-site assessment				
B	Inspection of UA				
B	Acceptance of UA				
B	Demonstration Flight				
B	Acceptance of Demonstration Flight				
B	ERP Simulation				
B	Acceptance of ERP				
	OTHER				

Operations Manual Template

When required by the SORA, the OM should contain at least the information listed below, if applicable, customized for the area and type of operation.

Note. - Items in italic are some topics/items to be considered by the UAS Operator when compiling the Operations Manual.

0	**Cover and contact**	
	0.1	Cover identifying the UAS operator with the title ‘Operations Manual’, contact information and OM revision number.
	0.2	Table of contents.
1	**Introduction**	
	1.1	Definitions, acronyms and abbreviations.
	1.2	System for amendment and revision of the OM (list the changes that require prior approval and the changes to be notified to the CAAM). ***<u>System for amendment and revision of the OM’</u>*** *a) A description of the system for indicating changes and of the methodology for recording effective pages and effectivity dates; and* *b) Details of the person(s) responsible for the revisions and their publication.*
	1.3	Record of revisions with effectivity dates.
	1.4	List of effective pages (list of effective pages unless the entire manual is re-issued and the manual has an effective date on it).
	1.5	Purpose and scope of the OM with a brief description of the different parts of the documents.
	1.6	Safety statement (include a statement that the OM complies with the relevant requirements of this CAD and contains instructions that are to be complied with by the personnel involved in flight operations).
	1.7	Approval signature (the accountable manager must sign this statement).

2	**Description of the UAS operator's organisation** (include the organigram and a brief description thereof). ***<u>Description of the UAS operator's organisation'</u>*** *a) The organisational structure and designated individuals. Description of the operator's organisational structure, including an organisational chart showing the different departments, if any (e.g., flight/ground operations, operational safety, maintenance, training, etc.) and the head of each department;* *b) Duties and responsibilities of the management personnel; and* *c) Duties and responsibilities of remote pilots and other members of the organisation involved in the operations (e.g., payload operator, ground assistant, maintenance technician, etc.).*	
3	**Concept of operations (ConOps)** For each operation, please describe the following:	
	3.1	Nature of the operation and associated risks (describe the nature of the activities performed and the associated risks).
	3.2	Operational environment and geographical area for the intended operations (in general terms, describe the characteristics of the area to be overflown, its topography, obstacles etc., and the characteristics of the airspace to be used, and the environmental conditions (i.e.,, the weather and electromagnetic environment); the definition of the required operation volume and risk buffers to address the ground and air risks).
	3.3	Technical means used (in general terms, describe their main characteristics, performance and limitations, including UAS, external systems supporting the UAS operation, facilities, etc.)

3	3.4	Competency, duties and responsibilities of personnel involved in the operations such as the remote pilot, UA observer, visual observer (VO), supervisor, controller, operations manager, etc. (initial qualifications; experience in operating UAS; experience in the particular operation; training and checking; compliance with the applicable regulations and guidance to crew members concerning health, fitness for duty and fatigue; guidance to staff on how to facilitate inspections by CAAM personnel). ***<u>Competency, duties and responsibilities of personnel involved in the operations such as the remote pilot, UA observer, VO, supervisor, controller, operations manager etc.'</u>*** *a) Theoretical, practical (and medical) requirements for operating UAS in compliance with the applicable regulation;* *b) Training and check programme for the personnel in charge of the preparation and/or performance of the UAS operations, as well as for the VOs, when applicable;* *c) Training and refresher training records; and* *d) Precautions and guidelines involving the health of the personnel, including precautions pertaining to environmental conditions in the area of operation (policy on consumption of alcohol, narcotics and drugs, sleep aids and anti-depressants, medication and vaccination, fatigue, flight and duty period limitations, stress and rest, etc.).*
	3.5	Risk analysis and methods for reduction of identified risks (description of methodology used; bow-tie presentation or other).
	3.6	Maintenance (provide maintenance instructions required to keep the UAS in a safe condition, covering the UAS manufacturer's maintenance instructions and requirements when applicable).
4	**Normal procedures;** (The UAS operator should complete the following paragraphs considering the elements listed below. The procedures applicable to all UAS operations may be listed in paragraph 4.1.)	
	4.1	General procedures valid for all operations
	4.2	Procedures peculiar to a single operation

