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

Title of Requirement	**Development of an autonomous robotic concept demonstrator to conduct chemical and radiological area survey and reconnaissance.**
SoR Version	**0.1**

1.	**Statement of Requirements**
1.1	**Summary and Background Information**
	Summary The aim of this contract is to produce a concept demonstrator which successfully demonstrates the feasibility and utility of using autonomous robotic systems to effectively conduct the roles associated with CBRN Area Survey and Recce (AS&R). There are three distinct tasks of this contract: 1) Creation of a palletised payload containing CBRN sense and sampling capability 2) Modification of a UGV platform for the integration of the palletised payload 3) Development of a virtual system simulator The resultant concept demonstrator system will appropriately carry and employ a fully removable chemical and radiological sensors and associated samplers to conduct representative tasks for the AS&R. This system will be trialled outdoors in simulated missions, alongside the current manned capability conducting equivalent tasks, to collect data on system performance and utility. This will work inform requirements development for future CBRN AS&R aspirations regarding the feasibility of utilising autonomous robotics to augment or replace manned capabilities to reduce burden, improve safety and increase operational tempo. **Background** The Counter-CBRN Policy is clear that hazard avoidance is the starting point for mitigating the threat. There is therefore interest in the development of autonomous systems that can reduce or remove the need for the humans and equipment to be exposed to contaminated environments as far as practicably possible. This work will be the first specific UK study targeted at use of autonomous robotic systems to complete mounted AS&R tasks. Further it will demonstrate the feasibility of using general purpose autonomous platforms to provide a CBR capability by adding a modular payload which has the potential to reduce the life cycle cost and improve the flexibility of such capabilities. CBR recce and survey (mounted) in support of military operations is a task currently conducted by the FUCHS vehicle. Dstl is seeking to develop a capability demonstrator capable of autonomously conducting this task during outdoor field trials.

1.2	Requirement
	Mandatory All essential work outlined within this contract is to be completed by December 2022 in order to inform parallel work on-going to develop concepts and strategies in support of future plans. The system developed in this contract will be required to demonstrate Technology Readiness Level 6 during the field trials, which are to take place in September/October 2022. The contractor must supply a team of Suitably Qualified and Experienced Personnel (SQEP) in the field of autonomous vehicles and robotics. The contractor is required to provide evidence of a proven track record of developing, building and trialling prototype autonomous ground robots, with prototype demonstrations undertaken for chemical, radiological or biological survey purposes. It is not the intention of this contract to procure a platform, consequently the platform shall be either owned by the contractor or by MoD. In the case of the latter, the contractor should make clear any requirements for access to the platform as GFE if this a more efficient means of delivering the contract. The contractor shall augment the capabilities of an existing and previously demonstrated autonomous medium sized ground vehicle (hitherto referred to as the "Platform") for use within this contract. The Platform must have previously undergone trials conducted and witnessed by an external (preferably government) authority that have successfully demonstrated the attributes and capabilities contained within the System Requirements List (SRL) under Platform. **Task 1 – Payload Development** The contractor shall develop a palletised payload capable of being integrated onto the platform. The payload shall provide a sense and sampling capability for airborne chemical vapours, deposited chemicals and gamma radiation to enable the platform to conduct chemical and radiological recce and survey missions. The contractor shall produce a payload that utilises all of the sensors listed below under Government Furnished Equipment/Assets (GFE/A). These sensors will be provided to the contractor for the duration of the project. The contractor shall produce a payload with on-board data processing and automation to control the instruments and systems of the payload and process the raw data produced by the sensors. The systems of the payload shall allow the platform to control the overall system (Payload and Platform) and command the sensors and sampler(s), without requiring the platform to directly control any of the payload's sub systems. The payload shall provide the platform with processed detection levels for the targets without requiring the platform to process raw sensor data. The payload shall mount directly to the load bed of the platform and draw its power from the platform. All communications to the payload will be through the communications system of the platform. The following sensors will be provided to the contractor as GFE/A: • Smiths Detection LCD 3.3 - Ion Mobility Spectrometer • Smiths Detection CAM XTR- Ion Mobility Spectrometer • Bruker MM2 – Mass Spectrometer • Mirion SPIR-Explorer – Gamma Spectrometer. The Bruker MM2 will be provided with the manufacturer's software and associated licenses to allow the remote operation of the MM2 and it's interfacing to third party IT systems. If required, additional software for the other GFE items will be also be provided. These licences will be provided for the duration of the contract and must not be passed to a third party without the express permission of Dstl. It is expected that reasonable wear and tear due to normal operation of the equipment will remain the liability of MoD. Liability for the loss or damage to the GFE/A due to wilful damage, negligent use or operation of the GFE/A outside of manufacturer's guidance will be the liability of the contractor. The contractor shall produce a palletised payload that successfully demonstrates the attributes and capabilities contained within the System Requirements List (SRL) under Task 1; Physical, Electrical, Digital, Data and Sampling.

