

Exploration Extra-Vehicular Mobility Unit (xEMU) Composite Hard Upper Torso (CHUT) Development

S. Yarlagadda, D. Roseman, J. Cipriani, N. Shevchenko, J.J. Tierney, J.W. Gillespie Jr.
Center for Composite Materials, University of Delaware, Newark, DE 19716

M. Parthasarathy, E. Nelson
Altair Engineering, Inc.

R. Rhodes, D. Kim, J. Jacobs
NASA Johnson Space Center, Houston

The xEMU is the Exploration Mobility Unity or space suit designed for microgravity (cislunar and low earth orbit (LEO)) and lunar surface operations. This suit design allows crewmembers to perform extravehicular exploration, science, construction, maintenance, and contingency operations while unattached to a vehicle for life support in pressure and thermal environments that exceed human capability. The xEMU provides life support, environmental protection, and communications capabilities to the EVA crewmember while allowing sufficient mobility and visibility to perform dexterous EVA tasks. The effort documented in this paper, addressed the design, analysis, manufacturing, full-scale test article testing and validation for a Composite Hard Upper Torso (CHUT) unit. Design and analysis of the CHUT was based on measured B-basis properties of the selected S-glass/epoxy composite, and established final geometry, composite layup and interface details that met requirements. A complete manufacturing and assembly protocol was established for the CHUT starting from composite layup in the tool, to final assembly of all interface metal hardware prior to delivery to NASA for suit integration. Full-scale CHUT test articles underwent static and fatigue pressure testing (2 lifetimes), impact testing at critical stress locations for tool drop/microgravity scenarios, followed by post-impact fatigue testing. Effect of manufacturing defects was evaluated by manufacturing a full-scale CHUT with 0.375"/0.5" defects at critical stress locations, followed by static and life-cycle fatigue testing. In all cases, the CHUT design met or exceeded mass, structural, interface and functional requirements. Two (2) complete CHUT articles were delivered to NASA for full-scale suit integration and testing.