University Consortium for Applied Hypersonics:

PROJECT CALL

RWP/RPP NUMBERS: TEES/JHTO-RPP-2020-001

Project Call Release Date	November 17, 2020
RWP/RPP Questions Cutoff	December 2, 2020
Phase 1: White Paper Submission Deadline	December 14, 2020 (5:00 PM CST)
Notification of White Paper Evaluations	January 18, 2021
Phase 2: Prototype Proposal Submission Deadline	February 22, 2021 (5:00 PM CST)
Award Notifications	March 29, 2021
Projected Project Start Date	August 1, 2021
Period of Performance	Up to 3 Years
Funding Award Ceiling	Up to $500,000 / year

TO APPLY TO THIS PROJECT CALL, YOUR UNIVERSITY'S AUTHORIZED ORGANIZATIONAL REPRESENTATIVE WILL NEED TO CREATE AN ACCOUNT AND SUBMIT WHITE PAPER/PROPOSAL DOCUMENTS THROUGH THE UNIVERSITY CONSORTIUM FOR APPLIED HYPERSONICS (UCAH) WEBSITE,

https://hypersonics.tamu.edu

WHITE PAPERS/PROPOSALS WILL BE RECEIVED UNTIL THE ABOVE DEADLINE. IF YOU ENCOUNTER ANY ISSUES OR CONCERNS WITH YOUR SUBMISSION, PLEASE EMAIL ucah@tamu.edu. QUESTIONS REGARDING THE CONTENT OF THE RWP/RPP MUST BE POSED THROUGH THE UCAH WEBSITE ABOVE.

CONTENTS

1. PROJECT OVERVIEW

Funding Opportunity Title: University Consortium for Applied Hypersonics (UCAH) Project Call (TEES/JHTO-RPP-2020-001).

Dates: Questions regarding the RWP/RPP may be emailed to UCAH@tamu.edu through **December 2, 2020 at 5:00 PM (CST).** Responses to the questions will be posted on the UCAH website (https://hypersonics.tamu.edu). Questions and responses to questions regarding White Papers will be made available to all proposers.

Phase 1: Project white paper submissions must be submitted through the UCAH website proposal call link and **must be received no later than December 14th, 2020 at 5:00 PM (CST).** Submissions received after the deadline will not be considered. The Government is interested in receiving top applied research proposals; hence White Paper submissions are limited to three (3) per university[1], and a maximum of seven (7) Principal Investigators (PI) are authorized per proposal.

Phase 2: White papers will be evaluated and a Request for Prototype Proposal (RPP) may be issued to those which best meet the intent of the Office of the Undersecretary of Defense, Research and Engineering Joint Hypersonics Transition Office (OUSD(R&E)/JHTO), per Section 3.5 of this document. Principal Investigators whose White Papers were not selected for continuation to the prototype proposal phase will be notified. Prototype Project Proposal submissions must be submitted through the UCAH website proposal call link and must be **received no later than February 22, 2021 at 5:00 PM (CST).** Submissions received after the deadline will not be considered.

Submission Instructions: Proposal submission will be conducted utilizing the UCAH website. After creating an initial account (see https://hypersonics.tamu.edu), proposal teams can upload proposal documents. You should verify that the person authorized to submit proposals for your organization has completed registration well in advance of the submission deadline. To apply for grants on behalf of your organization, you will need the Authorized Organizational Representative (AOR) role. Proposal submissions cannot be accomplished before your organization is fully registered. The portal is the single point for submission.

Funding Opportunity Description: OUSD(R&E)/JHTO, in partnership with Texas A&M Engineering Experiment Station (TEES) and UCAH, is soliciting competitive white papers/proposals supporting hypersonic research and technology, per the defined Statement of Need (SON) in Section 2.1. JHTO reserves the right to select for prototype proposal and award all, some or none of the submissions made in response to this announcement. JHTO reserves the right to fund all, some or none of the proposals received under this solicitation. TEES and the JHTO provide no funding for direct reimbursement of white paper/proposal development costs.

Estimated Total Program Funding: Award Ceiling: Up to a three-year period of performance at $500,000 per year.

Applicant Eligibility: Applicant must be a university-affiliated UCAH Consortium Member by the time of proposal award on March 29, 2021.

[1] This does not preclude teaming between faculty members from different Universities, as long as no University submits more than three (3) White Papers, on which it is the lead.

Proposal awards are made under 10 U.S.C. § 2371b, and as such all awardees must meet at least one of the following conditions:

i. A least one nonprofit research institution or nontraditional defense partner is participating to a significant extent in the prototype project;

OR

ii. At least one-third of the total cost of the project is to be paid for out of funds provided by participants in the project.

Individuals supported by an awarded agreement as a result of this solicitation process must be U.S. citizens prior to award. Research projects may include ITAR or Distribution C information, which means that universities responding to this solicitation must be able to appropriately maintain and handle sensitive data. For more information, please contact Dr. Kevin Gamache (979.862.1965, krgamache@tamu.edu).

Affiliate Consortium Members, including Industry, University Affiliated Research Centers (UARCs), a University Affiliated Laboratory (UAL) and Federally Funded Research & Development Centers (FFRDCs), and universities (on a case by case basis) from Australia, Canada, New Zealand, and the United Kingdom are not eligible to respond to this solicitation but may team with an eligible principal bidder.

Teams are encouraged in all areas, to include with:

- Other universities;
- Industry;
- UARCs/FFRDCs;
- Minority Serving Institutions;
- Nontraditional Members.

Period of Performance: Three years with an anticipated start date no later than August 1, 2021.

