Office Of The Secretary Of Defense (OSD)
Deputy Director Of Defense Research & Engineering
Deputy Under Secretary Of Defense (Science & Technology)
Small Business Innovation Research (SBIR)
FY2007.1 Program Description

Introduction

The Deputy Under Secretary of Defense (Science & Technology) SBIR Program is sponsoring the Energy and Power Security Technology theme this solicitation.

The Army, Navy, and Air Force are participating in the OSD program this year. The service laboratories act as our OSD Agent in the management and execution of the contracts with small businesses. The service laboratories, often referred to as a DoD Component acting on behalf of the OSD, invite small business firms to submit proposals under this Small Business Innovation Research (SBIR) program solicitation. In order to participate in the OSD SBIR Program this year, all potential proposers should register on the DoD SBIR website as soon as you can, and should follow the instruction for electronic submittal of proposals. It is required that all bidders submit their proposal cover sheet, company commercialization report and their firm's technical and cost proposal form electronically through the DoD SBIR/STTR Proposal Submission Website at http://www.dodsbir.net/submission. If you experience problems submitting your proposal, call the help desk (toll free) at 1-866-724-7457. You must include a Company Commercialization Report as part of each proposal you submit; however, it does not count against the proposal page limit. Please note that improper handling of this form may result in the proposal being substantially delayed. Information provided may have a direct impact on the review of the proposal. The DoD SBIR Proposal Submission Website allows your company to come in any time (prior to the proposal submission deadline) to edit your Cover Sheets, Technical and Cost Proposal and Company Commercialization Report.

We <u>WILL NOT</u> accept any proposals that are not submitted through the on-line submission site. The submission site does not limit the overall file size for each electronic proposal, there is only a page limit. However, file uploads may take a great deal of time depending on your file size and your internet server connection speed. If you wish to upload a very large file, it is highly recommended that you submit prior to the deadline submittal date, as the last day is heavily trafficked. You are responsible for performing a virus check on each technical proposal file to be uploaded electronically. The detection of a virus on any submission may be cause for the rejection of the proposal. We will not accept e-mail submissions.

Firms with strong research and development capabilities in science or engineering in any of the topic areas described in this section and with the ability to commercialize the results are encouraged to participate. Subject to availability of funds, the DUSD(S&T) SBIR Program will support high quality research and development proposals of innovative concepts to solve the listed defense-related scientific or engineering problems, especially those concepts that also have high potential for commercialization in the private sector. Objectives of the DUSD(S&T) SBIR Program include stimulating technological innovation, strengthening the role of small business in meeting DoD research and development needs, fostering and encouraging participation by minority and disadvantaged persons in technological innovation, and increasing the commercial application of DoD-supported research and development results. The guidelines presented in the solicitation incorporate and exploit the flexibility of the SBA Policy Directive to encourage proposals based on scientific and technical approaches most likely to yield results important to DoD and the private sector.

Description of the OSD SBIR Three Phase Program

Phase I is to determine, insofar as possible, the scientific or technical merit and feasibility of ideas submitted under the SBIR Program and will typically be one half-person year effort over a period not to exceed six months, with a dollar value up to $100,000. We plan to fund 3 Phase I contracts, on average, and downselect to one Phase II contract per topic. This is assuming that the proposals are sufficient in quality to fund this many. Proposals should concentrate on that research and development which will significantly contribute to proving the scientific and technical feasibility of the proposed effort, the successful completion of which is a prerequisite for further DoD

support in Phase II. The measure of Phase I success includes technical performance toward the topic objectives and evaluations of the extent to which Phase II results would have the potential to yield a product or process of continuing importance to DoD and the private sector, in accordance with Section 4.3.

Subsequent Phase II awards will be made to firms on the basis of results from the Phase I effort and the scientific and technical merit of the Phase II proposal in addressing the goals and objectives described in the topic. Phase II awards will typically cover 2 to 5 person-years of effort over a period generally not to exceed 24 months (subject to negotiation). Phase II is the principal research and development effort and is expected to produce a well defined deliverable prototype or process. A more comprehensive proposal will be required for Phase II.

Under Phase III, the DoD may award non-SBIR funded follow-on contracts for products or processes, which meet the component mission needs. This solicitation is designed, in part, to encourage the conversion of federally sponsored research and development innovation into private sector applications. The small business is expected to use non-federal capital to pursue private sector applications of the research and development.

This solicitation is for Phase I proposals only. Any proposal submitted under prior SBIR solicitations will not be considered under this solicitation; however, offerors who were not awarded a contract in response to a particular topic under prior SBIR solicitations are free to update or modify and submit the same or modified proposal if it is responsive to any of the topics listed in this section.

For Phase II, no separate solicitation will be issued and no unsolicited proposals will be accepted. Only those firms that were awarded Phase I contracts, and have successfully completed their Phase I efforts, will be invited to submit a Phase II proposal. Invitations to submit Phase II proposals will be released at or before the end of the Phase I period of performance. The decision to invite a Phase II proposal will be made based upon the success of the Phase I contract to meet the technical goals of the topic, as well as the overall merit based upon the criteria in section 4.3. DoD is not obligated to make any awards under Phase I, II, or III. DoD is not responsible for any money expended by the proposer before award of any contract. For specifics regarding the evaluation and award of Phase I or II contracts, please read the front section of this solicitation very carefully. Every Phase II proposal will be reviewed for overall merit based upon the criteria in section 4.3 of this solicitation, repeated below:

a. The soundness, technical merit, and innovation of the proposed approach and its incremental progress toward topic or subtopic solution.
b. The qualifications of the proposed principal/key investigators, supporting staff, and consultants. Qualifications include not only the ability to perform the research and development but also the ability to commercialize the results.
c. The potential for commercial (defense and private sector) application and the benefits expected to accrue from this commercialization.

In addition, the OSD SBIR Program has a *Phase II Plus* Program, which provides matching SBIR funds to expand an existing Phase II contract that attracts investment funds from a DoD acquisition program or Private sector investments. ***Phase II Plus*** allows for an existing Phase II OSD SBIR contract to be extended for up to one year to perform additional research and development. ***Phase II Plus*** matching funds will be provided on a one-for-one basis up to a maximum $500,000 of SBIR funds. All ***Phase II Plus*** awards are subject to acceptance, review, and selection of candidate projects, are subject to availability of funding, and successful negotiation and award of a ***Phase II Plus*** contract modification. The funds provided by the DoD acquisition program must be obligated on the OSD Phase II contract as a modification prior to or concurrent with the OSD SBIR funds. Private sector funds must be deemed an "outside investor" which may include such entities as another company, an investor, or a non-SBIR/non-STTR government program. It does not include the owners or family members, or affiliates of the small business (13 CFR 121.103).

