Fiscal Year:	FY 2014	**Task Last Updated:**	FY 05/20/2014
PI Name:	Barstow, Thomas Ph.D.		
Project Title:	Standardized 'Pre-flight' Exercise Tests to Predict Performance during Extravehicular Activities in a Lunar Environment		
Division Name:	Human Research		
Program/Discipline:	HUMAN RESEARCH		
Program/Discipline--Element/Subdiscipline:	HUMAN RESEARCH--Biomedical countermeasures		
Joint Agency Name:		**TechPort:**	Yes
Human Research Program Elements:	(1) **HHC**:Human Health Countermeasures		
Human Research Program Risks:	(1) **Aerobic**:Risk of Reduced Physical Performance Capabilities Due to Reduced Aerobic Capacity (2) **Muscle**:Risk of Impaired Performance Due to Reduced Muscle Size, Strength and Endurance		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
PI Email:	tbarsto@k-state.edu	**Fax:**	FY
PI Organization Type:	UNIVERSITY	**Phone:**	785-532-0712
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City:	Manhattan	**State:**	KS
Zip Code:	66506-0109	**Congressional District:**	1
Comments:			
Project Type:	GROUND	**Solicitation / Funding Source:**	2009 Crew Health NNJ09ZSA002N
Start Date:	07/01/2010	**End Date:**	06/30/2015
No. of Post Docs:	0	**No. of PhD Degrees:**	1
No. of PhD Candidates:	2	**No. of Master' Degrees:**	3
No. of Master's Candidates:	3	**No. of Bachelor's Degrees:**	5
No. of Bachelor's Candidates:	4	**Monitoring Center:**	NASA JSC
Contact Monitor:	Loerch, Linda	**Contact Phone:**	
Contact Email:	linda.loerch-1@nasa.gov		
Flight Program:			
Flight Assignment:	NOTE: Extended to 6/30/2015 per PI and NSSC information (Ed., 5/19/14) NOTE: New end date is 9/2/2014 per NSSC information (Ed., 5/9/2013)		
Key Personnel Changes/Previous PI:	May 2012 report: Chris Lewis, Ph.D. has left Kansas State University and is no longer on the project. We are actively pursuing a replacement engineer.		
COI Name (Institution):	Warren, Steven (Kansas State University) Schinstock, Dale (Kansas State University)		
Grant/Contract No.:	NNX10AK60G		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	The original Apollo missions and more recent extravehicular activities on the International Space Station have provided basic information that can be applied to activities that may occur during future long-duration lunar missions. However, despite these previous efforts, significant gaps remain in our understanding of the more complex physiological costs of different activities in a true lunar environment. Recently a ground-based simulation of a 10-kilometer Lunar Walkback was conducted to better understand the physical capabilities of a suited astronaut in partial gravity. Unfortunately, this study was limited because of the use of a stationary treadmill that did not accurately simulate the lunar environment (i.e., landscape and terrain). To date this overall lack of physiologic data collected during true lunar activities or their accurate simulation has limited the ability of NASA physicians and scientists to predict if an astronaut candidate is physically capable of completing the multiple lunar activities that may be required during long-duration missions. Therefore, the goals of this proposal are to 1) develop a mobile testbed to accurately simulate partial-gravity lunar activities, and 2) determine subject performance and the concomitant physiological responses to these activities, which will allow us to 3) create a series of standardized tests that can be performed in a pre-flight setting to determine the readiness of the astronaut to perform physically demanding activities during a lunar mission.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	The results of these studies will help identify which key components of physical fitness are required to perform different physical tasks. These results will, therefore, be applicable in a wide variety of settings, from rehabilitation to athlete evaluation, to determining the relative preparedness of astronauts for in-flight and destination extravehicular activities (EVAs). These insights will be especially important when astronauts return to a gravitational environment, either on Earth or at their destination. These results will provide target information regarding minimum required strength and endurance from which in-flight and destination exercise countermeasures can be based. The strategy employed here can also function as a template for approaching the establishment of field tests for other occupations in which there is a demand for minimal physical performance, such as what has been done for firefighters and police officers.
