

Information note on Regulation 12 and 13 (Wales)



Monitoring for radioactive substances

Introduction to this Information note

This information note is split into several sections:-

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1. Executive Summary

It is recommended that the whole of this information note is read in order to give a fuller understanding of Regulation 12 and 13, the information can be summarised as follows:

- risk assess supply at least once every 5 years;
- if radioactivity has not been previously detected and the risk assessment confirms it is unlikely to be detected then monitoring for indicative dose, tritium and radon is not required;
- if monitoring is not required, then the local authority must provide DWI with evidence for that decision;
- if radioactivity is found, or the risk assessment indicates it is likely to be detected, then the local authority should conduct further monitoring;
- if radioactivity is naturally occurring and stable, then monitoring may be reduced; and
- take into account any changes advised to the LA through external stakeholders (EA, Water company, etc.).

2. Introduction to radioactivity

Radioactivity from several naturally occurring and man-made sources is present throughout the environment. Water contains a small and variable quantity of natural radioactivity from the decay of uranium and thorium and their daughters, together with potassium-40.

- Natural radionuclides, including potassium-40, carbon-14 and those originating

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from the uranium and thorium decay series, in particular radium-226, radium-228, uranium-234, uranium-238, lead-210 and radon-222, can be found in water for natural reasons (e.g. desorption from the aquifer rock strata and wash-off by rain water) or can be released from technological processes involving naturally occurring radioactive materials (e.g. the mining and processing of mineral sands or phosphate fertilizer production and use).

- Human-made radionuclides, such as the trans-uranium elements (americium, plutonium, neptunium, curium), tritium, carbon-14, strontium-90 and some gamma emitting radionuclides, can also be found in natural waters as a result of authorized routine releases into the environment in small quantities in the effluent discharged from nuclear fuel cycle facilities. They are also released into the environment following their use in unsealed form for medical and industrial applications. They are also found in the water as a result of past fallout contamination resulting from the explosion in the atmosphere of nuclear devices and accidents such as those that occurred in Chernobyl (which affected the UK) and Fukushima.

Drinking water may contain radionuclides at activity concentrations which could present a risk to human health. In order to assess the quality of drinking water with respect to its radionuclide content and to provide guidance on reducing health risks by taking measures to decrease radionuclide activity concentrations, water resources (groundwater, river, lake, (sea), etc.) and drinking water are monitored for their radioactivity content as required by the national authorities.

3 Legislation (general)

Regulations 12 and 13 covers the monitoring requirements for the indicator radioactivity parameters indicative dose (ID), radon and tritium in Table D, in Part 3 of Schedule 1.

Radioactivity monitoring should primarily be informed by local authorities' risk assessments, taking into account the geology and any artificial sources that could lead to an increase in natural background levels of radioactivity. There are a variety of reference sources available to facilitate this, but the most comprehensive source of monitoring data is a joint publication issued annually by the Environment Agency (EA), the Food Standards Agency (FSA), the Scottish Environment Protection Agency (SEPA) and the Northern Ireland Environment Agency (NIEA) called the *Radioactivity in Food and the Environment* (RIFE) report, available on the FSA website. Other sources of information include:

- the report produced for DWI by AEA Ricardo discussed below;
- existing monitoring results (including any taken by the local water company and NRW if from the same water body);
- where a water company or other water supplier has a source in the same water body, details of notices authorising them not to monitor; ;

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- geological data, evidence from historic pollution events; and
- relevant Natural Resource Wales permitting information (radioactive discharges).

A table of common radioactive isotopes and their sources is included in Annex 1 – Radioactivity Monitoring. These risk assessments should be kept under continuous review if there are changes identified, and as a minimum at least every five years as required in the Regulations. If radioactivity has not previously been detected in a water supply source, and the risk assessment carried out by the local authority confirms that it is unlikely to be detected, then monitoring for radon, tritium and ID is not required until such a time as information becomes available which would materially affect the risk classification, based upon the risk assessment review process. This is permitted under Schedule 2A paragraphs 1(1)(a), 2(1)(a) and 3(1) – see below for further guidance.