The Fast Track provisions in section 4.0 of this solicitation apply as follows. Under the Fast Track policy, SBIR projects that attract matching cash from an outside investor for their Phase II effort have an opportunity to receive interim funding between Phases I and II, to be evaluated for Phase II under an expedited process, and to be selected for Phase II award provided they meet or exceed the technical thresholds and have met their Phase I technical goals, as discussed Section 4.5. Under the Fast Track Program, a company submits a Fast Track application, including statement of work and cost estimate, within 120 to 180 days of the award of a Phase I contract

(see the Fast Track Application Form on www.dodsbir.net/submission). Also submitted at this time is a commitment of third party funding for Phase II. Subsequently, the company must submit its Phase I Final Report and its Phase II proposal no later than 210 days after the effective date of Phase I, and must certify, within 45 days of being selected for Phase II award, that all matching funds have been transferred to the company. For projects that qualify for the Fast Track (as discussed in Section 4.5), DoD will evaluate the Phase II proposals in an expedited manner in accordance with the above criteria, and may select these proposals for Phase II award provided: (1) they meet or exceed selection criteria (a) and (b) above and (2) the project has substantially met its Phase I technical goals (and assuming budgetary and other programmatic factors are met, as discussed in Section 4.1). Fast Track proposals, having attracted matching cash from an outside investor, presumptively meet criterion (c). However, selection and award of a Fast Track proposal is not mandated and DoD retains the discretion not to select or fund any Fast Track proposal.

Follow-On Funding

In addition to supporting scientific and engineering research and development, another important goal of the program is conversion of DoD-supported research and development into commercial (both Defense and Private Sector) products. Proposers are encouraged to obtain a contingent commitment for follow-on funding prior to Phase II where it is felt that the research and development has commercialization potential in either a Defense system or the private sector. Proposers who feel that their research and development have the potential to meet Defense system objectives or private sector market needs are encouraged to obtain either non-SBIR DoD follow-on funding or non-federal follow-on funding, for Phase III to pursue commercialization development. The commitment should be obtained during the course of Phase I performance, or early in the Phase II performance. This commitment may be contingent upon the DoD supported development meeting some specific technical objectives in Phase II which if met, would justify funding to pursue further development for commercial (either Defense related or private sector) purposes in Phase III. The recipient will be permitted to obtain commercial rights to any invention made in either Phase I or Phase II, subject to the patent policies stated elsewhere in this solicitation.

Contact with DoD

General informational questions pertaining to proposal instructions contained in this solicitation should be directed to the topic authors and point of contact identified in the topic description section. Proposals should be electronically submitted. Oral communications with DoD personnel regarding the technical content of this solicitation during the pre-solicitation phase are allowed, however, proposal evaluation is conducted only on the written submittal. Oral communications during the pre-solicitation period should be considered informal, and will not be factored into the selection for award of contracts. Oral communications subsequent to the pre-solicitation period, during the Phase I proposal preparation periods are prohibited for reasons of competitive fairness. Refer to the front section of the solicitation for the exact dates.

Proposal Submission

Proposals shall be submitted in response to a specific topic identified in the following topic description sections. The topics listed are the only topics for which proposals will be accepted. Scientific and technical information assistance may be requested by using the SBIR/STTR Interactive Technical Information System (SITIS).

It is required that all bidders submit their proposal cover sheet, company commercialization report and their firm's technical and cost proposal form electronically through the DoD SBIR/STTR Proposal Submission Website at http://www.dodsbir.net/submission. If you experience problems submitting your proposal, call the help desk (toll free) at 866-724-7457. You must include a Company Commercialization Report as part of each proposal you submit; however, it does not count against the proposal page limit. Please note that improper handling of this form may result in the proposal being substantially delayed. Information provided may have a direct impact on the review of the proposal. The proposal submission website allows your company to come in any time (prior to the proposal submission deadline) to edit your Cover Sheets, Technical and Cost Proposal and Company Commercialization Report. We **WILL NOT accept any proposals which are not submitted through the on-line submission site.** The submission site does not limit the overall file size for each electronic proposal, only the number of pages is limited. However, file uploads may take a great deal of time depending on your file size and

your internet server connection speed. You are responsible for performing a virus check on each technical proposal file to be uploaded electronically. The detection of a virus on any submission may be cause for the rejection of the proposal. We will not accept e-mail submissions.

The following pages contain a summary of the technology focus areas, which are followed by the topics.

Energy and Power Security Technology Focus Area

Improvements in electric power will enable transformational new military capabilities. Power can be freed on ships, aircraft, and other platforms for use in advanced weapon and survivability systems, as well as significant enhancements in system flexibility. Potential life cycle and acquisition savings can be had by reducing fuel requirements, maintenance, personnel, logistics, and inventory. The Army's transformation challenge in the Future Combat System is to develop a smaller, lighter, and faster force, utilizing hybrid electric drive, electric armament and protection, and a reduced logistical footprint. The Navy is considering future ship concepts that will count on electric power for propulsion and to enable directed energy weapons, electromagnetic launch and recovery, and new sensors as well as supporting significant fuel, maintenance, and manning reductions. The Air Force requires advanced power and propulsion systems on aircraft in order to reduce the thermal load on tactical aircraft, improve fuel efficiency, reduce the logistics tail and also enable advanced directed energy weapon systems. Improved batteries will support the individual soldiers by permitting longer mission durations and reduced weight borne by the soldier. Improvements toward lighter and more powerful batteries and solar cells provide enhanced operational capabilities for both ground and space-based systems. All services can benefit from more efficient power and heating/cooling concepts for fixed and deployable bases from both conventional and renewable energy sources. Technologies that improve fuel efficiency, provide energy from alternate sources and increase platform efficiency provide enhanced energy security through reduced dependence on fossil fuels.

