Fiscal Year:	FY 2012	**Task Last Updated:**	FY 10/08/2012
PI Name:	Czeisler, Charles A. M.D., Ph.D.		
Project Title:	Sleep-Wake Actigraphy and Light Exposure During Spaceflight		
Division Name:	Human Research		
Program/Discipline:	HUMAN RESEARCH		
Program/Discipline--Element/Subdiscipline:	HUMAN RESEARCH--Behavior and performance		
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	(1) **HFBP**:Human Factors & Behavioral Performance (IRP Rev H)		
Human Research Program Risks:	(1) **BMed**:Risk of Adverse Cognitive or Behavioral Conditions and Psychiatric Disorders (2) **Sleep**:Risk of Performance Decrements and Adverse Health Outcomes Resulting from Sleep Loss, Circadian Desynchronization, and Work Overload		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
PI Email:	caczeisler@rics.bwh.harvard.edu	**Fax:**	FY 617-732-4015
PI Organization Type:	UNIVERSITY	**Phone:**	617-732-4013
Organization Name:	Brigham and Women's Hospital/Harvard Medical Center		
PI Address 1:	Division of Sleep Medicine		
PI Address 2:	221 Longwood Ave., Ste. 438		
PI Web Page:			
City:	Boston	**State:**	MA
Zip Code:	02115-5804	**Congressional District:**	8
Comments:			
Project Type:	Flight	**Solicitation / Funding Source:**	98-HEDS-02
Start Date:	01/24/2001	**End Date:**	04/30/2017
No. of Post Docs:	0	**No. of PhD Degrees:**	1
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:**	NASA JSC
Contact Monitor:	Leveton, Lauren	**Contact Phone:**	
Contact Email:	lauren.b.leveton@nasa5.gov		
Flight Program:	Shuttle/ISS		
Flight Assignment:	STS-133, STS-134, STS-135 (addt'l flight info per PI report 11/2011) STS 129, 130, 131, 132 ; ISS increments 22-24 (addt'l flight info per PI 11/2009) STS 126, STS 127, STS 128 ; ISS Increments 18-21 (addt'l flight info per PI office, 11/2008) STS 122, STS 123, STS 124, STS 125; ISS Increment 17 (add'l flight info per PI office, 1/2008) STS 116, STS 118, STS 120; ISS Increments 14, 15, 16 (add'l flight info provided 11/06) STS 121, STS 115; ISS Increments 13-14 STS 104, STS 109, STS 111, STS 112, STS 113, STS 114 NOTE: Expected to be extended to 4/30/2017 per CoI L. Barger (Ed., 8/31/13) NOTE: End date changed to 4/30/2013 per CoPI Barger (Ed., 9/10/2012) NOTE: End date is not firm per CoI/PI (Ed., 11/18/2011) NOTE: End date is 7/31/2012 per PI/CoI (Ed., 10/27/11) NOTE--end date should be around 4/30/2012 per JSC (11/08)		

Key Personnel Changes/Previous PI:	Laura K. Barger, Ph.D. is assigned as Co-Principal Investigator (1/2008 report).
