



Broad Agency Announcement
Bio-inspired Restoration of Aged Concrete Edifices
(BRACE)

BIOLOGICAL TECHNOLOGIES OFFICE

HR001122S0029

March 28, 2022

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PART I: OVERVIEW INFORMATION

- **Federal Agency Name** – Defense Advanced Research Projects Agency (DARPA), Biological Technologies Office (BTO)
- **Funding Opportunity Title** – Bio-inspired Restoration of Aged Concrete Edifices (BRACE)
- **Announcement Type** – Initial Announcement
- **Funding Opportunity Number** – HR001122S0029
- **North American Industry Classification System (NAICS)** – 541714
- **Catalog of Federal Domestic Assistance Numbers (CFDA)** – 12.910 Research and Technology Development
- **Dates**
 - Posting Date: March 28, 2022
 - Proposal Abstract Due Date and Time: April 29, 2022; 4:00pm EST
 - Full Proposal Due Date and Time: June 17, 2022; 4:00pm EST
 - BAA Closing Date: June 17, 2022
 - Proposers' Day: April 13, 2022
- **Concise description of the funding opportunity** – The Bio-inspired Restoration of Aged Concrete Edifices (BRACE) program aims to prolong the serviceability of Department of Defense (DoD) structures and airfield pavements by integrating a self-repair capability into existing concrete. The DoD relies on steel-reinforced concrete structures such as missile silos and naval piers that are many decades old, not easily replaced, and subject to cracking and corrosive deterioration. The DoD also relies on concrete airfield pavements in expeditionary settings, which are vulnerable to damage from overuse or attack and require rapid repair under logistically challenged circumstances. Unfortunately, state-of-the-art approaches to maintain concrete are one-time interventions, limited to remediation of defects at or near the surface, and typically necessitate down-time for critical assets. No current technology provides ongoing crack repair and prevention for defects deep inside existing aged concrete or prolonged repair of damaged airfield pavements. Inspired by vascular systems that support repair in multicellular organisms and ecosystems, the BRACE program will develop bio-inspired approaches that 1) integrate deep within aged concrete to form a healing “vasculature” for ongoing damage repair; and 2) combine with new concrete to increase the durability of runway patch repairs. To achieve these goals, BRACE performers will engineer and operationalize vascularizing effectors for both long-term (e.g., steel-reinforced marine or buried infrastructure) and rapid (e.g., expeditionary airfield) use cases.
- **Anticipated individual awards** – Multiple awards are anticipated.
- **Types of instruments that may be awarded** – Procurement contract, cooperative agreement, or other transaction.
- **Agency contact**

The BAA Coordinator for this effort may be reached at:
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PART II: FULL TEXT OF ANNOUNCEMENT

1. Funding Opportunity Description

This publication constitutes a Broad Agency Announcement (BAA) as contemplated in Federal Acquisition Regulation (FAR) 6.102(d)(2) and 35.016 and 2 C.F.R. § 200.203. Any resultant award negotiations will follow all pertinent laws and regulations, and any negotiations and/or awards for procurement contracts will use procedures under FAR 15.4, Contract Pricing, as specified in the BAA.

The Biological Technologies Office (BTO) is soliciting innovative proposals to engineer approaches for vascularizing aged concrete to support ongoing crack repair that enhances and prolongs the durability of thick structural components and runway pavement repairs. Proposed research should investigate innovative approaches that enable revolutionary advances in engineering biology, chemical engineering, non-line-of-sight crack repair diagnostics, accelerated concrete aging protocols, and multi-scale predictive modeling. Specifically excluded is research that primarily results in incremental improvements to the existing state of practice.

1.1. PROGRAM OVERVIEW

The Department of Defense (DoD) relies on strategic facilities composed of concrete that are many decades old and are not easily replaced due to the sheer volume of concrete infrastructure inherited over the past century. Much of the DoD's shoreside infrastructure and hardened terrestrial infrastructure, such as Minuteman missile silos, date from the '40s and '50s. For the Navy, shoreside infrastructure alone contributes hundreds of millions of dollars in annual sustainment costs. In addition to aged structural concrete, repairing airfield pavements after an attack involves a logistically complex process to restore operational capability as quickly as possible, which is especially challenging in expeditionary settings where resources are limited.

Extending the service life of existing concrete structures is critical for maintaining an asymmetric advantage over potential adversary nations, some of whom are building new military facilities at a rapid pace. These new structures will likely incur far lower maintenance costs than the DoD's older facilities in the coming decades. Cracking and corrosive deterioration of steel-reinforced concrete are the primary contributors to lost serviceability of aged, strategic military assets such as buried, hardened structures (e.g., missile silos). State-of-the-art maintenance relies on a process of inspection followed by discrete repairs that typically necessitate down time of critical assets and provide only modest efficacy in extending service life when not replacing substantial portions of a deteriorating structure. Most repairs are one-time surface interventions (e.g., mortar coatings, compressive sleeves, and more recently, biomineralizing sprays). However, cracking often arises in the interior of thick concrete components before propagating to the surface, so surface-based repairs cannot mitigate cracks at their site of origin. Particularly in corrosive environments (e.g., marine structures) or when architecture limits access (e.g., buried, hardened structures often have steel liners covering concrete), new approaches are needed to improve durability by healing and preventing cracks when and where they emerge.

In addition to steel-reinforced structures, airfield pavements, including those in expeditionary settings, are comprised largely of concrete, making this material essential for the DoD's force projection capabilities. Airfields are key targets for an adversary; following an attack, pavement

repairs must be made on rapid, tactical timelines to minimize down time, avoid further vulnerabilities, and maintain operational tempo. Rapid patching of craters is the current repair strategy to restore runway surfaces after an attack. However, the logistical requirements of transporting bulky materials used in more standard airfield damage repair solutions present a significant vulnerability. To address this challenge, the DoD is developing an Expedient and Expeditionary Airfield Damage Repair (E-ADR) capability suited to austere settings. E-ADR minimizes the time to restore airfield operations with a minimal logistic footprint by sacrificing the durability of the patch repairs (e.g., these repairs are only rated to support 500 passes of a fighter aircraft). This tradeoff results in a quick restoration of operations; however, the potential for rapid deterioration and failure of a repair patch is likely to lead to subsequent periods of inoperability.

No current technology provides ongoing crack repair and prevention for deep defects in existing aged concrete or prolonged repair of damaged airfield pavements. Several emerging technologies seek to address the challenge of self-sustainable concrete construction, including new classes of Engineered Living Materials (ELMs) and self-healing concretes. While these approaches show promise to repair cracks, including those emerging at depths within a material beneath the immediate surface, neither ELMs nor self-healing concretes address challenges posed by extant concrete structures or rapid runway repairs performed in austere settings with limited resources.

A major challenge to imbue concrete with ongoing repair of deep defects is the need to transport substances for crack healing and prevention throughout the three-dimensional bulk of material. Many biological systems solve this problem via vascular networks that are typically composed of filamentous structures. Large and complex multicellular organisms, including many species of animals and plants, possess vascular systems that transport nutrients and metabolites across macroscopic distances (> 10 meters) to support functions such as injury repair. Ecosystems also include vascular approaches for nutrient and signal translocation across large distances, and in some ecosystems, soil-dwelling filamentous fungi subserve this function by forming symbiotic relationships with plants and other species across areas spanning >1000 acres. Inspired by these biological systems, BRACE technology will develop strategies to impart aged structures and E-ADR patch repairs with a healing vasculature that can be applied rapidly to integrate deep within concrete and provide prolonged functionality to repair cracks and restore the material's durability (Figure 1).

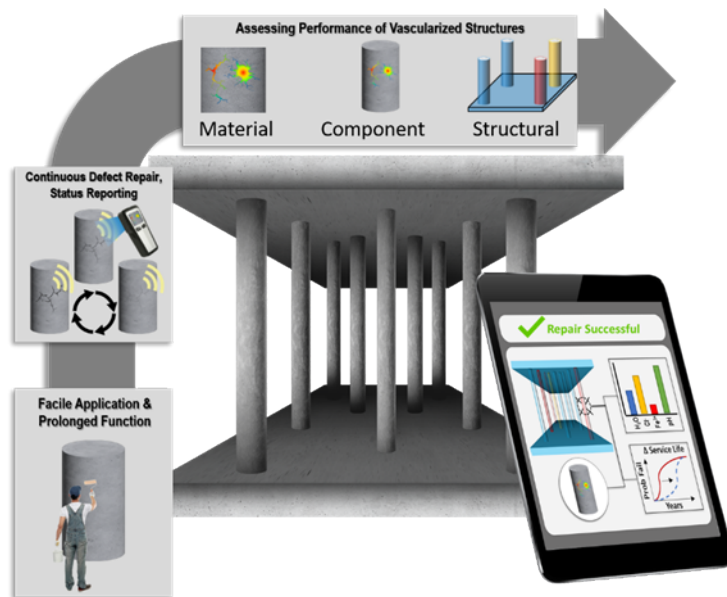


Figure 1. BRACE will develop a platform with prolonged functionality that supports ongoing repair of defects in aged concrete structures to improve the durability of material and extend the serviceability of structures.

1.2. TECHNICAL APPROACH AND PROGRAM STRUCTURE

BRACE aims to develop and operationalize bio-inspired effectors with prolonged functionality that 1) integrate deep within aged concrete to form a healing “vasculature” for ongoing repair; and 2) combine with new concrete to increase the durability of airfield pavement repairs. Accordingly, BRACE performers will develop vascularization technologies on **two Program Tracks** aligned to long-term (e.g., steel-reinforced marine or buried infrastructure) and rapid (e.g., expeditionary airfield) use cases, respectively. Performers will develop their solutions in **two Technical Areas (TAs)** executed in parallel to engineer vascularizing effectors (TA1) within design constraints informed by their operationalization (TA2), tailoring these technologies to address each Program Track’s use cases, including associated damage repair challenges, logistics, and timelines. **All abstracts and proposals must address BOTH Program Tracks and BOTH Technical Areas (TAs) across all Program Phases. Abstracts or proposals that do not address both Program Tracks and both TAs for all Program Phases will be considered non-conforming and may be removed from consideration (rejected without review).** The following sections describe both the Program Tracks and TAs in detail.

1.2.1. Program Tracks

The BRACE program will develop healing vascularization technologies that improve the durability of concrete for use cases that differ in their respective timeframes for both deterioration and repair and that have distinct logistical and implementation challenges. Structural concrete deteriorates on “strategic” (years to decades) timelines, and to be effective in this program, repairs to aged strategic assets, such as hardened structures, must be ongoing over these prolonged timelines. Conversely, expeditionary airfield pavement repair patches deteriorate on “tactical” (days to months) timelines. The process for placing these repairs must be rapid and relies on locally harvested materials combined with new concrete, and consequently, the repairs lack durability.

The constraints imposed by these two timescales and the different defect processes associated with each necessitate different approaches for repair technologies. Consequently, the BRACE program will be executed on two parallel Program Tracks, allowing performers to tailor their vascularizing technologies to address challenges associated with each use case. Proposals should address technical approaches to develop an ongoing repair capability for both the Strategic and Tactical Tracks as described below. A list of Milestones and Deliverables associated with each track is located in Section 1.3.2 of this BAA.

Strategic Track

In the Strategic Track, performers will focus on developing vascularizing technologies that address challenges inherent to one of two broad classes of aged infrastructure that are difficult to maintain: buried, hardened structures in terrestrial settings (e.g., missile silos) or shoreside structures in marine settings (e.g., piers). Each of these use cases presents unique challenges. Concrete in buried, hardened structures may be sandwiched between earth and a steel liner, making it difficult to access. Comparatively, marine concrete is in a highly corrosive environment due to constant exposure to an inexhaustible source of chloride ions. **Proposals must identify whether they are developing solutions for either buried terrestrial concrete or marine concrete and address the challenges associated with that setting.** Additionally, proposers should explain which, if any, aspects of their solutions are generalizable across these two classes of infrastructure.

On the Strategic Track, performers will develop technologies that heal and prevent cracking in aged, steel-reinforced concrete. Vascularizing effectors developed in this track will exhibit repair functionality to restore concrete's compressive strength and bind chloride ions to prevent them from contributing to corrosion. Corrosion and cracking processes are the two leading causes of deterioration of structural concrete, and these processes facilitate one another. Cracks in concrete allow corrosion-promoting substances, like chloride ions, to penetrate the cement and interact with embedded steel reinforcement. Corrosion swells these rebar elements, which causes further cracking. These mechanisms are slow, so proposals must discuss technologies that will function over prolonged timescales (> 2 years) after they are applied to concrete surfaces with little to no manual intervention. While performers will empirically demonstrate technologies that function for at least 2 years on the BRACE program, proposals should provide a logical narrative describing how their approach could maintain functionality for at least a decade.

As an ongoing repair solution for slow, persistent deterioration processes, it is important that Strategic Track technologies provide feedback for facilities managers to monitor vascular performance to extend structural serviceability. Proposers must describe how they will monitor the presence and function of vascular networks embedded in concrete and how these signals will inform model-based predictions of their impact on service life. Proposals should describe how this capability will help to avoid passive assumptions that the vascularizing effectors are functioning as intended in all parts of a structure in perpetuity.

Proposals must describe how their Strategic Track solutions can be applied to existing concrete surfaces. BRACE technologies in the Strategic Track will repair aged concrete that is part of legacy infrastructure, which may already be many decades old. Thus, it will not be possible to mix vascularizing effectors into cement during the casting process. Strategies for forcing vascular components, precursors, or trophic factors into porous cracked concrete are of interest, as are approaches to grow the vasculature into the depth of concrete from a purely surface application. However, proposals must detail a strategy to obtain vascular integration extending $> \frac{1}{2}$ meter deep while maintaining function at that depth without replacing large volumes of concrete in a structure.

Tactical Track

Under the Tactical Track, BRACE seeks to develop vascularizing effectors that integrate with E-ADR materials and procedures to extend the durability of expeditionary airfield pavement repairs, within the same constraints imposed by the existing concept of operations (CONOPS) for E-ADR.

Current CONOPS: After an attack, palletized E-ADR kits containing equipment and limited materials for patching airfields are airdropped from four C-130's (≤ 32 pallets) near the repair site. The airfield surface surrounding a crater is cut and removed to establish a clean, squared interface between the patch and runway. Ejected debris is cleared from the airfield, and together with locally harvested aggregates (e.g., local soil, rock, coral, etc.), this material may be used to fill the subgrade, followed by stabilization with cement and subsequent compaction to achieve a low California Bearing Ratio of $\geq 4\%$. Finally, capping concrete comprised of calcium sulfoaluminate cement is used to create a patch surface flush with the adjacent pavement. Each E-ADR kit is sufficient to repair up to 18 craters (total volume of 72 m^3).

Proposals must describe approaches to extend the durability of E-ADR patches without impacting the logistical footprint of E-ADR repair kits and without impacting the CONOPS of repair implementation. The tradeoff for E-ADR's relatively light payload is low durability, with patches rated to withstand only 500 passes of a fighter aircraft. Furthermore, E-ADR is meant to restore airfield operations as quickly as possible (≤ 48 hours after repairs begin). Proposals must describe how they will eventually triple the durability of E-ADR repairs with an additive that does not require more time to complete repairs, is compatible with found materials and calcium sulfoaluminate, and adds minimal volume to an E-ADR kit.

Vascularizing repair technologies developed on BRACE's Tactical Track will improve the durability of E-ADR repairs via rapid crack filling and strengthening the material interface between newly-filled craters and undamaged runway. The low durability of E-ADR's repairs means patches degrade rapidly from cyclic loading by transiting aircraft, and this deterioration arises from the rapid evolution of cracks in the cementitious substrate. During the first 12 months of the program, there will be no explicit differences between the Strategic and Tactical Tracks, and therefore, there will be no tasks under the Tactical Track in the first year of the program. ***Proposals should include Tactical Track tasks for BOTH Technical Areas as a separately costed option that begins in month 13 only after performers demonstrate a candidate vascularizing effector capable of a rapid crack filling rate meeting entry criteria (≥ 0.0005 mL cracks filled per mL concrete per day).*** Performers unable to meet this criterion may still be allowed to continue with their Strategic Track tasks.

