RCloud Tasking Form – Part B: Statement of Requirement (SoR)

Title of Requirement	Development of threat/target risk matrices for drone impact on civilian aircraft
Requisition No.	**1000164583**
SoR Version	**0.1**

1.	**Statement of Requirements**
1.1	**Summary and Background Information**
	This SOR concerns two work packages concerning the development target/threat risk matrices for drone/aircraft impact. The principal purpose of the matrices will be to illustrate which drone/aircraft combinations will result in a catastrophic event. The work should be undertaken via a combination of "Subject Matter Expert (SME)" judgement and high fidelity numerical modelling. The contracted agency should have a demonstrable pedigree in drone/aircraft design and performance along with leading expertise in simulation development. A detailed knowledge of general aircraft airworthiness is also essential. In recent times the sighting of drones in the airspace surrounding civilian airports has resulted in significant economic disruption and inconvenience to passengers. The consequences of drone strike on the operability of inflight aircraft are largely unquantified and so, currently, airline fleets are grounded during such an event. It is highly desirable (for the UK Department of Transport) that less conservative, risk-based measures, are instigated upon drone incursion. This approach, potentially probabilistic in nature, would be predicated on the use of a "threat/target matrix" illustrating which combination of drone class and aircraft type would result in a catastrophic outcome. It is noted that similar procedures are currently available when considering the consequences of bird strike on aircraft. This requirement has been issued under the following taxonomy references: • Engineering Technology and Design, • Mechanical Engineering • Engineering Technology and Design, • Test and Evaluation Capability
1.2	**Requirement**
	Task 1 – The generation of an initial threat/target risk matrix Based on existing information and Subject Matter Expert judgement a preliminary matrix should be developed demonstrating which drone/target combinations present immediate concern. In order to achieve this it is expected that the following tasks will have to be undertaken (although other activities may also be necessary): • Identification of the various drone classes and specifications together with the key aspect of the drone (e.g. geometry, material make-up, trajectory) which influence response to impact (development of simple scaling laws relating mass and type to outcome).

- Classification and characterisation of the various generic aircraft types and their critical components including the Windshield, leading edge (wing and tail) as well as the engines tail stabilises. Focus should be placed on commercial passenger aircraft (including business jets and smaller civilian aircraft) constructed from Aluminium- and Carbon Fibre Reinforced Plastic-based materials.
- Study of the aircraft flight envelope (and general aerodynamics) to determine the influence on drone kinematic prior to engagement.
- Potential transposition of existing standards (e.g. those based on bird strike) to address the drone impact issue
- Identification of robust (albeit conservative at this stage) metrics for denoting the series of potential outcomes upon impact (including catastrophic failure)
- Identification of areas of uncertainty or imponderability where more advanced analytical treatment would lead to significantly improved levels of understanding and operational benefit due to higher levels of confidence-see requirement Task 2.

Task 2 – Refinement of risk matrix to be comprehensive and provide greater levels of confidence

Although SME judgement can be relied upon to determine the outcome for many drone class/aircraft combinations, it is recognised that uncertainties will likely remain (e.g. it is predicted that only the cusp of failure may be reached or that subtle variation in the impact conditions may result in a totally different outcome). In order to quantify the full collision envelope with greater granularity, and hence increase its utility in making operational decisions, it is required that high fidelity physics modelling is undertaken to:

- Provide greater confidence in predicted outcomes (analysis may result in the original matrix, discussed above, being extended)
- Better understand and quantify the structural outcome from each collision providing more information about the consequences of impact
- Incorporate levels of probability within the risk matrix (rather than rely on “worst” or “typical” impact cases)

This should be achieved by building fully representative numerical models of both the drones (typically for each class) and the various aircraft components of interest. It is accepted that particular idealisations and approximations may have to be exercised but the models should be verified and validated to a reasonable level of detail. It is recognised for example that a scaling law should be implemented to account for drone impacts of different type. Data for the latter exercise could be supplied from the open literature and new (or historical) bespoke testing and, as a consequence of Dstl’s technical collaborations with international parties, additional validation data may also be available for this purpose.

To populate the more granular matrix (which should include elements of probability), the drone and aircraft component models should be brought together to simulate the various key combinations, under the expected impact conditions. Again, appropriate validation and verification procedures should be exercised where possible during this process.

