

Advanced Compatibility Characterization Of AF-M315E With Spacecraft Propulsion System Materials Project

Center Innovation Fund: JSC CIF (Also Includes JSC IRAD) Program
Space Technology Mission Directorate (STMD)

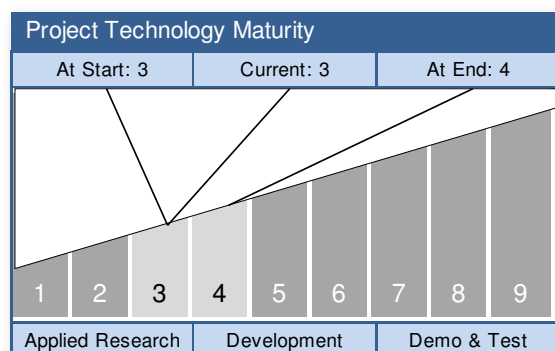
National Aeronautics and
Space Administration



ABSTRACT

All spacecraft require propulsion systems for thrust and maneuvering. Propulsion systems can be chemical, nuclear, electrical, cold gas or combinations thereof. Chemical propulsion has proven to be the most reliable technology since the deployment of launch vehicles. Performance, storability, and handling are three important aspects of liquid chemical propulsion. Bipropellant systems require a fuel and an oxidizer for propulsion, but monopropellants only require a fuel and a catalyst for propulsion and are therefore simpler and lighter. Hydrazine is the state of the art propellant ...**Read more on the last page.**

Material Tests with AF-M315E



Technology Area: In-Space Propulsion Technologies TA02 (Primary)

ANTICIPATED BENEFITS

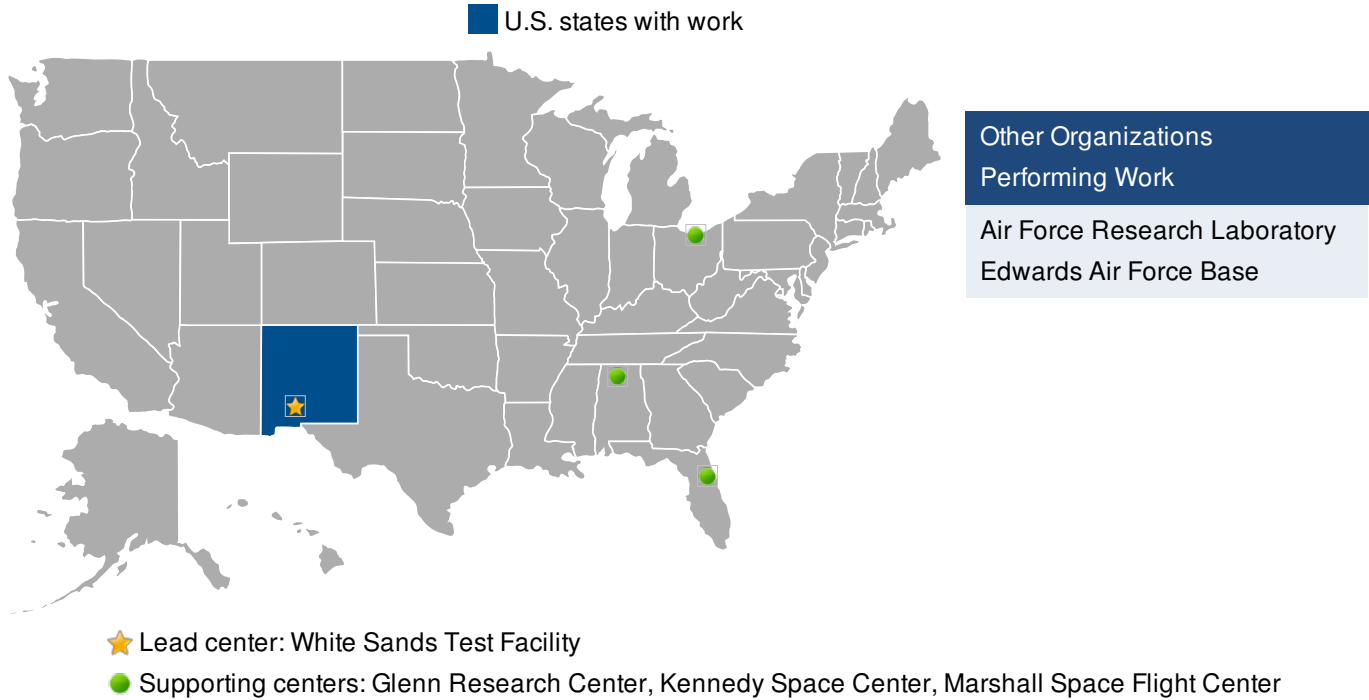
To NASA funded missions:

