Fiscal Year:	FY 2011	**Task Last Updated:**	FY 05/04/2011
PI Name:	Prisk, G. Kim Ph.D., D.Sc.		
Project Title:	Clearance of Particles Depositing in the Human Lung in Low Gravity		
Division Name:	Human Research		
Program/Discipline:	NSBRI		
Program/Discipline--Element/Subdiscipline:	NSBRI--Human Factors and Performance Team		
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	(1) **SHFH**:Space Human Factors & Habitability (archival in 2017)		
Human Research Program Risks:	(1) **Dust**:Risk of Adverse In-Mission Health and Performance Effects and Long-Term Health Effects Due to Celestial Dust Exposure (2) **Medical Conditions**:Risk of Adverse Health Outcomes and Decrements in Performance Due to Medical Conditions that occur in Mission, as well as Long Term Health Outcomes Due to Mission Exposures (3) **Renal Stone**:Risk of Renal Stone Formation		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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City:	La Jolla	**State:**	CA
Zip Code:	92093-0852	**Congressional District:**	53
Comments:			
Project Type:	Ground	**Solicitation / Funding Source:**	2007 Crew Health NNJ07ZSA002N
Start Date:	06/01/2008	**End Date:**	05/31/2012
No. of Post Docs:	1	**No. of PhD Degrees:**	0
No. of PhD Candidates:	0	**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:**	NSBRI
Contact Monitor:		**Contact Phone:**	
Contact Email:			
Flight Program:			
Flight Assignment:			
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Bennett, William (University of North Carolina at Chapel Hill) Darquenne, Chantal (University of California, San Diego)		
Grant/Contract No.:	NCC 9-58-HFP01604		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	Original Aims: The deposition of particulate matter (PM) in the human lung is known to bring with it both long-term and short-term adverse health consequences. The deposition of particles in the lung is strongly influenced by gravitational sedimentation. Studies by our group have shown that normal gravity provides a screening effect whereby inhaled PM larger than 0.5 micron is mainly deposited in the larger airways where it is cleared by mucociliary clearance transport within ~one day. However in low-gravity, such as that on the surface of the Moon (~1/6G) and Mars (~3/8G), this protective 'gravitational screening' is less efficient, and as a result particles are deposited in the sensitive alveolar regions of the lung where residence times are very much longer. Further, there is evidence that the dust present on the surface of the Moon may possess potent toxicological properties. We hypothesize that clearance rates from the lung of particles deposited in low-gravity will be substantially reduced compared to that in 1G, resulting in increased residence times of these particles in the periphery of the lung, enhancing their potential to cause lung damage. In order to test this hypothesis we propose to measure the clearance rates (measured in 1G) over a few hours to ~1-2 days, of radio-labeled particles deposited in healthy humans both in 1G and in low-gravity corresponding to the lunar surface (~1/6G) during parabolic flight. These data will provide a comprehensive assessment of alterations in the clearance rate of particles inhaled under normal 1G conditions compared to particles inhaled under conditions of lunar gravity (1/6G). Such an assessment is needed to determine the degree of effort and cost required to control lunar dust within a planned lunar outpost. Key Findings: In this third year of the project we have completed all technical requirements for flight and stand ready to fly. However flight scheduling has been once again virtually impossible. As a consequence we have performed some ground studies in advance of flight studies. These are part of the post-doctoral fellowship work of Dr. Rui-Carlo Sa. In addition we attempted to manifest the experiment on the ESA/Novespace A-300 flying out of Bordeaux, France. However the difficulties with the French nuclear regulatory authorities to fly the necessary radioactive tracer proved insurmountable. The details of our activities can be found in the "Task Progress" section of the report. Our current status can be summarized as follows: - CPHS/Radiation approval in place - Subject certifications complete - Hardware and procedures fully tested and functional - Structural issues resolved - Ready for flight - Waiting on flight manifesting, which we are informed will not be before July 2011. Year 4 Plan: We hope to fly both the 4 micron particle size objective AND the 1 micron particle size objective in Year 4 of the project. In response to the extreme difficulty experienced in scheduling reduced gravity flights, we devised and have now fully verified (as part of the ground studies performed for Dr. Sa's studies) a 2-subject-per-flight experimental structure that will permit more efficient use of scarce reduced gravity flight opportunities.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	Airborne particulate matter is a health hazard. The deposition of particulate matter (PM, often referred to as aerosols) in the human lung is known to bring with it both long-term and short-term adverse health consequences. On Earth, effects of PM-induced lung injury are most readily seen in individuals with pre-existing lung disease (i.e. asthma, chronic obstructive pulmonary disease). Studies suggest that particle-induced inflammation or edema likely enhance underlying pulmonary disease, leading to a worsening of already abnormal pulmonary ventilation/perfusion relationships and gas exchange. Such worsening can result in hypoxemia leading to fatal cardiac arrhythmia. There is also little question that even healthy individuals exposed to PM for extended periods are susceptible to PM-induced lung injury. For example, the increase in risk of death from long-term exposure to PM in six US cities has been shown to be in the area of 17% for the general population for a modest increase in total PM load of 24.5 micro-g/m3. These studies will directly determine the consequences of a more peripheral site of aerosol deposition on the subsequent clearance of PM from the lung. It is well established that the negative health consequences of exposure to environmental PM increase as particle size is reduced. These studies will provide insight into how much of this effect is a consequence of the increased residence time of particles that are deposited more peripherally in the lungs. Such peripheral deposition occurs not only on the Lunar surface but here on Earth.
