Continuing Human Enabling, Enhancing, Restoring, and Sustaining (CHEERS) Multiple Authority Announcement (MAA) Technical Requirements - Statement of Objectives (SOO)

1.0 Objective

CHEERS is an Open Two-Step MAA with the ability to issue Calls that enable study efforts on novel concepts as well as R&D contracts to mature specific technologies to appropriate Technology Readiness Levels (TRLs) depending on end use. This MAA allows consideration of white papers as well as calls issued by the Government when specific requirements are identified. Submitted white papers and/or proposals should target specific research challenges within the Product Line (PL), Core Technical Competency (CTC) and/or Core Research Areas (CRA) and exactly identify the technical requirement(s) (by nomenclature below) for which they are proposing.

2.0 Scope

The Air Force Research Laboratory's (AFRL) Airman Systems Directorate (RH) is a key component of the 711th Human Performance Wing (711HPW). The directorate is composed of a diverse group of scientists and engineers studying developing technologies specific to the human element of warfighting capability. We are leading the United States Air Force (USAF) in its human-centered research, and we integrate biological and cognitive technologies to optimize and protect the Airman's capabilities to Fly, Fight, and Win in Air, Space, and Cyberspace.

The Airman Systems Directorate (RH) is the heart of Airman-centered science and technology for the USAF. RH is focused on enduring challenges to enable, sustain, and enhance multi-domain capable Airman and Airman-machine operations. RH leverages five primary Technical Competencies to deliver technology options for future USAF capabilities: Training, Adaptive Warfighter Interfaces, Bioeffects, Bioengineering and Warfighter Medical Optimization.

The RH Directorate develops Airman-related technology for systems crucial to continued aerospace superiority. We work to transfer the same or similar technology to civilian applications when appropriate. We are organized into three divisions located at Wright-Patterson Air Force Base, Ohio and Joint Base San Antonio, Texas.

- **Airman Biosciences (RHB):** Discover, demonstrate, and transition knowledge products and technology solutions from the full spectrum of bioscience, biotechnology and aerospace medicine, to enable, enhance, sustain, and restore the health and performance of the multi-domain Airman.
- **Bioeffects (RHD):** Protects against and exploits the bioeffects of battlefield environmental stressors.
- **Warfighter Interactions & Readiness (RHW):** Enable a more informed, agile, and lethal force by delivering revolutionary capabilities that enhance preparation and mission execution across the full range of military operations.

3.0 Technical Requirements

Activities within the 711HPW are organized into research areas which are categorized based on the technology readiness level (TRL). Product lines focus on advanced technology development and identifying paths for technology transition while the CTC’s and CRA’s focus on basic research through early applied research. Each division further breaks down the research into Lines of Effort (LoE) or Product Area (PA) for each CTC or PL, respectively. Descriptors of PL, CTC and CRA are provided below:

- **Product Line (PL):** An organizational construct within the Airman Systems Directorate for engineering and transition of technology to the Department of the Air Force and Department of Defense. A Product Line organizes and manages inter-related technology demonstrations and transition paths for Airman Systems Directorate technologies at late applied and advanced technology development stages. The product line may integrate research and engineering tasks across several CTCs within AFRL.

- **Core Technical Competency (CTC):** CTCs represent the technical foundation that is difficult to duplicate and allows AFRL to provide unique technical leadership. They span basic research, applied research, and advanced technology development encompassing the people, information, facilities, equipment, and programs allowing AFRL to solve critical AF and national security problems.

- **Core Research Area (CRA):** A subset of the Core Technical Competencies within the Airman Systems Directorate. CRAs represent a focused group of basic and early applied research, focused on investigating revolutionary, higher risk concepts. The CRAs mature new foundational technologies and transition promising research to product lines of the organization.