1.2.2. Technical Areas

Within each of the two Program Tracks, BRACE will divide technical development across two Technical Areas (TAs) executed in parallel. As shown in Figure 2, while TA1 and TA2 have distinct objectives and technical challenges, they provide design constraints to one another in a design, build, test, and learn cycle. TA1, Engineer Vascularizing Effectors, will address the challenges of engineering bio-inspired effectors that form vascular structures deep in concrete with prolonged functionality to both repair cracks and provide quality control (QC) diagnostic signals regarding their activity. TA2, Operationalize Vascularizing Effectors, will develop methods for applying and maintaining TA1 effectors in concrete, rapid aging testbeds for vascularized concrete, and models to predict TA1 effectors' effect on structures. Proposals must present comprehensive development strategies and evidence of feasibility to address each TA and are encouraged to describe additional technical challenges, technical and programmatic risks, and potential mitigation strategies. For example, proposals should discuss strategies to contain vascularizing effectors within their intended concrete environment, and strategies to prevent and mitigate unwanted formation of vasculature in adjacent environments such as soil and seawater. The following subsections provide a detailed qualitative description of each TA.

Specific quantitative Metrics by Program Track and Technical Area are provided in Section 1.3.1 of this BAA, and detailed Milestones and Deliverables are specified in Section 1.3.2.

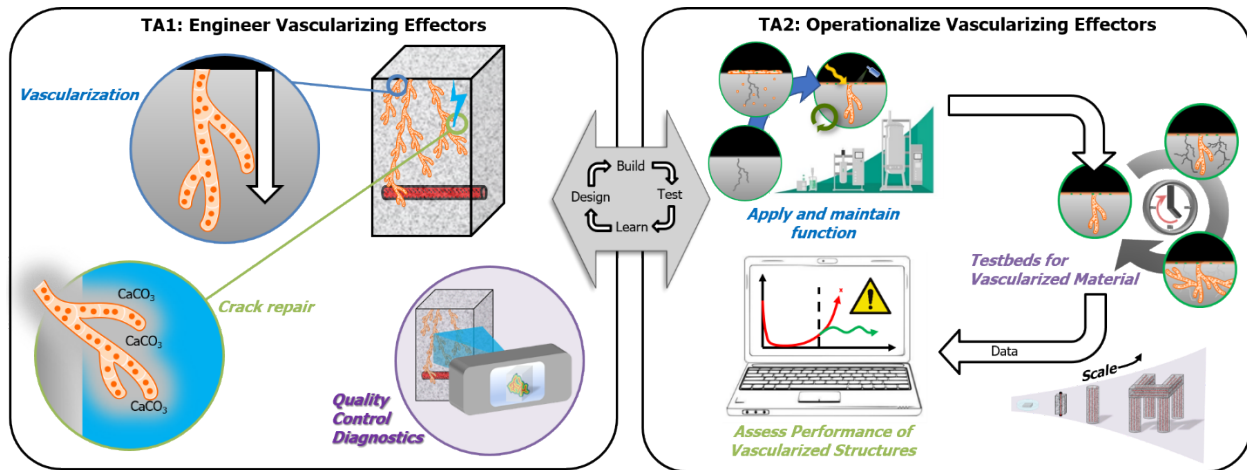


Figure 2. BRACE will include two Technical Areas (TAs) executed in parallel. TA1 will engineer vascularizing effectors with prolonged functionality that implements ongoing crack repair deep within concrete, while providing quality control diagnostics signals to monitor the presence and function of the embedded vasculature over time. TA2 will operationalize vascularizing effectors by establishing methods to apply and maintain them in concrete, test the characteristics of vascularized concrete, and assess the performance of vascularizing effectors in extending the serviceability of concrete structures. These capabilities will be developed across increasing scales approaching structural and operational realism.

Technical Area 1 (TA1): Engineer Vascularizing Effectors

The overall goal of TA1 is to create a bio-inspired vascularizing effector that will improve existing concrete durability by implementing an ongoing repair capability. Accordingly, TA1 will harness recent advances to address three key challenges: Vascularization, Crack Repair, and QC Diagnostics.

Challenge 1: Vascularization will focus on creating networks deep in concrete to serve as a platform with prolonged functionality to implement ongoing crack healing and prevention. Potential approaches could utilize rock-inhabiting microbes or consortia that can survive in concrete, form filamentous, vascular structures, and be engineered for customizable function, such as biomineralization for crack repair. In addition to biological strategies, non-biological or cross-disciplinary solutions are also strongly encouraged.

Proposals must describe how their approach will enable vascular structures to integrate themselves within concrete through existing pores and cracks to depths $> \frac{1}{2}$ meter from the surface. Cracks and defects may emerge within the bulk of concrete before propagating to the surface, necessitating repair approaches that enable the transport of healing substances deep into the interior of concrete. On the Strategic Track, vascularizing effectors can only be applied to the surface of existing aged concrete. For the Tactical Track, proposals must explain how contiguous vascular networks will be assembled across the subgrade and capping concrete.

The timeframe for maintaining the functionality of the vascular network depends on the use case and the primary driver of concrete deterioration. The growth of cracks is a dynamic process arising from both chemical changes in the material and mechanical stressors. For the Strategic Track, where slow corrosive processes dominate, proposals must advocate why their approach will provide decades-long repair functionality. During the program, performers will demonstrate the prolonged functionality of their vascular effectors to implement repairs over

at least a two-year timeframe. For the Tactical Track, where E-ADR patch repairs are short-lived, proposals must describe how their approach will maintain robust, rapid crack repair and prevention for at least 4 months. Approaches that require frequent renewal or upkeep beyond the typical inspection cycle for the proposed use case cannot be considered as having truly prolonged functionality and are not aligned with the BRACE program goals.

Challenge 2: Crack Repair will heal and prevent cracks to improve durability. Strategies could include but are not limited to approaches for 1) precipitating minerals (e.g., calcite) to restore strength; and 2) binding chloride to prevent corrosion, deterioration, and future cracking. Crack repair solutions that significantly increase durability and exceed the pace of defect growth are central to this challenge.

Durability requirements are governed by the type of infrastructure and, therefore, the target use cases specified in each Program Track. American Concrete Institute (ACI) 318 establishes standards for concrete durability as thresholds for compressive strength based on environmental exposure classes. In contrast, airfield pavement durability is principally quantified as the number of aircraft passes until failure. Proposals must describe how Strategic Track solutions will restore the compressive strength of deteriorated concrete to meet or exceed the standard for highly corrosive environments (≥ 35 MPa) and how Tactical Track solutions will triple the number of aircraft passes an E-ADR repair can sustain (≥ 1500 passes of a fighter aircraft).

The deterioration of structural concrete and low-durability airfield repair patches occur via distinct mechanisms and timescales, and BRACE performers will develop commensurate strategies to mitigate deterioration. Strategic Track solutions, where chloride intrusion is a major driver of failure over decades-long timescales, must mitigate chloride's ability to promote corrosion of embedded steel (e.g., binding free chloride ions), and their final metric of crack filling is 0.0004 mL cracks filled/(mL concrete * day). In contrast, in expeditionary runway repairs, repeated mechanical loading over a few months is the primary source of repair patch failure. Therefore, proposals must describe how they will engineer solutions to exceed a relatively fast metric for crack filling (0.0005 mL cracks filled/(mL concrete * day)) as entry criteria for the Tactical Track, and how they will further engineer those solutions to rapidly repair cracks (0.015 mL cracks filled/(mL concrete * day)) by the program's end. *It is not necessary for Tactical Track solutions to incorporate mitigations for chloride as neither E-ADR patch repairs nor airfield pavements are reinforced concrete.*

Challenge 3: Quality Control (QC) Diagnostics will provide empirical data to evaluate whether an ongoing repair solution is working as intended inside concrete over prolonged timeframes spanning years to decades. However, to be of repeated use, QC diagnostics must be non-destructive to both concrete and the embedded vasculature. While BRACE is not seeking to develop new methods of non-destructive evaluation (NDE), approaches that augment existing NDE imaging are of interest (e.g., vascular production of nanostructures, proteins, etc. that are detectable in NDE sensing modalities). In the Strategic Track, proposals must describe their approach to QC diagnostics providing information on 1) the distribution of the vasculature in concrete; 2) localized free chloride concentrations; and 3) at least one more functionally-relevant signal. Proposers must justify their selection of additional signals for

their ability to assess vascular function (e.g., increasing ferric ions indicative of a failure to mitigate steel corrosion). *While Tactical Track solutions are not required to address this challenge, proposals may include optional tasks for QC diagnostics related to the E-ADR use case.*

To provide time-dependent information on the efficacy of ongoing repair, proposals must describe quantitative QC diagnostics that establish actionable information about where in a structure their vascularizing effector is present and actively mitigating deterioration. To this end, they must specify how they will achieve limits of detection (LOD) and dynamic range (DR) for detecting and quantifying the presence of the vasculature (LOD: 0.030 %mass; DR: 3 decades) and free chloride (LOD: 0.0030 %mass; DR: 3 decades).

Technical approaches are not constrained to engineered biology or chemistry such as microbial engineering or nanoparticle solutions, and cross-disciplinary strategies are highly encouraged. Biological strategies do not need to be limited to monoculture approaches; combining multiple biological systems into consortia that supports multifunctional aspects of vascularization, crack repair, and QC diagnostics are of interest.

Technical Area 2 (TA2): Operationalize Vascularizing Effectors

The overall goal of TA2 is to develop approaches for operationalizing TA1 vascularizing effectors, so they are easy to adopt and deploy and provide well-characterized service life extension. Performers will develop TA2 technologies in concert with TA1 to ensure design constraints imposed by operational considerations inform the development of the vascularizing. Over the course of the program, performers will develop techniques to apply, characterize, and model vascularizing effectors on specimens of increasing size and complexity, approaching structural and operational realism by the program's end. Accordingly, TA2 will address three key challenges in deploying a valid, ongoing repair capability: Applying and Maintaining Function, Testbeds for Vascularized Material, and Performance Assessment for Vascularized Structures.

Challenge 1: Applying and Maintaining Function will develop the methods to suffuse aged extant concrete and E-ADR airfield patches with precursors or components of vascularizing effectors and all necessary material for prolonged function. Proposals must describe application method(s) (e.g., formulations, symbiotic co-cultures, etc.) or support approaches that provide nutrients or chemical precursors to sustain vascular function. Production and application must also be increasingly scalable to demonstrate functional vascularization approaches of entire structures by the end of the program. Furthermore, application methods must be rapid enough to minimize downtime for Strategic Track structures and have a negligible impact on E-ADR repair timelines.

For the Strategic Track, vascularizing effectors may only be applied via the surface, and, to enable deep vascularization, application methods may rely on vasculature self-assembly or forcing vascular components into the pores and cracks to accelerate distribution throughout the material (e.g., electrokinetic methods). Combined approaches are also of interest, but approaches that destroy or replace concrete to embed a vasculature will be deemed non-conforming to this BAA. To apply and maintain function for relevant DoD structures, Strategic Track application methods will be required to exceed 300 m²/day to surfaces.

For the Tactical Track, vascularizing effectors must be incorporated into the existing E-ADR workflow to fill craters with new material. Consequently, BRACE performers may incorporate vascularizing additive(s) into the mixture emplaced into the subgrade and capping concrete or create treatments applied directly to the crater and adjacent surfaces. To apply and maintain function for E-ADR, Tactical Track application rates must treat crater volumes within E-ADR timelines ($\geq 72 \text{ m}^3/\text{day}$).

Challenge 2: Testbeds for Vascularized Material will develop approaches to evaluate the mechanical properties of vascularized concrete and to characterize the efficacy of vascularizing effectors in repairing concrete. Performers will develop testbeds that enable experimental timeframes on the order of days to months. These testbeds will adapt paradigms for accelerated aging of concrete to spare the function of embedded vasculature, which enables empirical measurements of the vasculature's response to emergent defects.

For the Strategic Track, accelerated corrosion testbeds compatible with vascularized concrete will enable characterization of both crack repair and QC diagnostic signals. For the Tactical Track, testbeds will recapitulate mechanical fatigue via cyclic loading to assess the ability of the vasculature to improve durability and strengthen the interfaces between different materials in a repaired crater. Initial testbeds will focus on crack repair in concrete microcosms ($\sim 10^{-6} \text{ m}^3$, e.g., a petri dish) before graduating to mesocosms ($\sim 0.0025 \text{ m}^3 - 0.005 \text{ m}^3$, e.g., rectangular prisms) with rebar (Strategic Track) and without (Tactical Track). These small-scale testbeds should allow for high-throughput screening of multiple candidate solutions. Later, Strategic Track testbeds will focus on structural realism by using component-scale specimens (e.g., columns, slabs, beams, etc.); Tactical Track testbeds will focus on mechanical fatigue at material interfaces. As the size of the concrete test specimens grows, the number of test replicates will likely be reduced, and proposals should describe experimental designs to account for this reduced throughput by identifying select parameters for further optimization at larger scales. Proposals must also describe how testbeds and associated empirical measures of vascular function will enable experiments within short timeframes and test specimen volumes defined in the BRACE program metrics (see Section 1.3.1).

Challenge 3: Performance Assessment for Vascularized Structures on the Strategic Track will establish predictive serviceability models for vascularized structures that use data from the above testbeds, QC diagnostic signals, structural inspections, and as-built diagrams to estimate vasculature growth, changes in concrete defects, and net impact on concrete durability over time. By imparting an old material with new capability for ongoing crack repair, BRACE technologies will alter the material properties of concrete and, consequently, the behavior of concrete structures. Performers must develop models that predict the efficacy of vascularizing effectors to extend service life at structural and sub-structural resolution (i.e., components or regions of components). To this end, models incorporating multiple mechanisms on multiple scales, such as diffusion and corrosion, growth characteristics of filamentous structures, and structural mechanics, are of particular interest. Proposals should state explicitly all assumptions regarding data availability, type(s), and source(s). Additionally, proposals also must describe how model outputs can inform allocation of maintenance resources, predicated on the efficacy of vascularizing effectors to repair concrete. Proposing teams must justify how their models

will make accurate predictions ($R^2 > 0.95$; root-mean-squared error (RMSE) < 1 MPa strength) of their vascularizing effector's ability to restore and maintain structural concrete. *While Tactical Track solutions are not required to address this challenge, proposals may include optional tasks for performance assessment with metrics related to the E-ADR use case.*

1.3. Program Metrics, Milestones and Deliverables

BRACE is a 54-month program divided into three phases, with a demonstration at the end of each phase (Figure 3; Section 1.4). Down-selections of performer teams or subcomponents of a team's effort are anticipated at the conclusion of Phases I and II. Both Program Tracks and both Technical Areas will proceed in parallel throughout the program.

- **Phase I** is 24 months long and is focused on developing vascularizing effectors at the “Materials” scale (microcosms and mesocosms), with experiments performed in a controlled laboratory setting. Through the use of these testbeds, proposers will develop and demonstrate vascularizing technologies for concrete repair.
- **Phase II (Option)** is 12 months long and is focused on developing vascularizing effectors at the “Components” scale. For the Strategic Track, component testbeds will be columns, beams or slabs. For the Tactical Track, testbeds will continue to be mesocosm scale, but with added complexity by combining new and aged concrete to mimic the interface between different cementitious materials associated with a patch. End of phase demonstrations of component-scale solutions will be hosted in facilities managed by BRACE program Independent Verification and Validation (IV&V) partners. HR001122S0029 is not soliciting proposals for IV&V, and BRACE IV&V partners will be selected separately by the government. Consequently, proposals in response to this BAA should not include tasks or costs for IV&V testing beyond those required to supply Government IV&V partners with vascularizing technology necessary for evaluation.
- **Phase III (Option)** is 18 months long and is focused on developing vascularizing effectors at the “Structural” scale, which generally refers to entire DoD structures or multiple airfield patch repairs. These experiments necessitate highly-specialized, custom laboratory equipment, for example, mock structures or runway testing facilities, which will be provided by Government IV&V partners as described below in Section 1.4. Field trials in actual structures also will be orchestrated by IV&V and carried out in Phase III.

