MIL-UAS-SPECIFIC: Guidelines

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REFERENCE DOCUMENTS

ID	Title	No./Author	Issuing date (dd/mm/yyyy)	Issued by
[RD1]	SORA Annex F (external consultation)	JARUS WG-SRM	19/03/2021	JARUS
[RD2]	First dynamic national-scale population map based on mobile phone data	U. L. de Bruxelles	2004	Science Daily
[RD3]	Advisory Circular (AC) 102-37	N.A.	23/06/2022	ICAO
[RD4]	MIL-UAS-SPECIFIC - D2 Methodology	Rev 2.0 / MIL-UAS-SPECIFIC consortium	23/05/2022	MIL-UAS-SPECIFIC consortium
[RD5]	Drone–drone collisions over New York City via the kinetic theory of gases	Edward W. Walbridge	22/09/2021	American Journal of Physics
[RD6]	EU Regulation 376/2014	N.A.	2014	European Commission
[RD7]	Ex-post evaluation of Regulation (EU) no 376/2014 on the Reporting, analysis and Follow-up of occurrences In civil aviation	Various authors	March 2020	Ramboll and partners

ACRONYMS

Acronym	Description
AEH	Airborne Electronic Hardware
AGL	Above Ground Level
ARMS	Air Risk Mitigation Score
ATC	Air Traffic Controller
ATS	Air Traffic Service
ATZ	Aerodrome Traffic Zone
FTS	Flight Termination System
BVLOS	Beyond Visual Line Of Sight
C2 link	Command-and-Control link

CAC	Containment Assessment Checklist
CRM	Crew Resource Management
CS	Containment system Score
CTA	Control Area
CTR	Control Zone
DAA	Detect-And-Avoid
DAL	Development Assurance Level
DIAC	Design and Integrity Assessment Checklist
DIS	Design and Integrity Score
FH	Flight Hours
GCS	Ground Control Station
MAC	Mid-Air-Collision
MDARC	Minimum Detect-and-Avoid Requirements Checklist
METAR	METeorological Aerodrome Report
MUS(s)	Military UAS Scenario(s)
MUSRA	MIL-UAS-SPECIFIC Risk Assessment methodology
NMAA	National Military Aviation Authority
NOTAM	Notice To Airmen
OPU	Operational Unit
PD	Population Density
PDRA	Pre-Defined Risk Assessment
RA	Risk Assessment
RCS	Required Containment system Score
RDIS	Required Design and Integrity Score
RFC	Remote Flight Crew
SDO	Standard Developing Organisation
SLA	Service level Agreement
SW	Software
TAF	Terminal Aerodrome Forecast
TCR	Traffic Conflict Risk
TEC	Traffic Encounter Category
TSA	Temporary Segregated Area

UA	Unmanned Aircraft
UAS	Unmanned Aircraft System
Vc	Cruise speed
VLL	Very Low Level

Terms and definitions

The following list provides the definitions used in this document.

Word	***Description***
Adjacent Airspace	The airspace adjacent to the Operational Volume
Adjacent area/airspace	The ground area/airspace adjacent to the Ground/Air Risk Buffer. The extent of the adjacent area depends on the particular UA performance and the resulting likelihood of flying into an area with an increased level of risk.
Military Temporary Segregated Area	Airspace temporarily reserved and allocated for the exclusive use of specific military user during a determined period of time.
Contingency volume	The volume outside the flight geography where contingency procedures are used to regain full control of the UAS. E.g. the volume within which the UAS may fly during a temporary loss of the C2 link.
Flight geography	The volume within which the UAS mission is planned. Flight geography should be defined considering the overall accuracy in the UAS positioning, i.e. the Total System Error (TSE)
Operational volume	The combination of the flight geography and contingency volume
Target Level of Safety (TLS)	The TLS is the "safety goal of an oversight authority, an operator, or a service provider. It provides the minimum safety objective(s) acceptable to the oversight authority and to be achieved by the operators/service providers while conducting their core business functions." (ICAO Annex 11, Attachment E).

1 INTRODUCTION

1.1 Scope

This document complements the MUSRA methodology by providing additional guidance and examples about how to use the methodology. It also contains a preliminary validation of the risk assessment process carried out by applying MUSRA to one civilian (EASA PDRA G-03) and one military uses case. Finally, it contains the plan to update the methodology in the coming years considering the feedback received from military users and the developments of its parent methodologies and reference documents, such as the latest standards issued by Standard Development Organizations (SDOs).

1.2 Structure of the document

This document breaks down into 6 chapters as follows:

- ***Chapter 1 "Introduction"*** *provides an* overview of the content of this deliverable, explaining the background and establishing the purpose and scope of the document.
- ***Chapter 2 "MUSRA guidelines"*** contains additional guidelines to determine the population density, the shelter factor, the effect of different payloads on the impact area. It also provides guidance about how to deal with operations involving more than one UAS at the same time in the same airspace volume.
- ***Chapter 3 "Application of MUSRA to EASA PDRA G-03"*** contains an application of MUSRA to the EASA PDRA-G03 to assess differences and similarities between MUSRA and the civilian approach (i.e. SORA) leading to PDRA G-03.
- ***Chapter 4 "Apply the methodology: a military use case"*** contains a complete example of application of MUSRA to a realistic military use case.
- ***Chapter 5 "Military UAS Scenarios (MUSs)"*** contains guidelines to develop typical mission scenarios using MUSRA (similar to PDRAs included in AMC/GM to Commission Regulation (EU) 2019/947) to speed up and simplify the risk assessment process.
- ***Chapter 6 "MUSRA update plan"*** proposes strategies and actions to keep MUSRA constantly updated considering the users' inputs and its parent methodologies and including monitoring the work of Standards Developing Organization (SDO).
- ***Chapter 7 "Conclusion and recommendations"*** provides conclusions and recommends the way forward for the implementation and update of MUSRA.

2 MUSRA Guidelines

This section provides additional guidance to carry out a risk assessment using MUSRA methodology. The following topics are addressed:

1. How to evaluate the Population Density (PD) when local conditions are uncertain (e.g. consider a maximum population density);
2. How to evaluate the shelter factor (S);
3. How to evaluate the effect of different payloads on the definition of the impact area;
4. How to evaluate the risk related to operations involving more than one UAS in the same operational volume

2.1 Population Density (PD)

This section outlines the process to accurately determine the population density for the assessment of the Ground Risk in MUSRA. The process is composed by two steps:

1. Determining the area to be considered for the assessment of the population density, i.e. the operational footprint
2. Identify an adequate representation of the population density.

2.1.1 Determining the operational footprint

The operational footprint contains the Operational Volume, and it may include a Ground Risk Buffer. The Operational Volume is made of:

- Flight geography: the volume within which the UAS mission is planned. Flight geography should be defined considering the overall accuracy in the UAS positioning, i.e. the Total System Error (TSE)
- Contingency volume: the volume outside the flight geography where contingency procedures are used to regain full control of the UAS. E.g. the volume within which the UAS may fly during a temporary loss of the C2 link.

Outside the operational volume the OPU may define a Ground Risk Buffer to cope for malfunctions or failures that could lead to an operation outside the Operational Volume. These failures would be handled by the containment systems to ensure the operation is terminated inside the Ground Risk Buffer.

2.1.2 Determining the population density

When determining the population density of the operational footprint two cases may arise:

1. The population density is homogenous, and a single value can be used for the whole operation
2. The population density is heterogeneous because the UA overflies different types of areas or because there are areas where there is a concentration of people inside the operational volume (e.g. in case of public events).

For case 1 the OPU should identify the population density using census data or other official sources. The figure below shows an example of a census data map where areas with different population densities are identified.

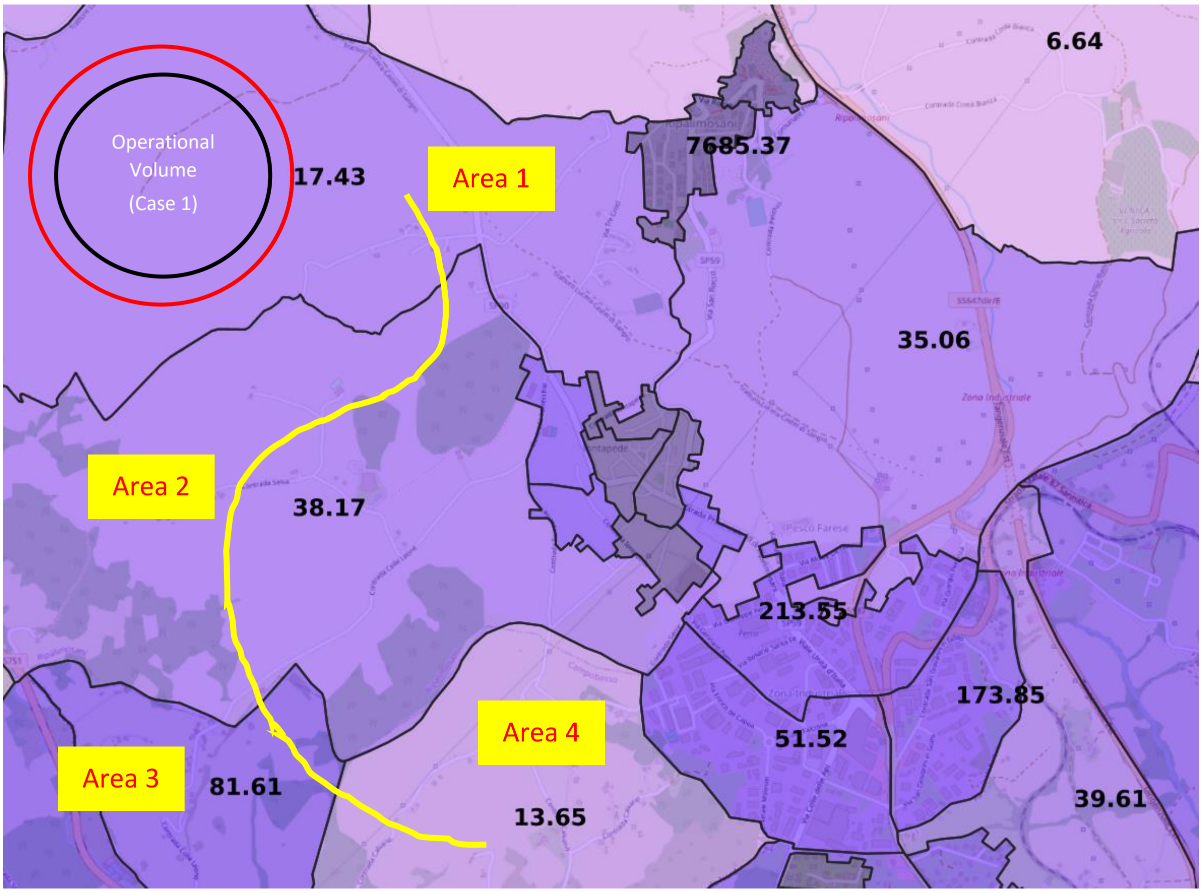

Figure 1: Population density map

For case 2, the most conservative approach would be to select the highest population density among the overflown areas. This approach would also allow the maximum operational flexibility without violating any assumption of the risk analysis.

However, if the planned time spent over the higher population density is significantly lower compared to the overall flight time, this may lead to overestimate the risk for people on the ground.

For example, let us consider the yellow flight trajectory represented in Figure 1. In this case the conservative approach would be to select the highest population density, i.e. 81.61 ppl/km2 from Area 3. However the planned time spent over this area is limited compared to the overall flight time. Therefore the OPU may want to select a lower population density, i.e. 38.17 ppl/km2 from Area 2. Selecting a lower population density would not underestimate the risk if the planned time spent over Area 3 is sufficiently low, but this would limit the operational flexibility and the OPU would need to guarantee that the planned flight trajectory remains unchanged. The following formula can be used, assuming that the TLS is expressed in number of fatalities per flight hour.

$$t_{max} \leq \frac{PD \times 60}{PD_{max}} \quad (1)$$

Where:

- t_{max} is the maximum time expressed in minutes that can be spent over the area with the highest population density, if this is not selected as the reference value
- PD_{max} is the population density of the area with the highest value

- PD is the population density the OPU would like to select for the ground risk assessment

In the above example if the time needed to overfly area 3 is less than 28 minutes, the population density of Area 2 can be selected as reference without affecting the overall target level of safety. However, it must be noted that if the higher density areas are those where critical phases of the flight take place (e.g. take-off and landing) the above approach may lead to an underestimation of the risk and the actual population density should thus be selected.

2.1.3 Data sources for population density

The primary data source for population density should come for census data. However, there are a variety of methods used to build population density maps starting from these data. In assessing suitability of the map used, the following general rules may assist, as proposed by [RD1]:

- Higher resolution maps are preferred to minimize the homogeneous assumption effects.
- Maps using census and ancillary data with more recent epochs are preferred.
- Preference should be given to maps produced by organisations providing detail on the methodology used for their map production, in addition to detail on validation efforts on accuracy.

When quantitative data for population density are not available the OPU unit should use their sound judgment to estimate the actual overflow populations density. As proposed by SORA Annex F, the following mapping between qualitative and quantitative measures could be adopted:

- If the operational volume and the buffer contain no people except those involved in the operation (e.g. pilot, payload operator, other military staff), the population density can be considered to be less than 1 people per square kilometre
- If the operation takes place over a rural area the population density could be considered less than 300 people per square kilometre. The actual value can be determined by considering the presence of building, public roads or other areas open to public access.
- If the operation takes place over a populated area the population density can be assumed to be between 3.300 and 15.000 people per square kilometre.

To support the above evaluation the OPU can make use of satellite images or on-site inspections.

2.1.4 Temporal variations of population density

Population density may vary over time in relation to daytimes and seasons. For this reason there are studies (e.g. [RD2]) suggesting the use of mobile phone data to have a better representations of population density over time. This information may be used to better reflect population density in different seasons, days of the week and even times of the day. In the future mobile data may be even used to provide real-time information on the population density of a given area.
It must be noted that mobile phone data, despite being available in principle, may be difficult to access in practice. Therefore Operational Units should always complement the information from static population density maps with additional analysis to confirm the correctness of the information used. This is particularly relevant for areas for which the population density estimated through census data is very low, but where the actual density may be significantly higher in practice. This is the case of shorelines in summer or ski resorts in winter.

2.2 Shelter factor

The quantitative model proposed by MUSRA for the computation of the shelter factor relies on the availability of several parameters. The capacity of a UA to penetrate a building/structure when crashing (*Protection_Factor*) and the lethality it causes when hitting a person (*Fatality_Factor*) are usually not available for commercial UAS but they can be modelled using the equation proposed by MUSRA. However, the factors related to the presence of people in each area and the percentage of them that are protected inside buildings are always difficult to be estimated. These numbers may have in fact a significant variability over time that makes difficult to estimate them in a consistent manner.

The Factor representing the percentage of the population that is protected inside buildings during the UAS flight needs therefore to be estimated in qualitative way considering the local conditions at the time of the flight. This factor should always be set to zero (leading to an overall shelter factor of zero) unless there are evidence that at least part of the people in the overflown or adjacent area are protected inside buildings. The supporting evidence may be based on:

- On-site inspections and appraisals
- Agreements with local authorities that may issue notices to remain inside buildings
- Considerations about daylight, season, temperature, office hours or other factors affecting the presence of people outside

In order to avoid overestimating the effect of people that are protected inside buildings, the overall shelter factor should always be proportionate to the actual reduction of people at risk on the ground. For example, if the population density of the overflown area is estimated to be of 100 ppl/km^2 and the number of people inside buildings is estimated to be 10, the overall shelter factor should not exceed 0.1.

2.3 Payloads

The carriage of dangerous payloads may affect the evaluation of the ground risk. MUSRA model explicitly considers the carriage of explosives as a worsening factor for the ground risk but the carriage of other types of dangerous goods can be handled by MUSRA as well. However, they are not considered as a worsening factor in the estimation of the risk but rather as a source of additional requirements for the operator to make sure they are handled correctly.

The reference for the definition of the abovementioned requirements is the ICAO Advisory Circular (AC) 102-37 [RD3]. This AC classifies the dangerous goods in 9 different classes in accordance with the United Nations Recommendations Transport of Dangerous Goods. In addition it requires the operator to develop and implement Dangerous Goods Standard Operating Procedures including as a minimum:

- a training program that ensures that individuals handling dangerous goods are competent to perform the function;
- instructions for communicating information to relevant persons related to the dangerous goods being transported in case of an accident or incident;
- action to be taken in the event of emergencies involving dangerous goods; and
- instructions for the collection of safety data related to dangerous goods accidents and dangerous goods incidents.

With reference to MUSRA, the suggested process is to first check if the payload can be classified as dangerous and then implement the additional requirements as suggested by [RD3]. These requirements have been already included in the MUSRA Operational Questionnaire.

2.4 Operations involving more UAS in the same volume

As explained in D2 Annex A.7 [RD4], a collision between two UAS with no people on board will only cause fatalities if people on the ground would be hit by the falling debris created by the collision. For this reason, operating more than one UAS at the same time in the same airspace is considered a worsening factor only for the Ground Risk.

Assuming that a collision between two UASs will always cause the crash of the two aircraft, the probability of having a MAC between two UASs is equal to the probability of having a catastrophic failure on each of the UAS involved, as follows:

$$P_{cat\_ground} = P_{MAC\_UAS} \quad (2)$$

This value of P_{cat_ground} needs to be compared with the one obtained by assessing the characteristics of the ground area. The value obtained here must be lower or equal, otherwise the risk for people on the ground will be higher than what is needed to meet the TLS. If this is not the case, the probability of having a MAC between two UA must be mitigated.

2.4.1 Initial P_{MAC_UAS}

The initial probability of having a MAC between two UAS depends on several factors, namely:

- The dimensions of the operational volume
- The number of UAS operated simultaneously
- The dimensions and relative velocity of the UA

Assuming that drones are following independent trajectories with no coordination and that they are not equipped with any DAA system, following the analysis carried out in [RD5], we can treat this problem as drones were molecules in a gas. According to this module the average distance a UAS can travel before having a collision, assuming that all UAS in the volume are moving at the same speed, can be computed as:

$$\lambda = \frac{0.75}{2\pi d^2 N} \quad (3)$$

Where:

- d is the typical dimension of the UAS involved in the collision [m]
- N is the number of UAS in the airspace per unit volume [1/m^3]

The unmitigated probability of having a MAC between UAS in a given airspace can thus be computed by considering how much distance each UAS flying at a speed of v will travel in a given amount of time as follows:

$$P_{MAC\_UAS} = \frac{2\pi d^2 n v}{0{,}75 A H} \cdot 3600 \quad (4)$$

Where:

- d is the typical dimension of the UAS involved in the collision [m]
- n is the number of UAS in the airspace [a-dimensional]
- v is the average speed of the UAS in the considered airspace [m/s]

- A is the ground area of the airspace considered [m^2] and H the altitude interval where the flights take place [m]
- P_{MAC_UAS} is the probability of having a Mid-Air-Collision per Flight Hour

For example if we consider a swarm of 10 UAS with a dimension of 0.3m flying over a 1km^2 area between ground and 100 m AGL and flying at 10m/s, the unmitigated probability of having a MAC can be found to be $2.7*10^{-3}$/FH.

2.4.2 *Mitigated P_{MAC_UAS}*

The probability of having a MAC between UA can be reduced by implementing appropriate mitigations. Identifying the quantitative reduction of the collision probability thanks to the mitigations is not trivial. Therefore this guidance proposes to use a qualitative approach. Two cases are considered:

1. If the different UAS are under the responsibility of the same operator it is possible to assume that their flight is coordinated in such a way that the UAS are never put on a collision course unless there is a failure leading to a loss of control. Therefore it is possible to assume that in this case P_{MAC_UAS} is the highest value between the one computed from equation (2) and the highest probability of having a catastrophic failure of any of the UAS involved in the operation. This is a conservative assumption that does not consider the capability of the UAS that are still fully operational to avoid the one that is out of control.
2. If the different UAS are NOT under the responsibility of the same operator, external services (e.g. U-space) and/or a Detect and Avoid capability are needed to mitigate the risk of a MAC. In both cases the effectiveness of the mitigations will need to be assessed quantitatively considering their reliability and how much the probability of having a MAC is reduced thanks to their availability. For example if we assume to have a DAA on board with a Risk Ratio for MAC of 0.9, the mitigated P_{MAC_UAS} will be reduced of 10 times compared to the unmitigated value.

3 Application of MUSRA to EASA PDRA G-03

In this chapter we apply MUSRA to the operational scenario of EASA PDRA G-03. This PDRA was published by EASA based on the work carried by JARUS WG-SRM. As all EASA PDRA the operational limitations and requirements are determined based on a risk assessment carried out using SORA methodology. The objective of this chapter is to compare the results obtained by assessing the same scenario with MUSRA to highlight similarities and differences between the civilian and the proposed military risk assessment methodology.

3.1 Scenario description

PDRA G-03 applies to operations conducted according to the following limitations:

1. with UA with maximum characteristic dimensions (e.g. wingspan, rotor diameter/area or maximum distance between rotors in case of a multirotor) of up to 3 m and typical kinetic energies of up to 34 kJ;
2. BVLOS of the remote pilot;
3. over sparsely populated areas;
4. within the range of the direct C2 link in an operational volume under 30 m above the overflown area;
5. following pre-programmed or pre-planned flexible routes within the operational volume;
6. in one of the following conditions:
   - reserved or segregated airspace for UAS operations;
   - operating at a maximum height not exceeding 30 m from the ground;
   - when operating at no more than 30 m horizontally from an obstacle, operating at a maximum height not exceeding 15 m from the obstacle; if the height of the obstacle does not exceed 20 m, then the hight of the operation may be up to 30 m from the obstacle (meaning no more than a total of 50 m from the ground);

3.2 MUSRA Input parameters

In order to apply MUSRA the parameters defining PDRA G-03 need to be "translated" into the input parameters required by MUSRA. The following table provides a comparison of the input parameters used in PDRA G-03 and the one needed for applying MUSRA.

PDRA G-03 Parameter		MUSRA parameter		Notes
Name	**Value**	**Name**	**Value**	
Max UAS dimension	< 3 m	UAS dimensions	3 m	To include in MUSRA all possible cases covered by PDRA G-03 a value of 3m is selected
Kinetic Energy	< 34kJ	MTOM	42 kg	The MTOM and impact speed used yield to a KE of 33.6 kJ
		Impact speed	40 m/s	

Type of flight	BVLOS	N.A.	N.A.	In MUSRA the type of flight is not considered as an input parameter
Characteristics of ground area	Sparsely populated	Population density	< 10 ppl/km^2	In order to convert a qualitative value from PDRA into a quantitative one, the proposed SORA 2.5[1] iGRC table is used as a reference considering that the iGRC of PDRA G-03 is 4.
Airspace characteristics	Atypical airspace that is either reserved, below 30m or close to obstacles (ARC-a)	Airspace characteristics	Reserved with no other operative traffic (TCR-1)	MUSRA does not consider atypical airspace as such, but this notion can be considered equivalent to that of a reserved airspace where the probability of encountering other manned traffic is the lowest possible.
Adjacent area characteristics	Airspace classified as Arc-d	Adjacent airspace	TCR-4	Arc-d in SORA is equivalent to TCR-4 in MUSRA
	Assembly of people	Adjacent area population density	< 100000 ppl/km^2	In order to convert a qualitative value from PDRA into a quantitative one, the proposed SORA 2.5 iGRC table is used as a reference.
	None of the above	Adjacent airspace	TCR-1,2,3	
		Adjacent area population density	< 100000 ppl/km^2	In order to convert a qualitative value from PDRA into a quantitative one, the proposed SORA 2.5 iGRC table is used as a reference.

In addition to the above, other parameters are set in MUSRA as follows:

- Maximum acceptable probability of causing fatalities both on the ground ($Pkill$): this is set to 10^{-6}/FH to be consistent with the value used by EASA as explained in section 2.2 of D2.
- Shelter factor: PDRA G-03 does not consider specific sheltering condition, thus this parameter is set to 0 in MUSRA
- Mitigation means to reduce the impact energy: no specific mitigation mean is considered by PDRA G-03 and therefore this parameter is set to 0 in MUSRA.
- Carriage of dangerous payloads: this condition is not considered as it is excluded from the applicability of PDRA G-03

[1] SORA 2.5 Main Body, version published for internal consultation on 27 October 2021

- Presence of other UAS in the operations volume: this condition is also explicitly excluded from the applicability of PDRA G-03

Finally, we considered that the SORA analysis supporting PDRA G-03 makes use of mitigation M1 to further reduce the number of people at risk. Mitigation M1 is used to reduce the GRC of 1 point and bring it to a value of 3. According to EASA version of SORA (ref. Step#3, point (h)) a 1 point reduction should correspond to a reduction of one order of magnitude in the population density. Therefore a value of 1 ppl/km^2 is used in MUSRA.

