Public Health England

Protecting and improving the nation's health

Frequently Asked Questions:

Land contaminated with radioactivity

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1: What is radioactivity?

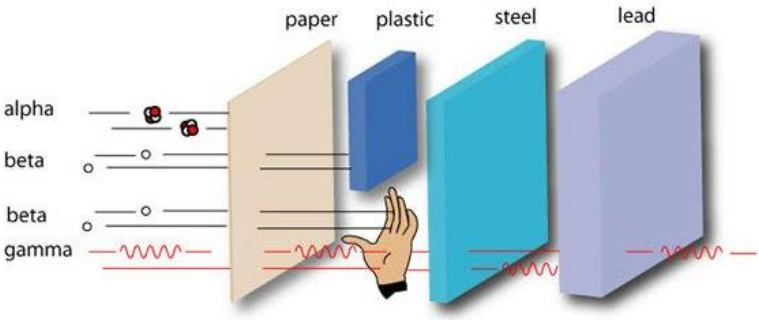
Radioactivity, or radioactive decay, is the process by which an atom with an unstable nucleus, called a radionuclide, loses energy by emitting radiation. The amount of radioactivity present is expressed in units of “Becquerel”, or “Bq” for short.

2: What is a half-life?

The time it takes for half of the atoms of a radionuclide to undergo radioactive decay is called a half-life. Each radionuclide has its own half-life: radium-226 for example, which is a radioactive isotope of the element radium, has a half-life of 1600 years whilst polonium-210, a radioactive isotope of the element polonium, has a half-life of 138 days. Once time equal to one half-life has passed, the activity of a radionuclide present, and the risks posed by that radionuclide, have also halved.

3: What is ionising radiation?

Radiation is the emission of energy in the form of waves or subatomic particles. Ionising radiation is a type of high energy radiation which can remove electrons from atoms. There are three main types of ionising radiation: alpha particles, beta particles, and gamma rays. Although other types of radiation are emitted from radionuclides, including X-rays and neutrons, they generally pose a much lower risk than alpha or beta particles or gamma rays; for simplicity, they are not discussed further in this leaflet.



- **Alpha particles** have relatively large mass and electric charge which means they interact strongly with matter. Alpha particles are very damaging to tissue but are unable to travel very far, being stopped by a few centimetres of air. Alpha particles cannot penetrate the skin and so they only pose a hazard if they are emitted by radionuclides located inside the body.
- **Beta particles** have relatively low mass and electric charge and so they interact with matter less strongly than alpha particles. Beta particles are less damaging to tissue than alpha particles. Beta particles are, however, able to travel up to several metres in air or a few centimetres into the body. Although there is some hazard when beta particles are emitted by radionuclides located outside the body, the main hazard from beta particles is when they are emitted by radionuclides located inside the body.
- **Gamma rays** can penetrate through anything other than thick shielding and they can pass right through the body. Although they are not as damaging to tissue as alpha or beta particles, they are able to travel tens of metres in air and so pose a hazard over considerable distances.

4: What are the risks from exposure to radiation?

The impact of radiation on the body is evaluated in terms of a dose. At very high doses, which are very unlikely to be received on sites where radioactivity is present as a contaminant, radiation can kill cells resulting in the individual showing visible signs that they had been exposed to radiation in days or weeks. Such severe tissue damage will only occur when the dose received exceeds a threshold level whose value depends on which tissue or organ is exposed. For example, reddening or blistering of the skin may occur if the skin receives a dose greater than its threshold dose whilst, if the eye is exposed above its threshold dose, cataracts may develop. When large parts of the body are exposed to high doses of radiation then many organs are affected; in such situations, radiation sickness or even death may result.

Where doses from exposure to radiation are below the threshold for severe tissue damage the main impact on health is the potential development of cancer. The probability that cancer develops depends on the level of dose; a higher dose means a greater risk of cancer. The potential for developing cancer because of being exposed to radiation is evaluated in terms of the effective dose, which has units of the sievert (Sv). As the sievert is a large quantity, doses are often expressed in terms of a millisievert, or mSv, which is a thousandth of a Sv.

5: How can land become contaminated with radioactivity?