Progress toward program goals will be determined through the use of Metrics, Milestones, and Deliverables, specified here to bound the effort while still affording the maximum flexibility, creativity, and innovation in proposing solutions to the stated problems. To highlight technology development, demonstrations facilitated by IV&V will be carried out at regular intervals as described in Section 1.4.

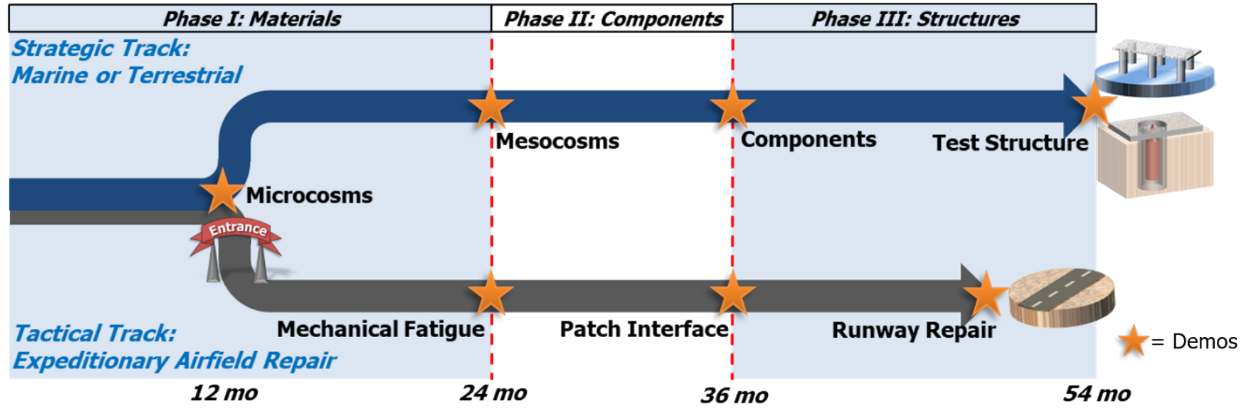


Figure 3. The BRACE program will be executed in two parallel Tracks (Strategic and Tactical) over three Phases. Phase I (24 mos.) is focused on initial development of vascularizing effectors with prolonged functionality for ongoing crack repair that can be applied to material-scale testbeds, and the Phase II Option (12 mos.) will refine these approaches and apply them to component-scale testbeds (Strategic Track) and material interface testbeds (Tactical Track). The Phase III Option will demonstrate approaches on full-scale structures (18 mo; Strategic Track) or E-ADR runway patches (12 mos; Tactical Track). Each phase will conclude with a demonstration at the respective scale of development.

All abstracts and proposals must address BOTH Technical Areas (TAs) and respond to BOTH the Strategic Track AND the Tactical Track. Abstracts and proposals that do not address both TAs and both Tracks will be considered non-conforming and may be removed from consideration (rejected without review).

1.3.1. Metrics

For each Track, the minimum metrics for every TA and Phase are outlined below (Table 1 and Table 2). Proposers are also encouraged to identify metrics beyond the minimum defined below.

Table 1. Strategic Track Metrics

	Metric	Unit	Phase I	Phase II	Phase III	
TA 1	Integration Depth	Centimeters (cm)	5 cm	25 cm	50 cm	
	Prolonged Function	Months (mos)	4 mos	8 mos	24 mos	
	QC Diagnostics	Quantitation	Limit of Detection (%mass)	Vascularization	Vascularization	Chloride
				<0.30%	<0.030%	<0.030%
				<0.030%	<0.0030%	Option
	Crack Repair	Crack Filling Rate	mL/(day*mL Concrete)	Chloride Binding	≥ 25% Reduction in Free Chloride in < 1 mo.	≥ 50% Reduction in Free Chloride in < 1 mo.
N.A.				0.0004 mL/(day*mL Concrete)	0.0004 mL/(day*mL Concrete)	
Compressive Strength				>17 MPa	>26 MPa	>35 MPa
TA2	App. Methods	S.A./Time (m ² /day)	>18 m ² /7 days	≥100 m ² /7 days	≥300 m ² /7 days	
	Testbeds	Experimental Timeframe	mos, days	<2.5 mos	<1.5 mos	Structure-scale testing performed entirely by IV&V
		Test Unit Size	m ³	0.005 m ³	0.5 m ³	
		Experimental Throughput	N Replicates	40	10	
		Predicted Strength	RMSE (MPa), R ²	<10 Mpa, R ² >0.80	<5 Mpa, R ² >0.90	

Table 2. Tactical Track Metrics

	Metric	Unit	Phase I	Phase II	Phase III
TA 1 Crack Repair	Integration Depth	Centimeters (cm)	5 cm	25 cm	50 cm
	Prolonged Function	Months (mos)	4 mos	4 mos	4 mos
	Crack Filling Rate	mL/(day*mL Concrete)	0.001 mL/(day*mL Concrete)	0.005 mL/(day*mL Concrete)	0.015 mL/(day*mL Concrete)
	Longevity of Repair	N Aircraft Passes	625 passes	1000 passes	1500 passes
TA2 App. Methods Testbeds	Application Rate	Vol./Time (m ³ /day)	N.A.	4 m ³ /day	72 m ³ /day
	Experimental Timeframe	mos, days	<30 days	<3 days	Structure-scale testing performed entirely by IV&V
	Test Unit Size	m ³	0.0025 m ³	0.0025 m ³	
	Experimental Throughput	N Replicates	80	40	

1.3.2. Milestones and Deliverables

For each Track, a minimum set of Milestones and Deliverables are outlined below according to TA and Phase (Table 3 and Table 4). Proposers must explain quantitative success criteria for each Milestone and how these will be achieved in their Statement of Work (SOW). For some milestones related to the performance of testbeds, performers will be working with Government IV&V partners to ensure that concrete is relevant to DoD structures and is consistent across teams.

Table 3. Strategic Track Milestones and Deliverables

		Milestones	Deliverables
Phase I (24 months)	TA1	<p>Month 3: Identify Candidate Vascularization Approaches</p> <p>Month 9: Initial down selection of Vascularization Approaches</p> <p>Month 12: Crack Filling; QC Diagnostic Detection of Vascularization in Concrete</p> <p>Month 21: Crack Healing</p> <p>Month 24: QC Diagnostic Imaging of Vascularized Concrete</p>	<p>Month 4: Report summarizing choices of vascularizing approaches and experimental strategy for culling vascularization approaches.</p> <p>Month 11: Microscale model code provided to IV&V; Report summarizing candidate culling process and crack-filling performance in microcosm testbeds.</p> <p>Month 13: Microscale model results.</p> <p>Month 18: Report, including feedback from EPA, summarizing experimental approaches to satisfy regulatory requirements for Toxic Substances Control Act Experimental Release Application (TERA) approval.</p> <p>Month 22: Mesoscale model code provided to IV&V; Report on crack healing.</p> <p>Month 24: Phase I Final Report; Mesoscale model results.</p>
	TA2	<p>Month 3: Finalized Microcosm Testbeds</p> <p>Month 6: Finalized Microcosm Application Methods</p> <p>Month 12: Microscale Models</p> <p>Month 15: Finalized Mesocosm Testbeds and Application Methods</p> <p>Month 24: Mesoscale Models</p>	
	Reg	<p>Month 18: EPA Toxic Substances Control Act (TSCA) Pre-Notice Consult</p>	
	IVV	<p>Month 12: Support Microcosm Demo (led by performers)</p> <p>Month 24: Support Mesocosm Demo (led by performers)</p>	
Phase II Option (4 months)	TA1	<p>Month 28: Initiate component-scale testing at IV&V facility</p> <p>Month 30: Final Vascularization Approach</p> <p>Month 33: QC Diagnostic Imaging of Concrete Chloride Concentration</p> <p>Month 36: Chloride Sequestration</p>	<p>Month 27: Report describing component-scale approach to testing, including instructions for applying vascularizing effectors at this scale.</p> <p>Month 28: Deliver formulated vascularizing effector to IV&V facilities for evaluation with test components.</p> <p>Month 30: Report describing final</p>
	TA2	<p>Month 27: Component Application</p>	

		Approaches; Finalized Component Testbed Month 36: Component-scale Models	vascularization approach, including initial performance data at component scale, and all information necessary for EPA TERA application. Month 34: Component-scale model code provided to IV&V; Report documenting vascularizing effector performance at component scale. Month 36: Phase II Final Report; Component scale model results.
	Reg	Month 33: EPA TERA Approval Month 36: Component Demo	
Phase III Option (18 months)	TA1	Month 45: Initial Quality Control Diagnostics Assessment Month 48: Restored Durability Month 51: Vascularization Longevity Assessment Month 54: Final Quality Control Diagnostics Assessment	Month 41: Deliver formulated vascularizing effector to IV&V facilities for application to test structures. Month 47: Report on initial assessment of test structure, including performance data for restored durability. Month 52: Structure-scale model code provided to IV&V; Report documenting vascularizing effector performance at structural scale. Month 54: Program Final Report; Structure scale model results.
	TA2	Month 39: Scaled Production of Vascularizing Effector Month 42: Complete Application to Test Structure; Structure Specific Model Parameterization Month 54: Structural Models	
	Reg	Month 45: EPA Pre-notice consult for Commercial Microbial Activity.	
	IVV	Month 39: Baseline Survey Test Structure Month 42: Initiate Structure-scale testing in both mock structure (controlled setting) and field-demonstration Month 54: Final Survey Test Structure	

Table 4. Tactical Track Milestones and Deliverables

		Milestones	Deliverables
		Prior to Month 12, No Tactical Track-Specific Milestones	
Phase I (24 months)	TA1	Month 12 (Tactical Track Entry Criteria): Crack Filling (≥ 0.0005 mL/(day*mL concrete) Month 22: Durability Against Mechanical Fatigue	Month 12: Report documenting candidate approaches that meet or exceed entry criteria. Month 18: Report, including feedback from EPA, summarizing experimental approaches to satisfy regulatory requirements for TERA. Month 22: Report on crack healing and mechanical fatigue durability. Month 24: Phase I Final Report.
	TA2	Month 15: Mesocosm Application Approaches; Mechanical Fatigue Testbed	
	Reg	Month 18: EPA Toxic Substances Control Act Experimental Research Authorization (TERA) Pre-Notice Consult	
	IVV	Month 24: Support Mechanical Fatigue Demo (led by performers)	
Phase II Option (12 months)	TA1	Month 30: Final Vascularization Approach Month 36: Bond Strength	Month 30: Report describing final vascularization approach, including initial performance data to strengthen material interfaces and all information necessary for EPA TERA application. Month 36: Phase II Final Report
	TA2	Month 27: Patch-scale Application Approaches; Material Interface Testbed	
	Reg	Month 33: EPA TERA Approval	
	IVV	Month 36: Material Interface Demo	

Phase III Option (18 months)	TA1	Month 45: Subgrade Integration Month 48: Repair Longevity	Month 40: Deliver formulated vascularizing effector to IV&V facilities for application in E-ADR test patches. Month 43: Report on initial field test of vascularizing effector applied to E-ADR patches. Month 48: Program Final Report.
	TA2	Month 39: Scaled Production of Vascularizing Effector	
	Reg	Month 45: EPA Pre-notice consult for Commercial Microbial Activity	
	IVV	Month 42: Initial Field Test Month 48: Runway Demo	

1.4. Demonstrations and IV&V

There will be four demonstration events during the course of the program to be held at the facilities of one or more Government IV&V partners. Proposals should not include tasks and costs associated with performance of IV&V demonstrations; however, proposals should include costs for supplying Government IV&V partners with vascularizing technology for evaluation in Phase II and III demonstrations. Similarly, travel to IV&V-hosted demonstrations in Phases II and III is anticipated, and for planning, proposers should assume travel to one demonstration event in San Diego, California and one in Panama City, Florida per Program Track per Phase. Notionally illustrated in Figure 4, the first is planned for approximately the midpoint of Phase I and the remaining three at or near the ends of each of the Phases. These provide checkpoints to assess performance across both TAs in all Phases of the program to ensure the resulting technologies meet DoD needs. Just as the scale of the concrete specimens under study increases throughout the program, the demonstrations will also grow in size and complexity and ensure regular integration across TAs. Furthermore, these timelines support the validation of service-life effects on DoD structures and rapid runway repairs.

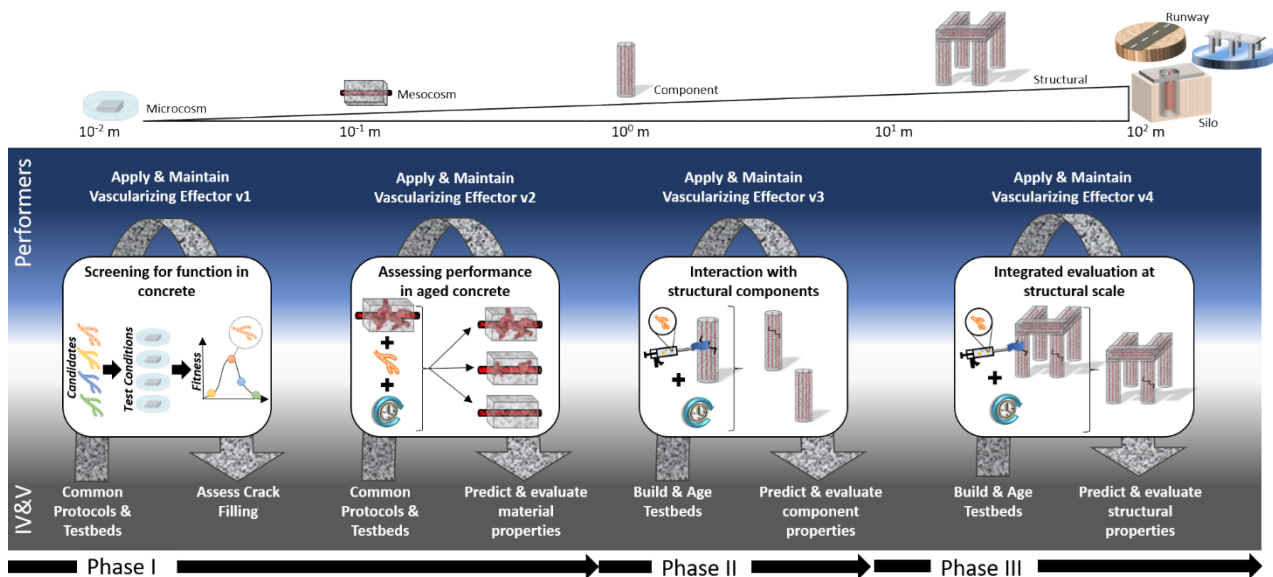


Figure 4. Scheme for regular interaction between performers and IV&V on the BRACE program. Performers will interact with IV&V to ensure they are developing their vascularizing effectors for ongoing concrete repair toward DoD-relevant endpoints. IV&V will work across performers teams to ensure that all teams are using a common set of specifications for concrete test specimens relevant to each track and phase within the program.

At each of these demonstrations, performers will be expected to provide concrete specimens of appropriate scale that have been vascularized and repaired using their effector(s) for their appropriate and specified duration to be tested at the demonstration. For example, if the performer claims their effector can achieve full vascularization and repair in 4 weeks, they must begin preparing the demo specimens 4 weeks before the demonstration. Performers will also be expected to demonstrate application of their effectors on specimens of appropriate scale at the demonstration, and those specimens will later be tested by IV&V after a performer-specified time (continuing the example above, 4 weeks later). Performers will also bring any equipment necessary to demonstrate their QC diagnostic functionality and present their results in overcoming each of the challenges, including their testbed and modeling efforts.

Metrics for end-of-phase demonstrations are summarized in Section 1.3.2 for all Demonstrations, Phases, and Tracks.

Phase I – Demonstrations are hosted by performers, with support from IV&V.