3.3 MUSRA process and results

3.3.1.1 Step #1a: Ground Area

In this sub-step the maximum allowed **probability of catastrophic failure for the ground area** is computed considering the following parameters:

- Maximum allowable probability of fatalities.
- Overflown population density
- The area where the debris can be spread if the UAS impacts the ground
- Shelter factor of the overflown area
- Availability of systems to reduce the impact energy
- Carriage of dangerous payloads.
- The simultaneous presence of other UAS in the operational volume.

The maximum allowed probability of catastrophic failure considering only the ground area characteristics is as:

$$P_{cat\_ground} = \frac{P_{Kill}}{A_{impact} PD(1-E_r)(1-S)} = 2.9 \times 10^{-2} \quad (5)$$

Where A_{impact} = 34.9 m^2

The maximum allowable probability of exiting the operational volume, if there is an assembly of people in the adjacent area, is computed as:

$$P_{exit\_ground} = \frac{P_{Kill}}{A_{impact}(1-E_r)(1-S_{Adj})PD_{Adj}} = 2.9 \times 10^{-7} \quad (6)$$

However, the value of P_{exit_ground} is set to 1E-6 because it would not make sense to require a lower probability of exiting the operational volume than the Target Level of Safety (TLS).

3.3.1.2 Step #1b: Airspace

In this step the maximum allowable probability of catastrophic failure P_{cat_air} that is related to the intrinsic characteristics of the airspace where the flight takes place (i.e. the operational volume) and the characteristic of the adjacent airspace is identified. From Table 5 of D2 we derive the following output:

- Operational Volume Airspace: TCR-1, $P_{cat\_air} = 1 \times 10^{-2}$
- Adjacent airspace is classified as TCR-4, $P_{cat\_air\_adj} = 1 \times 10^{-4}$

Air Risk Mitigations

No additional air risk mitigation is considered in the PDRA G-03 other than flying in atypical airspace. The same approach is therefore used in MUSRA.

Minimum Detect-And-Avoid Requirements (MDAR)

Since the Final TCR is 1 no MDAR are defined in MUSRA. This is consistent with the PDRA G-03 where no tactical mitigation is required.

3.3.2 Step #2: Score computation

This step is intended to determine the score related to the UAS design and the containment system required to safely fly the intended mission. Two scores are defined as follows:

a. ***Required Design and Integrity Score (RDIS)***: this score is computed starting from the maximum allowable probability of catastrophic failure computed in Step #1. The lowest value between P_{cat_ground} and P_{cat_air} is taken as the reference value (i.e. 1×10^{-2}). The relationship between this score and the maximum probability of a catastrophic failure is given by the following equation:

$$RDIS = -\frac{\ln(10P_{cat})}{0.069} = 33 \qquad (7)$$

b. ***Required Containment Score (RCS):*** this score indicates the reliability of the containment system. This score is compute using the minimum value between P_{exit_ground} computed from equation and P_{cat_air} of the adjacent airspace. The relationship between this score and the probability for the UA to exit the operational volume is as follows:

$$RCS = -\log\left(\frac{P_{exit}}{P_{cat}}\right) = 4 \qquad (8)$$

3.3.3 Step #3: UAS verification and score correction

In this step, MUSRA requires to verify that the UAS selected for the mission fulfils the required scores computed in Step#2. For this example, this step will be used to identify the applicable requirements from MUSRA to subsequently compare them with the ones from PDRA G-03.

3.3.3.1 *Step#3a: Verification of Design and Integrity Score*

Design and Integrity Requirements

The UAS design and integrity requirements are extracted from the DIAC considering that the score the UAS needs to achieve is 33. Given the structure of the DIAC, there are different combinations that could lead to the same score. For this reason, we use for this example a combination that leads to requirements that are comparable with those of PDRA G-03. The table below shows the requirements extracted from the DIAC with the associated score and compares them to the requirements of PDRA G-03.

DIAC Topic	DIAC requirement	Score	PDRA G-03 requirement
1. ORGANISATION	1.1 The UAS design and production organizations must be certified as per AS/EN ISO 9100/ ISO 9001 for undertaking UAS design and production activities, and should deliver evidence of usage of approved processes for management of safety within the design and production of systems, or as an alternative comply with EMAR-21 Subpart G (or F) and J.	0	PDRA requirements are intended only for the UAS operator. It is possible to assume that the basic elements required by the DIAC are available for COTS UAS manufacturers.
	1.1.1 The applicant shall deliver a copy of the Quality Manual.	1.8	
	1.2 The applicant shall demonstrate that the materials and manufacturing processes used in the construction of the UAS are adequate.	0.3	
	1.3 The applicant shall demonstrate that the materials and manufacturing processes used in the construction of the UAS are adequate.	0.1	
	1.4 The applicant must demonstrate the existence of a process to manage design changes and communicate these to the Operators.	0.5	
	1.5 The applicant shall ensure that the operator is educated about the criticality	0.3	

	of configuration management processes for the UAS.		
2. DESIGN STANDARDS	2.1 The applicant shall show evidence of the design criteria and standards used to design the UAS structure, engine, propeller, and UAS systems and equipment.	0	
3. TESTED USAGE SPECTRUM	3.1 The applicant shall deliver the design usage spectrum as well as the set of all the foreseen operational conditions of the UAS	2.5	There is no corresponding requirement in the PDRA, but it is reasonable to assume that all COTS UAS are provided with a data sheet including the usage spectrum limitations
	3.2 The applicant shall show evidence of how the design spectrum was defined.	0	No such evidence is required by the PDRA
	3.3 The applicant shall show evidence of the in-service experience accumulated.	0	No such evidence is required by the PDRA
	3.4 The applicant shall show evidence that flight experience and/or in-service experience has demonstrated that the design is free from unsafe features in the complete operational spectrum.	0	No such evidence is required by the PDRA
	3.5 The applicant shall show evidence that all safety-critical equipment is functioning properly throughout the full tested operational envelope when integrated into the UAS system (including ground station, datalink equipment, air vehicle, etc.).	0	No such evidence is required by the PDRA
	3.6 The applicant shall show evidence of the existence of a system to track problem reports from development and qualification tests of the UAS.	0	No such evidence is required by the PDRA
	3.7 The applicant shall show evidence of the state of all the problem reports,	0	No such evidence is required by the PDRA

	that have derived from the development and qualification of the UAS.		
4. **STABILITY AND CONTROL/NAVIGATIONAL PERFORMANCE AND EMERGENCY CONDITIONS**	4.1 The applicant shall show evidence that the UA is stable and controllable in all sequences of flight and on-ground (as applicable), in all operational modes, throughout the full operational envelope. Note: Including wind conditions as applicable, phases of take-off/launch, and landing/recovery in the worst environmental condition (including wind).	0	No such evidence is required by the PDRA
	4.1.1 The applicant shall show evidence that operational procedures exist for the phases of take-off/launch and landing/recovery.	1	The UAS operator should: - 4.1.1 develop an operation manual (OM) (for the template, refer to AMC1 UAS.SPEC.030(3)(e) and to the complementary information in GM1 UAS.SPEC.030(3)(e));
	4.2 The applicant shall show evidence of the existing flight control protecting System functions for: - Stall; - speed exceedance; - overload; - dangerous oscillations; - spinning.	0	No such evidence is required by the PDRA
	4.2.1 The applicant shall show evidence of all UAS features which are meant to minimise the effects of the operator mistake. (in all operational modes including direct piloting and semi-automatic modes as applicable).	0	No such evidence is required by the PDRA
	4.3 The UAS should be stable and controllable after failure of sensors and primary aerodynamic control surface actuation (even if only in a degraded	0	No such evidence is required by the PDRA

	mode).		
	4.4 The applicant should demonstrate a minimum level of navigation precision adequate for the mission profile, and the precision tolerances shall be provided in the operational manual of the UAS.	1.5	3.2 In particular, the accuracy of the navigation solution, the flight technical error of the UAS and the path definition error (e.g. map error) and latencies should be considered and addressed when determining the operational volume.
	4.5 The UAS must include means to monitor and indicate the UAS health status (including Data Link) to the Designated UAS Operator throughout the mission profile.	1.25	6.1.3 the status of critical functions and systems; as a minimum, for services based on RF signals (e.g. C2 link, GNSS, etc.), means should be provided to monitor the adequate performance and trigger an alert when the performance level becomes too low.
	4.5.1 The datalink performance must be shown to be sufficiently robust for the type of operations, ranges, and environment of the UAS.	2	6.7 The UAS should comply with the appropriate requirements for radio equipment and the use of the RF spectrum. 6.8 Protection mechanisms against interference should be used, especially if unlicensed bands (e.g. ISM) are used for the C2 link (mechanisms such as FHSS, DSSS or OFDM technologies, or frequency deconfliction by procedure).
	4.6 The UAS shall maintain safe operation in case of datalink loss.	2	6.10 In case of a loss of the C2 link, the UAS should have a reliable and predictable method for the UA to recover the C2 link or terminate the flight in a way that reduces the effect on third parties in the air or on the ground.
5. GROUND CONTROL STATION/CONTROL BOX	5.1 The UAS MUST include means to interact with the Operator (Human-machine Interaction), allowing for the management of the mission workload and safety.	1	6.5 The UAS information and control interfaces should be clearly and succinctly presented and should not confuse, cause unreasonable fatigue, or contribute to causing any disturbance to the personnel in charge of duties essential to the UAS operation such that this could adversely affect the safety of the operation. 6.6 The UAS operator should conduct a UAS evaluation that considers and addresses human
	5.1.1 The information provided by the UAS to the operator must be sufficient, clear, unambiguous and should be readable in the worst light conditions.	0.5	
	5.1.2 The UAS must show an adequate warning for	0.5	

	malfunctions, failures, or any unsafe condition.		factors to determine whether the HMI is appropriate for the operation.
	5.1.3 The UAS shall provide to the operator information about limit exceedances and unsafe conditions of the UAS.	1	
6. STRUCTURAL INTEGRITY	All requirements	0	No requirements on structural integrity are included in the PDRA
7. PROPULSION AND FEEDING SYSTEM INTEGRITY	7.1 The applicant shall demonstrate the reliability of the UAS propulsion system.	0	No such evidence is required by the PDRA
	7.1.1 The UAS shall demonstrate adequate engine reliability by operational experience.	0	No such evidence is required by the PDRA
	7.2 The applicant shall demonstrate that the Engine Control System (including propeller pitch) performs the intended functions in all its control modes throughout the full operational envelope	0	No such evidence is required by the PDRA
	7.3 For electrical engine applications, the applicant shall demonstrate that the battery provides the necessary voltage and current required by the engine and electrical equipment throughout the operational envelope.	1.5	4.1.1 develop an operation manual (OM) (for the template, refer to AMC1 UAS.SPEC.030(3)(e) and to the complementary information in GM1 UAS.SPEC.030(3)(e));
	7.5.a For electrical engine applications, the UAS shall include means to minimize the risk of battery overheating / explosion	0	No such evidence is required by the PDRA
	7.6.1.a For electrical engine applications, the UAS should have the means to measure the engine battery status (voltage, drown current, estimated battery time)	1	The UAS should be equipped with means to monitor the critical parameters for a safe flight, and in particular the following: 6.1.2 UAS energy status (fuel, battery charge, etc.)
	7.6.1.a1 For electrical engine applications, the UAS should include provisions to alert the UA operator that the battery has discharged to a level, which requires immediate UA recovery actions.	1	

	7.6.2 The UAS should include means to mitigate the hazards from engine failures.	2	This requirement is not explicitly included in the PDRA but is covered by the need to have an Operations Manual compliant with the reference AMC.
8. SYSTEM AND EQUIPMENT INTEGRITY	8.1 The UAS critical equipment should be qualified for worst expected case environmental conditions the design spectrum.	0	No such evidence is required by the PDRA
	8.1.1 The UAS installation provisions and the intended usage of all equipment should be designed under the qualification conditions.	0	No such evidence is required by the PDRA
	8.2 The UAS must account for electromagnetic Effects (E) in the design	2	6.4 The UAS should be protected against potential electromagnetic interferences from the infrastructure/facilities in the overflown area.
	8.3 The UAS electrical design should be robust and designed to function in the worst foreseen conditions.	0	No such evidence is required by the PDRA
	8.3.1 The UAS electrical capacity generation must be adequate for the intended use.	0	No such evidence is required by the PDRA
	8.3.2 The UAS backup energy system must allow for UAS recovery and/or safe flight termination the duration defined by the flight manual.	0	No such evidence is required by the PDRA
	8.4 The UAS should be designed to incorporate means for fault detection/fault isolation / fault management.	0	No such evidence is required by the PDRA
	8.4.1 The UAS should have procedures established to mitigate the effects of detected faults.	0	No such evidence is required by the PDRA
9. SAFE DEMONSTRATION	All requirements	0[2]	No such evidence is required by the PDRA.

[2] There could be a penalization for 9.3 of up to 80 point if nothing is done on safety. We assumed that any UAS is developed with at least some safety consideration and that the penalisation is less than 80. Since the final score is around 30 this is not further reduced. 9.4 can also give a penalisation up to 66 points but our final score is already below 34.

10. SOFTWARE INTEGRITY	All requirements	0	No such evidence is required by the PDRA
11. CONTINUING AND CONTINUED AIRWORTHINESS	11.1 The applicant shall provide the UAS Flight Manual, with all the approved standard operating and emergency procedures.	1	This is implicitly included in requirement 4.1.1 develop an operation manual (OM) (for the template, refer to AMC1 UAS.SPEC.030(3)(e) and to the complementary information in GM1 UAS.SPEC.030(3)(e));
	11.2 The UAS Flight Manual shall be clear, unambiguous, and written in the English language.		This requirement is not explicitly covered but all commercial UAS typically employed in civil operations have one.
	11.3 The applicant shall provide the maintenance manual with all necessary instructions for ensuring continuing airworthiness.	1	4.2.1 The UAS Operator shall ensure that the UAS maintenance instructions that are defined by the UAS operator are included in the OM and cover at least the UAS manufacturer's instructions and requirements, when applicable
	11.4 The applicant should provide a pre-flight checklist and a post-flight checklist.	1	This is implicitly included in requirement 4.1.1 develop an operation manual (OM) (for the template, refer to AMC1 UAS.SPEC.030(3)(e) and to the complementary information in GM1 UAS.SPEC.030(3)(e));
	11.5 The applicant should provide a training syllabus by the complexity of the UAS operation and maintenance.	1	4.2.1 The UAS Operator shall ensure that maintenance staff follow the UAS maintenance instructions when performing maintenance; 5.8 Any staff member authorised by the UAS operator to perform maintenance activities should have been duly trained regarding the documented maintenance procedures.
	11.6 The UAS maintenance manual shall be complete and identify the qualifications for each type of inspection, maintenance, and repair required	1	4.2.4 The UAS Operator shall establish and keep up to date a list of the maintenance staff employed by the operator to carry out maintenance activities;
	11.7 The applicant should demonstrate to have a method to track technical occurrences (that have been reported) affecting safety throughout the life of the program.	1.5	This is implicitly included in requirement 4.1.1 develop an operation manual (OM) (for the template, refer to AMC1 UAS.SPEC.030(3)(e) and to the complementary information in GM1 UAS.SPEC.030(3)(e));

	11.8 The applicant should demonstrate to have a method to implement preventive and corrective actions as necessary to continuously improve airworthiness.		4.2.3 The UAS Operator shall keep for a minimum of 3 years and maintain up to date a record of the maintenance activities conducted on the UAS;
TOTAL		**30.75**	

According to MUSRA the score obtained from the DIAC should be corrected using a correction matrix. In this example, since many areas of the DIAC are not covered at all this would lead to a further reduction of the score. In particular in the PDRA G-03 there is no requirement related to:

- Structural integrity
- The need of performing an FTA
- Software Life Cycle Assurance

By applying the correction matrix this leads to a final score of **17.44**. The corrected score is much lower than the required value of 33. This means that given the scenario of PDRA G-03 MUSRA requires more safety evidence related to the integrity of the UAS than the corresponding civilian case.

3.3.3.2 Step #3b: Verification of Containment Score

In this step, the OPU would verify that the Containment Score (CS) of the UAS selected for the mission is adequate. The table below shows the requirements extracted from the CAC with the associated score and compares them to the requirements of PDRA G-03. The UAS containment requirements are extracted from the CAC considering that the score the system needs to achieve is 4.

CAC requirement	Score	PDRA G-03 requirement	CAC score justification
C.1 Is the system used for containment independent and dissimilar from the main Flight Control System?	N.A.	6.13.1 The UAS should be 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: 6.13.1.2 no single failure of the UAS or of any external system supporting the operation should lead to operation outside the ground risk buffer.	
C.2.1 Were tests and analyses conducted to demonstrate that the UAS containment system is not likely to experience probable failures that may lead to an operation outside the operational volume?	3	6.13.1.1 the probability of the UA leaving the operational volume should be less than 10^{-4}/FH; and	Assuming a demonstrated reliability < 10^{-4}
C.2.2 Are the Software (SW) and Airborne Electronic Hardware (AEH) of the containment	1	6.13.2 SW and AEH whose development error(s) could directly lead to operations outside the	SW is developed according to ED-12C or DO-178C, DAL D if

system developed against a standard recognised by the NMAA?		ground risk buffer should be developed according to an industry standard or methodology that is recognised as adequate by the competent authority.	the score assigned to C2.1 is 3 AEH must be developed according to ED-80 or DO-254, DAL D if the score assigned to C2.1 is 3

3.3.3.3 Operational requirements

In MUSRA the DIS of the UAS is defined assuming that:

- The UAS will always fly in an operational environment for which it is designed
- The operator possesses the required competencies and procedures to effectively manage the UAS operation
- The personnel possess all required qualifications to safely execute the mission
- All externally provided services are adequate for the intended mission.

To evaluate the above points the operational unit carries out a self-assessment checklist. For this example the checklist will be used to extract the applicable operational requirements and compare them with those extracted from PDRA G-03.

Topic	MUSRA Operational requirement	PDRA G-03 requirement
(A) Competences of the Remote Flight Crew (RFC)	A.1 Remote Flight Crew (RFC) is adequately trained for the planned operation	4.1.11 designate for each flight a remote pilot with adequate competency and other personnel in charge of duties essential to the UAS operation if needed;
	A.2 Remote Flight Crew is subject to periodic health checks (mentally and physically) to demonstrate that they are fit to operate A.3 There is a policy defining how the Remote Flight Crew must be fit to operate before conducting any operation A.4 There is a policy defining how to manage the fatigue and stress of the Remote Flight Crew to reduce human error	4.1.9 have a policy that defines how the remote pilot and any other personnel in charge of duties essential to the UAS operation can declare themselves fit to operate before conducting any operation 5.4 The remote pilot should: 5.4.1 not perform any duties under the influence of psychoactive substances or alcohol, or when they are unfit to perform their tasks due to injury, fatigue, medication,
	A.5 Remote Flight Crew receive Crew Resource Management (CRM) training	5.5 Where multi-crew cooperation (MCC) is required, the UAS operator should: 5.6 ensure that the training of the remote crew covers MCC.
(B) Mission Planning	B.1 Operational volume is defined considering the required elements	3.1 To determine the operational volume, the UAS operator should consider the position-keeping capabilities of the UAS in 4D space (latitude, longitude, height, and time).
	B.2 and B.3 All parameters affecting the Ground Risk are properly evaluated	3.4 The UAS operator should establish a ground risk buffer to protect third parties on the ground outside the operational volume.

		3.5 The operational volume and the ground risk buffer should be all contained in a sparsely populated area. 3.6 The UAS operator should evaluate the area of operations, typically by means of on-site inspection or appraisal, and should be able to justify the significantly lower density of people at risk than in sparsely populated areas within the entire operational volume including the ground risk buffer.
	B.4 The adjacent area is defined considering the required elements	6.13 The following additional conditions should apply if the adjacent area includes an assembly of people or if the adjacent airspace is classified as ARC-c or ARC-d (in accordance with the SORA)
	B.5 Mission is planned considering the environmental limitations of the UAS	4.1.1 develop an operation manual (OM) (for the template, refer to AMC1 UAS.SPEC.030(3)(e) and to the complementary information in GM1 UAS.SPEC.030(3)(e));
	B.6 Procedure to evaluate the environmental conditions are available	
(C) Blast/impact Containment system	Not applicable for this scenario	1.15 The UA should not be used to drop material or to carry dangerous goods, except for dropping items in connection with agricultural, horticultural or forestry activities where the carriage of such items does not contravene any applicable regulations.
(D) Operational procedures	D.1. Operational procedures are developed and take into account the required elements	4.1.1 develop an operation manual (OM) (for the template, refer to AMC1 UAS.SPEC.030(3)(e) and to the complementary information in GM1 UAS.SPEC.030(3)(e));
	D.2 Checklists for normal operation condition procedures are available for the Remote Fight Crew	
	D.3 Remote Flight Crew trained for normal operation condition procedures and are these considered in the Training Syllabus	4.1.11 designate for each flight a remote pilot with adequate competency and other personnel in charge of duties essential to the UAS operation if needed;
	D.4 Emergency procedures are established, and these procedures take into account the required elements	4.1.8 ensure the adequacy of the contingency and emergency procedures and prove it through any of the following: (a) dedicated flight tests; (b) simulations, provided that the representativeness of the simulation means is proven for the intended purpose with positive results; (c) any other means acceptable
	D.5 Checklists for emergency procedures are available for the Flight Remote Crew	
	D.6 Remote Flight Crew is trained for emergency procedures, and these are considered in the training syllabus	4.1.11 designate for each flight a remote pilot with adequate competency and other personnel in charge of duties essential to the UAS operation if needed;
	D.7 Crew is adequately trained for multi-crew coordination and is this	5.5 Where multi-crew cooperation (MCC) is required, the UAS operator should:

	aspect covered in the Training Syllabus	5.6 ensure that the training of the remote crew covers MCC.
	D.8 Multi-crew coordination procedures established	5.5.2 include procedures to ensure the coordination between the remote crew members with robust and effective communication channels; those procedures should cover as a minimum the following[…].
	D.9 and D.10 Not applicable as handover is not possible for PDRA G-03 scenario	1.6 The remote pilot should not hand the control of the UA over to another command unit.
	D.11 and D.12 Not applicable as operation from moving platform is not possible for PDRA G-03 scenario	1.5 The remote pilot should not operate the UA from a moving vehicle.
	D.13 and D.14 Not applicable as operation involving more UAS is not possible for PDRA G-03 scenario	1.4 The remote pilot should only operate one UA at a time.
(E) Military UAS Operator's competence	E.1 The Structure of the Organisation (operations, maintenance, quality, and safety) is included in the Operations Manual.	All requirements are covered by: 4.1.1 develop an operation manual (OM) (for the template, refer to AMC1 UAS.SPEC.030(3)(e) and to the complementary information in GM1 UAS.SPEC.030(3)(e));
	E.3 The roles, responsibilities, and duties of the staff planning, and ordering flight missions clearly defined.	
	E.4 The roles, responsibilities, and duties of the Remote Flight Crew are clearly defined.	
	E.5 The roles, responsibilities, and duties of the Maintenance staff are clearly defined.	
	E.6 Not applicable as there are no dangerous goods involved in PDRA G-03 scenario	N.A.
	E.7 The Training Syllabi are periodically updated to demonstrate that the planning staff, maintenance personnel, and personnel authorised to manipulate dangerous goods are adequately trained for the planned duties and ensure knowledge and practical skills to execute respective tasks.	5.1 The UAS operator should ensure that all personnel in charge of duties essential to the UAS operation are provided with competency-based theoretical and practical training specific to their duties, which consists of theoretical elements defined in AMC1 UAS.SPEC.050(1)(d) and practical elements defined in AMC2 UAS.SPEC.050(1)(d). 5.2 The UAS operator should keep and maintain up to date a record of 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 to be employed by the organisation or have changed position within the organisation.
	E.8 There are records of training and qualification of the Remote Flight Crew, of the Maintenance staff, or the planning staff and the personnel manipulating dangerous goods.	

