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JANNAF
PIB / 11th MSS / 9th LPS / 8th SPS
Joint Subcommittee Meeting
5 – 9 December 2016

Abstract Due Date: Monday, 11 July 2016

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Architectures for extended duration missions often include an on-orbit replenishment of the space vehicle's cryogenic liquid propellants. Such a replenishment could be accomplished via a tank-to-tank transfer from a dedicated tanker or a more permanent propellant depot storage tank. Minimizing the propellant loss associated with transfer line and receiver propellant tank thermal conditioning is essential for mass savings. A new methodology for conducting tank-to-tank transfer while minimizing such losses has been demonstrated.

Charge-Hold-Vent is the traditional methodology for conducting a tank-to-tank propellant transfer. A small amount of cryogenic liquid is introduced to chill the transfer line and propellant tank. As the propellant absorbs heat and undergoes a phase change, the tank internal pressure increases. The tank is then vented to relieve pressure prior to another charge of cryogenic liquid being introduced. This cycle is repeated until the transfer lines and tank are sufficiently chilled and the replenishment of the propellant tank is complete. This method suffers inefficiencies due to multiple chill and vent cycles within the transfer lines and associated feed system components. Additionally, this system requires precise measuring of cryogenic fluid delivery for each transfer, multiple valve cycling events, and other complexities associated with cycled operations.

To minimize propellant loss and greatly simplify on-orbit operations, an alternate methodology has been designed and demonstrated. The Vented Chill / No Vent Fill method is a simpler, constant flow approach in which the propellant tank and transfer lines are only chilled once. The receiver tank is continuously vented as cryogenic liquid chills the transfer lines, tank mass and ullage space. Once chilled sufficiently, the receiver tank valve is closed and the tank is completely filled. Interestingly, the vent valve can be closed prior to receiver tank components reaching liquid saturation temperature. An incomplete fill results if insufficient energy is removed from the tank's thermal mass and ullage space. The key to successfully conducting the no vent fill is to assure that sufficient energy is removed from the system prior to closing the receiver tank vent valve. This paper will provide a description of the transfer methodology and test article, and will provide a discussion of test results.

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- Direct questions to Shelley Cohen, by phone at 410.992.7302 x 215, or email to scohen@erg.jhu.edu.