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Project Title:  Validation of Times for Duty Standards Using Pre- and Post-Flight Capsale Egress and Suited Functional Performance Tasks in Smuthated Reduced (Fensity)  Birksian Name:  Hurnan Research  Program Discipline:  Program Discipline:  Program Discipline:  Program Discipline:  (1) HIC-Human Health Countermeasures  (1) HYA-Risk of Injury and Compromised Performance Due to EVA Operations (2) Sensor/innutor-Risk of Altered Sensor/innutor-Visit Industry Function Impacting Critical Mission Tasks  Space Biology Special Category:  None  Space Biology Special Category:  None  Pr Kmail:  Juson noterous-Infrasa gov:  Fax: FY  Programization Type:  NASA CENTER  AND NASA Play  Pr Address 1:  2400 NASA Play  Pr Address 2:  Pl Address 2:  Pl Address 3:  Pl Address 3:  Pl Web Page:  City:  Apacetic Type:  Fl KillT  Solicitation / Funding  Project Type:  Fl KillT  Solicitation / Funding  Source:  Source:  Solicitation / Funding  Source:  S	Fiscal Year:	FY 2021	Task Last Updated:	FY 04/07/2021
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Program/Discipline-  Elements   Substitution   Su	Division Name:	Human Research		
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Human Research Program Elements: (1) BHC:Human Health Countermeasures  Human Research Program Risks: (1) EVA,Risk of Injury and Compromised Performance Due to EVA Operations (2) Sensorimotor-Risk of Altered Sensorimotor-Vestibular Function Impacting Critical Mission Tasks  Space Biology Cross-Element None  Space Biology Special Category: None  PI Email: Jason norcross-Islants abov Fax: FY  PI Organization Type: NASA CENTER Phone: 281-483-7114  Organization Name: KBR/NASA Johnson Space Center  PI Address 1: 2400 NASA Pkwy  PI Address 2: FY  PI Web Page:  City: Houston Sara Compressional District: 36  Comments:  Project Type: FI IGHT Solicitation / Funding State: TX  Zip Oade: 77058-3711 Congressional District: 36  Comments:  Project Type: FI IGHT Solicitation / Funding State: TX  Zip Oade: No. of Pab Decress  No. of Pab Decress  No. of Pab Decress  No. of Master's Candidates: No. of Master' Degrees:  No. of Master's Candidates: No. of Master's Candidates: No. of Master's Candidates: No. of Bachelor's Degrees:  No. of Bachelor's Candidates: No. of Bachelor's Degrees:  No. of Bachelor's Candidates: No. of Bachelor's Degrees:  No. of Bachelor's Candidates: No. of Master's Degrees:  No. of Master's Degrees: No. of Master's Degrees:  No. of Master's Degrees: No. of Master's Degrees:  No. of Master's Degrees: No. of Mas	Program/Discipline Element/Subdiscipline:			
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Appear Biology Element None Space Biology Element None Space Biology Element None Discipline: None Plemail: Jason noterous-1@mass nov NaSA CENTER None Pl Organization Type: NASA CENTER NASA Johnson Space Center Pl Address 1: 2400 NASA Pkwy Pl Organization Name: KBR/NASA Johnson Space Center Pl Address 2: Pl Web Page: City: Houston State: TX Zip Code: Organization Solicitation / Funding S	<b>Human Research Program Elements:</b>	(1) HHC:Human Health Countermeasures		
Space Biology Cross-Element Discipline: Space Biology Special Category: None PI Email: Jason.nonrose-1@nass.gov, Fax: FY PI Organization Type: NASA CENTER Phone: 281-483-7114 Organization Name: KBR/NASA Johnson Space Center PI Address 1: 2400 NASA Pkwy PI Address 2: PI Address 2: PI Web Page: City: Houston State: TX Zip Code: 77058-3711 Congressional District: 36 Comments: Project Type: FLIGHT Solicitation / Funding 80JSC017N001-BPBA Topics in Sources: Biological, Physiological, and Rehavioral Adaptations Space Spaceflight. Appendix C No. of PhD Deardidates: No. of PhD Deardidates: No. of Master's Candidates: No. of Master's Candidates: No. of Bachelor's Can	Human Research Program Risks:			
Discipline: ' Space Biology Special Category: None    Plemail:   Jason noncross-1 Ginasa gov   Fax: FY	Space Biology Element:	None		
PI Email:  Jason norcross-1@nasa acv  Fax: FY Pl Organization Type:  NASA CENTER  Phone: 281-483-7114  Organization Name:  KBR/NASA Johnson Space Center  PI Address 1:  2400 NASA Pkwy  PI Address 2:  PI Web Page:  City:  Houston  State: TX  Zip Code:  77058-3711  Congressional District:  36  Comments:  Project Type:  FLIGHT  Solicitation / Funding Source:  BiOgline Physiological, and Behavioral Adaptations to SpaceClight. Appendix C  Start Date:  0130/2019  End Date:  No. of PhD Degrees:  No. of PhD Candidates:  No. of Master's Degrees:  No. of Master's Candidates:  No. of Master's Candidates:  No. of Bachelor's	Space Biology Cross-Element Discipline:	None		
Pl Organization Type: NASA CENTER Phone: 281-483-7114  Organization Name: KBR/NASA Johnson Space Center  Pl Address 1: 2400 NASA Pkwy  Pl Address 2: Fl Web Page:  City: Houston State: TX  Zip Code: 77058-3711 Congressional Distric: 36  Comments:  Comments:  Project Type: FLIGHT Solicitation / Funding Solicitation / Funding Solicitation in Source: S	Space Biology Special Category:	None		
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PI Address 1: 2400 NASA Pkwy  PI Address 2:	PI Organization Type:	NASA CENTER	Phone:	281-483-7114
