

## The Boice Report #22



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### NASA—The Final Frontier in Radiation Protection

I had lunch with Neil Armstrong. It was exhilarating to be so close to greatness and humility. Neil sat across a table from me during a National Aeronautics and Space Administration (NASA) meeting that I had attended briefly by mistake. There were two NASA meetings ongoing and I entered the wrong room, which resulted in a brief encounter with an American legend. When mentioning this to Miles O'Brien, PBS science correspondent, he commented that this would be similar to someone in his profession sitting down and dining with J.D. Salinger.

NASA continues to effervesce with a special aura and excitement that goes beyond *Star Trek* and *Star Wars*. It might be related to accomplishing the unimaginable, overcoming extreme obstacles, facing the unknown, and having a vision for the future of mankind in the vastness of the universe. And perhaps some of you attended and were inspired by the Dade Moeller Lecture by physicist and cosmologist Larry Krauss at the [2013 Health Physics Society \(HPS\) Midyear Meeting](#) in Scottsdale—"Life, the Universe and Nothing . . . A Cosmic Mystery Story."



**Neil Armstrong**  
photo courtesy of  
Michael Wright  
Space Collection

The National Council on Radiation Protection and Measurements (NCRP) basks in the NASA ambience with two scientific committees dealing with radiation protection in space. I find it remarkable that the prestige of NASA is such that no one, when asked, declines participating. Radiation protection, of course, is just one of many challenges facing long-term and short-term space flights, but it is an important one as the space radiation environment is so different from anything experienced here on Earth, and once launched, astronauts have little opportunity to turn back or implement new protection measurements.

**Radiation Protection Guidance in Space:** [Scientific Committee \(SC\) 1-22](#) is examining the radiation protection issues in space. Over the last several decades there has been new understanding on the effects of radiation that might affect space travelers. This includes an increased awareness of noncancer effects such as cataracts, heart disease, and possibly central nervous system (CNS) disorders. The cochairs of SC 1-22 are Dudley Goodhead (Medical Research Council, United Kingdom) and Julian Preston (U.S. Environmental Protection Agency [EPA], retired) and the committee's photo can be seen below. The current guidance is based on limiting astronaut exposure such that a greater than 3 percent increase in lifetime risk of cancer does not occur. Based on the number of assumptions that go into this risk assessment, the guidance is set on the upper 95 percent confidence limit of the cancer risk projection. Thus, for missions as lengthy as one to Mars, astronauts might very well approach the current limits and guidelines.

- **Space Environment:** The challenging issues of radiation in space include the unusual environment of galactic cosmic rays of high-mass and high-energy (HZE) particles. The effect on human health following such exposures is not entirely clear and extrapolation across species is required to get an inkling of what the potential health effects might be. Over the years, NASA has supported a broad-based program of basic research to address the unique radiation environment in space ([NRC/NAS 2010](#)).

- **SC 1-22 Report Content:** The SC 1-22 report is expected to be out shortly and will include a summary and overview of NASA's radiation protection standards for space travel and exploration. NASA guidelines differ from those set for terrestrial workers in that they account for different radiation sensitivities by gender and age ([NCRP Report No. 98](#)) and by whether or not the astronauts have unhealthy lifestyles such as cigarette smoking ([NRC/NAS 2012](#)). Because women are at higher lifetime risk of developing cancer than men, their allowable radiation cumulative dose limits are lower. The report will include a brief overview of cancer risk projection models, the potential for noncancer risks, how dose can be managed to be "as low as reasonably achievable," ethical and informed consent issues, and research priorities that might be helpful to NASA in providing guidance on space radiation.
- **Ethics:** The Institute of Medicine of the National Academies has an ongoing committee on the [ethics principles and guidelines](#) for health standards for long-duration and exploration space flights. This committee will address ethical and policy principles that might guide decision making when existing standards cannot be fully met or when knowledge of a given health effect is sufficiently limited that guidance cannot be clearly developed.

**SC 1-24 on CNS:** A new NCRP scientific committee is addressing potential CNS effects following exposure to space radiations. There is concern that dementia and cognitive dysfunction might be associated with the peculiar radiation environments in space. SC 1-24 is cochaired by Les Braby (Texas A&M University) and Richard Nowakowski (Florida State University). Other members include Greg Armstrong (St. Jude Children's Research Hospital), John Fike (University of California at San Francisco, retired), Lee Goldstein (Boston University), Kathy Held (Harvard, Massachusetts General Hospital), Greg Nelson (Loma Linda University), Julian Preston (EPA, retired), James Root (Memorial Sloan Kettering Cancer Center), Walter Schimmerling (NASA/Universities Space Research Association [USRA], retired), Rudy Tanzi (Harvard), and Marvin Rosenstein (NCRP technical consultant).

- **CNS Health Issues:** The issue is whether radiation exposures in space might result in acute CNS effects that could impair missions and whether late CNS effects might occur that result in serious cognitive and mental dysfunction in exposed astronauts ([NCRP Report No. 153](#)). Recent animal experiments have indicated an accelerated rate of deleterious effects in a mouse model of Alzheimer's disease in animals exposed to HZE particles and at radiation levels lower than previously suspected ([Cherry 2012](#)). There are human data on early onset dementia following radiotherapy exposures for non-CNS conditions in childhood ([Armstrong 2013](#)) and in adulthood ([Alhes 2012](#)) but their relevance to space radiation is uncertain. Conceivably, risk-limitation strategies to reduce CNS effects may require a distinct strategy that differs from approaches used in the past ([Cucinotta 2013](#)).
- **SC 1-24 Scope:** During the first phase of the committee deliberations, critical issues surrounding the potential short-term and long-term consequences of space radiation on the CNS will be evaluated, existing human and experimental data will be described, research needs will be outlined, and the groundwork will be provided for a comprehensive subsequent report (Phase 2). Phase 1 will culminate with a detailed proposal outlining the steps and approaches needed in Phase 2 to fully understand the risk of CNS effects following radiation exposure in space and to provide guidance for risk management and radiation protection.

I saw "Peter and the Starcatcher" at the Kennedy Center this weekend and was reminded how Peter answered Wendy when asked where he lived: "Second star to the right and then straight on till morning" (J.M. Barrie, *Peter Pan*). As NASA has an unbounded vision for space exploration, NCRP has an all-encompassing vision for radiation protection in the nation's interest! So don't forget the upcoming NCRP Annual Meeting, 10–11 March 2014, in beautiful downtown Bethesda. You can still register ([registration.ncrponline.org](http://registration.ncrponline.org)) for this spectacular event celebrating 50 years since NCRP was chartered by Congress in 1964. And you shouldn't be surprised that one of the highlights will be "[Radiation Safety and Human Spaceflight: Importance of the NCRP Advisory Role in Protecting Against Large Uncertainties](#)" presented by Francis Cucinotta (formerly NASA and now University of Nevada Las Vegas).

## NCRP SC 1-22 Radiation Protection in Space



Left to right, Pat Fleming (St. Mary's College), Julian Preston (cochair, EPA, retired), Mike Weil (Colorado State University), Dudley Goodhead (cochair and Medical Research Council, United Kingdom), Marvin Rosenstein (NCRP consultant), Amy Kronenberg (Lawrence Berkeley National Laboratory), Roger Shaw (Shaw Partners), and Walter Schimmerling (NASA/USRA, retired). Missing are Kathy Held (Harvard, Massachusetts General Hospital) and Greg Nelson (Loma Linda University).