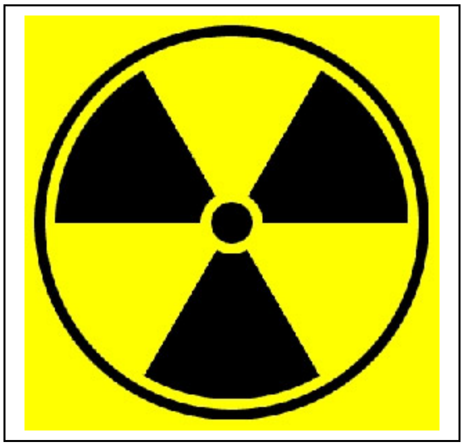
Radiation Dose and Dose Rate



Radiation is measured in two units. The first is a measure of the rate at which you are being exposed to a source of radioactivity, while the second is a measure of how much radiation you have accumulated over time. Radiation dose is measured in units of microSeiverts while dose rate is measured in terms of dose per unit time such as microSeiverts per hour or milliSeiverts per year.

Hasty reports about the devastating Japan 2011 nuclear power plant radiation leakages have occasionally confused these two concepts. When you consider the analogy of filling up a 1-liter kettle of water from the water tap, it is easy to keep the distinction between dose and dose rate clear. The volume of water in the kettle (the dose) depends on the rate of water flow (the dosage rate) times the filling time.

Problem 1 - The natural radiation background at sea level is about 0.4 microSeiverts/hour. In terms of milliSeiverts, what is your total radiation dose after A) 1 year? B) a 70-year lifetime?

Problem 2 - At the typical cruising altitude of a passenger jet, about 10,000 meters (33,000 feet), the dose rate is about 5 microSeiverts/hour. During its years of operation, the French Concorde jet traveled at altitudes of 18,000 meters (54,000 feet) where the cosmic radiation dose rate was about 15 microSeiverts/hour. If a flight from Paris to New York takes 8 hours by ordinary jet and 3.5 hours by Concorde, what are the total radiation doses for a passenger in each case?

Problem 3 - The Japan 2011 earthquake damaged several nuclear reactors, causing radiation leakage across northern Japan. On March 22, 2011 typical radiation levels across most of Japan are now below 50 microSeiverts/hour. The typical annual radiation dose from all forms of natural sources, medical tests, and food consumption is about 0.4 milliSeiverts. How many days will it take for a Japanese citizen to reach this annual dose level?

Problem 1 - The natural radiation background at sea level is about 0.4 microSeiverts/hour. In terms of milliSeiverts, what is your total dose after A) 1 year? B) a 70-year lifetime? Answer: A) 0.4 microSeiverts/hour x (24 hours/1 day) x (365 days/1 year) = 3500 microSeiverts. Converting this to milliServerts: 3500 microSeiverts x (1 milliSeivert/1000 microSeiverts) = **3.5 milliSeiverts**. B) In a 70-year lifetime ,your total dose will be 70 years x 3.5 milliSeiverts/year = **245 milliSeiverts**.

Problem 2 - At the typical cruising altitude of a passenger jet, about 10,000 meters (33,000 feet), the dose rate is about 5 microSeiverts/hour. During its years of operation, the French Concorde jet traveled at altitudes of 18,000 meters (54,000 feet) where the cosmic radiation dose rate was about 15 microSeiverts/hour. If a flight from Paris to New York takes 8 hours by ordinary jet and 3.5 hours by Concorde, what are the total doses for a passenger in each case?

Answer: Ordinary jet: 5 microSeiverts/hour x 8 hours = **40 microSeiverts**.
Concorde: 15 microSeiverts/hour x 3.5 hours = **53 microSeiverts**.

Problem 3 - The Japan 2011 earthquake damaged several nuclear reactors, causing radiation leakage across northern Japan. On March 22, 2011 typical radiation levels across most of Japan are now below 10 microSeiverts/hour. The typical annual radiation dose from all forms of natural sources, medical tests, and food consumption is about 0.4 milliSeiverts. How many days will it take for a Japanese citizen to reach this annual dose level?

Answer: Time = Amount / Rate

$$Time = \frac{0.4 milliSeiverts}{10 microSeiverts/hr}$$

$$Time = \frac{400 microSeiverts}{10 microSeiverts/hr}$$ so Time = 40 hours.

This means that in one year they will accumulate over 88 milliSeiverts of radiation dose, which is 88/0.4 = 220 times the normal annual dosage.

Fortunately, the dose rates are declining each day as the radioactive isotopes decay, and are also diluted through wind action. The actual accumulated dose may only be 10% of this in most regions of the country. This is still, however, 20 times the natural pre-contamination dose rate. Other communities where the dose rates are higher than 10 microSeiverts/hr will have to be decontaminated by soil removal and other time-consuming and expensive methods.