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Statement of Requirement for the R-Cloud Chemical, Biological and Radiological (CBR) Strategic Capability

Introduction:

The Defence Science and Technology Laboratory (Dstl), which is part of the UK Ministry of Defence (MOD), is refreshing its commercial agreement for Science and Technology (S&T) research contracts, known as R-Cloud (Research Cloud).
MOD places extensive fundamental, experimental and applied research with industry and academic suppliers and wants to broaden access for this supply base, reducing the cost of trading with MOD and enabling agile contracting. R-Cloud complements MOD's other contracting mechanisms and academic and industry suppliers of S&T research are now invited to apply to join MOD's research supplier community within the CBR Strategic Capability.

This statement of requirement relates to suppliers joining R-Cloud within the CBR capability area. R-Cloud provides a low barrier to entry for potential suppliers and offers direct access to MOD's current and future research requirements. Academic and industrial suppliers of CBR research are invited to apply to R-Cloud if you are a supplier of Science and Technology Research in this area.

The UK is fully committed to its obligations under the Biological and Toxin Weapons Convention and the Chemical Weapons Convention. All MOD sponsored work must be in the context of the prophylactic, protective or other peaceful purposes that are not prohibited under the terms of these Conventions.

Proposals using animals must be fully compliant with national legislation and institutions may be audited to ensure work is conducted to a suitable standard prior to a contractual commitment and whilst under contract.

CBR encompasses a broad range of technical areas, these are summarised here:

1) Understanding the hazard associated with biological and chemical agents

Technical research may be required to support the assessment of chemical and biological materials and systems which pose potential threats to military or civilian populations. Technical research required may include, for example, that which:

- enables an understanding of bacterial or viral virulence, or mode of action of toxins and chemicals
- enables an understanding of the persistence of biological or chemical agents in the environment, including in aerosols

- enables an understanding of the presence of chemical or biological agents requiring decontamination

This may include:

- conceptual work to consider possible misuse of technologies, and to predict scientific developments within biology or chemistry that may lead to misuse concerns in the future
- literature extraction relating to bacteria, viruses, toxins or chemicals
- assessment of the toxicity of chemicals or toxins, or the pathogenicity and infectivity of infectious agents
- assessment of methods for production and dispersion of bacteria, viruses, toxins or chemicals
- assessment of environmental stability of bacteria, viruses, toxins or chemicals
- determination of droplet or particle sizes of chemical and biological agents
- mathematical modelling of the dispersion, persistence and toxicity of bacteria, viruses, toxins or chemicals

2) Mathematical modelling of chemical and biological hazards

Mathematical models are used to provide specialist advice, supporting situations ranging from operational decision making to supporting procurement for defence equipment. Technical research may be required to develop and validate mathematical models in order to support this activity. The models may be empirically based or based on first principles. The types of models will likely include but are not limited to models which:

- predict the dispersion of, environmental persistence of and hazard associated with chemical and biological agents
- predict the performance of detection systems for chemical and biological agents
- predict the utility of protective equipment, e.g. respirators and protective suits, for chemical and biological agents
- predict the physiological effects of CBR agents on people
- predict the management and operational consequences of chemical and biological agents
- predict the effects of intervention decisions in the event of a disease outbreak
- include optimisation algorithms related to CBR modelling and simulation tools

Research may also be required to support the development and validation of these models including, but not limited to:

- experimental and computational fluid dynamics
- mass transfer
- materials and surface science
- meteorology
- aerosol science
- building science

3) Operational analysis

Research and analysis may be required to support the understanding of the impact that chemical or biological substances may have on the UK or its deployed armed forces, or to support understanding of the UK's opportunities to prevent the proliferation and use of such substances. Research and analysis may be required in a number of areas including, but not limited to:

- soft systems methods and other qualitative techniques
- methods for assessing and understanding the risk from CBR incidents
- methods for conducting balance of investment and cost-effectiveness assessments of potential mitigation measures
- methods for assessing the effectiveness of options to prevent an adversary developing the ability to use chemical or biological substances against UK interests
- methods for identifying and analysing future technologies / emerging materials that if used nefariously could increase the risk from CBR incidents