3.1 Airman Biosciences (RHB)

3.1.1 RHB Product Line (PL) & Product Area (PA)

3.1.1.1 Aerospace & Operational Medicine PL1: Matures and transitions aeromedical knowledge, technology, and materiel solutions in force health protection, human health and performance, and aeromedical evacuation & enroute care in order to enable, sustain, enhance, and restore operational and aeromedical health and human performance for Airmen executing Air Force missions across all operational domains. Objectives focus on generating high performance Airmen and Guardians through medical availability, enhancing joint combatant commander capabilities, and maximizing human capital and strategic resources by aligning resources to strategic and workforce development. The goal is to transition products that address validated AF/AFMS requirements by focusing on stakeholder engagement to ensure clear demand signals and to create and maintain extensive partnership network to ensure rapid execution and flexibility.

3.1.1.1.1 **Air & Space Austere Environment Patient Transport (En Route Care) PA1:** Advances combat casualty care in the air through biomedical research into interventional strategies and technologies that mitigate the risks for additional insult due to aeromedical evacuation. Transitions promising Science and Technology (S&T) into knowledge and material products that promote the recovery and return to duty of injured or ill service members, from point of injury back to definitive care. Research within this program includes but is not limited to ground medical operations in agile combat employment, autonomous care of patient movement, and optimization of patient movement.

3.1.1.1.2 **Air & Space Force Health Protection (FHP) PA2:** Medical development and biomedical technology investments seek to deliver an improved FHP capability across the full spectrum of operations with research that prevents injury/ illness through improved identification and control of health risks. Under FHP, sub-project areas include Occupational Hazard Exposure (Includes Flight Hazards and Integrated Risk), Targeted Risk Identification, Mitigation and Treatment (Formerly Pathogen ID and Novel Therapeutics and includes Big Data), FHP Technologies Development and Assessment (Assay and disease detection), and Health Surveillance, Infection, Injury & Immunity. FHP also includes Innovations and Personalized Medicine. Operational medicine is focused on in garrison care – our next most critical issue post OIF/OEF – and how to care for the whole patient and consideration of comorbidities in treatment of wounded warriors and dependents.

3.1.1.2 **Biotechnology for Performance, Research, and Demonstration PL2:** Develops and delivers capabilities to enhance human performance in near-peer conflict. Objectives focus on modular systems that integrate with warfighting platforms and maintaining and enhancing end-user engagement to ensure relevance and realism all while working in close sync with DoD and external partners to deliver high value solutions. The goal is to build momentum for Wearable technology, continue to develop and advocate for human assessment & tracking, strategically plan for product usage in austere environments, and expand on current platform products to develop and connect capabilities with operational challenges.

3.1.1.2.1 **Airman Sensing & Assessment PA1:** Develop and demonstrate advanced prototype products that integrate physiological, cognitive, behavioral, and environmental sensing capabilities with validated analytics, assessments, and intervention capabilities to sustain and enhance air and space operator performance.

3.1.1.2.2 **Human Performance Augmentation & Development PA2:** Develop and deliver capabilities to enhance human performance in near-peer conflict by focusing on modular systems that integrate with warfighting platforms. Working in close sync with DoD and external partners to deliver high value solutions to maintain and enhance end-user engagement to ensure relevance and realism.

3.1.1.2.3 **Air & Space Physiology, Medicine, and Human Performance (HP) PA3:** Enables, sustains, and optimizes performance of Airmen through elevation and alleviation of health effects associated with AF operational missions. Addresses operational environments such as the mitigation of stress in AF personnel, to include aircrew, care providers, aircraft maintainers, intelligence, surveillance and cyber operators, as well as remote piloted aircraft operators. Research within this project includes but is not limited to airman performance and readiness, advancing air and space medicine, and medical operator performance digital engineering. Advanced technology development to enable, sustain, and optimize cognitive, behavior and physiologic performance in high-priority career fields for the United States Air Force (USAF) and in multidomain operations. The sub-project areas include cognitive and physiologic performance under operational and environmental stressors, detection and improvement of physiological performance, and safety via sensor systems and targeted conditioning, which includes training techniques for optimal performance. This project also develops and demonstrates technologies which ingest health status monitoring data to provide scalable situational awareness of individual, unit, and group medical readiness in support of command and control and develops strategies to mitigate performance limitations through physical, pharmacological/non-pharmacological, or behavioral medical interventions and/or technological augmentation.

