

Thermal Performance Testing of EMU and OSS Liquid Cooling Garments

Richard Rhodes and Grant Bue
NASA Johnson Space Center, Houston, TX 77058

Mary Hakam
Oceaneering Space Systems, Houston, TX 77058

A test was conducted to evaluate three factors influencing the thermal performance of liquid cooling garments (LCG): (1) the comparable thermal performance of an Oceaneering developed engineering evaluation unit (EEU) prototype LCG, (2) the effect of the thermal comfort undergarment (TCU), and (3) the performance of a torso or upper body only LCG configuration.

To evaluate the thermal performance of each configuration a metabolic test was conducted, utilizing suited subjects to generate the metabolic heat. For this study three (3) test subjects of similar height and weight produced a metabolic load on the LCG configurations by either resting (300-600 BTU/hr), walking at a slow pace (1200 BTU/hr), and walking at a brisk pace (2200 BTU/hr), as outlined in Figure 1, the metabolic profile. During the test, oxygen consumption, heart rate, relative humidity, air flow, inlet and outlet air pressure, inlet and outlet air temperature, delta air temperature, water flow (100 lb/hr), inlet water temperature (65 °F), delta water temperature, water pressure, core body temperature, skin temperature, and sweat loss data was recorded. Four different test configurations were tested, with one configuration tested twice, as outlined in Table 1.

The test was conducted with the suit subjects wearing the Demonstrator Suit, pressurized to vent pressure (~0.5 psig). The demonstrator suit has an integrated ventilation duct system and was used to create a relevant environment with a captured ventilation return, an integrated vent tree, and thermal insulation from the environment.



Figure 1: Metabolic Profile

Table 1: Test Matrix

Subject 1 EEU Shirt and Pants Run 1	Subject 1 EEU Shirt and Pants Run 2	Subject 1 EEU Shirt Only	Subject 1 SSA LCVG w/ TCU	Subject 1 SSA LCVG w/o TCU
-------------------------------------	-------------------------------------	--------------------------	---------------------------	----------------------------

Subject 2 EEU Shirt and Pants Run 1	Subject 2 EEU Shirt and Pants Run 2	Subject 2 EEU Shirt Only	Subject 2 SSA LCVG w/ TCU	Subject 2 SSA LCVG w/o TCU
Subject 3 EEU Shirt and Pants Run 1	Subject 3 EEU Shirt and Pants Run 2	Subject 3 EEU Shirt Only	Subject 3 SSA LCVG w/ TCU	Subject 3 SSA LCVG w/o TCU