The Energy and Power Security Technology topics are:

OSD07-ES1	Portable Cogeneration of Power and Cooling (Navy)
OSD07-ES2	Energy Conversion of JP-10 Fuel (Navy)
OSD07-ES3	Low-Cost Thin-Film Based Advanced Solar Power Technologies for DOD Space and Terrestrial Applications (Air Force)
OSD07-ES4	Advanced Multijunction Solar Cell & Concentrator System Development for DOD Terrestrial and Space Applications (Air Force)
OSD07-ES5	Intensified Unit Operations and Lightweight Plant Design for Mobile Synthetic Fuel Plants (Army)
OSD07-ES6	Modular High Power Fuel Cell System Design (Navy)
OSD07-ES7	Develop plug and play architecture for Tactical power grids (Army)
OSD07-ES8	Intelligent Control System for Soldier Power (Army)
OSD07-ES9	Demonstration of Inter-Turbine Burners for Part-Power Fuel Efficiency Improvements (Air Force)
OSD07-E10	Retrofittable (Aftermarket) Tactical and Non Tactical Vehicle Performance and Fuel Economy Optimization System (Navy)

OSD SBIR 07.1 Topic Index

OSD07-ES1	Portable Cogeneration of Power and Cooling
OSD07-ES2	Energy Conversion of JP-10 Fuel
OSD07-ES3	Low-Cost Thin-Film Based Advanced Solar Power Technologies for DOD Space and Terrestrial Applications
OSD07-ES4	Advanced Multijunction Solar Cell & Concentrator System Development for DOD Terrestrial and Space Applications
OSD07-ES5	Intensified Unit Operations and Lightweight Plant Design for Mobile Synthetic Fuel Plants
OSD07-ES6	Modular High Power Fuel Cell System Design
OSD07-ES7	Develop plug and play architecture for Tactical power grids
OSD07-ES8	Intelligent Control System for Soldier Power
OSD07-ES9	Demonstration of Inter-Turbine Burners for Part-Power Fuel Efficiency Improvements
OSD07-E10	Retrofittable (Aftermarket) Tactical and Non Tactical Vehicle Performance and Fuel Economy Optimization System

OSD SBIR 07.1 Topic Descriptions

OSD07-ES1 TITLE: Portable Cogeneration of Power and Cooling

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: DDR&E EPTI

OBJECTIVE: Develop a portable, ultraquiet power generation system capable of simultaneously providing 5 kW of electric power and 10 kW of cooling power.

DESCRIPTION: The escalating use of electronic equipment on the battlefield requires increasing amounts of field deployable electric power. These electronic systems are often housed in sealed enclosures or shelters to provide protection against environmental hazards. When operating in warm environments, these enclosures require additional air conditioning to maintain ambient air temperatures below that required for reliable operation of electronics. One solution is to incorporate an external air conditioning system to provide the necessary cooling while drawing power from the same electric source. If power is provided from a diesel generator, it may be more efficient to directly convert heat from fuel burning to cooling power through an absorption chiller, for example, while simultaneous providing the power for the electronic equipment. At the same time, quiet operation is required in many tactical situations. Technologies which use external combustion, such as Stirling, thermoacoustic, and thermophotovoltaics, perform quieter and often with less exhaust emissions in comparison with internal combustion engines. This topic seeks innovative approaches to applying such technologies to the efficient cogeneration of power and cooling.

PHASE I: Evaluate technologies for providing quiet cogeneration of power and cooling in a battlefield environment. Design a prototype system capable of providing 5 kW (continuous) of 120 VAC, 60 hz electric power and 10 kW of cooling power. The generator should be able to operate directly on JP-8 fuel with no additional logistic load, weigh approximately 500 pounds (excluding fuel), and have an acoustic signature of less than 40 dB at 5 meters. The unit should be able to operate at ambient temperatures from -25 to 140 deg F.

PHASE II: Demonstrate a prototype system using the concept developed in Phase I. This unit must be portable, maintainable, and reliable. Evaluate the efficiency of the prototype under various electrical and cooling loads and temperatures.

PHASE III: Develop final design and commercialization plans using the knowledge gained during Phases I and II.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Cogeneration of electrical power and air conditioning has application in both residential and commercial settings. High efficiency, quiet cogeneration units in this power range have potential markets in commercial trucking and recreational vehicles.

REFERENCES: 1. http://www.marcorsyscom.usmc.mil/sites/PMEPS/MEP.asp

2. S. Backhaus, E. Tward, and M. Petach, “Traveling-wave thermoacoustic electric generator,” Appl. Phys. Lett. 85, 1085 (2004).

3. X.Q. Kong, R. Z. Wang, and X.H. Huang, “Energy efficiency and economic feasibility of CCHP driven by stirling engine,” Energy Convers. Manage. 45, 1433 (2004).

KEYWORDS: power generation, cogeneration, therrmoacoustic refrigeration, Stirling engine

OSD07-ES2 TITLE: Energy Conversion of JP-10 Fuel

TECHNOLOGY AREAS: Ground/Sea Vehicles, Weapons

ACQUISITION PROGRAM: DDR&E EPTI

OBJECTIVE: Develop methods of converting the chemical energy contained in JP-10 fuel into propulsive energy to power the unmanned undersea vehicles and undersea weapons. This energy conversion allows extended operation in low-power missions.

DESCRIPTION: The energy supply for the majority of unmanned undersea vehicles (UUVs) has typically been through the use of batteries. However, the requirements of extended duration low-power missions and for occasional sustained higher-power operations, as described in the U.S. Navy's UUV Master Plan1 highlights the need for increases in energy density and specific energy. The UUV Master Plan cites an energy density of about 150 Wh/lb for large vehicles at 5 kts. Additionally, the navy desires lower fuel cost and more capability to quickly "gas and go". The focus of this SBIR solicitation is on Navy logistics fuels, specifically JP-10, as a fuel for large diameter UUVs2. The navy is interested in the development of methods of converting the chemical energy contained in JP-10 into UUV propulsive energy. Possible means of doing this include but are not limited to: solid oxide fuels cells, PEM fuel cells with reformers, and thermal heat engines. Storage of oxidizer onboard the UUV is a principal challenge to the use of logistics fuels, and has been the topic of previous SBIR solicitations. Apparently, different methods of oxidizer storage may be more appropriate for different power plants. Although novel means of dense oxidizer storage are of interest to the navy, emphasis of this SBIR is on fuel and energy conversion.

PHASE I: Conduct analysis and develop energy conversion system concepts that use JP-10 fuel to power the UUVs and undersea weapons. The deliverable will be a preliminary design of a JP-10 energy conversion system with oxidizer that will drive the power shaft of the UUVs and undersea weapons.

PHASE II: Design and develop an integrated JP-10 fuel energy conversion system for UUVs and undersea weapons. Experiments and testing will be conducted in the laboratory to demonstrate the capabilities of the energy conversion system including the oxidizer. The energy conversion system should be coupled to the mechanical system, and to demonstrate its capabilities to drive the power shaft of the UUVs and undersea weapons.

PHASE III: Extend the Phase II effort to incorporate the JP-10 energy conversion system in next generation or future UUVs and undersea weapons. Collaborate with Navy laboratory and industry to transition the energy conversion technology to UUVs, undersea weapons, and other non-military applications.

PRIVATE SECTOR USE OF TECHNOLOGY: The JP-10 fuel energy conversion system developed in this SBIR can be easily applied to the private sector. Examples are the propulsion systems that power ground (automobiles), sea and air vehicles.

