Fiscal Year:	FY 2013	**Task Last Updated:**	FY 08/08/2013
PI Name:	Adelstein, Bernard Ph.D.		
Project Title:	Display Reading Performance Under Lateral Whole-Body Vibration Due to 12-Hz Thrust Oscillation		
Division Name:	Human Research		
Program/Discipline:	HUMAN RESEARCH		
Program/Discipline--Element/Subdiscipline:	HUMAN RESEARCH--Space Human Factors Engineering		
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	(1) **SHFH**:Space Human Factors & Habitability (archival in 2017)		
Human Research Program Risks:	(1) **HSIA**:Risk of Adverse Outcomes Due to Inadequate Human Systems Integration Architecture		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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City:	Moffett Field	**State:**	CA
Zip Code:	94035-1000	**Congressional District:**	18
Comments:			
Project Type:	GROUND	**Solicitation / Funding Source:**	Directed Research
Start Date:	06/13/2013	**End Date:**	10/30/2013
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
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Flight Program:			
Flight Assignment:	NOTE: Extended to 10/30/2013 per E. Connell/HRP (Ed., 10/21/13)		
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Beutter, Brent (NASA Ames Research Center) Kaiser, Mary (NASA Ames Research Center) Dory, Jonathan (NASA Johnson Space Center)		
Grant/Contract No.:	Directed Research		
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Task Description:	Current analyses for the Orion and Space Launch System (SLS) Programs indicate that the crew will be subject predominantly to lateral (left-right for Orion seat occupant) vibration caused by out-of-phase ~12-Hz thrust oscillation (TO) in the SLS's two side-mounted solid rocket boosters. While these analyses show that the axial (occupant chest-to-spine) component of TO vibration will remain below the 0.21-grms and 0.7-gpeak limits established by the Constellation Program (CxP) for crew performance, the lateral component potentially could exceed the CxP requirement's 0.1-gpeak limit for concurrent off-axis vibration. The 0.1-gpeak lateral component limit has never been verified empirically, and may be overly conservative. The 0.1-gpeak limit is traceable to vibration studies conducted by our lab that enabled CxP's to define axial TO requirements. In those studies, under deliberately controlled axial vibration, we observed that participants exhibited oscillatory lateral head motion up to 0.1 gpeak as a "side effect" of the applied chest-to-spine vibration input, and that this had a negligible impact on their performance. This observation of negligible impact provided the basis of the CxP lateral vibration limit that according to the Orion and SLS Loads Panel was inherited by those programs. In recent months, the Orion and SLS Loads Panel has inquired about the validity of the TO vibration requirements' lateral component, and asked whether it could be relaxed in the presence of negligible axial vibration. Spaceflight launch environments have several unique aspects including semi-supine (recumbent) seating posture, supported and potentially restrained crew head configuration, and peak vibration being accompanied by concurrent elevated G-load. These factors produce head-neck-torso biodynamic responses that differ significantly from the typical non-NASA configuration of upright, seated individuals without head restraints. Therefore, the existing literature for visual performance under vibration is of marginal applicability to the anticipated lateral SLS-Orion TO vibration. Specifically, human performance data under relevant seating and head-constraint conditions have been collected only to address the axial vehicle vibration concerns that arose for the Gemini and Constellation Programs. The absence of lateral performance data consequently necessitates further human-in-the-loop testing before (a) validated lateral vibration requirement(s) can be written for Orion and SLS. Presently, a new task covering lateral vibration is being planned for Gap SHFE-HAB-03. After completion of the proposed study, we will narrow this gap specifically by having addressed numeric text legibility (visual performance) under controlled single-frequency (12-Hz) lateral vibration, the current Orion/SLS concern. Specific Aims: In the proposed work, we will control lateral vibration (while minimizing chest-to-spine input components) at the predicted 12-Hz frequency of TO vibration in the first empirical investigation of the impact of lateral vibration amplitude on semi-supine observers' visual performance. We will measure observer performance in terms of response time and error rate, using the same numeric text legibility procedure that we employed previously to deliver similar data to CxP for axial (chest-to-spine) TO vibration. These new data will provide the SLS and Orion programs with a rational, quantitative basis to update the inherited CxP limit for lateral TO in the presence of minimal axial vibration, thereby allaying a human performance risk as well as potentially offering design relief for SLS and Orion. In addition, we will also investigate the efficacy of a strobing countermeasure to improve the readability of display panels under lateral TO vibration. In previous work for axial TO, we showed strobing to be an effective mitigation, restoring display reading error rates at 0.7-g, 12-Hzvibration to the error rates measured for zero vibration. Knowledge gained from this work will provide the help augment the HIDH vibration section, which currently lacks information about the impact of lateral vibration on human performance relevant to spaceflight. Requirement(s) resulting from the proposed study may also be added to NASA-STD-3001 Vol. 2. , 12-Hz vibration to the error rates measured for zero vibration.
Rationale for HRP Directed Research:	Insufficient time for solicitation because data for human performance under lateral vibration are needed to support thrust oscillation and seat analyses, respectively, for SLS DAC-3 and MPCV MDAC-2 program milestones. The first milestone is SLS DAC-3 completion in September 2013.
Research Impact/Earth Benefits:	
Task Progress:	New project for FY2013.
Bibliography Type:	Description: (Last Updated: 04/13/2017)