Fiscal Year:	FY 2015	**Task Last Updated:**	FY 12/30/2014
PI Name:	Sandridge, Chris Ph.D.		
Project Title:	Integrated Radiation Analysis and Design Tools		
Division Name:	Human Research		
Program/Discipline:	HUMAN RESEARCH		
Program/Discipline--Element/Subdiscipline:	HUMAN RESEARCH--Radiation health		
Joint Agency Name:		**TechPort:**	Yes
Human Research Program Elements:	(1) **SR**:Space Radiation		
Human Research Program Risks:	(1) **ARS**:Risk of Acute Radiation Syndromes Due to Solar Particle Events (SPEs) (2) **Cancer**:Risk of Radiation Carcinogenesis (3) **CNS**:Risk of Acute (In-flight) and Late Central Nervous System Effects from Radiation Exposure (4) **Degen**:Risk of Cardiovascular Disease and Other Degenerative Tissue Effects From Radiation Exposure and Secondary Spaceflight Stressors		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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PI Organization Type:	NASA CENTER	**Phone:**	757-864-2816
Organization Name:	NASA Langley Research Center		
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PI Web Page:			
City:	Hampton	**State:**	VA
Zip Code:	23681-2199	**Congressional District:**	1
Comments:			
Project Type:	GROUND	**Solicitation / Funding Source:**	Directed Research
Start Date:	10/01/2005	**End Date:**	09/30/2015
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:	1	**Monitoring Center:**	NASA LaRC
Contact Monitor:		**Contact Phone:**	
Contact Email:			
Flight Program:			
Flight Assignment:	NOTE: End date changed to 9/30/2015 per 9/7/2012 HRP Master Task List information (Ed., 9/14/12)		
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Badavi, Francis (Old Dominion University) Blattnig, Steve (NASA Langley Research Center) Clowdsley, Martha (NASA Langley Research Center) Simonsen, Lisa (NASA Langley Research Center) Slaba, Tony (NASA Langley Research Center)		
Grant/Contract No.:	Directed Research		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	The Integrated Radiation Analysis and Design Tools (IRADT) Project develops and maintains an integrated tool set that collects the current best practices, databases, and state-of-the-art methodologies to evaluate and optimize human systems such as spacecraft, spacesuits, rovers, and habitats. IRADT integrates design models and methodologies in support of evaluation/verification of design limits and design solutions to meet As Low As Reasonably Achievable (ALARA) requirements (NASA STD 3001, Vol 2). IRADT provides the radiation community access to physics and transport capabilities and research improvements. The capabilities are developed under strict version control and are independently verified and validated (IV&V) to the extent possible. Current customers include NASA Exploration Systems Mission Directorate's (ESMD) Directorate Integration Office studies (i.e., LAT, MAT, LSOS), Lunar Surface Systems as well as Constellation's Orion and Vehicle Integration Office, universities, industry, and Small Business Innovation Research (SBIR). IRADT is designed for utilization by future commercial customers concerned about transfer of proprietary data and results. Deliverables and access to the Integrated Radiation Design Tools fill identified gaps documented in the Human Research Program (HRP) Integrated Research Plan (HRP-47065, Rev. A) to support the evaluation of effective shielding options by the engineering community: · Cancer - 11: What are the most effective shielding approaches to mitigate cancer risks? · Cancer - 13: What are the most effective approaches to integrate radiation shielding analysis codes with collaborative engineering design environments used by spacecraft and planetary habitat design efforts? · Acute - 6: What are the most effective shielding approaches to mitigate acute radiation risks, how do we know, and implement? IRADT will specifically address the limitations associated with simplified geometry description (equivalent aluminum, three-layer transport interpolation, random orientation) and straight ahead transport. The design tools increases fidelity by incorporating common spacecraft and user specified materials in the geometry description with ray-by-ray transport to minimize the uncertainties due to range-scaling of material thicknesses and material ordering. Ray-by ray transport also establishes the basis to calculate the forward/backward neutron generation within vehicle/lunar surface geometries. The back-scattered neutron environment will be calculated from the opposite sides of the vehicle for a crew member's specific orientation at specific tissue locations. This will increase our ability to evaluate the effectiveness of shielding systems. In supporting the closure of these gaps, the Design Tool Project tools and models will support specification, implementation, verification, and monitoring of Spaceflight Human Systems Standard, Vol. 2 (NASA STD 3001, Vol. 2) radiation design and operational requirements with improved uncertainty quantification. The integrated tools and models will be supplied to the user community via a website called OLTARIS (On-Line Tool for the Assessment of Radiation in Space), which can be accessed at https:// .