Any work at OFFICIAL-SESNITIVE will need to use the Dstl IT infrastructure, and access to this shall be provided by Dstl as GFA. Prof Lorenzo Iannucci holds the required security clearance, where required to utilise Dstl IT Infrastructure, and must be prepared to be subject to Dstl policies whilst utilising Dstl IT Infrastructure to access OFFICIAL-SENSITIVE information. Dstl set out to confirm that the supplier will not have access to any intellectual property gained at OFFICIAL-SENSITIVE during or

	after the contract, as all such information will be classified as GFA, and only accessible via the GFA provided by Dstl. In addressing this point Dstl set out to confirm: 1. The individual models of drones and aircraft can be built at the suppliers' location, and on the supplier IT Network as these are classified as OFFICIAL. 2. These models can then be delivered to Dstl, where Dstl shall be responsible for loading the delivered models onto our (Dstl) IT Infrastructure. 3. Prof Iannucci, through Dstl GFA provision (access to Dstl IT Infrastructure access), shall bring the models together, run them and interpret the outcome; generate a risk matrix on that system) and it is noted that these activities are classified as OFFICIAL-SENSITIVE. Dstl reserves the right to run the simulations, in isolation, on its own systems to assess the pedigree of the modelling. In the interests of facilitating a thorough technical audit, all models should be developed using the LS-DYNA finite element software. These will be reviewed, in detail, by Dstl experts for quality and representativeness. Any additional information resulting from the Dstl simulations, necessary for populating the risk matrices, will be passed back to the contractor in an appropriate form.
1.3	**Options or follow on work** *(if none, write 'Not applicable')*
	Not Applicable
1.4	**Contract Management Activities**
	In addition to the delivery schedule tabulated in section 1.6, the monthly progress updates are required from the Contractor to the Authority via an e-mail and virtual meetings. Provision of Government Furnished Information (GFi): Dstl shall be available, were required, to act as a technical partner in support of task delivery via the provision and support of technical data where required by the supplier. GFA-1: Data related to Drones construction and response under impact conditions (Nb. Supplied to Dstl by the Canadian Government), available from TBC Issued GFi must be returned to, or a certificate of destruction provided to, Dstl by 31 March 2022. GFA-2: Modelling guidance note, available from TBC. Issued GFi must be returned to, or a certificate of destruction provided to, Dstl by 31 March 2022. **All OFFICIAL-SENSITIVE aspects will be carried out via access to Dstl IT infrastructure using a nominated member of the suppliers staff. No data at OFFICIAL-SENSITIVE is allowed to be copied or transferred from Dstl IT systems.**

1.5	**Health & Safety, Environmental, Social, Ethical, Regulatory or Legislative aspects of the requirement**
	For packaging and sending GFA, the Authority shall take the relevant steps to minimise risks related to COVID-19, as detailed in the Dstl COVID-19 Risk Assessment, dated 16/06/2020. REDACTED UNDER FOIA EXEMPTION (Available as GFI where requested)

1.6	Deliverables & Intellectual Property Rights (IPR)					
Ref.	**Title**	**Due by**	**Format**	**Expected classification (subject to change)**	**What information is required in the deliverable**	**IPR Condition**
CUAS-D1	Work plan- This should be presented to the Authority via a virtual meeting (**Tasks 1 & 2**)	T0+2 Weeks	Presentation	REDACTED UNDER FOIA	Plan for tackling work packages one and two with associated time lines.	FULL RIGHTS VERSION Default RCloud Agreement Terms and Conditions shall apply
CUAS-D2	Preliminary matrix together with explanation of its development (**Task 1**)	T0+3 Months	Presentation	REDACTED UNDER FOIA	Relatively coarse, SME-based drone/target risk matrix identifying combinations result in a catastrophic outcome.	FULL RIGHTS VERSION Default RCloud Agreement Terms and Conditions shall apply
CUAS-D3	Initial supply of numerical models of aircraft and drones to Dstl (**Task 2**)	T0+4 Months	Modelling input files	REDACTED UNDER FOIA	LS-DYNA FE Models (developed with guidance from Dstl). It is understood that further model refinement may be required at this stage (in consultation with Dstl experts).	Default RCloud Agreement Terms and Conditions shall apply
CUAS-D4	Final supply of (verified and validated) numerical models of aircraft and drones to Dstl (**Task 2**)	T0+5 Months	Modelling input files	REDACTED UNDER FOIA	Finalised LS-DYNA FE models which have undergone verification and validation processes agreed by Dstl.	FULL RIGHTS VERSION Default RCloud Agreement Terms and Conditions shall apply