PI Address 2:  PI Web Page:  City: Houston State: TX  Zip Code: 77058-3711 Congressional District: 36  Comments:  Project Type: FLIGHT Solicitation / Funding SOUSCO1/TN0001-BPBA Topics in Biological, Physiological, and Behavioral Adaptations to Spaceflight. Appendix C  Start Date: 01/30/2019 End Date: 12/01/2027  Story of PhD Degrees:  No. of Post Docs: No. of PhD Degrees:  No. of Master's Candidates: No. of Master' Degrees:  No. of Master's Candidates: No. of Master' Degrees:  No. of Bachelor's Candidates: No. of Master' Degrees:  No. of Bachelor's Candidates: Monitoring Center: NASA JSC  Contact Monitor: Stenger, Michael Contact Phone: 281-483-1311  Contact Email: michael.b.stenger@nasa.gov  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): Reschee, Millard Ph.D. (NASA Johnson Space Center)  Rosenberg, Marissa Ph.D. (KBR/NASA Johnson Space Center)  Ryder, Jeffrey Ph.D. (NASA Johnson Space Center)  Young, Millennia Ph.D. (NASA Johnson Space Center)	Organization Name:	KBR/NASA Johnson Space Center		
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City: Houston State: TX  Zip Code: 77058-3711 Congressional District: 36  Comments:  Project Type: FLIGHT Solicitation / Funding Solicitation / Funding Boulscal, Physiological, and Behavioral Adaptations to Spaceflight. Appendix C  Start Date: 01/30/2019 End Date: 12/01/2027  No. of Post Does: No. of PhD Degrees: No. of PhD Degrees: No. of PhD Candidates: No. of Master' Degrees: No. of Master' Degrees: No. of Bachelor's Candidates: No. of Bachelor's Degrees: No. of Bachelor's Candidates: No. of Bachelor's Candidates: Monitoring Center: NASA JSC  Contact Monitor: Stenger, Michael Contact Phone: 281-483-1311  Contact Email: michael.b.stenger@nasa.gov  Flight Program: NOTE: End date changed to 12/1/2027 per HHC element/JSC (Ed., 12/14/20)  Key Personnel Changes/Previous PI: Abercomby, Andrew Ph.D. (NASA Johnson Space Center) Rosenberg, Marissa Ph.D. (KBR/NASA Johnson Space Center) Reschke, Millard Ph.D. (NASA Johnson Space Center) Reschke, Millard Ph.D. (NASA Johnson Space Center) Voung, Millennia Ph.D. (NASA Johnson Space Center)	PI Address 2:			
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No. of Master's Candidates:  No. of Bachelor's Degrees:  No. of Bachelor's Candidates:  No. of Bachelor's Candidates:  Monitoring Center:  NASA JSC  Contact Monitor:  Stenger, Michael  Contact Phone:  281-483-1311  Contact Email:  michael.b.stenger@nasa.gov  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) Rosenberg, Marissa Ph.D. (NASA Johnson Space Center) Reschke, Millard Ph.D. (NASA Johnson Space Center) Young, Millennia Ph.D. (NASA Johnson Space Center)  Grant/Contract No.:  Internal Project  Performance Goal No.:	No. of Post Docs:		No. of PhD Degrees:	
No. of Bachelor's Candidates:  Nortact Monitor:  Stenger, Michael  Contact Phone: 281-483-1311  Contact Email:  michael.b.stenger@nasa.gov  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:  Abercromby, Andrew Ph.D. (NASA Johnson Space Center) Rosenberg, Marissa Ph.D. (KBR/NASA Johnson Space Center) Reschke, Millard Ph.D. (NASA Johnson Space Center) Ryder, Jeffrey Ph.D. (NASA Johnson Space Center) Young, Millennia Ph.D. (NASA Johnson Space Center) Young, Millennia Ph.D. (NASA Johnson Space Center) Performance Goal No.:	No. of PhD Candidates:		No. of Master' Degrees:	
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Contact Email: michael.b.stenger@nasa.gov  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 ) Rosenberg, Marissa Ph.D. (KBR/NASA Johnson Space Center ) Reschke, Millard Ph.D. (NASA Johnson Space Center ) Ryder, Jeffrey Ph.D. (NASA Johnson Space Center ) Young, Millennia Ph.D. (NASA Johnson Space Center ) Forant/Contract No.: Internal Project  Performance Goal No.:	No. of Bachelor's Candidates:		<b>Monitoring Center:</b>	NASA JSC
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Performance Goal No.:	COI Name (Institution):	Rosenberg, Marissa Ph.D. (KBR/NASA Johnson Reschke, Millard Ph.D. (NASA Johnson Space Ryder, Jeffrey Ph.D. (NASA Johnson Space Ce	on Space Center ) Center ) enter )	
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Task Book Report Generated on: 04/26/2024

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. 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.

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:**

Progress report dated December 2020 Study Title: Pilot Egress Fitness

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.

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.

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.

Data collection has not been initiated and there are no preliminary results to share.

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.

Study Title: Validation of Fitness for Duty Standards Using Pre- and Post-Flight Capsule Egress and Suited Functional Performance Tasks in Simulated Reduced Gravity

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.

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.

Hardware development for the capsule egress task is on the second revision and will be tested on 12/7/2020 and analysis

Task Progress:

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.

Data collection has not been initiated and there are no preliminary results to share.

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Bibliography Type:

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