REFERENCES: 1. The Navy Unmanned Undersea Vehicle (UUV) Master Plan, Nov. 9, 2004, www.chinfo.navy.mil/navpalib/technology/uuvmp.pdf

2. Daniel H. Kiely and James Moore, Hydrocarbon Fueled UUV Power Systems, IEEE AUV 2002 Energy Systems Workshop, San Antonio, TX, 2002.

KEYWORDS: JP-10 Fuel, Energy Conversion, Fuel Cell, Unmanned Undersea Vehicle, Undersea Weapons

OSD07-ES3 TITLE: Low-Cost Thin-Film Based Advanced Solar Power Technologies for DOD Space and Terrestrial Applications

TECHNOLOGY AREAS: Ground/Sea Vehicles, Space Platforms

ACQUISITION PROGRAM: DDR&E EPTI

OBJECTIVE: Develop and demonstrate high-specific power, flexible, electric power generation technologies for DOD terrestrial, near space, and space platforms.

DESCRIPTION: High efficiency solar cells are needed to reduce solar array mass and stowed volume, and increase specific power, at reduced cost and with quicker design and fielding on demand for DOD missions. Thin-film solar cell (TFSC) technology has high potential to meet a number of future DOD power systems needs. While TFSC efficiencies are low compared to state-of-the-art (SOA) crystalline solar cells, they can be manufactured in large scale on lightweight, flexible substrates at low cost. The primary impediment to market acceptance and wide usage of TFSCs in both terrestrial and space systems is the relatively low efficiency. For space systems, higher efficiency results in smaller arrays which reduce drag and lower the complexity needed for deployment systems. For terrestrial use, higher efficiencies also translate into reduced cost per watt which makes the technology more competitive with other forms of terrestrial power. When integrated into mobile and deployable structures, TFSCs have the potential to provide efficient and reliable mobile electric power generation for military and commercial operations. TFSCs are expected to cost a tenth of today's SOA multijunction solar cells yet are expected to be 3 to 5 times lighter and can be deposited on flexible substrates. The flexibility and low mass of TFSCs are particularly advantageous because they allow innovative solar array support structures. In particular, thin-film solar arrays and modules could potentially provide much greater stowage efficiency (45-60 W/m3 vs. 10-15 W/m3), much greater specific power (250-500 W/kg vs. 70 W/kg), and much lower cost (~$250/W vs. ~$1000/W) than rigid flat panel solar arrays based on SOA multijunction solar cells. Typical efficiencies for TFSCs are ~9-12 % in manufacturable processes. Development of TFSC technologies, based on, but not limited to, amorphous silicon and copper indium gallium diselenide materials that exhibit significantly higher efficiencies while maintaining low cost, lightweight, and flexibility are sought. Performance degradation caused by environmental factors and durability should also be addressed. Areas of interest include (but are not limited to): (1) increasing conversion efficiency to 15% or greater, (2) implementation of multijunction structures, (3) monolithic integration with development of suitable lightweight substrates, and (4) increasing durability and environmental stability under both, the space and terrestrial environments as well as increasing efficiency in actual operating environments. Increased conversion efficiency over SOA combined with low cost and higher manufacturability will enable high power platforms for space missions and efficient reliable stationary or mobile electric power generation for both military and commercial applications across all DOD services. System level array integration issues should also be considered.

PHASE I: Design and validate innovative approaches for producing high efficiency thin-film solar cells and their modules with efficiencies 15% or greater (under AM0 solar spectrum or equivalent AM1.5 efficiency) on lightweight substrates and establish feasibility of proposed concepts. The contractor will identify key technical challenges and establish a plan to address and overcome those challenges. The contractor will also develop a Phase II program plan, including (but not limited to) a development of suitable lightweight materials, monolithic integration, and large scale manufacturing. Address space environment concerns (UV radiation, electron and proton radiation, atomic oxygen, space plasma, and thermal cycling).

PHASE II: Build subscale prototypes of high efficiency TFSC. The prototypes should be functionally tested in representative environments to characterize performance and to assist in developing a Phase II design strategy. Using the results of phase I, design, fabricate, and optimize large area prototypes. The contractor should keep in mind the goal of commercialization of this innovation for the Phase III effort, to which end they should have working relationships with, and support from large-scale manufacturers.

PHASE III: The technologies developed as a result of the Phase II contract(s) will be applicable to many other military and commercial applications that can benefit from the enhanced capabilities, as well as mass and cost savings associated with this technology.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The commercial potential for increased performance, thin-film based electric power sources is very high. Commercial satellite vendors are a significant fraction of the space market and are continually looking for ways to reduce system mass, decrease costs, and increase spacecraft reliability and lifetime. Compact and lightweight solar electric power sources for DOD terrestrial operations will also benefit from this technology.

REFERENCES: 1. P. E. Hausgen, P. Tlomak, J. Merrill, J. E. Granata, and D. Senft, "AFRL Thin Film Solar Cell Development and Upcoming Flight Experiments", 2nd IECEC, Providence, RI, August 16-19, 2004

2. J. E. Granata, P. Tlomak, P. Hausgen, R. Walters, and S. Messenger, “Thin-Film Photovoltaic Radiation Testing & Modeling for a MEO Orbit (Both long and short abstract),” The 31st IEEE PVSC Lake Buena Vista, FL, 3-7 Jan 05.

KEYWORDS: Solar Electric Power Generation, Space Power, Solar Cells, Thin-Film Solar Cells

OSD07-ES4 TITLE: Advanced Multijunction Solar Cell & Concentrator System Development for DOD Terrestrial and Space Applications

TECHNOLOGY AREAS: Ground/Sea Vehicles, Space Platforms

ACQUISITION PROGRAM: DDR&E EPTI

OBJECTIVE: Develop advanced, high efficiency multijunction solar cells and associated concentrator system to yield low cost, grid independent power for DOD installations while advancing space solar cell technology for increased on-orbit performance metrics.

DESCRIPTION: DOD use of high efficiency multijunction crystalline solar cells has been limited to spacecraft where a premium is paid for high performance (~$300/Watt). The required cost premium for these high efficiency solar cells has prevented consideration of their use for terrestrial power systems that would be useful for mobile and fixed DOD installations. However, the use of high concentration drastically lowers the required solar cell material and correspondingly, the cost per Watt. Because of this, terrestrial concentrator systems utilizing high efficiency multijunction crystalline solar cells are becoming competitive with other terrestrial solar cell technologies. With moderate increases in cell level conversion efficiency, it is possible that such concentrator systems would equal or surpass the Watts/$ of other terrestrial solar cell technologies. As such, improvements are sought in cell level conversion efficiency (>40% at 500 AM1.5 suns). Since there are similarities in component technologies for both concentrator solar cells and high efficiency space solar cells, it is expected that such a development would also lead to higher conversion efficiency for solar cells designed for 1 AM0 sun (>30%). In addition to increased solar cell performance, improvements in the concentrator system are also sought in terms of longevity, simplicity, mobility, and cost.

