Extravehicular Activity Technology Development – Portable Life Support System Packaging

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As NASA missions shift from microgravity extravehicular activities (EVAs) to EVAs performed on the lunar surface, the mass and center of gravity of spacesuits will become much more critical to mission success. Well-designed component packaging is crucial to hold, connect, and protect the hardware that ensures a spacesuit's life support functions. The current shuttle Portable Life Support System (PLSS) has a mass of 158 lbs., 79 lbs. of which are packaging. The EVA Technology Development Team, consisting of Johnson Space Center Crew and Thermal Systems Division personnel, is developing for the Constellation Program's lunar spacesuit an innovative foam packaging concept that will decrease the mass associated with packaging PLSS components.

Portable Life Support System packaging design and evaluation

The team has evaluated packaging arrangements to optimize the center of gravity of the suit as well as enable maintenance of PLSS components (figure 1). The components are held in place by compressible, open-celled foam that also helps protect the components in case a suited crew member falls on the lunar surface. A thin plastic cover is used to distribute the loads more uniformly across the foam, and multilayer insulation is placed on top of this cover to provide thermal control. Team members have performed the following: both analytical and experimental evaluations of this packaging concept; thermal analyses to define temperature requirements for the foam; and dynamic computer simulations to look at stresses seen by different components, optimize the shell design, and determine the amount of foam needed to protect the components. Several series of tests have correlated the dynamic models (figures 2 and 3). These include 1g drop tests using mass simulators, 1g drop tests of entire PLSS mockups in various

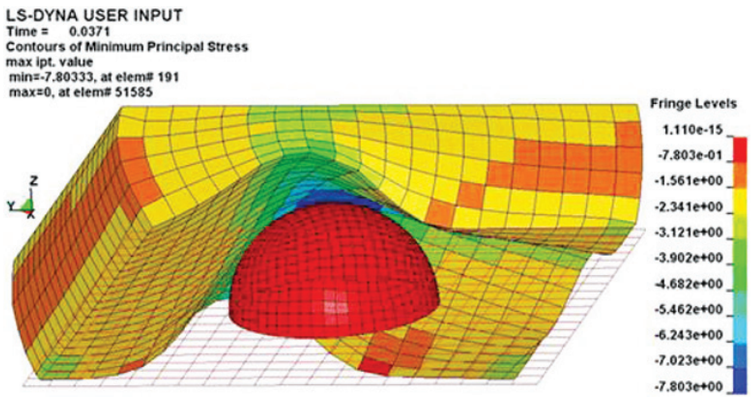

Fig. 2. *Stress analysis – falling on a rock.*

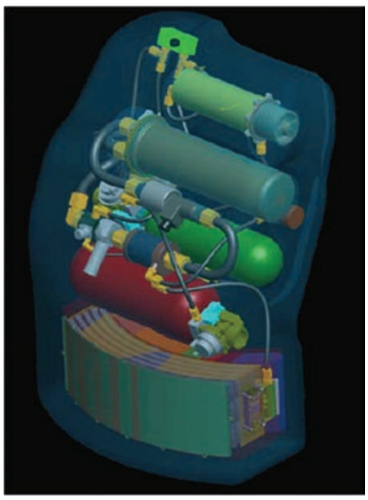

Fig. 1. *PLSS component layout.*

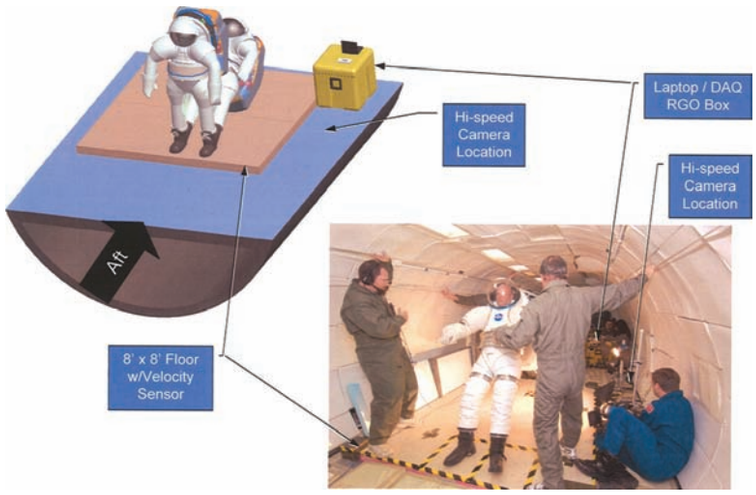

Fig. 3. *Reduced-gravity fall testing.*

orientations and using simulated rocks, and reduced-gravity fall tests with the PLSS mockup attached to a Mark III spacesuit.

Foam selection and development

The EVA Technology Development Team performed extensive research of available foams (figure 4). The foams that held promise of meeting the PLSS requirements mechanical properties were tested in a variety of simulated environments. These environments included the full temperature range based on the thermal analysis described above and also vacuum conditions. Stress-strain curves were produced, and the foam's compression set was measured for this range of environments.

The next step in developing PLSS foam packaging is under way. Contracts with Zotefoams plc (Croydon, England) and the Rochester Institute of Technology (Rochester, N.Y.) were awarded. These contractors are focusing on the development of new foams that improve performance at temperatures in the lower end of the PLSS requirements.

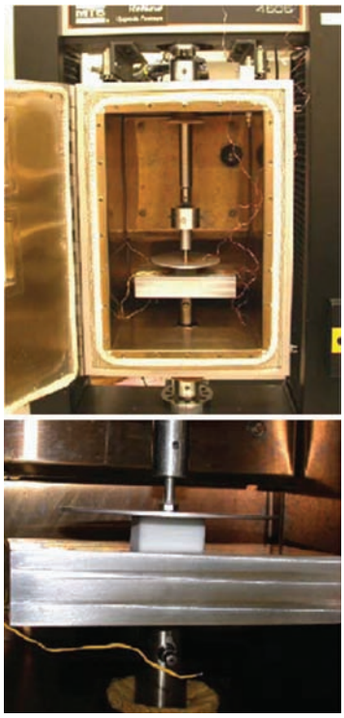

Fig. 4. *Foam properties testing.*

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