Administrative and Evaluation Support: All submissions will be treated as "source selection information" as defined by 41 U.S.C. § 2101(7), and contents will be disclosed only in accordance with 41 U.S.C. § 2102. Nonetheless, during the evaluation process submissions may be handled by government support contractors, TEES personnel, and Consortium members for both administrative purposes and to support technical evaluations. All persons performing these roles are expressly prohibited from performing sponsored technical research and are bound by appropriate nondisclosure agreements.

2. PROJECT TOPIC DESCRIPTIONS

A Statement of Need (SON) will be issued for all Prototype Projects (PPs) in Section 2.1 and the submission process will begin with the Request for White Paper (RWP). White Papers (WPs) shall follow the format described in Section 3.2. Selections of WPs will follow the basis of selection summarized in Section 3.3. UCAH members are responsible for all expenses associated with responding to the RWPs.

2.1 Proposal Project Calls

OUSD(R&E)/JHTO in partnership with the UCAH are interested in receiving white papers and prototype proposals for the following areas:

2.1.1 Technology Area 1: Materials, Structures and Thermal Protection Systems

Topic 1: Non-Destructive Testing for Hypersonics Materials Manufacturing

Technology Discipline: MSM - Materials, Structures, and Manufacturing

Proposal Description: Materials variability in the production process can lead to failures in subcomponent tests and operational use. Proposals are sought for improved Non-Destructive Testing of raw materials (e.g., woven fabrics, resins, prepregs, etc.) and partially processed materials (e.g., "green" composites, and partially densified parts, unmachined billets, etc.) in the production of C/C and CMC materials in use for hypersonic system production and operational use. These improvements may include using standard techniques in new ways and the development of new methods. Voids, broken threads, and other defects in raw materials, partially processed materials, and final products can lead to ultimate failure of thermal protection systems and full vehicle failure while in operational use. The current state of the art approach to detect and identify defects is the use of x-ray computed tomography (CT), which is expensive, time-consuming, requires the component be taken out of the manufacturing process, and has limits on component size and resolution.

Proposals are sought for the development of novel NDT methods to quickly assess material and/or component quality, preferably without subcomponent size limitations and the ability to be used by skilled technicians on the factory floor. It is anticipated that testing to determine effects of defects and identify critical defects classes or sizes will be required. As a result, proposers are expected to be able to produce or collaborate with a partner that can produce C/C and CMC materials. NDT approaches that leverage artificial intelligence, machine learning and multi-scale physics-based computational modeling approaches to accelerate determination of relevant defects are welcome. As there is a need to be able to detect critical defects early in the manufacturing line to improve the ultimate quality of the products, proposed quality metrics should be able to quantify the amount, distribution, and types of defects that are acceptable/non-acceptable in the production process.

Topic 2: Joining and Sealing Technologies for Hypersonic Vehicle Materials

Technology Discipline: MSM - Materials, Structures, and Manufacturing

Proposal Description: Proposal Description: Bonding, joining and sealing technologies lag behind the development of materials used in the development and manufacture of hypersonic

vehicles, which operate in the hypersonic environment. Bonding, joining and sealing technologies are required to support the manufacture and repair of vehicles used in the hypersonic regime (1-time use and reusable vehicles). Any time there is a similar material or dissimilar materials (metal or composite) used in the vehicle there is a need for bonding and joining the materials together to minimize control, aerodynamic, and flow control issues. Additionally, there is the need for sealing between body materials and antenna structures, apertures, and non-structural repairs.

Proposals are sought to develop and mature bonding, joining and sealing technologies for hypersonic vehicle applications. Any solution must ensure that materials are compatible with Carbon/Carbon, Ceramic Matrix Composites, and high temperature metals and do not degrade the life and material response properties. Technologies used must not degrade ability to withstand weather and operational environments.

Topic 3: Seeker and Sensor Development for Hypersonic Vehicles

Technology Discipline: MSM - Materials, Structures, and Manufacturing

Proposal Description: Offensive and defensive hypersonic weapons require seekers and sensors to perform their mission against challenging targets while incurring significant SWaP limitations imposed by hypersonic airframe designs. At these speeds, traditional radomes, apertures, and windows do not perform well because of aerothermal induced ablation and heating. In particular, transmissivity properties are decreased and difficult to predict with potential impacts to weapon system effectiveness. Additionally, wavefront distortions induced by the heated windows can cause significant guidance perturbations. Aperture materials and window configurations are needed that can survive the high temperatures, support large a Fields-of-Regard and bandwidth, minimize transmission loss and self-emissions while achieving required measurement accuracies.

Proposals are being sought for the development of new materials and seeker/window configurations along with prediction and mitigation algorithms to improve system performance. In addition, methods to quickly and cheaply test the performance of the new concepts in flight representative configurations and conditions are desired to prove concepts early in system development. Any of the following areas of research are of particular interest:

1. New radome, aperture, and/or window materials, along with sensor configurations and mitigation algorithms that support SWaP constraints and performance requirements.
2. New manufacturing methodologies for advanced radomes, apertures, windows and antennae, and new integration techniques to enable incorporation into vehicles and structures, or robust methods to mitigate or compensate for these effects.
3. Method to accurately predict radome, aperture and/or window performance or the potential survivability impacts of radome, aperture, and/or window materials in a wide range of hypersonic flight conditions (speed, altitude, angle of attack, and environmental/weather conditions).
4. Methods to cheaply and quickly test radomes, apertures, and windows, in hypersonic flight representative conditions or test results emulating selected flight environments anchoring the M&S predictions.