Month 12

Strategic and Tactical Tracks: Microcosm testbeds

- Demonstrate ability to fill cracks in concrete.
- Demonstrate ability to detect vascularization within concrete specimens.
- Tactical Track Entry Criteria: crack filling rate ≥ 0.0005 mL/(day*mL concrete).

Month 24

Strategic Track: Mesocosm testbeds

- Demonstrate application methods along with the integration depth and prolonged functionality of vascularizing effectors in concrete according to metrics.
- Demonstrate crack healing to restore compressive strength.
- Demonstrate the ability to image the distribution of vascularizing effectors in concrete via non-destructive evaluation.

Tactical Track: Mesocosm testbeds

- Demonstrate rapid crack filling capability and durability against mechanically-induced fatigue according to metrics.
- Demonstrate application approaches to E-ADR materials and material properties of these materials with the vascularizing additive vs. without.

Phase II Option – Demonstrations are hosted and orchestrated by IV&V

Month 36

Strategic Track: Component-scale testbeds

- Demonstrate application methods along with the integration depth and prolonged functionality of vascularizing effectors in concrete according to metrics.
- Demonstrate crack filling and healing to restore compressive strength, while binding chloride to prevent corrosion.
- Demonstrate non-destructive imaging of both the presence of the vasculature in concrete and function vasculature to reduce free chloride.
- Demonstrate component-scale model predictions of compressive strength vs. empirical assessment of concrete compressive strength.

Tactical Track: Mesocosm testbeds for materials-interface

- Demonstrate E-ADR integrated application and maintenance of final, EPA-approved vascularization approach to patch-scale testbeds.
- Using a mesoscale patch interface testbed, achieve increased bond strength between new and old concrete compared to untreated control.
- Demonstrate rapid crack filling capability and durability against mechanically-induced fatigue according to metrics.

Phase III Option – Demonstrations are hosted and orchestrated by IV&V

Month 48

Tactical Track: Field demonstrations

- Demonstrate complete integration of application methods into E-ADR workflow capable of repairing 72 m³ (18 small craters) in less than a single day, according to E-ADR CONOPS.
- Demonstrate vascularizing effectors capable of integrating with both the subgrade and capping concrete to improve the longevity of E-ADR repairs for at least 1500 passes of fighter aircraft.

Month 54

Strategic Track: Mock structures and field demonstrations

- Demonstrate application and maintenance of vascularizing effector to DoD test structure.
- Demonstrate restored durability of concrete according to Phase III metrics for the Strategic track, while binding chloride in concrete at rates commensurate with reducing the concentration of free chlorides by half each month.
- Demonstrate multiplexed, non-destructive imaging of the distribution and function of vascularization in concrete structures. Demonstrate the ability to capture data on two function-related chemical species, including chloride and at least one other signal chosen by performer.
- Demonstrate multi-scale models capable of predicting the impact of the vascularizing effectors' impact on concrete durability in different parts of a test structure with accuracy according to Phase III metrics.

1.5. GENERAL REQUIREMENTS

1.5.1. Proposing Teams

DARPA anticipates that performers will be comprised of cross-disciplinary teams that include personnel with complementary and diverse technical expertise (e.g., synthetic biology, molecular biology, microbiology, mycobiology, chemistry, physics, materials science, structural and civil engineering). Specific content, communications, networking, and team formation are the sole responsibility of the proposer team. Proposer teams must submit a single, integrated proposal led by a single integrator/manager or prime contractor that addresses all program Phases, Tracks, and TAs. The Government will select and fund IV&V partner(s) for the BRACE program at a later date. Proposals submitted in response to HR001122S0029 should not include tasks or costs associated with conducting IV&V.

1.5.2. Data Sharing and Associate Contractor Agreement (ACA)

DARPA anticipates that a large amount of data will be generated under this program by each performer. Data analysis and modeling will be strengthened by compiling and integrating information across performers and Tracks. Therefore, proposals must include the description of a plan to share data with teams internally to the BRACE performer group. As needed, data sharing plans to facilitate exchange will then be formalized in an ACA (See Section 0), to be included in the contract or agreement awarded. Performers will be encouraged to share data externally with the broader research community and may include plans for external data sharing in the Metrics, Milestones, and Deliverables in their proposed project plan.

1.5.3. Permits and Compliance

It is the proposing team's responsibility to obtain all necessary federal, state, and local government permits and approvals, and abide by all applicable laws where necessary for the proposed work to be conducted. Testing engineered biological technologies for repairing concrete in Phase III field demonstrations will likely require permitting. Proposed approaches that include genetically engineered solutions are subject to the Toxic Substances Control Act (TSCA), at minimum, and specific Milestones for engaging with the Environmental Protection Agency are included in the program plan with the aim of having performer teams secure a TSCA Experimental Release Authorization prior to the start of Phase III. Depending on the nature of the proposed solution, proposing teams are expected to provide additional/alternative regulatory pathways and to justify how they will meet regulatory milestones prior to Phase III.

1.5.4. Ethical, Legal, and Societal Implication (ELSI)

DARPA maintains its commitment to ensuring that efforts funded under this BAA adhere to ethical and legal regulations currently in place for Federally and DoD-funded research. In addition to obtaining all necessary regulatory permits, proposers should plan to support ELSI activities with DARPA, including semi-annual teleconference calls with a BRACE program ELSI group that DARPA will engage. Development of long-acting concrete vascularization technologies under BRACE will enable ongoing repair to improve the longevity of infrastructure, and if successful, these technologies will be developed for use in the built environment. Therefore, BRACE performers will need to consider the feedback from the ELSI group regarding their research activities, and to this end, ELSI outcomes will be reported regularly to DARPA.

1.5.5. Down-selects

A down-selection process (as mentioned in Section 1.3) will occur at the end of Phases I and II. Down-selections will be based on the performer's ability to meet Metrics (Section 1.3.1) and Milestones (Section 1.3.2) specified in this BAA and their likelihood of success in developing vascularizing effectors that can be tested in field studies in Phase III. All Phase II/III tasks are considered options that the Government may elect to exercise, and down-selection refers to the Government electing not to exercise some or all options associated with work in a given phase. In addition to meeting metrics, down-selection decisions will be informed by:

- Solutions with the most reasonable technical path to achieving metrics in subsequent Program Phases.
- Effective intra-team working relationships across co-/sub-Principal Investigators.
- Clear ability to achieve objectives of Phase II/III Options within their proposed budget.

To inform down-selects, DARPA will hold an internal program review at the end of Phase I to make an overall Go/No-Go determination for continuing the BRACE program on to Phases II and III.

1.5.6. Transition and Commercialization Strategy

Proposers must present a detailed plan for transition of the technologies developed during the BRACE program both to the defense community and to other stakeholder entities and industry. The goal of the BRACE program is to develop and operationalize vascularizing strategies with prolonged functionality to impart ongoing repair capability to concrete infrastructure, and while the program will focus on use cases that are critically important to the DoD, concrete is a fundamental building material for civil works and commercial infrastructure in every conceivable setting. Given the ubiquitous nature of concrete, proposals should discuss their strategy to leverage technical developments on the BRACE program for commercial markets and how this approach could support strategies to reengage smaller DoD markets. In particular, market engagement strategies must include but should not be limited to engagement with IV&V partners and DoD stakeholders to ensure technology development is aimed at transition targets. To further support transition and commercialization goals, performers may consider inclusion of qualified personnel to support these activities in order to increase a performer team's ability to move technology from the lab to a sustainable business that can provide new capabilities to the military.

1.5.7. Other Requirements

Performers are expected to attend semi-annual program reviews to provide updates to the DARPA program management team and other BRACE performers on progress towards their milestones and scientific goals on the BRACE program. Performers will also summarize outstanding challenges and limitations that must still be overcome to achieve the overarching goals of the program. Program level meetings will also be held at the kick-off of each phase (Phases 1, 2, and 3). In addition to program-wide meetings, performers will also engage regularly with the DARPA program team, including quarterly progress reviews and site visits as well as informal, ad hoc teleconferences to ensure progress is being made toward program objectives.

2. Award Information

2.1. GENERAL AWARD INFORMATION

Multiple awards are possible. The amount of resources made available under this BAA will depend on the quality of the proposals received and the availability of funds.

The Government reserves the right to select for negotiation all, some, one, or none of the proposals received in response to this solicitation and to make awards without discussions with proposers. The Government also reserves the right to conduct discussions if it is later determined to be necessary. If warranted, portions of resulting awards may be segregated into pre-priced options. Additionally, DARPA reserves the right to accept proposals in their entirety or to select only portions of proposals for award. In the event that DARPA desires to award only portions of a proposal, negotiations may be opened with that proposer. The Government reserves the right to fund proposals in phases with options for continued work, as applicable.

The Government reserves the right to request any additional, necessary documentation once it makes the award instrument determination. Such additional information may include but is not limited to Representations and Certifications (see [Section 6.2.4.](#), “Representations and Certifications”). The Government reserves the right to remove proposers from award consideration should the parties fail to reach agreement on award terms, conditions, and/or cost/price within a reasonable time, and the proposer fails to timely provide requested additional information. Proposals identified for negotiation may result in a procurement contract, cooperative agreement, or other transaction, depending upon the nature of the work proposed, the required degree of interaction between parties, whether or not the research is classified as Fundamental Research, and other factors.

Proposers looking for innovative, commercial-like contractual arrangements are encouraged to consider requesting Other Transactions. To understand the flexibility and options associated with Other Transactions, consult <http://www.darpa.mil/work-with-us/contract-management#OtherTransactions>.

In accordance with 10 U.S.C. § 4003(f), the Government may award a follow-on production contract or Other Transaction (OT) for any OT awarded under this solicitation if: (1) that participant in the OT, or a recognized successor in interest to the OT, successfully completed the entire prototype project provided for in the OT, as modified; and (2) the OT provides for the award of a follow-on production contract or OT to the participant, or a recognized successor in interest to the OT.

In all cases, the Government contracting officer shall have sole discretion to select award instrument type, regardless of instrument type proposed, and to negotiate all instrument terms and conditions with selectees. DARPA will apply publication or other restrictions, as necessary, if it determines that the research resulting from the proposed effort will present a high likelihood of disclosing performance characteristics of military systems or manufacturing technologies that are unique and critical to defense. Any award resulting from such a determination will include a requirement for DARPA permission before publishing any information or results on the program. For more information on publication restrictions, see the section below on Fundamental Research

2.2. FUNDAMENTAL RESEARCH

It is DoD policy that the publication of products of fundamental research will remain unrestricted to the maximum extent possible. National Security Decision Directive (NSDD) 189 defines fundamental research as follows:

‘Fundamental research’ means basic and applied research in science and engineering, the results of which ordinarily are published and shared broadly within the scientific community, as distinguished from proprietary research and from industrial development, design, production, and product utilization, the results of which ordinarily are restricted for proprietary or national security reasons.

As of the date of publication of this solicitation, the Government expects that program goals as described herein may be met by proposers intending to perform fundamental research and does not anticipate applying publication restrictions of any kind to individual awards for fundamental research that may result from this solicitation. Notwithstanding this statement of expectation, the

Government is not prohibited from considering and selecting research proposals that, while perhaps not qualifying as fundamental research under the foregoing definition, still meet the solicitation criteria for submissions. If proposals are selected for award that offer other than a fundamental research solution, the Government will either work with the proposer to modify the proposed statement of work to bring the research back into line with fundamental research or else the proposer will agree to restrictions in order to receive an award.

University or non-profit research institution performance under this solicitation will include effort categorized as fundamental research. In addition to Government support for free and open scientific exchanges and dissemination of research results in a broad and unrestricted manner, the academic or non-profit research performer or recipient, regardless of tier, acknowledges that such research may have implications that are important to U.S. national interests and must be protected against foreign influence and exploitation. As such, the academic or non-profit research performer or recipient agrees to comply with the following requirements:

- (a) The University or non-profit research institution performer or recipient must establish and maintain an internal process or procedure to address foreign talent programs, conflicts of commitment, conflicts of interest, and research integrity. The academic or non-profit research performer or recipient must also utilize due diligence to identify Foreign Components or participation by Senior/Key Personnel in Foreign Government Talent Recruitment Programs and agree to share such information with the Government upon request.
 - i. The above described information will be provided to the Government as part of the proposal response to the solicitation and will be reviewed and assessed prior to award. Generally, this information will be included in the Research and Related Senior/Key Personnel Profile (Expanded) form (SF-424) required as part the proposer's submission through Grants.gov.
 1. Instructions regarding how to fill out the SF-424 and its biographical sketch can be found through Grants.gov.
 - ii. In accordance with USD(R&E) direction to mitigate undue foreign influence in DoD-funded science and technology, DARPA will assess all Senior/Key Personnel proposed to support DARPA grants and cooperative agreements for potential undue foreign influence risk factors relating to professional and financial activities. This will be done by evaluating information provided via the SF-424, and any accompanying or referenced documents, in order to identify and assess any associations or affiliations the Senior/Key Personnel may have with foreign strategic competitors or countries that have a history of intellectual property theft, research misconduct, or history of targeting U.S. technology for unauthorized transfer. DARPA's evaluation takes into consideration the entirety of the Senior/Key Personnel's SF-424, current and pending support, and biographical sketch, placing the most weight on the Senior/Key Person's professional and financial activities over the last 4 years. The majority of foreign entities lists used to make these determinations are publicly available. The DARPA Countering Foreign Influence Program (CFIP) "Senior/Key Personnel Foreign Influence Risk Rubric" details the various risk ratings and factors. The rubric can be seen at the

following link:

<https://www.darpa.mil/attachments/092021DARPACFIPRubric.pdf>

- iii. Examples of lists that DARPA leverages to assess potential undue foreign influence factors include, but are not limited to:
1. Executive Order 13959 “Addressing the Threat From Securities Investments That Finance Communist Chinese Military Companies”: <https://www.govinfo.gov/content/pkg/FR-2020-11-17/pdf/2020-25459.pdf>
 2. The U.S. Department of Education’s College Foreign Gift and Contract Report: [College Foreign Gift Reporting \(ed.gov\)](https://www.ed.gov/collegeforeigngiftreport)
 3. The U.S. Department of Commerce, Bureau of Industry and Security, List of Parties of Concern: <https://www.bis.doc.gov/index.php/policy-guidance/lists-of-parties-of-concern>
 4. Georgetown University’s Center for Security and Emerging Technology (CSET) Chinese Talent Program Tracker: <https://chinatalenttracker.cset.tech>
 5. Director of National Intelligence (DNI) “World Wide Threat Assessment of the US Intelligence Community”: [2021 Annual Threat Assessment of the U.S. Intelligence Community \(dni.gov\)](https://www.dni.gov/2021-annual-threat-assessment)
 6. Various Defense Counterintelligence and Security Agency (DCSA) products regarding targeting of US technologies, adversary targeting of academia, and the exploitation of academic experts: <https://www.dcsa.mil/>

DARPA’s analysis and assessment of affiliations and associations of Senior/Key Personnel is compliant with Title VI of the Civil Rights Act of 1964. Information regarding race, color, or national origin is not collected and does not have bearing in DARPA’s assessment.

University or non-profit research institutions with proposals selected for negotiation that have been assessed as having high or very high undue foreign influence risk, will be given an opportunity during the negotiation process to mitigate the risk. DARPA reserves the right to request any follow-up information needed to assess risk or mitigation strategies.

- iv. Upon conclusion of the negotiations, if DARPA determines, despite any proposed mitigation terms (e.g. mitigation plan, alternative research personnel), the participation of any Senior/Key Research Personnel still represents high risk to the program, or proposed mitigation affects the Government’s confidence in proposer’s capability to successfully complete the research (e.g., less qualified Senior/Key Research Personnel) the Government may determine not to award the proposed effort. Any decision not to award will be predicated upon reasonable disclosure of the pertinent facts and reasonable discussion of any possible alternatives while balancing program award timeline requirements.
- (b) Failure of the academic or non-profit research performer or recipient to reasonably exercise due diligence to discover or ensure that neither it nor any of its Senior/Key Research Personnel involved in the subject award are participating in a Foreign

Government Talent Program or have a Foreign Component with an a strategic competitor or country with a history of targeting U.S. technology for unauthorized transfer may result in the Government exercising remedies in accordance with federal law and regulation.