CUAS-D5	Refined matrix together with explanation of its development (**Task 2**)	T0+6 Months	Presentation	REDACTED UNDER FOIA	Final, more granular, probabilistic drone/target risk matrix, based on input from numerical simulation.	Default RCloud Agreement Terms and Conditions shall apply
CUAS-D6	Brief final report (**Tasks 1 & 2**)	T0+6 Months	Presentation	REDACTED UNDER FOIA	Considering work package 1 and 2, a description of the overall approach, assumptions and idealisation as well as bounds on applicability. Direct description of how the matrices should be used to make operational decisions and associated justifications is also required.	FULL RIGHTS VERSION Default RCloud Agreement Terms and Conditions shall apply

1.7	Deliverable Acceptance Criteria
	Models With reference to section 1.2 Requirement and section 1.6 Deliverables & IPR, all models should be developed using the LS-DYNA FE software (in "k-file format"). Stipulation on the desirable "model format will be provided by Dstl upon contract award. This would include guidance on the ordering of input and general formatting of commands as well as annotation of material models and other functionality. **Presentations and reports** Presentations and reports should be written in MS Powerpoint and MS Word respectively, containing description of the overall approach, assumptions and idealisation as well as bounds on applicability and significance/utility of derived output. **Matrices** Dstl does not stipulate the precise matrix format although early discussion (and agreement) of their form during the running of the project is desired. Matrices should contain clear descriptions and annotation proportionate to their intended purpose (e.g. readily digestible for policy makers and those responsible for operational decisions). **All deliverables should be sent to the Technical project lead** REDACTED UNDER FOIA EXEMPTION The Authority/Dstl will be responsible for acceptance of the deliverable/s. The outputs will be checked by the Authority for consistency and quality before acceptance. Acceptance will take place at Dstl Porton Down. Acceptance will be determined by a formal review of the delivered document/reports by the Authority. Acceptance will take place within 30 days of receipt of the deliverable by the Authority/upon completion of the Contract by the Contractor. The Contractor will be advised if and when the deliverable is acceptable. If any deliverables are not accepted, the Contractor shall be required to take remedial action to the satisfaction of the Authority, at no additional cost to the Authority

2	Evaluation Criteria
2.1	Method Explanation
	The proposal shall be assessed against a Value for Money (VfM) Index, whereby the technical score is divided by the cost. The proposal shall be assessed against a Technical assessment (Scoring questions), and a number of Commercial governance questions (Pass / Fail).
2.2	Technical Evaluation Criteria
	The technical proposal shall be assessed against the following questions:

ID	Criteria	Score	Weighting

	1	The proposal provides strong evidence that the bidder has the expertise and deep technical knowledge in the areas of **aircraft design and performance as well as airworthiness (in the event of collision)**, They should demonstrate: production of related historical reports/papers; strong relationships with aircraft manufacturers etc.	0-10	5
	2	The proposal provides strong evidence that the bidder has the expertise and deep technical knowledge in the areas of Drone analysis, design and performance, demonstrating: production of historical reports/papers, relationships with manufacturers and other relevant organisations or authorities etc.	0-10	4
	3	The bidder has provided a feasible and detailed work plan of activities, with risks and mitigations clearly identified. A project plan in the form of a Gantt chart or similar is expected.	0-10	4
	4	The bidder has provided details of their expertise in numerical model generation and the use of the LS-DYNA FE code (particularly in the area of Drone/Aircraft collision). Historical reports, papers or similar, demonstrating this capability are to be supplied with this bid.	0-10	5

The Technical questions shall be marked against the following scoring criteria:

Score	**Definition**
10	**Excellent:** The response addresses all elements of the requirement, and provides a comprehensive, unambiguous and thorough explanation of how the requirement will be fulfilled.
7	**Good:** The response addresses all of the elements of the requirement and provides sufficient detail and explanation of how the requirement will be fulfilled.
3	**Adequate:** The response addresses the majority of elements of the requirement but is weak in some areas and does not fully detail or explain how the requirement will be fulfilled.
0	**Inadequate:** The response does not address or explain how the requirement will be fulfilled and fails to demonstrate the ability to meet the requirement.

2.3	Commercial Evaluation Criteria
	The commercial evaluation shall consider:

	• Has the supplier provided One Full Technical proposal excluding all Price Date, and One Fully Commercial Proposal including all price data? • Has the supplier provided a Supplier Assurance Questionnaire (SAQ) in response to the Cyber risk requirement, and provided a copy of the DCPP correspondence? • Has the supplier submitted a completed RCloud Part C Task Response Form? • Has the supplier submitted a firm price proposal?