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| **Fiscal Year:** | FY 2021 | **Task Last Updated:** | FY 04/07/2021 |
| **PI Name:** | Norcross, Jason M.S. | | |
| **Project Title:** | Validation of Fitness for Duty Standards Using Pre- and Post-Flight Capsule Egress and Suited Functional Performance Tasks in Simulated Reduced Gravity | | |
| **Division Name:** | Human Research | | |
| **Program/Discipline:** | | | |
| **Program/Discipline--Element/Subdiscipline:** | | | |
| **Joint Agency Name:** | | **TechPort:** | No |
| **Human Research Program Elements:** | (1) **HHC**:Human Health Countermeasures | | |
| **Human Research Program Risks:** | (1) **EVA**:Risk of Injury and Compromised Performance Due to EVA Operations<br>(2) **Sensorimotor**:Risk of Altered Sensorimotor/Vestibular Function Impacting Critical Mission Tasks | | |
| **Space Biology Element:** | None | | |
| **Space Biology Cross-Element Discipline:** | None | | |
| **Space Biology Special Category:** | None | | |
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| **PI Organization Type:** | NASA CENTER | **Phone:** | 281-483-7114 |
| **Organization Name:** | KBR/NASA Johnson Space Center | | |
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| **Zip Code:** | 77058-3711 | **Congressional District:** | 36 |
| **Comments:** | | | |
| **Project Type:** | FLIGHT | **Solicitation / Funding Source:** | 2017-2018 HERO 80JSC017N0001-BPBA Topics in Biological, Physiological, and Behavioral Adaptations to Spaceflight. Appendix C |
| **Start Date:** | 01/30/2019 | **End Date:** | 12/01/2027 |
| **No. of Post Docs:** | | **No. of PhD Degrees:** | |
| **No. of PhD Candidates:** | | **No. of Master' Degrees:** | |
| **No. of Master's Candidates:** | | **No. of Bachelor's Degrees:** | |
| **No. of Bachelor's Candidates:** | | **Monitoring Center:** | NASA JSC |
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| **Flight Program:** | | | |
| **Flight Assignment:** | NOTE: End date changed to 12/1/2027 per HHC element/JSC (Ed., 12/14/20) | | |
| **Key Personnel Changes/Previous PI:** | | | |
| **COI Name (Institution):** | Abercromby, Andrew Ph.D. ( NASA Johnson Space Center )<br>Rosenberg, Marissa Ph.D. ( KBR/NASA Johnson Space Center )<br>Reschke, Millard Ph.D. ( NASA Johnson Space Center )<br>Ryder, Jeffrey Ph.D. ( NASA Johnson Space Center )<br>Young, Millennia Ph.D. ( NASA Johnson Space Center ) | | |
| **Grant/Contract No.:** | Internal Project | | |
| **Performance Goal No.:** | | | |
| **Performance Goal Text:** | | | |

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| **Task Description:** | Rigorous adherence to available inflight countermeasures has effectively mitigated losses or maintained muscle strength and aerobic capacity in some returning long-duration International Space Station (ISS) crewmembers; however, all astronauts demonstrate significant decrements in functional performance upon return to a gravity environment. These losses in functional performance can be largely attributed to neurovestibular / sensorimotor deficits that can take days or weeks from which to recover and for which there is no current operational countermeasure. Although these losses are tolerable for current land-based returns to Earth, where ground personnel can quickly support the crew at the landing site, this will not be the case for future off-nominal water-based Orion landings or for nominal Mars surface landings, both of which will require crewmembers to be capable of egressing their landing vehicle unassisted.<br>Quantification of astronauts' post-landing functional capacity including ability to perform an unassisted capsule egress and critical planetary extravehicular activity (EVA) tasks is necessary to design concepts of operation for Moon and Mars exploration mission systems and ultimately to promote exploration mission success. These results can then be reviewed in combination with other pre-flight, in-flight, and post-landing measures and determinants of health and performance (e.g., sleep, nutrition, exercise) to help develop and select necessary countermeasures capable of protecting all crewmembers or to identify characteristics (both behavioral and inherent) that might allow for selection of crew dependent on mission objectives.<br><br>Data collected in this proposal will provide unique data on unassisted capsule egress while wearing an unpressurized launch, entry, abort (LEA) suit in Earth's gravity and on EVA-relevant functional task performance by testing astronauts shortly after return to Earth while suited and pressurized in a simulated reduced gravity analog. The research product will be a temporal profile of unassisted capsule egress and planetary EVA task performance pre-flight and at multiple post-landing intervals, the timing of which will be determined based on post-landing logistics and coordination with other investigations. Data will be collected for spaceflight missions ranging from 2 months, 6 months, and up to 1 year in duration. Results of the proposed study will be used in combination with subsequent definition and design of exploration mission systems and operations concepts to define data-based Fitness for Duty standards. |
| **Rationale for HRP Directed Research:** | |
| **Research Impact/Earth Benefits:** | |
