Cosmic radiation exposure of aircrew and space crew

Improving radiation protection in practice

Cosmic radiation is high-energy radiation generated in outer space. Everybody receives small radiation doses due to cosmic radiation reaching the Earth's surface. The dose increases with altitude. On average, around 10 per cent of all radiation exposure of the pubic comes from cosmic radiation.

Aircrew and frequent flyers receive higher radiation doses from cosmic radiation than the general public. Astronauts receive even higher radiation doses. Depending on the altitude reached and time spent there, space tourists would be expected to receive an increased dose from cosmic radiation.

Life on Earth is protected from the impact of cosmic radiation by the magnetic fields that surround the Earth and by its atmosphere. The Earth's magnetic field is very effective in deflecting cosmic radiation and only the highest energy particles can penetrate.

Cosmic radiation consists of particles travelling close to the speed of light. It has two components — one component is constant within our galaxy while the other comes from the sun at irregular intervals.

Galactic cosmic radiation originates from supernova remnants and pulsar wind nebulae outside the solar system but primarily from within our Milky Way galaxy. It is isotropic, which means that it is the same in all directions. As a result, the entire surface of the Earth is constantly exposed to this radiation.

Cosmic radiation from the sun consists primarily of electrons, protons, and helium nuclei and is produced at irregular intervals.

How much radiation does air and space crew receive?

<1 mSv in a year is on average received by aircrew where all routes flown do not exceed an altitude of about 9000 metres.

6 mSv in a year is a typical radiation doses received by aircrew flying long-haul polar routes.

For comparison:

3.0 mSv is an average radiation dose per year received by a person from all sources of radiation. This can range from about 1 to 10 mSv, or more, depending on where people live.

20 mSv is the dose limit per year for people who are occupationally exposed to radiation due to their work.

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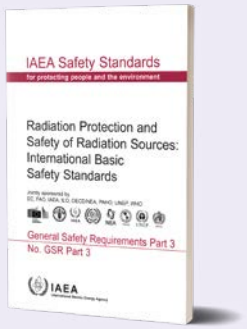
What do the IAEA Safety Standards say?



In 2014, the IAEA has published the *General Safety Requirements Part 3: Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards*. This is often referred to simply as the BSS. The BSS is jointly sponsored by eight international organizations with responsibilities in various areas of radiation protection.

The requirements in the BSS take account of the most recent scientific evidence relating to exposure due to radiation. The BSS is used by many States as the basis for their national regulations dealing with radiation protection and safety.

The BSS requires that, where national authorities decide that the assessment of the radiation doses received by aircrew is warranted, they are required to establish a framework and a methodology for the assessment and recording of doses received. Female aircrew are required to inform their employer if they are pregnant. In such circumstances the employer is required to provide information on the risk to the embryo and the fetus from exposure due to radiation. Additionally, lower radiation dose limits apply to pregnant aircrew.

Radiation doses received by frequent flyers and couriers are excluded from the requirements in that they are considered not to be amenable to control.

Where necessary, national authorities are required to establish a framework, appropriate for the exceptional conditions of space, addressing radiation protection of individuals involved in space-based activities.

In addition to the IAEA, the BSS is jointly sponsored by the European Commission, the Food and Agriculture Organization of the United Nations, the International Labour Organization, the Nuclear Energy Agency of the Organisation for Economic Co-operation and Development, the Pan American Health Organization, the United Nations Environment Programme and the World Health Organization.

Challenges

Flying hours for aircrew are controlled by the International Air Transport Association (IATA). This in turn limits the radiation doses received by aircrew.

The highest radiation doses are received by long-haul crews flying the polar routes. These can be up to 6 mSv in a year. For short-haul routes and other long-haul routes, aircrew receive annual doses two to three times lower.

Radiation doses received by aircrew are assessed using computer codes. Several such codes exist and, for the same route and conditions, they show good agreement.

Solar flares and solar storms release much larger amounts of radiation than normal. Passengers and aircrew will receive higher radiation doses if flying during these events.

To reduce fuel consumption, airlines are likely to fly at higher altitudes in the future. It has been estimated that long-haul doses to aircrew could increase by 30-50%.

Individual doses could be reduced by changing work practices to allow crew to fly a combination of short- and long-haul routes. Such measures would have cost implications, also for consumers.

Organizations such as the European Space Agency (ESA) and national space agencies have established career dose limits for astronauts. So far, no limits have been established for space tourism.

Radiation does for selected world air travel routes*

Below you can see typical radiation doses for selected world air travel routes. The radiation doses received on many factors including the time spent in the plane but also an altitude of your flight.

Origin	Destination	Mean Passenger Dose (μSv)
Bangkok	New York City	101.0
New York City	Beijing	95.9
Cairo	Los Angeles	92.6
New York City	Hong Kong	79.7
Frankfurt	San Francisco	70.7
Tokyo	New York City	63.8
London	Los Angeles	58.8
Los Angeles	Seoul	50.5
London	Chicago	42.1
Singapore	London	34.1

* Luis E Alvarez, Sebastian D Eastham and Steven R H Barrett, "Radiation dose to the global flying population," Laboratory for Aviation and the Environment, Department of Aeronautics and Astronautics, Massachusetts Institute of Technology, Cambridge, MA, USA (2016)

https://scholar.harvard.edu/files/seastham/files/jrp_36_1_93.pdf

How does the IAEA support Member States?

The IAEA supports its Member States in the implementation of all aspects of the Safety Standards through the organization of national and regional workshops and other training events. Online webinars are also regularly organized.

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