	The payload shall incorporate a sampler to continuously collect samples from the ground while the platform is in motion and present it to the heated inlet probe of the Bruker MM2. The system shall use the dual wheel sampler as used on FUCHS that will be configured such that the system provides continuous sampling and periodic analysis, the period to be specified by the user. A supply of wheels will be provided as GFE and the contractor should indicate how many they anticipate needing. Additional wheels can be requested during the contract, at the discretion of the authority. The authority will not provide the means of attaching and controlling the sampling wheels however and the manufacture of that system is the responsibility of the contractor. The payload shall provide an on-board meteorological sensor capable of measuring as a minimum, wind speed, direction and ambient temperature. Task 2 – Modification to the Platform The contractor shall modify the platform to allow integration of the payload for the purposes of supporting trials set for September/October 2022. The integration shall be carried out in such a way that the payload can be removed after which the primary role of the platform can be re-instated. The modifications to the platform shall not reduce the platforms ability to perform its primary role. Once the payload is mounted, the combined system shall provide a capability to conduct chemical and radiological recce and survey missions in an autonomous manner with the user input restricted to setting up missions, monitoring progress and dealing with exceptions, though the ability of a user to tele-operate the system when required must be provided. The contractor shall produce an integrated payload platform system that successfully demonstrates the attributes and capabilities contained within the System Requirements List (SRL) under Task 2; Physical, Electrical, Digital, Autonomous Behaviours, Communications and Human Machine Interface (HMI). Task 3 – Virtual System Simulator To support the development and optimisation of the concept demonstrator, its algorithms and autonomous behaviours; and to enable virtual testing of the system prior to the intended field trials it is required that the contractor provides a virtual simulator. The contractor shall produce and provide a virtual test environment inside which the software behaviour of the system can be embedded. The contractor shall produce a virtual system simulator that successfully demonstrates the attributes and capabilities contained within the System Requirements List (SRL) under Task 3.

1.3	**Options or follow on work** *(if none, write 'Not applicable')*
	Option 1 – Incorporation of a probalistic inference algorithm for chemical source location. This shall provide a capability which utilises the chemical sensor data from the LCD 3.3 along with platform location and wind speed and direction to predict the location of deposited chemical contamination (the "source"). It shall use this prediction to update the navigation of the platform to further refine the prediction by relocating the platform to gain sensor data that improves the probability estimate. • The Inference algorithm shall be user selectable by means of the HMI • The Inference algorithm shall automatically generate navigation feeds to the autonomous behaviours of the platform • The Inference algorithm shall operate without reducing the normal function of the autonomous platform (for example it must not place such a processor load on platform such that the duty cycle of the autonomous systems is reduced) • It is accepted that the platform may need to be stationary while taking a point vapour measurement to update the inference algorithm. • The normal recce and survey functionality shall be operating while the platform moves between point measurement locations, to avoid the platform driving through deposited contamination unless otherwise selected by the user. • The inference algorithm shall provide the user with an update of the current prediction location on the HMI by means of markers on the map shown by the HMI. • In the event that the concept demonstrator detects deposited contamination during an inference based search, the platform shall stop and the inference algorithm should update the location prediction accordingly. The user shall be given the option of either continuing the inference based search to find the area of greatest contamination, or placing the concept demonstrator back into standard recce and survey behaviour. • Following a search using the inference algorithm, the concept demonstrator shall pause and allow the user to decide the next course of action. This could include the platform being tele-operated out of the contamination, or the platform retracing its path back to the last known clean location. • It is accepted that the performance of the inference algorithm may be impacted by multiple deposits and that manual intervention may be needed to command the concept demonstrator to the upwind side of a located area of contamination prior to restarting the inference algorithm. **Option 2** - Provide a sampling system based on a novel/developmental sampling: • Should provide a continual sampling capability while the vehicle is in motion by integrating the contamination picked up for subsequent analysis • Should be capable of collecting a sample while simultaneously analysing a previous sample • To have a means of keeping the sampler in touch with the ground while the platform is moving. • Should be compatible with sampling from all terrain types while minimising the levels of dirt being passed on to the sensor payload • Should be capable of sampling from all terrain types while minimising the level of hydrocarbon pickup from the surface (e.g. when sampling from concrete) • Should be capable of sampling from all terrain types without causing damage to the surface • To have a means to lift the sampler from the ground when not in use, or when the platform is expecting to manoeuvre in such a manner as the sampler may be damaged • To develop a means to automatically replace any consumable items required when commanded by the user • Be controllable from the platform so that the sampling conditions and status can be defined by the user using the HMI of the platform.