PHASE I: Perform a feasibility analysis and design a system concept with efficiency goals as stated in the topic description. Key technical challenges shall be identified and a plan established to address and overcome those challenges in Phase II. The chosen solar cell material system must be current matched for two-terminal operation.

PHASE II: Apply the results of Phase I to develop and demonstrate a fully functioning prototype system with cell level conversion efficiency >40% under 500 AM1.5 suns. Demonstrate how solar cell developments are traceable to >30% operation under a 1 sun AM0 spectrum.

PHASE III DUAL USE APPLICATIONS: The commercial potential for increased performance terrestrial solar cell systems that are competitive to grid power costs is extremely high. Commercial satellite providers are a significant fraction of the space market and are continually looking for ways to reduce system mass, decrease costs, and increase spacecraft performance.

REFERENCES: 1. Law, D. C., C. M. Fetzer, R. R. King, P. C. Colter, H. Yoon, T. D. Isshiki, K. M. Edmondson, N. H. Karam, and M. Haddad, "Multijunction Solar Cells with Subcell Materials Highly Lattice-Mismatched to Germanium," 31th IEEE PVSC, pp. 575, Orlando, FL, Jan. 2005.

2. Wanlass, Mark W., J. F. Geisz, Sarah Kurtz, R. J. Wehrer, B. Wernsman, S. P. Ahrenkiel, R. K. Ahrenkiel, D. S. Albin, J. J. Carapella, A. Duba, and T. Moriaty, "Lattice-Mismatched Approaches for High Performance III-V Photovoltaic Energy," 31th IEEE PVSC, pp. 530, Orlando, FL, Jan. 2005.

3. A. Fontcuberta i Morral, Appl. Phys. Lett. 83, 5413, 2003.

KEYWORDS: Space Power, Photovoltaics, Solar Cells, Multijunction Solar Cells

OSD07-ES5 TITLE: Intensified Unit Operations and Lightweight Plant Design for Mobile Synthetic Fuel Plants

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: DDR&E EPTI

OBJECTIVE: To identify and develop technologies that facilitate development of small (50-500 barrel per day) mobile Fischer-Tropsch synthetic fuel plants through weight and volume reduction of process and supporting equipment and modular plant design.

DESCRIPTION: There is ongoing Department of Defense (DoD) interest in mobile systems to produce Fischer-Tropsch (FT) synthetic fuels from resources present in a combat theater. The resources could include natural gas, crude oils of various qualities, biomass, coal and peat, petroleum coke and other carbon-based feed stocks. However, Fischer-Tropsch plants made with conventional chemical plant technologies weigh about 3 tons per barrel-day of output for a 10,000 barrel-day capacity. Weight per barrel-day output appears to increase rapidly as plant capacity is reduced; one sub-100 barrel-per-day plant is known to weigh around 14 tons per barrel-day of output. The goal is to approach or exceed large scale plants on a mass per through put basis at the smaller scales of interest under this topic.

DoD has funded projects to develop and demonstrate a high-throughput FT reactor which can accomplish 10 or more times as much chemical conversion per unit volume as conventional reactors. Process intensified gasifiers have been demonstrated and FT upgrading reactors have been proposed.

Mobile FT plants that produce finished fuel will require many supporting unit operations to be intensified if major weight and size reductions are to be attained. The proposed research should provide substantial weight and volume reductions in one or more supporting unit operations in an FT plant.

PHASE I: Perform bench scale validation of the proposed approach. Phase I should also include initial plans for scaling the process (supporting unit operations) up in phase II to a size and construction that realistically represents application to FT synthesis plants over the 50-500 bpd range. These plans should describe how the demonstration will be carried out, and present preliminary estimates of the plant-level economic and functional benefits of utilizing the approach in a full scale production facility.

PHASE II: Refine the promising concepts developed under the phase I effort and scale the synthesis approach to a level appropriate for validating the benefits at full scale production, and operate the equipment in a realistic manner to determine actual performance. It is assumed that interactions with a full-scale FT synthesis plant will have to be physically simulated, as an actual full FT plant will be unavailable. Conduct follow-on analysis to update projected plant capital and operating expense reductions versus conventional plant designs currently under construction around the world. Analysis should also include an assessment of benefits to full scale plant configuration, particularly plant footprint and plant transportability, but including construction cost, startup and operation.

PHASE III: The technology developed under this SBIR should be applicable to the production of both military and commercial fuels. The reduction in plant footprint may serve to reduce commercial plant capital expense, improving the business case.

REFERENCES: 1. Anderson, R., The Fischer-Tropsch Synthesis, Academic Press, 1984

2. ChevronTexaco Aviation Fuels Technical Review, ChevronTexaco Corporation, 2005 (www.chevrontexacoaviation.com/prodserv/fuels)

3. http://www.fe.doe.gov/programs/powersystems/publications/Strategic_Plans/2001/mypp_2001_all.pdf

4. http://www.netl.doe.gov/technologies/coalpower/gasification/adv-gas/concepts.html

KEYWORDS: Process intensification, fischer-tropsch, hydrocarbon synthesis, synthetic fuel

OSD07-ES6 TITLE: Modular High Power Fuel Cell System Design

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: DDR&E EPTI

OBJECTIVE: Develop a high density water recovery subsystem for advanced fuel cell systems operating on logistics fuel (JP5, JP8, NATO F76 and similar feedstocks).

DESCRIPTION: Fuel cells operating on high sulfur logistics diesel fuel (NATO F-76, JP5, JP8) offer a viable means to provide distributed ship service and forward deployed base electrical power. These systems provide the potential benefit for improved fuel efficiency, reduction in airflow requirements, improved survivability, and reduction in signature. Multiple modular 1-2MW systems are necessary to enable these benefits for Navy shipboard distributed power as well as future microgrid power generation needs.

In order to properly operate in all military applications, advanced high efficiency steam and autothermal fuel cell reformers require a constant high purity water source to generate the hydrogen rich reformate stream. A method to achieve this constant source of water is to separate and recirculate process water from the reformate gas. Presently, this includes use of a significant number of auxiliary components to separate and clean the recovered water to high purity levels which add to the total complexity and cost of the system.