4) Detection of chemical agents

Technical research may be required to support the development of chemical detection systems, including research for innovative means to detect toxic chemicals in vapour, aerosol and/or deposited form. In particular, capability in one or more of the following areas may be required:

- High selectivity of chemical agents, ideally providing molecular classification or identification
- High sensitivity of chemical agents
- Broad range agent detection on an easily and rapidly programmable platform

The research may require, but is not limited to:

- sensing technologies, including optical spectroscopy, hyperspectral imaging, spectrometry, acoustic and thermal
- sampling, control and characterisation of aerosols
- molecular recognition
- sample processing
- photonics developments (including lasers and detectors)
- systems engineering
- analytical chemistry
- computational fluid dynamics

5) Detection of biological agents

Technical research may be required to support the development of biological detection systems, including in innovative means to detect biological agents in aerosol form and in complex environmental matrices (soil, liquid etc). In particular, capability in one or more of the following areas may be required:

- Timely, high selectivity and specificity high confidence identification of biological agents
- High sensitivity of detection of biological agents
- Broad range agent detection on an easily and rapidly programmable platform

The research may use, but is not limited to:

- biological recognition elements and assay design
- spectroscopy and spectrometry
- DNA and protein sequencing
- sample processing and complex sample handling
- microarray development
- systems engineering
- aerosol sampling

6) Diagnostics for chemical and biological agents

Technical research may be required to deliver technology options that support and inform the diagnosis of infection by biological agents or intoxication by chemicals and toxins. In particular, research may focus toward, but is not limited to, providing diagnostic capabilities that may be used for:

- Identification of agent at point of care
- Enhance current clinical laboratory diagnostic capabilities
- Early (pre-symptomatic) identification of individuals exposed to hazardous agents via physiological and molecular biomarker signatures
- supporting technologies for key elements of the diagnostic process including, but not limited to, sample preparation and enhanced data analysis techniques

These diagnostic approaches may focus on:

- providing a high confidence, minimal burden, capability
- enabling the identification of as many agents as possible in one test
- a holistic approach to technology development that is not necessarily reagent or agent- specific.

7) Physical protection against chemical and biological agents

Technical research may be required to develop materials and technologies that lower the physiological and logistical burden associated with using CBR individual and collective protection equipment whilst maintaining appropriate levels of protection. Technical research may be required for, but is not limited, to:

- novel concepts and materials for providing respiratory, dermal and collective protection
- systems approach to integrated protection and containment technologies pertinent to collective protection

- air purification technologies, including emerging adsorbents (especially in physical forms relevant to practical filtration systems) and their interactions with chemical vapours, vapour destruction methods and aerosol removal/destruction systems
- understanding liquid-solid interactions and novel approaches to dermal liquid protection
- behaviour of aerosols in clothing systems
- micro-dosimetry and real time dosimetry techniques for chemical vapours
- novel methods for assessing the protection afforded by protective clothing, respiratory protection and collective protection systems

8) Decontamination and destruction of chemical and biological agents (Hazard Management)

Technical research may be required to support the development and evaluation of technologies that can be used reduce the hazards from, or destroy chemical, biological or radiological agents. For example, research may be required for, but is not limited to, the following activities:

- Novel concepts for decontamination
- Novel concepts for disposal and waste management
- Novel concepts for disclosing the presence of contamination on surfaces
- Development of novel chemistries and formulations: with the potential to be effective against a broad spectrum of contaminants, minimize impact on materials and equipment, and reduce logistic footprint and life-cycle costs
- Development of responsive materials that can target the contaminant and trigger a response
- Use of predictive models for accelerated formulation development and optimised application process
- Development of surface coatings
    - Chemically hard coatings
    - Sacrificial absorbent coatings
    - Self-decontaminating surfaces
    - Disclosing coatings
- Other specific research sub-areas may include:
    - Nano-fibers, nano-structured composites for particulate removal and destruction
    - Molecular recognition
    - Dynamic combinatorial chemistry
    - Advances in the design and synthesis of high affinity ligands
    - Advances in spectroscopy, electrochemistry, or other analytical techniques
    - Emerging approaches utilizing novel molecular signatures or coupling techniques
    - Improved spray application and run-off processing techniques
    - Biotic and abiotic enzymes/peptides for chemical and biological agent removal and destruction including rational design, synthesis, stabilization, performance, and scale-up
    - Crystalline nano-porous framework materials and nano-composites for adsorption and low-temperature catalysis
    - Evaluation of commercial products/methods for decontamination of surfaces.
- Evaluation of commercial products/methods for waste treatment

- Evaluation of commercial products/methods for agent disclosure (including, for example, disclosure sprays or coatings)
- Evaluation of decontamination products/methods for compatibility with materials.

