Radiation: A Science Media Centre of Canada Backgrounder Last updated April 13, 2011

How do scientists measure radiation?

Radiation is often reported as a *dose equivalent*, a function of the density of energy absorbed by the body. This is measured in an SI unit called the sievert (Sv), a measure of the overall risk of a long term effect on health from the particular radiation exposure.

The nuclear incidents in Japan are reporting dosages using sieverts as the unit. Most doses that humans are exposed to are smaller than one sievert - they are on the order of a few millisieverts (thousandths (0.001) of a sievert, or mSv), or even microsieverts (thousandths of a millisievert, denoted by or 0.000001 Sv).

Often, exposures are described by millisieverts per year, as that's the scale of background exposures. However, when reading about doses, check if the dose is given as a dose rate (millisieverts per year, millisieverts per hour), or a single dose (microsieverts or millisieverts).

Guidelines for radionuclide concentration are established on the assumption that these levels of exposure are the norm, and will continue indefinitely. Therefore, temporarily exceeding doses may or may not be a worry, depending on what the time unit is. (for example, temporarily exceeding an hourly dose isn't a problem if the yearly dose remains low.)

When a particular dose is described compared to the "background" rate, it should also be clarified exactly what the background rate is describing – just for that species of nuclide, all radioactive material, or other parameters – before the comparison can be considered serious. The energy absorption can also use the old unit Roentgens equivalent man (rem). 1 rem = 0.01 Sv = 10 mSv.

What do the numbers mean?

According to the UN Scientific Committee on the Effects of Atomic Radiation, the average person receives about 2.4 mSv (0.0024 Sv) of radiation a year through background sources like cosmic rays, soils, and food. In addition, the average person receives about 1 mSv/year from medical X-rays. This can vary widely, from x to y a year depending on where you live. In North America, we receive about 3.5 mSv a year. One sievert, in a single dose, would cause radiation sickness and nausea. If people are exposed to 1-2 sieverts, roughly 1 in 20 people would die within 30 days if they did not receive medical treatment. In fact, radiation sickness can occur at doses as low as 100-500 mSv. According to the US Nuclear Regulatory Commission, if each person in a population was exposed to 3500 to 5000 mSv (or 3.5 to 5 Sieverts), we would expect 50 per cent to die within thirty days.

Links to radiation dose charts:

http://www.epa.gov/rpdweb00/understand/health_effects.html

http://www.world-nuclear.org/info/inf05.html http://nuclearsafety.gc.ca/eng/readingroom/radiation/protecting_workers.cfm

So how much radiation is being released from the Fukushima plant?

Up to now, most radiation released has been in the form of radioactive gasses that can spread through the air, driven primarily by winds. The latest reports show levels harmful to human health at the site itself, though such levels drop off rapidly as distance increases – Japanese officials reported maximum levels of 0.33 millisieverts per hour 20 km from the plant on Wednesday, March 16. The levels will drop off rapidly with time after each explosion, as well. The situation is unstable, and we'll continue to monitor.

What kind of radiation is being released?

Different elements have different half-lives. A half-life is the time it takes for half of a sample of radioactive material to decay to daughter isotopes. The shorter the half-life, the more intense the radiation, as particles are being emitted at a greater rate.

Radioactive isotopes of gasses such as iodine, cesium, xenon and krypton could be released in the steam and emissions from the Fukushima plant. All of these undergo beta/gamma decay. *Beta decay* is where a beta particle (an electron or positron) is emitted from the atom as it decays. Energy comes from these particles being absorbed by the body. Other forms of decay include *gamma decay*, in which a gamma ray is emitted, and *alpha decay*, where an alpha particle - 2 neutrons and 2 protons - is emitted (essentially an ionized helium atom). Decay is often takes more than one step to get to a stable isotope, and may therefore emit more than one type of radiation.

Isotopes include:

Iodine-131 - has a half-life of about 8 days. Half-life indicates that half the amount of Iodine 131 will decay to stable xenon-131 in 8 days, and half of that amount will decay in another 8 days, and so on. This isotope can be taken easily up by the thyroid gland, and those at risk of exposure often take potassium iodide pills to saturate the thyroid with non-radioactive iodine. This prevents the gland from taking up the radioactive isotope when and if the person is exposed. Iodine-131 is sometimes used clinically for medical imaging scans. Potassium iodide should only be taken upon the advice of a physician, when there is substantial exposure to radioiodine, as it can have some health effects. The relative risks should always be weighed.

Cesium-137 - has a half-life of about 30 years.

Fuel like uranium and plutonium, that undergoes alpha decay, could also be ejected into the air if the fuel elements are sufficiently heated and if the containment structures were breached. This kind of radiation is stopped by clothing or skin if it is kept outside the body. Alpha decay is more damaging than beta decay when inside the body. These metals also persist for a long time in the environment, and may be stored for years in human bone if absorbed into the body, so exposing a person for years to come. It would take a huge explosion, beyond what we have seen, to eject these heavy metals, and they would quickly drop to the ground very near the plant.

How do they measure radiation in the environment?

Monitoring will include air samples and swab tests to detect the concentration of radioactive particles, at the plant and throughout the surrounding area. International agreements have developed a worldwide network of radiation monitors and detection equipment as part of the Comprehensive Test Ban Treaty and non-proliferation initiatives. As a result, very little goes on that is not carefully monitored and tracked in terms of airborne radioactivity. It would not be possible for a major release in Japan to go undetected by international scientists.

What are the chances of BC receiving dangerous doses of radiation?

In Japan, the prevailing winds blow west-to-east, carrying emissions out over the ocean. As this happens, it will disperse and become quite diffuse. According to Health Canada, "Given current wind patterns, it would take several days for any radioactive material to reach Canada. Based on the information available, it is anticipated that the amount of radiation reaching Canada, if any, would be negligible and not pose a health risk to Canadians." At current levels, any radioactive materials released from the plant would be negligible if it reached Canada.

Other

Journalists should take note that news reports, medical literature, and background information can describe radiation and its effects in different ways.

The number of ionizing emissions (alpha, beta, or gamma) per unit of time are measured in *becquerels* (1 decay / second). An older unit, the curie, is 3.7 x 10e10 disintegrations per second.

The *absorbed dose*, or rad, is defined as a unit of energy per mass: The *gray* is defined as one joule per kilogram of absorbing mass (usually a human body), and replaces the old *rad*.

One Sievert is defined as the gray, multiplied by a Quality Factor, a number that's specific to the type of radiation (alpha, beta, and gamma). That way it is a measure of the overall risk of a long-term effect on health from the particular radiation exposure.

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Health Canada