It is desired therefore to develop a technology that allows for the separation and recirculation of water from the reformate stream back to the reformer without the need for phase change and with minimum purification equipment. This subsystem shall enhance the overall system design in order to achieve the following goals:
• Efficiency: Greater than 40%
• Volumetric density: 35 watts/liter
• Gravimetric density: 75 watts/kg
The system should be designed to operate given the following conditions:
• Reformate stream composition:

Mole Frac	
HYDROGEN	0.308034
WATER	0.304921
CO	0.014565
CO2	0.142315
METHANE	0.012746
O2	0
N2	0.217343
F76	0
DIBENZS	0
H2S	7.73E-05
SO2	1.95E-17

• Recirculated stream pressure/temperature: 7 Atm, >350C
• Outlet stream purity: >95% water

PHASE I: Develop a conceptual design for a modular, fuel cell water recovery system. The system is to operate in conjunction with advanced fuel processing configurations, per the reformate gas properties and stated goals as provided above. The conceptual design will include a chemical process model (static) and 3D layout of the notional system in an integrated subsystem module. In addition, the concept design will also include a basis for operation including startup, shutdown, load pickup / reduction, and provide an analysis for the effect of the water recovery subsystem on overall system modularity. Additionally, the design should provide information regarding the

interfaces required at necessary power levels (lab (50 kWe), pilot (500 kWe), full scale (1-2 MWe)). A proof of concept operation of the notional system in a sub-50 kWe scale would be beneficial.

PHASE II: Develop a detailed design, including Process & Instrumentation Diagram and Failure Mode Effect Analysis, and construct a 50 kWe prototype of the Phase I concept, to be delivered at the end of the phase II effort. In conjunction with this work, further refinements of static process model, 3-D conceptual layouts, component maintenance strategies, and notional operational performance, should be performed. Develop a dynamic model based upon the testing of the Phase I concept, and design of the phase II prototype, that simulates the operability and transient performance of the water recovery system.

PHASE III: The advanced technology design will transition to commercial and military fuel cell applications where the reformation of liquid fuels is required.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The system will be applied to a variety of commercial fuel cell technologies currently being applied to civilian applications and being evaluated for use in marine applications.

REFERENCES: 1. A. Nickens, D. Hoffman, E. House, B. Prew, “US Navy Shipboard Fuel Cell Program”, Fuel Cell Seminar, Palm Springs, CA, Nov 2005

2. J.Heinzel, M. Cervi, D. Hoffman, J. Kuseian, “Fuel Cell System Models for U.S. Navy Shipboard Application”, Fuel Cell Seminar, Palm Springs, CA Nov 2005

3. A. Nickens, D. Hoffman, S. Miller, J. Heinzel, E. House, V. Tsourapas, “A Dynamic Model of a Shipboard PEM Fuel Cell Reformer System with an Integrated Gas Turbine”, ASME International Gas Turbine Institute Conference, Barcelona, Spain, June 2006

KEYWORDS: Energy, modular, power, reformer, fuel cell, water

OSD07-ES7 TITLE: Develop plug and play architecture for Tactical power grids

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: DDR&E EPTI

OBJECTIVE: With today’s advances in digital control systems, integrated software power management has much potential to aid power planning, economically improve energy systems and eliminate “stranded energy” on the battlefield. It is also envisioned that advanced sensor technologies could be incorporated into all source and consumer platforms for accurate feedback into the power management software and command and control system. Power management must be as robust and versatile as the equipment it is used with and the missions to which it is applied.

DESCRIPTION: To develop a tactical energy control system architecture with “plug and play” capabilities. The energy network architecture should allow for the use of intelligent techniques for planning deployments, and measuring and managing demand when requests for services (location, targeting, and mobility) are made. The architecture must consider advanced control algorithms, multiple sensors, mission equipment identification, power sources, mission profile integration, prognostics and diagnostics, and have the ability to integrate legacy systems that do not have embedded intelligence. The system should also consider and plan for the actual physical connections with minimum cable runs and power distribution fixtures. The architecture must be modular enough to manage energy decisions across an entire unit and be completely scalable, resulting in power efficiency for the whole force as well as detached elements. The control system should be flexible enough to address various electric power generation technologies, energy storage devices, energy conversion mechanisms, energy conservation mechanisms, methods of performance enhancement of the various generation and storage technologies, as well as multiple information technologies.

With the rapid changes in technology the control system must be able to operate on different DOD operating platforms, be rapidly reconfigurable, and have the ability to accommodate third party interests as well as integrate into existing control systems and protocols. This architecture would also allow for tracking energy, as a resource, at all levels of deployment and provide logisticians with better information for re-supplying the force.

PHASE I: Outline the basis of a control architecture, propose protocols and outline a dispatch strategy for a plug-and-play control system. The goal is to demonstrate average active generator loading of greater than 75%. The system should incorporate or mirror existing capability in the AutoDise automated layout tool. Technical discussions should include the following elements:
a. Narrative and graphical depiction of the design
b. Projected physical attributes (size, weight…) of support components and subsystems
c. Projected performance metrics

A decision model of selected components and subsystem designs shall be constructed with weighted values for performance & operational/logistics parameters. Weighting factors shall be assigned to each parameter by the contractor and justification for these weights shall be provided. It shall also be possible to easily change weighting factors to study the effects on the overall utility of the design.

PHASE II: Develop, demonstrate, and validate a scaleable proof of concept system in a realistic environment. Demonstrate that tactical power /energy sources can be "intelligently" dispatched in response to a variable demand while maximizing the efficiency or cost of power sources, and demonstrate that demand can be managed in response to limited source power.

PHASE III: Develop final design and commercialization plans using the knowledge gained during Phases I and II.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Architectures for power systems that integrate different power sources and load types have application in both residential and commercial settings for emergency backup systems and uninterruptible power supplies.

REFERENCES: 1. TM – 5 – 766 Electric Power Generation in the Field. TM – 5 - 765 Transmission and distribution

2. Borbely, A. and Kreider, J.F. Distributed Generation: The Power Paradigm for the New Millennium, CRC Press, Boca Raton, FL, 2001.

3. Shavit, G., Control Requirements for CoGen and MicroGen Plants in a Deregulated Electricity Industry, ASHRAE Transaction, Vol. 1, 2000, pp.655-660.

4. Ackermann, T. Knyazkin, V., Interaction between distributed generation and the distribution network: operation aspects. Transmission and Distribution Conference and Exhibition. 2002.

5. TRADOC Pamphlet 525-66 Department of the Army *TRADOC Pamphlet 525-66, FORCE OPERATING CAPABILITIES, Headquarters, United States Army Training and Doctrine Command, 1 July 2005.

