Fiscal Year:	FY 2013	**Task Last Updated:**	FY 05/09/2013
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		
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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:		**No. of PhD Degrees:**	
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; previously was 9/2/2014 (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 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:	Phase I has been completed, with a total of 72 subjects (32 females) completing the entire protocol for Phase 1.1 (including all laboratory and field tests). We have recruited subjects with an intentionally wide range of fitness levels. The purpose of this wide range of fitness levels is to improve our ability to predict relative success in the lunar field tests from one or more fitness characteristics. Analysis of the complete data set confirms previous conclusions based on a smaller sample size. Simple regression analysis revealed a modest correlation ($r = 0.64$) between average speed during the 10 km walk-back time and treadmill VO2max, but the correlation with gas exchange (or ventilatory) threshold (GET) was weaker ($r = 0.48$). In contrast, there was a highly significant relationship between 10 km average speed and critical speed ($r = 0.84$, $p<0.0005$). When examined by gender, women had a significantly lower relative VO2max (44.7 ± 6.8 vs. 50.4 ± 7.5 ml/kg/min), relative arm VO2peak (24.2 ± 5.7 vs. 27.8 ± 5.0 ml/kg/min), relative arm GET (12.3 ± 1.9 vs. 14.5 ± 2.8), CS (11.2 ± 2.0 vs. 12.5 ± 2.5 km/hr), CP (44.3 ± 13.7 vs. 73.3 ± 16.2 Watts). However, there was no significant difference for treadmill relative GET (27.7 ± 3.3 vs. 29.1 ± 5.0 ml/kg/min), arm GET (52.0 ± 1.0 vs. 52.0 ± 1.0 %VO2peak), CS (81.2 ± 1.0 vs. 79.3 ± 1.0 %Speak), CP (61.8 ± 1.0 vs. 66.8 ± 1.0 %Ppeak) 10-km Walkback time (66.0 ± 14.3 vs. 58.9 ± 12.7 min), and 10-km Walkback velocity (84.8 ± 1.0 vs. 85.2 ± 1.0 %CS). Importantly, simulated EVA performance was best predicted by the same laboratory assessment tests for both women and men. With 72 subjects we have begun more sophisticated analyses using multiple regression and CART approaches. These approaches continue to reinforce that the most influential predictors of field test performance are critical speed and critical power, as previously found with a subset of subjects. We have begun collecting preliminary data from wireless biosensors (EMG, respiration, accelerometer) and , near infrared spectroscopy-NIRS) while subjects are performing the field tests. The goal of this work is to characterize the cardiorespiratory and metabolic responses to the field tests, and to identify how these signals change as the subject fatigues. Very promising, in subjects who have failed the planetary navigation field test to date, EMG and NIRS signals have indicated impending fatigue with patterns of change different from those seen when subjects are able to successfully complete the course, while the VO2 responses exceed those associated with the subject's critical speed CS. Finally, the suspension system continues to develop. We are at the stage of evaluating safety redundancy in the hoist system, and anticipate pilot work with humans this summer 2013. This system will eventually permit the creation of a microgravity setting for the subjects while they perform certain of the field test tasks.
Bibliography Type:	Description: (Last Updated: 01/23/2020)
Abstracts for Journals and Proceedings	Song Q, Ade C, Broxterman R, Nelson T, Gude D, Barstow T, Warren S. "Classification Algorithms Applied to Accelerometer Data as a Means to Identify Subject Activities Related to Planetary Navigation Tasks." 2013 NASA Human Research Program Investigators' Workshop, Galveston, TX, February 12-14, 2013. 2013 NASA Human Research Program Investigators' Workshop, Galveston, TX, February 12-14, 2013. , Feb-2013
Abstracts for Journals and Proceedings	Gude D, Broxterman R, Ade C, Barstow T, Nelson T, Song W, Warren S. "Automated Hand-Forearm Ergometer Data Collection System." 2013 NASA Human Research Program Investigators' Workshop, Galveston, TX, February 12-14, 2013. 2013 NASA Human Research Program Investigators' Workshop, Galveston, TX, February 12-14, 2013. , Feb-2013
Abstracts for Journals and Proceedings	Dong X, Sobering T, Barstow T, Warren S. "A Wireless Inductance Plethysmograph as a Precursor to a Networked Suite of Low-Power Sensors for In-Spacesuit Health Monitoring." 2013 NASA Human Research Program Investigators' Workshop, Galveston, TX, February 12-14, 2013. 2013 NASA Human Research Program Investigators' Workshop, Galveston, TX, February 12-14, 2013. , Feb-2013
Articles in Peer-reviewed Journals	Broxterman RM, Ade CJ, Poole DC, Harms CA, Barstow TJ. "A single test for the determination of parameters of the speed-time relationship for running." Respir Physiol Neurobiol. 2013 Jan 15;185(2):380-5. Epub 2012 Sep 5. http://dx.doi.org/10.1016/j.resp.2012.08.024 ; PubMed PMID: 22981969 , Jan-2013

Articles in Peer-reviewed Journals	Gude D, Broxterman R, Ade C, Barstow T, Nelson T, Song W, Warren S. "Automated hand-forearm ergometer data collection system." Conf Proc IEEE Eng Med Biol Soc. 2012;2012:2379-82. http://dx.doi.org/10.1109/EMBC.2012.6346442 ; PubMed PMID: 23366403 (EMBC 2012. 34th Annual International Conference of the IEEE Engineering in Medicine and Biology Society, San Diego, CA, August 28 – September 1, 2012.) , Sep-2012
Articles in Peer-reviewed Journals	Song W, Ade C, Broxterman R, Barstow T, Nelson T, Warren S. "Activity recognition in planetary navigation field tests using classification algorithms applied to accelerometer data." Conf Proc IEEE Eng Med Biol Soc. 2012;2012:1586-9. http://dx.doi.org/10.1109/EMBC.2012.6346247 ; PubMed PMID: 23366208 (EMBC 2012. 34th Annual International Conference of the IEEE Engineering in Medicine and Biology Society, San Diego, CA, August 28 – September 1, 2012.) , Sep-2012