3.1.2 RHB Core Technical Competencies (CTC), Critical Research Areas (CRA) & Lines of Effort (LOE)

3.1.2.1 Medical and Operational Biosciences CTC1: Develops, validates, and enhances medical and operational biosciences and emergent biotechnologies for transition into advanced development products in the Air and Space operational environment to lead to a highly resilient and medically ready force. These products can sense, assess, sustain, and segment warfighter physiological-cognitive performance in multi-domain operations. Deliverables will be enhancing and researching new technologies and concepts to sustain, augment, and restore the multi-domain Airman & Guardian Health and Performance. Customers, end-users, and stakeholders include the DHP and DAF 6.3 programs and product lines: Human Performance/Medical Readiness, Force Health Protection, and En Route Care as some of the primary users.

3.1.2.1.1 **Biotechnology for Health and Performance CRA1:** The Biotechnology for Health and Performance CRA utilizes multivariant, systems biology approaches to provide advanced science and technology solutions to understand the warfighter's biologic state and the underlying mechanism of responses with the goal of enabling, enhancing, and sustaining the human's ability to dominate air, space and cyberspace.

3.1.2.1.2 **Applied Cognitive Neurosciences CRA2:** Develops and validates technologies in cognitive neuroscience and physical performance to sustain, augment, and recover operator performance and determine medical attributes/metrics for optimal career field alignment.

3.1.2.1.3 **Health and Performance Sensing and Assessment CRA3:** Develops sensing technologies in a variety of form factors to identify, validate and monitor human signatures related to Airmen's and Guardians' health, exposures and physical/cognitive performance in their associated environments. The research from this CRA will develop sensing solutions optimized for real-time, non-invasive and autonomous sensing and assessing capabilities to enhance and protect Airmen and Guardians in a variety of operational environments.

3.1.2.1.4 **Biomedical Impact of Air and Space CRA4:** Conducts research investigating Airman and Guardian performance degradation resulting from exposure to air and space environments and seek understanding the fundamental mechanisms driving environmental and operational risks. Develop technologies to mitigate or eliminate the root physiologic causes of these degradations and to ultimately optimize Airman and Guardian performance resulting in the capability to fly faster, higher, and longer than our adversaries.

3.2 Bioeffects (RHD)

3.2.1 RHD Product Line (PL)

3.2.1.1 Bioeffects PL: Creates and demonstrates developmental technology & tools to generate products/applications. These products provide optimized design requirements for weapon systems & personal protection device developers, risk and collateral hazard assessments for directed energy systems, and analysis libraries for the representation of humans as part of model-based systems engineering approaches and within engineering-level models of system performance, informing overall system performance impacts and adding fidelity to concepts in wargames. Approaches include the integration of components in engagement and mission-level simulation tools within USAF and DoD software architectures, and model-based systems engineering artifacts to enable future integration and technology transition. Key technologies include directed energy bioeffects systems characterization and risk assessment, directed energy bioeffects components of modeling and simulation tools, and human representation in digital engineering.

3.2.2 RHD Core Technical Competencies (CTC), Critical Research Areas (CRA) & Lines of Effort (LOE)

3.2.2.1 Bioeffects CTC1: The Bioeffects CTC will conduct research to enable the maximum safe exploitation of the electromagnetic spectrum for nation defense by protecting personnel & communities and assessing weapons applications. CTC research will focus on characterizing fundamental bioeffects, optimizing the safety/effectiveness of directed Energy systems, developing/assessing dosimetry tools, modeling & simulation of products/applications, protecting device development and providing science-based information to national & international safety standards.

3.2.2.1.1 Directed Energy Bioeffects Modeling, Simulation, & Analysis CRA1: The directed energy bioeffects modeling, simulation, & analysis core research area

emphasizes research that focuses on new modeling, simulation, and analysis techniques which represent and optimize concepts of directed energy systems employment from the bioeffect standpoint, develops capabilities for studies and means of measuring of effectiveness and suitability for directed energy systems to include direct, scalable, and collateral effects. Research areas include high-performance/high-fidelity multi-physics simulations, advanced electromagnetic dosimetry models, mechanistic theories & models of injury, thermal/thermoregulatory response models, physics-to-physiology color vision theory, component models of human response to directed energy, statistical approaches for risk assessment, near-real-time numerical approaches and surrogating complexity through machine learning.

