Space RAD Health Newsletter

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US and Russian EVA Suits Tested for Radiation

For the first time, NASA's EMU and RSA's Orlan-M Extra Vehicular Activity (EVA) suits were tested with proton and electron beams to determine the protective threshold limits that can be expected during an EVA. These tests were conducted at the Loma Linda University Medical Center (LLUMC) facilities in California.

The International Space Station (ISS), which orbits at an inclination of 51.6º and an altitude from 360 - 450 km, is being constructed during a period of high solar activity with an estimated 1000 hours of required Extra Vehicular Activity (EVA). During the ISS construction phase, EVA crewmembers could be exposed to substantial numbers of protons and electrons resulting from a solar particle event or electron belt enhancement. Understanding the radiation transport properties of the EMU (extravehicular maneuvering unit) and Orlan-M suit material is of concern to NASA for assessing the radiation risks during EVA activity for crewmembers.

Calculated from CT Image Data	EMU	Orlan-M
Electron Threshold Energy (MeV)	0.74	0.70
Proton Threshold Enerby (MeV)	16.01	15.50

Tests were conducted at the Loma Linda University facilities using an instrumented phantom. Radiation doses received at different skin sites and at several organ locations were measured for several energies of incident protons (50 - 250 MeV) and electrons (1 - 6 MeV). Also, for the first time, CT Images of both the suits were obtained from the same machine at the LLUMC facilities. These CT images of the EVA suits with the human phantom provided the radial distribution and variations of the material densities of the multi-layer suit composition. This data was used for calculating the overall protection threshold limits offered by each suit for a crewmember during an EVA in a typical ISS construction activity.

Dr. Francis Cucinotta and JSC's Space Radiation Health Project directed this radiation testing activity with support from several other NASA-JSC organizations during January 2000. Several research investigators were involved in the data collection and analysis process for this project, and their final results and analysis reports are now available. The principal investigator, Dr. Jack Miller, and his team from Lawrence Berkeley National Laboratory collected and analyzed data with active solid state detectors (Si). Other investigators who participated in the project are: 1) the LLUMC team, who provided active detector measurements utilizing ionization chambers (IC); 2) the Dosimetry Lab at NASA-JSC, who provided passive radiation dose measurements with Thermoluminesence (TLD) detectors; and 3) Eril Research Inc., in collaboration with the University of San Francisco, who provided LET measurements obtained utilizing plastic nuclear track detectors (PNTD).

"Models for Evaluation of Radiation Risk" Workshop

A three-day workshop on "Models for Evaluation of Radiation Risk Factors" was organized by the Space Radiation Health Project at the Center for Advanced Space Studies in Houston from November 12th through 15th.

Perspectives on Risk (W. Schimmerling)			
Risk Prediction	**Risk Assessment**	**Risk Management**	**Risk Adjudication**
Will it be safe?	Is it safe?	How can we make it safe?	Was it safe?
. . . and how can we tell?			

The workshop started with four invited presentations to set the stage on the current status of the radiation risk assessment for crewmembers in the low earth orbit (LEO) such as the STS or ISS missions and future manned missions to Mars. The invited presenters were: Drs. RJM Fry of the Oak Ridge National Laboratory, RF Jostes of the National Academy of Sciences, DT Goodhead of the MRC, UK, and RL Ullrich of the University of Texas Medical

Branch. Their presentations included discussions on the current radiation exposure limits for the NASA crewmembers that were defined more than a decade ago (based on NCRP-98, 1989) as well as needed updates to these exposure limits which had been prompted by the most recent radiobiological research and epidemiological data. Also, some of the high LET radiation concerns and their biophysical modeling challenges were discussed and analyzed.

A total of 40 scientific papers were presented to a group of 50 participants over the three-day period. These presenters and papers represented major national and international institutions with radiation concerns specifically related to space exploration. A wealth of experimental data and expertise of mathematical modeling were presented. Many challenging aspects were discussed, including the understanding the nature of radiation track structure, chromosome aberration, and double strand DNA break phenomena.