- i. If, at any time, during performance of this research award, the academic or non-profit research performer or recipient should learn that it, its Senior/Key Research Personnel, or applicable team members or subtier performers on this award are or are believed to be participants in a Foreign Government Talent Program or have Foreign Components with a strategic competitor or country with a history of targeting U.S. technology for unauthorized transfer , the performer or recipient will notify the Government Contracting Officer or Agreements Officer within 5 business days.
 1. This disclosure must include specific information as to the personnel involved and the nature of the situation and relationship. The Government will have 30 business days to review this information and conduct any necessary fact-finding or discussion with the performer or recipient.
 2. The Government's timely determination and response to this disclosure may range anywhere from acceptance, to mitigation, to termination of this award at the Government's discretion.
 3. If the University receives no response from the Government to its disclosure within 30 business days, it may presume that the Government has determined the disclosure does not represent a threat.
- ii. The performer or recipient must flow down this provision to any subtier contracts or agreements involving direct participation in the performance of the research.

(c) Definitions

- i. Senior/Key Research Personnel
 1. This definition would include the Principal Investigator or Program/Project Director and other individuals who contribute to the scientific development or execution of a project in a substantive, measurable way, whether or not they receive salaries or compensation under the award. These include individuals whose absence from the project would be expected to impact the approved scope of the project.
 2. Most often, these individuals will have a doctorate or other professional degrees, although other individuals may be included within this definition on occasion.
- ii. Foreign Associations/Affiliations
 1. Association is defined as collaboration, coordination or interrelation, professionally or personally, with a foreign government-connected entity where no direct monetary or non-monetary reward is involved.

2. Affiliation is defined as collaboration, coordination, or interrelation, professionally or personally, with a foreign government-connected entity where direct monetary or non-monetary reward is involved.
- iii. Foreign Government Talent Recruitment Programs
1. In general, these programs will include any foreign-state-sponsored attempt to acquire U.S. scientific-funded research or technology through foreign government-run or funded recruitment programs that target scientists, engineers, academics, researchers, and entrepreneurs of all nationalities working and educated in the U.S.
 2. Distinguishing features of a Foreign Government Talent Recruitment Program may include:
 - a. Compensation, either monetary or in-kind, provided by the foreign state to the targeted individual in exchange for the individual transferring their knowledge and expertise to the foreign country.
 - b. In-kind compensation may include honorific titles, career advancement opportunities, promised future compensation or other types of remuneration or compensation.
 - c. Recruitment, in this context, refers to the foreign-state-sponsor's active engagement in attracting the targeted individual to join the foreign-sponsored program and transfer their knowledge and expertise to the foreign state. The targeted individual may be employed and located in the U.S. or in the foreign state.
 - d. Contracts for participation in some programs that create conflicts of commitment and/or conflicts of interest for researchers. These contracts include, but are not limited to, requirements to attribute awards, patents, and projects to the foreign institution, even if conducted under U.S. funding, to recruit or train other talent recruitment plan members, circumventing merit-based processes, and to replicate or transfer U.S.-funded work in another country.
 - e. Many, but not all, of these programs aim to incentivize the targeted individual to physically relocate to the foreign state. Of particular concern are those programs that allow for continued employment at U.S. research facilities or receipt of U.S. Government research funding while concurrently receiving compensation from the foreign state.
 3. Foreign Government Talent Recruitment Programs DO NOT include:
 - a. Research agreements between the University and a foreign entity, unless that agreement includes provisions that create situations of concern addressed elsewhere in this section,
 - b. Agreements for the provision of goods or services by commercial vendors, or

c. Invitations to attend or present at conferences.

iv. Conflict of Interest

1. A situation in which an individual, or the individual's spouse or dependent children, has a financial interest or financial relationship that could directly and significantly affect the design, conduct, reporting, or funding of research.

v. Conflict of Commitment

1. A situation in which an individual accepts or incurs conflicting obligations between or among multiple employers or other entities.
2. Common conflicts of commitment involve conflicting commitments of time and effort, including obligations to dedicate time in excess of institutional or funding agency policies or commitments. Other types of conflicting obligations, including obligations to improperly share information with, or withhold information from, an employer or funding agency, can also threaten research security and integrity and are an element of a broader concept of conflicts of commitment.

vi. Foreign Component

1. Performance of any significant scientific element or segment of a program or project outside of the U.S., either by the University or by a researcher employed by a foreign organization, whether or not U.S. government funds are expended.
2. Activities that would meet this definition include, but are not limited to:
 - a. Involvement of human subjects or animals;
 - b. Extensive foreign travel by University research program or project staff for the purpose of data collection, surveying, sampling, and similar activities;
 - c. Collaborations with investigators at a foreign site anticipated to result in co-authorship;
 - d. Use of facilities or instrumentation at a foreign site;
 - e. Receipt of financial support or resources from a foreign entity; or
 - f. Any activity of the University that may have an impact on U.S. foreign policy through involvement in the affairs or environment of a foreign country.
3. Foreign travel is not considered a Foreign Component.

vii. Strategic Competitor

1. A nation, or nation-state, that engages in diplomatic, economic or technological rivalry with the United States where the fundamental strategic interests of the U.S are under threat.

Proposers should indicate in their proposal whether they believe the scope of the research included in their proposal is fundamental or not. While proposers should clearly explain the intended results of their research, the Government shall have sole discretion to determine whether the proposed research shall be considered fundamental and to select the award instrument type. Appropriate language will be included in resultant awards for non-fundamental research to prescribe publication requirements and other restrictions, as appropriate. This language can be found at <http://www.darpa.mil/work-with-us/additional-baa>.

For certain research projects, it may be possible that although the research to be performed by a potential awardee is non-fundamental research, its proposed subawardee's effort may be fundamental research. It is also possible that the research performed by a potential awardee is fundamental research while its proposed subawardee's effort may be non-fundamental research. In all cases, it is the potential awardee's responsibility to explain in its proposal which proposed efforts are fundamental research and why the proposed efforts should be considered fundamental research.

3. Eligibility Information

3.1. ELIGIBLE APPLICANTS

All responsible sources capable of satisfying the Government's needs may submit a proposal that shall be considered by DARPA.

3.1.1. Federally Funded Research and Development Centers (FFRDCs) and Government Entities

FFRDCs

FFRDCs are subject to applicable direct competition limitations and cannot propose to this solicitation in any capacity unless they meet the following conditions. (1) FFRDCs must clearly demonstrate that the proposed work is not otherwise available from the private sector. (2) FFRDCs must provide a letter, on official letterhead from their sponsoring organization, that (a) cites the specific authority establishing their eligibility to propose to Government solicitations and compete with industry, and (b) certifies the FFRDC's compliance with the associated FFRDC sponsor agreement's terms and conditions. These conditions are a requirement for FFRDCs proposing to be awardees or subawardees.

Government Entities

Government Entities (e.g., Government/National laboratories, military educational institutions, etc.) are subject to applicable direct competition limitations. Government Entities must clearly demonstrate that the work is not otherwise available from the private sector and provide written documentation citing the specific statutory authority and contractual authority, if relevant, establishing their ability to propose to Government solicitations and compete with industry. This information is required for Government Entities proposing to be awardees or subawardees.

Authority and Eligibility

At the present time, DARPA does not consider 15 U.S.C. § 3710a to be sufficient legal authority to show eligibility. While 10 U.S.C. § 4892 may be the appropriate statutory starting point for some

entities, specific supporting regulatory guidance, together with evidence of agency approval, will still be required to fully establish eligibility. DARPA will consider FFRDC and Government Entity eligibility submissions on a case-by-case basis; however, the burden to prove eligibility for all team members rests solely with the proposer.

3.1.2. Non-U.S. Organizations

Non-U.S. organizations and/or individuals may participate to the extent that such participants comply with any necessary nondisclosure agreements, security regulations, export control laws, and other governing statutes applicable under the circumstances.

3.2. ORGANIZATIONAL CONFLICTS OF INTEREST

FAR 9.5 Requirements

In accordance with FAR 9.5, proposers are required to identify and disclose all facts relevant to potential OCIs involving the proposer's organization and *any* proposed team member (subawardee, consultant). Under this Section, the proposer is responsible for providing this disclosure with each proposal submitted to the solicitation. The disclosure must include the proposer's, and as applicable, proposed team member's OCI mitigation plan. The OCI mitigation plan must include a description of the actions the proposer has taken, or intends to take, to prevent the existence of conflicting roles that might bias the proposer's judgment and to prevent the proposer from having unfair competitive advantage. The OCI mitigation plan will specifically discuss the disclosed OCI in the context of each of the OCI limitations outlined in FAR 9.505-1 through FAR 9.505-4.

Agency Supplemental OCI Policy

In addition, DARPA has a supplemental OCI policy that prohibits contractors/performers from concurrently providing Scientific Engineering Technical Assistance (SETA), Advisory and Assistance Services (A&AS) or similar support services and being a technical performer. Therefore, as part of the FAR 9.5 disclosure requirement above, a proposer must affirm whether the proposer or *any* proposed team member (subawardee, consultant) is providing SETA, A&AS, or similar support to any DARPA office(s) under: (a) a current award or subaward; or (b) a past award or subaward that ended within one calendar year prior to the proposal's submission date. If SETA, A&AS, or similar support is being or was provided to any DARPA office(s), the proposal must include:

- The name of the DARPA office receiving the support;
- The prime contract number;
- Identification of proposed team member (subawardee, consultant) providing the support; and
- An OCI mitigation plan in accordance with FAR 9.5.

Government Procedures

In accordance with FAR 9.503, 9.504 and 9.506, the Government will evaluate OCI mitigation plans to avoid, neutralize or mitigate potential OCI issues before award and to determine whether it is in the Government's interest to grant a waiver. The Government will only evaluate OCI mitigation plans for proposals that are determined selectable under the solicitation evaluation criteria and funding availability.

The Government may require proposers to provide additional information to assist the Government in evaluating the proposer's OCI mitigation plan.

If the Government determines that a proposer failed to fully disclose an OCI; or failed to provide the affirmation of DARPA support as described above; or failed to reasonably provide additional

information requested by the Government to assist in evaluating the proposer's OCI mitigation plan, the Government may reject the proposal and withdraw it from consideration for award.

3.3. COST SHARING/MATCHING

Cost sharing is not required; however, it will be carefully considered where there is an applicable statutory condition relating to the selected funding instrument. Cost sharing is encouraged where there is a reasonable probability of a potential commercial application related to the proposed research and development effort.

4. Application and Submission Information

4.1. ADDRESS TO REQUEST APPLICATION PACKAGE

This announcement, any attachments, and any references to external websites herein constitute the total solicitation. If proposers cannot access the referenced material posted in the announcement found at <http://www.darpa.mil>, contact the administrative contact listed herein.

4.2. CONTACT AND FORM OF APPLICATION SUBMISSION

All submissions, including abstracts and proposals, must be written in English with type no smaller than 12-point font. Smaller font may be used for figures, tables, and charts. The page limitation includes all figures, tables, and charts. All pages shall be formatted for printing on 8-1/2 by 11-inch paper. Margins must be 1-inch on all sides. Copies of all documents submitted must be clearly labeled with the DARPA BAA number, proposer organization, and proposal title/proposal short title.

4.2.1. Proposal Abstract Format

Proposers are strongly encouraged to submit an abstract in advance of a proposal to minimize effort and reduce the potential expense of preparing an out-of-scope proposal. DARPA will respond to abstracts providing feedback and indicating whether, after preliminary review, there is interest within BTO for the proposed work. DARPA will attempt to reply within **20** calendar days of receipt. Proposals may be submitted irrespective of comments or feedback received in response to the abstract. Proposals are reviewed without regard to feedback given as a result of abstract review. The time and date for submission of proposal abstracts are specified in Part I above.

The abstract is a concise version of the proposal comprising a maximum of **ten (10)** pages, including all figures, tables, and charts. All submissions must be written in English with type no smaller than 12-point font. Smaller font may be used for figures, tables, and charts. All pages shall be formatted for printing on 8-1/2 by 11-inch paper. Margins must be 1-inch on all sides. Copies of all documents submitted must be clearly labeled with the DARPA BAA number, proposer organization, and proposal abstract title.

The page limit does NOT include:

- Official transmittal letter (optional);
- Cover sheet;

- Executive summary slide;
- Resumes; and
- Bibliography (optional).

Abstracts must include the following components:

A. Cover Sheet (does not count towards page limit): Include the administrative and technical points of contact (name, address, phone, fax, e-mail, lead organization). Also include the BAA number, title of the proposed project, primary subcontractors, estimated cost, duration of the project, and the label “ABSTRACT.”

B. Goals and Impact: Clearly describe what is being proposed and what difference it will make (qualitatively and quantitatively), including brief answers to the following questions:

1. What is the proposed work attempting to accomplish or do?
2. How is it done today? And what are the limitations?
3. What is innovative in your approach, and how does it compare to the current state-of-the-art (SOA)?
4. What are the key technical challenges in your approach, and how do you plan to overcome these?
5. Who will care, and what will the impact be if you are successful?
6. How much will it cost, and how long will it take?

C. Executive Summary Slide: The slide template is provided as **Attachment 1** to the BAA posted at <https://beta.SAM.gov>. Use of this template is required.

D. Technical Plan: Outline and address all technical areas and challenges inherent in the approach and possible solutions for overcoming potential problems. Both TA1 and TA2, as well as both Program Tracks, must be addressed. This section should provide specific objectives, metrics, and milestones at intermediate stages of the project to demonstrate a plan for accomplishment of the program goals. Propose additional appropriate qualitative and quantitative metrics specific to the approach, as needed. Outline of intermediary milestones should occur at no greater than 6-month increments.

E. Management and Capabilities: Provide a brief summary of expertise of the team, including subcontractors and key personnel.

A principal investigator for the project must be identified, and a description of the team’s organization, including a breakdown by Technical Area (TA) and Program Track. All teams are strongly encouraged to identify a Project Manager/Integrator to serve as the primary point of contact to communicate with the DARPA Program Manager, IV & V partner, and Contracting Officer’s Representative, coordinate the effort across co-performer, vendor, and subcontractor teams, organize regular performer meetings or discussions, facilitate data sharing, and ensure timely completion of milestones and deliverables.

Include a description of the team's organization, including roles and responsibilities. Team member descriptions should address the Technical Plan (and should include members with needed regulatory/environmental compliance expertise). Describe the time and percent effort divisions for members participating across multiple TAs, and delineate individuals to avoid duplication of efforts.

Describe the organizational experience in this area, existing intellectual property required to complete the project, and any specialized facilities to be used as part of the project. List Government-furnished materials or data assumed to be available. Describe any specialized facilities to be used as part of the project, the extent of access to these facilities, and any biological containment, biosafety, and certification requirements.

F. Cost and Schedule: Provide a cost estimate for resources over the proposed timeline of the project, broken down by phase and major cost items (e.g., labor, materials, etc.). Include cost estimates for each potential subcontractor (may be a rough order of magnitude).

G. Curriculum Vitae (do not count towards page limit): Include CVs of key team members, one of which must be from/for the Principal Investigator.

H. References (Optional, does not count towards page limit): If desired, include a brief list of references cited in the abstract with links to relevant papers and reports. The references list should not exceed two (2) pages.

4.2.2. Proposal Format

As soon as the evaluation of all proposals is complete, the proposer will be notified that (1) the proposal has been selected for funding pending award negotiations, in whole or in part, or (2) the proposal has not been selected. These official notifications will be sent via e-mail to the Technical POC and Administrative POC identified on the proposal coversheet.