Green Propellant Infusion Mission (GPIM)

To NASA unfunded & planned missions:

AF-M315E offers greatly reduced toxicity, safety, and environmental issues, as well as increased performance compared to hydrazine. AF-M315E monopropellant has been selected by NASA's Headquarters (HQ) Space Technology and Mission Directorate Green Propellant Infusion Mission (GPIM) as a candidate to replace monopropellant ...

Read more on the last page.



DETAILED DESCRIPTION

This project will apply advanced techniques to characterize the engineering properties of materials used in AF-M315E propulsion systems after propellant exposure. AF-M315E monopropellant has been selected by NASA HQ's Green Propellant Infusion Mission (GPIM) to replace toxic hydrazine for improved performance and reduce safety and health issues that will shorten reusable spacecraft turn-around time.

The compatibility of propulsion system materials with AF-M315E is not well characterized and a specification for the propellant has not been finalized. The corrosion and degradation properties of materials available to design engineers will be examined and corrosion/degradation will be reduced by surface modification. This work will provide data for the selection and improvement of candidate materials used in AF-M315E spacecraft propulsion systems with potential applications to ground support equipment and an improved propellant specification.

WSTF has developed and used in previous work the infrastructure and experience to perform the tests which AF-M315E's classification as an explosive requires.

The goal of this project is to provide enhanced material and fluid compatibility data for designers to build ...

MANAGEMENT

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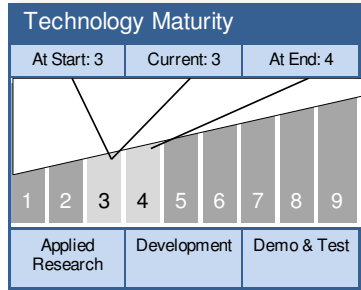
DETAILED DESCRIPTION (CONT'D)

spacecraft and GSE with a higher degree of confidence. In addition, a specification suitable for characterizing the fluid will be provided. The compatibility of propulsion system materials with AF-M315E is not well characterized, there is little information in the literature, and few entities have performed material and fluid compatibility testing. In addition, this project will fundamentally strengthen JSC's core competency to evaluate, use and infuse liquid propellant systems.



TECHNOLOGY DETAILS

Advanced Compatibility Characterization of AF-M315E with Spacecraft Propulsion System Materials



TECHNOLOGY DESCRIPTION

The selected topic area falls under HAT # 2.1.c (Non-Toxic Reaction Control Engines) and TABS # 2.1.1 (Non-toxic propellants with improved performance, safety, handling, and reduced ground operations requirements). Performance Targets include reduced time for ground operations with better safety and reduced handling risks. AF-M315E toxicity data has been identified as meeting the better safety and reduced handling risks criteria. This project will characterize and enable selection of compatible materials for use in engines and GSE that will, in addition, improve benefits for ground ops because of superior material selection, will enable less refurbishment requirements and longer engine lifetimes. By selecting corrosion resistant materials or by improving the corrosion resistance of materials, stress corrosion cracking, catalyst bed poisoning, out-of-specification propellant, and flow decay issues may be reduced or avoided. These corrosion issues not only jeopardized flight but increased ground ops refurbishment and maintenance requirements of spacecraft components. Ground ops time and associated costs with hardware replacement/refurbishment and propellant maintenance (i.e. treatment with molecular sieve technology) may be greatly reduced.

This technology is categorized as a material for unmanned flight

- Technology Area
 - TA02 In-Space Propulsion Technologies (Primary)

The intended products of the project activity are tests, data, standard procedures, and technical reports and presentations (NASA and/or JANNAF), an evaluated MIL specification. Gas evolution rates may be acquired to quantify the catalytic nature of test materials towards AF-M315E decomposition. Accelerated rate calorimetry, adiabatic compression test data may also be acquired.

Expected outcomes of this project are enhanced material and fluid compatibility data to provide designers critical tools to build spacecraft and GSE with a higher degree of confidence, and a specification suitable for characterizing the fluid. This project also aims to provide an increase in the Technology Readiness Level (TRL) from 3 (Proof-of-Concept) to 4 (Technology ...

