INFORMATION SHEET Nov. 2005

World Health Organization

Cosmic Radiation and Air Travel

Several hundred thousand cockpit and cabin crew worldwide are occupationally exposed to cosmic radiation, and the number of frequent flyers is steadily increasing. Our understanding of the health effects of cosmic radiation has been advanced through recent scientific studies focusing on aircrew. This fact sheet provides summary information on the health aspects of cosmic radiation as they relate to air travel.

What is Cosmic Radiation?

Cosmic radiation (CR) is a form of ionizing radiation. Radiation particles constantly travel through the universe and reach the Earth's atmosphere. Cosmic Radiation mainly consists of primary particles (e.g., protons, electrons, and heavier ions) and secondary particles (e.g. neutrons) formed when these particles reach the Earth's atmosphere. At sea level CR contributes about 13% to the natural background radiation.

Cosmic radiation is different from other forms of ionizing radiation. For example, nuclear industry workers or medical personnel are mostly exposed to gamma-radiation and X-rays. In contrast, neutrons contribute up to 50% of the effective radiation dose [1] that aircrew and air travelers receive from CR. The biological effects of these neutrons and CR in general are not fully understood at this time, which is one reason why health studies of aircrew are being conducted worldwide.

The level of CR in the Earth's atmosphere depends primarily on four factors, listed here in order of their importance in contributing to radiation levels:

1. **Altitude** The Earth's atmospheric layer provides significant shielding from cosmic radiation. At higher altitudes, this shielding effect decreases, leading to higher levels of cosmic radiation. The radiation exposure at conventional aircraft flight altitudes of 30.000 - 40.000 feet (9 - 12 km) is about 100 times higher than on the ground.
2. **Geographic Latitude** The Earth's magnetic field deflects many CR particles that would otherwise reach ground level. This shielding is most effective at the equator and decreases at higher latitudes, essentially disappearing at the poles. As a result, there is approximately a doubling of CR exposure from the equator to the magnetic poles.

[1] The effective dose is a measure used to estimate the risk resulting from exposure to ionizing radiation. It takes into account the different radiation sensitivity of tissues and the different relative biological effect of different types of ionizing radiation

3. **Normal Solar Activity** The sun's activity varies in a predictable way with a cycle of approximately 11 years. Higher solar activity leads to lower cosmic radiation levels and vice versa..
4. **Solar Proton Events (SPEs)** (also sometimes called "solar particle events", or "solar events") Occasionally large explosive ejections of charged particles occur on the sun. They can lead to sudden increases in radiation levels in the atmosphere and on Earth, the solar proton events. SPEs are not predictable, and levels of radiation caused by an SPE are not uniform over the Earth. Large SPEs in which significant levels of CR reach Earth are rare events.

Aircrew and frequent flyer exposure

Radiation dose is measured in milliSieverts (mSv). Aircrew flying 600-800 hours per year are exposed to 2 to 5 milliSievert (mSv) of radiation each year in addition to the usual radiation of 2-3 mSv through man-made (mostly medical) and natural radiation sources.

Aircrew are now recognized in many countries as occupationally exposed to radiation, and radiation protection limits for aircrew are similar to those established for nuclear workers. Frequent flyers generally do not reach the number of hours flown by aircrew. Thus, unless they fly as much or more than typical aircrew, their radiation exposure and associated possible health risks are likely to be lower than that of aircrew.

Short-haul flights are often flown at lower altitudes than long-haul flights, so that generally, short-haul flights incur less radiation exposure than long-haul flights. The other factors which influence CR exposure levels vary with each flight. Also, methods of measuring CR are still being developed and compared by scientists. An estimate of the radiation dose for a specific flight can be obtained from the following and other websites:

- http://www0.gsf.de/epcard/eng_fluginput.php
- http://www.faa.gov/education_research/research/med_humanfacs/aeromedical/radiobiology/cari6m/download/index.cfm

Health effects

Cancer is the principal health effect that has been associated with low-dose radiation. As cosmic radiation is a very low-level source of radiation, the associated risk of developing cancer is also likely to be very low and difficult to establish with the scientific tools at hand.