9) Medical countermeasures for biological agents

Technical research may be required to support the discovery, assessment or development of medical countermeasures for pathogenic bacteria and viruses. Such medical countermeasures may include vaccines and/or therapies to be administered prior to or after exposure to a biological agent. Technical research required may include, for example, that which:

- enables a greater understanding of bacterial or viral virulence
- enables a greater understanding of host responses to infection with bacterial or viral agents
- identifies and/or evaluates novel medical countermeasures

This will likely include but is not limited to:

- mutagenesis studies to determine the role of individual or multiple factors in virulence or host responses to infection
- immunological analysis of host responses to infection or immune modulation approaches
- mathematical modelling of bacterial/viral pathogenesis or host-pathogen interactions
- molecular structure-function determination
- design of assays for molecular interactions
- delivery approaches for vaccines/therapies
- development and use of *in vitro* or *in vivo* models of infection

10) Medical countermeasures for chemical agents

Technical research may be required to support the discovery, assessment and development of medical countermeasures for chemical agents. Such medical countermeasures may include pretreatments and/or therapies to be administered prior to or after exposure to chemical agents such as nerve agents, vesicants and lung damaging agents and related chemicals. Technical research required may include, but is not limited to that which:

- enables a greater understanding of the mechanism of action of the toxic chemical
- identifies and/or evaluates novel medical countermeasures

This will likely include but is not limited to:

- development and use of *in vitro* models of chemical toxicity
- molecular toxicology studies to determine mechanisms of action

- molecular pharmacology and quantitative structure activity determination to identify and optimise medical countermeasures
- characterisation of chemical toxicity in animals
- experimental determination and mathematical modelling of chemical agent and medical countermeasure actions in the body
- determination of the efficacy of medical countermeasures *in vivo*

11) Chemical and biological (including new and emerging materials) analysis and attribution

Technical research may be required to support the development of analytical methods and knowledge to confirm to the highest levels of confidence the identity of chemical and biological agents and to provide information on how, where, when and by whom these agents were produced or used. In addition, particularly for biological agents, it may be necessary to determine whether an outbreak is naturally occurring, accidental or deliberate in origin. This is likely to include, but is not limited to:

- mass spectrometry-based techniques for the analysis of chemical and biological agents
- genomics (including metagenomics) and proteomics based research for the analysis of biological agents, with a well developed bioinformatics capability to facilitate this capability
- techniques for the analysis of human and animal samples to confirm exposure to chemical and biological agents
- the application of 'forensic analysis' techniques (e.g. those applied to fine art or food authentication) to chemical and biological materials to determine how, when or where the material was produced
- the recovery of forensic trace (e.g. human DNA and fingerprints) from chemically or biologically contaminated items
- development of knowledge and models on the effects of CB weapons, including assessment of weapons fragments and images of damage post-event to enable the identification of the specific weapon used in an event

12) International biological threat reduction and counter-proliferation

Technical research may be required to support activities to strengthen global biological security. These may link UK experts with scientists and networks in a number of priority regions including the Caucasus, Central Asia, the Middle East/North Africa and Afghanistan, to promote best practice in biosecurity and biosafety in a sustainable way.

This will include:

- Development of collaborative scientific research projects to include: developing an understanding of host reservoirs of disease, improving in-country/regional surveillance, monitoring and control of biological agents.

- Local approaches to biosecurity, biosafety and/or dual-use bioethics issues.
- Development of sustainable capacity for effective understanding and control of biological agent threats (human, animal or plant).
- Support to UK national capabilities for reducing risk from infectious disease threats.