Fiscal Year:	FY 2010	**Task Last Updated:**	FY 05/21/2010
PI Name:	Moore, Alan Ph.D.		
Project Title:	Maximal Oxygen Uptake (VO2max) and Submaximal Estimates of VO2max Before, During and After Long Duration International Space Station Missions		
Division Name:	Human Research		
Program/Discipline:	HUMAN RESEARCH		
Program/Discipline--Element/Subdiscipline:	HUMAN RESEARCH--Biomedical countermeasures		
Joint Agency Name:		**TechPort:**	No
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		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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Zip Code:	77058	**Congressional District:**	22
Comments:			
Project Type:	Flight	**Solicitation / Funding Source:**	Directed Research
Start Date:	12/13/2007	**End Date:**	12/17/2012
No. of Post Docs:	0	**No. of PhD Degrees:**	0
No. of PhD Candidates:	1	**No. of Master' Degrees:**	0
No. of Master's Candidates:	0	**No. of Bachelor's Degrees:**	0
No. of Bachelor's Candidates:	0	**Monitoring Center:**	NASA JSC
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Flight Program:	ISS		
Flight Assignment:	ISS 19, 20 NOTE: change in start/end dates per JSC--now showing as 12/13/2007-12/17/2012 (previously 10/1/08-10/1/11)--2/2010 NOTE: Title change per JSC ; previous title: Evaluation of Maximal Oxygen Uptake (VO2max) During Long Duration International Space Station Missions (9/2009) NOTE: Start/end dates changed per JSC (4/27/2009)		
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Feiveson, Alan (Johnson Space Center) Lee, Stuart (Wyle Laboratories) McCleary, Frank (Wyle Laboratories) Platts, Steven (Johnson Space Center) Evetts, Simon (European Astronaut Centre)		
Grant/Contract No.:	Directed Research		
Performance Goal No.:			

Performance Goal Text:	
Task Description:	Maximum oxygen uptake (VO2max, sometimes referred to as VO2peak)* is the standard measure of aerobic capacity and is directly related to the physical working capacity of an individual. Reduction in VO2max is commonly reported as a result of ground-based analogues of long duration spaceflight. Due to early concerns related to the safety of performing maximal exercise testing during or shortly after long duration flight, and until recently lack of a device to measure exercise VO2 on International Space Station (ISS), VO2max has never been directly measured over the course of or following long duration space flight. For operational purposes, for example, to assess crew member readiness to perform Extra Vehicular Activities during long missions, the heart rate (HR) response to submaximal exercise testing have been used to infer changes in aerobic capacity. Recent work by the investigators of this study has suggested that the validity of using the HR response to track changes in aerobic capacity during ISS flight is suspect, as a fundamental assumption underlying this technique (equivalence of preflight and in-flight submaximal VO2 per set exercise work rate), was demonstrated as questionable. The specific aims of this research are: 1. To directly measure VO2max during and following long duration ISS missions. 2. To examine the current method of estimating VO2max change during and following ISS missions, and establish if it can used to validly track actual measures of VO2max. 3. To determine if the addition of a non-invasive cardiac output measures during exercise will improve the accuracy of estimating changes in VO2max during and following ISS missions. *- Exercise Physiology investigators will often refer to the maximum oxygen uptake value assessed in this study as “VO2peak” as repeated exercise tests are not used to verify the subject is truly at physiological maximum (not practical or even possible for certain time points of the study). For the purposes of this study and report, the investigators use the more familiar term “VO2max.”
Rationale for HRP Directed Research:	This research is directed because it contains highly constrained research, which requires focused and constrained data gathering and analysis that is more appropriately obtained through a non-competitive proposal.
Research Impact/Earth Benefits:	The application of the research findings of this investigation will be most relevant to space flight operations, addressing the questions of whether or not maximum testing will be required to accurately assess aerobic capacity during the course of long-duration missions and determining the time-course of VO2max changes during and following long-duration space flight. However, the findings of this research may also be applied to the clinical realm on Earth by quantifying the time-course of recovery of VO2max after long-term deconditioning. This would aide in the determination of how long rehabilitation would be required after extended periods of bed rest confinement or other severe deconditioning.
Task Progress:	Progress on the VO2max study has been excellent in its first year of conduct. The VO2max study serves as an exemplary model of an international collaborative effort in support of research on the ISS. The device used to measure VO2 and cardiac output, the European Space Agency (ESA) provided Portable Pulmonary Function System (PPFS; Damec, Odense, DK) was successfully validated during ground trials. The PPFS was launched to ISS on board the Japan Aerospace Agency (JAXA) H-II transfer vehicle in September, 2009. The first 4 ESA and NASA astronaut volunteers (of 12 planned) have completed the experiment. The fifth subject is currently on board ISS, with two additional participating astronauts due to launch in June, 2010. Minor problems have been encountered with equipment set-up and calibration prior to some of the in-flight test sessions, which lead to those sessions running slightly longer than planned, but troubleshooting by the crew members in coordination with the NASA and ESA ground support teams have been effective in resolving the issues and good data were successfully obtained. In addition, due to the arrival of the PPFS in the middle of the first expedition that the experiment was manifested on, the response of VO2max early in flight was not measured for the first three subjects. It is too early in the study to draw any conclusions from the findings to date. However, some preliminary observations are offered here: 1. The VO2max responses of the subjects during flight have been variable, with 2 subjects demonstrating declines >20%, 1 subject having a more modest decline (~10%) and one subject remaining unchanged from preflight levels. 2. There are differences observed between the estimates of aerobic capacity derived by submaximal test data (calculated using either HR and work rate data, or HR and submaximal VO2 data) and measured VO2max. The magnitude of this difference has been inconsistent when compared across subjects.
Bibliography Type:	Description: (Last Updated: 03/03/2016)
Abstracts for Journals and Proceedings	Moore AD, Evetts SN, Feiveson AH, Lee SMC, McCleary FA, Platts SH. "Maximum oxygen uptake during and after long-duration space flight." Presented at the 2010 NASA Human Research Program Investigators' Workshop, Houston, TX, February 3-5, 2010. 2010 NASA Human Research Program Investigators' Workshop, 2010. Published online and available at: http://www.dsls.usra.edu/meetings/hrp2010/pdf/Muscle/1148AMoore.pdf , Feb-2010
Articles in Peer-reviewed Journals	Moore AD, Lee SMC, Stenger MB, Platts SH. "Cardiovascular exercise in the U.S. space program: Past, present and future." Acta Astronautica. 2010 Apr-May;66(7-8):974-88. http://dx.doi.org/10.1016/j.actaastro.2009.10.009 , Apr-2010