Radionuclides are naturally present in all materials and some industrial processes can inadvertently concentrate those radionuclides in wastes. For example, radionuclides naturally present in coal concentrate in ash produced through burning. Other industries made use of radioactivity and any wastes they produced may contain radioactive material. For example, during the mid-twentieth century paint containing radioactive radium was added to watches and aircraft instrument dials so they could be seen in the dark. Any pots and brushes used by the painters, which were disposed of as wastes, would have radioactivity on them.

Prior to 1963, industrial waste, including that containing radioactivity, was disposed of in any convenient piece of land. As some radionuclides have very long half-lives, even wastes containing radioactivity which were disposed of over a century ago may still pose a hazard today.

6: What are the most common radionuclides detected in land contaminated with radioactivity?

The most common radionuclides likely to be detected in land contaminated with radioactivity are radium-226, lead-210 and polonium-210, which all emit radiation primarily in the form of alpha particles. Other radionuclides commonly detected include caesium-137, bismuth-214, lead-214 and bismuth-210, which all emit radiation in the form of both beta particles and gamma rays.

7: What is radioactive contaminated land?

The term “radioactive contaminated land” is used when the level of radioactivity present in land is sufficiently high that it poses unacceptable risks to human health as defined under Part 2A of the Environment Protection Act 1990.

For land to be legally defined as being radioactively contaminated, the effective dose to someone using that land for a year must be greater than 3 mSv and that there are no suitable processes in place to reduce those doses (for example, barriers to prevent access to the land). Where exposure to radioactivity is not certain to occur, for example when radioactivity is associated with small items, separate criteria exists to determine if the land meets the legal definition of being contaminated or not.

The term ‘radioactive contaminated land’ is different to the term ‘land contaminated with radioactivity’. This is because

‘land contaminated with radioactivity’ is used to describe any land that has radioactive contamination in it regardless of the hazard posed, whilst ‘radioactive contaminated land’ only refers to land that has high levels of contamination in it and where regulatory control is needed to reduce the risk the contamination poses. As a result, not all land contaminated with radioactivity will be radioactive contaminated land as the level of radioactivity present may be too low to pose a risk that needs to be controlled using regulatory powers.

8: What is the process used to determine whether land meets the criteria of being radioactive contaminated land?

As part of its statutory duties, a local authority in England or Wales will review all information related to a site to determine whether there is any possibility that elevated levels of radioactivity could be present. This may include looking at records to see how the site was used in the past. If that review shows elevated levels of radioactivity could be present then the site is inspected using radiation monitors.

If elevated levels of radioactivity are found, then an assessment is carried out to estimate the radiation dose people may receive when using that land. The results of that assessment are then compared against the legal definition of when land may be radioactive contaminated land (see Question 7).

9: How does the dose criteria used to define radioactive contaminated land compare with other radiation exposures?

Everyone is exposed to a wide variety of radiation sources; some sources are naturally occurring, like cosmic radiation, whilst other sources are artificial, such as X-rays used for diagnostic purposes in medicine. Typical doses when exposed to some sources of radiation are given in the following table.

Source of exposure	Effective dose
Dose from a single dental X-ray	0.005 mSv
Dose from a single transatlantic flight	0.04 mSv
Average annual dose from naturally occurring radiation in the UK	2.3 mSv
Average annual dose from all sources of radiation in the UK	2.7 mSv
Annual dose used to define radioactive contaminated land	**3 mSv**
CT scan of the whole spine	10 mSv
Action level to reduce radon gas in domestic dwellings	10 mSv
Annual limit for occupational exposures	20 mSv

People in the UK receive an average effective dose from all sources of radiation of about 2.7 mSv a year. The dose at which land can be legally defined as being contaminated, of 3 mSv in a year, is therefore about equal to the average dose people in the UK receive from all sources of radiation. This level of dose is less than that received during some medical

procedures or the annual limit allowed to be received by those who are occupationally exposed to radiation.

10: My land has been investigated but not determined to be radioactive contaminated land, what does that mean?