Topic 4: Additively Manufactured Components for Hypersonic Vehicles

Technology Discipline: MSM - Materials, Structures, and Manufacturing

Proposal Description: Hypersonic vehicles rely on advanced high-temperature materials to protect them from the extreme temperatures experienced during flight. Because of this extreme

environment, material fabrication and machining need to produce reliable and robust material solutions. The combination of several factors can lead to the inability to manufacture advanced materials using additive manufacturing (AM).

Proposals are sought in one of two areas. The first area is the development of novel refractory alloys that are efficiently and affordably processable while at the same time can take advantage of the unique thermomechanical constraints associated with AM to give superior mechanical properties and improved component performance. The second area is the development of AM processes to improve the printability of difficult-to-print existing metal/ceramic refractories. Further research is needed to support the development of these metallurgical aspects related to AM mentioned above, specifically for materials used in hypersonic applications. Thorough attention should be paid to materials characterization and design of experiments to investigate how processing parameters impact mechanical properties for the materials of interest. Concepts utilizing artificial intelligence, machine learning and multi-scale physics-based computational modeling approaches to accelerate materials discovery, predict and optimize material properties, and guide component design are welcome. Ideally the proposer will collaborate with a hypersonic materials supplier to understand the current material trade space and to increase the likelihood of transition of technology developed under the proposed work.

2.1.2 Technology Area 2: Guidance, Navigation and Control

Topic 5: Control Methodology for Changing Aerodynamic Structures

Technology Discipline: NGC - Navigation, Guidance, and Control

Proposal Description: Hypersonic vehicle structures are under tremendous stress based on the extreme environment in their flight path. These stresses may contribute to structural changes to the vehicle which can create difficulties in maintaining precise control.

Proposals are being sought to develop novel control algorithms and actuation methodologies that are provably robust to maximize airframe performance in challenging environments. Hypersonic offensive and defensive weapons require robust, precise controls to achieve high acceleration levels with low time constants to accomplish their respective missions. Severe aero-thermal environments encountered by these vehicles can cause substantial, non-deterministic, time-varying distortion of the airframe outer mold line (OML), including the control surfaces, which introduces a significant amount of uncertainty into the controls problem. System response to its environment may lag due to control algorithm processing time or physical response of the controls (actuator, etc.). There is a need for novel control algorithms and actuation methodologies that are provably robust to maximize airframe performance in these challenging environments. Development of instrumentation, hardware, and algorithm concepts that allow a hypersonic vehicle to more quickly react to aerodynamic upsets based on intelligent sensing of its environment (attitude, vehicle state) are needed. Alternative control and actuation system concepts are sought to accomplish these objectives.

Topic 6: High Accuracy Hypersonic Trajectory Prediction

Technology Discipline: NGC - Navigation, Guidance, and Control

Proposal Description: Hypersonic vehicles typically require more complex guidance and controls due to ablation and other issues inherent in high-speed flight. Calculating and selecting optimal trajectories can present challenges to system designers.

Proposals are being sought to develop algorithms for very rapid high accuracy simulation of hypersonic vehicles for use in both operational software and general simulation. New methods must balance computational speed to accuracy, memory required, and incorporation of multi-physics effects. Recent work in numerical methods for differential equations has demonstrated orders-of-magnitude speed-ups in calculating trajectories of non-ballistic rocket vehicles for equivalent accuracy, with potential of further speed-ups through parameterizing solutions and fast perturbed solutions (e.g. simultaneously generating trajectories with different control surface deflections or state variation in tracks). Solutions that extend these methods beyond the simulation of kinematics of rocket vehicles to add aerothermodynamics, more complex guidance and controls, ablation and other issues inherent in hypersonic vehicles are of interest. Adaptation of these methods to support optimal trajectory selection, adaptive controls, multi-hypothesis tracking and other operationally useful capabilities are desired.

2.1.3 Technology Area 3: Air Breathing Propulsion

Topic 7: Robust Feedback Control of Coupled Inlet Operability

Technology Discipline: PROP - Propulsion

Proposal Description: The maximum combustor pressure dictates the optimal performance of the dual-mode cycle, which affects inlet/isolator unstart susceptibility due to excessive static-pressure conditions generated within the combustor. Hence, operating at the optimal pressure ratio, requires that the forebody/inlet/isolator compression system operate at states near unstart conditions underlying the need for a robust control system.

Proposals are being sought to design a control system with the ability to adaptively control combustion and simultaneously match the inlet/isolator unstart margins. Additional considerations include the need to accommodate for time-varying inputs induced by vehicle orientation, thermal/structural deformations, freestream fluctuations, engine-fuel system and sensor aberrations (as well as other sources). Therefore, it is desired that the adaptive-control system implement an uncertainty-based algorithm (using a Uncertainty Quantification framework) which is robust and fault tolerant.

Topic 8: Widening Flammability Limits of Solid Fuel for Air Breathing Applications

Technology Discipline: PROP - Propulsion

Proposal Description: Widening the flammability limit and increasing the performance of solid fuels used in ramjet/scramjet engines improves the operational range, provides the possibility of autoignition from incoming air alone, and ensures that the fuel characteristics can meet all practical operational requirements.

Proposals are being sought for experimental research to create a new solid fuel for airbreathing propulsion that could provide longer range for a constrained volume and wider flammability limits while maintaining or improving other key thermal and mechanical properties necessary for high-performance, high-speed operation. Baseline candidate fuels would be formulated with advanced solid fuels doped with additives that are hypothesized to produce greater mass fractions of low ignition temperature species to widen flammability limits. Secondary additives are included to the mixtures to maintain structural properties and promote efficient combustion of metal additives. Finally, various metal additives are considered to increase fuel density and improve performance.