Task Progress:	Several manuscripts have been submitted or are in final preparation for submission from the Phase I data. Phase II has been completed, with a total of 12 subjects finishing the protocol. Each subject attempted to complete 9 laps of our obstacle course at two different paces; one representing the average pace of the Apollo astronauts during lunar EVAs (VO2 of ~20 ml/kg/min) and one at an estimated suited Martian cost of 30 ml/kg/min. All subjects were able to complete the course at the Lunar pace. However, at the Martian pace, 5 of the 12 subjects failed ~ lap 5. Subjects who completed the Martian pace had a VO2max on average of 44.3 ± 5.0 ml/kg/min, while the 5 who failed (3 men, 2 women) had a VO2max of 36.8 ± 2.9 ml/kg/min. Further, the Martian pace was likely at or above the critical speed of the subjects who failed. Electromyography (EMG) and Near InfraRed Spectroscopy (NIRS) signals differed by pace, but were not different between those who successfully completed both paces and those who failed at the Martian pace. Initial analysis of EMG and NIRS data failed to find any differences in the responses between those that failed and those that successfully completed the 9 laps. These results are being written up for submission to a peer-reviewed journal. In addition, the hoist suspension system is operational to the point of being able to conduct pilot experiments. We have acquired preliminary VO2 responses during ambulation at 3 mph under 1-g, Martian (3/8-g), and Lunar (1/6-g) offloading. In addition, during the Lunar offloading, subjects naturally and unconsciously assumed an almost skipping stride pattern, very similar to that adopted by the Apollo astronauts during lunar EVAs.
Bibliography Type:	Description: (Last Updated: 01/23/2020)
Abstracts for Journals and Proceedings	Kuhn W, Warren S, Day D, Dong X, Gruenbacher D, Natarajan B, Soberting T, Taj-Eldin M, Barstow T, Broxteman R, Stonestreeet A 2nd. "Biomedical Sensing and Wireless Technologies for Long Duration EVAs and Precursor Scout Missions." 2014 IEEE Aerospace Conference, Big Sky, Montana, March 1–8, 2014. Advanced technologies forum. 2014 IEEE Aerospace Conference, Big Sky, Montana, March 1–8, 2014. , Mar-2014
Papers from Meeting Proceedings	Chen J, Kuehl P, Gude D, Broxteman R, Barstow T, Warren T. "Robust Algorithms for EMG Burst Identification and Processing." 36th Annual International Conference of the IEEE Engineering in Medicine and Biology Society, Chicago, IL, USA, August 26–30, 2014. 36th Annual International Conference of the IEEE Engineering in Medicine and Biology Society, Chicago, IL, USA, August 26–30, 2014. In press as of May 2014. , May-2014
Papers from Meeting Proceedings	Kuehl P, Chen J, Gude D, Broxteman R, Barstow T, Warren T. "Real-Time Processing of Electromyograms in an Automated Hand-Forearm Ergometer Data Collection and Analysis System." 36th Annual International Conference of the IEEE Engineering in Medicine and Biology Society, Chicago, IL, USA, August 26–30, 2014. 36th Annual International Conference of the IEEE Engineering in Medicine and Biology Society, Chicago, IL, USA, August 26–30, 2014. In press as of May 2014. , May-2014
Significant Media Coverage	Barstow TJ, Broxterman R, Kuhn W, Warren S. "Discovery Channel Canada, Daily Planet, January 21, 2014, Segment on K-State work of NASA Crew Performance and NASA EPSCoR project overviews." Television. Discovery Channel Canada, Daily Planet, January 21, 2014. Segment on K-State work Segment on K-State work was aired on January 21, 2014 (Ed., video no longer accessible as of 11/18/14). A companion video segment taken in the K-State communications lab can be found here: https://www.youtube.com/watch?v=bIAnUY0cC4Q ; accessed 5/20/2014., Jan-2014
Significant Media Coverage	Elliott L. " 'Suit up: Engineers Design Spacesuit Tools, Biomedical Sensors to Keep Astronauts Healthy,' KSU News Release and Video for the NASA EPSCoR Project, K-State Video News Service, Pathfire # 131125." KSU News Release and Video for the NASA EPSCoR Project, K-State Video News Service, Pathfire # 131125, November 25, 2013., Nov-2013