There is little evidence so far that occupational exposure to cosmic radiation increases cancer risk, and only limited evidence that increasing amounts of CR exposure may cause a corresponding increase in certain cancers. Several aircrew studies have shown an increased risk of melanoma and non-melanoma skin cancer. Solar ultraviolet radiation such as obtained through sun tanning is an established risk factor for these cancers, but further information is needed to determine if CR exposure also influences the risk.

Breast cancer among female aircrew, measured as new illness or related death, was also found to be increased in several studies. Causes other than radiation, such as those from a woman's reproductive history, do not seem to fully explain this increase.

Occasionally studies have found risk increases for other cancers but these may have been chance findings not confirmed in the other studies. More evidence will be available as additional studies of aircrew are conducted, and as aircrew who have already been studied are followed-up further.

There are no studies yet that directly answer questions on the effects of cosmic radiation on pregnancy and the health of offspring. However, based on current knowledge, the limited radiation doses obtained during occasional air travel during pregnancy confer very small risks to the offspring. If pregnant aircrew members continue to fly regularly during pregnancy, they may, however, reach recommended dose limits (see below).

In addition, studies are currently being conducted which examine other health effects or markers of health effects, including cataracts, chromosomal (genetic) damage, and measures of reproductive health. These studies will expand what is known about the health risks of cosmic radiation in the near future.

Guidelines on radiation dose limits

In 1990, the International Committee on Radiological Protection (ICRP) recommended that jet aircrew should be considered occupationally exposed to ionizing radiation.

Guidelines concerning dose limits for occupational exposure have been established by international agencies involved in radiation protection. Occupational exposure of any worker should not exceed an effective dose of 20 mSv per year averaged over five consecutive years or an effective dose of 50 mSv in any single year. In case of pregnancy, the equivalent dose for the fetus may not exceed 1 mSv during the declared term of the pregnancy. Many airlines follow a policy of transferring pregnant flight staff to ground duties once the pregnancy has been declared, based on overall considerations of potential negative effects of flying on pregnancy.

For the general public, exposure limits concerning cosmic radiation as well as other natural radiation sources have not been set. The dose limit of 1 mSv per year established for artificial exposures can, however, serve as orientation. Some frequent flyers may, under certain conditions, reach or exceed this value. However, there is currently no intent or mechanism to monitor the exposure of frequent flyers.

WHO recommendations concerning cosmic radiation

National governments are advised:

- to protect flying personnel by law from excessive radiation exposure.

Airline management is advised:

- to assess and track aircrew radiation doses;
- to provide aircrew with a record of their personal cumulative radiation dose;
- to consider radiation exposure and to reduce occupational radiation exposure where feasible in creating flight rosters;
- to inform personnel about the effects of cosmic radiation;
- to the extent possible, warn personnel about potential major solar proton events, and advise those who have traveled in an area of increased radiation during an SPE.

Aircrew are advised:

- to keep themselves informed about health effects of cosmic radiation;
- to record their personal cumulative radiation doses on a regular and permanent basis (if not done by the respective airline or governmental bodies);
- to consider radiation exposure when selecting flight schedules;
- to limit flight travels during pregnancy.

Frequent flyers are advised:

- to keep themselves informed about health effects of cosmic radiation;
- to limit flight travels during pregnancy.

If the flying time of a frequent flyer is similar to that of aircrew, they are advised:

- to record their personal cumulative radiation doses on a regular and permanent basis;
- to consider radiation exposure when selecting flight schedules.

Cosmic radiation - WHO activities

WHO recognizes that there is a widespread interest in clear and trustworthy information on potential health risks associated with cosmic radiation. Through the Radiation and Environmental Health programme, WHO provides authoritative and evidence-based information on health and environmental issues of ionizing - including cosmic - radiation. WHO co-sponsors guidelines and safety standards for the protection against ionizing radiation and is providing guidance to member states regarding radiation protection for specific groups and the public at large.

WHO thanks all involved experts for their contribution in drafting this information sheet.

Contact:

World Health Organization
Radiation and Environmental Health
20 Avenue Appia
1211-Geneva 27, Switzerland
Internet: www.who.int/ionizing_radiation
e-mail: ionizingradiation@who.int