3.2.2.1.1.1 **Directed Energy Bioeffects Modeling Simulation & Analysis LOE1:** Develop and mature physics & engineering-level models for directed energy dosimetry & the resulting biological effects; create algorithms encapsulating empirical datasets & physics-level models of directed energy dose response; supports directed energy modernization campaign and enables the Directed Energy Weapons Review and Approval (DEWRAP) process.

3.2.2.1.1.2 **Directed Energy Bioeffects Dosimetry LOE3:** Develop novel dosimetry to better understand directed energy interactions and injury to inform software approaches enabling simulation of dynamic scenarios; supports directed energy modernization.

3.2.2.1.2 **Directed Energy Bioeffects & Mechanisms CRA2:** The directed energy bioeffects & mechanisms CRA provides fundamental knowledge of mechanisms of interaction of directed energy with molecules, cells, tissues, and organs in support of military directed energy systems and enables future weapon systems with scalable, disruptive, and ultra-precise effects. Research areas include: discovery science for understanding mechanisms, neurobiological & behavioral response to directed energy, hardening of biological targets to directed energy, mechanistic response of human vision to directed energy, epigenetic response to directed energy exposure, membrane and ion channel response to rapid onset exposures, supra-threshold response – severity of effects, and human factors in technologies for protection.

3.2.2.1.2.1 **Research in Directed Energy Multi-Interaction Systems LOE2:** Develop and deliver an integrated modeling environment and studies to address critical national defense interests & prevent technological surprises. Study radio frequency, combined or synergistic responses, and their interaction with biology.

3.2.2.1.2.2 **Directed Energy Hazard & Protection Assessment LOE4:** Feedback & expertise for DoD to optimize safety/performance trades for directed energy systems; evaluation of dose-response of directed energy exposures to achieve specific endpoint; understand human vision response to optical radiation and related protective devices; elucidate margin of effectiveness and safety to meet DoD mission success. Assure no technology surprise.

3.2.2.1.2.3 **Directed Energy Weapon Effects LOE5:** Feedback & expertise for DoD to optimize safety/performance trades for directed energy systems & provide scientific basis for risk criteria definitions; Allows directed energy weapon modernization & enables review and approval processes for weapons systems.

3.3 Warfighter Interactions & Readiness (RHW)

3.3.1 RHW Product Lines (PL)

3.3.1.1 Airman-Machine Integration PL1: Delivers advanced, situationally-adaptive and scalable interface technologies and decision aiding tools. S&T is focused on ABMS-compliant, intuitive user interfaces, and intelligent aided decision support to provide rapid, accurate battlefield awareness, maximized distributed human-machine team performance and decision superiority. Operator-centric interfaces increase human combat capabilities while managing human cognitive workload in complex, degraded environments. Key technologies include human-autonomy collaboration and trust in autonomy, development of successful distributed, heterogeneous teams with metrics of team performance, exploitation of human perception and enhancement of operational communication. These efforts address the critical needs for ABMS and JADC2 with optimal human-machine teams ready to operate.

3.3.1.2 Readiness PL2: Develops and extends technologies and tools for improving the cognitive effectiveness, performance and proficiency of airmen in current and potential future operational mission contexts. Aims to deliver operationally relevant, unobtrusive, integrated metrics, software, & hardware to assess proficiency & readiness in real-time. Develops methodologies to create models & algorithms for performance prediction, training support, & automated instruction. Key technologies include the ability to support multi-capable airmen resilience and mission performance in austere deployed contexts and develop standards for sharable scenario content, data, models, & metrics.

3.3.1.3 Analytics PL3: Identifies & matures software that streamlines workflow & enables cognition at the scale of war, enabling airmen effectiveness in the air, space, & cyberspace domains for effective C2ISR in Multi-Domain Operations. Develops analytic tools that optimize human cognition with the power of machine computation, thereby enabling consumers to better visualize, interpret, and act on information. Aims to deliver software that is open-architecture, modular, networked, and distributed; able to leverage statistics, machine learning, and artificial intelligence; and focuses on speed, accuracy, insight, and action.

