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C3Or4A-01: Upgrades and initial weathering test results of the liquefied natural gas testbed at NASA Kennedy Space Center

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Responding to commercial space launch vehicle providers developing rocket engines fueled by liquefied natural gas (LNG) in recent years, NASA began exploring the so-called "weathering"of the cryogenic mixture —the preferential evaporation of lower boiling point constituents over time, leading to a change in the bulk liquid composition. Due to relatively long delays between launches historically, cryogenic propellants sit idle in storage tanks, with the normal boiloff vented to atmosphere. In the case of LNG, boiloff gas would primarily be methane, the main constituent in the mixture, leading to a build-up of other species in the bulk liquid, which could affect engine performance or cause a violation of launch commit criteria. To better understand LNG weathering, in 2019 NASA performed boiloff testing using a custom 400-L dewar with five vertical sample ports within the fluid volume. Samples were routed to a gas analyzer to determine the compositional change over time. Although successful, numerous system improvements were identified following the 2019 campaign. In 2022, NASA funded an effort to perform these improvements and conduct additional testing, which culminated in two successful LNG tests in 2024. Upgrades to the LNG testbed will be presented, as well as the new weathering test results.

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