Topic #20: High Temperature Silicon Carbide (SiC) Power Electronics

1. OBJECTIVE: Under this topic, the Government invites proposals for projects to explore the further development of efficient, high temperature SiC power electronics to be used in military vehicles that encompass hybrid electric mobility and power generation systems. The government desires SiC power electronics that can operate with coolant inlet temperatures at 100°C or higher. Increased coolant temperatures increase cooling efficiency and allow for reduced cooling system size. The power electronics developed must use the SiC power semiconductors to maximize efficiency, power density (kW/liter) and specific power (kW/kg), while maintaining or improving power converter reliability. The corresponding reductions in size and weight for the cooling system and the electrical power converter, along with increased cooling efficiency and power conversion efficiency will make vehicle electric and hybrid electric power systems smaller, lighter and more fuel-efficient.

2. DESCRIPTION:

a. This announcement seeks to develop and demonstrate efficient, high temperature SiC power electronics suitable for use in Army hybrid electric vehicles and vehicle electrical power systems. Offerors must respond to all five (5) of the Power Converter Types listed below. An Offeror's proposal must clearly and separately identify the proposed technical solution and cost for each of the five (5) Power Converter Types. All converters must be liquid cooled and have the capability of operating at full rated power with coolant inlet temperatures ≥100 0C. Offerors must develop and demonstrate power converters at the power levels and nominal electrical ratings indicated in the five Power Converter Types listed below. In addition, Offerors must seek to maximize efficiency, power density (kW/liter), and specific power (kW/kg). Offerors must develop the deliverables shown below to a TRL level 5 by the end of the contract, and must clearly substantiate improvements in power density, specific power, and efficiency. Prototype power converters will be delivered to TARDEC at the end of the period of performance for validation of system-level benefits.
* Note – Appendix A, which provides the TRL definitions, has been provided.

b. Power Converter Types:

1) Bidirectional battery to bus DC-DC Converter: 180 kW output, 650Vdc bus, 300Vdc battery; [1]
2) Bidirectional battery to bus DC-DC converter: 30 kW output, 300Vdc bus, 28Vdc battery; [2]
3) Inverter to supply high quality AC power at 50-60 Hz: 30 kW output, 300Vdc bus, with different outputs of 110V single phase, 220V single phase, and 208V 3-phase; [3]
4) Motor Drive Inverter: 50kW output, 650Vdc bus;
5) Traction Motor Drive Inverter: 200kW output, 650Vdc bus.

[1] Converter #1 must be capable of operating at battery voltage down to 250Vdc. When supplying power to the bus, converter #1 must regulate the bus voltage within +/- 5% of the nominal 650Vdc bus voltage, under steady-state conditions.

[2] Converter #2 must be capable of operating at battery voltage down to 20Vdc, and bus voltage down to 250Vdc.

[3] Inverter #3 must regulate AC output voltage within +/- 3% of the specified output voltage (110V, 220V 208V). The outputs of inverter #3 must be galvanically isolated from the DC inputs. AC output voltage must be user-selectable. Inverter #3 is required to produce only one output voltage at any given time, but must be capable of providing 30kW at any of the specified output voltages. The AC output frequency must be user-selectable to be either 50 Hz or 60 Hz.

PROPOSALS THAT REFLECT A "PARTIAL SOLUTION" TO THE TECHNICAL OBJECTIVE, OR DO NOT ADDRESS ALL FIVE (5) POWER CONVERTER TYPES, ARE NOT ACCEPTABLE. THE GOVERNMENT WILL CONSIDER ONLY THOSE PROPOSED PROJECTS THAT ADDRESS ALL ELEMENTS OF THE OBJECTIVE.

3. PROJECT DURATION AND ESTIMATED MAXIMUM FUNDING AVAILABLE:

a. **Period of Performance:** 24 months

b. **Funding.** Estimated Maximum Government funding available for Topic # 20 is $12.15M. The Government reserves the right to award part or all of an offeror's proposal resulting in one or multiple contracts (for various amounts, but the sum of multiple contract awards shall not exceed $12.15M) that may address one or more or all of the Power Converter Types listed at subparagraph 2.b of the Description section.

c. **Cost Ceiling/Share.** Proposed projects with costs to the Government exceeding the amount identified in b. immediately above will be determined unaffordable. The contractor may propose total project costs in excess of the Government funded cost ceiling only if the excess costs are to be funded by a cost sharing arrangement. Please note that a cost sharing arrangement is not a consideration for award; therefore, no evaluation preference will be given if a cost share arrangement is proposed.