3.3.2 RHW Core Technical Competencies (CTC), Critical Research Areas (CRA) & Lines of Effort (LOE)

3.3.2.1 Warfighter Interfaces and Teaming CTC1: The Warfighter Interfaces and Teaming CTC will conduct research to enable robust decision superiority across our Air and Space Forces by dynamically optimizing the integration of Warfighter cognition with increasingly complex and intelligent machines/systems, creating maximally effective and resilient warfighting teams. CTC research will focus on discovering, developing, evaluating, and transitioning advanced adaptive warfighter interface technology, mission-optimized distributed team performance enhancements, communication management processes, and context-tailored intelligent decision aids/analytics in order to achieve and maintain decision superiority in uncertain environments against peer threats.

***3.3.2.1.1* Distributed Teaming and Communication CRA1:** The Distributed Teaming & Communication CRA emphasizes research that explores the rapid formation, real-time assessment, and dynamically optimized performance of distributed heterogeneous teams of warfighters as well as human-machine teams in order to enable rapid, agile & robust mission operations. Research areas will include: methods to enable the rapid formation of mission-effective heterogeneous teams, dynamic monitoring / assessment of team performance via optimal assemblage of novel and existing metrics, adaptive tactics for recovery from real or predicted team performance degradations, and novel distributed communication & collaboration tools, technologies and management methods that are responsive to variable network environments.

***3.3.2.1.1.1* Dynamic Team Performance Assessment LOE1:** Enable the rapid formation, real-time assessment, and dynamically optimized performance of distributed heterogeneous teams of warfighters as

well as human-machine teams in order to enable rapid, agile & robust mission operations. Research areas include methods to support the rapid formation of mission-effective heterogeneous teams, dynamic monitoring of team performance via optimal assemblage of novel and existing metrics, and real-time contextual aids from team communication.

3.3.2.1.1.2 **Team Optimization and Recovery LOE2:** Design, develop, and evaluate team optimization and recovery technologies to enhance communication, coordination, and improve decision making among distributed teams. Research areas include interfaces to support joint tasking and team shared awareness (SA) across multiple domains as well as conversational AI technologies to enable high bandwidth natural communications.

3.3.2.1.2 **Human Machine Interactions CRA2:** The Human-Machine Interactions CRA emphasizes research to identify principles of human interaction with highly complex systems, including advanced automation & increasingly intelligent AI-enabled machines. The goal of this research is to achieve and sustain decision superiority across complex & uncertain mission environments. Research areas include identifying, characterizing and overcoming key challenges to warfighter interactions with complex and intelligent systems such as situationally-adaptive interface design and usability, knowledge representation across sensory modalities, system observability & transparency, directability, joint cognitive decision making, and maintaining calibrated trust across changing conditions.

3.3.2.1.2.1 **Rapid Joint-Cognitive Awareness LOE1:** To develop human-centric interfaces and interaction strategies for improved AI/automation transparency, closed-loop adaptive systems that are responsive to warfighter state, and advanced techniques for effectively visualizing large, complex data sets.

3.3.2.1.2.2 **HMI-enabled Decision Superiority LOE2:** To develop capabilities for continuous planning for C2, next generation interfaces for complex intelligent platforms, and interfaces tailored for emerging Cognitive Warfare (CogWar) concepts.

3.3.2.2 **Human Learning and Cognition (HLC) CTC2**: The Human Learning and Cognition CTC enables more lethal Air and Space Forces through research on human multisensory perception, learning, information processing, and action. The research seeks to maximize mission effectiveness by (1) Establishing a persistent, global training and test ecosystem that creates the foundation for personalized, proficiency-based readiness for multi-capable Airmen and Guardians in joint all-domain operations, (2) Creating capabilities that allow teams of humans and machines to adapt and learn together in real time in training and operational settings, & (3) Advancing considerations of human performance in system development and operational planning with digital models of perception, cognition, & action.