2.1.4 Technology Area 4: Hypersonic Environments and Phenomenology

Topic 9: Directed Energy Radiation Interaction with Hypersonic Airflow

Technology Discipline: ENV – Hypersonic Environments

Proposal Description: Interaction between shock/boundary layer and impinging directed energy beams are loosely characterized and need to be addressed to support lethality studies of High-Power Microwave (HPM)/High Energy Laser (HEL) against hypersonic flight vehicles. Further reliable characterization and representative data are necessary for the assembly of a reliable database supporting mathematical models to model how different impinging beam characteristics (wavelengths, energy profile and magnitude, etc) interact with the ambient surrounding airflow and vehicle body. Mathematical, benchmarked models can support lethality analysis and design to maximize survivability and the design of countermeasures against hypersonic threats.

Proposals are sought to develop and validate a database characterizing the directed energy radiation and the hypersonic airflow, including ablation residues changing the thermochemistry balance at the reacting boundary layer. This database should have the non-dimensional flow parameters (e.g., Damkholer, Nusselt, Stanton, Reynolds, Prandtl, Peclet, Knudsen numbers, etc.), boundary/shock layer characteristics and composition (in equilibrium and non-equilibrium), and characterization of incoming radiation (e.g. wavelength, beam profile (pulsed/CW), Transverse Electromagnetic Mode (TEM), etc.). This database can lead to the development of a benchmarked model and numerical tools for the simulation of the interconnected phenomena leading to the development of future capabilities.

2.1.5 Technology Area 5: Applied Aerodynamics and Hypersonic Systems

Topic 10: Improved Methods for Development of Aerodynamic Databases

Technology Discipline: AERO - Applied Aerodynamics and Aerothermodynamics

Proposal Description: Aerodynamic databases for hypersonic vehicles are necessary to form the basis of our understanding and control of the systems aerodynamic performance. The creation of aerodynamic databases (forces, moments, stability derivatives) that features quantified uncertainties in these parameters utilizing only sparse source data (wind tunnel measurements or computational simulations) is a reality in system design.

Proposals are being sought that employ the creative use of machine learning, design of experiments, and statistics techniques to create completed databases from sparse sources of data which could include force/moment measurements and dynamic stability derivatives, flow visualization, high-rate surface data, laser diagnostics, etc. Approaches are sought along with insertion paths for inclusion of second order or nonlinear effects such as fluid/structure interaction, shock/boundary-layer interaction, jet interaction effects as reduced order models into routine use within aerodynamic databases. Methods are needed for anchoring complex multi-physics phenomena with high-fidelity simulations while incorporating them into rapidly deployable correlations or reduced order models that simulate these effects more robustly with increased computational throughput. Methods for development of complete aerodynamic databases within university facilities could be developed and demonstrated within the scope of the proposed research, as well as identification of transition paths of these methods to large scale T&E facilities/production tunnels.

Topic 11: Characterization, Modeling, and Validation of Divert and Attitude Jet Control for Hypersonic Vehicles

Technology Discipline: AERO - Applied Aerodynamics and Aerothermodynamics

Proposal Description: Hypersonic strike weapon interceptors must execute precise, rapid maneuvers over a wide battlespace. Propulsive control (such as divert and attitude control and thrust vector control) is a potential path for increased endo-atmospheric maneuverability but will result in interactions between the free stream flow over the flight body, attenuating or amplifying the forces and moments; consequently, the control system must effectively respond to maintain stability and precise control. Additionally, the interactions of control jets with traditional control surfaces may inhibit performance. The interaction of these jets may create a challenging unsteady flow environment along with interactions with the boundary layer and shocks in the vehicle flow field.

Proposals are sought to develop and validate models of these jet interactions, particularly in the near-space atmospheric regime. Moreover, aspects of beneficial airframe configurations and thruster placement to minimize or leverage jet interactions are desired. Development of models and computational fluid dynamics tools with refinement and validation of the models based on test data on nominal vehicle configurations is useful. Usable models of these interactions across a wide parameter space of altitudes, Mach numbers, dynamic pressures, including endoatmospheric conditions, would aid in more accurate predictions of these effects on hypersonic systems. Recommendations to improve design of these systems are also sought, to include proposed airframe integration and thruster placement, as well as concepts for control and feedback of these thruster systems. Unique concepts for experimental validation of computational predictions of these effects are sought.

Topic 12: Thermal Energy Harvest and Management

Technology Discipline: AERO - Applied Aerodynamics and Aerothermodynamics

Proposal Description: Hypersonic vehicles generate extreme kinetic energy. This energy can be beneficial for maneuvering, lethality, and speed. This energy may also challenge the system in terms of thermal management and the breakdown of the flow field molecular flow

Proposals are sought for concepts to manage and utilize thermal energy on board a hypersonic vehicle with emphasis on novel methods that could convert and transport the heat energy for other purposes more effectively. Such energy harvesting concepts could be used for charging vehicle batteries, increased fuel efficiency, powering of subsystems, etc. Proposals are also sought for novel thermal energy transport methods that meet acceptable size, weight, and power requirements within a hypersonic vehicle for active cooling of leading edges or structures, cooling of sensitive internal electronic components, or external windows.

Topic 13: Modeling, Simulation, and Testing of Separation Events

Technology Discipline: AERO - Applied Aerodynamics and Aerothermodynamics

Proposal Description: Hypersonic vehicle concepts can include separating boosters, protective shrouds, or internal stores to accomplish their mission. The multi-body physics of hypersonic flight can present significant challenges to system designers. Shock interactions, interference from forces resulting from separation, and interactions of the separating bodies are among the challenges for these multi-body problems.