	Year 3 of this project has been largely stalled by the lack of flight availability, forcing us to re-order some activities and focus on ground studies in conjunction with Rui-Carlos Sa. The major milestones achieved in this year are summarized as follows: - Finalized the structural changes of flight hardware incorporating revisions arising from interim structural analyses. - Performed a formal structural analysis of the equipment rack (requested by ESA/NASA). Rack shows positive margins in all aspects following modifications to lower the center of gravity (see appendices for images). - Submitted an update Test Equipment Data Package reflecting the revised configuration of the system to NASA for pre-approval. - Received formal radiation-use approval from JSC Radiation Safety group completing previous interim approval. - In January used the flight system for collection of data in support of Rui-Carlos Sa's study at UNC on first 4 subjects. No issues identified. Note that these studies were moved ahead of flights in light of inability to secure flights.

Task Progress:	- Performed end-to-end timeline tests of the flight timeline during January tests, confirming our ability to study 2 subjects per flight. This testing involved not only the inflight timeline, but the postflight timeline with the intersection with the following day's activities. Following minor adjustments in the timeline we are no confident of a 2-subject per day flight scenario with back to back flight days. - Confirmed scientific comparability between Dicom (integrated) data and List Mode (real-time) data. This confirms our ability to acquire and use List Mode data inflight (our preferred approach). Note that Dicom data will still be acquired as well providing a degree of redundancy. In addition to the activities listed above, we actively investigated the flight of the experiment on the ESA/Novespace A-300 Airbus flying from Bordeaux France. These attempts were ultimately unsuccessful but are included in the summary of attempts to fly this experiment and because they represented a considerable effort on our part. Despite these considerable achievements we have been severely hampered by a lack of access to the reduced gravity aircraft. In addition to these technical achievements, Dr. Rui-Carlos Pereira de Sá was awarded a NSBRI Post-Doctoral fellowship with Dr. G.K. Prisk as his mentor. Abbreviated Statement of Status: - CPHS/Radiation approval in place - Subject certifications complete - Hardware and procedures fully tested and functional - Structural issues resolved (awaiting final approval) - Ready for flight - Waiting on flight manifesting
Bibliography Type:	Description: (Last Updated: 03/11/2021)
Articles in Peer-reviewed Journals	Darquenne C, van Ertbruggen C, Prisk GK. "Convective flow dominates aerosol delivery to the lung segments." J Appl Physiol. 2011 Jul;111(1):48-54. http://dx.doi.org/10.1152/japplphysiol.00796.2010 ; PubMed PMID: 21474695 , Jul-2011
Articles in Peer-reviewed Journals	Sá RC, Cronin MV, Henderson AC, Holverda S, Theilmann RJ, Arai TJ, Dubowitz DJ, Hopkins SR, Buxton RB, Prisk GK. "Vertical distribution of specific ventilation in normal supine humans measured by oxygen-enhanced proton MRI." J Appl Physiol. 2010 Dec;109(6):1950-9. Epub 2010 Oct 7. PMID: 20930129 http://dx.doi.org/10.1152/japplphysiol.00220.2010 , Dec-2010
Awards	Prisk GK. "G.K. Prisk: Appointed Associate Editor Journal of Applied Physiology (effective 7/1/2011), April 2011." Apr-2011
Awards	Bennett W. "William Bennett: Elected President International Society of Aerosols in Medicine (ISAM), January 2011." Jan-2011
Books/Book Chapters	Prisk GK. "Gas exchange under altered gravitational stress." in "Comprehensive Physiology." Comprehensive Physiology, vol. 1/issue 1, p. 339-355, January 2011. Oxford, UK : Wiley-Blackwell, 2011. http://dx.doi.org/10.1002/cphy.c090007 , Jan-2011
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Books/Book Chapters	Prisk GK. "Pulmonary circulation in extreme environments." in "Comprehensive Physiology." Comprehensive Physiology vol. 1, issue 1, p. 319-338, 2011. Oxford, UK : Wiley-Blackwell, 2011. http://dx.doi.org/10.1002/cphy.c090006 , Jan-2011