If radioactive contamination is present then the level of radioactivity, and any associated risks, are sufficiently low that the land is not considered to meet the legal definition of being radioactive contaminated land (see Question 7). As the level of risk posed by radionuclides present on that land is low, management of the land using legislation is not warranted.

11: My land meets the criteria for being radioactive contaminated land, what should I do?

The level of radioactivity present is sufficiently high that the associated risks need to be managed. How those risks are managed, including what remediation work should be done, needs to be agreed with the enforcing authority. Consultation with a suitably qualified independent expert should be considered to make sure any work is carried out appropriately.

12: I have a planning condition in relation to radioactive contamination, what do I do?

In some cases, the risks from radioactivity associated with the current use of the land are sufficiently low that regulatory control is not needed. However, if the land was to be used for another purpose then the level of risk may change as people may be exposed in different ways. To make sure that any change in land use does not result in the risks becoming unacceptable, a condition may be added to the planning consent which sets out the steps the developer must take to keep risks low. Any requirements of the condition must be followed. Consultation with a suitably qualified independent expert should be considered to make sure any work carried out is appropriate.

13: How do you remediate land that is contaminated with radioactivity?

Remediation means doing something to reduce the risks associated with any radioactivity present. There are three main types of remediation:

a. Protecting or removing people from the source of contamination. This can be done by restricting access to the land, by changing how the land is used, or by imposing restrictions on living conditions such as stopping domestic food production

b. Removing contaminated material such as soil, or reducing the level of radioactivity present

c. Disrupting the pathway of exposure, for example by burying the contamination or reducing its uptake by food.

Each site has its own unique characteristics which need to be considered when deciding on a remediation plan. These characteristics include how the land is being used and the type of radionuclides present. Other factors that may influence the remediation plan include the potential cost of the remediation, the impact of any work on the environment, and how much waste may be produced. It is also important that the concerns of those who own or use the land are addressed so that any remedial action undertaken is accepted in the long term. Any remediation plan should be developed in consultation with a suitably qualified independent expert and the enforcing authority.

14: Who pays for any remediation?

Where possible, the person or organisation that caused the contamination should pay for any remediation. However, in some circumstances the enforcing authority may decide that some other person or organisation should pay. For example, the current land owner may be required to pay if they purchased the land whilst knowing it is contaminated.

15: I have used land which has been contaminated with radioactivity, am I or my family at risk?

The risk to health from using land which has been contaminated with radioactivity depends on the level of radioactivity present, how the land was being used, and the age of those using the land. To determine the risk to health from using land contaminated with radioactivity a risk assessment should be carried out. If you are concerned about your health or that of your family then talk to your GP.

16: I garden or grow food on land contaminated with radioactivity, am I at risk?

The risk to health from gardening or growing food on land which has been contaminated with radioactivity depends on the level of radioactivity present, the type of food grown, and how much time is spent working the soil. To determine the risk to health from gardening or growing food on land contaminated with radioactivity, a risk assessment should be carried out. However, some simple measures like washing your hands after being on the land, and washing any food produced on the land prior to eating, can reduce your risk. If you want advice on how to reduce the risk from contamination in the soil when consuming home grown produce then speak to your local authority. If you are concerned about your health or that of your family then talk to your GP.

17: Is my drinking water safe?

Mains water comes from many sources, often far away from where it is used, and so its quality will not be affected by localised radioactive contamination. In addition, water supplied through the mains is monitored for harmful substances, including radioactivity, before it reaches your tap.

Some people obtain water from private water supplies. If the source of that water is close to land contaminated with radioactivity then it is possible that radioactivity can get into it, although it will be significantly diluted. Where needed, privately abstracted water can be monitored for radioactivity; this can be arranged through your local authority.

18: Where can I go to get more information about radiation?

More information on radiation can be found on PHE's website - https://www.gov.uk/topic/health-protection/radiation.

19: Where should I go if I am concerned about my health?

If you are concerned about your health or that of your family then talk to your GP.

About Public Health England

Public Health England exists to protect and improve the nation's health and wellbeing, and reduce health inequalities. It does this through advocacy, partnerships, world-class science, knowledge and intelligence, and the delivery of specialist public health services. PHE is an operationally autonomous executive agency of the Department of Health and Social Care.

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