Proposals are being sought to develop improved methods to model, simulate, and test complex hypersonic multi-body problems such as booster, submunition or shroud separation events, and development of models that are proven to simulate the behavior of the bodies during these events in the presence of appropriate dispersions (e.g. based on realistic uncertainties or experimental data).

Topic 14: Multi-Disciplinary Optimization

Technology Discipline: SEDA - Systems, Engineering, Design, and Analysis

Proposal Description: Proposals are being sought for the development of novel algorithms to be implemented as modules in optimization tools (for example, the missile Multi-Disciplinary Optimization tool ORION, which is MATLAB based). The goal is to expand our understanding of tradeoffs between subsystems in complex offensive and defensive hypersonic systems and to produce conceptual design studies and algorithms (software code, algorithm design documents) to optimize total system performance. Proposals are also sought for methods to optimize performance for flight (drag/stability, center of mass/center of control), sensor, internal thermal loading, control surfaces/guidance/maneuverability, launch loads (setback/setforward/ballasting), and offensive and defensive lethality. Investigation of ways to implement optimization for axisymmetric and non-axisymmetric geometry or subsystems are of value. Successful solutions should include conceptual design studies and software codes as deliverables.

2.1.6 Technology Area 6: Lethality and Energetics

Topic 15: Development of Coupled Machine Learning and Topology Optimization Processes

Technology Discipline: ORD - Ordnance

Proposal Description: "Generative design" software tools, such as topology optimization (TO), have the potential to: (a) increase the impact survivability and lethality of novel penetrator designs (e.g., cellular warheads) via a systematic, robust, and reliable design process; and (b) enable the design of more mass-efficient multi-functional structures with spatially-varying local and global properties (e.g., stiffness, strength, natural frequency, fluid permeability, thermal conductivity). However, current TO tools, designed for static or low-rate loads rather than the highly-dynamic loads encountered during penetration/perforation of complex targets, use conditions/approximations that may not be relevant to warhead design (e.g., linear-elastic and isotropic materials, static loadings, single physics, etc.). Additionally, TO tools suffer from numerical inefficiencies that can result in long solution times even with high-performance supercomputers.

Proposals are being sought to develop an efficient design framework, based on TO and machine learning (ML), for optimizing ordnance structures for multi-functional applications and dynamic (transient and aperiodic) loading conditions. Objectives may include the development of TO tools that incorporate multiple physics and integrate a time-resolved, finite element (FE) solver. Additional objectives may be to utilize physics-informed ML technologies to increase the speed of, and confidence in, design iterations. Machine Learning would enable faster analysis and selection of TO designs and aid in situations where the correlation between physics with TO inputs/outputs is unclear (e.g., additive manufacturing processing parameters correlated to material mechanical properties). Validation of these design tools by designing and fabricating prototypes via additive manufacturing and characterizing their performance through testing (e.g., impact

survivability via high-speed ballistic tests) is desirable. Solutions to this challenge align with OSD's Digital Engineering initiative, offering the ability to reduce the time and cost of design, development, test, and evaluation, and accelerate agile acquisition decisions.

Topic 16: Damage Mitigation and Evolution in Blast Explosive Formulations

Technology Discipline: ORD - Ordnance

Proposal Description: Energetic materials experience thermo-mechanical environments – such as extreme thermal cycling or high strain rate loading events -- that may affect their safe handling and performance. Thermal cycling in air-delivered weapons may lead to hysteresis of mechanical properties that become significant over time as damage accumulates. High strain rate loading due to penetration or perforation events may induce significant damage into an energetic system. That damage may result in undesirable auto-ignition or degraded system performance.

Proposals are being sought to address the following technical challenges:

(1) Development of experimental techniques that enable the quantification of thermo-mechanically induced damage as a function of loading event or history. Damage induced via high strain rate events consistent with perforation or penetration is of primary interest. These techniques should focus on the generation of semi-homogenous damage at length scales that will facilitate follow-on performance testing. Length scales may range from 10's of microns to several millimeters.

(2) Investigation of the effects of binder system and material microstructure on quasi-static and dynamic material properties with the objective of reducing incipient and hysteretic damage. We are most interested in proposals that initially focus on main fill blast explosives such as PAX-30 and AFX-808. Results of that work should guide the optimization of future formulations that simultaneously optimize blast performance and mechanical survivability of the main fill and surrounding weapon components such as the fuse.

2.1.7 Next Generation

Topic 17: Disruptive Technologies

Technology Discipline: Next-Gen

Proposal Description: The design, development, test and production of hypersonic vehicles requires making progress in complex, interwoven disciplines. This progress is often evolutionary and incremental. In soliciting for Next Generation Disruptive Technologies, we wish to open the door to the potential for revolutionary advancements, recognizing that research which might not typically be considered as 'hypersonics-related" may, with intuition and expertise, be leveraged in a manner that leapfrogs over technological roadblocks. We request proposals for research in related fields that have the potential to provide breakthroughs in our ability to design, develop, test and produce novel hypersonic systems.

