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Executive Summary

Measures to Reduce Radiation Risk in Moon and Mars Exploration: Dose Limits

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Ionizing radiation exposure is well known to increase both early and late morbidity. Only at levels greater than a threshold are deterministic (nonstochastic) consequences seen, such as skin burns and cataracts, and the severity of these effects rises with dose. Acute radiation burden in space can be problematic during powerful solar storms, when dosages could possibly be lethal for a crew with insufficient shielding. The severity of stochastic effects appears to be dosage independent and does not appear to have a threshold. The primary issue for late stochastic effects in radiation protection is cancer induction, which can develop several years after exposure.

Astronauts are categorized as radiation workers due to their unavoidable exposure to space radiation during missions. The safety of radiation workers on Earth has evolved significantly and is based on reliable epidemiological studies. To calculate the risk of death and morbidity brought on by radiation exposure, scientific evidence is used. Limits on radiation exposure have been established for both the public and radiation workers because of ethical decisions regarding acceptable risk. The most recent International Commission on Radiological Protection (ICRP) study is the foundation for the current radiation exposure guidelines for Earth. The survivors of the 1945 atomic bombings of Hiroshima and Nagasaki remain the primary source of these recommendations.

Dose caps are determined by acceptable risk. Depending on the situation, a risk may be considered acceptable. For example, the ICRP advises a cap of 1 mSv/year for the public and up to 20 mSv/year for radiation professionals. For the liquidators involved in nuclear accidents who are devoted to controlling the event, unusual exposures up to 100 mSv are permissible. The idea that dosage limits should be determined by an acceptable level of danger for astronauts is supported by ethical considerations. Due to the ALARA principle, attempts to ignore all restrictions and turn to measures like informed consent have typically failed. Given the dearth of epidemiological information, the key area of ambiguity is to the relative biological effectiveness (RBE) of space radiation.

There is no worldwide consensus on the dose limitations for the crew members of exploratory-class missions, even though space radiation is widely recognised as the primary health danger in human space exploration. There is no universally agreed-upon career dose limit for astronauts in Low-Earth Orbit (LEO), new commercial players are now exempt from space agencies' restrictions, limitations in Beyond LEO (BLEO) are poorly defined, and noncancer dangers are seldom ever considered. The task group TG115 of the International Commission on Radiological Protection is now examining the various approaches to make recommendations for a unified method.

Source: Physics

KEYWORDS
Space travel; galactic cosmic radiation; shielding; nuclear propulsion