		5.7 Any staff member authorised by the UAS operator to perform maintenance activities should have been duly trained regarding the documented maintenance procedures.
	E.9 There are maintenance procedures, covering at least the UAS manufacturer instructions and requirements.	All requirements are covered by: 4.1.1 develop an operation manual (OM) (for the template, refer to AMC1 UAS.SPEC.030(3)(e) and to the complementary information in GM1 UAS.SPEC.030(3)(e));
	E.10 There are procedures to ensure that the tools & instruments used in maintenance tasks are in accordance with the UAS manufacturer requirements (e.g. calibration, life limit).	
	E.11 There are procedures to ensure that materials and spare parts used in maintenance tasks are per the UAS manufacturer requirements and are properly stored.	
(F) External services	F.1 There are procedures to ensure that the level of performance for any externally provided service necessary for the safety of the flight is adequate for the intended operation.	In PDRA G-03 there is no explicit mention of the provision of external service, so these requirements are not covered.
	F.2 The roles and responsibilities between the UAS operator and the commercial external service provider are clearly defined (e.g. in a Service Level Agreement - SLA).	
	F.3 There are procedures to continuously monitor the performance of the externally provided services.	

3.4 *Final comparison and conclusions*

From the application of MUSRA to the scenario defined by EASA PDRA G-03 it is possible to conclude that:

- Given an operational scenario and the same TLS, MUSRA and the civilian approach (i.e. SORA) lead to comparable results in terms of the required probability of having a catastrophic failure. The scenario of PDRA G-03 is classified as SAIL II according to SORA and this corresponds to a probability of the UAS to go out of control[3] of 1E-2/FH that is aligned with the values determined by MUSRA. It is acknowledged that despite having the same order of magnitude the value may be different, but this is because while SORA uses a discrete

[3] The concept of "UAS operation out of control" in SORA can be considered equivalent to the "probability of catastrophic failure in MUSRA"

approach (there is nothing in the middle between SAIL II and III), MUSRA implements a continuous one.

- PDRA G-03 and MUSRA requirements are mostly aligned but the following differences can be identified:
    - By applying MUSRA to the PDRA G-03 scenario the DIS obtained is lower than what would be required to operate safely according to the methodology. This means that design integrity plays a more important role in MUSRA than in SORA for “low” risk applications (i.e. SAIL I and II) while for higher risk scenarios the two approaches are possibly more aligned from this point of view. Additional validation activities will take place within the second phase of the project to confirm this assumption.
    - MUSRA always requires the OPU to provide evidence to support the demonstration of compliance independently from the level of risk, while for the PDRA most of the requirements can be demonstrated through declarations.
    - The containment reliability required by MUSRA is different than the one required by the PDRA. This is justified by the more analytical approach used in MUSRA to determine the characteristics of the adjacent areas/airspaces.

In conclusion, the application of MUSRA to the scenario of EASA PDRA G-03 shows that the military and civilian approaches are mostly aligned. The differences are mainly related to the verification of the design and integrity of the UAS that is more important in MUSRA than in the civilian counterpart. However, this reflects the need of military organisations to use UAS with a proved level of reliability to ensure both safety and operational effectiveness.

4 Apply the methodology: a military use case

In this chapter MUSRA is used to assess the risk of a night military operation carried out in BVLOS for border patrol with a UA of 450 kg. As required by MUSRA, before starting the assessment, the acceptable probability of causing fatalities on the ground (i.e. the Target Level of Safety) is set to 10^{-6}/FH. This value is consistent with what is currently used as a reference in the civil sector as explained in [RD4].

4.1 Scenario description

A military Operational Unit (OPU) has planned a border patrol mission on the coastline involving the surveillance of a sector at the border of the territorial waters intersecting different types of airspaces and overflown areas. Take-off and landing are executed in BVLOS from the same airport. The operation is conducted in **BVLOS** using a UAS with a UA with MTOM of **450 kg** and a wingspan of **7 m**. The UA has a cruise speed of **30 m/s** and is equipped with a **DAA system** based on non-cooperative pulse doppler radar operating in X band, that is able to detect any civilian and military aircraft in the detection volume. The maximum operational altitude planned for the mission is set at **3000 ft AMSL** within the vertical limits of the temporary segregated area. The flight is executed at night in January when no gatherings of people are expected on the coastline and when the air traffic density in the area is expected to be limited since most of the traffic is generally flying in VFR. Procedures are established to **coordinate with the military ATS units** during the entire flight. The departing airport is open to other traffic both civil and military, but UA take-off and landing is coordinated with the ATS unit to avoid the presence of other manned or unmanned traffic in the area at the same time. Figure 2 shows the proposed mission profile.

The operational volume is divided in the following volumes (see Figure 3):

- Flight Geography: this is the volume where the flight takes place in nominal conditions. It is 300 m wide on each side of the trajectory to take into account for existing navigation and flight management errors.
- Contingency volume: this is the volume where the UA can enter in case of contingencies such as temporary degradation or loss of C2 Link. The contingency volume horizontal dimension is defined as follows, assuming a 3s delay in the execution of the contingency procedures with the UA flying at a cruise speed of 30 m/s:

$$Extension\ of\ the\ contingency\ area = Vc\ \times 3\ s = 90\ m$$

- Ground risk buffer: this is the volume where the UA may end up crashing in case of emergencies such as a full loss of C2 Link or any other catastrophic failure. It is established considering the glide path of the aircraft starting from the operational altitude of 3000 ft. Given the lift/drag ratio, the buffer is set to 20km on each side of the operational volume

4.1.1 Airspace

As shown in Figure 2 the mission begins from an airport located in **uncontrolled airspace** (class “G”). The UA then follows a pre-planned route that crosses different types of ground areas both **urban and sparsely populated areas** before getting to the open sea. Once the UA has left the uncontrolled ATZ, the flight continues within **uncontrolled airspace (class G)**. At point “A” the UA climbs to get and maintain 3000 ft AMSL entering a **military controlled CTA (class D)**. At point “B” it enters the **temporary segregated area (TSA)** in which no other known traffic is expected. Once arrived at point “C”, it leaves the TSA and begins the procedures to return to the ATZ and land.

4.1.2 Ground area

The flight takes place over areas with different population densities. Figure 4 shows the population density values defined for each area/polygon for the part of the trajectory that is over populated or sparsely populated areas. The population density of the areas above the sea is considered negligible. Population density data are retrieved from census data that are publicly available. In principle, the highest population density of the overflown areas should be selected as the reference value i.e. 86 ppl/km^2. However, the planned time spent over this area is significantly lower compared to the overall flight time and this may lead to overestimate the risk for people on the ground as explained in section 2.1.2. In this example a value of 10 ppl/km^2 corresponding to the next more populated area in the operational volume is selected. This choice does not underestimate the risk for people on the ground if the time spent over the area with the highest population density is sufficiently low. Using equation (**1**) we find that this time must be lower than 7 minutes.

$$t_{max} \leq \frac{10 \times 60}{86} = 7\ minutes$$

Where:

- t_{max} is the maximum time expressed in minutes that can be spent over the area with the highest population density, if this is not selected as the reference value
- PD_{max} is the population density of the area with the highest value = 86 ppl/km^2
- PD is the population density the OPU would like to select for the ground risk assessment = 10 ppl/km^2

Since the length of the route segment crossing the area with the highest population density value is estimated to be around 1km, considering that the UA has a cruise speed of 30 m/s, the area will be overflown in around 33 seconds that is well below the above limit. Therefore, the reference Population Density (PD) can be set to **10** ppl/km^2.

The shelter factor of the operational area is the one associated with the value taken as reference for the population density. In this case it corresponds to a sparsely populated areas with limited presence of building. Therefore the shelter factor is assumed to be zero.

4.1.3 Adjacent area/airspace

Before assessing the characteristics of the adjacent area/airspace, these volumes need to be identified. In this case they are defined as the volumes that the UA can reach while flying for 30 minutes at the cruise speed, assuming this is the maximum flying time before emergency actions are taken to terminate the flight. The **adjacent area** is therefore defined as everything within a radius of around 50 km from the flight trajectories. Within this area it is assumed that the adjacent area contains urban area with a population density of 1000 ppl/km^2. The adjacent airspace is considered within the same horizontal distance but within 5000ft of altitude considering the UA flight envelope limitations. Within this range there is **controlled airspace (class D)** and uncontrolled airspace (class G).

The information related to the above scenario are summarised in the following table.

Scenario details

Characteristics	*Description*
UAS Specifications	
Type of UAS	*Fixed wing*
MTOM of UA	*450 kg*
Flight condition	*BVLOS*
Maximum characteristic dimension of the UA	*Wingspan (b) of 7 m*
Cruise speed (Vc)	*30 m/s*
Lift-to-Drag ratio	*20:1*
Mitigations to reduce the impact energy (e.g., parachute, tether, etc.)	*Not applied*
Operational area characteristics	
Operative altitude	*Up to 3000 ft AGL*
Operational range	*BVLOS limitations*
Selected population density	*10 people/km^2*
Shelter factor	*N.A.*
Operational airspace environment	*Temporary Segregated area* *Uncontrolled ATZ (class G)* *Uncontrolled airspace (class G)* *Controlled airspace – Military CTA (class D)*
Adjacent area characteristics	
Population density of the adjacent area	*1000 people/km^2*
Airspace environment of the adjacent area	*Controlled airspace – Military CTA (class D)* *Uncontrolled airspace (class G)*
Shelter factor of the adjacent area	*N.A.*
Other information	
Dangerous payload	*N.A.*
Notes	- *Coordination with military ATS units available*

Table 1 – Military use case scenario description

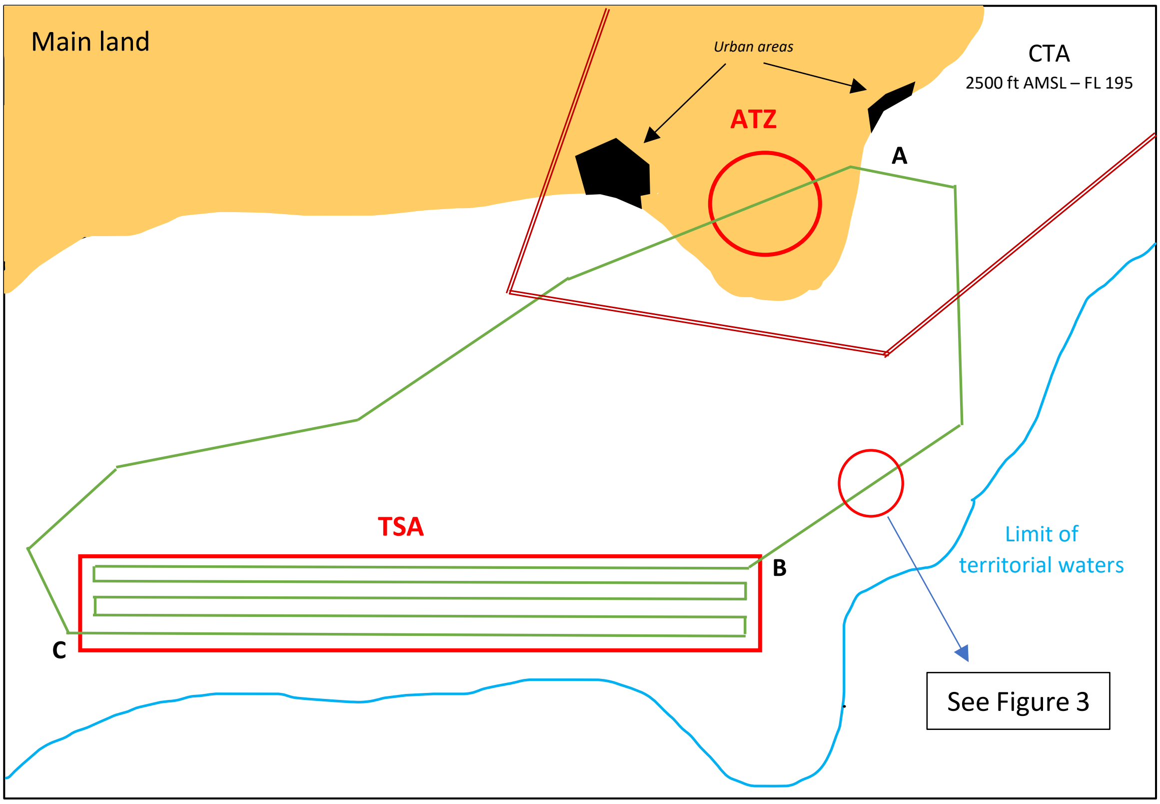

Figure 2: Military Use Case Scenario (figure not to scale)

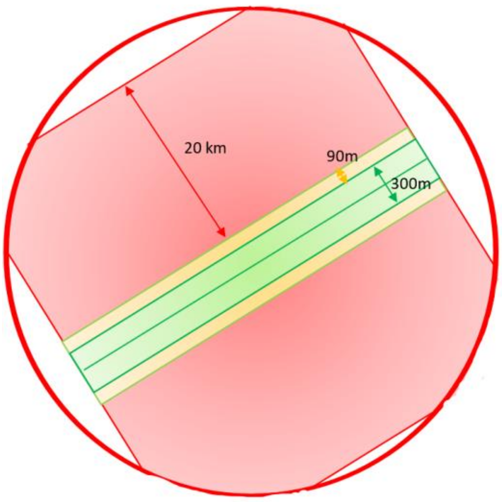

Figure 3: Military Use Case Scenario Flight Geography (green), Contingency volume (orange) and Buffer (red). Figure not to scale

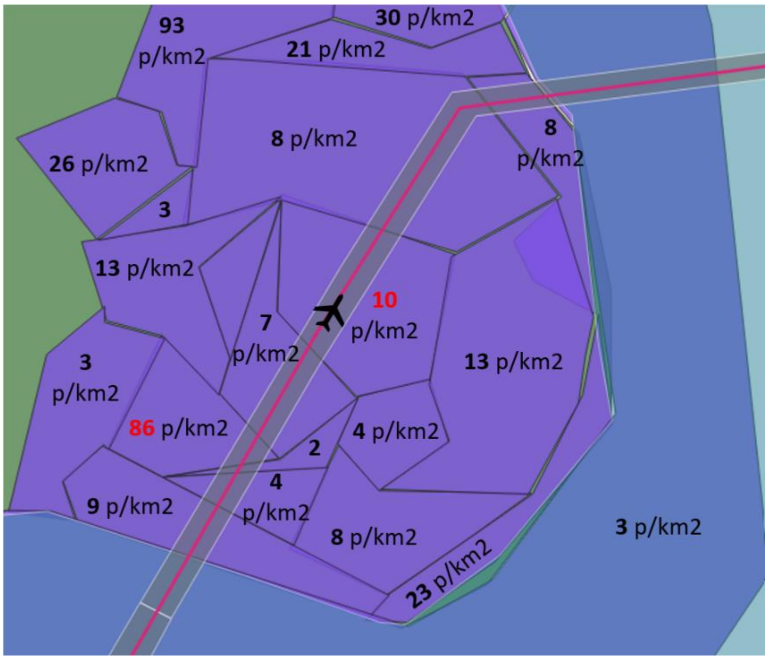

Figure 4 - Population Density distribution

4.1.4 *Step #1: Scenario description*

4.1.4.1 *Step #1a: Ground area*

The crash/impact area is calculated as:

$$A_{debris} = K \times b^2$$

Where:

- $K = min[50; E \times 0.0175 + 3.2858]$ and
- b is the UAS characteristics dimension in [m] = 7 m

The kinetic impact energy of the UAS is calculated as:

$$E = \frac{0.5 \times MTOM \times V^2}{10^3} = 202.5\ kJ$$

$$K = min[50; E \times 0.0175 + 3.2858] = 6.8$$

$$A_{debris} = K \times b^2 = 333\ m^2$$

Given that there are no dangerous payloads onboard $A_{impact} = A_{debris}$. The maximum allowable probability of a catastrophic failure considering the characteristics of the overflown area can be computed as follows:

$$P_{cat\_ground} = \frac{P_{Kill}}{A_{impact} \times PD \times (1 - E_r) \times (1 - S)} = 3.0 \times 10^{-4}/FH$$

Where:

- PD is the selected population density: 10 ppl/km^2
- E_r is set to 0 since there are no system on board to reduce the impact energy
- S is set to 0 since the scenario assumes all people are potentially outside and not protected by buildings

Similarly the maximum allowable probability of the UA to exit the operational volume and the buffer can be computed as follows:

$$P_{exit\_ground} = \frac{P_{Kill}}{A_{impact} \times PD_{Adj}\,(1 - E_r)(1 - S_{Adj})} = 3.0 \times 10^{-6}/FH$$

Where:

- PD_{Adj} is the population density of the adjacent: 1000 ppl/km^2
- E_r is set to 0 since there are no system on board to reduce the impact energy
- S_{Adj} is set to 0 since the scenario assumes all people are potentially outside and not protected by buildings

4.1.4.2 Step #1b: Airspace

Initial Air Risk

The flight trajectory crosses the following types of airspaces:

- Temporary Segregated Area (TEC 8) corresponding to **TCR 1**
- Above sovereign territory/territorial waters including uncontrolled aerodromes (TEC 4) and Controlled Airspace managed by Military ATC – Military CTA (TEC 3), both corresponding to **TCR 3**

Categories	Operational airspace environment	TEC	TCR	P_{cat_air}
Controlled airspace[4]	Around controlled Aerodromes	TEC 1	TCR 4	Operations not possible in MIL-UAS-SPECIFIC category
	Controlled Airspace managed by Civil ATC (e.g. TMA, CTA, AWY, Routes, CTR)	TEC 2		
	Controlled Airspace managed by Military ATC (e.g. CTR)	TEC 3	TCR 3	<5E-4
Uncontrolled airspace	Above sovereign territory/territorial waters including uncontrolled aerodromes	TEC 4		
	At or above 500ft AGL over international waters	TEC 5		

[4] All controlled airspaces may be integrated, i.e. with the simultaneous presence of both civil and military aircraft.

	Below 500ft AGL over international waters	TEC 6	TCR 2	[5E-4;1E-2[
Reserved/Segregated airspace	Reserved areas with other involved operative traffic (e.g. DMA, transit corridors)	TEC 7		
	Reserved areas without any other involved operative traffic	TEC 8	TCR 1	[1E-2;1E-1]

Table 2 - Operational airspace environment

Adjacent Airspace

The adjacent airspace contains both uncontrolled and controlled airspace managed by military ATC and is therefore classified as TCR 3.

Air Risk Mitigations

The Air Risk related to the airspace classified with TCR 3 can be lowered using strategic mitigations. In order to lower the initial TCR to a lower level the available mitigations must have an overall score of at least 30, as shown is Table 3.

FROM: Initial TCR level	TO: Final TCR level	Minimum ARMS
4	3	30
4	2	60
3	2	30

Table 3 - ARMS - Air Risk Mitigations Score (use case)

In order to achieve the required score two mitigations are selected, as shown in Table 4.

			ARMS
Air risk Mitigations	Strategic Mitigations	Time of exposure	18
		Day/time of the operation	18
		UAS transit routes/Corridor	30
		Flight plan	12
		Dangerous area	6
		Strategic U-space services	30
	Tactical Mitigations	Increased separations	15
		Coordination/Communications with ATS units	12

Table 4 - Air risk mitigations (use case)

The use of the above mitigations is justified as follows:

- The operation takes place at night when the traffic density below 3000ft AMSL is expected to be much lower than the average since most of the traffic flies in that volume in VFR.
- Coordination with ATS units plays an important role in reducing the risk of encountering other traffic. This assumption is fully applicable for the flight inside the CTA, but even outside military ATS may inform the UAS pilot of the presence of other traffic.

The sum of the applied mitigations is 30 and therefore the TCR has been lowered from TCR 3 to **TCR 2**. Evidence provided for the air risk mitigations and further details are contained in Annex A.1. P_{cat_air} is therefore conservatively set at 5E-4 for the operational airspace and at 1E-5 for the adjacent airspace.

Minimum Detect and Avoid Requirements (MDAR)

With a maximum final TCR of 2 the Minimum Detect-And-Avoid Requirements (MDAR) to meet are shown in the table below, taking account that operation is performed in BVLOS.

	Minimum Detect-And-Avoid Requirements (MDAR)	
	VLOS	**BVLOS**
Final TCR		
4	Operation not allowed in MIL-UAS-SPECIFIC category	
3	• Use of airspace observers (optional) • De-confliction scheme • Communication phraseology and procedures	Detect-And-Avoid system with Medium Performance
2	• De-confliction scheme	Detect-And-Avoid system with Low Performance
1	No requirement	No requirement

Table 5 - MDARs (use case)

Evidence demonstrating compliance to the MDAR is provided in Annex A.2.

4.1.5 Step #2: Score computation

In this step the Required Design and Integrity Score (RDIS) and the Required Containment Score (RCS) are computed. The parameters used are those obtained in Step #1: Scenario description and are reported hereafter for convenience:

- P_{cat_ground}= 3.0 $\times 10^{-4}$ /FH
- P_{exit_ground}= 3.0 $\times 10^{-6}$ /FH
- P_{cat_air} = 5.0 x 10^{-4} /FH
- P_{exit_air} = 1.0 x 10^{-5} /FH

Therefore the maximum allowable probability of catastrophic failure is:

$$P_{cat} = min[P_{cat\_ground}; P_{cat\_air}] = 3.0 \times 10^{-4}$$

The maximum allowable probability of exiting the operational volume is computed as

$$P_{exit} = min[P_{exit\_ground}; P_{exit\_air}] = 3.0 \times 10^{-6}$$

RDIS and RCS are then computed as follows:

$$\boldsymbol{RDIS} = -\frac{\ln(10P_{cat})}{0.069} = 84$$

$$\boldsymbol{RCS} = -\log\left(\frac{P_{exit}}{P_{cat}}\right) = 2$$

4.1.6 Step #3: UAS verification and score correction

4.1.6.1 Step #3a: Verification of Design and Integrity Score

In this step we need to demonstrate that the UAS selected for the mission has the required design and integrity characteristics. A Design and Integrity Assurance Checklist (DIAC) is filled in to compute the Design and Integrity Score (DIS). The DIAC referred to the UAS selected for this scenario is reported in annex A.3. The DIAC was filled in considering as reference the Falco Evo Maritime, a real UAS model manufactured and operated by Leonardo S.p.A. with similar characteristics than the UAS selected for this example.

The **DIS** obtained from the DIAC is **85.** The evidence to support the demonstration of this score is not provided in this document as it contains confidential information that cannot be disclosed.

The DIS obtained above may need to be corrected since the DIAC does not consider the relationship between the different areas, and how failing to comply with one of them may affect the others. For this reason it may be necessary to apply a **correction factor matrix** (see Table 6) to reduce the score of specific domains with cross-domain items whose absence will have a negative impact on the reliability of that domain.

	Organization	Adopted Design Standards	Tested Usage Spectrum	Stab Control / Nav Accuracy & Emergency Cond.	Ground Control Station	Structural Integrity	Propulsion Integrity	System Integrity	Safety Demonstration	Software Integrity	Continued
No Quality Assurance System	1	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.6
No Technical Occurance Tracking	1	1	0.8	1	1	0.8	0.8	0.8	0.6	0.8	1
No DO Configuration Management	1	1	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	1
Human Machine Interface not Considered	1	1	1	1	0.6	1	1	1	0.8	1	0.6
No Evidence of Structural Integrity	1	0.8	1	1	1	1	1	1	1	1	0.6
No Evidence of Propulsion Integrity	1	0.8	1	1	1	1	1	1	1	1	0.6
Inadequate E3	1	0.8	0.8	0.8	1	1	0.8	0.8	1	1	0.8
No FTA	1	1	1	0.6	1	1	0.6	1	1	1	0.6
No Fail-safe **(functionalities)**	1	1	1	1	1	1	1	1	0.8	1	1
No Software Life Cycle Assurance	1	0.8	1	0.6	0.8	1	0.8	1	1	1	1
No Instructions for Cont AW	1	1	1	0.6	0.6	0.6	0.6	0.6	0.8	0.6	1

Table 6 - Correction factor matrix (DIAC)

For this operation the correction factor matrix does not negatively impact the DIS since there are no absences in the specific domains. The DIS needs then to be confirmed or reduced by assessing the operational aspects of the mission. For this reason an *operational questionnaire* needs to be completed. The operational questionnaire is contained in Annex A.4.

Considering the answers to the operational questionnaire, the correction matrix reported in Table 7 is used to assess the effect of the lack of evidence on one of the areas and how this could lead to a reduction of the DIS. Since the OPU is fully compliant with all the applicable requirements of the operational questionnaire the DIS is not reduced.

