Department of the Navy SBIR/STTR Transition Program

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NAVAIR 2020-846

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

WHO

SYSCOM: NAVAIR

Sponsoring Program:

Transition Target: Initially targeted aircraft engine platforms include SH-60 Seahawk (GE T-700 engines) and V-22 Osprey (Rolls Royce AE1107C engines). NAVAIR has developed a sand ingestion facility for testing the T-700.

TPOC:
(703)696-7917

Other transition opportunities: This particulate sensing system can be applied to any gas turbine engine platforms. It is particularly applicable to engines that experience high dust loading, such as Navy, Marine and Army helicopters. It may also be applied to other non-turbine engine platforms. This particle sensing technology is applicable to sensing of particulates in both gases and liquids.

US Navy photo, available at https://www.navy.mil/view_image.asp?id=56727 and https://www.navy.mil/management/photodb/photos/080316-F-2114K-325.jpg with Hal Technology created photo overlaid

Notes: SH-60 Seahawk helicopter sets off dust and dirt as it lands

WHAT

Operational Need and Improvement: The Navy desires a sensor for assessment of an aircraft engine's exposure to dust and particulates. 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 mineralogy from global Naval littoral spaces are currently ingested into Naval propulsion and power gas turbines in large but unknown and variable amounts. Significant internal accumulations are at times seen in repair processing, occluding both hot-primary and cooler-secondary flowpaths. A Naval gas turbine may process up to one million pounds of air during each two-hour sortie with instantaneously varying contaminant levels. 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: It is desired to create a flight-weight, low-volume, engine-integrated sensor system that can measure instantaneously and trending over full-engine life, the total mass, inlet loading rate, particle size distribution, compositional melting point, and salt-fractions.

Technology Developed: The Hal Technology developed sensor can non-intrusively measure the real-time dust loading within the flowpath of a gas turbine engine and the technology platform is also being extended to determine the material composition of the dust. The sensor system can operate in harsh environments because the sensor head(s) are separated from the electronics unit by optical fibers. One patent has already been granted.

Warfighter Value: The sensor can be integrated into many aircraft engines and engine health management systems and can be used to both avoid regions with high dust levels and perform condition-based maintenance. It will contribute engine in-flight risk assessment to damaging events from volcanic ash and low melting temperature mixtures. The sensor will be capable of reporting historical exposure rates and ingestion totals in all air-breathing operating environments and altitudes.

WHEN

Contract Number: N68335-19-C-0669 **Ending on:** March 31, 2023

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Verification of sensor probe performance	N/A	Measured particle size, concentration, and distribution of a dust standard	5 for sizing	April 2016
Durability testing of sensor probe	N/A	Probe behavior unaffected after 24 hours of high particle rate exposure	6 for sizing	October 2019
Dust ingestion sensor system(s) that can measure particle size, distribution, and concentration delivered to NAVAIR	Low	Measuring particulate loading rates in T-700 engines	6 for sizing	September 2021
If Option exercised, enhanced dust ingestion sensor system(s) that can additionally include material identification delivered to NAVAIR	Med	Identifying particulate composition in T-700 engine	6 for material identification	March 2023

HOW

Projected Business Model: Hal Technology's goal is to transition this technology to a gas turbine engine sensor manufacturer with flight qualification and mass production experience for eventual integration into government and prime contractor engine health management systems. While we can continue to drive the technology aspects of the development, we realize that we are a small company that does not have the resources or experience to deal with the flight qualification process.

Company Objectives: Technology briefings have been presented to each of the three main gas turbine prime manufacturers and each has expressed interest in our technology and offered testing services once the technology has been further developed. We are still looking to identify a gas turbine engine sensor manufacturer for making the transition. We anticipate preliminary evaluation of our sensor on an engine test with one of the gas turbine prime manufacturers before the end of 2020.

Potential Commercial Applications: This sensor system can be applied to particulate sensing on any engine platforms, including gas turbine and diesel engines. This particle sensing technology is applicable to both gases and liquids, and could also be used to measure particulate contamination in oil. The fiber-optic sensor implementation will also find unique applications and result in a family of new products. Once the material identification capability of this particle sensor system is realized, the particle sensors and instruments market will become another avenue for commercialization, and this market size is over $10 billion/year.

Contact: Gregor Waldherr, Principal Engineer
gwaldherr@haltechnologies.com 9092026205