Department of the Navy SBIR/STTR Transition Program

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Topic # N18A-T023
Operational Sand and Particulate Sensor System for Aircraft Gas Turbine Engines
Creare LLC

WHO

SYSCOM: ONR

Sponsoring Program: Power and Propulsion

Transition Target: Rotary Wing Aircraft

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Other transition opportunities: The EPIC sensor can be adapted for different applications through modification of interface to account for differences in engine geometry and flow path.The EPIC sensor is sufficiently small to enable mounting on a variety of different aircraft and turbine engine nacelles. Measurements by the sensor could also be adapted to advanced fighter aircraft, turbofan engines, or utilized by other turbine-powered platforms such as the Navy's Ship to Shore Connector or the Army's Abrams Tank.

050427-N-7286M-038 U.S. Navy photo by Photographer's Mate 2nd Class Daniel R. Mennuto

Notes: Particle ingestion in gas turbine engines impacts engine lifetime, durability, and maintenance schedules. High sand and dust loadings can cause cooling holes to become plugged and erosion of components such as turbine blades. In the most extreme cases, ingested sand and dust particles can lead to compressor stall and result a sudden in-flight engine failure and loss of the aircraft.

WHAT

Operational Need and Improvement: A Naval gas turbine may process up to one million pounds of air during each two-hour sortie with instantaneously varying contaminant levels. Ingestion of coarse sand to fine dusts, aerosol particulates, organic dirt, aerosol and water-spray salts at low altitudes, uniquely volcanic ash generally at high altitudes, and any similar natural minerology encountered in the operational environment is a significant safety hazard and maintenance degrader. As engines are operated to higher gas and component surface temperatures, rapid accumulation of the combined dusts and salt may generate molten fusions in turbine hot sections, especially when low melting temperatures mixtures are ingested.

Specifications Required: Project requirements: 1. Determine and justify needed measurement uncertainty requirements for the various measurement characteristic options. 2. Identify steps to meet the overall device specifications within a specific application context including what attributes should be included within any new context to improve either affordability, measurement fidelity, or reliability.

Technology Developed: Creare and our partners are developing a novel sensor technology for measuring AND characterizing sand and dust ingestion in gas turbine engines. We call our sensor EPIC: Engine Particle Ingestion Classifier. The EPIC sensor is a hybrid combining an optical backscatter probe for counting and sizing particles, with an X-Ray Fluorescence (XRF) sensor for measuring the elemental composition of the particles. The Creare EPIC will measure particle size, loading, and composition onboard an aircraft. The sensor is inherently compact and lightweight, and does not require probes or sampling tubes that interact with the flow.

Warfighter Value: Creare's EPIC technology will prevent aircraft mishaps because pilots will have early warning of possible engine failure due to sand and dust ingestion. EPIC also fully supports Navy initiatives to improve readiness and reduce sustainment costs. Information provided by EPIC will enable data-driven decisions on major component replacement intervals, and enhance baselines for repairable component lifecycles. Integration of EPIC data will also facilitate higher fidelity root cause analysis of engine performance degraders as well as enable rapid engineering investigations of failed or suspect components. This new capability will preemptively identify readiness constraints and drive down sustainment costs.

WHEN

Contract Number: N68335-20-C-0093

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Demonstrate the feasibility of the optical component of the EPIC technology	Low	Validation in laboratory sand and dust environment	5	1st QTR FY22
Demonstrate a new capability to classify particles ingested in gas turbine engines	High	Established XRF detection limits in laboratory sand and dust environment	5	1st QTR FY22
Develop Integration Hardware	Med	Meet SWaP Requirements	5	1st QTR FY22
Engine tests and finalize product	Med	Validation in ground engine test	6	2nd QTR FY23
Flight certification	Low	EPIC Sensor certified for flight	6	3rd QTR FY24

HOW

Projected Business Model: As we intend to provide a prototype that has been validated in a laboratory environment at the end of Phase II, EPIC is an ideal candidate for further maturation as an Office of Naval Research (ONR) Future Naval Capability (FNC) that could reach the fleet within three years. By leveraging the FNC construct to transition EPIC, we will identify which Navy platform is best suited to adapted and iterate a ruggedized design so we can mature the sensor for a specific application of interest to a Navy acquisition sponsor. This approach will facilitate the best partnerships going forward to reduce program risk, and utilize cost-effective methods to further improve affordability, measurement fidelity, and reliability of the EPIC sensor.

Company Objectives: Licencing our EPIC technology to a prime manufacturer of high performance optical equipment.

Potential Commercial Applications: The adaptability of the EPIC makes it appropriate for a variety of different aircraft and turbine engine nacelles of ground assault vehicles and support equipment. There is great potential for opening the overall market to other DoD services and the Department of Homeland Security to further prove reliability for applications in civil aviation.

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