Topic: N17A-T003

Combustion Science & Engineering, Inc.

Ignition Modeling for Present and Future Combustors and Augmentors

Ignition issues, including difficulties with high-altitude relight, are a complex phenomenon involving turbulent flow, combustion chemistry and heat transfer. To handle these challenges, the current technology consists of a physics-based approach to model the ignition process in devices such as combustors and augmentors. Our innovative tool can be used to determine the proper placement of an ignitor in the combustion device, to assist in understanding problems with high altitude relight under specific flight conditions or in designing ignitors with specific characteristics for optimal ignition probability. This technology is applicable to current and future Navy aircraft, as well as propulsion systems for all branches of the military, or any device with a combustion system, including power generation systems (e.g. gas turbines and boilers). This tool is physics-based, relying on fundamental principals in modeling the ignition process, and has been validated and tested using experimental data from a variety of different combustion systems.

Technology Category Alignment:

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SYSCOM: NAVAIR
Contract: N68335-18-C-0860

Booth: 405
Room: FST at AIAA Aviation 2020
Corporate Brochure: https://navystp.com/vtm/open_file?type=brochure&id=N68335-18-C-0860

Department of the Navy SBIR/STTR Transition Program

NAVAIR 2019-1082

Topic # N17A-T003

Ignition Modeling for Present and Future Combustors and Augmentors

Combustion Science & Engineering, Inc.

WHO

SYSCOM: NAVAIR

Sponsoring Program:

Transition Target: PMA-265 for the F/A -18

TPOC:
(301)757-4201

Other transition opportunities: This technology is useful for engineering centers and technology development groups within DOD and in contractors involved in aircraft and combustor design. The technology can be used by the developers in a consulting role when working with engineers and designs from both the government or OEMs.

Navy released image 190414-N-PI330-0002.jpg from https://www.navy.mil/viewGallery.asp

WHAT

Operational Need and Improvement: Having the ability to predict the optimal location and energy setting of an ignition kernel in a combustor or augmentor at any/all flight conditions will reduce the required energy for ignition at most flight envelope conditions. This ability will extend the life of the ignition system, while reducing costs to the warfighter. Understanding the ignition limits of a combustor or augmentor could expand the operation envelope of an aircraft currently limited by engine high-altititude re-ignition conditions, increasing the capabilities of the warfighter. Current modeling technology uses simple empirical correlations to determine ignition likelihood. These models imply a relationship between blowout physics and ignition physics that may be unfounded. The probabilistic determination of location and magnitude of delivered energy for optimal relight performance is paramount to designing a viable replacement to current ignition systems.

Specifications Required: This analysis tool should be capable of predicting the probability of ignition at operating conditions relevant to Navy propulsion systems and aviation fuels. The analysis tool must be made modular by specifying standardized Application Programming Interfaces (APIs) which enable the models to be utilized as libraries in turbulent reacting flow codes relevant to current and future Navy gas turbine engine applications of interest, such as operation envelope and system durability improvement.

Technology Developed: The current technology consists of a physics-based approach to model the ignition process in devices such as combustors and augmentors. Our innovative tool can be used to determine the proper placement of an ignitor in the combustion device, to assist in understanding problems with high altitude relight under specific flight conditions or in designing ignitors with specific characteristics for optimal ignition probability.

Warfighter Value: Numerous high-performance aircraft encounter issues with stabile combustion throughout their entire flight envelope. The inability to quickly and fully re-ignite an engine after blowout puts the operators of the aircraft in danger from sudden loss of thrust. Furthermore, a constant maintenance concern for any aircraft is the ignition system, for both the main combustors and for the afterburners/augmentors. The ability to predict the ignitibility potential of a combustor at various operating conditions is not practical at this time due to the complexity of this process.

WHEN

Contract Number: N68335-18-C-0860 **Ending on:** September 27, 2020

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Development of Multi-Dimensional Ignition Model	Med	Validation against Experimental Data	5	June 2020
Ignition Mapping Design Tool	Low	Validation against Experimental Data	5	March 2020

HOW

Projected Business Model: CSE anticipates that the revenue from this work will be generated from providing engineering services to the large defense contractors (OEMs) and government agencies for design and analysis of new and existing combustion systems. Futhermore, the technology could be licensed to similar organizations who wish to conduct these studies in-house. CSE also envisions using the high-fidelity nature of these tools to design or modify existing ignition systems to optimize their characteristics for high-performance aircraft operating over a wide flight envelope. This work could be done with an OEM who specializes in manufacturing ignition systems for military aircraft.

Company Objectives: The short-term objective is to find a transition program and/or partner that will enable testing and validation of the technology in relevant operating environments. Longer term objectives include identifying potential partners for commercializing this technology as well as additional modeling technologies that CSE has developed for combustor design and simulation.

Potential Commercial Applications: The technology developed in this project will have applications to commercial aircraft to improve operation, maintenance and reliability of these engines. Large defense contractors, such as Pratt & Whitney and General Electric, also sell combustor hardware in the civilian aviation markets where this capability can improve.

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