

Space Suit Portable Life Support System (PLSS) 2.0 Human-in-the-Loop (HITL) Testing

The space suit Portable Life Support System (PLSS) 2.0 represents the second integrated prototype developed and tested to mature a design that uses advanced technologies to reduce consumables, improve robustness, and provide additional capabilities over the current state of the art. PLSS 2.0 was developed in 2012, with extensive functional evaluations and system performance testing through mid-2014. In late 2014, PLSS 2.0 was integrated with the Mark III space suit in an ambient laboratory environment to facilitate manned testing, designated PLSS 2.0 Human-in-the-Loop (HITL) testing, in which the PLSS prototype performed the primary life support functions, including suit pressure regulation, ventilation, carbon dioxide control, and cooling of the test subject and PLSS avionics. The intent of this testing was to obtain subjective test subject feedback regarding qualitative aspects of PLSS 2.0 performance such as thermal comfort, sounds, smells, and suit pressure fluctuations due to the cycling carbon dioxide removal system, as well as to collect PLSS performance data over a range of human metabolic rates from 500-3000 Btu/hr.

Between October 27 and December 18, 2014, nineteen two-hour simulated EVA test points were conducted in which suited test subjects walked on a treadmill to achieve a target metabolic rate. Six test subjects simulated nominal and emergency EVA conditions with varied test parameters including metabolic rate profile, carbon dioxide removal control mode, cooling water temperature, and Liquid Cooling and Ventilation Garment (state of the art or prototype). The nineteen test points achieved more than 60 hours of test time, with 36 hours accounting for simulated EVA time. The PLSS 2.0 test article performed nominally throughout the test series, confirming design intentions for the advanced PLSS. Test subjects' subjective feedback provided valuable insight into thermal comfort and perceptions of suit pressure fluctuations that will influence future advanced PLSS design and testing strategies.