Fiscal Year:	FY 2024	**Task Last Updated:**	FY 09/07/2023
PI Name:	Newby, Nathaniel M.S.		
Project Title:	Soyuz Landing Injury Risk Characterization		
Division Name:	Human Research		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:	HUMAN RESEARCH--Space Human Factors Engineering		
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	(1) **HFBP**:Human Factors & Behavioral Performance (IRP Rev H)		
Human Research Program Risks:	(1) **Dynamic Loads**:Risk of Injury from Dynamic Loads		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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City:	Houston	**State:**	TX
Zip Code:	77058	**Congressional District:**	36
Comments:			
Project Type:	GROUND	**Solicitation / Funding Source:**	Directed Research
Start Date:	10/01/2015	**End Date:**	10/01/2031
No. of Post Docs:	0	**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:**	NASA JSC
Contact Monitor:	Whitmire, Alexandra	**Contact Phone:**	
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Flight Program:			
Flight Assignment:	NOTE: End date changed to 10/1/2031 per L. Dang/HFBP (Ed., 10/6/23) NOTE: End date changed to 10/1/2022 per PI (Ed., 2/11/22) NOTE: End date change to 10/1/2021 per PI (Ed., 9/28/20) NOTE: End date change to 10/1/2020 per PI (Ed., 7/24/19) NOTE: End date change to 10/1/2019 per PI (Ed., 9/18/18) NOTE: Element change to Human Factors & Behavioral Performance; previously Space Human Factors & Habitability (Ed., 1/19/17) NOTE: Original task was with PI Jeffrey Somers and period of performance 7/2/2014-10/31/2016; PI change with the delayed start, per E. Connell/JSC SHFH element (Ed., 8/10/16)		

Key Personnel Changes/Previous PI:	August 2022 Report: No personnel changes August 2021 Report: Removed Brian Rodriguez as a co-investigator as he is no longer working on this study. Added Kevin Dolick, Keegan Yates, and Jacob Putnam to assist with data collection and management, and to share study outcomes with them as they are working on an NASA Engineering Safety Center (NESC)-funded effort to model the Soyuz vehicle and seat, and will be running recreated landing finite element simulations with human and anthropomorphic test device (ATD) models. August 2020 Report: Added Brian Rodriguez as a co-investigator to assist with statistical analysis. Added Teresa Reiber as a co-investigator to assist with data collection and processing. August 2019 report: Preston Greenhalgh added to the project as a co-investigator. September 2018 report: Brett Siders and Jacob Putnam are no longer Co-Investigators. Nate Newby remains the PI, and Jeff Somers Co-I. September 2017 report: Brett Siders, University of Houston, and Jacob Putnam, KBRwyle, were added to the project as CoInvestigators. August 2016 report: Nathaniel Newby - new Principal Investigator (PI), KBRwyle Science, Technology and Engineering Group; Jeffrey T. Somers - now CoInvestigator (CoI), KBRwyle Science, Technology and Engineering Group; Michael Gernhardt - no longer a CoI
COI Name (Institution):	Somers, Jeffrey M.S. (KBR/NASA Johnson Space Center) Greenhalgh, Preston M.S. (KBR/NASA Johnson Space Center) Reiber, Teresa M.S. (KBR/NASA Johnson Space Center) Dolick, Kevin B.S. (KBR/NASA Johnson Space Center) Yates, Keegan Ph.D. (KBR/NASA Johnson Space Center) Putnam, Jacob M.S. (NASA Langley Space Center)
Grant/Contract No.:	Directed Research
Performance Goal No.:	
Performance Goal Text:	
Task Description:	NOTE: Original task was with Principal Investigator (PI) Jeffrey Somers and period of performance 7/2/2014-10/31/2016; PI change with the delayed start, per E. Connell/JSC SHFH element (Ed., 8/10/16) Currently the impact load imparted to crewmembers landing in the Soyuz vehicle is unknown. This study is the first systematic assessment of the number and types of injuries associated with Soyuz landing. To date, we have found than more than a third of US Orbital Segment (USOS) crewmembers are experiencing injuries. Most of these injuries are minor, but they exceed expected rates based on analysis of seat accelerometer data from airborne and drop tests of the vehicle. The yet to be answered question is whether spaceflight deconditioning renders crewmembers more susceptible to landing impact injuries. Another possibility is that the Soyuz landing load is higher than our current estimates. It could also be that our analytical tools are insufficient to predict injury rates accurately for space vehicles. A final possibility is that some combination of these factors are responsible. The following are the specific aims for this task: 1. Collect retrospective post-landing questionnaire data and develop injury database 2. Determine the occurrence of landing injuries to crewmembers 3. Determine whether the Soyuz meets current Multi-Purpose Crew Vehicle (MPCV) and Commercial Crew Program (CCP) requirements 4. Evaluate whether injury rates are consistent with the results of Finite Element (FE) modeling Using data contained