Fiscal Year:	FY 2011	**Task Last Updated:**	FY 02/27/2012
PI Name:	Duda, Jessica Ph.D.		
Project Title:	Space Suit Simulator (S3) for Partial Gravity EVA Experimentation and Training		
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) **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:	jduda@aurora.aero	**Fax:**	FY
PI Organization Type:	INDUSTRY	**Phone:**	(617) 500-0552
Organization Name:	Aurora Flight Sciences Corporation		
PI Address 1:	1 Broadway, 12th Floor		
PI Address 2:			
PI Web Page:			
City:	Cambridge	**State:**	MA
Zip Code:	02142-1189	**Congressional District:**	8
Comments:			
Project Type:	Ground	**Solicitation / Funding Source:**	SBIR Phase II
Start Date:	06/01/2011	**End Date:**	06/02/2014
No. of Post Docs:		**No. of PhD Degrees:**	
No. of PhD Candidates:		**No. of Master' Degrees:**	
No. of Master's Candidates:		**No. of Bachelor's Degrees:**	
No. of Bachelor's Candidates:		**Monitoring Center:**	NASA JSC
Contact Monitor:	Norsk, Peter	**Contact Phone:**	
Contact Email:	Peter.norsk@nasa.gov		
Flight Program:			
Flight Assignment:	NOTE: End date changed to 6/2/14 (from 5/31/2013) per HRP technology information (Ed., 8/28/14)		
Key Personnel Changes/Previous PI:			
COI Name (Institution):			
Grant/Contract No.:			
Performance Goal No.:			
Performance Goal Text:			
	Pressurized space suits impose high joint torques on the wearer, reducing mobility for upper and lower body motions. Using actual space suits in training or experimentation is problematic due to the expense, bulk, weight, and difficulty in donning/doffing. The goal of this project was to demonstrate a novel method for simulating space suit joint torques, which are non-linear and vary with angular position. We designed a knee joint simulator using McKibben actuators with active control (also known as artificial muscles), which are cylindrical pneumatic actuators constructed of flexible rubber with an inextensible weave that causes the cylinder to contract longitudinally when pressurized. A commercial knee brace was used as an exoskeleton to mount the actuators. One actuator was mounted anterior to the knee to provide resistance to flexion, and a second actuator was mounted posterior to the knee to provide resistance to extension. The active controller read angle input from a potentiometer mounted to the brace and output the appropriate pressures for each actuator to provide the needed torque. The knee joint was installed on MIT's Robotic Space Suit Tester (RSST), a		

Task Description:	full-sized anthropometric robot equipped with torque and angle sensors on each of the joints. Results from testing indicated that the torque vs. angle relationship achieved using the actively controlled spacesuit joint simulator was qualitatively similar to the non-linear trend observed in prior testing of the EMU on the RSST. We conclude that the use of these actuators potentially results in higher fidelity than passive actuation. POTENTIAL NASA COMMERCIAL APPLICATIONS: The primary customer for this device will be NASA. The timing of this Phase 2 effort is important to facilitate planned microgravity and lunar and martian surface EVA research and training in support of NASA's current vision for future exploration missions. Development of surface operations activities on the moon or Mars will benefit from the support of human testing and training; e.g. what is the metabolic cost of performing specific tasks in partial gravity while wearing a space suit? Additionally, experimentation in support of development of the future moon/Mars EVA space suit will require human testing; our adjustable space suit simulator joint torques will allow for characterization of various suit configurations in order to optimize the future suit design. We anticipate that EVA S3 systems will be used to support training and simulation activities at multiple centers including JSC, GRC, and ARC, and that this market will require initial production of 10 to 15 systems.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	Joint torque devices such as those developed during this program are useful in medical technologies as orthopedic devices: either restricting motion in order to prevent injury, or providing resistance to motion in order to improve muscle function or promote bone growth. For example, a controlled resistance suit could be used as an exercise device (e.g. performing squats with a controlled resistance suit rather than with weights) or individual components of the EVA S3 design could be used separately for rehabilitation of specific joints. Alternately the control scheme can be changed to provide performance augmentation to the wearer. To support these various markets, the EVA S3 technology is adjustable to accommodate individuals of different heights and weights, is rugged, portable, has low power requirements and is compatible with under water operations.
Task Progress:	New project for FY2011. Reporting not required for this SBIR Phase 2 project.
Bibliography Type:	Description: (Last Updated:)