	Organization	Adopted Design Standards	Tested Usage Spectrum	Stab Control / Nav Accuracy & Emergency Cond.	Ground Control Station	Structural Integrity	Propulsion Integrity	System Integrity	Safety Demonstration	Software Integrity	Continued / continuing Airworthiness
No evidence of operational procedures	1	1	0.5	0.5	0.5	0.5	0.5	0.5	1	1	1
No evidence of remote crew training	1	1	0.5	0.1	0.1	0.5	0.5	0.5	1	1	1
No evidence of external service SLA	1	1	0.5	0.5	1	1	1	1	1	1	1
No evidence of *maintenance* organisation and competences at operator's level	1	1	1	0.1	0.1	0.5	0.5	0.5	1	1	0.5
No evidence of Blast/impact	1	1	0.5	0.5	1	0.5	1	0.5	0.1	0.5	0.5
No evidence of mission-planning aspects	1	1	0.1	0.5	0.5	1	1	1	0.1	1	1

Table 7 - Operational questionnaire correction matrix

A DIS of 85 is sufficient to fulfil the RDIS of 84, which means that the operation can be conducted safely[5] according to MUSRA.

4.1.6.2 Step #3b: Verification of Containment Score

In this step the operator needs to demonstrate that the containment system on board the UA is adequate to fulfil the RCS. A Containment Assessment Checklist is filled in to provide the required evidence and prove that the available system is adequate. The complete CAC is reported in Annex A.5. The Containment Score obtained from the CAC is **2** and this fulfils the requirement identified in Step 2.

4.1.7 Conclusion of the use case

The application of MUSRA has shown that the operation can be conducted safely. The final Design and Integrity Score and the Containment Score are sufficient to fulfil the required values (i.e. RDIS and RCS). If the DIS of the UAS has been already verified by the NMAA the Operational Unit (OPU) can proceed to execute the mission, provided that the required coordination have been established. Otherwise, the OPU in coordination with the manufacturer of the UAS will need to submit the required evidence to the NMAA to obtain the verification of the Design and Integrity Score.

[5] The term "safely" means that the TLS set at the beginning of the process is achieved

5 MUSRA update plan

5.1 MUSRA maintenance plan

5.1.1 Scope of the maintenance plan

This chapter contains the plan to maintain MUSRA after its initial release, during the triennium 2023-25. The scope of such plan includes:

a) possible feedback received by EDA pMS during actual implementation of MUSRA;
b) developments in rules applicable to unmanned civil aviation;
c) evolution of parent methodologies (i.e. SORA) taking place at international level;
d) progress of related industry standards; and
e) development of additional PDRAs or standard scenarios following the needs that might emerge from EDA pMS

5.1.2 MUSRA implementation issues

At any moment, pMS using MUSRA might encounter problems with its application. Therefore, the EDA Airworthiness Regulatory Framework Working Group (ARF WG) and the SEC UAS Integration Working Group should be kept informed during the triennium through a systematic collection of possible feedback received by pMS during actual implementation of MUSRA. Collection of information should be followed by analysis and subsequent continuous improvement, based on the classic “Plan-Do-Check-Act” cycle, described in ISO 9001.

This process is even more detailed in EC Regulation 376/2014 [RD6] which contains seven subsequent steps. The Project Reporting Occurrences in Civil Aviation (ROCA), executed on behalf of DG-MOVE [RD7], suggested to complement the seven steps in the regulation, with a final one, named ‘act upon’. Taking inspiration from the mentioned 7 + 1 steps, the maintenance plan 2023-26 for the implementation issues could be:

Step (ref. Reg. 376/2014 and ROCA)		**Actions**	
		No.	**Description**
1	Report problems encountered when using MUSRA	1	Develop a form for pMS to report problems encountered during use of MUSRA
		2	Distribute the form for data collection to EDA WGs pMS
2	Collect reports	3	Provide EDA WGs a Point of Contact for sending their possible reports
3	Store reports	4	Create a repository of the received reports
4	Protect reports	5	Apply GDPR 679/2016 to protect confidentiality of reports
5	Exchange information	6	Inform EDA PO within 72 hrs if a reported problem could require immediate action by EDA WGs

Step (ref. Reg. 376/2014 and ROCA)		Actions No.	Description
		7	Provide a summary quarterly report to EDA WGs on the received problem reports
6	Disseminate lessons learned	8	Report to EDA WGs twice yearly on the lessons learned from received reports, including on quality of received information and, where necessary, recommend action to improve MUSRA
7	Analyse problems	9	In conjunction with action 8, justify any recommended action with short explanation of the rationale
8	Act upon	10	After possible decision by EDA WGs implement corrective action to improve MUSRA. Depending on the type of problem different actions will be carried out: • Update of training material if a problem in using the tool is identified • Update the methodology if an issue in the concept of MUSRA is identified • Update the tool if a bug or an issue with the interface in the tool is identified

5.1.3 Monitor rules applicable to unmanned civil aviation

The EU rules on the conformity verification processes of industrial products, including Classes of Small drones, have been developed since the mid '80s and they are quite stabilised. No specific action is recommended to monitor their possible evolution. Monitoring the evolution of the related industry standards is covered in 4.2.5. Equally, the basic authorisation process in specific category in EC Implementing Regulation 2019/947 is neither expected to significantly change in the triennium 2023-25, nor it is applicable to the military environment in which the legal entity of the UAS operator does not exist. Conversely the rules may evolve quite significantly in the following domains:

a) Flight rules at VLL;
b) Regulatory approach to higher levels of automation and eventually full autonomy;
c) New civil PDRA;
d) Oversight of external service providers.

The proposed most effective approach to monitor the evolution of civil rules in the domains listed above, during the triennium 2023-25, could hence encompass the following actions:

Action No.[6]	Domain	Most relevant international civil aviation regulators		Description
		Org./body	Activity	
11	Flight rules at VLL	ICAO/RPAS Panel	WG6 deals with ATM matters, but so far, no clear proposal to amend flight rules. Filippo Tomasello (FTO) is advisor to the Italian member of the RPAS Panel	Inform ARF WG, if any developments would emerge in ICAO to amend flight rules in Annex 2 to the Chicago Convention
12		ICAO/sUAS Advisory Group	Development of the ICAO UTM framework, whose 3rd edition[7] does not however contain any recommendation for new flight rules	Monitor the ICAO public website to remain aware of possible new editions of the ICAO UTM framework
13		JARUS/WG OPS/ORG/PERS	JARUS is currently developing plans for its future deliverables FTO is member of this WG	Inform ARF WG, if any developments related to possible new flight rules at VLL would emerge in JARUS
14		EASA/Expert Group	EASA RMT.0230 includes possible amendment of the Standard European Rules of the Air (SERA; regulation 923/2012) FTO is member of such Expert Group	Monitor developments in RMT.0230 for possible amendments to SERA and inform ARF WG accordingly
N/A	Autonomy	ICAO/RPAS Panel	Currently no significant discussions on autonomy	Do nothing
N/A		ICAO/sUAS Advisory Group	Currently no significant discussions on autonomy	Do nothing
15		JARUS WG Automation	By end of 2022, JARUS should produce a concept for regulation of highly automated or autonomous UAS	Inform ARF WG, when JARUS will release its document on automation/autonomy
16		EASA	EASA has a roadmap on application of Artificial Intelligence.[8] An EASA – EDA arrangement for enhanced cooperation	Monitor developments in EASA for regulation of higher levels of automation and inform ARF WG accordingly

[6] Numbering of actions continues after those listed in previous paragraph.
[7] Development of the ICAO UTM framework, whose 3rd edition does not
[8] https://www.easa.europa.eu/newsroom-and-events/news/easa-artificial-intelligence-roadmap-10-published

Action No.[6]	Domain	Most relevant international civil aviation regulators		Description
		Org./body	Activity	
			between the two agencies was established on 18 June 2013.	
N/A	PDRA	ICAO/RPAS Panel	So far ICAO has neither developed PDRAs nor plans to do so	Do nothing
N/A		ICAO/sUAS Advisory Group	As above	As above
N/A		JARUS	JARUS has developed some STS or PDRA, but they are systematically considered by EASA for possible transposition in EU. Not necessary to follow this activity in JARUS	Do nothing
17		EASA	So far EASA has published 5 PDRAs and more may come in the future. Any proposed new PDRA would undergo the NPA consultation process	Monitor possible EASA NPAs on new PDRAs and inform ARF WG on the matter
18	Service providers	ICAO/RPAS Panel	ICAO is developing provisions for oversight of external service providers which might be interesting also for military operations. These external SP might support also HAPS operations.	Inform ARF WG, if any developments in ICAO (e.g. 2nd edition of Doc 10019 or other Annex or Manual) on oversight of providers of external services could potentially impact MUSRA
N/A		ICAO/sUAS Advisory Group	This matter has never been touched by the Advisory Group	Do nothing
19		JARUS/WG ORG/OPS/PERS	The JARUS WG is developing a paper on performance-based regulation which might include oversight of organisations	Inform ARF WG, when JARUS will release its document on performance-based regulation
20		EASA	EASA NPA 2021-14 proposed AMC/GM to Regulation 2021/664 on U-space.	Monitor EASA website for publication of the ED Decision on AMC/GM for U-space and inform ARF-WG accordingly

Action No.[6]	Domain	Most relevant international civil aviation regulators		Description
		Org./body	Activity	
			The subsequent EASA ED decision is expected in 2nd half of 2022	

5.1.4 *MUSRA parent methodologies*

MUSRA, in particular for the air risk, took into account the Specific Operation Risk Assessment (SORA) methodology developed by JARUS and 3nshrined through EASA AMC 1 to Art. 11 of Commission Implementing Regulation 2019/947. JARUS WG on Safety and Risk Management (SRM) is constantly engaged in further development of SORA. Marco Ducci (MDU) is member of that WG. The Project will remain updated on the evolution of SORA, through active and regular participation to JARUS WG SRM. During the triennium 2023-25 the following actions will therefore be pursued:

Action No.[9]	Domain	Most relevant international civil aviation regulators		Description
		Org./body	Activity	
21	SORA	JARUS WG SRM	Monitor evolution of methodologies in JARUS WG SRM	Inform ARF WG if any evolution of SORA in JARUS could impact MUSRA
22		EASA	Monitor evolution of EASA AMCs related to Art. 11 of EC Regulation 2019/947	Inform ARF WG if any evolution of EASA AMCs could impact MUSRA

5.1.5 *Monitor progress of industry standards*

The scope of the MUSRA maintenance plan for the triennium 2023-25 includes as well monitoring the progress of related industry standards, since they are necessary in the context of performance-based regulation.

The Project will therefore remain updated on the evolution of industry standards which could support MUSRA, through:

a) Active participation to the EU UAS Standard Coordination Group (EUSGG)[10] whose members include not only the European Commission, EASA, EDA and EUROCONTROL, but also the most relevant European SDOs and some international SDOs (e.g. ASTM, SAE); This Coordination Group will offer the opportunity to remain in particular updated on the activities of ASTM Committee F38, without the need to become affiliated to a foreign organisation;

[9] Numbering of actions continues after those listed in previous paragraph.
[10] https://www.euscg.eu/

b) Active participation, through the Italian ISO Member (i.e. FTO) to Sub-Committee SC 16 (UAS) and SC 17 (aerodromes, including vertiports) of ISO Technical Committee TC 20 (aerospace);
c) Active participation to EUROCAE WG 105 on UAS, most activities of which are coordinated with foreign RTCA Sub-Committee SC 228;
d) Participation to ASD-STAN[11] D5 WG8 on UAS which is developing detailed standards for small UA (MTOM < 25 kg) intended for the open category and low risk (i.e. up to SAIL II) operations in the specific category. The resulting standards in the CEN series EN 4709-xxx might in fact allow Military agencies to procure dual use COTS platforms for tactical short range ISR missions, highly vulnerable to electro-magnetic interference, but of reduced cost.

During the triennium 2023-25 the following actions will therefore be pursued:

Action No.[12]	Most relevant international civil aviation regulators		Description
	Org./body	Activity	
23	ASTM F38	Standards for UAS, whose progress is reported to the EUSCG	Inform ARF WG if any evolution of ASTM UAS standards which could impact MUSRA
24	ISO/TC 20	ISO Technical Committee TC 20 (aerospace) comprises several Sub-Committees, among which SC 16 (UA) and SC 17 (aerodromes including small vertiports)	Inform ARF WG if any evolution of ISO TC 20 standards which could impact MUSRA
25	EUROCAE/ WG 105	Standards for UAS (excluding passenger carrying electrically powered VTOL capable aircraft), but including standards related to U-space. The priority is to provide Means of Compliance (MOCs) with EU/EASA provisions (e.g. Certification Specifications or Special Conditions)	Inform ARF WG if any evolution of EUROCAE WG 105 standards which could impact MUSRA
26	CEN/M567 (ASD-STAN D5 WG8)	Technical specifications (equivalent to EASA certification specifications, but published by industry) for Classes of drones from C0 to C6 as established through EC	Inform ARF WG on any evolution of the series of standards EN 4709-xxx

[11] CEN has received Mandate M567 from DG-GROW to develop industry standards, mainly for the 'open' category. CEN has tasked ASD-STAN to draft such standards.

[12] Numbering of actions continues after those listed in previous paragraph.

Action No.[12]	Most relevant international civil aviation regulators		Description
	Org./body	Activity	
		Delegated Regulation 2019/945	

5.1.6 Additional PDRA

Pre-Defined Risk Assessment (PDRA) may make the application of SORA much quicker. For this reason, EASA has already published five of them and additional ones may be published in the future. However, the civil PDRAs may not fully catch the military needs.

The scope of the MUSRA maintenance plan therefore includes both monitoring new PDRAs originated by EASA and possible development of additional MIL PDRAs following the needs that might be expressed by pMS.

During the triennium 2023-25 the following actions will hence be pursued:

Action No.[13]	Most relevant international civil aviation regulators		Description
	Org./body	Activity	
27	EASA	Develop and promulgate new civil PDRAs, as AMCs to Art. 11 of EC Regulation 2019/947	Inform ARF WG if any evolution of EASA civil PDRAs which could complement MUSRA
28	EDA/ARF WG	Explore needs of pMS	In the 1st half of 2023 launch a survey across the pMS to ARF WG to elicit possible need for additional MIL PDRAs
29	EDA/ARF WG	Development of new MIL PDRAs	TBD subject to outcome of action 28

[13] Numbering of actions continues after those listed in previous paragraph.

6 Military UAS Scenarios (MUSs)

6.1 Introduction

The Military UAS Scenarios (MUSs) are developed to simplify and speed up the authorisation process. To obtain an authorisation to operate in accordance with a MUS, the Military UAS operational unit (OPU) needs only to demonstrate compliance to the requirements and limitations set for the scenario. The risk assessment process is carried out by the NMAA that defines the applicable airworthiness requirements and by the military operational authority that defines the operational ones.

6.2 MUS Development

In order to develop a MUS, the competent authority needs to:

- Define the operational scenario including the applicable limitations.
- Carry out the risk assessment process of the selected scenario using MUSRA, from the perspective of the Operational Unit.
- Identify the applicable requirements in terms of:
    - Design and Integrity Assurance: this is done by defining the Required Design and Integrity Score (RDIS) and setting specific limitations about the UAS characteristics.
    - Containment requirements: this is done by defining a Required Containment Score (RCS) .
    - Operational requirements: this is done by looking at the Operational Questionnaire and extracting the applicable requirements to avoid a reduction in the DIS of the selected UAS.
    - Air Risk Mitigations: these are extracted from the MUSRA process if they are used to reduce the initial Traffic Conflict Risk.
- Fill in the MUS template with the requirements and limitations identified above.

Two complete examples of MUSs can be found in the ANNEX A .

6.3 MUS Template

After having carried out the MUSRA process on a selected scenario the competent authority will need to fill in the template reported in Table 9. This template has been developed to capture all relevant MUSRA parameters that are needed to univocally characterise an operational scenario and define limitations and requirements. In particular, the template is structured considering the following MUSRA elements:

- Operational Checklist,
- MDARC,
- CAC
- Air risk mitigations.

Details on the technical characteristics of the UAS are not explicitly addressed as they are implicitly covered by the Required Design And Integrity Score (RDIS) that is set as one of the scenario parameters.

The template is always introduced by an overview of the MUS (see Table 8) containing general information about the operational scenario.

The template is structured with four columns:

- “Area” contains the main topic being addressed.
- “Topic” column identifies a specific element of the “Area”.
- “Limitations / Requirements” includes the conditions to be fulfilled under a specific “area/topic”.
- “Evidence” where the OPU can provide reference to the documents containing the proofs of compliance or include a statement to confirm that the applicable limitation/requirement is fulfilled.

Military UAS Scenario n° x "Title of the MUS"	
Characteristics	*Description*
Features of the operation	
MTOM of UA	
Type of UAS	
Flight condition	
*Maximum characteristic dimension of the UA** **if:* • *fixed wing enter the wingspan,* • *rotorcraft enter diameter of the rotor,* • *multicopter enter the maximum dimension*	
Speed *Cruise speed (Vc) for fixed-wing aircraft* *Terminal Velocity for Multicopters/Rotorcraft*	
Operational volume characteristics	
Maximum altitude	
Maximum range	
Population density	
Shelter factor	
Airspace	
Adjacent area characteristics	
Population density of the adjacent area	
Airspace of the adjacent area	

Shelter factor of the adjacent area	
Other information	
Dangerous payload	
Critical infrastructure(s)	
Air risk mitigations	
Notes	

Table 8 – Template of MUS n° Overview

CHARACTERISATION OF THE MUS			
Required Design and Integrity Score (RDIS)			
Required Containment system Score (RCS)			
Traffic Conflict Risk (TCR)			
Area	Topic	Limitations / Requirements	Evidence (to be fulfilled by OPU)
1. Operation limitations			
Level of human intervention	Autonomous operations		
	UAs controlled at a time* * Only if the operation includes multiple UASs operations		
	Operations from moving vehicle		
Overflown areas	Population density of the overflown area		
	Shelter factor of the overflown area		
UA limitations	Maximum Take-Off Mass (MTOM) of the UAS		
Flight height limit	Maximum operational height (m or feet)		
Airspace	Operational Airspace environment		
Adjacent area	Population density of the adjacent area		

	Shelter factor of the adjacent area		
Dangerous good(s)	Type of material* * Only if the operation includes transport of dangerous goods		
	Quantity of material* * Only if the operation includes transport of dangerous goods		
	Availability of Crash-proof container and/or Blast containment system * * Only if the operation includes transport of dangerous goods		
2. Flight planning			
Operational volume	Operational volume design		
	Accuracy		
Ground risk	Definition of the ground risk buffer		
	Evaluation of the shelter factor		
	Evaluation of the population density at risk		
	Inspection activities to evaluate the population density at risk in the operational area		
Air risk	Evaluation of airspace characteristics		
Adjacent area	Adjacent area evaluation		
	Evaluation of the population density		
	Evaluation of the shelter factor		
Weather conditions	Adverse weather conditions		
	Evaluation of weather conditions		
Critical infrastructure	Procedures to avoid / mitigate the interferences impact* * Only if the operation includes critical infrastructure		
	Interference evaluation* * Only if the operation includes critical infrastructure		
Multiple UASs operation	Procedures to avoid / mitigate the interferences impact* * Only if the operation is a multiple UASs operation		
	Procedure to safe recovery one or more UAS * Only if the operation is a multiple UASs operation		
	Interference evaluation* * Only if the operation is a multiple UASs operation		

Observer(s)	Quantity of airspace observers		
	Minimum visibility for conducting the operation		
	Maximum flight distance covered by the airspace observer(s)		
	Potential terrain/artificial obstructions for the airspace observer's visibility		
	Maximum distance from each airspace observers (if any) and the remote pilot in command		
	Communications protocol and procedures for the UAS flight crew		
	Means used by airspace observer to determine the position of the UA		
3. Operational procedures			
Procedures for Normal operation condition	Procedures		
	Normal operation checklist		
	Training		
Emergency procedures	Procedures		
	Emergency checklist		
	Training		
Multi-crew	Training* * Only if the operation includes multi-crew operations		
	Procedures* * Only if the operation includes multi-crew operations		
Handover	Training* * Only if the operation includes handover		
	Procedures * Only if the operation includes handover		
Operation from moving platform	Training* * Only if the operation includes operations from moving platform		
	Procedures* * Only if the operation includes operations from moving platform		
Simultaneous operation with	Training* * Only if the operation includes simultaneous operations with UAS and/or manned aircraft		

UAS and/or manned aircraft	Procedures* * Only if the operation includes simultaneous operations with UAS and/or manned aircraft		
4. Military UAS operator's competence			
Organisation	Structure		
	Roles and responsibilities (flight planning)		
	Roles and responsibilities (execution)		
	Roles and responsibilities (maintenance)		
	Roles and responsibilities (dangerous goods management)		
Training	Training syllabus		
	Training syllabus for the OPU		
	Training records and qualifications		
Maintenance procedures	Manufacturer instructions		
	Tools and instruments		
	Materials		
	Personnel in charge of maintenance activities		
Human error	Health routine checks		
	Fit-to-operate policy		
	Policy on stress and fatigue management		
	Crew Resource Management (CRM) training		
5. Mitigations			
Systems to reduce the effects of the ground impact (e.g., parachute)	Training of the OPU		
	Training of the personnel in charge of installation and maintenance		
	Installation and maintenance		
Air Risk	Day/Time of the operation		
	Exposure at risk		
	Flight Plan		
	Coordination / Communication with ATS unit		
6. Technical conditions			
Containment system	Design and installation appraisal		
	Failure test and analysis of the containment system reliability		

	Development process of UAS' software (SW) and Airborne Electronic Hardware (AEH)		
	Reliability level and design of the containment system		
Detect-And-Avoid (DAA)	De-confliction scheme		
	Performance of DAA system* * Only if BVLOS operation		
External service	U-space service / External service performance		
	Adequacy of the external service's performance		
	Roles and responsibilities		
	Monitoring procedures		
Crash-proof container / Blast containment system	Adequacy of the blast containment system* * Only if the mission includes transport of dangerous goods		
	Effectiveness assessment* * Only if the mission includes transport of dangerous goods		
	Training of the OPU* * Only if the mission includes transport of dangerous goods		
	Training of the personnel in charge of the dangerous goods management* * Only if the mission includes transport of dangerous goods		
	Installation and maintenance* * Only if the mission includes transport of dangerous goods		
	Procedures and checklist* * Only if the mission includes transport of dangerous goods		

Table 9 - Template of MUS n° characterisation

7 Conclusion and recommendations

This document complements the description of MUSRA provided in the deliverable D2: Methodology. It provides additional guidance on specific steps of the process and two examples of application of MUSRA to real use cases. In addition two military UAS scenarios are proposed which are conceptually like the Pre-Defined-Risk-Assessment published by EASA for the civil sector. By testing most of the methodology on real use cases and comparing it to a civilian scenario (i.e. EASA PDRA G-03) it is possible to draw the following conclusions:

- MUSRA and the civilian approach (i.e. SORA) lead to comparable results in terms of maximum allowable probability of having a catastrophic failure. As a consequence the requirements coming from the two approaches are mostly aligned. However, UAS design and integrity requirements are generally more stringent in MUSRA than in the civilian approach for operations with a similar level of risk.
- The Air Risk process in MUSRA needs to be improved by providing fixed values of P_{cat_air} for each Traffic Conflict Risk category. With the current approach it could be difficult to justify the value chosen between the proposed intervals. In addition a value of P_{cat_air} needs to be associated also with TCR-4 to allow for a better quantification of the adjacent airspace risk.
- As already identified in the review phase of D2, the Design and Integrity Assurance Checklist (DIAC), needs to be fully revised. In addition to the comments provided by the reviewers of D2, other parts need to be clarified to better guide the applicant in determining the correct score and provide the related evidence. Moreover, adapting the DIAC could also improve the alignment between the civil and the military approach for design integrity requirements in low risk use cases.

The above points will be addressed in the second phase of the project that is going to start in September 2022. In particular, as part of the regular maintenance and update of the methodology that was presented in section 5, the required improvements will be implemented in MUSRA together with any other feedback received from EDA pMS. These improvements will address the methodology itself, the development of additional training and guidance material and the deployment and maintenance of a supporting software tool.

The two military UAS scenarios will also be revised following the feedback received from EDA pMS and new scenarios may be proposed and included in the next releases of the methodology. In addition feedback from EDA pMS will be used to tune all the MUSRA parameters that have been set based on expert judgement (ref. Annex D of D2).

