HABITABILITY ASSESSMENTS AND LESSONS-LEARNED FROM 3-DAY AND 11-DAY ENRICHED OXYGEN HYPOBARIC CHAMBER TESTS AT NASA JOHNSON SPACE CENTER

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INTRODUCTION: Decompression sickness (DCS) is a risk to the health and performance of astronauts and high-altitude aircrew. Tolerance to flammability, hypoxia, prebreathe duration, and DCS risk varies across different organizations, vehicles, suits, and destinations, necessitating a variety of DCS risk mitigation approaches. Existing models of altitude DCS risk are often insufficient to enable accurate risk-informed decisions during hardware development, mission planning, and flight operations.

METHODS: NASA completed outfitting of a dedicated facility at Johnson Space Center to support testing of up to eight human subjects for multiple days in hypobaric and enriched oxygen atmospheres. The primary purpose of the testing capability is validation of DCS risk mitigation protocols for Artemis missions to the Moon; however, it will also support development and validation of a generalizable altitude DCS risk estimation tool.

A 3-day and an 11-day prebreathe validation test were completed in 2022, each with 8 human subjects living at 56.5 kPa (8.2 psia), 34% O_2, 66% N_2, with 5 simulated EVAs performed on masks at 29.6 kPa (4.3 psi), 85% O_2, 15% N_2. Facility and organizational lessons-learned and process improvements were recorded during and following the tests, and subjective habitability ratings were recorded daily during the 11-day test. Hypoxia and DCS-related physiological and cognitive outcome measures were recorded during both tests and are reported in companion presentations.

RESULTS & DISCUSSION: All subjects completed each of the tests. Primary habitability issues related to mask discomfort during simulated EVAs and poor sleep quality due to thin mattresses. Polybenzimidazole (PBI) clothing was worn by all subjects due to the increased fire risk and may be required for Artemis missions; clothing was found to be acceptable overall with the worst ratings being due to poor fit and inelasticity. Chamber O_2 and CO_2 sensor inconsistency was observed that did not result in test termination but required post-test follow-up. Forward plans include additional hypobaric testing and integration of existing and future physiological outcome data into an open-source Aerospace Estimation Tool for Hypobaric Exposure Risk (AETHER). NASA is also working to make the testing capability available to commercial companies.