If the local authority decides that monitoring is not required they must provide the Welsh Ministers (in practice the DWI) documentary evidence for that decision.

The DWI risk assessment tool has been revised to include hazard identification for tritium, radon and ID. The annual data return on private water supplies will be updated to include radioactivity risk assessment results which can be used to provide an annual record of the supporting evidence to determine the risk of a supply containing radioactive substances from the DWI risk assessment tool. The local authorities can therefore populate these columns for each supply which they have determined the risk indicates monitoring is not required. This process will take some time, and software providers for local authorities have advised us that updating their systems will add in further delay. Therefore, in addition, we have adapted the risk assessment tool to prompt the local authority if they would like a report sent directly to us each time they complete a risk assessment with sufficient information to confirm the risk of radioactive substances in a supply is low, and monitoring is therefore not required.

Where monitoring is required, the frequency of sampling must comply with the Group B monitoring frequency shown in Schedule 2 for Regulation 9 supplies, and where multiple samples are required over a year, their timings should vary to take account of any seasonal variations. Annual sampling should similarly take place at different times of the year. Regulation 11 supplies should be sampled every five years and Regulation 10 supplies (single domestic dwellings not used for a commercial activity or provided to the public) are monitored on request.

If a sample fails a parametric value set in the Regulations, a local authority should collect at least two further samples at three-monthly intervals in order to check the validity of the original result and ensure that sampling is representative of an average activity concentration for a full year. If all the repeat samples are within 20% of the mean of the set of numbers, then the averaging method is suitable and will give a

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representative average throughout the year, or period covered by the repeat samples.

In the event of exceeding any of the radiation standards, a local authority should conduct an investigation (see Information Notes on Guidance for Regulations 15 and 16). The sample location points and the number of investigational samples should be proportionate to the likely cause and magnitude of the failure. It is recommended that the Public Health England UK Recovery Handbooks for Radiation Incidents 2015, Drinking Water Supplies Handbook should be followed for the investigation of exceedances in tritium or indicative dose (gross alpha and gross beta).

A further option available, where radioactivity is naturally occurring and the levels of activity are stable, is provided in Regulation 10A (8) in which local authorities may exclude from their Group B monitoring suite any parameters which they consider are unlikely to be present at concentrations of values which pose a risk of that supply failing the standards set out for radioactive parameters, taking into account of any risk assessment and following guidance from DWI. If levels of natural radioactivity are stable, a reduced frequency of monitoring for those parameters of up to 50% can be applied. If it can be demonstrated that detections of gross alpha and/or gross beta activities are attributable to specific radionuclide, the local authority may monitor for this radionuclide instead, at the Group B monitoring frequency.

4 Radon

Schedule 3 paragraph 1 prescribes the monitoring requirements for radon which has a specified value (i.e. the value above which an investigation must be carried out) of 100Bq/l.

Schedule 3 paragraph 1(1)(a) requires that a local authority must ensure that a representative survey is carried out to determine the likelihood of radon exceeding the specified value. A representative survey may include reliable information from a variety of geological, hydrogeological or other sources. Much of the reliable information available was used in the production of the following report commissioned by the Inspectorate to ensure that this requirement (DWI 70/2/301 *Understanding the implication of the EC's proposals relating to radon in drinking water for the UK*).

In this report, areas of England and Wales have been mapped and delineated based on whether the existing analytical data for radon in water, the risk map for radon potential in air or hydrogeological factors relevant to radon in groundwater are indicative of a high, moderate or low risk of radon being present as a drinking water quality hazard. Local authorities have been provided with the hazard scores for all of the supplies reported in the 2013 data return.