It is acknowledged that, despite being based on existing methodologies, MUSRA needs to be further validated by applying it to different use cases to test its flexibility and completeness. It is expected that the regular update process planned for the next phase of the project will help in improving the methodology and making it fit-for-purpose considering military specificities and needs.

ANNEX A Military Use Case questionnaires

This annex contains all questionnaires that the OPU needs to fill in as part of the MUSRA process. For details on the mission scenario refer to chapter 4.

A.1 Air Risk mitigations

The content of this table was edited for the aim of the use case described in chapter 4. The complete table is reported in annex C.4 of D2 - "Methodology" [RD1].

Question Number	Applicable mitigation / question	ARMS	Evidence
NOTE:	This is the Mitigations application questionnaire. To fill up the questionnaire the operator has to be fully familiar with the Air Risk Assessment process detailed by MUSRA. Once determined the Operational Environment of the operation and its TCR level, the operator can proceed to lower the TCR by applying strategic and tactical mitigations. Mitigations application has to be demonstrated through evidence.		
	Time of Exposure		
M.1	What mean(s) is applied to reduce the time of exposure to the risk and what is the impact on the latter? Are the following parameters taken into account: - evaluation of the operational risk (E.g., frequency of take-off/landing of aircraft, the density of air traffic in the operational volume, etc.); and - definition of the procedures to reduce the time of exposure.	18	Mitigation not available
	Day/time of the operation		
M.2	When does the UAS operation take part and how can it affect the risk of the mission? Are the following parameters taken into account: - evaluation of the operational risk (E.g., frequency of take-off/landing of aircraft on a specific day/time, the density of air traffic in the operational volume on a certain day/time, etc.).	18	The UAS operation is performed at night. The OPU provides evidence that: • Airports in the area only serve VFR traffic • IFR traffic routes are all designed above the maximum operational altitude of the UAS • There is coordination established with the military ATS unit to be informed about the presence of emergency or other military traffic.
	UAS transit routes/corridor		

M.3	Which UAS transit route/corridor shall be flown by the UAS during the operation? Are the following parameters taken into account: - operational characteristics of the UAS transit route/corridor (availability, dimensions, type of traffic allowed, operational limitations); and - definition of the procedures to fly the UAS transit route/corridor; and - mandatory/optional requirements needed to fly the UAS corridor/transit route (if any).	30	Mitigation not available
	Flight plan		
M.4	Is a Flight Plan filed for the intended operation? Is the information about the planned flight expected to be distributed to other airspace users by ATC?	12	Mitigation not available
	Dangerous area		
M.5	Is the area and characteristics of the operation notified by the issue of a NOTAM for "Dangerous Area"? Is the Dangerous area reserved for UAS operations only or does it allow other military activities?	6	Mitigation not available.
	U-space strategical services		
M.6	Which U-space service(s) is used for the intended operation? What is the expected impact on the operation when the U-space service(s) mitigation has been applied? Is the performance level of the U-space service assessed and guaranteed?	30	Mitigation not available
	Increased separations		
M.8	Are there increased separations applied? What kind of increased separations are applied for the intended operation and how do they reduce the risk? Are the following parameters taken into account: - operational characteristics of the operational environment (airspace dimensions and class, operational limitations); and - definition of the increased separations procedures; and - requirements needed to cover the increased separations procedures.	15	Mitigation not available
	Coordination/Communications with ATS units		
M.9	Do you implement coordination with the ATS unit? Do you implement communications with ATS unit? Are the following parameters taken into account: - ATS unit(s) involved in coordination; - definition of the impact of this mitigation on the operation;	12	Procedures for coordination and communications with military ATC are established in order to maintain the situational awareness about other traffic in the area.

A.2 Minimum Detect-and-Avoid Checklist – MDARC

The following table contains the evidence of the implementation of the MDARs related to the use case described in chapter 4.

Question Number	Question or Minimum Detect-And-Avoid Requirements (MDAR)	Supplemental Information	Evidence
NOTE:	This is the Minimum Detect-And-Avoid Requirements Checklist (MDARC). To fill up the questionnaire the OPU has to be fully familiar with Air Risk Assessment process detailed in the "MIL-UAS-SPECIFIC D2 Methodology" document. Once determined the Final TCR, the operator can proceed to fill in this questionnaire to verify compliance with the MDAR. Compliance with MDAR has to be demonstrated through evidence.		
TCR 2			
VLOS/EVLOS			
MY.1	Is there a de-confliction scheme that explains how the detection is carried out, what criteria are applied to decide to start an avoidance manoeuvre and how this is implemented?		Not applicable
MY.2	If an airspace observer is used to aid the pilot in detecting other traffic, Is there a phraseology protocol to be used among the Remote Flight Crew?		
MY.3	If the de-confliction scheme requires radio communication between Flight Crew members, is the maximum latency of the communications system less than 15 seconds?		
BVLOS			
MY.4	Is the UAS equipped with a DAA system that was assessed by the NMAA as adequate for TCR 2 environment?		The DAA system is adequate for TCR 2. It is composed of a radar for the detection of non-cooperative traffic and an ADS-b transponder to detect cooperative traffic.
MY.5	Is the detection system used by the DAA able to detect most of the traffic in the detection volume?	Depending on the type of traffic that can be encountered some sensors maybe not effective. (e.g. Mode-S transponders in uncontrolled airspace.	The non-cooperative pulse doppler radar operating in X band can detect VFR traffic not equipped with ADS-b within a range that allows avoidance manoeuvre to be executed.

			The ADS-b transponder allows to detect cooperative traffic.
MY.6	Is there a de-confliction scheme that explains how the detection is carried out and what criteria are applied to decide to start avoiding incoming traffic?		A de-confliction scheme is available. It is adequate for the use and for the potential type of incoming traffic (IFR and VFR flights). It is based on the execution of avoidance manoeuvres in the horizontal plane and loitering on specific locations.
MY.7	Is there a phraseology protocol to be used during the support of the DAA system?		Not applicable.
MY.8	If the UAS is not equipped with any DAA system, what external service is used to detect other traffic (Monitoring aeronautical radio communication, relying on defence radar capability, U-space)? Is the system selected able to effectively provide awareness about most of the traffic in the detection volume? Is the Maximum Command-to-Execute latency not exceeding 5 seconds, and the Normal Command-to-Execute latency not exceeding 2 seconds? Is the UAS rate of descent at least 500 ft/min? Is the maximum latency for an intruder and own aircraft vector less than 10 seconds with a minimum update rate of 5 seconds? Is the failure probability of the external system lower than 1E-2/FH?		The maximum Command-to-Execute latency is less than 2 seconds. The same applies to the Normal Command-to Execute latency. The UAS has a Descent rate of 1400 ft/min. The maximum latency for an intruder is less than 10 seconds with a minimum update rate of 5 seconds.

A.3 Design and Integrity Checklist – DIAC

Requirement	Proof of Evidence	Type of requirement	Partial Score applicable to the Method of Compliance	Max. Score	SCORE	RATIONALE
1. ORGANISATION						
1.1 The UAS design and production organizations must be certified as per AS/EN ISO 9100/ ISO 9001 for undertaking UAS design and production activities, and should deliver evidence of usage of approved processes for management of safety within the design and production of systems, or as an alternative comply with EMAR-21 Subpart G (or F) and J.	**Doc.**	**Mandatory**	If the applicant is certified per ISO 9001 (generic quality system), for the design and production of the platforms **(1)([+1*)** If the applicant is certified per AS/EN ISO 9100 (specific for aerospace manufacturers), for the design and production of the platforms. **(3) (+1*)** If the applicant shows evidence of compliance to EMAR-21 (Subpart G or F) and J **(5);** If the applicant has no certification **(0) (+1*);** * If the applicant shows evidence of the procedures for the management of safety issues within the design and production of systems	**5**	**4**	**The design and production organization are EN-9100 certified.** **Dedicated internal procedure covers the management of safety issue within design and production.**
1.1.1 The applicant shall deliver a copy of the Quality Manual.	**Doc.**	**Desirable**	Work is undertaken by competent individuals (trained and qualified) **(1)** Adequate facilities, with adequate tools, material, procedures, and data **(0.8)** Safety culture is demonstrated: - The documented statement of the quality policy shall include explicitly system safety as one of the main objectives; - Safety management processes are implemented **(0.2)**	**2**	**2**	**Dedicated procedure cover the training and qualification of individuals.** **Facilities have adequate tools, materials, procedure and use data released by the design organization.** **Safety management process are implemented**
1.2 The applicant shall demonstrate that the materials and manufacturing processes used in the construction of the UAS are adequate.	**Doc.**	**Desirable**	The suitability and durability of materials used are established on the basis of experience or tests. **(0.3)** Materials conform to approved specifications; **(0.7)** Manufacturing processes conform to recognized standards; **(1)**	**2**	**1.3**	**Composite materials are used whose suitability and durability are established on the basis of experience and test.** **The design and production organization are EN-9100 certified**

Requirement	Proof of Evidence	Type of requirement	Partial Score applicable to the Method of Compliance	Max. Score	SCORE	RATIONALE
1.3 The applicant shall demonstrate that the materials and manufacturing processes used in the construction of the UAS are adequate.	**Doc**	**Desirable**	- Critical parts/systems/components are inspected by special/detailed procedures after manufacture (or before installation) for all items; **(1)** - Critical parts/systems/components are inspected by special/detailed procedures after manufacture (or before installation) on a sampling basis; **(0.7)** - Critical parts/systems/components are inspected after manufacture (or before installation) for all items, but without any special/detailed procedures; **(0.2)** - Critical parts/systems/components are inspected after manufacture (or before installation) on a sampling basis, but without any special/detailed procedures; **(0.1)** - No inspection is made **(0)** Notes: For structural part a special/detailed procedure is to be considered NDT or similar test; For systems/avionics, functional tests are to be considered;	**1**	**1**	**All critical parts are inspected by means of dedicated NDT procedure. Avionics and Electric equipment are tested and inspected before installation and tested at system level before production release**
1.4 The applicant must demonstrate the existence of a process to manage design changes and communicate these to the Operators.	**Doc**	**Desirable**	- A process exists to communicate to known operators the Mandatory design changes; **(0.25)** - The control of the implementation of these design changes is traced by the manufacturer; (actual feedback) **(0.05)** - The organisation has a way (e.g. database) to properly identify which platform was delivered with which version of the systems **(0.2)**	**0.5**	**0.5**	**Appropriate processes and procedure (including communication) manage design changes and configuration control by the Design Organization.**
1.5 The applicant shall ensure that the operator is educated about the criticality of configuration management processes for the UAS.	**Doc.**	**Desirable**	Through developed informatics system **(0.5)** This shall be done through the delivery of Manuals, through Training; **(0.3)**, or another type of configuration management system **(0.3)**	**0.5**	**0.3**	**No informatics system available. Manuals and related supplements or temporary revision are delivered to the operator and dedicated set of logbooks are used for managed the configuration of UAS.**
2. DESIGN STANDARDS						

Requirement	Proof of Evidence	Type of requirement	Partial Score applicable to the Method of Compliance	Max. Score	SCORE	RATIONALE
2.1 The applicant shall show evidence of the design criteria and standards used to design the UAS structure, engine, propeller, and UAS systems and equipment. Note: the following questions are meant to be answered for the aircraft's critical systems, powerplant, critical structures, flight control subsystems (autopilot, actuators).	**Doc.**	**Desirable**	1. Does the organisation design its engines and propellers? (if yes) 1.1 Does the design consider standards for the design of engines and propellers? (if yes) Y1.1.1 Are the standards recognized for aeronautics? Yes=**(0.5)** Y1.1.2 Are the standards considered adequate? Yes=**(0.5)** (if no) 1.2 Does the organization have adequate control over the norms and specifications of the engines and propellers included in the platforms? (if yes) Y1.2.1 Are the norms and specifications recognized for aeronautics? Yes= **(0.5)** Y1.2.2 Are the norms and specifications considered adequate? Yes=**(0.5)** 1.3 Is the manufacturer of the props and engines recognized for the manufacture of these items within the market? Yes=**(0.5)** 1.4 Are the engines and props used in other platforms (from other manufacturers) with adequate reliability? Yes=**(0.5)** Aerospace standards and practices used to design UAS structure, engine, propeller and UAS systems and equipment are to be considered as best.	**2**	**1**	**Engine and propeller are provided by supplier. Norm and Specification are considered adequate. Propellers are used in other platform and the manufacturer is recognized. Engine manufacturer is relatively young in the sector.**
3. TESTED USAGE SPECTRUM						
3.1 The applicant shall deliver the design usage spectrum as well as the set of all the foreseen operational conditions of the UAS	**Doc**	**Mandatory**	1. Velocities **(0.5)** 2. Load Factors **(0.5)** 3. Weather (Wind, Rain, moist) **(0.5)** 4. Altitude **(0.5)** 5. MTOM **(0.5)** 6. Performance (climb rates, max bank, sideslips) **(0.5)**	**3**	**3**	**The design usage spectrum of the Falco Maritime cover all the necessary information like mission profiles with velocities and altitude. It defines also load factor, MTOW and target performance, climatic zones etc.**
3.2 The applicant shall show evidence of how the design spectrum was defined.	**Doc.**	**Desirable**	Flight Testing **(0.13)** + Lab Testing **(0.06)** + Ground Testing **(0.06)** Has enough and adequate testing been performed? **[0 to 1.0]**	**1.25**	**1.25**	**The design usage spectrum was defined initially by dedicated analysis and simulation and subsequently confirmed by adequate lab, ground, and flight test.**

Requirement	Proof of Evidence	Type of requirement	Partial Score applicable to the Method of Compliance	Max. Score	SCORE	RATIONALE
3.3 The applicant shall show evidence of the in-service experience accumulated.	**Doc**	**Mandatory**	To what extent do you consider the experience to be sufficient, w.r.t i. number of in-service units; ii. number of known operators; iii. number of Known flight hours; iv. other produced and in-service models? To what extent do you consider the flight testing to be representative of the actual platform and configuration? - Same platform with same configuration **[1.0]**; - Different Powerplant **[-0.2]**; - Diff mainframe **[-0.5]**; - Diff autopilot **[-0.15]**; - Surface actuators **[-0.15]**;	**1**	**1**	**Number of Know Flight hours even if with little differences in the payload configuration. Flight testing is considered representative considering that the platform is the same with the same configuration.**
3.4 The applicant shall show evidence that flight experience and/or in-service experience has demonstrated that the design is free from unsafe features in the complete operational spectrum.	**Doc**	**Mandatory**	Has any major system of the platform been involved in unsafe/accident conditions or has the applicant been informed or is aware of past/recent accidents with the platform, regardless of configuration? No=**(0.5)** Note: This shall be demonstrated (for a configuration similar to the proposed UAS) through a statement referring to the ratio of known occurrences per flight hour, the number of investigations conducted, the number of necessary redesigns, and the number of eventual unsafe conditions identified. If no occurrence exists, the applicant must STATE that no occurrence has been reported by the operators in the total of Known flight hours.	**0.5**	**0.5**	**No occurrences have been reported with reference to the UAS object of this DIAC.**
3.5 The applicant shall show evidence that all safety-critical equipment is functioning properly throughout the full tested operational envelope when integrated into the UAS system (including ground station, datalink equipment, air vehicle, etc.).	**Doc.**	**Desirable**	Is there a way of ensuring that the systems have been fully tested at their functional level before installation on the platform? Yes=**(0.4)** Is there a system to ensure that when the system identifies problems, these problems are researched and corrected? Yes=**(0.1)** Note: This shall be made through: Functional tests of the safety-critical systems including ground station, datalink equipment, air vehicle, etc.) for the operational envelope; Safety analysis for the safety-critical functions;	**0.5**	**0.5**	**Safety critical equipment and subsystem was fully tested with reference to the operational envelope of the UAS. An occurrence reporting system is in place in order to have information about issues and take the relevant corrective actions.**

Requirement	Proof of Evidence	Type of requirement	Partial Score applicable to the Method of Compliance	Max. Score	SCORE	RATIONALE
3.6 The applicant shall show evidence of the existence of a system to track problem reports from development and qualification tests of the UAS.	**Doc.**	**Mandatory**	Is there a way to follow or track Open Problem Reports (OPR)? Yes=**(0.5)** Note: Approved Organization Manual with Statement with identification of the section in the approved organization manual where the system is identified.	**0.5**	**0.5**	**A dedicated tool is in place to track problem reports during the development phase and during the qualification phase.**
3.7 The applicant shall show evidence of the state of all the problem reports, that have derived from the development and qualification of the UAS.	**Doc.**	**Desirable**	Is there a system to identify the state of the open problem reports that are derived during and qualification phase? Yes=**(0.25)** Note: The applicant shall state all the reported problems that have derived from the development and qualification of the UAS. If there are open problems yet under investigation, the applicant must identify eventual limitations to the UAS operating Manual that derive from the ongoing investigation of those reports.	**0.25**	**0.25**	**A dedicated tool is in place to track problem reports during the development phase and during the qualification phase. All the open reports are evaluated (depending on the development / qualification phase) to define possible limitations or mitigation and to define the corrective action.**
4. STABILITY AND CONTROL/NAVIGATIONAL PERFORMANCE AND EMERGENCY CONDITIONS						
4.1 The applicant shall show evidence that the UA is stable and controllable in all sequences of flight and on-ground (as applicable), in all operational modes, throughout the full operational envelope. Note: Including wind conditions as applicable, phases of take-off/launch, and landing/recovery in the worst environmental condition (including wind).	**Doc.**	**Mandatory**	The applicant shall show evidence of complete testing of the aircraft for the limits of the flight envelope and the A/C was shown to be stable and controllable for all the extent of the flight envelope. - when the analysis is performed **(0.5)** - rig tests **(0.5)** - flight tests **(1)** - quantitative evidence of adequate gain/phase margins **(0.25)** - including adequate flying qualities **(0.25)** - Include the phases of take-off/launch and landing/recovery; **(0.25)** - The test of these phases includes the worst environmental condition considered in the usage spectrum **(0.25)**	**3**	**2.75**	**The kind of UAS has more than 5000 FH of activity. In addition the UAS was internally qualified by means of dedicated analysis, rig, ground. Flight test campaign (including take-off and landing phase) were performed for performance, handling qualities, stall characteristics etc.**

Requirement	Proof of Evidence	Type of requirement	Partial Score applicable to the Method of Compliance	Max. Score	SCORE	RATIONALE
4.1.1 The applicant shall show evidence that operational procedures exist for the phases of take-off/launch and landing/recovery.	**Doc.**	**Mandatory**	Is there evidence that these procedures are implemented in the Operations manual or the Flight manual? Yes=**(0.5)** No=**(0)** Is there evidence of analysis of procedures of operation at the level of safety **(0.5)** Note: Sufficient evidence of the assessment of the procedures w.r.t the levels of safety and mitigation of any safety issues that have been identified. The flight manual should include the cautions of each operational procedure.	**1**	**1**	**UAS is accompanied by a dedicated set of manuals, including a Pilot Operating Manual that reports the relevant take-off and landing procedure. Each procedure was fully tested for its validation.**
4.2 The applicant shall show evidence of the existing flight control protecting System functions for: **- Stall;** **- speed exceedance;** **- overload;** **- dangerous oscillations;** **- spinning.**	**Doc.**	**Mandatory**	Evidence of existing control protecting System functions for: - Stall; **(1)** - speed exceedance; **(0.5)** - over-load; **(0.5)** - dangerous oscillations; **(1)** - spinning; **(0.5)** Note: This evidence must be delivered in the form of documentation	**3.5**	**1.5**	**The UAS has the following protection: Stall and overspeed.**
4.2.1 The applicant shall show evidence of all UAS features which are meant to minimise the effects of the operator mistake. (in all operational modes including direct piloting and semi-automatic modes as applicable).	**Doc**	**Desirable**	Evidence of UAS features: - including direct piloting; **(0.5)** - semi-automatic modes as applicable **(0.5)** - fully automatic mode **(0.5)** **Note**: Score is based on how many protections (and their margin) are in place. The Design Organization should provide information about protection requirements and corresponding evidence. If requirements and evidence are not provided score is zero.	**1.5**	**1.5**	**Automatic, semi-auto modes and direct modes are available.**

Requirement	Proof of Evidence	Type of requirement	Partial Score applicable to the Method of Compliance	Max. Score	SCORE	RATIONALE
4.3 The UAS should be stable and controllable after failure of sensors and primary aerodynamic control surface actuation (even if only in a degraded mode).	**Doc**	**Desirable**	The applicant shall provide documentation demonstrating that the UAS maintains some stability and controllability, after failure of sensors and primary aerodynamic control surface actuation: - Pitot tube/ IAS failsafe **[0.5]**; - IMU Failsafe **[0.5]**; - GPS Failsafe **[0.5]**; - Fail-safe design for main flight controls surface actuation **[1.5]**; alternatively by: Demonstration by test evidence of ability to control after failure: - Pitot tube/ IAS failsafe **[0.5]**; - IMU Failsafe **[0.5]**; - GPS Failsafe **[0.5]**; - Primary aerodynamic control surface **[1.5]**	**3**	**2.5**	**Fail-safe design for sensors and primary aerodynamic control surface are implemented in the UAS.**
4.4 The applicant should demonstrate a minimum level of navigation precision adequate for the mission profile, and the precision tolerances shall be provided in the operational manual of the UAS.	**Doc**	**Mandatory**	- GPS PDOP values; **(0 to 1.5)** - Is the UAS capable of SBAS augmentation? **Yes =(0.1)** - Nav Solution: • Wind < half of cross-max limit: min req: 10x max dimension of AC. **(0.2)** • and wind > half of cross-max limit, min req: 15x max dimension of AC. **(0.2)**	**2**	**1.7**	**A minimum level of navigation precision adequate for the mission profile is established , and the precision tolerances is provided in the operational manual of the UAS**
4.5 The UAS must include means to monitor and indicate the UAS health status (including Data Link) to the Designated UAS Operator throughout the mission profile.	**Verification & DOC**	**Mandatory**	Proof of the following must be included: - Is there a way of monitoring the UAS data link on the Operator GCS? Yes=**(0.5)** - Has the UAS monitoring link been tested through flight testing? Yes=**(0.75)** - Does the system indicate loss of link through visual or sound warning? Yes=**(0.375)** - Does the system indicate loss of link through RSSI (Received Signal Strength Indication), link of another indicator? Yes=**(0.375)** **Note: If this function does not exist, the UAS will fail.**	**2**	**1.8625**	**GCS in equipped with a dedicated operator console for link parameters control, including RSSI. Visual warning is provided in case of link loss (no aural warning). Dedicated flight test was performed for link verification.**
4.5.1 The datalink performance must be shown to be sufficiently robust for the type of operations, ranges, and environment of	**Test**	**Mandatory**	Test description: The applicant shall demonstrate by flight test adequate datalink level throughout a mission comprising operation near other systems,	**2**	**2**	**Dedicate flight test campaign was performed for the evaluation of datalink. No link loss event**

Requirement	Proof of Evidence	Type of requirement	Partial Score applicable to the Method of Compliance	Max. Score	SCORE	RATIONALE
the UAS.			maximum operation altitude, and maximum range. Notes - **If more than 3 short datalink losses are verified the UAS will fail. (PLATFORM is not accepted)** - If no datalink loss is verified fails during the test **(2)**; - If less than 3 datalink loss are verified **(1)**			**occurred.**
4.6 The UAS shall maintain safe operation in case of datalink loss.	**Doc.& Test**	**Mandatory**	The applicant shall show evidence of procedure for loss of datalink in the Operation Manual (Mandatory) - loss of datalink for short period and long period with adequate warning of operators; **(0.75)** - possibility of recovery of mission profile, upon reset of datalink **(0.25)** - existence of return to home (RTH) procedure: **(0.5)** - existence of a safe landing procedure for loss of datalink **(0.5)** Additionally, the applicant shall demonstrate by flight test that a data link loss will not initiate unsafe operation or flight of the UAS. (Mandatory).	**2**	**1,5**	**Pilot operating handbook show abnormal and emergency procedure for link loss event. Return home procedure available. Parachute activation as a last chance.**
5. GROUND CONTROL STATION/CONTROL BOX						

