In 1999, Dr. Sten Odenwald wrote a book called 'The 23rd Cycle: Learning to live with a stormy star" that described all of the ways that severe space weather events, called solar storms, can affect our satellite technology, our electrical power, and even the health of astronauts and airline passengers and crew.

Read the excerpt from his book, and answer the following questions based on the information in the excerpt.

Question 1: What topic is this part of the book describing?

Question 2: Describe how a solar storm is involved with this topic?

Question 3: What does the article identify as a possible risk for passengers?

Here is a short list of your radiation exposure at ground level each year, in terms of a unit of radiation dosage called the milliRem.

Radon gas in your basement ……160 milliRems per year
The ground under your feet…… 60
Nuclear reprocessing plants…… 40
Cosmic rays at sea level…… 38
Cosmic rays from high altitude city (Denver)….130
Medical imaging…… 30
Food and water…… 25

Question 4: If you add up the different exposures in the list above, what is your total dosage each year if you were living at sea level? Living at high altitudes in Denver?

Question 5: According to the information in the article, how much extra radiation exposure would a passenger receive in a 10-hour flight at 35,000 feet?

Question 6: How much extra radiation will an airline crew member receive during 900 hours per year of flying?

Question 7: Do you think the radiation risk from solar storms is a significant one? Present the evidence that demonstrates the size of the health risk, and the evidence that suggests that the health risk is minimal.

Airline Travel and Solar Storms

Jet airliners fly at altitudes above 35,000 feet which is certainly not enough to get them into space, but it is more than enough to subject the pilots and stewardesses to some respectable doses when looked at over the course of their careers, and thousands of flights. A trip on a jet plane is often taken in a party-like atmosphere with passengers confident that, barring any unexpected accidents and food problems, they will return to Earth safely and with no lasting physical affects. But depending on what the Sun is doing, a solar storm can produce enough radiation to equal a significant fraction of a chest X-ray's dosage even at typical passenger altitudes of 35,000 feet. Airline pilots and flight attendants can spend over 900 hours in the air every year, which makes them a very big target for cosmic rays and anything else our Sun feels like adding to this mix. According to a report by the Department of Transportation, the highest dosages occur on international flights passing close to the poles where the Earth's magnetic field concentrates the particles responsible for the dosages.

Although the dosage you receive on a single such flight per year is very small, about one milliRem per hour, frequent fliers that amass over 100,000 miles per year would accumulate nearly 500 millirems each year. Airline crews who spend 900 hours in the air would absorb even higher doses, especially on polar routes. For this population, their lifetime cancer rate would be 23 cancers per 100 people. By comparison, the typical cancer rate for ground dwellers is about 22 cancers per 100. But the impact does not end with the airline crew. The federally recommended limit for pregnant women is 500 millirems per year. Even at these levels, about four extra cases of mental retardation would appear on average per 100,000 women stewardesses if they are exposed between weeks 8 to 15 in the gestation cycle. This is a time when few women realize they are pregnant, and when critical stages in neural system formation are taking place in the fetus.

Matthew H. Finucane, air safety and health director of the Association of Flight Attendants in Washington DC, has claimed that these exposure rates are alarming, and demands that the FAA to do something about it. One solution is to monitor the cabin radiation exposure and establish OSHA guidelines for it. If possible, he also wants to set up a system to warn crews of unusually intense bursts of cosmic radiation, or solar storm activity during a flight. Meanwhile, the European Aviation Agency is contemplating going even further. They want to issue standard dosimetry badges to all airline personnel so that their annual exposures can be rigorously monitored. This is a very provocative step to take, because it could have a rather chilling effect on airline passengers. It might also raise questions at the ticket counter that have never been dealt with before*, 'Excuse me, can you give me a flight from Miami to Stockholm that will give me less than one chest X-ray extra dosage?'* How will the traveler process this new information, given our general nervousness over simple diagnostic X-rays?

Consider this: during September 29, 1989, for example, a powerful X-ray flare caused passengers on high-flying Concord airliners to receive dosages equal to two chest X-rays per hour. At the end of the flight, each passenger had silently received hundreds of additional millirems added to their regular background doses. Still, these occasional dosages the average person receives while flying, compared to the dosages we might accumulate once we land at another geographic location, are rather inconsequential over a lifetime. Compared to the quality of life that we gain in exchange for the minor radiation exposure we risk, most people will grudgingly admit the transaction is a bargain. Statisticians who work with insurance companies often think in terms of the number of days lost to your life expectancy from a variety of causes. On this scale, smoking 20 cigarettes a day costs you 2200 days; being overweight by 15% costs you 730 days; and an additional 300 millirem per year over the natural background dose (about 250 milliRem) reduces your life expectancy by 15 days. "

[Dr. Sten Odenwald, 'The 23rd Cycle' Columbia University Press, 2000]