5	**Contingency procedures** (The UAS operator should complete the following paragraphs considering the elements listed below. The procedures applicable to all UAS operations are listed in paragraph 5.1).	
	5.1	*General procedures valid for all operations* ***<u>General procedures valid for all operations</u>*** *a) Consideration of the following to minimise human errors:* *1) a clear distribution and assignment of tasks; and* *2) an internal checklist to check that staff are properly performing their assigned tasks.* *b) Consideration of the deterioration of external systems supporting the UAS operation; in order to assist in the identification of procedures related to the deterioration of external systems supporting the UAS operation, it is recommended to:* *1) identify the external systems supporting the operation;* *2) describe the deterioration modes of these external systems which would prevent the operator maintaining a safe operation of the UAS (e.g., complete loss of GNSS, drift of the GNSS, latency issues, etc.);* *3) describe the means put in place to detect the deterioration modes of the external systems; and* *4) describe the procedure(s) in place once a deterioration mode of one of the external systems is detected (e.g., activation of the emergency recovery capability, switch to manual control, etc.).* *c) Coordination between the remote pilot(s) and other personnel;* *d) Methods to exercise operational control; and* *e) Pre-flight preparation and checklists. These include, but are not limited to, the following points:* *1) The site of the operation:* *i) the assessment of the area of operation and the surrounding area, including, for example, the terrain and potential obstacles and obstructions for keeping a VLOS of the UA, potential overflight of uninvolved persons, potential overflight of critical infrastructure (a risk*

		assessment of the critical infrastructure should be performed in cooperation with the responsible organisation for the infrastructure, as they are most knowledgeable of the threats) *ii) the assessment of the surrounding environment and airspace, including, for example, the proximity of restricted zones and potential activities by other airspace users;* *iii) when UA VOs are used, the assessment of the compliance between visibility and planned range, the potential terrain obstruction, and the potential gaps between the zones covered by each of the UA VOs; and* *iv) the class of airspace and other aircraft operations (local aerodromes or operating sites, restrictions, permissions).* *2) Environmental and weather conditions:* *i) environmental and weather conditions adequate to conduct the UAS operation; and* *ii) methods of obtaining weather forecasts.* *3) Coordination with third parties, if applicable (e.g., requests for additional permits from various agencies and the military when operating, for example, in environmentally protected areas, areas restricted to photographic flights, near critical infrastructure, in urban areas, emergency situations, etc.);* *4) the minimum number of crew members required to perform the operation, and their responsibilities;* *5) the required communication procedures between the personnel in charge of duties essential to the UAS operation, and with external parties when needed;* *6) compliance with any specific requirement from the relevant authorities in the intended area of operations, including those related to security, privacy, data and environmental protection, use of the RF spectrum; also considering cross-border operations (specific local requirements) when applicable;* *7) the required risk mitigations put in place to ensure the operation is safely conducted (e.g., a controlled ground area,*

		securing the controlled ground area to avoid third parties entering the area during the operation, and ensuring coordination with the local authorities when needed, etc.); and *8) procedures to verify that the UAS is in a condition to safely conduct the intended operation (e.g., update of geographical zones data for geo-awareness or geo- fencing systems; definition and upload of lost link contingency automatic procedures; battery status, loading and securing the payload;).* *f) Launch and recovery procedures;* *g) In-flight procedures (operating instructions for the UA (reference to or duplication of information from the manufacturer's manual); instructions on how to keep the UA within the flight geography, how to determine the best flight route; obstacles in the area, height; congested environments, keeping the UA in the planned volume);* *h) Post-flight procedures, including the inspections to verify the condition of the UAS;* *i) Procedures for the detection of potentially conflicting aircraft by the remote pilot and, when required by the UAS operator, UA VOs; and* *j) Dangerous goods (limitations on their nature, quantity and packaging; acceptance prior to loading, inspecting packages for any evidence of leakage or damage).*
	5.2	Procedures peculiar to a single operation
6	**Emergency procedures** (The UAS operator should define procedures to cope with emergency situations.) ***<u>Emergency procedures</u>*** *a) Procedures to avoid or, at least minimise, harm to third parties in the air or on the ground. With regard to the air risk, an avoidance strategy to minimise the collision risk with another airspace user (in particular, an aircraft with people on board); and* *b) Procedures for the emergency recovery of the UA (e.g., landing immediately, termination of the flight with FTS or a controlled crash/splash, etc.).*	