<table>
<tr><th>Requirement</th><th>Proof of Evidence</th><th>Type of requirement</th><th>Partial Score applicable to the Method of Compliance</th><th>Max. Score</th><th>SCORE</th><th>RATIONALE</th></tr>
<tr><td>5.1 The UAS MUST include means to interact with the Operator (Human-machine Interaction), allowing for the management of the mission workload and safety.</td><td>Doc.</td><td>Mandatory</td><td>The following information must be provided to the operator, depending on the type of operation/distance to the operator:
For UAS intended to be flown within <u>VLOS</u>:
- Elapsed Flight time
- remaining battery/fuel
- audible buzzer for low battery/fuel
- visual/ audible warning for low link / RSSI
(0.5 if all the above are satisfied; 0 otherwise)

For UAS intended to be flown <u>BVLOS</u>:
- Elapsed Flight time
- remaining battery/fuel
- visual/ audible warning for low battery/fuel
- visual/ audible warning for low link / RSSI
- GPS status (PDOP/HDOP + Satellites)
- Link and RSSI indication
- Altitude
- attitude
- airspeed
- distance to the home point
- navigation solution status
- engine power or RPM
- control surface deflection command
(0.5 if all the above are satisfied; 0 otherwise)

WORKLOAD
(Estimated by the evaluator, through the analysis of the procedures that an operator must execute for loading and executing a new flight plan -> software shall ask the applicant to copy-paste the operating procedures for change and execution of a new flight plan in less than 1500 characters);
(0-1 to be determined by evaluator x 0.5)

Compliance shall be demonstrated by the existence of these functions in the Operation Manual.
<u>Note</u>: If HMI and workload aspects are not considered a negative score of -5 is be assigned.</td><td>1</td><td>0.5</td><td>UCS consoles, monitors and commands are designed considering HMI aspects. All those information is provided to the operator:
- Elapsed Flight time
- remaining battery/fuel
- visual/ audible warning for low battery/fuel
- visual/ audible warning for low link / RSSI
- GPS status (PDOP/HDOP + Satellites)
- Link and RSSI indication
- Altitude
- attitude
- airspeed
- distance to the home point
- navigation solution status
- engine power or RPM
- control surface deflection command</td></tr>
<tr><td>5.1.1 The information provided by the UAS to the operator must be sufficient, clear, unambiguous and should be readable in the worst light conditions.</td><td>Verification</td><td>Mandatory</td><td>The applicant shall show an image or document describing the operator interface with all items identified before duly highlighted.
(Verification of quality of information: Clear, complete unambiguous [0.3])

The applicant shall show evidence of GCS modifications that will assure</td><td>0.5</td><td>0.5</td><td>HMI was considered taking into account during the development activities considering also the feedback by the Experimental Pilots. In addition dedicated UCS light test was performed in order to verify</td></tr>
</table>

Requirement	Proof of Evidence	Type of requirement	Partial Score applicable to the Method of Compliance	Max. Score	SCORE	RATIONALE
			operator readability in worst light conditions (e.g., screen protection for outdoor tactical GCS or high contrast screens, lateral view angle) **(0.2)** Note: If information is considered insufficient the UAS will fail			**correct readability and discernibility.**
5.1.2 The UAS must show an adequate warning for malfunctions, failures, or any unsafe condition.	**Doc.& Verification**	**Mandatory**	The applicant shall show an image or document describing the operator interface with all itemsidentified before duly highlighted. Compliance shall be demonstrated by the existence of these functions in the OperationManual. **(0.5)** **Note: If warnings are considered insufficient the UAS will fail**	**0.5**	**0.5**	**Dedicated CWP (Cockpit Warning Panel) is present in the UCS and adequately described in the Pilot Operating Handbook.**
5.1.3 The UAS shall provide to the operator information about limit exceedances and unsafe conditions of the UAS.	**Doc.& Verification**	**Desirable**	The applicant shall show an image or document describing the operator interface with all itemsidentified before duly highlighted. Compliance shall be demonstrated by the existence of these functions in the OperationManual. **(1)**	**1**	**1**	**Dedicated warning and caution indication are available in UCS for limit exceedance and unsafe attitude of the UAS.**
6. STRUCTURAL INTEGRITY						
6.1 The UAS shall have defined the maximum operating limits for all the conditions (flight, ground, launch, recovery, transportation, handling, etc)	**Doc.**	**Mandatory**	Limits are to be established the Operation Manual. (Limits to be described in the manual: Load factor, Speeds, rate of climb, max RPM, altitude, turn radius, attitude limits) (**0 to 1** based on evaluator's experience)	**1**	**1**	**Limits are defined and reported in forms of diagrams/graphs in the Pilot Operating Handbook**
6.1.1 The applicant shall show evidence that the UAS withstands, without rupture, the maximum operational loads multiplied by an adequate factor of safety, at each critical combination of parameters.	**Doc.**	**Mandatory**	The applicant shall deliver the Structural demonstration. (**0 to 2** based on evaluators experience) **Notes:** Maximum score may be achieved when loads are established based on recognized aerospace standards and quantitative evidence of positive margin of safety on primary structural elementsare shown by an adequate combination of analyses and tests.	**2**	**2**	**Structural performance is substantiated through analysis and test.**
6.1.2 The applicant shall show evidence that all the structurally relevant metallic, composite and polymeric parts of the UAS do not yield (metallic) nor fail / permanently deform at the maximum operational loads.	**Doc.**	**Desirable**	The applicant shall deliver the Structural demonstration. (**0 to 1** based on evaluators experience)	**1**	**1**	**Structural performance is substantiated through analysis and test.**

Requirement	Proof of Evidence	Type of requirement	Partial Score applicable to the Method of Compliance	Max. Score	SCORE	RATIONALE
6.2 Is there evidence that fatigue inspections are put into the maintenance program for metallic and/or BVID inspections for composite structures?	**Doc.**	**Desirable**	The applicant shall deliver the maintenance program. The applicant shall identify all components with fatigue limits. **(0 to 0.2)**	**0.2**	**0.1**	**Dedicated inspections are defined in the Preventive Maintenance Manual.**
6.2.1 The UAS maintenance programme should include a pre-flight checklist considering composite parts inspection for identification of damages.	**Doc.**	**Desirable**	The applicant shall deliver the maintenance program **(0.3)**	**0.3**	**0.3**	**UAS maintenance program include a pre-flight checklist**
6.2.2 The applicant shall deliver a maintenance program that is able to ensure the structural integrity of UAS integrity throughout its service life	**Doc.**	**Mandatory**	The applicant shall deliver the maintenance program, which is to be evaluated forsuitability. Areas to be considered in the maintenance program **(1.5)**: - Corrosion inspections - fatigue inspections - life limit components - engine - main structural components	**1.5**	**1.5**	**The UAS maintenance program ensure the structural integrity of UAS throughout its service life**
7. PROPULSION AND FEEDING SYSTEM INTEGRITY						
7.1 The applicant shall demonstrate the reliability of the UAS propulsion system. The following standards may be used: a) ASTM F3298 − 19 - Standard Specification for Design, Construction, and Verification of Lightweight Unmanned Aircraft Systems (UAS), b) ISO 21384-2:2021 UAS — Part 2: UAS Components.	**Test**	**Mandatory**	Applicant shall deliver detailed report of: - Inspections / maintenance during test cycle **(0 to 1)** - Inspection after tear down of powerplant **(0 to 1)** - Classification **(0 to 1)**, with **0** = no report submitted	**3**	**2**	**Dedicated report of Inspections / maintenance on the propulsion system are available**
7.1.1 The UAS shall demonstrate adequate engine reliability by operational experience.	**Doc.**	**Mandatory**	The applicant shall deliver a document stating the reliability of the engine, and the number of flight hours upon which that statement is based upon. A failure rate for the propulsion system should be delivered. = 3/0.8 * **[1+1/log(probability)]** NOTE: The probability of failure larger than 10-3 will have a penalty of over 50% of the total score of the current question	**3**	**2.5**	**Dedicated report of engine reliability by operational experience is available. Failure probability is 10-3/FH**

Requirement	Proof of Evidence	Type of requirement	Partial Score applicable to the Method of Compliance	Max. Score	SCORE	RATIONALE
7.2 The applicant shall demonstrate that the Engine Control System (including propeller pitch) performs the intended functions in all its control modes throughout the full operational envelope	**Test**	**Mandatory**	Have the following been assessed and passed during the test phase: - propeller pitch if applicable **(0.25)** - fuel admission control **(0.25)** - air admission system **(0.25)** - refrigeration system **(0.25)** The minimum level of demonstration of engine control system performances is Mandatory if safety-critical.	**1**	**1**	**Dedicated ground and flight test campaign were performed for verification of Engine Control System.**
7.3 For *<u>electrical engine</u>* applications, the applicant shall demonstrate that the battery provides the necessary voltage and current required by the engine and electrical equipment throughout the operational envelope.	**test**	**Mandatory**	The applicant shall: 1) Include in the Operation Manual, the minimum value of current and voltagerequired for engine and electro avionic systems functioning **(1.5)** 2) Demonstrate by a test that during a mission covering the complete mission profile the power voltage supply and the current remains above those values (plus atolerance for possible degradation of battery performances) **(1.5)**	**3**		**N/A. No electrical engine.**
7.4 For *<u>combustion engine</u>* applications, the applicant shall demonstrate that the fuel system provides the necessary fuel flow at the necessary conditions required by the engine throughout the operational envelope.	**test**	**Mandatory**	The applicant shall demonstrate by test, that during the complete mission profile, the fuel system allows for the supply of fuel for all requirements, without failures. Is there proof, under the form of a test, that the fuel system can supply the necessary fuel to the engine at all operating conditions. Yes **(0 to 1)** depending on the description of the conditions that were tested No **(0)**	**1**	**1**	**Dedicated ground and flight test campaign were performed for verification of Fuel System.**
7.4.1 For *<u>combustion engine</u>* applications, the UAS must include a filtering system adequate to avoid those foreign particles passing through the engine will not critically affect engine functioning.	**Doc.**	**Desirable**	The applicant shall deliver a document demonstrating that a failsafe design is considered for the filtering system, namely through a by-pass in the filtering device. Does the system include a filter that retains particles harmful to the engine? Yes=**(0.5)** No=**(0)**	**0.5**	**0.5**	**Fuel system include filters in order to retain harmful particles.**

Requirement	Proof of Evidence	Type of requirement	Partial Score applicable to the Method of Compliance	Max. Score	SCORE	RATIONALE

7.4.2 For *combustion engine* applications, the applicant shall demonstrate that the engine oil system will function properly in the complete UAS operational envelope.	**test**	**Mandatory**	The applicant shall demonstrate by test, that during the complete mission profile, the lubricating system works without failures, and that the engine temperature does not rise above allowable values.
			The applicant shall state if the UAS lubricating system should be protected by suitable filter(s) or strainer(s).
			
			The applicant shall show that lubricant used, and the lubrication system is adequate for the powerplant installed.
			The tests performed show evidence that:
			- The temperature did not rise above the limits **(0.5)**
			- For the oil-fuel mixture: Was there evidence of wear during tear down? **(1** if **no wear)**
			- For independence lubricant system:
			    ○ Was there a reduction of oil level below 2/3 of maximum value? **(-0.5 if answer is yes)**
			    ○ Did the oil inspection reveal any issues or particles above the limit? **(-0.5 if answer is yes)**
				1.5	**1.5**	**Dedicated ground and flight test campaign were performed for verification of Lubrication System.**

7.5.a For *electrical engine* applications, the UAS shall include means to minimize the risk of battery overheating / explosion	**Doc.**	**Desirable**	The applicant shall deliver a document demonstrating the existence of systems means tominimize the risk of battery overheating / explosion for all batteries on board (powerplant + onboard systems): - Depending on the class and type of system: ○ Should the system have a means to measure battery temperature? IF YES Is the monitoring system adequate (cooling system, temperature sensor, Active battery management system) **(0 to 2)** Note Active bat. Man. Sys. Should be given the highest value. IF NO **(1)**	**2**		**N/A. No electrical engine.**

Requirement	Proof of Evidence	Type of requirement	Partial Score applicable to the Method of Compliance	Max. Score	SCORE	RATIONALE
7.5.b For *combustion engine* applications, the UAS design should consider ventilation, drainage, fuel lines, and tanks installation to minimize fire hazards.	**Doc.**	**Desirable**	The applicant shall deliver a document demonstrating the existence of systems means to minimize the risk of battery overheating / explosion for all batteries on board: Depending on the class and type of system: - Should the system have a means to measure battery temperature? IF YES Is the monitoring system adequate (cooling system, temperature sensor, Active battery management system) **(0 to 1)** Note Active bat. Man. Sys. Should be given the highest value. The applicant shall deliver a document with a safety assessment addressing ventilation, drainage, fuel lines, and tanks installation to reduce fire hazards. Does the system show that there are physical barriers between fuel lines and tanks from electrical systems/batteries? **(0 to 1)**	**2**	**1.5**	**Batteries are kind of type that minimize the risk of explosion. Temperature sensor are installed in the avionic and engine bay. Fuel line and tank are installed in order to reduce the fire risk**
7.6.1.a For *electrical engine* applications, the UAS should have the means to measure the engine battery status (voltage, drown current, estimated battery time)	**Doc.**	**Desirable**	The applicant shall deliver a document defining how the battery status is assessed **(0.5)** The system presents estimated flight time based on battery level **(0.5)**	**1**		**N/A. No electrical engine.**
7.6.1.a1 For *electrical engine* applications, the UAS should include provisions to alert the UA operator that the battery has discharged to a level, which requires immediate UA recovery actions.	**Doc.**	**Desirable**	The applicant shall deliver a document defining the function for issuing a warning for the battery charge critical level. Does the system have the means to alert UA operators of low battery? **(1)**	**1**		**N/A. No electrical engine.**
7.6.1.b For *combustion engine* applications, the UAS should include means to measure the UAS fuel quantity during the whole mission.	**Doc.**	**Mandatory**	The applicant shall deliver a document defining how the fuel quantity measurement is made: - direct **(1)**; or - calculated from fuel flow **(0.5)**	**1**	**1**	**Fuel quantity is measured both directly (Fuel level sensor is installed) and calculated through the fuel flow.**

Requirement	Proof of Evidence	Type of requirement	Partial Score applicable to the Method of Compliance	Max. Score	SCORE	RATIONALE
7.6.1.b1 For *combustion engine* applications, the UAS should include provisions to alert the UA operator the fuel quantity has reached a level, which requires immediate UA recovery actions.	**Doc.**	**Desirable**	The applicant shall deliver a document defining the function for issuing a warning for the fuel quantity critical level. Does the system have the means to alert the UA operator that the fuel level requires immediate action? **(0.5)**	**0.5**	**0.5**	**Fuel quantity indicator is provided in the UCS MFD and dedicated caution and warning for low fuel is provided to the pilot through CWP.**
7.6.1.b2 For *combustion engine* applications, the UAS should include means to provide the operator with information about fuel quantity.	**Doc.**	**Mandatory**	The applicant shall deliver a document defining the function for providing (continuously and permanently) to the operator the fuel quantity. Does the system have the means to inform UA operators of fuel level status? **(0.5)**	**0.5**	**0.5**	**Fuel quantity indicator is provided in the UCS MFD and dedicated caution and warning for low fuel is provided to the pilot through CWP.**
7.6.2 The UAS should include means to mitigate the hazards from engine failures.	**Doc.**	**Desirable**	The applicant shall deliver a document as a safety analysis demonstrating how engine failures effects are mitigated. Namely, the assessment should consider: - There is a strategy to manage the loss of power, executed by the operator using checklists. **(1)** - There is a strategy to manage the loss of power, executed automatically by the system. **(1.5)** - Is the increase in workload compatible with operator training and experience? **(0.5)** - There is no power loss risk mitigation strategy. **(0)**	**2**	**1.5**	**UAS POH include dedicated checklist for engine failure management.**
8. SYSTEM AND EQUIPMENT INTEGRITY						

Requirement	Proof of Evidence	Type of requirement	Partial Score applicable to the Method of Compliance	Max. Score	SCORE	RATIONALE
8.1 The UAS critical equipment should be qualified for worst expected case environmental conditions the design spectrum.	**Doc.**	**Desirable**	1) Are all UAS critical equipment qualified for the worst expected case environmental conditions following the design spectrum? Yes=**(0 to 1.5)** Are there datasheets and reports confirming the qualification of the system? Yes=**(0.5)** 2) Are the UAS critical equipment tested for environmental conditions? Yes=**(0 to 1)** Are there datasheets of the equipment? Yes=**(0.5)** 3) Is there an analysis regarding the environmental conditions? Yes=**(0 to 1)**	**2**	**1**	**All UAS equipment are qualified for the environmental condition expected in service.**
8.1.1 The UAS installation provisions and the intended usage of all equipment should be designed under the qualification conditions.	**Doc.**	**Desirable**	The applicant shall deliver a document demonstrating how the environmental conditions were included in the design. This can be made (for example) through a Safety analysis with a specific risk assessment of the humidity, operating temperatures, ice conditions, etc. - Was the hazard of humidity considered in the design (Safety analysis)? Yes=**(0.5)** - Was the hazard of temperature, including icing conditions considered in the design? Yes=**(0.5)**	**1**	**1**	**Climatic condition (e.g. humidity and temperature) expected in service are considered in the design activity.**
8.2 The UAS must account for electromagnetic Effects (E) in the design	**Doc.& Test**	**Mandatory**	The applicant shall provide documentation that supports qualification and/or design features of the UAS that account for the Environmental Electromagnetic Effects (E3) The applicant shall define in UAS documentation all required operation limitations regarding E3. - A statement referring that testing and experience has posed no limits **(1)** - Limits that cause no limitation for desired operation **(0.5)**	**2**	**1,5**	**EMC condition expected in service are considered and verified during the design activity.**

Requirement	Proof of Evidence	Type of requirement	Partial Score applicable to the Method of Compliance	Max. Score	SCORE	RATIONALE
			- Limits that penalize operation **(0.5)** <u>Note:</u> The applicant is required to demonstrate by the test that the UAS is safe when in operation within the established limitations. This test must include ground station, datalinkequipment, air vehicle, etc.) If failures or inadequate E3 behaviour occurs during a demonstration, the UAS may be penalized with a negative score **up to -20**			
8.3 The UAS electrical design should be robust and designed to function in the worst foreseen conditions.	**Doc.**	**Desirable**	Did the applicant provide documentation that supports the adequate design of electricalsystems? Yes=**(0.2)**	**2**	**0.2**	**Electrical system performance is verified through analysis and test.**
8.3.1 The UAS electrical capacity generation must be adequate for the intended use.	**Doc.& Test**	**Mandatory**	The flight manual must specify the maximum flight endurance. Does the flight manual include the maximum flight endurance? Note: If this is not demonstrated, the UAS platform will fail. A test must be performed without failure of the electrical system for at least 1.5 times the number of allowable hours, with all systems working. Is there test-based evidence that the electrical system sustained full 1.3 times the maximum flight endurance? No=**(0)** If Yes Is there test-based evidence that the electrical system sustained full 1.5 times the maximum flight endurance? Yes=**(1.8)**; No=**(0.9)**		**1.8**	**Electrical system is adequate for the expected service conditions and its performance is verified through analysis and test.**
8.3.2 The UAS backup energy system must allow for UAS recovery and/or safe flight termination the duration defined by the flight manual.	**Test**	**Mandatory**	A test demonstration must be made for UAS recovery and/or safe flight termination with only the backup energy system. Is there evidence that the UA is controllable or that flight termination can be asserted on a backup battery only? **Yes -> pass** **No -> fail** Note: If this is not demonstrated the UAS platform will fail.		**pass**	**Backup energy system is sized for assure the UAS safe flight termination/recovery. Electrical system performance is substantiated through analysis and test.**

Requirement	Proof of Evidence	Type of requirement	Partial Score applicable to the Method of Compliance	Max. Score	SCORE	RATIONALE
8.4 The UAS should be designed to incorporate means for fault detection/fault isolation / fault management.	**Doc.**	**Desirable**	The UAS design should incorporate a sufficient set of Built-In-Tests (BIT): - power-up self-test **(0.25)** - computers check-sum **(0.125)** - (D)GPS receiver failure indication from power-up **(0.2)** - System health (processor, data packages, memory) **(0.2)** - Navigation solution **(0.1)** - Self-test or background BIT **(0.125)** - motherboard under-voltage detection **(0.5)** - temperature monitoring **(0.5)**	**3**	**1.15**	**The UAS design incorporate means for fault detection and management.**
8.4.1 The UAS should have procedures established to mitigate the effects of detected faults.	**Doc.**	**Desirable**	The UAS should have procedures in place to respond to the faults identified by the system. The system responds to faults identified: - Automatically **(0.8)** - Through operator input **(0.5)** - Automatic with operator cross-check **(1)**		**1**	**The UAS implement various methodology to respond to the faults identified by the system depending on the criticality and type of fault.**
9. SAFE DEMONSTRATION						
9.1 The UAS design should include Functional Hazard Analysis and a Failure Mode Effect and Criticality Analysis for the critical functions.	**Doc.**	**Desirable**	**All failure modes should be identified. The failure mode analysis should address:** - The UAS platform, including actuators, powerplant, lift surfaces surfaces/devices, wheels/landing gear **(1)** - UCS/UCB, including autopilot, sensors, IMU, control boards, central processing computer, cables to actuators **(1)**	**3**	**3**	**UAS level FHA and system level FHA were issued.**

Requirement	Proof of Evidence	Type of requirement	Partial Score applicable to the Method of Compliance	Max. Score	SCORE	RATIONALE
			- Data Link and any other equipment necessary to operate the UAS), including data link module (RF module), cables to antennas, and antennas **(1)**			
9.2 The UAS design should incorporate mitigations established for all failure modes identified.	**Doc.**	**Desirable**	Are all failure modes identified? **(1)** Are respective mitigation strategies established and documented? **(1)**	**2**	**2**	**All failure modes are correctly identified by the relevant FHAs. Mitigation strategies are in place for particular failure conditions.**
9.3 The applicant must provide an FTA for the UAS cumulative probability of uncontrolled flight/crash.	**Doc.**	**Mandatory**	If the FTA is not done and we do not have a quantitative value for P_cum_cat, but all safety-critical systems are fail-safe and/or all safety-critical system failures are mitigated in such a way not to have an uncontrolled crash scenario, the total score of 100 could get a penalization of -20 points. If only some systems are fail-safe and/or mitigated adequately, the total budget of 60 points between maximum penalization (-80 if nothing is done on safety) and minimum penalization (-20 without FTA but fail-safe design of all safety-critical systems) could be equally split among safety-critical systems. Penalization will be calculated as: **Score = [-20 – (60/num_of_critical_sys) *num_of_non_redundant_sys] *ClassFactor** With reference to weight classes: - weight < 4kg ClassFactor = 0; - weight <25kg ClassFactor = 1/8; - weight <150kg ClassFactor = ¼; - weight >150kg ClassFactor = 1;		/	**A cumulative probability of uncontrolled flight/crash is available and is supported by an FTA.**

Requirement	Proof of Evidence	Type of requirement	Partial Score applicable to the Method of Compliance	Max. Score	SCORE	RATIONALE
9.4 The cumulative probability of uncontrolled flight/crash of the UAS should be inferior to 10^{-4}	**Doc.**	**Desirable**	If the Probability of failure is bigger than 10-4 the number of points to be removed is as follows: Points removed $= 100 + 14{,}5 * \ln\left(\frac{P\_failure}{0{,}1}\right)$ 10^{-4}: **No penalty** 10^{-3}: **- 33** 10^{-2}: **- 66**		**No penalty**	**A cumulative probability of failure is assessed to be less than 10^{-4}.**
10. SOFTWARE INTEGRITY						
10.1 The applicant should deliver a safety assessment to identify all the software critical functions of the UAS for the lifecycle, including flight control, propulsion, electrical power, etc. **10.1.1 The applicant should deliver documented life cycle assurance processes to deal with the SOFTWARE UAS critical functions.** **10.1.2 Software integrity should be considered in the design of the UAS.**	**Doc.**	**Desirable**	If weight < 4Kg **(10)** + following questions x 0.3; If weight <25kg **(7.5)** + following questions x 0.5; If weight < 150kg **(5)** + following questions x 0.6; If weight > 150kg **(0)** + scores given by DO-178 DAL compliance. If the applicant delivers a safety assessment to identify all the software critical functions of the UAS for the lifecycle, including flight control, propulsion, electrical power, etc. **(3)** If the applicant delivers documented life cycle assurance processes to deal with the SOFTWARE UAS critical functions. **(4)** ******************************** (8) For Software development, the applicant should demonstrate that: **NOTE:** If software development is demonstrated per DO-178 objectives: For software that may lead to uncontrolled flight or crash: **(15)** for compliance or equivalency with DO-178 DAL B; **(5)** for compliance or equivalency with DO- 178 DAL C; **(+2 *)** **(-20)** for compliance or equivalency with DO- 178 DAL D. **(0 *)** Notes: If there is no evidence of software life cycle assurance processes, a negative score up to -50 may be assigned. ***** Extensive in-field experience with the same software configuration may be considered as a credit to increase the scores above if used with an adequate occurrence reporting system	**15**	**14**	**SW not developed according with DO-178 but following the MIL-STD-498.**