3. PHASE 1. WHITE PAPER SUBMISSION AND EVALUATION

3.1 General Requirements

White papers should adhere to the following:

- Section I of the White Paper should be no more than 3 pages in length.
- Figures and tables must be numbered and, when referenced in the text, be referenced by that number. They should be of a size that is easily readable and may be in landscape orientation. They must be formatted to print on an 8.5 x 11 inch paper size.
- White papers will be single-spaced with 1 inch margins on all sides. Font should be Times New Roman font (11 point minimum). Smaller font may be used in figures and tables, but must be legible.
- White papers must be in portrait orientation except for figures, graphs, images and pictures.
- Number pages sequentially within each section of the proposal showing proposal section and page number.
- All major sections shall begin on a new page.
- Proposal language shall be English.
- No classified information shall be submitted with the proposal.
- All information that is considered to be a trade secret or proprietary information should be marked as such. Note that Government Contractors, TEES personnel, and other Consortium members may have access to this information for the purposes of administrative and evaluation support.

3.2 Format

White Papers should be formatted as follows:

Cover Page. The Cover page should include:

- Project Title
- Technical Area and Topic Number (from Section 2)
- Applicant Organization
- Primary Technical Point of Contact (POC), including name, address, phone and email contact information
- Co-PI(s) names and institutions
- Primary Business POC, including name, address, phone and email contact information
- Total Solution Rough Order of Magnitude price

- Date of Submission

Section I: Technical Requirements (3 pages maximum)

a. Background and Benefits of Proposed Solution as related to the Statement of Need

b. Technical Approach, including clearly defined prototype solution

c. Schedule and Deliverables

Section II: Pricing

The Joint Hypersonics Transition Office (JHTO), as the final decision-authority in making WP selections, will consider affordability. Therefore, each WP shall include a Rough Order of Magnitude (ROM) price and narrative required to meet the technical solutions described in the WP. This ROM price shall include, at a minimum, the estimated cost for labor, material/equipment, other direct costs and subcontracts. The ROM narrative shall provide details on the following cost categories:

a. Labor Rates: Provide the basis for which the estimated total labor hours were calculated, including generic labor categories, estimated rates and hours for those individuals.

b. Fringe Benefits: The proposal should show the rates and calculation of the costs.

c. Travel: The proposed travel cost should include the following for each trip: the purpose of the trip, origin and destination if known, approximate duration, the number of travelers, and the estimated cost per trip must be justified based on the organizations historical average cost per trip or other reasonable basis for estimation. Such estimates and the resultant costs claimed must conform to the applicable Federal cost principals. Proposed travel should include funds for the Program Review.

d. Material/Equipment: Provide a list of the materials/equipment required to meet the technical approach as described in the WP and the estimated cost.

e. Subawards/Subcontracts: Provide a description of the work to be performed by the subrecipient/ subcontractor. For each subaward, a detailed cost proposal is required to be submitted by the subrecipient(s).

f. Recipient Acquired Equipment or Facilities: Equipment and/or facilities are normally furnished by the Recipient. If acquisition of equipment and/or facilities is proposed, a justification for the purchase of the items must be provided. Provide an itemized list of all equipment and/ or facilities costs and the basis for the estimate (e.g., quotes, prior purchases, catalog price lists). Allowable items normally would be limited to research equipment not already available for the project. General purpose equipment (i.e., equipment not used exclusively for research, scientific or other technical activities, such as personal computers, laptops, office equipment) should not be requested unless they will be used primarily or exclusively for the project. For computer/laptop purchases and other general purpose equipment, if proposed, include a statement indicating how each item of equipment will be integrated into the program or used as an integral part of the research effort.

g. Other Direct Costs – Provide an itemized list of all remaining proposed other direct costs, such as Graduate Assistant tuition, laboratory fees, report and publication costs, and the basis for the estimate (e.g., quotes, prior purchases, catalog price lists).

h. Indirect Costs: Provide an estimate of the total indirect costs and provide data supporting how the estimate was calculated, including any estimated costs other than the labor and material equipment, i.e., overhead, G&A, etc.

Section III: Data Rights Assertions

Identify any intellectual property, patents and inventions in the proposed solution and associated restrictions on JHTO use of that intellectual property, patents and inventions. The following information shall be presented for all assertions:

a. Technical data, computer software, or patent to be furnished with restriction

b. Basis for assertion

c. Asserted rights category

d. Name of entity asserting restrictions

Section IV: Key Personnel:

a. Include a description of contributions and significance of each

b. One-page biosketch for each participant

c. Current and pending sponsored research projects for each participant

Section V: Bibliography and References Cited

Section VI: Security Requirements

a. Address any special security and classification requirements, as necessary.

Section VII: Facilities

Identify any facilities required for the proposed research and whether those facilities are organic to project participants' organizations or must be leased or purchased. Note whether facility availability is likely to impact project cost/schedule/performance.

Section VIII: Affirmation of Business Status Certification

a. Name of Business Entity

b. Proposed NAICS Code

c. Cage Code

d. SAM Expiration Date

e. Address

f. Business POC Name, Title, Phone and Email

3.3 Evaluation Factors for White Papers

JHTO will conduct an evaluation of all eligible WPs based on an integrated assessment of the following:

a. The degree to which the solution meets the requirements of the SON in Section 2.
   i. Does the proposal address the problem articulated by the SON?
   ii. Is the scope of the proposal sufficient to address the problem?

b. The degree to which the proposal is feasible.
   i. Is the proposal technically feasible?
   ii. Does the proposed research team have necessary experience and expertise?
   iii. Can the proposal be completed in the time constraints articulated in this solicitation?
   iv. Are required facilities and test equipment available for the effort?
   v. Is required security infrastructure in place, if required?

c. The degree to which data rights assertions impact use of project output.
   i. Do data right assertions restrict follow on use of information and data resulting from the project?

d. The degree to which project costs are reasonable for the effort being undertaken,
   i. Does the ROM fall within solicitation guidelines?
   ii. Is the funding reasonable for the effort being undertaken?