7	**Emergency response plan (ERP)** ***Emergency Response Plan*** *a) When the UAS operator develops an ERP, the following should be considered:* *1) it is expected to cover:* *i) the plan to limit crash-escalating effects (e.g., notify the emergency services and other relevant authorities); and* *ii) the conditions to alert ATM.* *2) it is suitable for the situation;* *3) it limits the escalating effects;* *4) it defines criteria to identify an emergency situation;* *5) it is practical to use;* *6) it clearly delineates the responsibilities of the personnel in charge of duties essential to the UAS operation;* *7) it is developed to standards considered adequate by the CAAM and/or in accordance with means of compliance acceptable to that authority; and* *when considered appropriate by the CAAM, to be validated through a representative tabletop exercise consistent with the ERP training syllabus. The table top exercise may or may not involve all third parties identified in the ERP.*
8	**Security** (security procedures as required in paragraph 5.1.1.1 (b) and (c)) Instructions, guidance, procedures, and responsibilities on how to implement security requirements and protect the UAS from unauthorised modification, interference, etc.].
9	**Guidelines to minimise nuisance and environmental impact** as required in paragraph 5.1.1.1 (e).
10	**Occurrence reporting procedures** according to MCAR Regulation 165. (Refer to Appendix 7 of CAD 6011 (V))
11	**Record-keeping procedures** (instructions on logs and records of pilots and other data considered useful for the tracking and monitoring of the activity).

