Fiscal Year:	FY 2010	**Task Last Updated:**	FY 09/14/2010
PI Name:	Ritter, James A Ph.D.		
Project Title:	Development of Pressure Swing Adsorption Technology for Spaceflight Medical Oxygen Concentrators		
Division Name:	Human Research		
Program/Discipline:	NSBRI		
Program/Discipline--Element/Subdiscipline:	NSBRI--Smart Medical Systems and Technology Team		
Joint Agency Name:		**TechPort:**	Yes
Human Research Program Elements:	(1) **ExMC**:Exploration Medical Capabilities		
Human Research Program Risks:	(1) **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		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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City:	Columbia	**State:**	SC
Zip Code:	29208-4101	**Congressional District:**	6
Comments:			
Project Type:	Ground	**Solicitation / Funding Source:**	2008 Crew Health NNJ08ZSA002N
Start Date:	09/01/2009	**End Date:**	08/31/2013
No. of Post Docs:	1	**No. of PhD Degrees:**	0
No. of PhD Candidates:	5	**No. of Master' Degrees:**	0
No. of Master's Candidates:	0	**No. of Bachelor's Degrees:**	0
No. of Bachelor's Candidates:	1	**Monitoring Center:**	NSBRI
Contact Monitor:		**Contact Phone:**	
Contact Email:			
Flight Program:			
Flight Assignment:			
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Knox, James (NASA Marshall Space Flight Center) Edwards, Paul (SeQual Technologies) LeVan, Douglas (Vanderbilt University)		
Grant/Contract No.:	NCC 9-58-SMST02002		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	A source of medical oxygen will be needed at some point to keep an astronaut alive during a space mission. To meet this need, the ideal oxygen source would be a light, compact unit that uses minimal electricity, and can supply oxygen continuously for many days. No current technology meets these requirements. Traditional compressed-oxygen cylinders provide a limited amount of oxygen in a heavy, inconvenient package and are not suited for space missions. Oxygen concentrators, which extract oxygen from air using electricity, can eliminate the obvious problems with cylinder storage in space. These kinds of medical oxygen concentrators are already used in residential and military applications. However, existing systems are too big, use too much power, and are too heavy to be carried into space. For example, a unit that can produce oxygen continuously at 4 LPM, weigh less than 7 pounds and use less than 100 Watts of electric power requires a two-fold reduction in weight and power consumption, compared with the most advanced oxygen concentrators now in production by SeQual. As proposed herein, this requirement may be met by combining new air compressor designs with advances in Pressure Swing Adsorption (PSA) technology. SeQual and the team of researchers from the University of South Carolina, Vanderbilt University and the Marshall Space Flight Center are uniquely positioned to achieve this next level of performance. To determine whether the proposed technology advances are indeed possible, during the first year of this four year project, the four teams of researchers have been carrying out an extensive mathematical modeling study, combined with carefully planned experiments, based on SeQual's state-of-the-art Eclipse medical oxygen system. Results from the experiments were used successfully to validate the rigorous mathematical model. Subsequent results from the modeling effort were very enlightening and are currently being evaluated to determine whether they warrant carrying out a new breadboard system design. In the mean time, the group at Vanderbilt has been busy setting up equilibrium and mass transfer measurement apparatuses that will be key to ensuring the accuracy of the mathematical modeling effort; and the group at the MSFC has been setting up a test facility for evaluating the Eclipse and other breadboard system designs in different low pressure environments. Thus, during the first year of this four year project, this program is definitely on track for improving the efficiency of the PSA separation, with the project culminating in a breadboard system that will supply 4 LPM of oxygen, weigh 7.2 pounds and require 106 watts of electric power.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	A major expectation of the research is the development of smaller medical oxygen concentrators, which will be of benefit not only for space flight but also for medical patients on Earth in need of oxygen-enriched air.
Task Progress:	There are 8 tasks associated with this project. These are: 1. Refine model parameters; 2. Validate dynamic adsorption process simulator (DAPS) ; 3. Optimize and understand the SeQual PSA cycle; 4. Examine alternative PSA cycles; 5. Redesign and build improved PSA module for 4 LPM system; 6. Define compressor specifications and build feasibility prototype for 4 LPM system; 7. Assemble and test breadboard systems; and 8. Verify DAPS predictions of new PSA modules. In the first year, only Tasks 1, 2 and 6 were to be initiated. Progress has been made for each of these three tasks, as well as with Task 3 and Task 4 is just being initiated. More detail about each of these tasks is provided below. Task 1. Refine Model Parameters VU and USC): Professor LeVan and his team have been working with Professor Ritter and his team to update the dynamic cyclic adsorption process simulator (DAPS) with the most up to date thermodynamic and kinetic parameters. This task is on schedule. Task 2. Validate Dynamic Adsorption Process Simulator (USC and SeQual): Professor Ritter and his team have been working with SeQual to obtain system dimensions, operating conditions and extensive experimental performance data of SeQual's Eclipse system and then using it to calibrate and validate the dynamic adsorption process simulator (DAPS). This task is on schedule and significant progress has been made with respect to DAPS quantitatively predicting the performance of the Eclipse system. This task is on schedule. Task 3. Optimize and Understand the SeQual PSA Cycle (USC and SeQual): Using the refined and validated DAPS, Professor Ritter and his team, with input from SeQual, have been carrying out extensive parametric studies of SeQual's PSA cycle to determine if it is possible to improve oxygen recovery, productivity or both while maintaining the oxygen purity and without redesigning the PSA module. There have been some key findings with DAPS that will be tested experimentally by both SeQual and the MSFC in subsequent years of this project. This task is ahead of schedule. Task 4. Examine Alternative PSA Cycles (USC): Using the refined DAPS, Professor Ritter and his team, with input from SeQual, are just beginning to explore new cycle designs and cycle schedules to determine if it might be possible to improve the oxygen recovery, productivity or both while maintaining the oxygen purity by redesigning the PSA module. This task is ahead of schedule. Task 6. Define Compressor Specifications and Build Feasibility Prototype for 4 LPM System (SeQual): SeQual has an operating compressor suitable for a 3 LPM oxygen PSA system through a different funding source. Specifications and requirements have been identified and a feasibility prototype is being built to provide sufficient pressure and vacuum to supply the 4 LPM system. This task is on schedule.
Bibliography Type:	Description: (Last Updated: 08/28/2015)