	Option 3 - Integration of a [REDACTED] The [REDACTED] is a lightweight mass spectrometer manufactured by [REDACTED]. This lot is for the installation and integration of a GFE [REDACTED] into the payload. A Thermal Desorber suitable for interfacing the [REDACTED] with the sampling wheel will be provided as GFE. • The [REDACTED] shall be connected to the Thermal Desorber in accordance with instructions and guidance provided by Dstl. • The GFE shall be integrated with the deposited sampling system. • The [REDACTED] and thermal desorber shall be mounted in such a manner that it is operated in parallel to the [REDACTED] with desorption of the wheel occurring on both mass spectrometers simultaneously. • The data from the [REDACTED] shall be processed by the payload and provided to the platform's autonomous behaviours as processed concentration levels. • The [REDACTED] shall be used to provide high fidelity data to inform the real-time autonomy algorithm providing initial detection and hazard avoidance and report reading in real-time to the operator • The inlet for the [REDACTED] shall be heated and allow for high and low volatility analytes to be detected The inlets shall be designed as such that a "burn off", purge and clear down cycle can be performed if the detector is overloaded
1.4	**Contract Management Activities**
	To be decided at start-up meeting
1.5	**Health & Safety, Environmental, Social, Ethical, Regulatory or Legislative aspects of the requirement**
	These responsibilities lay with the contractor for all work under taken at their chosen sites for the duration of this contract.

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**
PKM	Project Kick Off Meeting	T0+2 weeks	Presentation (.pptx)	n/a	O-OS	Presentation pack to include but not limited to: - Communication plan - Schedule breakdown for achievements per quarter.
QPTR	Quarterly Progress and Technical Review	T0 + 3, 6, 12 & 15 Months	Presentation (.pptx)	n/a	O-OS	Presentation pack to include but not limited to: • Update on technical progress • Progress report against project schedule. • Commercial aspects. • Review of deliverables. • Risks/issues.
TR	Technical Report – Task 1	T0 + 6 months	Word (full rights)	n/a	O-OS	Report detailing the development of payload with use of GFE/A in line with Physical, Electrical, Digital, Data and Sampling requirements. *Milestone Payment 1.4*
TR	Technical Report – Task 2	T6 + 10 months	Word (full rights)	n/a	OS	Report detailing the integration of the payload (section 1) to the platform. Requirements to be further defined by Dstl at Project Kick-off meeting. *Milestone Payment 2.4*
TR	Technical Report – Task 3	T0 + 9 months	Word (full rights)	n/a	OS	Report detailing usage and functionality of Virtual Simulator. Requirements to be further defined by Dstl at Project Kick-off meeting. *Milestone Payment 3.3*

POT1	Physical Output – Task 1	TBD at PKM	Palletised Payload (full rights)	6	OS	Palletised payload of GFE/A sensing equipment for integration on to platform (section 2) which is in adherence to all Physical, Electrical, Digital, Data and Sampling requirements outlined within Part 1.4 (Section 1) above. *Milestone Payment 1.1: Software Architecture* *Milestone Payment 1.2: Hardware Design* *Milestone Payment 1.3: Hardware Build*
POT2	Physical Output – Task 2	TBC	Integrated Platform (full rights)	6	OS	Successful integration of Palletised payload (Section 1) to Platform which is in adherence to all Physical, Electrical, Autonomous Behaviours, Communications and Human Machine Interface requirements outlined within Part 1.4 (Section 2) above. *Milestone Payment(s)*
SOT3	Software Output – Task 3	TBC	Virtual Simulator (full rights)	6	OS	Requirements to be further defined by Dstl at Project Kick-off meeting. *Milestone Payment(s)*
STT	Support to Trials	T0 + 16 months	Support to trials	n/a	OS	Participation and support on field trials, currently estimated to take place September/October 2022.
FTR	Final Technical Report		Word (docx) full rights	n/a	OS	Detailed technical report Presentation to Stakeholders/customers

