COSMIC RADIATION EXPOSURE

IONISING RADIATION

All living organisms are exposed to ionising radiation on a continuous and daily basis. This type of exposure is referred to as background radiation. The international unit of radiation dose is called the sievert (Sv). A sievert is a large unit of dose and the unit most in use is the millisievert (1000 mSv= 1 Sv)

The sources of background radiation include radioactive materials and their decay products in the natural environment (referred to as terrestrial), in building materials and from outer space (referred to as cosmic radiation). There is considerable variation in the background radiation levels throughout the world. The world average is 2.4 mSv/year and the average Australian background radiation dose is around 2 mSv each year.

In terms of cosmic radiation because Australia has few high mountain ranges background radiation at ground level is low.

COSMIC RADIATION SOURCES AND EXPOSURES

Cosmic radiation is mainly in the form of particles from outer space. Some contribution also occurs from the sun, together with solar particle events. Solar particle events are rare occurrences that can result in higher exposures for short periods of time.

The Earth's atmosphere offers considerable protection from cosmic radiation, such that at ground level only small exposures occur. Airflight involves a change in the exposure to ionising radiation. With increasing altitude there is a reduction of exposure from terrestrial (earth-based) sources and an increase in exposure to cosmic radiation. In addition to altitude, latitude – the distance from the equator – also has an influence on the exposure level. Exposures increase the further that the flight path is away from the equator.

As altitude increases during flight, there is an initial lowering of the exposure due to the reduction of the terrestrial component of background radiation. As altitude increases further, the cosmic radiation component increases and can exceed the initial radiation exposure at ground level. The important part of a flight from an overall cosmic radiation exposure perspective is the cruising phase of jet airflight. This typically involves altitudes between 7000 and 12000 metres.
.

Exposures

ARPANSA Radiation Protection Series No. 1 (Republished 2002) describes Australia's system for radiation protection and includes an occupational exposure standard. RPS 1 can be found at http://www.arpansa.gov.au/rps_pubs.htm. In general, an occupational dose limit of 20 mSv per year applies, and for members of the public a 1 mSv per year dose limit applies. When a pregnancy is declared by an employee, the embryo or fetus must be protected to the same level as the general public. The latter is particularly important, as the most significant radiation risk at low doses is likely to involve the unborn child.

The groups with the most significant occupational exposure to cosmic radiation are pilots, flight engineers and cabin crew. Measurements and modelling of Australian aircrew exposures have indicated an additional dose from commercial airflight of around 1.8 mSv per year for those involved in domestic routes, and around 4 mSv per year for those involved in international flight routes. These figures are similar to those experienced by other pilots and aircrew in other countries. It is also possible for people who fly very frequently, for example 10-20 hours per week on long haul flights, to approach and exceed a 1 mSv per year dose. The table below provides some indication of doses for a number of routes and also indicates flying hours and number of flights taken to achieve a 1 mSv dose.

Hours Exposure for Effective Dose of 1 millisievert			
Altitude (ft)	**Altitude (m)**	**Hours at latitude 60° N**	**Hours at equator**
27,000	8,230	630	1,330
30,000	9,140	440	980
33,000	10,060	320	750
36,000	10,970	250	600
39,000	11,890	200	490
42,000	12,800	160	420
45,000	13,720	140	380
48,000	14,630	120	350
Source: Effects of Cosmic Radiation on Aircrew – Herbert R Meyer			

Route Estimates	**Dose/Flight (μSv)**	**Flights for 1 mSv**
Darwin-Perth	16	62
Perth-Broome-Darwin	8	131
Darwin-Singapore	9	107
Frankfurt-Singapore	39	25
Melbourne-Johannesburg	71	14
Melbourne-Singapore-London	65	15
London-Singapore-Melbourne	42	23

Data provided by Capt Ian Getley and adapted for presentation
1 mSv = 1000 μSv

Likelihood of Health Risk

Ionising radiation causes biological effects by directly damaging cells, tissues, components of cells and enzymes. Damage to important parts of the cell such as the DNA – the genetic material – can occur by ionising radiation directly breaking chemical bonds or by interacting with cellular chemicals that create agents that will break chemical bonds, or by mechanisms that change how cell divide, communicate or die. Damage to the DNA is felt to be an important step with regards to the risk of cancer and the risk of heritable defects; however human cells do have an enormous capacity to repair such damage. In the case of damage to an organ, a very substantial exposure is required. Such exposures do not occur when flying at commercial altitudes. From a standard setting perspective it is assumed that there is no threshold dose below which there are no effects, i.e. that small doses confer a small risk, and that risk can be judged from the known effects at high exposures.

For those occupationally exposed, it should be noted that the dose is a fraction of the occupational Standard. Large studies involving the health of pilots and aircrew have generally shown no significant association with an increased risk of cancer and, in particular, with the types of cancer that might be expected to arise from radiation exposure. This observation fits with the likely risks of low level exposure, and the scientific basis upon which the exposure standards are underpinned.

The lowest threshold of risk applies to the unborn child. For this reason a low limit of exposure is recommended. When a pregnancy is declared, active measures are required where doses may exceed 1 mSv for the remainder of the pregnancy. Noting the tables above, to achieve a 1 mSv dose will take a considerable number of flights, and is most likely to occur in circumstances of occupational exposure and in unusual circumstances for people who fly frequently. These flyers need to be aware of their doses and take appropriate actions in order to make the chance of exceeding 1 mSv remote.

Additional Information

ARPANSA web page: http://www.arpansa.gov.au

ARPANSA Publications: http://www.arpansa.gov.au/rps_pubs.htm

Radiation fact sheets: http://www.arpansa.gov.au/rad_health.htm