Requirement	Proof of Evidence	Type of requirement	Partial Score applicable to the Method of Compliance		Max. Score	SCORE	RATIONALE
			- requirements for software items are developed; **(1)**	for problem report collection.			
			- plans and Accomplishment Summaries to show software integrity are produced by the design organization; **(1)**				
			- an adequate number of tests is planned, performed and results are recorded; **(2)** - software problem reports are available and shown to be closed; **(1)** - configuration management processes for software are established and followed; **(2)** - in-filed experience as applicable; **(1)**				
11. CONTINUING AND CONTINUED AIRWORTHINESS							
11.1 The applicant shall provide the UAS Flight Manual, with all the approved standard operating and emergency procedures.	Doc.	Mandatory	The applicant shall provide the Flight Manual for evaluation. The operational procedures in the Flight Manual shall include (as applicable) take-off, launch, climb, descent, glide, flight in all operating modes, landing, recovery, handover, autorotation, link-loss procedures, etc). The UAS Flight Manual shall define all the operating procedures, limitations, and performance information for normal operations and emergency conditions.		1	1	**Pilot Operating Manual is provided. The manual reports the relevant normal take-off, climb, descent and landing procedure. It includes the abnormal and emergency procedure. POH is written in English in unambiguous way.**
11.2 The UAS Flight Manual shall be clear, unambiguous, and written in the English language.	Doc.	Mandatory	Does the flight manual provide all standard operating and emergency procedures? Attention to: All operating modes, landing, recovery, handover, autorotation, link-loss procedures **(0.5)**				

Requirement	Proof of Evidence	Type of requirement	Partial Score applicable to the Method of Compliance	Max. Score	SCORE	RATIONALE
			Is the flight manual written in English in an unambiguous way? **(0.5)**			
11.3 The applicant shall provide the maintenance manual with all necessary instructions for ensuring continuing airworthiness.	**Doc.**	**Mandatory**	Was a Maintenance Manual delivered with the system? No=**(-10)**; Yes=**(0 to 1)** <u>Attention to:</u> - life-limited parts, equipment inspection intervals, and techniques, equipment standard repairs and maintenance, corrosion prevention, etc. - All UAS systems and sub-systems, including the propulsion system, airframe, electrical system, fuel system, lubrication system, avionics, sensors calibration, actuators, communication system, ground station; - Transport and handling information - Airframe inspection intervals and techniques are described adequately in the operational manuals; - Identification of the airframe repairs standard. - Health tracking monitoring equipment and procedures of safety-critical systems. - Specification of safe storage conditions. - Identification of corrosion-related inspections. **Note:** Lack of instructions for continuing airworthiness or inadequate MaintenanceManual may be penalized with a negative score up to **-10.**	**1**	**1**	**A maintenance manual provided all necessary instructions for ensuring continuing airworthiness of the UAS**
11.4 The applicant should provide a pre-flight checklist and a post-flight checklist.	**Doc.**	**Mandatory**	Is there a Pre-flight Checklist? **(0.5)** Is there a Post-flight Checklist? **(0.5)**	**1**	**1**	**Pre and post flight check list are provided.**

Requirement	Proof of Evidence	Type of requirement	Partial Score applicable to the Method of Compliance	Max. Score	SCORE	RATIONALE
11.5 The applicant should provide a training syllabus by the complexity of the UAS operation and maintenance.	**Doc.**	**Mandatory**	If UAS MTOM < 4Kg Yes=**(1); No=(0)** If UAS MTOM < 25kg Yes=**(1);** No=**(0)** If UAS MTOM ≥ 25kg Yes=**(1)**; No=**(-5)**	**1**	**1**	**Training syllabus is provided.**
11.6 The UAS maintenance manual shall be complete and identify the qualifications for each type of inspection, maintenance, and repair required	**Doc.**	**Mandatory**	Does the maintenance manual identify the qualification requirements for performing the inspections? **(0.8)** Does the maintenance manual identify the qualification requirements for maintenance and repair?(0.2)	**1**	**0**	**Maintenance Manual do not include personnel qualification requirements**
11.7 The applicant should demonstrate to have a method to track technical occurrences (that have been reported) affecting safety throughout the life of the program.	**Doc.**	**Desirable**	Did the applicant deliver a process to manage tracking occurrences throughout the lifecycle of the UAS? **(1)** Is the method defined in the maintenance manual for answering reported technical occurrences robust regarding the implementation of preventive measures and corrective actions for future developments or improvements of the system? **(0.5)** Note: If the Company does not manage reported technical occurrences, a negative score **up to -5** may be assigned.	**1.5**	**1.5**	**Dedicated procedures are in place for manage technical occurrence during the operational life of the UAS.**
11.8 The applicant should demonstrate to have a method to implement preventive and corrective actions as necessary to continuously improve airworthiness.	**Doc.**	**Desirable**				

A.4 Operational Checklist

Question Number	Question or area	Supplemental Information	Evidence
(A) Competences of the Remote Flight Crew (RFC)			
Training			
A.1	Is there a periodically updated Training Syllabus to demonstrate that the Remote Flight Crew (RFC) is adequately trained for the planned operation and ensures knowledge of at least the following topics: 1 - the NMAA Regulation for UAS operations; 2 - National Airspace and Military Airspace; 3 - Airspace operating principles; 4 - Aviation safety; 5 - Human performance limitations; 6 - Meteorology; 7 - Navigation/Charts; 8 - UAS (system, flight mechanics, structure); 9 - Military operational procedures;	The Remote Flight Crew (RFC) is meant as the set of people involved in the operation and should have specific theoretical and practical training on their duties (e.g. preparation of the launch site, pre-flight inspection, ground equipment handling, flight conduction, preparation of the meteorological bulletins, etc.).	A training syllabus covering the topics associated with the requirement is available and is periodically updated.
Human Error			
A.2	Is the Remote Flight Crew subject to periodic health checks (mentally and physically) to demonstrate that they are fit to operate?	A medical standard considered adequate by the NMAA can be specified.	A policy on fitness is available and developed against standard deemed adequate by the competent authority. It includes periodic health checks to ensure that every person of the crew is fit to operate.
A.3	Is there a policy defining how the Remote Flight Crew must be fit to operate before conducting any operation?		Same as A.2
A.4	Is there a policy defining how to manage the fatigue and stress of the Remote Flight Crew to reduce human error (e.g., rest periods, remote flight crew duty times, operational breaks, the composition of the Remote Flight Crew)?		Same as A.2 In addition: the policy defines and rules the strategies to adopt for managing the stress and fatigue of the Remote Flight Crew. It includes rest periods, duty time of the personnel of the crew, operational breaks and minimum composition of the crew.

A.5	Does the Remote Flight Crew receive Crew Resource Management (CRM) training?	The CRM training aims to train the Remote Flight Crew on how to reduce potential human errors and avoid stress. It allows the Remote Flight Crew to ensure the safety and effectiveness of the operation.	CRM is provided to the Remote Flight Crew. The training includes: • Human errors and errors management; • Stress and fatigue management; • Visual attention; • Memory; • Perception; • Situational awareness; • Communications and types; • Decision making/problem solving. Information on the CRM training and syllabus are contained in the Operations Manual.
(B) Mission-planning aspects			
Operational volume			
B.1	Is the Operational volume defined taking into account the following elements? - Maximum dimension of the operational volume - Location (coordinates) - Topography and main obstacles (if any) - Failures or malfunctions of the propulsion system; - Meteorological conditions; - Possible interferences; - UAS performance; - Dangerous payload (if any); - UAS latencies.		The design of the operational volume has taken into account the elements listed in the requirements, not including the dangerous payload, since the operation does not include any. Details on the operational volume are reported in the Operations Manual.
B.2	How is the population density in the operational area evaluated?	The population density can be established by using authoritative density data	The population density of the overflown area is evaluated through authoritative data. It is also based on assumptions made considering the season of the year.
B.3	Is the shelter factor considered in the assessment of the Ground Risk? If yes, which parameters are used to compute it?	The shelter factor can be established by using authoritative density data	The shelter factor associated with the area taken as reference for the population density is considered. The evaluation of the shelter factor is based on authoritative data.
Adjacent area			

B.4	Is the adjacent area defined taking into account the following elements? - Adjacent area extension; - Population density in the adjacent area; - Topography and main obstacles (if any); - Shelter factor in the adjacent area.		The adjacent area was defined taking into account the elements listed in the requirement. Further details in the adjacent area are contained in the Operations Manual.
Environmental conditions evaluation			
B.5	Is the operation planned in meteorological conditions (e.g., CAVOK, drizzle, snow, haze, other severe adverse weather conditions, etc.) that are outside the design limits of the UAS?		The operation was planned considering the meteorological conditions minima to ensure the safety of the flight and systems supporting the operation. Moreover, the operations manual contains information
B.6	Are there procedures for evaluating ongoing and foreseen meteorological conditions on the operational volume and in the adjacent area?	These procedures could include the reading of METAR, TAF, MET-REPORT, NOTAM, etc.	Procedures to evaluate ongoing and foreseen meteorological conditions on the operational area and adjacent area include monitoring and reading updated METAR, TAF and NOTAM concerning the areas of interest.
Critical infrastructure (if included in the operation)			
B.7	Is the operation planned to overfly critical infrastructures (E.g., missile launch sites) that could lead to interferences in the C2 link? If yes, is this event addressed by the operational procedures?		N/A The operation does not include the overflying of critical infrastructure
B.8	How the interferences produced by critical infrastructures are evaluated?		N/A
Operation of multiple UASs (if included in the operation)			
B.9	Are there other UAS flying in the same area? Is the interference on the C2 link been evaluated and proper mitigations identified?		N/A The operation does not include multiple UASs operation
(C) Blast/impact Containment system (if included in the operation)			
Transport of Dangerous Goods (e.g., Blast Containment System, Crash-Proof Container)			

C.1	Does the operation include the transport of Dangerous Goods? If so, which one(s)?	For operations including the transport of dangerous goods (ICAO Doc 9284), depending on the type of payload a crash-proof container and/or a Blast containment system could be required	N/A The operation does not involve carriage of dangerous goods.
C.2	In case of dangerous goods transports the crash-proof container and/or the blast containment system certified as adequate to the carried payload? Is there a manufacturer's release note specifying the features and limitations of the container/containment system?		N/A
C.3	How is the effectiveness of the systems/means to contain the effects of ground impact assessed?	In the case of explosive payload, a higher risk is faced and could also impact the shelter factor	N/A
C.4	Is the *Flight Remote Crew* trained in the systems and any related operational functions? Are these aspects covered and clearly defined in the Training Syllabus?	See question A.1 for the Training Syllabus	N/A
C.5	Is the *personnel responsible for installation and maintenance* trained and are these aspects covered in the training syllabus?	See question E.3 for the Training Syllabus	N/A
C.6	Is the equipment used to contain the impact installed and maintained according to the manufacturer's instructions? Are there procedures on how to prepare, load, and unload the payload? Is a checklist related to these procedures available?		N/A
Systems to reduce effects of ground impact (e.g., Parachute)			
C.7	Is the *Remote Crew* trained in the systems and any related operational functions? Are these aspects covered and clearly defined in the Training Syllabus?	See question A.1 for the Training Syllabus	N/A Since no systems to reduce effects of ground impact are available
C.8	Is the *personnel responsible for installation and maintenance* trained and are these aspects covered in the training syllabus?	See question E.3 for the Training Syllabus	N/A
C.9	Is the equipment used to reduce the impact installed and maintained according to the manufacturer's instructions?		N/A
(D) Operational procedures			
Procedures in normal operation condition			

D.1	Are procedures in a normal operating condition defined and do these procedures take into account the following elements? - Mission planning (NOTAMs, weather reports, weather forecast, airspace availability, segregated airspace request, etc); - Preparation of the mission equipment; - Preparation of the launch site; - Preparation of the UAS; - UAS status and operational correctness check (Pre-flight check); - Take-off; - Preparation for landing; - Landing; - After landing; - UAS and equipment secured.		The flight when in normal operation condition and under-control follows the normal operation conditions procedures. These procedures cover all the listed elements in the requirement. Checklists on these procedures are made available to the personnel. The crew is trained to perform following these procedures. Normal operation condition procedures and checklists are contained in the Operations Manual.
D.2	Are checklists for normal operation condition procedures available for the Remote Fight Crew (RFC)?		Same as D.1
D.3	Is the Remote Flight Crew trained for normal operation condition procedures and are these considered in the Training Syllabus?	See question A.1 for the Training Syllabus	Same as D.1 In addition: the training syllabus containing the topics needed for the training on the normal operation condition procedures is available and described in the Operations Manual.
Emergency Procedures			
D.4	Are emergency procedures established and do these procedures take into account the following elements? - UAS leaving the operational volume - Failure of the propulsion system; - Hijacking; - Unacceptable weather conditions; - UAS or Remote Flight Crew under attack.		Emergency procedures are available and cover all the listed elements in the requirement. Emergency Checklists on these procedures are made available to the personnel. The crew is trained to perform following these procedures. Emergency procedures and checklists are contained in the Operations Manual.
D.5	Are checklists for emergency procedures available for the Flight Remote Crew (RFC)?		Same as D.4
D.6	Is the Remote Flight Crew trained for emergency procedures and are these considered in the training syllabus?	See question A.1 for the Training Syllabus	Same as D.4

			In addition: the training syllabus containing the topics needed for the training on the emergency procedures is available and described in the Operations Manual.
Multi-crew operations (if included in the operation)			
D.7	Is the crew adequately trained for multi-crew coordination and is this aspect covered in the Training Syllabus?	See question A.1 for the Training Syllabus	The crew is trained for Multi-crew operations and this topic is contained in the training syllabus as described in the Operations Manual.
D.8	Are the multi-crew coordination procedures established (e.g., crew tasks, communications protocol, the establishment of communications)?		Multi-crew procedures are established, and they include: • Exploitation of each crew task; • Communications protocol among the crew; • Establishment of communications. These procedures are included in the operations manual.
Handover (if included in the operation)			
D.9	Is the crew adequately trained for handover procedures and are those aspects covered in the Training Syllabus?	See question A.1 for the Training Syllabus	N/A The operation does not include handover
D.10	Are the handover procedures for the intended operations established?		N/A
Operations from moving platform (if included in the operation)			
D.11	Is the pilot adequately trained on procedures for UAS operations from the moving platform and is this aspect covered in the Training Syllabus?	See question A.1 for the Training Syllabus	N/A The operation does not include moving platform launch / recovery
D.12	Are the procedures for UAS operations from moving platforms established?		N/A
Simultaneous Operation with UAS and/or with manned aircraft/helicopter (if included in the operation)			
D.13	Is the crew adequately trained for simultaneous operation with UAS and/or with manned aircraft/helicopter and is this aspect covered in the Training Syllabus?	See question A.1 for the Training Syllabus	N/A The operation does not include Simultaneous Operation with UAS and/or with manned aircraft/helicopter
D.14	Are the procedures for simultaneous Operation with UAS and/or with manned aircraft established?		N/A

(E) Military UAS Operator's competence			
<u>Organisation</u>			
E.1	Is the Structure of the Organisation (operations, maintenance, quality and safety) included in the Operations Manual?		The operations manual describes the structure of the organisation including the dimension, the organisational chart showing different departments (operations, maintenance, safety, management and quality). Every role of the organisation and its associated tasks is clearly described.
E.3	Are the roles, responsibilities, and duties of the staff planning and ordering flight missions clearly defined?		Same as E.1 In addition: a description of the roles, responsibilities and duties of the staff planning the flight missions is provided in the Operations Manual.
E.4	Are the roles, responsibilities, and duties of the Remote Flight Crew clearly defined?		Same as E.1 In addition: a description of the roles, responsibilities and duties of the Remote flight crew is provided in the Operations Manual.
E.5	Are the roles, responsibilities, and duties of the Maintenance staff clearly defined?		Same as E.1 In addition: a description of the roles, responsibilities and duties of the Maintenance staff is provided in the Operations Manual.
E.6	Are the roles, responsibilities, and duties of the staff authorised to manipulate dangerous goods (e.g. explosives) clearly defined?		The operation does not include carriage of dangerous goods
E.7	Are there periodically updated Training Syllabus to demonstrate that the flight planning staff, maintenance personnel and personnel authorised to manipulate dangerous goods are adequately trained for the planned duties and ensure knowledge and practical skills to execute respective tasks?		Periodically updated training syllabus covering the theoretical and practical aspects for the training of maintenance and flight planning staff are available. These training syllabi are contained in the operations manual.
E.8	Are there records of training and qualifications of the Remote Flight Crew, of the Maintenance staff, or the flight planning staff or/and the personnel manipulating dangerous goods?		Records of training and qualifications of the Remote Flight Crew, Maintenance staff and flight planning staff are available. These records are contained in the operations manual.

E.9	Are maintenance procedures, covering at least the UAS manufacturer instructions and requirements, defined?		Maintenance procedures were developed in accordance with the UAS manufacturer instructions and requirements. Further details on the maintenance procedures are contained in the operations manual.
E.10	Are there procedures to ensure that the tools & instruments used in maintenance tasks comply with the UAS manufacturer requirements (e.g. calibration, life limit)?		Procedures to ensure that the tools and instruments used for maintenance activities are compliant with the UAS manufacturer requirements are available in the operations manual.
E.11	Are there procedures to ensure that materials and spare parts used in maintenance tasks are per the UAS manufacturer requirements and are properly stored?		Procedures to ensure that the materials and spare parts used for maintenance activities are properly stored are available and described in the operations manual.
(F) External services			
F.1	Are there procedures to ensure that the level of performance for any externally provided service necessary for the safety of the flight is adequate for the intended operation?		Procedures to ensure that the level of performance of the EGNOS services is adequate for the operation are provided in the operations manual. These procedures were designed taking into account the technical limitations of the area of the operation and obstacles impacting the performance of these services.
F.2	Are the roles and responsibilities between the UAS operator and the commercial external service provider clearly defined (e.g. in a Service Level Agreement - SLA)?		A Service Level Agreement stating the roles and responsibilities between the UAS operator and the EGNOS service provider are available. See Service Level Agreement document.
F.3	Are there procedures to continuously monitor the performance of the externally provided services?		Procedures to continuously monitor the performance of the EGNOS service are provided. These take into account: • The performance of EGNOS service; • The interference negatively impacting the EGNOS signal.

A.5 Containment Assessment Checklist – CAC

Question Number	Question or area	Score range	Method of compliance	Evidence
C.1	Is the system used for containment independent and dissimilar from the main Flight Control System?	This is a pre-requisite that must be always fulfilled.	*Design and installation appraisal that includes at least the following elements are available:* - *design of the features (independence, separation, and redundancy);* - *installation of the containment system* - *relevant risk related to the operation (e.g., severe snow, ice, etc.)*	The UA is fitted with a geo-fencing function and an independent and dissimilar Flight Termination System (FTS). Details on the design and installation containment system are contained in the UAS flight manual.
C.2.1	Were tests and analyses conducted to demonstrate that the UAS containment system is not likely to experience probable failures that may lead to an operation outside the operational volume?	0-4	*Tests reports available demonstrate a reliability of the containment system that is commensurate with the DAL used for SW and AEH development assurance.* *The scores can be assigned as follows:* • *Demonstrated reliability < 10^{-2} [1]* • *Demonstrated reliability < 10^{-3} [2]* • *Demonstrated reliability < 10^{-4} [3]*	Tests and numerical analysis were carried out demonstrating that the containment system has a reliability of less than < *10^{-3}*. That corresponds to a score of **[2].** Tests and numerical analysis on the containment system are contained in the experimental tests document.
C.2.2	Are the Software (SW) and Airborne Electronic Hardware (AEH) of the containment system developed against a standard recognised by the NMAA?	0-1	*SW is developed according to ED-12C or DO-178C, DAL D if the score assigned to C2.1 is 3 [0.5]* *AEH must be developed according to ED-80 or DO-254, DAL D if the score assigned to C2.1 is 3 [0.5]*	No evidence of software and hardware development assurance is available. That corresponds to a score of [0]
C.3	Is the system used for containment designed according to a recognised industry standard? If yes, what is the reliability level ensured by the chosen standard?	0-6 depending on the design standard	*Points are obtained only if a recognised standard is used (e.g. EUROCAE ED-270). Then score is assigned depending on the reliability of the system.*	N.A.

ANNEX B Military UAS Scenarios

This Annex contains two Military UAS Scenarios that are developed based on the ones presented in the MIL-UAS-SPECIFIC D1 “Set the Scene”. The following scenarios are proposed:

- **MUS-01 – BVLOS over sparsely populated area and within segregated airspace:** This scenario is intended for flights with the objective of intelligence, surveillance, reconnaissance, and possibly also target acquisition activity over a land area / seacoast. The operational is conducted in BVLOS over a sparsely populated area and within a Temporary Segregated Airspace (TSA). The UAS employed for this mission can have a UA with MTOM up to 250kg. The scenario does not consider any transfer flight to reach the TSA and assumes that the entire operation takes place under the defined conditions.
- **MUS-02 – BVLOS over a populated area within controlled airspace managed by military ATC:** This scenario is intended for flights with the objective of training personnel. The operational is conducted in BVLOS over a populated area and within controlled airspace. The UAS employed for this mission can have a UA with MTOM up to 25kg.