All full proposals must be in the format given below. Proposals shall consist of two volumes: 1) **Volume I, Technical and Management Proposal**, and 2) **Volume II, Cost Proposal**. All submissions must be written in English with type no smaller than 12-point font. A smaller font may be used for figures, tables, and charts. The page limitation includes all figures, tables, and charts. All pages shall be formatted for printing on 8-1/2 by 11- inch paper. Margins must be 1- inch on all sides. Copies of all documents submitted must be clearly labeled with the DARPA BAA number, proposer organization, and proposal title/proposal short title. Volume I, Technical and Management Proposal, may include an attached bibliography of relevant technical papers or research notes (published and unpublished) which document the technical ideas and approach upon which the proposal is based. Copies of not more than three (3) relevant papers may be included with the submission. The bibliography and attached papers are not included in the page counts given below. The submission of other supporting materials along with the proposals is strongly discouraged and will not be considered for review. **The maximum page count for Volume 1 is thirty-five (35) pages. Sections I, II.F-II.H, and III are not included in the page count.** Volume I should include the following components:

NOTE: Non-conforming submissions that do not address BOTH Technical Areas and BOTH Program Tracks and/or follow the instructions herein may be rejected without further review.

a. Volume I, Technical and Management Proposal

Section I. Administrative

A. Cover Sheet (LABELED “PROPOSAL: VOLUME I”):

1. BAA number (HR001122S0029);
2. Lead organization submitting proposal (prime contractor);
3. Type of organization, selected from among the following categories: “LARGE BUSINESS,” “SMALL DISADVANTAGED BUSINESS,” “OTHER SMALL BUSINESS,” “HBCU,” “MI,” “OTHER EDUCATIONAL,” OR “OTHER NONPROFIT”;
4. Proposer’s reference number (if any);
5. Other team members (if applicable) and type of business for each;
6. Proposal title;
7. Technical point of contact (Program Manager or Principle Investigator) to include: salutation, last name, first name, street address, city, state, zip code, telephone, fax, e-mail;
8. Administrative point of contact (Contracting Officer or Award Officer) to include: salutation, last name, first name, street address, city, state, zip code, telephone, fax, e-mail;
9. Award instrument requested: cost-plus-fixed-fee (CPFF), cost-contract—no fee, cost sharing contract – no fee, or other type of procurement contract (*specify*), GRANT, cooperative agreement, or other transaction;
10. Place(s) of performance, including all subcontractors and consultants;
11. Period of performance;
12. Total funds requested from DARPA, total funds requested per phase and the amount of any cost share (if any);
13. Proposal validity period; AND
14. Date proposal was submitted.

Information on award instruments is available at <http://www.darpa.mil/work-with-us/contract-management>.

B. Official Transmittal Letter

C. Executive Summary Slide: The slide template is provided as **Attachment 1** to the BAA posted at <https://beta.SAM.gov>. Use of this template is required.

Section II. Detailed Proposal Information

A. Executive Summary: Provide a synopsis of the proposed project, including answers to the following questions:

- What is the proposed work attempting to accomplish or do?
- How is it done today, and what are the limitations?
- What is innovative in your approach?
- What are the key technical challenges in your approach, and how do you plan to overcome these?
- Who or what will be affected, and what will be the impact if the work is successful?
- How much will it cost, and how long will it take?

B. Goals and Impact: Clearly describe what the team is trying to achieve and the difference it will make (qualitatively and quantitatively) if successful. Describe the innovative aspects of the project in the context of existing capabilities and approaches, clearly delineating the uniqueness and benefits of this project in the context of the state of the art, alternative approaches, and other projects from the past and present. Describe how the proposed project is revolutionary and how it significantly rises above the current state-of-the-art. Describe the deliverables associated with the proposed project and any plans to commercialize the technology, transition it to a customer, or further the work.

C. Technical Plan: Outline and address technical challenges inherent in the approach and possible solutions for overcoming potential problems. Proposals must address both TA1 and TA2 as well as both Program Tracks across all three phases. This section should provide appropriate measurable milestones (quantitative if possible) at intermediate stages of the program to demonstrate progress, plan for achieving the milestones, and must include a simple process flow diagram of their final system concept. The technical plan should demonstrate a deep understanding of the technical challenges and present a credible (even if risky) plan to achieve the program goal. Discuss mitigation of technical risk.

D. Management Plan: Provide a summary of expertise of the team, including any subcontractors, and key personnel who will be doing the work. A Principal Investigator (PI) for the project must be identified, along with a description of the team's organization, including the breakdown by Technical Area. All teams are strongly encouraged to identify a Project Manager/Integrator to serve as the primary point of contact to communicate with the DARPA Program Manager, IV & V partner, and Contracting Officer's Representative, coordinate the effort across co-performer, vendor, and subcontractor teams, organize regular performer meetings or discussions, facilitate data sharing, and ensure timely completion of milestones and deliverables.

Provide a clear description of the team's organization, including an organization chart that includes, as applicable: the programmatic relationship of team members; the unique capabilities of team members; the task responsibilities of team members, the teaming

strategy among the team members; and key personnel with the amount of effort to be expended by each person during each year. Provide a detailed plan for coordination, including explicit guidelines for interaction among collaborators/subcontractors of the proposed effort. Include risk management approaches. Describe any formal teaming agreements that are required to execute this program.

- E. Capabilities:** Describe organizational experience in relevant subject area(s), existing intellectual property, specialized facilities, and any Government-furnished materials or information. Describe any specialized facilities to be used as part of the project, the extent of access to these facilities, and any biological containment, biosafety, and certification requirements. Discuss any work in closely related research areas and previous accomplishments.
- F. Qualifications of Key Personnel:** Curriculum Vitae for Principal Investigator (PI), Program Manager (PM), and key co-Investigators.
- G. Current and pending awards:** Provide a list of current and pending awards related to the proposed research, including the funding source (for PI, PM/I, and key co-Investigators). Describe areas of overlap or leveraging with your BRACE proposal.
- H. Statement of Work (SOW):** The SOW should provide a detailed task breakdown, citing specific tasks for each Technical Area, and their connection to the milestones and program metrics. Each phase of the program should be separately defined. The SOW should be divided by Program Phase with high-level tasks for each Phase pertaining to each Program Track. Within Program Tracks, tasks should be broken down across TAs. The Tactical Track should be clearly marked as an OPTION with Phase I tasks beginning no earlier than 13 months and Phase III tasks finishing no later than 48 months. The SOW must not include proprietary information. It is encouraged, though not required, to use the SOW template provided as **Attachment 2**.

For each task/subtask, provide:

- A detailed description of the approach to be taken to accomplish each defined task/subtask.
 - Identification of the primary organization responsible for task execution (prime contractor, subcontractor(s), consultant(s), by name).
 - A measurable milestone, i.e., a deliverable, demonstration, or other event/activity that marks task completion. Include completion dates for all milestones. Include quantitative metrics.
 - A definition of all deliverables (e.g., data, reports, software) to be provided to the Government in support of the proposed tasks/subtasks.
 - The SOW must clearly and separately define tasks associated with each Technical Area, Program Track, and Phase of the program is separately defined.
- I. Schedule and Milestones:** Provide a detailed schedule showing tasks (task name, duration, work breakdown structure element as applicable, performing organization), milestones, and the interrelationships among tasks. The task structure must be consistent

with that in the SOW. Measurable milestones should be clearly articulated and defined in time relative to the start of the project.

- J. Technology Transfer Plan:** Provide information regarding the types of partners (e.g., government, private industry) that will be pursued and submit a timeline with incremental milestones toward successful engagement. The plan should include a description of how DARPA will be included in the development of potential technology transfer relationships. If the Technology Transfer Plan includes the formation of a start-up company, a business development strategy must also be provided.

Section III. Additional Information

Provide a list of technical references cited in Section II of the proposal that document the technical ideas upon which the proposal is based. Copies of not more than three (3) papers germane to the technical proposal and important for documenting the feasibility of proposed approach may be included in the submission.

b. Volume II, Cost Management Proposal

Cover Sheet (Labeled “PROPOSAL: VOLUME II”):

1. BAA Number (HR001122S0029);
2. Lead Organization Submitting proposal;
3. Type of organization, selected among the following categories: “LARGE BUSINESS”, “SMALL DISADVANTAGED BUSINESS”, “OTHER SMALL BUSINESS”, “HBCU”, “MI”, “OTHER EDUCATIONAL”, OR “OTHER NONPROFIT”;
4. Proposer’s reference number (if any);
5. Other team members (if applicable) and type of business for each;
6. Proposal title;
7. Technical point of contact (Program Manager or Principal Investigator) to include: salutation, last name, first name, street address, city, state, zip code, telephone, fax (if available), electronic mail (if available);
8. Administrative point of contact (Contracting Officer or Award Officer) to include: salutation, last name, first name, street address, city, state, zip code, telephone, fax (if available), and electronic mail (if available);
9. Award instrument requested: cost-plus-fixed-fee (CPFF), cost-fee, cost sharing contract – no fee, or other type of procurement contract (*specify*), GRANT, cooperative agreement, or other transaction;
10. Place(s) of performance, including all subcontractors and consultants;
11. Period of performance;
12. Total funds requested from DARPA, total funds requested per phase (as defined in Table 1), and the amount of any cost share (if any);
13. Name, address, and telephone number of the proposer’s cognizant Defense Contract Management Agency (DCMA) administration office (*if known*);
14. Name, address, and telephone number of the proposer’s cognizant Defense Contract Audit Agency (DCAA) audit office (*if known*);

15. Date proposal was prepared;
16. Unique Entity Identifier (UEI) (<https://www.gsa.gov/about-us/organization/federal-acquisition-service/office-of-systems-management/integrated-award-environment-iae/iae-systems-information-kit/unique-entity-identifier-update>);
17. Taxpayer ID number (<https://www.irs.gov/Individuals/International-Taxpayers/Taxpayer-Identification-Numbers-TIN>);
18. Commercial and Government Entity (CAGE) code (<https://cage.dla.mil/Home/UsageAgree>);
19. Proposal validity period

NOTE: Non-conforming submissions that do not address BOTH Technical Areas and BOTH Program Tracks and/or follow the instructions herein may be rejected without further review.

The Government requires that proposers use the provided MS Excel™ DARPA Standard Cost Proposal Spreadsheet in the development of their cost proposals. A customized cost proposal spreadsheet may be an attachment to this solicitation. If not, the spreadsheet can be found on the DARPA website at <http://www.darpa.mil/work-with-us/contract-management> (under “Resources” on the right-hand side of the webpage). All tabs and tables in the cost proposal spreadsheet should be developed in an editable format with calculation formulas intact to allow traceability of the cost proposal. This cost proposal spreadsheet should be used by the prime organization and all subcontractors. In addition to using the cost proposal spreadsheet, the cost proposal still must include all other items required in this announcement that are not covered by the editable spreadsheet. Subcontractor cost proposal spreadsheets may be submitted directly to the Government by the proposed subcontractor via e-mail to the address in Part I of this solicitation. **Using the provided cost proposal spreadsheet will assist the Government in a rapid analysis of your proposed costs and, if your proposal is selected for a potential award, speed up the negotiation and award execution process.**

- (1) Total program, per phase (Phase I (Base); Phase II (Option); and Phase III (Option)), and per task cost broken down by major cost items to include:
 - i. **Direct labor** – provide an itemized breakout of all personnel, listed by name or TBD, with labor rate (or salary), labor hours (or percent effort), and labor category. All senior personnel must be identified by name.
 - ii. **Materials and Supplies** – itemized list which includes description of material, quantity, unit price, and total price. If a material factor is used based on historical purchases, provide data to justify the rate.
 - iii. **Equipment** – itemized list which includes description of equipment, unit price, quantity, and total price. Any equipment item with a unit price over \$5,000 must include a vendor quote.
 - iv. **Animal Use Costs** – itemized list of all materials, animal purchases, and per diem costs, associated with proposed animal use; include documentation supporting daily rates.
 - v. **Travel** – provide an itemized list of travel costs to include purpose of trips, departure and arrival destinations, projected airfare, rental car and per GSA approved diem, number of travelers, number of days); provide screenshots

from travel website for proposed airfare and rental car, as applicable; provide screenshot or web link for conference registration fee and note if the fee includes hotel cost. Conference attendance must be justified, explain how it is in the best interest of the project. **Plan for two (2) DARPA program review meetings per year.**

- vi. **Other Direct Costs (e.g., computer support, clean room fees)** – Should be itemized with costs or estimated costs. Backup documentation and/or a supporting cost breakdown is required to support proposed costs with a unit price over \$5,000. An explanation of any estimating factors, including their derivation and application, must be provided. Please include a brief description of the proposers’ procurement method to be used.
 - vii. **Other Direct Costs** – Consultants: provide executed Consultant Agreement that describes work scope, rate and hours.
 - viii. **Indirect costs** including, as applicable, fringe benefits, overhead, General and Administrative (G&A) expense, and cost of money (see university vs. company-specific requirements below).
 - ix. **Indirect costs specific to a University performer:** (1) **Fringe Benefit Rate** (provide current Department of Health and Human Services (DHHS) or Office of Naval Research (ONR) negotiated rate package; if calculated by other than a rate, provide University documentation identifying fringe costs by position or HR documentation if unique to each person); (2) **F&A Indirect Overhead Rate** (provide current DHHS or ONR negotiated rate package); (3) **Tuition Remission** (provide current University documentation justifying per-student amount); and (4) **Health Insurance/Fee** (provide current University documentation justifying per-student amount, if priced separately from fringe benefits with calculations included in the EXCEL cost file).
Indirect costs specific to a Company performer: (1) **Fee/Profit** (provide rationale for proposed fee/profit percentage using criteria found in DFARS 215.404-70); and (2) **Fringe Benefit/Labor OH/Material OH/G&A Rates** (provide current Forwarding Pricing Rate Proposal (FPRP) or DCMA/DCAA Forward Pricing Rate Recommendation or Agreement (FPRR or FPRA). If these documents are not available, provide company historical data, preferably two years but a minimum of one, to include both pool and expense costs used to generate the rates).
- (2) A summary of total program costs by phase I, II, and III and task.
- (3) An itemization of Subcontracts. All subcontractor cost proposal documentation must be prepared at the same level of detail as that required of the prime. Subcontractor proposals should include Interdivisional Work Transfer Agreements (IWTA) or evidence of similar arrangements (an IWTA is an agreement between multiple divisions of the same organization). The prime proposer is responsible for compiling and providing all subcontractor proposals for the Procuring Contracting Officer (PCO). The proposal must show how subcontractor costs are applied to each phase and task. If consultants are to be used, proposer must provide a consultant agreement or other document that verifies the proposed loaded daily/hourly rate.

- (4) An itemization of any information technology (IT) purchase (including a letter stating why the proposer cannot provide the requested resources from its own funding), as defined in FAR Part 2.101.
- (5) A summary of projected funding requirements by month for all phases of the project.
- (6) A summary of tasks that have animal or human use funding.
- (7) The source, nature, and amount of any industry cost-sharing. Where the effort consists of multiple portions that could reasonably be partitioned for purposes of funding, these should be identified as options with separate cost estimates for each.
- (8) Identification of pricing assumptions of which may require incorporation into the resulting award instrument (e.g., use of Government Furnished Property/Facilities/Information, access to Government Subject Matter Expert/s, etc.).
- (9) Any Forward Pricing Rate Agreement, DHHS rate agreement, other such approved rate information, or such documentation that may assist in expediting negotiations (if available).
- (10) Proposers with a Government acceptable accounting system who are proposing a cost-type contract must submit the DCAA document approving the cost accounting system.

Per FAR 15.403-4, certified cost or pricing data shall be required if the proposer is seeking a procurement contract award per the referenced threshold, unless the proposer requests and is granted an exception from the requirement to submit cost or pricing data. Certified cost or pricing data” are not required if the proposer proposes an award instrument other than a procurement contract (e.g., a grant, cooperative agreement, or other transaction.)

Subawardee Proposals

The awardee is responsible for compiling and providing all subawardee proposals for the Procuring Contracting Officer (PCO)/Grants Officer (GO)/Agreements Officer (AO), as applicable. Subawardee proposals should include Interdivisional Work Transfer Agreements (ITWA) or similar arrangements. Where the effort consists of multiple portions which could reasonably be partitioned for purposes of funding, these should be identified as options with separate cost estimates for each.

All proprietary subawardee proposal documentation, prepared at the same level of detail as that required of the awardee’s proposal and which cannot be uploaded with the proposed awardee’s proposal, shall be provided to the Government either by the awardee or by the subawardee organization when the proposal is submitted. Subawardee proposals submitted to the Government by the proposed subawardee should be submitted via e-mail to the address in Section I.