3.3.2.2.1 **Digital Model of Cognition CRA1:** The Digital Models of Cognition Core Research Area emphasizes research to identify computational and mathematical mechanisms to represent human perception, information processing, and behavior, including the integration of models that reflect the role of internal and external factors that modulate performance efficiency and effectiveness. The goal is to develop holistic models that support quantitative understanding and prediction of mission effectiveness across domains and at different levels of abstraction for improved systems engineering, wargaming, and operational planning.

3.3.2.2.1.1 **Holistic Models for Decision-Making LOE1:** Develop models of cognitive systems that support quantitative understanding and prediction of mission effectiveness for decision superiority.

3.3.2.2.1.2 **Information Mastery in Cognitive Warfare LOE2:** Analytic methods, models, and tradecraft that enables operators to improve Information-Related Capability (IRC).

3.3.2.2.2 **Learning and Operational Training CRA2:** The Learning and Operational Training Core Research Area emphasizes learning and understanding in the context of evolving technology. This includes research to establish an ecosystem that maximizes mission effectiveness while minimizing costs by matching technologies to learning and performance needs; supporting high resolution human and system measurement and quantitative, proficiency-centric readiness assessment and prediction at the individual and team levels; and exploring how to enable human and machine co-learning to support mutual adaptation and understanding in human-machine teams.

3.3.2.2.2.1 **Warfighter Learning Technologies LOE1:** Research, demonstrate, & transition learning technologies, methods, & infrastructure for personalized, proficiency-based readiness**.**

3.3.2.2.2.2 **Co-Learning for Adaptive Human and Machine Teams LOE2:** Establish the foundation for interactive learning and collaborative training of humans and AI-enabled machines to enable uniquely effective human-autonomy teams.

4.0 Other Requirements

4.1 OPSEC: The technical research areas under this contract shall be specified per task order. At minimum, the contractor shall provide OPSEC protection for all sensitive/critical information and indicators involved in execution of this contract/Task Order, as defined by AFI 10-701 (Operations Security). 711 HPW Critical Information and Indicators are protected under the 711 HPW Operations Security Program and the 711 HPW Critical Information and Indicators List (CIIL). Contractor employees granted access to critical information and indicators will be provided initial OPSEC training by the 711 HPW OPSEC Coordinator upon in- processing and prior to being granted access to CIIL items related to the contract/Task Order. The contractor will also participate in 711 HPW's annual OPSEC training and education programs, which includes periodic updates and refresher training on CIIL items applicable to the contract/Task Order. The 711 HPW OPSEC coordinator will evaluate the OPSEC posture of AF contract activities and operations.

All contractor personnel require a minimum of a Tier 1 background check (T1)/SF85 for any position that requires access to the internet, use of automated information systems to cover standalone computers or unescorted entry into restricted or controlled areas prior to reporting for duty in support of any requirement. The investigation is not for a security clearance; it is for a position of trust. This is mandatory requirement set forth in DoDM 5200.02_AFMAN 16-1405, Air Force Personnel Security Program. All documentation required for security certification shall be the responsibility of the contractor.

Contractors shall complete the customer-provided Intelligence Oversight training as required by customer requirements and will report any Questionable Intelligence Activity (QIA), Significant/Highly Sensitive Matter (S/HSM), and/or Federal Crimes IA W procedures established in DoD Directive 5148.13, Intelligence Oversight, and AFI 14-104, Intelligence Oversight. For contracts involving cryptographic matters in addition to DoDD and AFI reference, USSID 18, Legal Compliance and US. Persons Minimization Procedures.

4.2 O&M Fiscal Considerations: To satisfy the Purpose Statute, proposed funding must be proper for the work to be performed (31 USC Sec. 1301 & DoD FMR, vol. 14, ch. 2, para. 020202.B.). The scope/purpose of the contract must be analyzed to ensure the use of O&M funds is proper and not an Anti-Deficiency Act violation. IAW the DoD Financial Management Regulation, RDT&E will finance research, development, test and evaluation efforts, including procurement of end items, weapons, equipment, components, materials and services required for development of equipment, material, or computer application software.