B.1 MUS-01 – BVLOS over sparsely populated area and within segregated airspace

Military UAS Scenario 01 BVLOS over sparsely populated area and within segregated airspace	
Characteristics	*Description*
Features of the operation	
MTOM of UA	• *Up to 250 kg*
Type of UAS	• *Fixed wing* • *Multicopter* • *Rotorcraft*
Flight conduction	• *BVLOS*
*Maximum characteristic dimension of the UA** **if:* • *fixed wing enter the wingspan,* • *rotorcraft enter diameter of the rotor,* • *multicopter enter the maximum dimension*	• *Up to 6 m*
Cruise speed (Vc)	• *Up to 40 m/s*
Operational area characteristics	
Operative altitude	• *Within the vertical limits of the TSA*
Operational range	• *Within the horizontal limits of the TSA*
Population density	• *Up to 20 people/km^2*
Shelter factor	• *No limitation (the scenario assumes a value of 0%)*
Operational airspace environment	• *Temporary Segregated Airspace (TSA)*
Adjacent area characteristics	
Population density of the adjacent area	• *Up to 2000 people/km^2*

Airspace environment of the adjacent area	• *Uncontrolled airspace with controlled aerodromes*
Shelter factor of the adjacent area	• *No limitation (the scenario assumes a value of 0%)*
Other information	
Dangerous payload	• *None*
Critical infrastructure(s)	• *None*
Air risk mitigations	• *None*
Notes	• *Possible presence of friendly troops in the operational area*

Table 10 – MUS-01 Overview

CHARACTERISATION OF THE MUS n°1			
Required Design and Integrity Score (RDIS)	**90**		
Required Containment system Score (RCS)	**2**		
Traffic Conflict Risk (TCR)	**1**		
Area	Topic	Limitations / Conditions to respect	Evidence (to be fulfilled by OPU)
1. Operation features			
Level of human intervention	Autonomous operations	• No	
	UAs controlled at a time* * Only if the operation includes multiple UASs operations	N.A.	
	Operations from moving vehicle	• No	
Overflown areas	Population density of the overflown area	• Up to 20 people/km^2	
	Shelter factor of the overflown area	• No limitation	

UA limitations	Maximum Take-Off Mass (MTOM) of the UAS	• Up to 250 kg	
Flight height limit	Maximum operational height (m or feet)	• Within the vertical limits of the military TSA	
Airspace	Operational Airspace environment	• Reserved areas without any other involved operative traffic (TEC 8)	
Adjacent area	Population density of the adjacent area	• Up to 2000 people/km^2	
	Shelter factor of the adjacent area	• No limitation	
Dangerous good(s)	Type of material* * Only if the operation includes transport of dangerous goods	N.A.	
	Quantity of material* * Only if the operation includes transport of dangerous goods	N.A	
	Availability of Crash-proof container and/or Blast containment system * * Only if the operation includes transport of dangerous goods	N.A.	
Documentation	Operations manual	An operations manual is available and includes at least the following elements: 1. Description of the UAS operator's organisation and of the personnel involved in the operation 2. ConOps: ▪ nature of the operation and associated risks, ▪ operational environment and operational area of the operations (characteristics of the overflown area, topography, dimensions, obstacles, type of airspace and environmental conditions) ▪ Competency, duties and responsibilities, qualifications of the personnel involved in the operation (maintenance, OPU, flight mission personnel)	

		▪ Maintenance (instructions and procedures to keep the UAS in a safe condition) 3. Normal procedures (procedures to use to keep the UAS in the flight geography) 4. Contingency procedures (procedures to use when the UAS enters the contingency volume and needs to go back to the flight geography volume) 5. Emergency procedures (procedures to use when the UAS leaves the operational volume) 6. Security procedures (procedures to ensure the security of the operations. It includes patrolling the launch/land site and the CGS. Cyber-security procedures are covered in these procedures 7. Occurrence reporting procedures 8. Record-keeping procedures (instructions on fulfilment of the logs and records related to the operations, UAS, personnel, incident/accident.	
2. Flight planning			
Operational volume	Operational volume design	The Operational volume is defined taking into account the following elements: • Position-keeping capabilities of the UAS in 4D space (latitude, longitude, height and time); • Maximum dimension of the Operational volume; • Topography and main obstacles (if any); • Failures or malfunctions of the propulsion system; • Meteorological conditions; • Possible interference; • UAS performance; • UAS latencies; • Critical infrastructures (e.g., missile launch sites, ammunition warehouse, hospital).	
	Accuracy	• Accuracy of the navigation solution, flight technical error of the UAS, flight path definition error (e.g., map error)	

		and latencies are considered when determining the operational volume	
Ground risk	Definition of the ground risk buffer	• The ground risk buffer is defined considering the glide path of the aircraft in case of failures.	
	Evaluation of the shelter factor	• Not applicable	
	Evaluation of the population density at risk	• The population density is defined using authoritative density data	
	Inspection activities to evaluate the population density at risk in the operational area	• Pre-flight inspections are carried out on-site to confirm the correctness of the population density data	
Air risk	Evaluation of airspace characteristics	• The flight takes place in a military Temporary Segregated Area (TSA).	
Adjacent area	Adjacent area evaluation	• The characteristics of the adjacent area are evaluated taking into account the following elements: ○ Population density in the adjacent area; ○ Shelter factor in the adjacent area; ○ Topography and main obstacles (if any); ○ Airspace class in the adjacent area; ○ Airports in the adjacent area; ○ Critical infrastructures (e.g., missile launch sites, ammunition warehouse, hospital).	
	Evaluation of the population density	• The shelter factor in the adjacent area was defined with authoritative density data.	
	Evaluation of the shelter factor	• Not applicable	
Weather conditions	Adverse weather conditions	• The operation is planned to take into account adverse weather conditions (e.g., drizzle, snow, heavy rain) that are outside the design limits of the UAS. • The operation is planned in meteorological conditions that do not compromise the safety of the UAS flight and of the UAS design.	
	Evaluation of weather conditions	• Procedures for evaluating the ongoing and foreseen weather conditions on the operational volume and adjacent area are established (reading METAR, TAF, MET-REPORT, NOTAM, etc.).	

Critical infrastructure	Procedures to avoid / mitigate the interferences impact* * Only if the operation includes critical infrastructure	N.A.	
	Interference evaluation* * Only if the operation includes critical infrastructure	N.A.	
Multiple UASs operation	Procedures to avoid / mitigate the interferences impact* * Only if the operation is a multiple UASs operation	N.A.	
	Procedure to safe recovery one or more UAS * Only if the operation is a multiple UASs operation	N.A.	
	Interference evaluation* * Only if the operation is a multiple UASs operation	N.A.	
Observer(s)	Number of airspace observers	• Not applicable	
	Minimum visibility for conducting the operation	• Not applicable	
	Maximum flight distance covered by the airspace observer(s)	• Not applicable	
	Potential terrain/artificial obstructions for the airspace observer's visibility	• Not applicable	
	Maximum distance from each airspace observers (if any) and the remote pilot in command	• Not applicable	
	Communications protocol and procedures for the UAS flight crew	• Not applicable	
	Means used by airspace observer to determine the position of the UA	• Not applicable	
3. Operational procedures			

Procedures for Normal operation condition	Procedures	1. Procedures for normal operating conditions are established and cover at least the following aspects: ▪ Mission planning (NOTAMs, weather reports, weather forecast, airspace availability, segregated airspace request, etc); ▪ Preparation of the mission equipment; ▪ Preparation of the launch site; ▪ Preparation of the UAS; ▪ UAS status and operational correctness check (pre-flight check); ▪ Take-off; ▪ Preparation for landing; ▪ Landing; ▪ After landing; and ▪ UAS and equipment secured.	
	Normal operation checklist	• Checklist for procedures in normal operation condition is available for the OPU	
	Training	• The OPU is trained for procedures in normal operation condition and this aspect is covered in the Training Syllabus	
Emergency procedures	Procedures	1. Emergency procedures are established and cover at least the following aspects: • UAS leaving the operational volume; • Failure of the propulsion system; • Hijacking; • Unacceptable weather conditions; • UAS or OPU under attack	
	Emergency checklist	• Checklist for emergency procedures is available for the OPU	
	Training	• The OPU is trained for emergency procedures and this aspect is covered in the Training Syllabus	
Multi-crew	Training* * Only if the operation includes multi-crew operations	• The OPU is trained for multi-crew coordination and this aspect is covered in the Training Syllabus	

	Procedures* * Only if the operation includes multi-crew operations	• Procedures for multi-crew coordination (e.g., crew tasks, communications protocol, establishment of communications) are established	
Handover	Training* * Only if the operation includes handover	N.A.	
	Procedures * Only if the operation includes handover	N.A.	
Operation from moving platform	Training* * Only if the operation includes operations from moving platform	N.A.	
	Procedures* * Only if the operation includes operations from moving platform	N.A.	
Simultaneous operation with UAS and/or manned aircraft	Training* * Only if the operation includes simultaneous operations with UAS and/or manned aircraft	N.A.	
	Procedures* * Only if the operation includes simultaneous operations with UAS and/or manned aircraft	N.A.	
4. Military UAS Operator's competence			
Organisation	Structure	• The organisation structure is described in the operations manual	
	Roles and responsibilities (flight planning)	• Roles and responsibilities of staff for the mission planning phase are clearly defined	
	Roles and responsibilities (execution)	• Roles and responsibilities of the OPU for the execution phase are clearly defined	
	Roles and responsibilities (maintenance)	• Roles and responsibilities of the maintenance staff for the maintenance activities are clearly defined	
	Roles and responsibilities (dangerous goods management)	• N.A.	
Training	Training syllabus	• A periodically updated training syllabus is available to demonstrate that the mission planning staff, maintenance, OPU are adequately trained the planned	

		duties and ensures knowledge and practical skills to execute the respective tasks	

	Training syllabus for the OPU	• The training syllabus for the OPU is available and covers at least the following topic:
		  • NMAA regulation for UAS operations;
		  • National airspace and Military airspace;
		  • Airspace operating principles;
		  • Aviation safety;
		  • Human performance limitations;
		  • Meteorology;
		  • Navigation / Charts;
		  • UAS (system, flight mechanics, structure);
		  • Military operational procedures	

	Training records and qualifications	• Training and qualification records of the OPU, of the maintenance staff, of the mission planning staff are available • The training record is kept for at least 3 years and maintained up to date a record.	
Maintenance procedures	Manufacturer instructions	• Maintenance procedures are available and cover the UAS manufacturer instructions and requirements	
	Tools and instruments	• Procedures to ensure that the tools and instruments used in maintenance tasks are in accordance with the UAS manufacturer instructions are available	
	Materials	• Availability of procedures to ensure that the materials and spare parts used in maintenance tasks are per the UAS manufacturer requirements and are properly stored	
	Personnel in charge of maintenance activities	• List of the maintenance staff employed to carry out maintenance activities is established	
Human error	Health routine checks	• The OPU is subjected to health (mentally and physically) routine checks to demonstrate they are fit to operate	
	Fit-to-operate policy	• A Fit-to-operate policy is available and explains how the crew must be fit to operate before conducting any operation	

	Policy on stress and fatigue management	• A policy for the management of the stress and fatigue to reduce the human error of the OPU is available (e.g., rest time, OPU duty times, breaks, composition of the crew)	
	Crew Resource Management (CRM) training	• The OPU receives the CRM training	
5. Mitigations			
Systems to reduce the effects of the ground impact (e.g., parachute)	Training of the OPU	• No requirements	
	Training of the personnel in charge of installation and maintenance	• No requirements	
	Installation and maintenance	• No requirements	
Air Risk	Day/Time of the operation	• No requirements	
	Exposure at risk	• No requirements	
	Flight Plan	• No requirements	
	Coordination / Communication with ATS unit	• No requirements	
6. Technical conditions			
Containment system	Design and installation appraisal	• Design and installation appraisal includes: - design of the features (independence, separation, and redundancy - installation of the containment system - relevant risk related to the operation (e.g., severe snow ice, etc.)	
	Failure test and analysis of the containment system reliability	• Test and analysis demonstrate that the reliability of the containment system is < 10^{-2}/FH	
	Development process of UAS' software (SW) and Airborne Electronic Hardware (AEH)	• No development assurance process required	
	Reliability level and design of the containment system	• The reliability level is deemed adequate for the intended operation.	
Detect-And-Avoid (DAA)	De-confliction scheme	• No requirement	
	Performance of DAA system* * Only if BVLOS operation	• No requirement	

External service	U-space service / External service performance	• No requirements	
	Adequacy of the external service's performance	• Procedures are established to ensure that the level of performance for any externally provided service is adequate for the intended operation	
	Roles and responsibilities	• Roles and responsibilities between the UAS operator and the commercial service provider are clearly defined (e.g., Service Level Agreement – SLA)	
	Monitoring procedures	• Procedures to continuously monitor the performance of the external service are available	
Crash-proof container / Blast containment system	Adequacy of the blast containment system* * Only if the mission includes transport of dangerous goods	N.A.	
	Effectiveness assessment* * Only if the mission includes transport of dangerous goods	N.A.	
	Training of the OPU* * Only if the mission includes transport of dangerous goods	N.A.	
	Training of the personnel in charge of the dangerous goods management* * Only if the mission includes transport of dangerous goods	N.A.	
	Installation and maintenance* * Only if the mission includes transport of dangerous goods	N.A.	
	Procedures and checklist* * Only if the mission includes transport of dangerous goods	N.A.	

B.2 MUS-02: BVLOS over a populated area within controlled airspace managed by military ATC

Military UAS Scenario 02 "BVLOS over a populated area within controlled airspace managed by military ATC"	
Characteristics	*Description*
Features of the operation	
MTOM of UA	• *Up to 25 kg*
Type of UAS	• *Multicopter*
Flight conduction	• *BVLOS*
*Maximum characteristic dimension of the UA** **if:* • *fixed wing enter the wingspan,* • *rotorcraft enter diameter of the rotor,* • *multicopter enter the maximum dimension*	• *Up to 1 m*
Cruise speed (Vc)	• *Up to 20 m/s*
Operational area characteristics	
Operational altitude	• *Up to 500 ft AGL*
Operational range	• *Depending on the C2 Link range*
Population density	• *Up to 500 people/km²*
Shelter factor	• *0%*
Operational airspace environment	• *Uncontrolled airspace*
Adjacent area characteristics	
Population density of the adjacent area	• *Up to 10000 people/km²*

Airspace environment of the adjacent area	• *Controlled airspace managed by civil ATC*
Shelter factor of the adjacent area	• *0%*
Other information	
Dangerous payload	• *None*
Critical infrastructure(s)	• *None*
Air risk mitigations	• *Coordination with ATS units* • *Day/time of the operation*
Notes	• *None*

Table 11 – MUS-02 Overview

Table 12 – MUS-02 characterisation

CHARACTERISATION OF THE MUS n°1			
Required Design and Integrity Score (RDIS)	**77**		
Required Containment system Score (RCS)	**2**		
Traffic Conflict Risk (TCR)	**3**		
Area	Topic	Limitations / Conditions to respect	Evidence (to be fulfilled by OPU)
2. Operation features			
Level of human intervention	Autonomous operations	• No	
	UAs controlled at a time* * Only if the operation includes multiple UASs operations	N.A.	
	Operations from moving vehicle	• No	

Overflown areas	Population density of the overflown area	• Up to 500 people/km^2	
	Shelter factor of the overflown area	• No limitation	
UA limitations	Maximum Take-Off Mass (MTOM) of the UAS	• Up to 25 kg	
Flight height limit	Maximum operational height (m or feet)	• 500 ft AGL	
Airspace	Operational Airspace environment	• Uncontrolled Airspace (TEC 4)	
Adjacent area	Population density of the adjacent area	• Up to 10000 people/km^2	
	Shelter factor of the adjacent area	• No limitation	
Dangerous good(s)	Type of material* * Only if the operation includes transport of dangerous goods	N.A.	
	Quantity of material* * Only if the operation includes transport of dangerous goods	N.A	
	Availability of Crash-proof container and/or Blast containment system * * Only if the operation includes transport of dangerous goods	N.A.	
Documentation	Operations manual	An operations manual is available and includes at least the following elements: 1. Description of the UAS operator's organisation and of the personnel involved in the operation 2. ConOps: ▪ nature of the operation and associated risks, ▪ operational environment and operational area of the operations (characteristics of the overflown area, topography, dimensions, obstacles, type of airspace and environmental conditions)	

		▪ Competency, duties and responsibilities, qualifications of the personnel involved in the operation (maintenance, OPU, flight mission personnel) ▪ Maintenance (instructions and procedures to keep the UAS in a safe condition) 3. Normal procedures (procedures to use to keep the UAS in the flight geography) 4. Contingency procedures (procedures to use when the UAS enters the contingency volume and needs to go back to the flight geography volume) 5. Emergency procedures (procedures to use when the UAS leaves the operational volume) 6. Security procedures (procedures to ensure the security of the operations. It includes patrolling the launch/land site and the CGS. Cyber-security procedures are covered in these procedures 7. Occurrence reporting procedures 8. Record-keeping procedures (instructions on fulfilment of the logs and records related to the operations, UAS, personnel, incident/accident.	
3. Flight planning			
Operational volume	Operational volume design	The Operational volume is defined taking into account the following elements: • Position-keeping capabilities of the UAS in 4D space (latitude, longitude, height and time); • Maximum dimension of the Operational volume; • Topography and main obstacles (if any); • Failures or malfunctions of the propulsion system; • Meteorological conditions; • Possible interference; • UAS performance; • UAS latencies; • Critical infrastructures (e.g., missile launch sites, ammunition warehouse, hospital).	

	Accuracy	• Accuracy of the navigation solution, flight technical error of the UAS, flight path definition error (e.g., map error) and latencies are considered when determining the operational volume	
Ground risk	Definition of the ground risk buffer	• The ground risk buffer is defined considering a ballistic descent initiated at maximum cruise speed.	
	Evaluation of the shelter factor	• Not applicable	
	Evaluation of the population density at risk	• The population density is defined using authoritative density data	
	Inspection activities to evaluate the population density at risk in the operational area	• Pre-flight inspections are carried out on-site to confirm the correctness of the population density data	
Air risk	Evaluation of airspace characteristics	• Airspace characteristics are evaluated using AIP data	
Adjacent area	Adjacent area evaluation	• The characteristics of the adjacent area are evaluated taking into account the following elements: ○ Population density in the adjacent area; ○ Shelter factor in the adjacent area; ○ Topography and main obstacles (if any); ○ Airspace class in the adjacent area; ○ Airports in the adjacent area; ○ Critical infrastructures (e.g., missile launch sites, ammunition warehouse, hospital).	
	Evaluation of the population density	• The shelter factor in the adjacent area was defined with authoritative density data.	
	Evaluation of the shelter factor	• Not applicable	
Weather conditions	Adverse weather conditions	• The operation is planned taking into account adverse weather conditions (e.g., drizzle, snow, heavy rain) that are outside the design limits of the UAS. • The operation is planned in meteorological conditions that do not compromise the safety of the UAS flight and of the UAS design.	
	Evaluation of weather conditions	• Procedures for evaluating the ongoing and foreseen weather conditions on the operational volume and	

		adjacent area are established (reading METAR, TAF, MET-REPORT, NOTAM, etc.).	
Critical infrastructure	Procedures to avoid / mitigate the interferences impact* * Only if the operation includes critical infrastructure	N.A.	
	Interference evaluation* * Only if the operation includes critical infrastructure	N.A.	
Multiple UASs operation	Procedures to avoid / mitigate the interferences impact* * Only if the operation is a multiple UASs operation	N.A.	
	Procedure to safe recovery one or more UAS * Only if the operation is a multiple UASs operation	N.A.	
	Interference evaluation* * Only if the operation is a multiple UASs operation	N.A.	
Observer(s)	Number of airspace observers	• Not applicable	
	Minimum visibility for conducting the operation	• Not applicable	
	Maximum flight distance covered by the airspace observer(s)	• Not applicable	
	Potential terrain/artificial obstructions for the airspace observer's visibility	• Not applicable	
	Maximum distance from each airspace observers (if any) and the remote pilot in command	• Not applicable	
	Communications protocol and procedures for the UAS flight crew	• Not applicable	
	Means used by airspace observer to determine the position of the UA	• Not applicable	

4. Operational procedures			
Procedures for Normal operation condition	Procedures	2. Procedures for normal operating conditions are established and cover at least the following aspects: ▪ Mission planning (NOTAMs, weather reports, weather forecast, airspace availability, segregated airspace request, etc); ▪ Preparation of the mission equipment; ▪ Preparation of the launch site; ▪ Preparation of the UAS; ▪ UAS status and operational correctness check (pre-flight check); ▪ Take-off; ▪ Preparation for landing; ▪ Landing; ▪ After landing; and ▪ UAS and equipment secured.	
	Normal operation checklist	• Checklist for procedures in normal operation condition is available for the OPU	
	Training	• The OPU is trained for procedures in normal operation condition and this aspect is covered in the Training Syllabus	
Emergency procedures	Procedures	2. Emergency procedures are established and cover at least the following aspects: • UAS leaving the operational volume; • Failure of the propulsion system; • Hijacking; • Unacceptable weather conditions; • UAS or OPU under attack	
	Emergency checklist	• Checklist for emergency procedures is available for the OPU	
	Training	• The OPU is trained for emergency procedures and this aspect is covered in the Training Syllabus	
Multi-crew	Training*	• The OPU is trained for multi-crew coordination and this aspect is covered in the Training Syllabus	

	* Only if the operation includes multi-crew operations		
	Procedures* * Only if the operation includes multi-crew operations	• Procedures for multi-crew coordination (e.g., crew tasks, communications protocol, establishment of communications) are established	
Handover	Training* * Only if the operation includes handover	N.A.	
	Procedures * Only if the operation includes handover	N.A.	
Operation from moving platform	Training* * Only if the operation includes operations from moving platform	N.A.	
	Procedures* * Only if the operation includes operations from moving platform	N.A.	
Simultaneous operation with UAS and/or manned aircraft	Training* * Only if the operation includes simultaneous operations with UAS and/or manned aircraft	N.A.	
	Procedures* * Only if the operation includes simultaneous operations with UAS and/or manned aircraft	N.A.	
5. Military UAS Operator's competence			
Organisation	Structure	• The organisation structure is described in the operations manual	
	Roles and responsibilities (flight planning)	• Roles and responsibilities of staff for the mission planning phase are clearly defined	
	Roles and responsibilities (execution)	• Roles and responsibilities of the OPU for the execution phase are clearly defined	
	Roles and responsibilities (maintenance)	• Roles and responsibilities of the maintenance staff for the maintenance activities are clearly defined	
	Roles and responsibilities (dangerous goods management)	• N.A.	
Training	Training syllabus	• A periodically updated training syllabus is available to demonstrate that the mission planning staff,	

		maintenance, OPU are adequately trained the planned duties and ensures knowledge and practical skills to execute the respective tasks	
	Training syllabus for the OPU	• The training syllabus for the OPU is available and covers at least the following topic: • NMAA regulation for UAS operations; • National airspace and Military airspace; • Airspace operating principles; • Aviation safety; • Human performance limitations; • Meteorology; • Navigation / Charts; • UAS (system, flight mechanics, structure); • Military operational procedures	
	Training records and qualifications	• Training and qualification records of the OPU, of the maintenance staff, of the mission planning staff are available • The training record is kept for at least 3 years and maintained up to date a record.	
Maintenance procedures	Manufacturer instructions	• Maintenance procedures are available and cover the UAS manufacturer instructions and requirements	
	Tools and instruments	• Procedures to ensure that the tools and instruments used in maintenance tasks are in accordance with the UAS manufacturer instructions are available	
	Materials	• Availability of procedures to ensure that the materials and spare parts used in maintenance tasks are per the UAS manufacturer requirements and are properly stored	
	Personnel in charge of maintenance activities	• List of the maintenance staff employed to carry out maintenance activities is established	
Human error	Health routine checks	• The OPU is subjected to health (mentally and physically) routine checks to demonstrate they are fit to operate	
	Fit-to-operate policy	• A Fit-to-operate policy is available and explains how the crew must be fit to operate before conducting any operation	

	Policy on stress and fatigue management	• A policy for the management of the stress and fatigue to reduce the human error of the OPU is available (e.g., rest time, OPU duty times, breaks, composition of the crew)	
	Crew Resource Management (CRM) training	• The OPU receives the CRM training	
6. Mitigations application			
Systems to reduce the effects of the ground impact (e.g., parachute)	Training of the OPU	• No requirements	
	Training of the personnel in charge of installation and maintenance	• No requirements	
	Installation and maintenance	• No requirements	
Air Risk	Day/Time of the operation	• The operation takes place at a time when the presence of other traffic is limited. The time has to be coordinated with military ATC.	
	Exposure at risk	• No requirements	
	Flight Plan	• No requirements	
	Coordination / Communication with ATS unit	• Procedures are established to coordinate with military ATS Units to ensure that there is a reduced presence of other aircraft in the operational volume	
7. Technical conditions			
Containment system	Design and installation appraisal	• Design and installation appraisal includes: - design of the features (independence, separation, and redundancy - installation of the containment system - relevant risk related to the operation (e.g., severe snow ice, etc.)	
	Failure test and analysis of the containment system reliability	• Test and analysis demonstrate that the reliability of the containment system is $< 10^{-2}$/FH	
	Development process of UAS' software (SW) and Airborne Electronic Hardware (AEH)	• No development assurance process required	
	Reliability level and design of the containment system	• The reliability level is deemed adequate for the intended operation.	

Detect-And-Avoid (DAA)	De-confliction scheme	• A de-confliction scheme is developed to explain the criteria used to decide if an avoidance manoeuvre is needed.	
	Performance of DAA system* * Only if BVLOS operation	• Maximum Command-to-Execute latency should be no more than 5 seconds, and Normal Command-to-Execute latency is no more than 2 seconds. • The UAS should have the following minimum manoeuvre performance: - Rate of descent: ≥ 500 ft/min • The maximum latency for the intruder and own aircraft vector data should be less than 10 seconds with a minimum update rate of 5 sec. • The failure probability of the system should be the same that is required for the whole system operated in a TCR 2 environment, i.e. < 1E-2/FH	
External service	U-space service / External service performance	• No requirements	
	Adequacy of the external service's performance	• Procedures are established to ensure that the level of performance for any externally provided service is adequate for the intended operation	
	Roles and responsibilities	• Roles and responsibilities between the UAS operator and the commercial service provider are clearly defined (e.g., Service Level Agreement – SLA)	
	Monitoring procedures	• Procedures to continuously monitor the performance of the external service are available	
Crash-proof container / Blast containment system	Adequacy of the blast containment system* * Only if the mission includes transport of dangerous goods	N.A.	
	Effectiveness assessment* * Only if the mission includes transport of dangerous goods	N.A.	

	Training of the OPU* * Only if the mission includes transport of dangerous goods	N.A.	
	Training of the personnel in charge of the dangerous goods management* * Only if the mission includes transport of dangerous goods	N.A.	
	Installation and maintenance* * Only if the mission includes transport of dangerous goods	N.A.	
	Procedures and checklist* * Only if the mission includes transport of dangerous goods	N.A.	