The workshop was concluded with a "Round Table Discussion" conducted by Dr. Walter Schimmerling of NASA-HQ. Click here for a summary. Round Table participants were Drs. Cucinotta, Fornace, Goodhead, Groer. They provided discussions on where we are at this point of time in predicting and determining the radiation risk and how best we can make progress to reduce radiation risk significantly. Also several suggestions were made to reduce error in predictions.

A total of 25 research papers were identified and manuscripts were prepared for publication as a special edition of Radiation Research journal in 2001.

1st International Workshop on Space Radiation Research & 11th Annual NASA Radiation Health Investigators' Meeting

Arona, Italy; May 27-31, 2000

The 1st International Workshop on Space Radiation Research and the 11th Annual NASA Space Radiation Health Investigators' Workshop was held in Arona, Italy (May 27-31, 2000) in collaboration with Italian Space Agency (ASI), the European Scientific Institute (ISE), and NASA.

More than 150 participants from 14 different countries attended this workshop that spanned over 11 sessions and presented more than 100 original scientific papers. The proceedings of this workshop will soon be released as a special edition of the *Physica Medica*, an International Journal Devoted to the Applications of Physics to Medicine and Biology. The guest editors of this special issue commented that:

> The radiobiology of protons and heavy ions irradiation continues to grow as a scientific discipline with important applications in space radiation protection, cancer therapy, biological countermeasures, and the basic understanding of DNA, cellular, and tissue responses. Because of the unique characteristics of these radiation fields, there is also substantial scientific interest in several areas of physics including nuclear reaction and transport theories, dosimetry and particle detection, and radiation shielding.

For more information from the preface of this special edition, click here.

Featured Investigator

Eleanor A. Blakely, Ph. D.
Senior Staff Scientist
Cell and Molecular Biology
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More than 25 years ago, Dr. Blakely joined the Lawrence Berkeley National Laboratory (LBNL) as a Staff Biophysicist after completing the doctoral program in physiology from the University of Illinois at Urbana in 1975. Over these past many years, Dr. Blakely has not only contributed to the scientific research of the radiation effects at cell level but also in the development of research investigations that paved a path for space applications particularly of radiation damage to the human eye which is believed to be one of the most radiosensitive organs of the human body. Over these past two decades, Dr. Blakely held several responsible positions including: Project Scientific Director for National Cancer Institute (NCI) funded research in radiobiology; Principal Investigator for Department of Energy (DOE) and National Eye Institute (NEI) supported research. Dr. Blakely is currently a Senior Staff Biophysicist at the Lawrence Berkeley National Laboratory and holds faculty affiliate appointments at Colorado State University (Fort Collins, CO), and as a Clinical Professor of Radiation Medicine at the Loma Linda University School of Medicine (Loma Linda, CA). See Dr. Blakely's biographical sketch for more details.

For the past 10 years, Dr. Blakely has been serving as one of the Project Directors of the NASA Specialized Center

of Research and Training for Radiation Health (NSCORT) at the LBNL. Dr. Aloke Chatterjee is the principal investigator for NSCORT.

Dr. Blakely notes on her research, "*Radiation-induced changes in FGF-2 expression in several different tissues indicates that these changes are highly dependent on the radiation quality of the exposure. This conclusion has relevance for the currently expanding use of particle beams for cancer radiotherapy, and for the estimation of risk from occupational particle radiation exposures in space flight.*"

Also, for the past five years, Dr. Blakely has been serving as a Principal Investigator on several NASA funded research investigations from the LBNL. One of the current NASA studies with Dr. Blakely as the Principal Investigator is the study on the radiation damage to the human eye, **"Lens Epithelium and Proton-Induced Cataractogenesis"**. Results from these investigations are expected to provide data for reducing the radiation risk for human eye and develop strategies to decrease the probability for early onset of radiation induced cataracts. See the list of Research Publications (2000-2001) for more information published about this ongoing NASA supported research.