

## Green Monopropellant Status at Marshall Space Flight Center

### Authors:

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NASA Marshall Space Flight Center is continuing investigations into the use of green monopropellants as a replacement for hydrazine in spacecraft propulsion systems. Work to date has been to push technology development through multiple activities designed to understand the capabilities of these technologies. Future work will begin to transition to mission pull as these technologies are mature while still keeping a solid goal of pushing technology development as opportunities become available.

The AF-M315E activities began with hot-fire demonstration testing of a 1N monopropellant thruster in FY 14 and FY15. Following successful completion of the preliminary campaign, changes to the test stand to accommodate propellant conditioning capability and better control of propellant operations was incorporated to make testing more streamlined. The goal is to conduct hot-fire testing with warm and cold propellants using the existing feed system and original thruster design. Following the 1N testing, a NASA owned 100 mN thruster will be hot-fire tested in the same facility to show feasibility of scaling to smaller thrusters for cubesat applications. The end goal is to conduct a hot-fire test of an integrated cubesat propulsion system using an SLM printed propellant tank, an MSFC designed propulsion system electronic controller and the 100 mN thruster.

In addition to the AF-M315E testing, MSFC is pursuing hot-fire testing with LMP-103S. Following our successful hot-fire testing of the 22N thruster in April 2015, a test campaign was proposed for a 440N LMP-103S thruster with Orbital ATK and Plasma Processes. This activity was funded through the Space Technology Mission Directorate (STMD) ACO funding call in the last quarter of CY15. Under the same funding source a test activity with Busek and Glenn Research Center for testing of 5N AF-M315E thrusters was proposed and awarded. Both activities are in-work with expected completion of hot-fire testing by the end of FY17.

MSFC is continuing to coordinate with the AF and academia on understanding the chemical reactions that occur in AF-M315E. An on-going investigation of the catalyst bed species using Raman Spectroscopy through the NASA Technology Research Fellowship Program (NSTRF) is looking for ways to minimize the amount of computation required by understanding the intermediate species created in the catalyst bed.

The MSFC team is also working with commercial partners through Cooperative Agreement Notices (CAN's). Partnerships with commercial and academia include work in non-catalytic ignition of AF-M315, spark ignition of hybrid cubesat systems, printed SLM tanks, and dual-mode (electric and chemical) propulsion systems is continuing.