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	
Task Progress:	Several new capabilities were added to the OLTARIS site over the last reporting period. The Matthia 2013 GCR (galactic cosmic ray) model (Matthiä, D., Berger, T., Mrigakshi A. , T., Reitz G., A Ready-to-Use Galactic Cosmic Ray Model, Adv. in Space Res. 51 (2013) pp. 329-338) was added for freespace, Earth orbit, and surface environments. The model can be defined one of three ways, by selecting an historic solar min/max, by entering specific dates, or by entering a fitting parameter. A comprehensive comparison of the various GCR models was published by Slaba, et. al. (see publications) and it showed that the Matthia model was on par with the Badhwar-O'Neill 2010 model in terms of uncertainty for space radiation calculations. The Badhwar-O'Neill 2010 and 2004 models are also still available. The linear energy transfer (LET) response has now been activated for all geometry and project types. It was previously only available for interpolation-based, thickness distribution jobs for free-space environments. Both the integral and differential flux/fluence vs. LET is computed and the target material can be specified as either tissue or silicon. A new atmosphere model has been added for Mars surface environments. The Mars Climate Database (MCD, http://www-mars.lmd.jussieu.fr/) is a database of atmospheric statistics compiled from state-of-the-art simulations of the Martian atmosphere. It is a much more refined model than MarsGRAM and takes into account the surface location (latitude and longitude), the Martian seasons (Solar longitude) and the time of day (Local solar time). OLTARIS (https://) currently has 223 active accounts, which is an increase of 53 accounts over the current reporting period. 81 accounts are government (including NASA, Oak Ridge National Laboratory, Jet Propulsion Laboratory, Air Force Research Laboratory, and Federal Aviation Administration), 86 are university professors/researchers/students, and 56 are industry (including Boeing, Space X, Lockheed-Martin, Alliant Techsystems Inc., Northrup Grumman, and Bigelow Aerospace). There have been nearly 4000 jobs run through OLTARIS during the current reporting period and 14,500 since counting began in November 2009.
Bibliography Type:	Description: (Last Updated: 09/07/2020)
Articles in Peer-reviewed Journals	Badavi FF. "Validation of the new trapped environment AE9/AP9/SPM at low Earth orbit." Advances in Space Research. 2014 Sep;54(6):917-28. http://dx.doi.org/10.1016/j.asr.2014.05.010 , Sep-2014
Articles in Peer-reviewed Journals	Slaba TC, Blattnig SR. "GCR environmental models I: Sensitivity analysis for GCR environments." Space Weather. 2014 Apr;12(4):217-24. http://dx.doi.org/10.1002/2013SW001025 , Apr-2014
Articles in Peer-reviewed Journals	Slaba TC, Blattnig SR. "GCR environmental models II: Uncertainty propagation methods for GCR environments." Space Weather. 2014 Apr;12(4):225-32. http://dx.doi.org/10.1002/2013SW001026 , Apr-2014

Articles in Peer-reviewed Journals	Slaba TC, Xu X, Blattnig SR, Norman RB. "GCR environmental models III: GCR model validation and propagated uncertainties in effective dose." Space Weather. 2014 Apr;12(4):233-45. http://dx.doi.org/10.1002/2013SW001027 , Apr-2014
Articles in Peer-reviewed Journals	Badavi FF, Walker SA, Santos Koos LM. "Evaluation of the new radiation belt AE9/AP9/SPM model for a cislunar mission." Acta Astronautica. 2014 Sep-Oct;102:156-68. http://dx.doi.org/10.1016/j.actaastro.2014.06.008 , Sep-2014