COI Name (Institution):	Barger, Laura (Co-PI: Harvard Medical School) Wright, Kenneth Ph.D. (University of Colorado) Ronda, Joseph M.S. (Harvard Medical School) Evans, Erin Ph.D. (Brigham and Women's Hospital)
Grant/Contract No.:	NCC9-119
Performance Goal No.:	
Performance Goal Text:	
Task Description:	Subjects will wear a small light-weight activity and light recording device for the entire duration of their mission. They will complete a sleep log each day on Shuttle flights and for three 1-week periods during an ISS mission. The sleep-wake activity and light exposure patterns obtained in-flight will be compared with baseline data collected for two weeks at L-90 and from L-11 through L-0. Recovery from space flight will also be assessed from R+0 through R+7. These data should help us better understand the effects of space flight on sleep as well as aid in the development of effective countermeasures for both short and long-duration space flight. See also http://www.nasa.gov/
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	The success and effectiveness of manned space flight depends on the ability of crew members to maintain a high level of cognitive performance and vigilance while operating and monitoring sophisticated instrumentation. Astronauts, however, commonly experience sleep disruption and may experience misalignment of circadian phase during space flight. Both of these conditions are associated with impairment of alertness and cognitive performance. A survey of 58 crew members from 9 shuttle missions revealed that most suffered from sleep disruption and were unable to sleep more than six hours per day of flight as compared to 7.9 hours per day on the ground. Ground-based studies have revealed that chronic exposure to such partial sleep loss results in progressive decrements in neurobehavioral performance during waking hours. In fact, nineteen percent of crew members on single shift missions and 50 percent of the crew members in dual shift operations have resorted to sleeping pill usage (principally benzodiazepines) during their missions, which represents more than 40% of all medication used by shuttle crew. Although benzodiazepines are effective hypnotics, their adverse next-day side effects include sedation, performance decrements, amnesia, and distortions in the sleep EEG. Relatively little is known of the severity or cause of space flight-induced insomnia in short duration mission, and less is know about the effect of long-duration space flight on sleep and circadian rhythm organization. This experiment will use state-of-the-art ambulatory technology to monitor sleep-wake activity patterns and light exposure in crew members aboard Space Shuttle and ISS missions. The proposed research could have significant implications for both sleep disorders medicine and space life sciences. The results of the proposed research could lead to the development of a new treatment regimen for sleep disturbances of various etiologies during space flight, which could enable crew members to avoid the decrements in alertness and performance associated with sleep deprivation. This work could therefore have a profound impact on the health, productivity and safety not only of astronauts during space flight, but also of other groups with a high prevalence of insomnia, such as shift workers and older people.
Task Progress:	REPORTING PROVIDED OCTOBER 2012: A critical OMB milestone was met on August 31st, 2012 when a final report was submitted to the Behavioral Health and Performance (BHP) Element on the Sleep-Wake Actigraphy Study – Risk Characterization and Monitoring Tools for Spaceflight Environments of Shuttle and ISS, by BHP Principal Investigators Drs. Laura Barger and Charles Czeisler of Harvard Medical School and Brigham and Women's Hospital. The study informs multiple gaps within the BHP risk of Performance Errors due to Fatigue Resulting from Sleep Loss, Circadian Desynchronization, Extended Wakefulness, and Work Overload and the risk of Adverse Behavioral Conditions and Psychiatric Disorders and in other Elements in the Human Research Program (e.g., Pharmacology). This investigation is the largest study of sleep in spaceflight for both short and long duration missions. This research task directly addresses NASA HRP spaceflight-related research gaps by providing objective actigraphy data collected from 21 ISS crewmembers (3,201 ISS in-flight days) and 60 astronauts on 80 Shuttle missions, encompassing 26 STS flights (1,066 STS in-flight days). Results indicated that astronauts obtain insufficient sleep during both STS and ISS missions. Furthermore, findings suggest that astronauts face significant chronic sleep debt, even 3 months prior to launch, and that sleep restriction is sustained throughout spaceflight even with the use of sleep promoting medications. Prior ground-based research indicates that chronic sleep loss, similar to that observed in the current study in-flight, produces