in the flight medicine databases, supplemented with data collected from crewmembers, flight surgeons, Russia sources, and international partner sources, an accurate estimation of the occurrences of injury during Soyuz landings will be determined. In addition, post-landing questionnaires have been developed for retrospective data collection to supplement the above sources. Through collaboration with our Russian colleagues, information about Soyuz landings will be collected to determine the dynamics of landing. The goal will be to obtain actual landing accelerations for individual landings; however, this may not be possible. If not available, all available information about nominal and off-nominal landings will be collected to develop a statistical model of possible landing distributions. Initial scope of this investigation included development of a Finite Element model of the Soyuz seat to be used in conjunction with the Test Device for Human Occupant Restraint (THOR), Hybrid III, and Human FE models. Using the landing data obtained or calculated, landing simulations would then be conducted. The resulting THOR, Hybrid III, and Human FE responses would be compared to the injury occurrences and current requirements. These comparisons would allow for an estimation of the true risk of injury to deconditioned crew related to THOR and Hybrid III metrics. However, NASA has currently descoped this aspect of the investigation.
Rationale for HRP Directed Research:	This task meets the criteria for a Directed Task due to the required access to operational data and because of insufficient schedule available to solicit this work. Because of the sensitive nature of the Soyuz injury and landing acceleration data, it would be very difficult to perform this task outside of NASA. In addition, based on the approved Path to Risk Reduction, this task is required to be completed by the end of FY18 in order to meet the Orion schedule for EM-2.
Research Impact/Earth Benefits:	This research benefits life on Earth by contributing to knowledge about how the body responds to multi-axial impact, particularly after exposure to microgravity.

Task Progress:	NASA Johnson Space Center (JSC) Institutional Review Board (IRB) approval for this investigation was obtained on June 16, 2016. The post-landing questionnaire was drafted and approved by the IRB. The Human Research Multilateral Review Board (HRMRB) approved the study in January 2017, extending the study to United States on-orbit segment (USOS) crewmembers and spaceflight participants. The potential subject pool (from TM-34, which returned one USOS crewmember from the International Space Station/ISS, to MS-18) is 97 total crew missions. Some crewmembers flew multiple missions, so the total number of astronauts is less than 97. Americans crewed 60 of these missions. USOS participants crewed 31 missions, and the remaining 6 spots were crewed by spaceflight participants. 2 US and 1 USOS crewmember have declined participation in the study, reducing the total potential dataset to 94. This aim consists of data collection from two sources. One is flight medical records from a database maintained by the NASA Lifetime Surveillance of Astronaut Health (LSAH). This data is only obtainable for US astronauts. To date, medical information from the database has been obtained for 48 of 60 crewmembers from TMA-1 through TMA-MS18. Two crewmembers from these missions declined release of their medical data. The other data source is from a survey that crewmembers are asked to complete. The survey can be completed by US and USOS astronauts, and spaceflight participants. The survey requires an additional consent process. Out of the 60 US crewed missions, 52 have consented to this part of the study, 6 have not responded, and 2 have declined. Of the 52 that have consented, 41 have completed the survey. Of the 31 USOS crewmembers, consent has been obtained from 22 crewmembers. 22 of the 22 have completed the survey, and 1 crewmember has declined participation. The NASA Research Operations and Integration (ROI) Element is working to obtain consent from the remaining 9 crewed missions. Informed consent was obtained from one spaceflight participant, who completed the survey, bringing the total number of completed surveys to 64. Data continues to be collected from crew returning to Earth on the Soyuz vehicle. The NASA Engineering and Safety Center (NESC)-funded effort to reconstruct the Soyuz landing energetics through modeling and simulation was completed this year. The final report is now under review, but a principal conclusion is that when NASA's occupant protection tools (Brinkley model and Anthropomorphic Test Devices/ATDs) are fed good Soyuz landing load information, they do a reasonable job at predicting the increased risk of injury. A manuscript based on the data collected to date has been published in the Journal SAFE.
Bibliography Type:	Description: (Last Updated: 02/12/2022)