KEYWORDS: distributed power, energy, network, generator, dispatch strategy, control architecture

OSD07-ES8 TITLE: Intelligent Control System for Soldier Power

TECHNOLOGY AREAS: Ground/Sea Vehicles, Battlespace

ACQUISITION PROGRAM: DDR&E EPTI

OBJECTIVE: Design and build an "intelligent" control system to maximize mission duration and dismounted Soldier effectiveness with an automated controller that can be integrated into a Soldier System.

DESCRIPTION: Effectiveness of dismounted Soldier systems is limited by the amount of energy an individual can carry for powering the vast array of equipment used by today's Soldiers. The equipment is used to provide actionable intelligence that provides commanders and Soldiers a high level of situational awareness, delivered with the speed, accuracy and timeliness necessary to operate at their highest potential and to conduct successful operations. Efforts are underway to reduce demand requirements and to improve energy sources, but the significant energy shortfall dictates the need for improved energy management. Compounding the problem is the large number of devices that have significantly different operating characteristics, such as a wide range of load factors and time-sensitive current draws. Furthermore, if the Soldier is managing energy, then it becomes difficult to focus on mission requirements.

One way to manage energy would be to develop an optimal controller that simultaneously manages sources and demand while integrating mission requirements and equipment variability associated with changing environmental conditions. In example, demand devices might be operated differently for a short time period just as radios are used during radio listening silence. Additionally, as equipment operating profiles change due to weather, such as changing battery characteristics in cold weather, the actual demand must also be captured and integrated into energy management strategies.

With the rapid changes in technology the control system must be able to operate on different operating systems, be rapidly reconfigurable and have ability to accommodate third party interests as well as integrate into existing control systems and protocols.

PHASE I: Study load profiles, equipment that must be controlled and develop control architecture and strategies. Establish interface protocol between hardware and existing control systems. Propose an optimization strategy. Develop a test and evaluation plan that contains discrete milestones for product development for verifying performance and suitability.

PHASE II: Develop, demonstrate, and validate a scaleable prototype system in a realistic environment. Demonstrate that loads can be "intelligently" dispatched so that a threshold is not exceeded, energy consumption is minimized and useful power storage capacity is maximized.

PHASE III: Develop final design and commercialization plans using the knowledge gained during Phases I and II.

PRIVATE SECTOR COMMERCIAL POTENTIAL: A control system to optimize energy use and power sources for man-portable systems could have applications for emergency response personnel, mobile wireless systems or other related activities.

REFERENCES: 1. Bailey, M., D. Sanders, and O. Arnas, "Meeting Military Energy Demands", Proceedings, ASME-ISEC 2003 International Solar Energy Conference, Hawaii, (2003).

2. TRADOC Pamphlet 525-66 Department of the Army *TRADOC Pamphlet 525-66, FORCE OPERATING CAPABILITIES, Headquarters, United States Army Training and Doctrine Command, 1 July 2005.

3. National Research Council, Meeting the Energy Needs of Future Warriors, The National Academies Press, 2004.

KEYWORDS: distributed power, energy management, network, Soldier systems

OSD07-ES9 TITLE: Demonstration of Inter-Turbine Burners for Part-Power Fuel Efficiency Improvements

TECHNOLOGY AREAS: Air Platform, Ground/Sea Vehicles

ACQUISITION PROGRAM: DDR&E EPTI

OBJECTIVE: Design a small, reheat cycle propulsion engine (<2000 lb. thrust) using interturbine burners (ITBs) with other advanced technologies that can significantly improve mission fuel efficiency.

DESCRIPTION: Gas turbine propulsion systems are typically optimized at one location on the flight map, and suffer poor performance at offdesign conditions. One example of this is the need for current and future military combat systems to spend a significant portion of their mission at part-power conditions. One possible method that can improve part-power efficiency, while maintaining high fuel efficiency at maximum power, is the use of a reheat cycle for propulsion systems. This is accomplished by placing a combustor, called an ITB, between the high- and low-pressure turbine, resulting in a reheat cycle engine. The reheat cycle is especially suited for missions that require large amounts of constant or intermittent power extraction such as takeoff power, high-speed maneuvers, lift fans, or additional power for sensors and weapons systems. The ITB can operate at maximum power and/or during high power requirements, while the main combustion system in the core engine can be optimized for part-power performance, ultimately resulting in a reduced fuel burn cycle. Some preliminary studies indicate that the part-power fuel efficiency can improve by 7 to 17 percent by using an ITB. Since the use of a reheat cycle can result in increased specific thrust for a fixed engine size, the resulting engine can be made smaller and lighter, which can translate to increased payload or increased time on station via additional fuel carried on the vehicle.

PHASE I: Work with DoD and industry to define combat aircraft and combat missions that can benefit from a reheat cycle (interturbine burner) design to improve mission fuel efficiency. Define suitable small (<2000 lb. thrust) engines for ITB insertion. Conduct preliminary design (including aero, thermal mechanical, and structural) of at least two ITB concepts and demonstrate concept feasibility. Investigate the interaction between ITB and turbine components, and optimize these components for maximum system performance.

PHASE II: Perform detailed design (aero, thermal/mechanical, structural) of the ITB concepts. Fabricate ITB component. Experimentally test each optimized ITB design in a reacting flow environment (rig and/or engine), and compare experimental and numerical results. Identify other advanced technologies that, when combined with an ITB, can provide significant performance improvements compared to baseline designs. Quantify fuel efficiency performance improvements compared to an engine baseline.

PHASE III DUAL USE APPLICATION: The reheat cycle and interturbine burner engine have potential for providing performance benefits for several military applications including lift fans, additional power extraction for weapons systems, and high efficiency turboprop and turboshaft engines for unmanned aerial vehicles (UAVs). The technology can also be used in the ground-based power industry to improve part-load engine performance. Similarly, there are potential benefits related to auxiliary power units, where the ITB can be used during peak power loads.

REFERENCE: 1. General information on the Propulsion Directorate can be found at: http://www.pr.afrl.af.mil .

2. Sirignano, W.A., Delplanque, J.P., and Liu, F., “Selected Challenges in Jet and Rocket Engine Combustion Research,” 33rd AIAA/ASME/SAE/ASEE Joint Propulsion Conference, Seattle, WA AIAA-97-2701 (1997).

3. Sirignano, W.A., and Liu, F., “Performance Increases for Gas-Turbine Engines Through Combustion Inside the Turbine,” Journal of Propulsion and Power, 15:1 pp.111-118 (1999).

4. Liu, F., and Sirignano, W.A., “Turbojet and Turbofan Engine Performance Increases Through Turbine Burners,” 38th Aerospace Sciences Meeting & Exhibit, Reno, NV, AIAA-2000-0741.

5. Dobbeling, K., Hellat, J., Koch, H., “Twenty-Five Years of BBC/ABB/ALSTOM Lean Premix Combustion Technologies,” ASME IGTI GT2005-68269.

6. Anthenien, R. A., Mantz, R. A., Roquemore, W. M., and Sturgess, G. J., “Experimental Results for a Novel, High Swirl, Ultra Compact Combustor for Gas Turbine Engines,” 2nd Joint Meeting of the U.S. Sections of the Combustion Institute, Oakland, CA March 2001.

7. Zelina, J., Ehret, J., Hancock, R.D., Shouse, D.T., Sturgess, G.J., and Roquemore, W.M., “Ultra-Compact Combustion Technology Using High Swirl to Enhance Burning Rate,” AIAA 2002-3725.

8. Zelina, J., Sturgess, G.J., Mansour, A., and Hancock, R.D., “Fuel Injection Design for Ultra-Compact Combustor,” ISABE 2003-1089.

9. Zelina, J., Shouse, D.T., and Hancock, R.D., “Ultra-Compact Combustors for Advanced Gas Turbine Engines,” ASME IGTI 2004-GT-53155.

10. Zelina, J., Sturgess, G J and Shouse, D.T., “The Behavior of an Ultra-Compact Combustor (UCC) Based on Centrifugally-Enhanced Turbulent Burning Rates,” AIAA 2004-3541.

11. Gahn, M.S., “Ultra-Compact Combustor/Inter-Turbine Burner Performance Analysis for Gas Turbine Engines,” 26th Annual Conference on Composites, Materials and Structures 2002, Cocoa Beach, FL, January 2002.

12. Sturgess, G.J., and Zeppieri, S., “Turbine Burner for Near-Constant Temperature Cycle Gas Turbine Engine,” AFRL-PR-WP-TR-2005-2067 (DTIC# ADB307489), February 2005.

13. Zelina, J., Shouse, D.T., Stutrud, J.S., Sturgess, G.J., and Roquemore, W.M., “Exploration of Compact Combustors for Reheat Cycle Aero Applications,” AMSE IGTI GT2006-90179.

14. Zelina, J., Greenwood, R., and Shouse, D.T., “Operability and Efficiency Performance of Ultra-Compact High-Gravity (g) Combustor Concepts,” AMSE IGTI GT2006-90119.

15. Anthenien, R.A., and Zelina, J., “Experimental Results on the Turbulent Combustion Regimes Within a Small-Scale Atmospheric Pressure High-g Combustor,” Central States Section- The Combustion Institute, Cleveland, OH 2006.

KEYWORDS: reheat cycle, power extraction, interturbine burners, compact combustors, small engines, advanced cycles

OSD07-E10 TITLE: Retrofittable (Aftermarket) Tactical and Non Tactical Vehicle Performance and Fuel Economy Optimization System

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: DDR&E EPTI

OBJECTIVE: Provide a retrofittable real time capability to determine the health and readiness of tactical and non-tactical vehicles to maintain maximum fuel economy and readiness in a distributed operational environment. Provide necessary monitoring to enable condition-based maintenance and minimize logistics footprint. Provide operational cueing to the crew to optimize platform performance during operations.

DESCRIPTION: System must perform real time monitoring, diagnostics, and prognostics to permit timely and appropriate action to improve fuel efficiency, prevent performance degradation, and avoid mission interruptions. Technologies may include onboard and/or remote capabilities for condition monitoring of systems such as oil/lubricant condition, fluid temperatures, tire pressure, fuel consumption at speed/grade, and other appropriate performance and environmental factors which may impact fuel efficiency or shorten equipment life. Expectations are that this capability will provide real-time guidance to the operator, asset status to the commander, and condition-based (rather than time-based) maintenance data for the logistician. The system must facilitate significant fuel savings over the varied operating profile of military tactical and non tactical vehicles.

The system must be easily installed on existing platforms with or without installed data buses during normal maintenance activities at the intermediate maintenance level or lower. The proposed technologies must integrate easily with onboard military tactical and non-tactical vehicle data buses. The system should be modular and maximize use of existing sensing and communications resources on the platform and off. Weight and volume impact will be a key performance parameter for the system. The implementation must be compliant with industry and military open architecture specifications to the maximum extent feasible. Any onboard user interface must be

intuitive and easy to use to provide driver cueing to optimize fuel economy and asset life while maintaining mission performance under any realistic operational scenario. The system must detect and identify mission impacting failure modes for the platform sufficiently far in advance of failure to allow normal logistic response times and minimal interruption to field operations. The system must communicate directly with extant and planned logistics supply chain applications to facilitate automatic parts and consumables ordering.

Also, it is necessary that the solution recognize the variety of fuels currently used in the field by the military. Primary fuels are JP-8 and diesel fuels, but the utilization of other jet fuels should not be ignored. Additionally, technology must be able to discern between combinations of different fuels in a given mixture when determining efficiency.

PHASE I: Apply reliability centered maintenance principles to analyze tactical and non tactical vehicle operations and maintenance experience to identify operational drivers of fuel economy and maintenance. Associate existing sensors with fuel economy/maintenance indicators. Identify additional sensors to fill gaps. Develop an overall system architecture and design to optimally meet objectives. Describe architecture and design in final report and predict readiness and fuel economy improvements over standard operational scenarios. Develop a test plan to evaluate the system and assess performance against predictions.

PHASE II: Build a laboratory “breadboard” system to emulate implementation on a selected military tactical or non-tactical vehicle. Using Reliability Centered Maintenance analysis from Phase I, gather data on vehicle mechanical systems to characterize both normal operations and compromised components. Take first cut at setting machinery diagnostics / prognostics thresholds and begin crafting operator interfaces. Move technologies off the laboratory bench and integrate into a “brass board” prototype system to be fit on one vehicle class for demonstration and field trials. Implement test plan done in Phase I and compare against performance predictions. Develop conceptual design of systems for three additional vehicle classes.

PHASE III: Commercialize and qualify the technology to facilitate rapid transition to weapon systems platforms, new and existing. Successful deployment of compact and efficient technology will have a multitude of commercial applications in military spin-offs. Included are adaptations into USMC land combat and support vehicles, USA land combat vehicle systems and both Army, Navy and USMC aviation assets. These technologies have commercial dual use applicability in the trucking industry, heavy machinery and railroad industries. For both military and commercial use, these technologies are vital for optimized asset management as both government and industry move toward implementation of Sense and Respond Logistics capabilities.

KEYWORDS: Prognostics, diagnostics, fuel efficiency, ground platforms