e. The degree to which the proposal meets the content and format requirements of the solicitation.
   i. Does the proposal include required technical, pricing, data rights and personnel information?
   ii. Does the proposal comply with formatting and page length requirements?

f. The degree to which the proposal leverages teaming with other institutions.
   i. Does the proposal include teaming with other academic institutions?
   ii. Does the proposal include teaming with industry?
   iii. Does the proposal include teaming with FFRDCs/UARCs?
   iv. Does the proposal include teaming with Minority Serving Institutions or Nontraditional Members?

g. Whether or not the proposal meets eligibility requirements stipulated in Section 1.
   i. Is the applicant a university-affiliated UCAH Consortium Member?
   ii. Is the applicant a U.S. citizen (must be prior to award)?
   iii. Does the proposal meet 10 U.S.C. § 2371b requirements?
      - Is at least one nonprofit research institution or nontraditional

defense partner participating in the project; or is at least one-third of the total cost of the project paid for out of funds provided by participants in the project?

3.4 Basis for Selection

JHTO plans to assess white papers according to the evaluation criteria in Section 3.3 and, based on that assessment, make a determination to:

- Select the white paper(s), or some portion of the white paper(s) as a basis for requesting a prototype proposal

Or

- Retain the white paper in a library for potential future requirements for the life of the Agreement.

When JHTO has made this determination, they will notify TEES who will issue a Request for Prototype Proposal to the author(s) of the selected white papers.

4. PHASE 2. PROTOTYPE PROPOSAL SUBMISSION AND EVALUATION

Phase 2 of the award process, Prototype Proposal submission and evaluation, will follow the evaluation process for Phase 1 discussed in section 3. The intent of the prototype proposal is to provide increased, contract-level fidelity to information provided in the previously-submitted white paper.

JHTO will issue a Request for Prototype Proposal (RPP) through TEES. TEES will assign a program specialist to assist each member with the proposal process and ensure that the required documents are completed properly. Prototype Proposals shall follow the format described in Section 4.1 and 4.2 and will be evaluated by JHTO based on the criteria in Section 4.3. UCAH consortium members are responsible for all expenses associated with responding to the RPPs.

4.1 General Requirements

Prototype Proposals should adhere to the following:

- Figures and tables must be numbered and, when referenced in the text, be referenced by that number. They should be of a size that is easily readable and may be in landscape orientation. They must be formatted to print on an 8.5 x 11 inch paper size.
- Prototype Proposals will be single-spaced with 1 inch margins on all sides. Font should be Times New Roman (11 point minimum). Smaller font may be used in figures and tables, but must be legible.
- Prototype Proposals must be in portrait orientation except for figures, graphs, images and pictures.
- Number pages sequentially within each section of the proposal showing proposal section and page number.
- All major sections shall begin on a new page.
- Proposal language shall be English.
- No classified information shall be submitted with the proposal.
- All information that is considered to be a trade secret or proprietary information should be marked as such. Note that Government Contractors, TEES personnel, and other Consortium members may have access to this information for the purposes of administrative and evaluation support.

4.2 Format

Prototype Proposals should be formatted as follows:

Cover Page. The Cover page should include:

- Prototype Project Title
- Technical Area and Topic Number (from Section 2)
- Applicant Organization

- Primary Technical Point of Contact (POC), including name, address, phone and email contact information
- Co-PI(s) names and institutions
- Primary Business POC, including name, address, phone and email contact information
- Facility Clearance Level (if required)
- Proposed Period of Performance
- Data Rights
- Date of submission
- Proposed Validity Date (must be valid for a minimum of ninety (90) days)

Section I: Statement of Work (12 pages maximum).

a. Abstract

b. Statement of Objectives

c. Research Narrative

i. Background and Benefits of Proposed Solution as related to the Statement of Need

ii. Technical approach, including clearly defined prototype solution

iii. Reporting and Delivery Requirements

iv. Schedule and Deliverables

d. Place of Performance

e. General Requirements to include Safety, Environmental, Security

f. Government Furnished Property/Equipment/Materials/High Performance Computing Requirements

g. Data Rights Assertions

Section II: Pricing

The Price Section shall provide sufficient detail to substantiate that the overall proposed price is realistic, reasonable, complete for the work proposed and reflects the best price for the prototype proposal. The Pricing Section shall also include a narrative explanation of proposed prices. For all team members that do not have Government-approved rates, their proposed rates shall represent the most favored customer rates.

a. Labor Rates: Provide the basis for which the estimated total labor hours were calculated, including generic labor categories, estimated rates and hours for those individuals.

b. Fringe Benefits: The proposal should show the rates and calculation of the costs.

c. Travel: The proposed travel cost should include the following for each trip: the purpose of the trip, origin and destination if known, approximate duration, the number of travelers, and the estimated cost per trip must be justified based on the organizations historical average cost per trip or other reasonable basis for estimation. Such estimates and the resultant costs claimed must conform to the applicable Federal cost principals. Proposed travel should include funds for the Program Review.

d. Material/Equipment: Provide a list of the materials/equipment required to meet the technical approach as described in the WP and the estimated cost.

e. Subawards/Subcontracts: Provide a description of the work to be performed by the subrecipient/ subcontractor. For each subaward, a detailed cost proposal is required to be submitted by the subrecipient(s).

f. Recipient Acquired Equipment or Facilities: Equipment and/or facilities are normally furnished by the Recipient. If acquisition of equipment and/or facilities is proposed, a justification for the purchase of the items must be provided. Provide an itemized list of all equipment and/ or facilities costs and the basis for the estimate (e.g., quotes, prior purchases, catalog price lists). Allowable items normally would be limited to research equipment not already available for the project. General purpose equipment (i.e., equipment not used exclusively for research, scientific or other technical activities, such as personal computers, laptops, office equipment) should not be requested unless they will be used primarily or exclusively for the project. For computer/laptop purchases and other general purpose equipment, if proposed, include a statement indicating how each item of equipment will be integrated into the program or used as an integral part of the research effort.

g. Other Direct Costs – Provide an itemized list of all remaining proposed other direct costs, such as Graduate Assistant tuition, laboratory fees, report and publication costs, and the basis for the estimate (e.g., quotes, prior purchases, catalog price lists).

h. Indirect Costs: Provide an estimate of the total indirect costs and provide data supporting how the estimate was calculated, including any estimated costs other than the labor and material equipment, i.e., overhead, G&A, etc.