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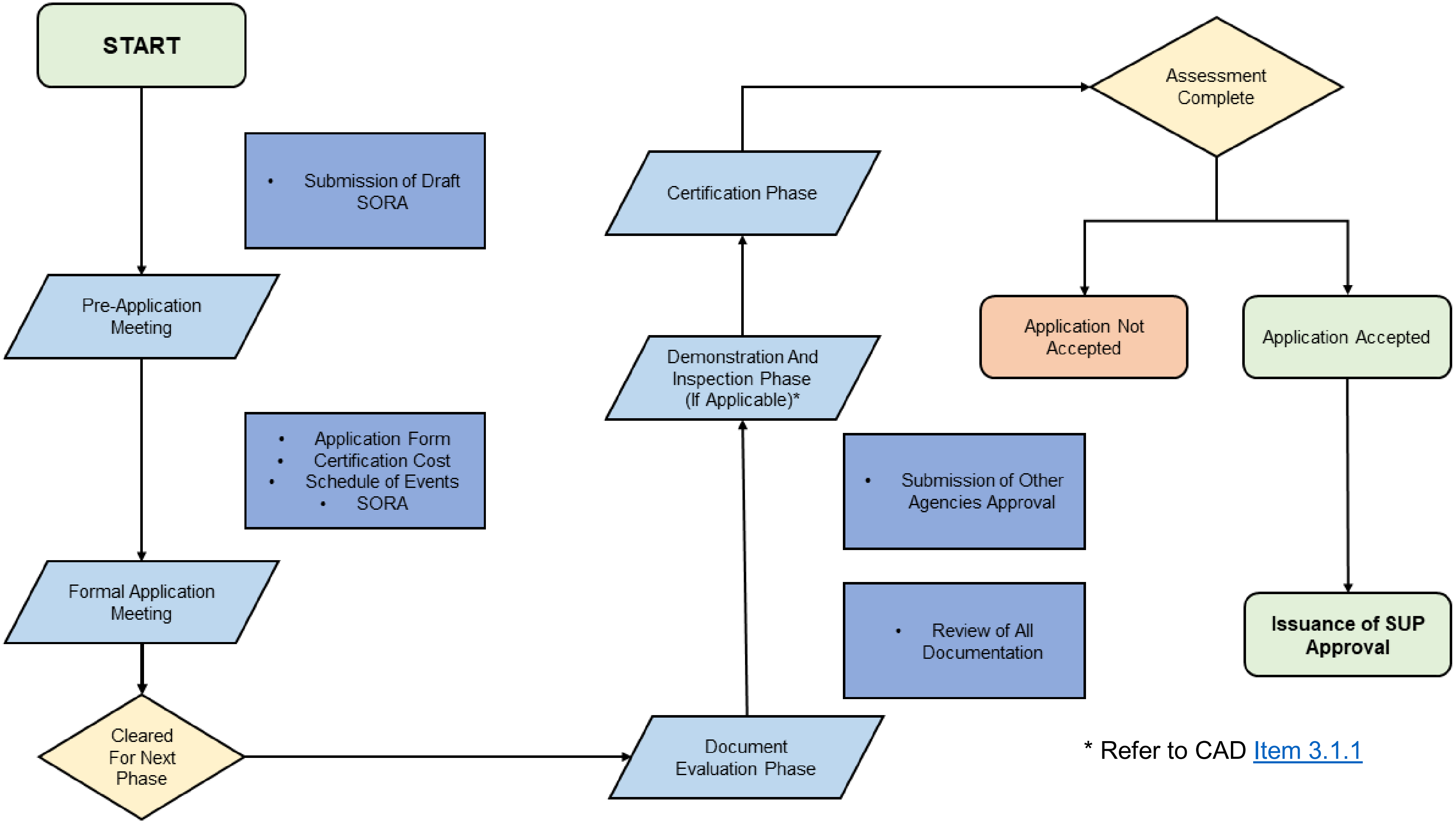
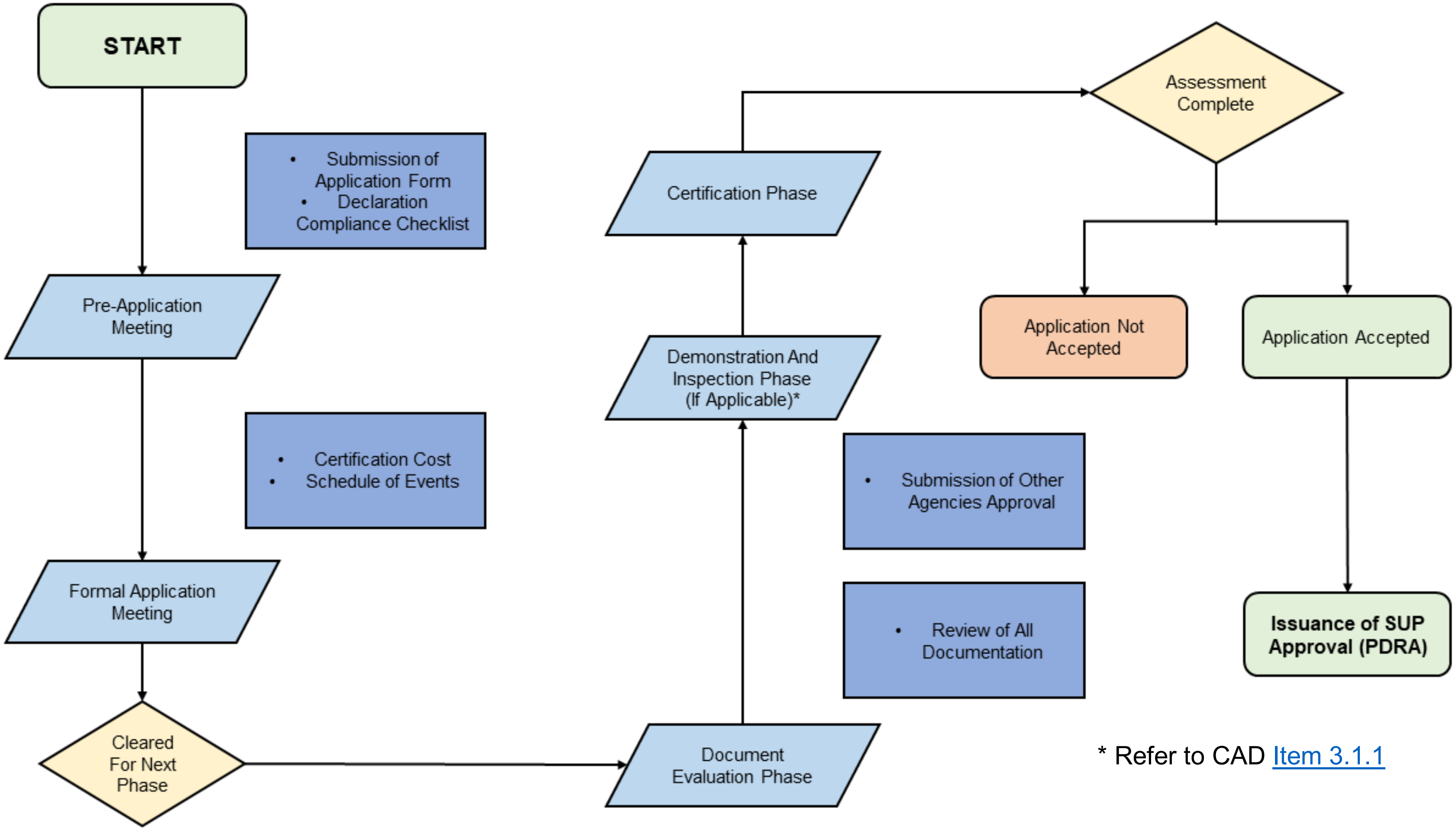
Special UAS Project Approval Process Flow Chart

