

EFFECTIVENESS OF SPACE SHUTTLE ANTI-EXPOSURE SYSTEM IN COLD WATER ENVIRONMENT

J. P. Bagian<sup>\*</sup>, J. W. Kaufman<sup>\*\*</sup>, and K. Y. Dejneka<sup>\*\*\*</sup>

<sup>\*</sup>National Aeronautics and Space Administration, JSC, Houston, Texas, USA, and  
<sup>\*\*</sup>Naval Air Development Center, Warminster, Pennsylvania, USA

**Address** for reprints:

James P. Bagian, M.D.  
NASA - JSC  
Astronaut Office - CB  
Houston, Texas 77058, USA

Within the last year, NASA has identified the need to provide expanded Shuttle crew protection against cold water immersion which may occur as a result of emergency bailout. Space Shuttle crews up to the present were only equipped with cotton flight ensembles which provided minimal thermal protection. This study was intended to determine whether the proposed anti-exposure system could provide adequate thermal protection for Shuttle crews to survive 24 hours of cold water immersion.

The NASA Crew Altitude Protection System (CAPS<sub>r</sub>), an integrated full-body partial pressure and dry-type, anti-exposure suit, was studied alone (CAPS<sub>r</sub>) and in conjunction with a derivative of the US Navy LPU-18/U raft (CAPS<sub>a</sub>). Conditions were selected to simulate expected worst case water and air temperatures along projected Space Shuttle ground track, i.e., T<sub>water</sub> = 4.4°C and T<sub>air</sub> = 5.6°C with 1-foot waves (chop) and constant spray. Four males, aged 31-44, and one female, aged 32, were studied once in each of the configurations. CAPS<sub>r</sub> and CAPS<sub>a</sub> trials were for 6-hour and 24-hour maximum exposures respectively.

None of the subjects proved able to endure the test conditions for the planned maximum exposure periods. The maximum CAPS<sub>a</sub> trial duration was 177 minutes (T<sub>re</sub> = 36.5°C), with termination resulting from discomfort due to development of excessive suit leakage. All other CAPS<sub>a</sub> trials were terminated for reaching a T<sub>re</sub> = 35.0°C or subject-requested termination due to discomfort and had durations of between 68 and 154 minutes. The maximum CAPS<sub>r</sub> trial duration was 801 minutes and was terminated due to subject discomfort. It should be noted that in the 801 minute run, the T<sub>re</sub> had steadily increased from a low of 35.1°C at minute 150 to 35.9°C at trial termination. All other CAPS<sub>r</sub> trials were terminated for reaching a T<sub>re</sub> = 35.0°C or subject-requested termination due to discomfort and had durations of between 176 and 598 minutes. At the termination of all trials, subjects demonstrated the ability to effectively aid in their own rescue.

CAPS<sub>a</sub> did not provide the same level of protection as CAPS<sub>r</sub>, and it is questionable if it can preserve adequate operational capabilities for a 6-hour exposure. Although trial durations were less than the maximum desired, CAPS<sub>r</sub> proved capable of providing Space Shuttle crews with effective thermal protection for periods exceeding 13 hours. It appears that operational capabilities may be preserved for up to 24 hours with the CAPS<sub>r</sub> for some individuals based on the trend of the subject's thermal state observed during the longest CAPS<sub>r</sub> trial.