Fiscal Year:	FY 2019	**Task Last Updated:**	FY 10/30/2019
PI Name:	Olson, Sandra Ph.D.		
Project Title:	Fundamental Research on International Standard of Fire Safety in Space - Subteam 1: Study of Flammability of Fabric Materials		
Division Name:	Physical Sciences		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:	COMBUSTION SCIENCE--Combustion science		
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	None		
Human Research Program Risks:	None		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
PI Email:	Sandra.Olson@nasa.gov	**Fax:**	FY 216 977-7065
PI Organization Type:	NASA CENTER	**Phone:**	216-433-2859
Organization Name:	NASA Glenn Research Center		
PI Address 1:	LTX, Combustion Physics and Reacting Systems Branch		
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PI Web Page:			
City:	Cleveland	**State:**	OH
Zip Code:	44135	**Congressional District:**	9
Comments:			
Project Type:	FLIGHT,GROUND	**Solicitation / Funding Source:**	2012 Japanese Space Agency (JAXA) AO for Fundamental Research on an International Standard of Fire Safety in Space
Start Date:	07/01/2014	**End Date:**	03/31/2021
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:**	1
No. of Bachelor's Candidates:	0	**Monitoring Center:**	NASA GRC
Contact Monitor:	Urban, David	**Contact Phone:**	216-433-2835
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Flight Program:	ISS		
Flight Assignment:	NOTE: Changed end date to 3/31/2021 per PI (Ed., 6/3/19)		
Key Personnel Changes/Previous PI:	Dr. Sandra Olson is U.S. Co-Investigator on Japan Aerospace Exploration Agency (JAXA)-sponsored project, “Flammability Limits At Reduced-g Experiment (FLARE)." JAXA Principal Investigator (PI) is Prof. Osamu Fujita, Hokkaido University.		
COI Name (Institution):			
Grant/Contract No.:	Internal Project		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	The objective of the project is to develop a methodology to correlate material flammability limits in normal gravity and microgravity, which allows quantitative estimation of material flammability limit in microgravity based on the flammability data obtained on the ground. The project involves an international team including JAXA, NASA, ESA (European Space Agency), and universities in Japan, USA, and France. Dr. Olson is a U.S. Co-Investigator for the Japan Aerospace Exploration Agency (JAXA)-sponsored experiments to be conducted aboard the Japanese Experiment Module, Kibo. To establish global standards for fire safety in space, we seek to develop a fundamental understanding of how NASA's material flammability test, NASA-STD-6001.A Test 1, relates to the actual flammability of materials in micro and partial gravity. The investigation strategy is to perform extensive research via ground-based experiments, including 1g and parabolic flight tests, and via theoretical formulations. Flight experiments on orbit in International Space Station (ISS)/KIBO will be performed to verify the correlation. The flight experiments on orbit are expected in 2018 or later. By the end of the project, a new fire safety standard test method for screening spacecraft materials will be proposed that addresses the shortcomings of existing standard test method such as NASA STD 6001B.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	Studying materials flammability in space allows us to accurately control the flow field and thus elucidate the importance of a critical Damkohler number (flow time /reaction time) on flame extinction. The anticipated improved methodology should reduce time and cost for the spacecraft material screening. Investigation and results have Earth benefits for terrestrial fire safety.
Task Progress:	The 2019 annual international Flammability Limits At Reduced-g Experiment (FLARE) January workshop was cancelled due to the Government shutdown. An expanded 'Spacecraft Materials Flammability Workshop' was held from May 20-22, 2019 at NASA Glenn Research Center's Guerin House. The workshop was an expansion of the JAXA flare experiment annual workshop, and included presentations on programs from international representatives from JAXA, German Aerospace Center (DLR), National Centre for Space Studies (CNES), ESA, NASA [Headquarters, Glenn Research Center (GRC), White Sands Test Facility (WSTF), and Johnson Space Center (JSC)], and a number of universities. Also at that meeting, the FLARE science teams presented their status to the group. In addition, results from parabolic aircraft campaigns were discussed. Workshop attendees toured the Zero Gravity Research Facility, the Telescience Support Center, and the Combustion Integrated Rack. Low-gravity aircraft parabolic trajectories and microgravity drop tower experiments have been conducted to study blowoff extinction limits for thin sheets of bleached grade#90 cheesecloth. To avoid confusion with ignition limits, the flames were ignited under a flammable condition, and the conditions were changed (flow, oxygen) to determine if the flame would blow off. Preliminary blowoff boundaries were mapped for both opposed and concurrent flow. The concurrent blowoff boundary occurs at lower oxygen concentrations for the same ambient flow velocities than the opposed blowoff boundary, and the slopes do not appear to be parallel. This is hypothesized to be due to the a higher Damkohler number at the flame base of a concurrent flame (stagnation flow) than at the leading edge of an opposed flow flame (boundary layer flow) under the same flows. Local blowoffs were observed during testing, where a significant fraction of the opposed flame width extinguishes, and where one whole side of the concurrent flame blows off. Often, the remaining flame will again spread to the affected area, only to have the event occur, often repeatedly, during the test. Due to the stochastic nature of the local extinctions along the 2D stabilization region [leading edge (opposed flow), flame base (concurrent flow)], they do not always result in total extinction of the flame, indicating the flammability boundary is a band rather than a sharp boundary of conditions (flow, oxygen concentration).
Bibliography Type:	Description: (Last Updated: 04/17/2024)
Abstracts for Journals and Proceedings	Olson S. "Update on GRC Research, FLARE Workshop." Spacecraft Materials Flammability Workshop, NASA Glenn Research Center, Cleveland, OH, May 20-22, 2019. (Expanded FLARE Workshop) Abstracts. Spacecraft Materials Flammability Workshop, NASA Glenn Research Center, Cleveland, OH, May 20-22, 2019. , May-2019
Papers from Meeting Proceedings	Olson S, Torikai H, Hokari K, Fukuda M. "Low-gravity near-blowoff opposed and concurrent flame behavior of burning cotton in parabolic aircraft testing and microgravity drop tower testing." 11th U.S. National Combustion Meeting, Pasadena, CA, March 24-27, 2019. 11th U.S. National Combustion Meeting, Pasadena, CA, March 24-27, 2019. https://wssci.us/meetings/ncm2019/ , Mar-2019