SORA Applicant SUP Approval Process Flow Chart



* Refer to CAD Item 3.1.1

PDRA Applicant SUP Approval Process Flow Chart



* Refer to CAD Item 3.1.1

Layout of Special UAS Approval Template

CAAM/BOP/UAS/SUP/05-01

Special UAS Project Approval

UAS Operator Data	
UAS operator number	(1)
UAS operator name	(2)
Operational point of contact Name Telephone Fax Email	

(3)
List of UA(s) permitted

Series	Manufacturer	Model	Amount/Unit	UA Authorisation Number	Registration marking (if applicable)
1					
2					
3					

(4)
Locations Permitted

Number	Name	Coordinates				Additional Limitations
1						
2						
3						

Limitations and conditions for the UAS operation	
Authorised location(s)	
Authorised airspace risk level	(5)
Operation limitations	(6)
Mitigation measures	(7)
Remote pilot competency	(8)

Competency of other staff essential for the safety of operation	**(9)**
Records to be kept	
Duration of the authorisation:	
i. Date start and end	
ii. Number of flights	

This Approval certifies that:

is authorised to conduct UAS operations with the UAs defined above and according to the conditions and limitations set above, as long as it complies with this Special UAS Project Approval, MCAR Part XVI and its supporting legislations pertaining UAS.

CAAM Stamp

Signature

Chief Executive Officer

Date

Civil Aviation Authority of Malaysia

Notes

(1) Insert the UAS Operator Number

(2) Insert the Operator's name

(3) List of UA permitted/accepted by Airworthiness. Include Registration Marking if applicable

(4) List of geographical area(s) of authorised operation (by coordinates). Name can Location known to public (e.g., Felda Aring, Pedas, etc.)

(5) Characterisation of the authorised airspace

   i. low risk – ARC A
   ii. medium risk – ARC – B
   iii. high risk ARC – C

(6) List the operational limitation including at least:

   i. The maximum height
   ii. Limitations on the payload
   iii. Limitations on the operations (i.e., the possibility to handover during the flight)
   iv. The minimum contents of the OM
   v. The methodology to verify the operational procedures
   vi. The need for an emergency response plan
   vii. The maintenance requirements
   viii. The record keeping requirements

(7) List the mitigation measures including at least protection of a third party on the ground (including the definition of a specific authorised flight path, if applicable)

(8) The minimum competency required for the remote pilot and the methodology to assess it

(9) The minimum competency required for the staff essential for the operation

   i. Maintenance staff
   ii. Launch and recovery assistance
   iii. UA Visual Observers
   iv. Other

   And the methodology to assess it

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