Performance Metrics		
Metric	Unit	Quantity
Military Specification Analysis Verification	ea	1

TECHNOLOGY DETAILS

CAPABILITIES PROVIDED (CONT'D)

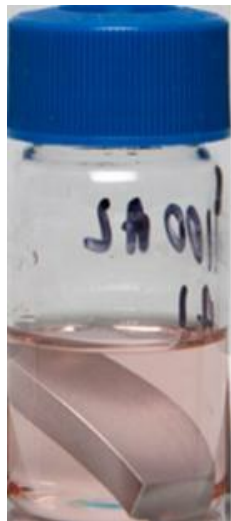
Demonstration).

POTENTIAL APPLICATIONS

GPIM, NASA's HQ Space Technology and Mission Directorate green propellant initiative, DoD, and commercial entities such as Aerojet will use the data generated from this project to improve spacecraft design and performance. The Chemical Propulsion Information Analysis Center (CPIAC) and Joint Army-Navy-NASA-Air Force (JANNAF) Propellant and Explosives Development mission area and Liquid Propellants Panel are forums for technical transfer of this information. Reference literature and a vetted specification will be technical benefits. This project will fundamentally strengthen JSC's core competency to evaluate, use and infuse liquid propellant systems.



IMAGE GALLERY



Material tests with AF-M315E

ABSTRACT (CONTINUED FROM PAGE 1)

for monopropellant systems, but has drawbacks because it is highly hazardous to human health, which requires extensive care in handling, complex ground ops due to safety and environmental considerations, and lengthy turnaround times for reusable spacecraft. All users of hydrazine monopropellant must contend with these issues and their associated costs. The development of a new monopropellant, intended to replace hydrazine, has been in progress for years.

This project will apply advanced techniques to characterize the engineering properties of materials used in AF-M315E propulsion systems after propellant exposure. AF-M315E monopropellant has been selected HQ's Green Propellant Infusion Mission (GPIM) to replace toxic hydrazine for improved performance and reduce safety and health issues that will shorten reusable spacecraft turn-around time. In addition, this project will fundamentally strengthen JSC's core competency to evaluate, use and infuse liquid propellant systems.



ANTICIPATED BENEFITS

To NASA unfunded & planned missions: (CONT'D)

hydrazine. As a new propellant, many engineering issues require solutions. One of the most important of these is materials selection. The fluid must be compatible with the materials that are used to preserve the integrity of both the fluid and the propellant, and a specification is needed to define fluid quality. The goal of this project is to provide enhanced material and fluid compatibility data for designers to build spacecraft and GSE with a higher degree of confidence. In addition, a specification suitable for characterizing the fluid will be provided. The compatibility of propulsion system materials with AF-M315E is not well characterized, there is little information in the literature, and few entities have performed material and fluid compatibility testing.

To other government agencies:

Department of Defense

To the commercial space industry:

Increasing the TRL of lower toxicity propellants will make them more attractive to the commercial space industry.

To the nation:

White Sands Test Facility (WSTF) has been engaged in compatibility testing and has taken the lead in laboratory testing for all of NASA. This project will extend and apply advanced techniques to characterize the engineering properties of materials used in AF-M315E propulsion systems after propellant exposure and to characterize the propellant during and after exposure. Materials including metals, non-metals, composites and advanced materials will be exposed to AF-M315E under various conditions including accelerated aging conditions and post-immersion materials and fluid properties will be examined. Advanced materials will be identified in collaboration with the user community. This work will provide data for the selection of candidate materials used in AF-M315E propulsion systems with potential applications to ground support equipment as well as to apply surface modification techniques to improve material compatibility. For example, the improvement of aluminum and titanium alloy compatibility with respect to corrosion will be addressed. In addition to the materials testing aspect of this project, the fluid characterization aspect of the project will be addressed. A draft military specification for AF-M315E will be evaluated and input provided to the preparing organization. Evaluation of the draft specification will include trial and examination of the proposed testing protocols and the resolution of inherent issues and issues that are found. The

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ANTICIPATED BENEFITS

To the nation: (CONT'D)

draft military specification will serve as an important part as a basis for evaluating posttest fluid characteristics. Evaluating and improving the draft specification is also part of this project because the analyses are numerous and complex and WSTF chemists experienced in propellant specification analysis will apply innovative techniques to improve and lower the cost of a specification analysis.

