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Title:
"Comparison of Single-Element and Multi-Element Oxygen/RP-1 Oxidizer-Rich Staged-Combustion Injector Hot-Fire Test Results"

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Abstract:

As part of the Combustion Stability Tool Development project funded by the Air Force Space and Missile Systems Center, the NASA Marshall Space Flight Center designed, fabricated, assembled and hot-fire tested an oxygen/hydrocarbon propellant multi-element integrated test article that included an oxidizer-rich oxygen/hydrocarbon propellant preburner and a staged-combustion main injector. Also as part of this project, the Air Force Research Laboratory fabricated single-element main injectors of the same designs as used in the NASA multi-element injectors, and tested them in a staged-combustion integrated test article that used an oxidizer-rich oxygen/hydrogen propellant preburner. Final results of the multi-element and single-element staged-combustion main injector test programs are described in companion papers at this JANNAF meeting. The design, development, and preliminary test results of these main injectors have also been described in previous JANNAF papers. The main injector element designs were all based on relatively conventional gas-centered swirl coaxial injector element configurations such as used in Russian RD-170 and NK-33 engines, and planned for use in future U.S.-built experimental engine systems such as the Hydrocarbon Boost program demonstration engine. Four different elements were tested in both the multi-element and single-element main injectors, at similar combustion chamber pressures, chamber contraction ratios, and mixture ratios. Variations of the element features included recess depth, fuel gap width, and the presence of the sleeve separating the swirling fuel flow from the axial oxidizer flow. This paper compares the hydraulics, combustion performance, stability, and compatibility characteristics of the single-element and multi-element injectors operated at similar conditions. The single-element hardware is shown to have captured a significant level of the operability of the multi-element hardware.