NEEMO 14: Evaluation of Human Performance for Rover, Cargo Lander, Crew Lander, and Exploration Tasks in Simulated Partial Gravity

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The ultimate success of future human space exploration missions is dependent on the ability to perform extravehicular activity (EVA) tasks effectively, efficiently, and safely, whether those tasks represent a nominal mode of operation or a contingency capability. To optimize EVA systems for the best human performance, it is critical to study the effects of varying key factors such as suit center of gravity (CG), suit mass, and gravity level. During the 2-week NASA Extreme Environment Mission Operations (NEEMO) 14 mission, four crewmembers performed a series of EVA tasks under different simulated EVA suit configurations and used full-scale mockups of a Space Exploration Vehicle (SEV) rover and lander. NEEMO is an underwater spaceflight analog that allows a true mission-like operational environment and uses buoyancy effects and added weight to simulate different gravity levels. Quantitative and qualitative data collected during NEEMO 14, as well as from spacesuit tests in parabolic flight and with overhead suspension, are being used to directly inform ongoing hardware and operations concept development of the SEV, exploration EVA systems, and future EVA suits. **OBJECTIVE**: To compare human performance across different weight and CG configurations. **METHODS**: Four subjects were weighed out to simulate reduced gravity and wore either a specially designed rig to allow adjustment of CG or a PLSS mockup. Subjects completed tasks including level ambulation, incline/decline ambulation, standing from the kneeling and prone position, picking up objects, shoveling, ladder climbing, incapacitated crewmember handling, and small and large payload transfer. Subjective compensation, exertion, task acceptability, and duration data as well as photo and video were collected. **RESULTS**: There appear to be interactions between CG, weight, and task. CGs nearest the subject's natural CG are the most predictable in terms of acceptable performance across tasks. Future research should focus on understanding the interactions between CG, mass, and subject differences.