performance decrements. These findings highlight the need for development of effective countermeasures to promote sleep in long duration missions and thereby enhance wakefulness in-flight. The results of this study have informed both the research and operations communities and generated interest in transitioning these procedures from research to operations. REPORTING PROVIDED NOVEMBER 2011: INTRODUCTION: The success of current and future human spaceflight demands that astronauts maintain peak levels of alertness and performance throughout mission operations; however, astronauts are often required to perform while under acute and chronic sleep deprivation during the biological night. Insufficient sleep is associated with cognitive impairment and decreased vigilance, which are critical to the success of mission operations. Findings from prior research studies show that sleep tends to be shorter during space flight than on the ground and that use of sleep medications during spaceflight is common. Several factors, such as circadian misalignment, noise, temperature and urine voids have been identified as possible causes that disrupt sleep in space. METHODS: The present analysis includes data for 64 astronauts (12F) from 76 space Shuttle subject missions. Data collection was initiated at four time points, approximately 90 days prior to launch (L-90), during the 11 days prior to launch (L-11), throughout a spaceflight mission (flight) and for seven days immediately following return from space

	(R+7). Objective sleep outcomes were assessed using wrist-borne actigraphy, which continuously collects accelerometer data averaged over 1 or 2 minute intervals of time (Actiwatch-L; Minimitter-Respironics, Bend, OR). Subjective sleep duration, number and duration of awakenings, environmental causes of sleep disruption, caffeine and medication use were assessed with daily sleep diaries. SPECIFIC AIMS: The specific aim of this study was to test the hypothesis that objective sleep duration would be shorter during space flight than on Earth. RESULTS: Findings from the present study confirm that actigraphy-derived sleep duration is significantly shorter in space (mean 5.98 ± 0.08 h) compared to a baseline data collection three months prior to flight (mean 6.27 ± 0.08 h). Repeated measures ANOVA confirmed that sleep during the L-90 baseline is significantly different than during all other data collection periods. DISCUSSION: The findings from this study are consistent with prior reports that found the average sleep duration in space to be approximately six hours. Results from data collection on Earth suggest that astronauts face a significant cumulative sleep debt, as the mean sleep duration for all conditions never exceeded 7 hours per night. These findings suggest that astronauts face a significant chronic sleep debt, even 90 days prior to embarking on a short-duration mission. This sleep restriction is sustained throughout mission operations. It is possible that the L-90 data collection point does not represent a true baseline due to mission preparation. Future research should involve detailed assessments on astronaut sleep need in order to determine the magnitude of the deficit faced by astronauts prior to and during spaceflight.
Bibliography Type:	Description: (Last Updated: 12/13/2023)
Abstracts for Journals and Proceedings	Barger LK, Flynn-Evans EE, Wright KP Jr, Kubey A, Czeisler CA. "Sleep and the Use of Sleep-Promoting Medications on Multiple Space Shuttle and International Space Station Missions." 18th IAA Humans in Space Symposium, Houston, TX, April 11-15, 2011. 18th IAA Humans in Space Symposium, Houston, TX, April 11-15, 2011. , Apr-2011
Abstracts for Journals and Proceedings	Flynn-Evans EE, Kubey A, Wright Jr. KP, Czeisler CA, Barger LK. "Sleep duration among 64 astronauts on short duration missions. " 2012 NASA Human Research Program Investigators' Workshop, Houston, TX, February 14-16, 2012. 2012 NASA Human Research Program Investigators' Workshop, Houston, TX, February 14-16, 2012. , Feb-2012
Abstracts for Journals and Proceedings	Flynn-Evans EE, Barger LK, Kubey A, Wright KP, Czeisler CA. "Sleep and circadian rhythms in crewmembers during space shuttle missions." 2012 Meeting of the Society for Research on Biological Rhythms, Destin, Florida, May 19-23, 2012. 2012 Meeting of the Society for Research on Biological Rhythms, Destin, Florida, May 19-23, 2012. Conference Program, Abstract P224, p. 239. http://www.conferences.uiuc.edu/SRBR/FINAL%20SRBR%202012%20Program%20and%20Abstracts.pdf , May-2012
Abstracts for Journals and Proceedings	Flynn-Evans EE, Kubey A, Wang W, Wright KP, Czeisler CA, Barger LK. "Sleep duration among 64 astronauts on space shuttle missions." 26th Annual Meeting of the Associated Professional Sleep Societies, Boston, MA, June 9-13, 2012. Sleep. 2012;35 Suppl:A116. http://www.journalsleep.org/Resources/Documents/2012abstractsupplement.pdf , Jun-2012