Fiscal Year:	FY 2011	**Task Last Updated:**	FY 07/29/2011
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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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:	0	**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 (Christopher Newport University) Blattnig, Steve (NASA Langley Research Center) Clowdsley, Martha (NASA Langley Research Center) Qualls, Garry (NASA Langley Research Center) Simonsen, Lisa (NASA Langley Research Center) Singleterry, Robert (NASA Langley Research Center) Slaba, Tony (NASA Langley Research Center) Zapp, Neal (NASA Johnson Space 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 ESMD's 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 SBIRs. 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 fills identified gaps documented in the 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 Solar Particle Event (SPE) environments were updated to allow the user to define their own spectrum using a variety of fitting functions. The user can still select from historical events or define their own using the Weibull, exponential in energy, exponential in rigidity, or Band function fits. The Galactic Cosmic Ray (GCR) environments were also updated to allow the user to define an environment based on the solar modulation parameter, in addition to selecting an historic solar min/max or by entering dates. The developers are currently working on giving the user the ability to upload trajectories for Earth orbit environment, and that capability should be available in the next reporting period. Complex geometries are evaluated by the user ray-tracing their vehicle at a specific location and then uploading the thickness distribution via an XML file. Until now, the thickness distributions were limited to three materials - aluminum, polyethylene, and tissue. This capability has been greatly enhanced by allowing the user to use any three-material combination they wish. The user first defines their material(s) via the OLTARIS materials page, then once the material cross sections have been computed, the user can reference their custom materials in the vehicle thickness distribution. This same methodology will eventually be expanded so that the user can define and use any number of materials. The design environments for the joint NASA/ESA missions to the moons of Jupiter were added (trapped electrons, protons, and heavy ions) along with an integrated electron transport capability. The user can now select from 4 mission scenarios and evaluate dose in silicon for both complex and slab geometries.
Bibliography Type:	Description: (Last Updated: 09/07/2020)
Articles in Peer-reviewed Journals	Singleterry RC Jr, Blattnig SR, Clowdsley MS, Qualls GD, Sandridge CA, Simonsen LC, Slaba TC, Walker SA, Badavi FF, Spangler JL, Aumann AR, Zapp EN, Rutledge RD, Lee KT, Norman RB, Norbury JW. "OLTARIS: On-line tool for the assessment of radiation in space." Acta Astronautica. 2011 Apr-May;68(7-8):1086-97. http://dx.doi.org/10.1016/j.actaastro.2010.09.022 , Apr-2011
Articles in Peer-reviewed Journals	Slaba TC, Blattnig SR, Badavi FF, Stoffle NN, Rutledge RD, Lee KT, Zapp EN, Dachev TP, Tomov BT. "Statistical validation of HZETRN as a function of vertical cutoff rigidity using ISS measurements." Advances in Space Research. 2011 Feb 15;47(4):600-10. http://dx.doi.org/10.1016/j.asr.2010.10.021 , Feb-2011
Articles in Peer-reviewed Journals	Badavi F, Blattnig S, Atwell W, Nealy J, Norman R. "A deterministic electron, photon, proton and heavy ion transport suite for the study of the Jovian moon Europa." Nuclear Instruments and Methods in Physics Research Section B. 2011 Feb;269(3):232-8. http://dx.doi.org/10.1016/j.nimb.2010.12.022 , Feb-2011

Papers from Meeting Proceedings	Sandridge CA, Blattnig SR, Norman RB, Slaba TC, Walker SA, Spangler JL. "On-Line Tool for the Assessment of Radiation in Space — Deep Space Mission Enhancements." 2011 IEEE Aerospace Conference, Big Sky, MT, March 5-12, 2011. 2011 IEEE Aerospace Conference Proceedings, 2011. IEEEAC paper #1107, http://dx.doi.org/10.1109/AERO.2011.5747248 , Mar-2011