| **Task Progress:** | Progress report dated December 2020<br>Study Title: Pilot Egress Fitness<br><br>Brief Overview of Study Plan: This study aims to obtain pilot data for the full Egress Fitness study. Physiological adaptation to microgravity (i.e., transit to Mars) and subsequent readaptation during gravitational transitions are likely to result in reduced functional capacity after landing on Earth or at an exploration destination. Quantification of astronauts' post-landing functional capacity is necessary to inform spaceflight hardware design and concepts of operation for exploration missions. Specifically, this study will quantify returning ISS crew performance of an unassisted capsule egress and planetary EVA. The study will accelerate the operational planning and implementation on how to execute this testing in the dynamic, operational environments of Soyuz, Boeing, and SpaceX landing zones.<br><br>Progress Report: Institutional Review Board (IRB) Approval has been completed for the pilot study (JSC eIRB STUDY00000242). End-to-end human subject testing for engineering evaluation of this protocol has been completed for the planetary EVA tasks on ARGOS using the Mark III spacesuit and newly developed hardware for this study. The TRR (Technology Readiness Review) for the capsule egress portion of the Pilot Egress Fitness study is scheduled for 12/17/2020 and the TRR for the planetary EVA portion will follow in late December or the first week of January and will be led by the ARGOS team and include stakeholders from the study team, suit team, and ARGOS team. Informed consent briefing was pitched to SpaceX Crew 2 and two subjects have consented to participate. Informed consent briefing for USCV-3 Crew is schedule for 12/18/2020.<br><br>Hardware development for the capsule egress task is on the second revision, with general design approved and further modifications only for reduction of mass or improvement of stability. Analysis for the TRR documents will be completed for 12/17/2020. Hardware development for the planetary EVA tasks is complete for all tasks except for the alignment with a rear entry suitport/donning stand. Documentation of detailed procedures and presentation materials for crew briefings have been completed for the planetary EVA and capsule egress tasks.<br><br>Data collection has not been initiated and there are no preliminary results to share.<br><br>Schedule Update: The first 2 (of 3) crew subjects could complete baseline data collection as soon as late January 2021 with launch scheduled for March 2021. Post-flight data collection for these subjects is be expected to occur in late September 2021.<br><br>Study Title: Validation of Fitness for Duty Standards Using Pre- and Post-Flight Capsule Egress and Suited Functional Performance Tasks in Simulated Reduced Gravity<br><br>Brief Overview of Study Plan: Physiological adaptation to microgravity (i.e., transit to Mars) and subsequent readaptation during gravitational transitions are likely to result in reduced functional capacity after landing on Earth or at an exploration destination. Quantification of astronauts' post-landing functional capacity is necessary to design concepts of operation for Moon and Mars missions and ultimately to promote exploration mission success. Specifically, the ability to perform an unassisted capsule egress task and planetary EVAs are critical performance parameters to quantify. These results can then be reviewed in combination with other preflight, in-flight, and post-landing measures to help develop necessary countermeasures or concept of operations that will be capable of protecting all crewmembers.<br><br>Progress: IRB Approval has been completed for Egress Fitness (JSC eIRB STUDY00000169). End to end development/engineering test have been completed for the immediate day of landing EVA test protocol on ARGOS using the Mark III spacesuit and newly developed hardware for this study. The tasks for the full EVA session have been evaluated for feasibility of executing on ARGOS, but a full end-to-end run using standard test procedures has not yet been done, but will be planned for FY21. The TRR for the partial EVA being performed in Pilot Egress Fitness study is scheduled for late December or first week of January 2021. A delta TRR will be needed to include the expanded task list for the full planetary EVA. Informed consent briefings will be handled through the full integration of the CIPHER study.<br><br>Hardware development for the capsule egress task is on the second revision and will be tested on 12/7/2020 and analysis |

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| | for the TRR documents will be completed for 12/17/2020. The hardware has been optimized for stability, but further effort will be made on revision 3 to improve portability. Hardware development for the planetary EVA tasks is complete for all tasks but the alignment with a rear entry suitport/donning stand. Detailed procedures and crew briefings have been completed for the 24-hr planetary EVA and capsule egress tasks, but will be finalized for the additional EVA tasks.<br><br>Data collection has not been initiated and there are no preliminary results to share. |
| **Bibliography Type:** | Description: (Last Updated: 02/21/2024) |