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QUALIFYING AN ADDITIVELY MANUFACTURED LIQUID ROCKET ENGINE FOR HOT-FIRE READINESS

Abstract

This paper covers the testing campaign conducted on an additively manufactured bi-propellant (LOX/Kerosene) liquid rocket engine to qualify it for hot-fire readiness. The engine, codenamed Balerion (IAC-18,C4,5,10,x45214), is a developmental class liquid rocket engine designed to produce 10 kN of thrust and will be iterated into a flight-ready configuration to integrate onto WIRES#13; a Japanese launch vehicle being developed by the Kyushu Institute of Technology. This development engine was used to characterize performance capabilities when using additive manufacturing, regenerative cooling, film cooling, and pintle injection.

All tests conducted on the engine and feed system are covered in detail with testing requirements, setup, operations, and results. The initial tests involved qualifying the engines' structural integrity and sealing capabilities for safety considerations. With pintle injection relying on the same flow as the regenerative channels, it was key to ensure that the flow was equalized as it traveled from the bottom of the nozzle up to the injector. Once at the injector, it was important to see the cone formation from the collision of fuel (spraying axially) and oxidizer (spraying radially) entering the combustion chamber as it was used to predict potential combustion instabilities before the hot-fire. These are but a few critical tests conducted as part of a full campaign to qualify the engine. Various cold flows were done to characterize the engine performance, feed system reliability, propellant/igniter timing, sensor accuracy, and the overall safety of the system. This all led up to a successful hot-firing of the Balerion development engine.