You must provide a detailed budget justification for each year of the effort. You should clearly explain the need for each item. The entire budget justification and supporting documentation must be combined into a single file and attached to budget.

Section III: Milestone Payment Schedule

The Milestone Payment Schedule shall include the payable events for the prototype project. Each event shall include a description and proposed price for the event.

Section IV: Key Personnel:
Include a description of contributions and significance of each, highlight any updates from

the white paper. Indicate what percentage of their total available time each will devote to this project. Each resume shall be no more than two (2) pages in length. Current and pending sponsored research projects for each PI.

Section V: Bibliography and References Cited

Section VI: Facilities

Identify any facilities required for the proposed research and whether those facilities are organic to project participants' organizations or must be leased or purchased. Note whether facility availability is likely to impact project cost/schedule/performance.

Section VII: Security Requirements

a. Address any special security and classification requirements, as necessary.

Section VIII: Affirmation of Business Status Certification

If different from information submitted in the white paper, updated certifications for each participant shall be provided.

4.3 Evaluation of Proposals

JHTO will evaluate all proposals submitted in response to this RPP, with the expectation that multiple prototype proposals may exist for a given Statement of Need. JHTO reserves the right to award all, some or none of the prototype proposal submitted. TEES and the JHTO provide no funding for direct reimbursement of white paper/proposal development costs. Technical and cost proposals (or any other material) submitted in response to this solicitation will not be returned.

If JHTO determines to make an award, TEES will issue a Project Sub-agreement(s) to the selected UCAH consortium member.

JHTO will conduct an evaluation of all prototype proposals based on an integrated assessment of the following:

a. The degree to which the solution meets the requirements of the SON in Section 2.
    i. Does the proposal address the problem articulated by the SON?
    ii. Is the scope of the proposal sufficient to address the problem?
b. The degree to which the proposal is feasible.
    i. Is the proposal technically feasible?
    ii. Does the proposed research team have necessary experience and expertise?
    iii. Can the proposal be completed in the time constraints articulated in this solicitation?
    iv. Are required facilities and test equipment available for the effort?
    v. Is required security infrastructure in place, if required?
c. The degree to which data rights assertions impact use of project output.
    i. Do data right assertions restrict follow on use of information and data resulting from the project?

d. The degree to which project costs are reasonable for the effort being undertaken,
    i. Do the costs fall within solicitation guidelines?
    ii. Is the funding reasonable for the effort being undertaken?
e. The degree to which the proposal meets the content and format requirements of the solicitation.
    i. Does the proposal include required technical, pricing, data rights and personnel information?
    ii. Does the proposal comply with formatting and page length requirements?
f. The degree to which the proposal leverages teaming with other institutions.
    i. Does the proposal include teaming with other academic institutions?
    ii. Does the proposal include teaming with industry?
    iii. Does the proposal include teaming with FFRDCs/UARCs?
    iv. Does the proposal include teaming with Minority Serving Institutions or Nontraditional Members?
g. Whether or not the proposal meets eligibility requirements stipulated in Section 1.
    i. Is the applicant a university-affiliated UCAH Consortium Member?
    ii. Is the applicant a U.S. citizen (must be prior to award)?
    iii. Does the proposal meet 10 U.S.C. § 2371b requirements?
        - Is at least one nonprofit research institution or nontraditional defense partner participating in the project; or is at least one-third of the total cost of the project paid for out of funds provided by participants in the project?

4.4 Potential for Follow-On Production

1. In accordance with 10 U.S.C. 2371b(f), a Prototype Agreement issued under the overarching Other Transaction (OT) agreement[2], if successfully completed and competitively awarded, may result in the award of a follow-on production contract or transaction without the use of competitive procedures. Success metrics for each Prototype Proposal shall be defined in the individual prototype agreement and subsequent Project Sub Agreements (PSAs).

2. Per DoD Policy, the following definition of "successfully completed" shall apply to any Project Agreements: 'A transaction for a prototype project is complete upon the written determination of the appropriate approving official for the matter in question that efforts conducted under an OT-Prototype Project: (1) met the key technical goals of a project; (2) satisfied success metrics incorporated into the Prototype-OT; or (3) accomplished a particularly favorable or unexpected result that justifies the transition to production. Furthermore, successful completion can occur prior to the conclusion of a Prototype Project to allow the Government to transition any aspect of the prototype project determined to provide utility into production while other aspects of the

[2] The agreement under which the University Consortium for Applied Hypersonics is established and managed by TEES.

prototype project have yet to be completed.'

All Project Agreements issued under the overarching OT agreement shall set forth the conditions for successful completion in the SOW.

The language of paragraphs 1 and 2 of this section shall be incorporated into all solicitations for PAs, and all subsequent PAs and PSAs in order to allow for the option of non-competitive follow-on production.