Other Transaction (OT) Requests

All proposers requesting an OT must include a detailed list of milestones for each phase of the program (I, II, and III). Each milestone must include the following:

- milestone description,
- completion criteria,
- due date, and

- payment/funding schedule (to include, if cost share is proposed, awardee and Government share amounts).

It is noted that, at a minimum, milestones should relate directly to accomplishment of program technical metrics as defined in the BAA and/or the proposer's proposal. Agreement type, expenditure or fixed-price based, will be subject to negotiation by the Agreements Officer. Do not include proprietary data.

4.2.3. Additional Proposal Information

Proprietary Markings

Proposers are responsible for clearly identifying proprietary information. Submissions containing proprietary information must have the cover page and each page containing such information clearly marked with a label such as "Proprietary" or "Company Proprietary." NOTE: "Confidential" is a classification marking used to control the dissemination of U.S. Government National Security Information as dictated in Executive Order 13526 and should not be used to identify proprietary business information.

Unclassified Submissions

DARPA anticipates that submissions received under this BAA will be unclassified. However, should a proposer wish to submit classified information, an *unclassified* e-mail must be sent to the BAA mailbox requesting submission instructions from the Technical Office Program Security Officer (PSO). If a determination is made that the award instrument may result in access to classified information, a Security Classification Guide (SCG) and/or DD Form 254 will be issued by DARPA and attached as part of the award.

Disclosure of Information and Compliance with Safeguarding Covered Defense Information Controls

The following provisions and clause apply to all solicitations and contracts; however, the definition of "controlled technical information" clearly exempts work considered fundamental research and therefore, even though included in the contract, will not apply if the work is fundamental research.

DFARS 252.204-7000, "Disclosure of Information"

DFARS 252.204-7008, "Compliance with Safeguarding Covered Defense Information Controls"

DFARS 252.204-7012, "Safeguarding Covered Defense Information and Cyber Incident Reporting"

The full text of the above solicitation provision and contract clauses can be found at

<http://www.darpa.mil/work-with-us/additional-baa#NPRPAC>.

Compliance with the above requirements includes the mandate for proposers to implement the security requirements specified by National Institute of Standards and Technology (NIST) Special Publication (SP) 800-171, "Protecting Controlled Unclassified Information in Nonfederal Information Systems and Organizations" (see

<https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.800-171r2.pdf>) and DoDI

8582.01 that are in effect at the time the solicitation is issued.

For awards where the work is considered fundamental research, the contractor will not have to implement the aforementioned requirements and safeguards. However, should the nature of the

work change during performance of the award, work not considered fundamental research will be subject to these requirements.

Human Subjects Research (HSR)/Animal Use

Proposers that anticipate involving human subjects or animals in the proposed research must comply with the approval procedures detailed at <http://www.darpa.mil/work-with-us/additional-baa>, to include providing the information specified therein as required for proposal submission.

Approved Cost Accounting System Documentation

Proposers that do not have a Cost Accounting Standards (CAS) compliant accounting system considered adequate for determining accurate costs that are negotiating a cost-type procurement contract must complete an SF 1408. For more information on CAS compliance, see <http://www.dcaa.mil/cas.html>. To facilitate this process, proposers should complete the SF 1408 found at <http://www.gsa.gov/portal/forms/download/115778> and submit the completed form with the proposal.

Small Business Subcontracting Plan

Pursuant to Section 8(d) of the Small Business Act (15 U.S.C. § 637(d)) and FAR 19.702(a)(1), each proposer who submits a contract proposal and includes subcontractors might be required to submit a subcontracting plan with their proposal. The plan format is outlined in FAR 19.704.

Section 508 of the Rehabilitation Act (29 U.S.C. § 749d)/FAR 39.2

All electronic and information technology acquired or created through this BAA must satisfy the accessibility requirements of Section 508 of the Rehabilitation Act (29 U.S.C. § 749d)/FAR 39.2.

Intellectual Property

All proposers must provide a good-faith representation that the proposer either owns or possesses the appropriate licensing rights to all intellectual property that will be utilized under the proposed effort.

For Procurement Contracts

Proposers responding to this BAA requesting procurement contracts will need to complete the certifications at DFARS 252.227-7017. See <http://www.darpa.mil/work-with-us/additional-baa> for further information. If no restrictions are intended, the proposer should state “none.” The table below captures the requested information:

Technical Data Computer Software To be Furnished With Restrictions	Summary of Intended Use in the Conduct of the Research	Basis for Assertion	Asserted Rights Category	Name of Person Asserting Restrictions
(LIST)	(NARRATIVE)	(LIST)	(LIST)	(LIST)

For All Non-Procurement Contracts

Proposers responding to this BAA requesting a Cooperative Agreement, Technology Investment Agreement, or Other Transaction for Prototypes shall follow the applicable rules and regulations governing these various award instruments, but, in all cases, should appropriately identify any potential restrictions on the Government's use of any Intellectual Property contemplated under the award instrument in question. This includes both Noncommercial Items and Commercial Items. Proposers are encouraged to use a format similar to that described in the section above. If no restrictions are intended, then the proposer should state "NONE."

System for Award Management (SAM) and Universal Identifier Requirements

All proposers must be registered in SAM unless exempt per FAR 4.1102. FAR 52.204-7, "System for Award Management" and FAR 52.204-13, "System for Award Management Maintenance" are incorporated into this solicitation. See <http://www.darpa.mil/work-with-us/additional-baa> for further information.

International entities can register in SAM by following the instructions in this link: https://www.fsd.gov/sys_attachment.do?sys_id=c08b64ab1b4434109ac5ddb6bc4bcbb8.

4.2.4. Submission Information

DARPA will acknowledge receipt of all submissions and assign an identifying control number that should be used in all further correspondence regarding the submission. DARPA intends to use electronic mail correspondence regarding HR001122S0029. Submissions may not be sent by fax or e-mail; any so sent will be disregarded.

Submissions will not be returned. An electronic copy of each submission received will be retained at DARPA and all other non-required copies destroyed. A certification of destruction may be requested, provided the formal request is received by DARPA within 5 days after notification that a proposal was not selected.

For abstract and proposal submission dates, see Part I., Overview Information. Submissions received after these dates and times may not be reviewed.

Abstracts and Full Proposals sent in response to HR001122S0029 may be submitted via DARPA's BAA Website (<https://baa.darpa.mil>). Visit the website to complete the two-step registration process. Submitters will need to register for an Extranet account (via the form at the URL listed above) and wait for two separate e-mails containing a username and temporary password. After accessing the Extranet, submitters may then create an account for the DARPA BAA website (via the "Register your Organization" link along the left side of the homepage), view submission instructions, and upload/finalize the abstract. Proposers using the DARPA BAA Website may encounter heavy traffic on the submission deadline date; it is highly advised that the submission process be started as early as possible.

All unclassified concepts submitted electronically through DARPA's BAA Website must be uploaded as zip files (.zip or .zipx extension). The final zip file should be no greater than 50 MB in size. Only one zip file will be accepted per submission. Classified submissions and proposals

requesting or cooperative agreements should NOT be submitted through DARPA's BAA Website (<https://baa.darpa.mil>), though proposers will likely still need to visit <https://baa.darpa.mil> to register their organization (or verify an existing registration) to ensure the BAA office can verify and finalize their submission.

Technical support for BAA Website may be reached at BAAT_Support@darpa.mil, and is typically available during regular business hours (9:00 AM- 5:00 PM EST Monday – Friday).

Proposers using the DARPA BAA Website may encounter heavy traffic on the submission deadline date; it is highly advised that the submission process be started as early as possible.

For Technology Investment Agreements only:

Proposers requesting Technology Investment Agreements (TIA) awarded under 10 U.S.C. § 4002 must include the completed form indicated below. This requirement only applies only to those who expect to receive a TIA as their ultimate award instrument.

The National Defense Authorization Act (NDAA) for FY 2019, Section 1286, directs the Secretary of Defense to protect intellectual property, controlled information, key personnel, and information about critical technologies relevant to national security and limit undue influence, including foreign talent programs by countries that desire to exploit United States' technology within the DoD research, science and technology, and innovation enterprise. This requirement is necessary for all research and research-related educational activities. The DoD is using the form below to collect the necessary information to satisfy these requirements.

The Research and Related Senior/Key Person Profile (Expanded) form, available on the Grants.gov website at https://apply07.grants.gov/apply/forms/sample/RR_KeyPersonExpanded_3_0-V3.0.pdf, will be used to collect the following information for all senior/key personnel, including Project Director/Principal Investigator and Co-Project Director/Co-Principal Investigator, whether or not the individuals' efforts under the project are funded by the DoD. The form includes 3 parts: the main form administrative information, including the Project Role, Degree Type and Degree Year; the biographical sketch; and the current and pending support. The biographical sketch and current and pending support are to be provided as attachments:

- Biographical Sketch: Mandatory for Project Directors (PD) and Principal Investigators (PI), optional, but desired, for all other Senior/Key Personnel. The biographical sketch should include information pertaining to the researchers:
 - Education and Training.
 - Research and Professional Experience.
 - Collaborations and Affiliations (for conflict of interest).
 - Publications and Synergistic Activities.
- Current and Pending Support: Mandatory for all Senior/Key Personnel including the PD/PI. This attachment should include the following information:

- A list of all current projects the individual is working on, in addition to any future support the individual has applied to receive, regardless of the source.
- Title and objectives of the other research projects.
- The percentage per year to be devoted to the other projects.
- The total amount of support the individual is receiving in connection to each of the other research projects or will receive if other proposals are awarded.
- Name and address of the agencies and/or other parties supporting the other research projects
- Period of performance for the other research projects.

Additional senior/key persons can be added by selecting the “Next Person” button at the bottom of the form. Note that, although applications without this information completed may pass Grants.gov edit checks, if DARPA receives an application without the required information, DARPA may determine that the application is incomplete and may cause your submission to be rejected and eliminated from further review and consideration under the solicitation. DARPA reserves the right to request further details from the applicant before making a final determination on funding the effort.

For Cooperative Agreements only:

Proposers requesting cooperative agreements must submit proposals through one of the following methods: (1) electronic upload per the instructions at <https://www.grants.gov/applicants/apply-for-grants.html> (DARPA-preferred); or (2) hard-copy mailed directly to DARPA. If proposers intend to use Grants.gov as their means of submission, then they must submit their entire proposal through Grants.gov; applications cannot be submitted in part to Grants.gov and in part as a hard-copy. Proposers using Grants.gov do not submit hard-copy proposals in addition to the Grants.gov electronic submission.

Submissions: In addition to the volumes and corresponding attachments requested elsewhere in this solicitation, proposers must also submit the three forms listed below.

Form 1: SF 424 Research and Related (R&R) Application for Federal Assistance, available on the Grants.gov website at https://apply07.grants.gov/apply/forms/sample/RR_SF424_2_0-V2.0.pdf. *This form must be completed and submitted.*

To evaluate compliance with Title IX of the Education Amendments of 1972 (20 U.S.C. § 1681 et.seq.), the Department of Defense (DoD) is collecting certain demographic and career information to be able to assess the success rates of women who are proposed for key roles in applications in science, technology, engineering or mathematics disciplines. In addition, the National Defense Authorization Act (NDAA) for FY 2019, Section 1286, directs the Secretary of Defense to protect intellectual property, controlled information, key personnel, and information about critical technologies relevant to national security and limit undue influence, including foreign talent programs by countries that desire to exploit United States’ technology within the DoD research, science and technology, and innovation enterprise. This requirement is necessary for all research and research-related educational activities. The DoD is using the two forms below

to collect the necessary information to satisfy these requirements. Detailed instructions for each form are available on Grants.gov.

Form 2: The Research and Related Senior/Key Person Profile (Expanded) form, available on the Grants.gov website at https://apply07.grants.gov/apply/forms/sample/RR_KeyPersonExpanded_3_0-V3.0.pdf, will be used to collect the following information for all senior/key personnel, including Project Director/Principal Investigator and Co-Project Director/Co-Principal Investigator, whether or not the individuals' efforts under the project are funded by the DoD. The form includes 3 parts: the main form administrative information, including the Project Role, Degree Type and Degree Year; the biographical sketch; and the current and pending support. The biographical sketch and current and pending support are to be provided as attachments:

- Biographical Sketch: Mandatory for Project Directors (PD) and Principal Investigators (PI), optional, but desired, for all other Senior/Key Personnel. The biographical sketch should include information pertaining to the researchers:
 - Education and Training.
 - Research and Professional Experience.
 - Collaborations and Affiliations (for conflict of interest).
 - Publications and Synergistic Activities.
- Current and Pending Support: Mandatory for all Senior/Key Personnel including the PD/PI. This attachment should include the following information:
 - A list of all current projects the individual is working on, in addition to any future support the individual has applied to receive, regardless of the source.
 - Title and objectives of the other research projects.
 - The percentage per year to be devoted to the other projects.
 - The total amount of support the individual is receiving in connection to each of the other research projects or will receive if other proposals are awarded.
 - Name and address of the agencies and/or other parties supporting the other research projects
 - Period of performance for the other research projects.

Additional senior/key persons can be added by selecting the “Next Person” button at the bottom of the form. Note that, although applications without this information completed may pass Grants.gov edit checks, if DARPA receives an application without the required information, DARPA may determine that the application is incomplete and may cause your submission to be rejected and eliminated from further review and consideration under the solicitation. DARPA reserves the right to request further details from the applicant before making a final determination on funding the effort.

Form 3: Research and Related Personal Data, available on the Grants.gov website at https://apply07.grants.gov/apply/forms/sample/RR_PersonalData_1_2-V1.2.pdf. *Each applicant must complete the name field of this form, however, provision of the demographic information is*

voluntary. Regardless of whether the demographic fields are completed or not, this form must be submitted with at least the applicant's name completed.

Grants.gov Submissions: Grants.gov requires proposers to complete a one-time registration process before a proposal can be electronically submitted. First-time registration can take between three business days and four weeks. For more information about registering for Grants.gov, see <http://www.darpa.mil/work-with-us/additional-baa>.

Proposal abstracts will not be accepted if submitted via Grants.gov.

Hard copy Submissions: Proposers electing to submit cooperative agreement proposals as hard copies must complete the SF 424 R&R form (Application for Federal Assistance), available on the Grants.gov website (https://apply07.grants.gov/apply/forms/sample/SF424_2_1-V2.1.pdf).

Failure to comply with the submission procedures may result in the submission not being evaluated. DARPA will acknowledge receipt of complete submissions via e-mail and assign control numbers that should be used in all further correspondence regarding proposals.

4.3. FUNDING RESTRICTIONS

Not applicable.

4.4. OTHER SUBMISSION INFORMATION

DARPA will post a consolidated Frequently Asked Questions (FAQ) document. To access the posting go to <http://www.darpa.mil/work-with-us/opportunities>. A link to the FAQ will appear under the HR001122S0029 summary. Submit your question(s) via e-mail to BRACE@darpa.mil.

5. Application Review Information

5.1. EVALUATION CRITERIA

Proposals will be evaluated using the following criteria, listed in descending order of importance: 5.1.1 Overall Scientific and Technical Merit; 5.1.2 Potential Contribution and Relevance to the DARPA Mission; 5.1.3 Cost Realism; 5.1.4 Realism of Proposed Schedule; and 5.1.5 Proposer's Capability and/or Related Experience.

5.1.1. Overall Scientific and Technical Merit

The proposed technical approach is innovative, feasible, achievable, and complete.

The proposed technical team has the expertise and experience to accomplish the proposed tasks. Task descriptions and associated technical elements provided are complete and in a logical sequence with all proposed deliverables clearly defined such that a final outcome that achieves the goal can be expected as a result of award. The proposal identifies major technical risks, and planned mitigation efforts are clearly defined and feasible. The timeline for achieving major milestones is aggressive but rationally supported with a clear description of the requirements and risks. The proposer's prior experience in similar efforts must clearly demonstrate an ability to deliver products that meet the proposed technical performance within the proposed budget and schedule. The proposed team has the expertise to manage the cost and schedule.

