Dz7

HAZARDS TO SPACE WORKERS FROM IONIZING RADIATION IN THE SPS ENVIRONMENT

N82 22765

John T. Lyman
Biology and Medicine Division - Lawrence Berkeley Laboratory
Berkeley, California 94720

This report presents a compilation of background information and a preliminary assessment of the potential risks to workers from the ionizing radiation encountered in space. The report (1) summarizes the current knowledge of the space radiation environment to which space workers will be exposed; (2) reviews the biological effects of ionizing radiation considered of major importance to a SPS project; and (3) discusses the health implications of exposure of populations of space workers to the radiations likely to penetrate through the shielding provided by the SPS work stations and habitat shelters of the SPS Reference System.

For the construction and maintenance of 60 SPS systems, each with a 30-year lifetime, it is estimated that about 50,000 man-years in space will be required. The hazards to the workers from the space ionizing radiation have been evaluated based upon the reference system scenario for a geosynchronous orbit (GEO) construction site. This will result in about 90-percent of the worker-years being spent in GEO. The number of maintenance workers needed per satellite is a large factor in the total space effort that is required.

The three phases of the SPS mission, low earth orbit (LEO), the transfer ellipse (TE), and GEO will result in radiation exposure of space workers with different situations of time dependence, radiation quality, and ease of predictability. The various components of the radiation environment are described, and those important to each mission phase identified.

LEO which is used for a staging area is fairly well shielded geomagnetically from the galactic cosmic rays (GCR) and the solar particle event (SPE) radiation. The major radiation hazard in LEO is from the trapped protons at the South Atlantic anomaly.

During the transfer between LEO and GEO the workers must pass through the high radiation regions of the Van Allen belts. Depending on the trajectory chosen, either the bremsstrahlung radiation from the electrons or the protons can be the major contributor to the total dose equivalent. Lower dose equivalents are expected to be received in the trajectories that minimize the proton dose.

In GEO the major contributor to the total dose equivalent will be the bremsstrahlung radiation from the electrons in the outer radiation belt. The GCR radiation is a fairly constant background of particle radiation that will be only slightly affected by the shielding of the reference system. Of the GCR, protons and helium ions are the largest contributors to the total flux, however, the HZE particles are more important in the calculations of the total dose equivalent. In addition, HZE particles may cause important biological effects not seen with low-LET radiations. Therefore the use of a quality factor to arrive at the dose-equivalent may result in underestimation of the health risks of exposure to HZE particles.

Most of the dose equivalent will be received in GEO and in the transfers between LEO and GEO. SPE radiation is expected to significantly increase the total dose equivalent in about 10-percent of missions of a 90-day duration.

Early health effects of radiation (those occurring within hours, days, or a few weeks of exposure) assume clinical significance with whole-body doses only in excess of about 150 rem. Such exposures are likely to be encountered rarely if at all in close-in space missions.

A potential increase in the risk of cancer is the principal and most serious late effect of exposure to ionizing radiation. Radiation causes an increase in the cancer risk at doses greater than 50-100 rem. At lower doses, it is difficult or impossible to demonstrate an increased risk even in large, exposed populations.

The low-LET radiation dose expected will be below the threshold for radiation-induced cataracts and the probability of any serious risk of cataracts from HZE particles seems low. Other effects considered are genetic and teratogenic effects, life-span shortening, and effects on fertility and the skin.

The probability of an individual of having a radiation-induced cancer will depend on many factors, included would be the total lifetime dose-equivalent, dose rate, duration of exposure, and the age, sex, and host susceptibility. The majority of the lifetime dose-equivalent will be from the space radiation. Therefore for this consideration, the dose per mission is not as important as the total career dose. The dose per mission would be expected to be a constraint on the total number of missions allowable for a space worker. If a worker spends five years in space, protected by the shielding of the reference system, it is anticipated that the potential risk of having cancer may be increased about 12 percent.

The health effects of ionizing radiations must be considered in the context of the potential health effects of other physical and chemical agents in the space environment. Such competing effects may interact to mask, enhance or diminish the induction of health effects which may occur under exposure to low-level radiation delivered at a slow rate.