1.7	**Deliverable Acceptance Criteria**
	All reports included as Deliverables under the Contract must comply with the Defence Research Reports Specification (DRRS) https://www.gov.uk/guidance/submit-a-report-to-athena , which defines the requirements for the presentation, format and production of scientific and technical reports, prepared for the MOD.
1.8	**Specific Deliverable Acceptance Criteria**
	As outlined within Section 1.2

2	**Evaluation Criteria**
2.1	**Technical Evaluation Criteria**
	Relevant Experience
	Demonstration of experience - management and delivery of research into autonomous ground vehicles The proposal clearly demonstrates experience of the management and delivery of research projects in the fields of robotics and autonomous systems. Assessors will be looking for the proposal to demonstrate a record of relevant high quality research into autonomous ground vehicle development.
	Demonstration of experience - management and delivery of AI applications The proposal should provide clear evidence of experience designing and delivering AI systems for object recognition in complex environments and demonstrating these in real world applications. Assessors will be looking for the proposal to demonstrate a record of implementing and demonstrating AI based object recognition in real world applications
	Demonstration of experience - management and delivery of research in to chemical sensing behaviours The proposal clearly demonstrates experience of the incorporation of chemical sensing systems in the data architecture, human machine interface and autonomous behaviours of a robot and have demonstrated this in real world applications. Assessors will be looking for the proposal to demonstrate a record of incorporation of chemical sensor data into the data architecture and HMI and using this to modify the robots autonomous behaviours.
	Technical Experience The proposal is demonstrated to be scientifically, technically and practically feasible within the proposed project timescales.

	Assessors will be looking for the bidder to clearly describe the project breakdown showing what can be achieved within the time and cost constraints and what will be the outcomes at the end of the contract.	
	Technology Suitability The proposal describes a system that adequately addresses the requirements outlined in the contract. Assessors will be looking for evidence that the technology described will provide a system capable of Autonomously exploring a defined area internally generated route planning and obstacle avoidance and that it incorporates chemical sensing into this route planning while providing AI based object recognition to the operator	
	Technical Feasibility The proposal appropriately addresses the technical risks and challenges and provides means for managing and minimising these. Assessors will be looking for the bidder to clearly demonstrate their understanding of the technical challenges associated with developing the technology, and have provided details of how these risks will be minimised.	
	Testing and Demonstration The proposal describes the testing regime that the contractor intends to use to demonstrate compliance with the contract. The assessors will expect the proposal to clearly set out a testing regime that will deliver confidence that the system will meet the requirements for the contract. The regime should be provide measurable targets and success criteria	
2.2	**Commercial Evaluation Criteria – all four elements must have a pass to enable the proposal to be evaluated.**	
	Compliance with the required quotation validity period of 60 days from tender due date.	Pass/Fail
	Please provide full details of the points of contacts for commercial, project management and technical, for the proposed contract duration.	Pass/Fail
	The Tenderer must provide a Firm Price to undertake the work detailed in the core requirement, and proposed milestone payment schedule as detailed above.	Pass/Fail
	The Tenderer must provide completed Personal Particulars form for each person working directly to the project.	Pass/Fail
2.3	**Management Evaluation Criteria**	
	Explanation of the approach in shaping the direction of the task during its delivery through clear scheduling including provision of suitable detailed work breakdown structure with appropriate time and risk mitigation included.	
	Demonstration of the allocation of suitably qualified and experienced personnel to the task.	
	Demonstrate that a balanced level of technical risk is being taken for each section task	
	Demonstration that Project management process is undertaken to defined industry standard or suitable equivalent.	

	Demonstration of how risks, assumptions and dependencies will be managed
	Affordability: Cost is within budget