5.1.2. Potential Contribution and Relevance to the DARPA Mission

The potential contributions of the proposed effort are relevant to the national technology base. Specifically, DARPA's mission is to make pivotal early technology investments that create or prevent strategic surprise for U.S. National Security.

5.1.3. Cost Realism

The proposed costs are realistic for the technical and management approach and accurately reflect the technical goals and objectives of the solicitation. The proposed costs are consistent with the proposer's Statement of Work and reflect a sufficient understanding of the costs and level of effort needed to successfully accomplish the proposed technical approach. The costs for the prime proposer and proposed subawardees are substantiated by the details provided in the proposal (e.g., the type and number of labor hours proposed per task, the types and quantities of materials, equipment and fabrication costs, travel and any other applicable costs and the basis for the estimates).

It is expected that the effort will leverage all available relevant prior research in order to obtain the maximum benefit from the available funding. For efforts with a likelihood of commercial application, appropriate direct cost sharing may be a positive factor in the evaluation. DARPA recognizes that undue emphasis on cost may motivate proposers to offer low-risk ideas with minimum uncertainty and to staff the effort with junior personnel in order to be in a more competitive posture. DARPA discourages such cost strategies.

5.1.4. Realism of Proposed Schedule

The proposed schedule aggressively pursues performance metrics in the shortest timeframe and accurately accounts for that timeframe. The proposed schedule identifies and mitigates any potential schedule risk.

5.1.5. Proposer's Capabilities and/or Related Experience

The proposer's prior experience in similar efforts clearly demonstrates an ability to deliver products that meet the proposed technical performance within the proposed budget and schedule. The proposed team has the expertise to manage the cost and schedule. Similar efforts completed/ongoing by the proposer in this area are fully described, including identification of other Government sponsors.

5.2. REVIEW OF PROPOSALS

Review Process

It is the policy of DARPA to ensure impartial, equitable, comprehensive proposal evaluations based on the evaluation criteria listed in Section V.A. and to select the source (or sources) whose offer meets the Government's technical, policy, and programmatic goals.

DARPA will conduct a scientific/technical review of each conforming proposal. Conforming proposals comply with all requirements detailed in this solicitation; proposals that fail to do so may be deemed non-conforming and may be removed from consideration. Proposals will not be evaluated against each other since they are not submitted in accordance with a common work

statement. DARPA's intent is to review proposals as soon as possible after they arrive; however, proposals may be reviewed periodically for administrative reasons.

Award(s) will be made to proposers whose proposals are determined to be the most advantageous to the Government, consistent with instructions and evaluation criteria specified in the BAA herein, and availability of funding.

Handling of Source Selection Information

DARPA policy is to treat all submissions as source selection information (see FAR 2.101 and 3.104) and to disclose their contents only for the purpose of evaluation. Restrictive notices notwithstanding, during the evaluation process, submissions may be handled by support contractors for administrative purposes and/or to assist with technical evaluation. All DARPA support contractors performing this role are expressly prohibited from performing DARPA-sponsored technical research and are bound by appropriate non-disclosure agreements.

Subject to the restrictions set forth in FAR 37.203(d), input on technical aspects of the proposals may be solicited by DARPA from non-Government consultants/experts who are strictly bound by the appropriate non-disclosure requirements.

Federal Awardee Performance and Integrity Information (FAPIS)

Per 41 U.S.C. § 2313, as implemented by FAR 9.103 and 2 C.F.R. § 200.205, prior to making an award above the simplified acquisition threshold, DARPA is required to review and consider any information available through the designated integrity and performance system (currently FAPIS). Awardees have the opportunity to comment on any information about themselves entered in the database, and DARPA will consider any comments, along with other information in FAPIS or other systems, prior to making an award.

Countering Foreign Influence Program (CFIP)

DARPA's CFIP is an adaptive risk management security program designed to help protect the critical technology and performer intellectual property associated with DARPA's research projects by identifying the possible vectors of undue foreign influence. The CFIP team will create risk assessments of all proposed Senior/Key Personnel selected for negotiation of a fundamental research grant or cooperative agreement award. The CFIP risk assessment process will be conducted separately from the DARPA scientific review process and adjudicated prior to final award.

6. Award Administration Information

6.1. SUBMISSION STATUS NOTIFICATIONS

Proposal Abstracts and Full Proposals submitted in response to HR001122S0029 will be evaluated following the submission deadlines listed in Part 1. DARPA will respond as described below. These official notifications will be sent via e-mail to the Technical Point of Contact (POC) and/or Administrative POC identified on the submission coversheet.

6.1.1. Proposal Abstracts

DARPA will respond to abstracts with a statement as to whether DARPA is interested in the idea. If DARPA does not recommend the proposer submit a full proposal, DARPA will provide feedback to the proposer regarding the rationale for this decision. Regardless of DARPA's response to an abstract, proposers may submit a full proposal. DARPA will review all conforming full proposals using the published evaluation criteria and without regard to any comments resulting from the review of an abstract.

6.1.2. Full Proposals

As soon as the evaluation of a proposal is complete, the proposer will be notified that (1) the proposal has been selected for funding pending award negotiations, in whole or in part, or (2) the proposal has not been selected.

6.2. ADMINISTRATIVE AND NATIONAL POLICY REQUIREMENTS

6.2.1. Meeting and Travel Requirements

There will be a program kickoff meeting in the Arlington, Virginia vicinity, and all key participants are required to attend. Performers should also anticipate regular program-wide Principal Investigator meetings and periodic site visits at the Program Manager's discretion to the Arlington, Virginia vicinity. Proposers shall include within the content of their proposal details and costs of any travel or meetings they deem to be necessary throughout the course of the effort, to include periodic status reviews by the government.

6.2.2. Solicitation Provisions and Award Clauses, Terms and Conditions

Solicitation clauses in the FAR and DFARS relevant to procurement contracts and FAR and DFARS clauses that may be included in any resultant procurement contracts are incorporated herein and can be found at <http://www.darpa.mil/work-with-us/additional-baa>.

6.2.3. Controlled Unclassified Information (CUI) and Controlled Technical Information (CTI) on Non-DoD Information Systems

Further information on Controlled Unclassified Information on Non-DoD Information Systems is incorporated herein can be found at <http://www.darpa.mil/work-with-us/additional-baa>.

6.2.4. Representations and Certifications

In accordance with FAR 4.1102 and 4.1201, proposers requesting a procurement contract must complete electronic annual representations and certifications at <https://www.sam.gov/>.

In addition, all proposers are required to submit for all award instrument types supplementary DARPA-specific representations and certifications at the time of proposal submission. See <http://www.darpa.mil/work-with-us/rep-cert> for further information on required representation and certification depending on your requested award instrument.

6.2.5. Terms and Conditions

For terms and conditions specific to grants and/or cooperative agreements, see the DoD General Research Terms and Conditions (latest version) at <http://www.onr.navy.mil/Contracts-Grants/submit-proposal/grants-proposal/grants-terms-conditions> and the supplemental DARPA-

specific terms and conditions at <http://www.darpa.mil/work-with-us/contract-management#GrantsCooperativeAgreements>.

6.3. REPORTING

The number and types of reports will be specified in the award document, but will include as a minimum monthly financial status reports, 6-week technical status reports, and quarterly technical status reports. The reports shall be prepared and submitted in accordance with the procedures contained in the award document and mutually agreed on before award. Reports and briefing material will also be required as appropriate to document progress in accomplishing program metrics. A Final Report that summarizes the project and tasks will be required at the conclusion of the performance period for the award, notwithstanding the fact that the research may be continued under a follow-on vehicle.

6.4. ELECTRONIC SYSTEMS

6.4.1. Wide Area Work Flow (WAWF)

Performers will be required to submit invoices for payment directly to <https://wawf.eb.mil>, unless an exception applies. Performers must register in WAWF prior to any award under this BAA.

6.4.2. I-EDISON

The award document for each proposal selected for funding will contain a mandatory requirement for patent reports and notifications to be submitted electronically through i-Edison (<http://public.era.nih.gov/iedison>).

7. Agency Contacts

Administrative, technical or contractual questions should be sent via e-mail to the mailbox listed below.

Points of Contact

The BAA Coordinator for this effort may be reached at:

BRACE@darpa.mil

DARPA/BTO

ATTN: HR001122S0029

675 North Randolph Street

Arlington, VA 22203-2114

For information concerning agency level protests see <http://www.darpa.mil/work-with-us/additional-baa#NPRPAC>.

8. Other Information

8.1. PROPOSERS DAY

DARPA will host a virtual Proposers Day in support of the BRACE program on **April 13, 2022**. The purpose is to provide potential proposers with information on the BRACE program, promote additional discussion on this topic, address questions, provide a forum to present their capabilities, and encourage team formation.

Interested proposers are not required to attend to respond to the BRACE BAA, and relevant information and materials discussed at Proposers Day will be made available to all potential proposers in the form of a FAQ posted on the DARPA Opportunities Page.

DARPA will not provide cost reimbursement for interested proposers in attendance. An online registration form and various other meeting details can be found at the registration website, <https://events.sa-meetings.com/BRACEProposersDay>.

Participants are required to register no later than **April 8, 2022**. This event is not open to the Press. The Proposers Day will be open to members of the public who have registered in advance for the event; there will be no onsite registration.

Proposers Day Point of Contact:

BRACE@darpa.mil

ATTN: DARPA-SN-22-31

8.2. ASSOCIATE CONTRACTOR AGREEMENT (ACA)

This same or similar language may be included in procurement contract awards against HR001122S0029. Awards other than FAR based contracts may contain similar agreement language:

(a) It is recognized that success of the BRACE research effort depends in part upon the open exchange of information between the various Associate Contractors involved in the effort. This language is intended to ensure that there will be appropriate coordination and integration of work by the Associate Contractors to achieve complete compatibility and to prevent unnecessary duplication of effort. By executing this contract, the Contractor assumes the responsibilities of an Associate Contractor. For the purpose of this ACA, the term Contractor includes subsidiaries, affiliates, and organizations under the control of the contractor (e.g., subcontractors).

(b) Work under this contract may involve access to proprietary or confidential data from an Associate Contractor. To the extent that such data is received by the Contractor from any Associate Contractor for the performance of this contract, the Contractor hereby agrees that any proprietary information received shall remain the property of the Associate Contractor and shall be used solely for the purpose of the BRACE research effort. Only that information which is received from another contractor in writing and which is clearly identified as proprietary or confidential shall be protected in accordance with this provision. The obligation to retain such information in confidence will be satisfied if the Contractor receiving such information utilizes the same controls as it employs to avoid disclosure, publication, or dissemination of its own

proprietary information. The receiving Contractor agrees to hold such information in confidence as provided herein so long as such information is of a proprietary/confidential or limited rights nature.

(c) The Contractor hereby agrees to closely cooperate as an Associate Contractor with the other Associate Contractors on this research effort. This involves as a minimum:

- (1) maintenance of a close liaison and working relationship;
- (2) maintenance of a free and open information network with all Government-identified associate Contractors;
- (3) delineation of detailed interface responsibilities;
- (4) entering into a written agreement with the other Associate Contractors setting forth the substance and procedures relating to the foregoing, and promptly providing the Agreements Officer/Procuring Contracting Officer with a copy of same; and,
- (5) receipt of proprietary information from the Associate Contractor and transmittal of Contractor proprietary information to the Associate Contractors subject to any applicable proprietary information exchange agreements between associate contractors when, in either case, those actions are necessary for the performance of either.

(d) In the event that the Contractor and the Associate Contractor are unable to agree upon any such interface matter of substance, or if the technical data identified is not provided as scheduled, the Contractor shall promptly notify the DARPA BRACE Program Manager. The Government will determine the appropriate corrective action and will issue guidance to the affected Contractor.

(e) The Contractor agrees to insert in all subcontracts hereunder which require access to proprietary information belonging to the Associate Contractor, a provision which shall conform substantially to the language of this ACA, including this paragraph (e).

(f) Associate Contractors for the BRACE research effort include:

9. APPENDIX 1 – Volume II checklist

Volume II, Cost Proposal Checklist and Sample Templates

The following checklist and sample templates are provided to assist the proposer in developing a complete and responsive cost volume. Full instructions appear in Section 4.2.2 of HR001120S0029. This worksheet must be included with the coversheet of the Cost Proposal.

1. Are all items from Section 4.2.2 (Volume II, Cost Proposal) of **HR001120S0029** included on your Cost Proposal cover sheet?
 YES NO Appears on Page(s) [Type text]
If reply is “No”, please explain:

2. Does your Cost Proposal include (1) a summary cost buildup by Phase, (2) a summary cost buildup by Year, and (3) a detailed cost buildup of for each Phase that breaks out each task and shows the cost per month?
 YES NO Appears on Page(s) [Type text]
If reply is “No”, please explain:

3. Does your cost proposal (detailed cost buildup #3 above in item 2) show a breakdown of the major cost items listed below:
Direct Labor (Labor Categories, Hours, Rates)
 YES NO Appears on Page(s) [Type text]

Indirect Costs/Rates (i.e., overhead charges, fringe benefits, G&A)
 YES NO Appears on Page(s) [Type text]

Materials and/or Equipment
 YES NO Appears on Page(s) [Type text]

Subcontracts/Consultants
 YES NO Appears on Page(s) [Type text]

Other Direct Costs
 YES NO Appears on Page(s) [Type text]

Travel
 YES NO Appears on Page(s) [Type text]

If reply is “No”, please explain:

4. Have you provided documentation for proposed costs related to travel, to include purpose of trips, departure and arrival destinations and sample airfare?
 YES NO **Appears on Page(s)** [Type text]

If reply is “No”, please explain:

5. Does your cost proposal include a complete itemized list of all material and equipment items to be purchased (a priced bill-of-materials (BOM))?
 YES NO **Appears on Page(s)** [Type text]

If reply is “No”, please explain:

6. Does your cost proposal include vendor quotes or written engineering estimates (basis of estimate) for all material and equipment with a unit price exceeding \$5000?
 YES NO **Appears on Page(s)** [Type text]

If reply is “No”, please explain:

7. Does your cost proposal include a clear justification for the cost of labor (written labor basis-of-estimate (BOE)) providing rationale for the labor categories and hours proposed for each task?
 YES NO **Appears on Page(s)** [Type text]

If reply is “No”, please explain:

8. Do you have subcontractors/consultants? If YES, continue to question 9. If NO, skip to question 13.
 YES NO **Appears on Page(s)** [Type text]

9. Does your cost proposal include copies of all subcontractor/consultant technical (to include Statement of Work) and cost proposals?
 YES NO **Appears on Page(s)** [Type text]

If reply is “No”, please explain:

10. Do all subcontract proposals include the required summary buildup, detailed cost buildup, and supporting documentation (SOW, Bill-of-Materials, Basis-of-Estimate, Vendor Quotes, etc.)?
 YES NO **Appears on Page(s)** [Type text]

If reply is “No”, please explain:

11. Does your cost proposal include copies of consultant agreements, if available?
 YES NO **Appears on Page(s)** [Type text]

If reply is “No”, please explain:

12. If requesting a FAR-based contract, does your cost proposal include a tech/cost analysis for all proposed subcontractors?
 YES NO **Appears on Page(s)** [Type text]

If reply is “No”, please explain:

13. Have all team members (prime and subcontractors) who are considered a Federally Funded Research & Development Center (FFRDC), included documentation that clearly demonstrates work is not otherwise available from the private sector AND provided a letter on letterhead from the sponsoring organization citing the specific authority establishing their eligibility to propose to Government solicitations and compete with industry, and compliance with the associated FFRDC sponsor agreement and terms and conditions.
- YES NO **Appears on Page(s)** [Type text]

If reply is “No”, please explain:

14. Does your proposal include a response regarding Organizational Conflicts of Interest?
- YES NO **Appears on Page(s)** [Type text]

If reply is “No”, please explain:

15. Does your proposal include a completed Data Rights Assertions table/certification?
- YES NO **Appears on Page(s)** [Type text]

If reply is “No”, please explain: