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SOFWERX RFI

Energy Source Objectives and Requirements

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1 Purpose and Background

SOFWERX, in concert with USSOCOM PEO-Maritime Undersea (PEO-M), will host a series of events to identify solutions to undersea systems fault-tolerant battery technology. A Virtual Collaboration Event (CE) was completed in June of 2021 to (1) promote specific areas of interest, (2) encourage an early exchange of information, and (3) provide an opportunity for both Government and Industry to gather more information prior to the release of a formal solicitation. With valuable information learned from that event, PEO-M is seeking White Paper level proposals that define system level solutions for PEO-M Program Office needs.

United States Special Operations Command (USSOCOM) Special Operations Forces Acquisition, Technology, and Logistics (SOF AT&L) Center is responsible for all USSOCOM research, development, acquisition, procurement, and logistics. SOF AT&L works closely with Government, academia, and industry in meeting its mission to provide rapid and focused acquisition, technology, and logistics support to Warfighters, delivering the most effective capabilities to our Special Operations Forces. Within SOF AT&L, the Program Executive Office for Maritime (PEO-M) is dedicated to providing Special Operations Forces (SOF) Warfighters with operationally effective and sustainable maritime mobility platforms and equipment with its primary customer being the Naval Special Warfare Command (NAVSPECWARCOM).

2 Energy/Power Source Description and Vehicle Interface

The undersea systems Energy Source will provide all power for the system during all mission phases. The undersea systems Energy Source will be a Direct Current (DC) electrical power source, supplying power to the vehicle and its various subsystems. The power source is mounted external to the vehicle's main pressure hull, and must be removable for maintenance and replacement. The power source connects to the vehicle's main electrical bus via electrical cables from the power source to the interior of the vehicle, through penetrations in the vehicle's main pressure hull.
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2.1 Concept of Operation (CONOPS)

The undersea systems Energy Source will be maintained at land-based facility, and will be capable of operating from and land-based facility and from various platforms, including surface ships and submarines. The undersea systems Energy Source will be used to support a broad range of undersea applications and will be required to support those applications over multiple sorties when deployed on a host ship or submarine, during which time physical access to and physical removal/replacement of the energy source will not be possible. The energy/power source must therefore be capable of being replenished (if necessary for multiple sorties) with the vehicle intact and aboard a host platform.

Undersea systems Energy Source will be transported to host platforms or other deployment locations using a combination of air and ground transport. It is intended that the Energy Source will be mounted to the vehicle during transport, and it is a goal to make the energy source's capacity capable of being replenished while being transported.

When not deployed, Energy Source will be housed in a facility where maintenance can be performed on the energy/power source and other subsystems. For vehicle maintenance, the energy/power source must be removable from the vehicle, and will be stored in conditions necessary to maintain the health of the energy/power system.

3 Performance Requirements

3.1 Capacity

The energy/power source must be scalable to overall capacities of > 2000 kWh. The target capacity for a single sortie is 2000 kWh minimum electrical energy to the vehicle, at the power levels and under the usage conditions defined here, at the beginning of life (BOL).

Provide data to support capacity estimates for the proposed energy/power source.

3.2 Specific Energy and Energy Density

The target specific energy is 235 Wh/kg dry weight, and the target energy density is 405 Wh/l.

Weights and volumes used in calculation of specific energy and energy density must include all vehicle-mounted energy/power system containment and management subsystems necessary to operate in the specified environments (e.g. pressure vessels for dry systems, compensating enclosure/components for wet systems, thermal management systems, power conversion components, vehicle-mounted replenishment systems, monitoring and control systems, etc.)

Provide data to support specific energy and energy density estimates for the proposed energy/power source.

3.3 Specific Power and Power Density

The target continuous specific power is 13 W/kg, and the target continuous power density is 22 W/l.

The target peak specific power is 20 W/kg, and the target peak power density is 34 W/l for a duration of 10 minutes.

Weights and volumes used in calculation of specific power and power density must include all vehicle-mounted energy/power system containment and management subsystems necessary to operate in the specified environments (e.g. pressure vessels for dry systems, compensating enclosure/components for wet systems, thermal management systems, power conversion components, vehicle-mounted replenishment systems, monitoring and control systems, etc.)

Provide data to support specific power and power density estimates for the proposed energy/power source.

Describe any special features or any operating restrictions necessary for the proposed energy/power source to meet the specified power levels.

3.4 Voltage

The target output voltage is within a range of 200 VDC to 400 VDC.

If the proposed energy/power source is outside of this range, describe the weight/volume of any power conversion equipment that would be required to meet the specified voltage range.

3.5 Cycle Life

Target cycle life is 300 cycles before degradation to 80 % BOL capacity.

Estimate the cycle life of the proposed energy/power source and provide any data to support those estimates.

3.6 Service Life

Target Service Life is 25 years, with periodic maintenance and replacement of wear-out parts as defined by the manufacturer.

Estimate the service life of the proposed energy/power source and provide any data to support those estimates.

3.7 Temperature and Thermal Environment

The energy/power source, as an objective should be capable of replenishment and discharge in air environments from -18°C to 49°C.

The energy/power source must be capable of operation in submerged temperature environments of -2 °C to 35 °C (including open circuit, discharge at specified continuous and peak rates, and full replenishment to meet turnaround requirements).

Describe any special thermal management features (e.g. active cooling, heating, etc.) or any operating restrictions necessary to operate the proposed energy/power source in the intended thermal environments.

3.8 Air Pressure Environment

The energy/power source must be capable of non-operating air pressure environments of 8.26 psia to14.7 psia, as needed for air transport.

The energy/power source must be capable of full replenishment and discharge at specified continuous rates in ambient air environments of 13.5 psia to14.7 psia, as needed for facility maintenance.

Describe any special features or any operating restrictions necessary to operate the proposed energy/power source in the intended air pressure environments.

3.9 Submerged Pressure Environment

The energy/power source must be capable of operation in submerged pressure environments within an Nitrogen purged pressure vessel if required (including open circuit, discharge at specified continuous and peak rates, and full replenishment to meet turnaround requirements). If there is a compliant technology that allows operation without containment in a Nitrogen (or other gas) purge container, this solution would be preferred but must meet all other requirements.Provide estimates for system dry weight, volume, specific energy, specific power, energy density, and power density as a function of seawater depth including encapsulation or protection methods

3.10 Shock

The energy/power source must be capable of meeting operating and non-operating transportation shock requirements for operational and transportation loads. The energy solution shall not be damaged nor shall subsequent operational performance be degraded as a result of being subjected to the following forces applied statically and independently when properly configured or packaged for transport. This shall be accomplished by installing an accelerometer on the package and dropping the package one time on each of its 6 sides on a flat, hard surface. The peak force on each face of the package shall be calculated using the peak accelerometer reading on each face. The force calculated shall be equal the g-levels shown below. After this test, the unit shall be removed from the package and tested to verify that it meets all performance requirements of this specification."

a. Horizontal (fore, aft and lateral) 3.0 g
b. Up 2.0 g
c. Down 4.5 g

3.2.5.1.4 Transport Vibration. When properly configured or packaged for transport, the Power Supply shall be designed to withstand vibrations up to 2g at 10 to 150 Hz frequency for a period of at least 2 hours.
Describe any special shock/vibration mitigation features or any operating restrictions necessary to operate the proposed energy/power source in shock/vibration environments.

3.11 Vibration

The energy/power source must be capable of meeting operating and non-operating transportation vibration requirements .

Describe any special shock/vibration mitigation features or any operating restrictions necessary to operate the proposed energy/power source in the intended shock/vibration environments.

3.12 Replenishment and Turnaround Time

Target replenishment time is 12 hours maximum for a single sortie replenishment.

Describe the time to replenish the full capacity of the energy source and make it ready for a follow-on sortie, including any times necessary to cool the energy source or otherwise prepare it for replenishment and re-use, under the environmental conditions specified herein.

3.13 Monitoring and Control Systems

The energy/power source must include a “management” system that monitors the health and condition of the energy/power system, that communicates this information to operators and maintainers, and that controls the replenishment and discharge of the system within safe operating limits.

Describe the energy/power source Monitoring and Control system, and features implemented to meet operational and safety requirements.

3.14 Reliability and Redundancy

Estimate the power system availability, reliability, and MTBF/MTTR.

Describe any redundancies implemented to improve reliability, to make the system fault-tolerant, and to provide continued operational capability of the energy/power source after a fault, including any reductions in capacity/power if a fault were to occur.

3.15 Modularity

Modularity is required to enable the energy/power source to be scaled up or down for use in a broad range of undersea applications and from the perspective of maintainability, spares inventory, handling, and allocation of volumes for mounting locations on the vehicle hull.

Describe the modularity of the proposed energy/power source, from the LRU level to the assembly level, including notional dimensional estimates.

3.16 Obsolescence

The proposed energy/power source must be available for procurement by the US Government for 20 years.

Describe any obsolescence challenges and the proposed solutions to meet those challenges.

4 Safety Requirements

The energy/power source shall not contain any single point failures that can lead to a catastrophic release of energy, or to collateral damage of other vehicle subsystems, host platform, and facilities, or to personnel injury or death. Failure may be induced by operational (e.g. overcharging, storage, over discharge…) or physical (e.g. penetration, incursion of contaminants, overpressure…).

Describe features of the proposed power source implemented to prevent single point failures.

Describe the total energy release, release rates, temperatures and related hazards that can result if a single point failure were to occur (due to manufacturing defect, component wear-out, or other causes).

Describe features of the proposed power source implemented to prevent a single point failure from propagating to other parts of the energy system.

Describe the total energy release, release rates, temperatures and related hazards that can result if a single point failure were to propagate to other parts of the energy system, and any features implemented to mitigate the effects of a propagating failure.

Describe any operating restrictions necessary to prevent single point failures, their propagation, or the effects thereof.

5 Performance Requirements

The Energy Source must be presented as a long term solution to supporting a broad range of undersea applications and any other Maritime system (e.g., CCM Surface CraftIt is recognized that it is impossible to forecast available technology in that timeframe but the White Paper needs to address the plan for achieving a high TRL/MRL for delivery and full scale production to include the following considerations.

5.1 Supply Chain

A secure and reliable supply chain is critical to providing energy solutions to serve the SOCOM missions Material, storage, shipping and sourcing considerations should be discussed. If software or computer systems are part of the solution, system and cyber security provisions or risks must be addressed..

5.2 Support and Maintainability

The general assumption for most systems of this complexity will have a 20 to 25 year service life following a 5 year development and test cycle. The White Paper needs to describe the expected longevity of the offered solution and the most likely support methods. With many traditional systems with volatile technology this may take the form of advanced procurement and storage for the life-cycle, preplanned product improvement or other support methods.

5.3 Preplanned Product Improvement

As discussed in section 6.2 Preplanned Product Improvement (P3I) is often designed into a solution that is expected to have a technology life cycle that is shorter that the useful operational life of the system that it is supporting. The White Paper needs to discuss what provisions need to be made to facilitate the offered technology. This includes both the energy solution and support systems such as the Battery Management System.

6.4 Material Availability and Sourcing

Sourcing should comply with the Buy America Act. The White Paper should describe key materials that are not domestically sourced, especially those coming from near peer adversaries or countries of know instability or conflict.

5.5 Environmental

The White Paper should discuss environmental impact of the offered solution especially as related to the manufacturing, operation, support and post decommissioning recycling. Discussion of key recoverable or reusable elements that will have a positive environmental impact should be discussed.

5.6 Commercial Applicability

Although the solution being sought is for a specific Maritime application, the White Paper should discuss the other potential applications of demonstrably similar applications. This would include a discussion of other defense or industry sectors who may be interested in co-development or co-production of the offered technology.