4. MILESTONE SCHEDULE:

a. Discussion Timeframe: 2009 May 27 through 2009 Jun 10

b. Electronic Copies of Proposals Due: All proposals must be received by 3:00 p.m. local time on July 24, 2009

i. **Note:** Effective 13 FEB 2009, all proposals must be submitted using the ASFI Bid Response System (BRS), which may be accessed at https://acquisition.army.mil/asfi/default.cfm

ii. **Note to Offerors:**
Your attention is called to the solicitation closing date and time of July 24, 2009 at 3:00 p.m. local time. In accordance with FAR 52.208(a), offerors are responsible for submitting proposals so as to reach the Government office designated in the solicitation by the time specified. Any proposal received at the designated Government office after the exact time specified is "late" and will not be considered unless one of the exceptions is met at FAR 15.208(b). There is no "expected" or "target" length of time for proposal submission; size and content may be factors. Therefore offerors are strongly cautioned to submit their proposals allowing adequate time for submission.

iii. You will find Topic #20 for proposal submission by searching Contracting Opportunities for "TARBAATOPIC20." As reflected by the results of this search, proposals for Topic #20 may be uploaded via the ASFI BRS at the following URL:
https://acquisition.army.mil/asfi/solicitation_view.cfm?psolicitationnbr=TARBAATOPIC20

c. Estimated Award Date: 2009 Sep 14

5. SPECIAL NOTES: This effort is funded with Recovery Act funds and therefore any resulting contract(s) will be subject to additional reporting requirements as specified at www.recovery.gov and will include the following clauses:

- FAR 52.204-11, "American Recovery and Reinvestment Act – Reporting Requirements (Mar 2009)"
  - Clause requires each contractor to report on its use of Recovery Act funds under this contract, to include information on types and numbers of jobs created and jobs retained in the United States and outlying areas.
- FAR 52.203-15, "Whistleblower Protections Under the American Recovery & Reinvestment Act of 2009 (Mar 2009)"
- FAR 52.215-2 Alt I (Mar 2009), "Audit and Records – Negotiations"

6. POINTS OF CONTACT

a. TECHNICAL:

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Appendix A

TECHNICAL READINESS LEVELS				
TRL	**Definition**	**Hardware Description**	**Software Description**	**Exit Criteria**
1	Basic principles observed and reported.	Scientific knowledge generated underpinning hardware technology concepts/applications.	Scientific knowledge generated underpinning basic properties of software architecture and mathematical formulation.	Peer reviewed publication of research underlying the proposed concept/application.
2	Technology concept and/or application formulated.	Invention begins, practical application is identified but is speculative, no experimental proof or detailed analysis is available to support the conjecture.	Practical application is identified but is speculative, no experimental proof or detailed analysis is available to support the conjecture. Basic properties of algorithms, representations and concepts defined. Basic principles coded. Experiments performed with synthetic data.	Documented description of the application/concept that addresses feasibility and benefit.
3	Analytical and experimental critical function and/or characteristic proof of concept.	Analytical studies place the technology in an appropriate context and laboratory demonstrations, modeling and simulation validate analytical prediction.	Development of limited functionality to validate critical properties and predictions using non-integrated software components.	Documented analytical/experimental results validating predictions of key parameters.
4	Component and/or breadboard validation in laboratory environment.	A low fidelity system/component breadboard is built and operated to demonstrate basic functionality and critical test environments, and associated performance predictions are defined relative to the final operating environment.	Key, functionally critical, software components are integrated, and functionally validated, to establish interoperability and begin architecture development. Relevant Environments defined and performance in this environment predicted.	Documented test performance demonstrating agreement with analytical predictions. Documented definition of relevant environment.
5	Component and/or breadboard validation in relevant environment.	A medium fidelity system/component breadboard is built and operated to demonstrate overall performance in a simulated operational environment with realistic support elements that demonstrates overall performance in critical areas. Performance predictions are made for subsequent development phases.	End-to-end software elements implemented and interfaced with existing systems/simulations conforming to target environment. End-to-end software system, tested in relevant environment, meeting predicted performance. Operational environment performance predicted. Prototype implementations developed.	Documented test performance demonstrating agreement with analytical predictions. Documented definition of scaling requirements.
6	System/sub-system model or prototype demonstration in an operational environment.	A high fidelity system/component prototype that adequately addresses all critical scaling issues is built and operated in a relevant environment to demonstrate operations under critical environmental conditions.	Prototype implementations of the software demonstrated on full-scale realistic problems. Partially integrate with existing hardware/software systems. Limited documentation available. Engineering feasibility fully demonstrated.	Documented test performance demonstrating agreement with analytical predictions.
7	System prototype demonstration in an operational environment.	A high fidelity engineering unit that adequately addresses all critical scaling issues is built and operated in a relevant environment to demonstrate performance in the actual operational environment and platform (ground, airborne, or space).	Prototype software exists having all key functionality available for demonstration and test. Well integrated with operational hardware/software systems demonstrating operational feasibility. Most software bugs removed. Limited documentation available.	Documented test performance demonstrating agreement with analytical predictions.
8	Actual system completed and "flight qualified" through test and demonstration.	The final product in its final configuration is successfully demonstrated through test and analysis for its intended operational environment and platform (ground, airborne, or space).	All software has been thoroughly debugged and fully integrated with all operational hardware and software systems. All user documentation, training documentation, and maintenance documentation completed. All functionality successfully demonstrated in simulated operational scenarios. Verification and Validation (V&V) completed.	Documented test performance verifying analytical predictions.
9	Actual system flight proven through successful mission operations.	The final product is successfully operated in an actual mission.	All software has been thoroughly debugged and fully integrated with all operational hardware/software systems. All documentation has been completed. Sustaining software engineering support is in place. System has been successfully operated in the operational environment.	Documented mission operational results.