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Local authorities should take the data provided in this report along with any other relevant information into account during their catchment risk assessments. Guidance on monitoring requirements is given in [Information Letter 05/2015 Publication of Research: Understanding the Implications of the European Requirements relating to Radon in Drinking Water](#), which is summarised below.

Based on the risk assessment incorporating information from the representative survey and any available monitoring data etc., local authorities should then determine an appropriate monitoring strategy for radon, according to the risk of it being present in treated water. Supplies should fall into one of the following categories:

- i. Surface waters that do not require monitoring for radon.

Some springs may have surface water characteristics which lead to low radon concentrations including one or more of the following: not directly derived from the ground (e.g. akin to land drains collection points), long residence time in a collection chamber or tank where no enhanced levels of the parent radionuclide (Radium-226) are present (if the gross-alpha measurement is low the Radium-226 level will be low), significant turbulence on collection or distribution, significant open air boundary.

- ii. Groundwater supplies in low hazard areas that do not require monitoring for radon.
- iii. Groundwater supplies in high and moderate hazard areas.

For private water supplies serving a small number of single dwellings, consideration can be given to carrying out a radon-in-air test within the properties supplied before any monitoring of water is carried out. The results of such tests will indicate whether any radon released from the water supply represents a significant health risk. If a test result exceeds 100 Bq/m³, the private water supply should be tested to confirm whether or not the source of the radon in air is derived from the supply. A radon in air test is still advised if the building has radon mitigation in place since any radon released from water to indoor air is unlikely to be affected by the mitigation measures to reduce ingress from the ground. In such premises the property owner may have up to date post-mitigation radon-in-air measurements. In such premises there may be a residual concentration of radon from the ground since radon remediation measured reduce but cannot entirely prevent radon ingress from the ground. Testing for radon-in-air is not useful in determining whether the drinking water PCV (100 Bq/l) may have been exceeded since a drinking water supply concentration at the PCV is only likely to contribute around 10 Bq/m³ in air which is less than the average radon concentration in UK homes. Charging for such testing, as a surrogate for radon in water, is permissible under the maximum charges set out in Schedule 6.

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Monitoring of private supplies that serve single domestic dwelling that are not used for commercial purposes or provided to the public is not required unless the authority is requested by the owner or occupier, or the authority considers it is necessary to fulfil its general duty under section 77 of the Water Industry Act.

It should be noted that the parametric value for radon of 100 Bq/l applies at consumers' taps. Although this is effectively the prescribed concentration value (PCV), it serves primarily as a trigger for further investigation and advice. An exceedence of the PCV of 100 Bq/l does not in itself automatically necessitate a requirement to install treatment. Action need only be taken if, following investigation, the supply is considered to be a risk to health. Advice should be sought from PHW if there is any concern. Properties in moderate or high risk areas may be at risk of elevated levels of atmospheric radon, which could be exacerbated by radon present in the tap water.

Advice should be provided to the users of the supply, including the suggestion that they may wish to monitor radon in air concentrations within buildings, especially if they are in radon Affected Areas. Advice to owners and users should include that:

- their water supply has been identified as a source of radon;
- radon is a naturally occurring gas that is released from certain rocks;
- radon is radioactive and prolonged exposure to radon by inhalation has been linked to increased instances of lung cancer;
- radon ingested directly within the water is unlikely to be a health issue itself, but this radon may contribute to the total amount of airborne radon within the building;
- radon in air monitoring within the buildings served by the supply may be appropriate; and
- further information on radon may be obtained at <http://www.ukradon.org/>

The Regulations specify an upper maximum limit for radon of 1,000 Bq/l. If this level is exceeded, then appropriate remedial action must be taken. The [Manual for Treatment of Small supplies](#) is available on the DWI website and contains guidance on remediation options for radon. Local authorities must serve a Regulation 20 Notice in this circumstance to ensure that the potential risk to human health is mitigated.

Radon analysis of a water sample must be carried out within a specified time period after collection due to the short half-life of radon (3.8 days). The laboratory will be able to confirm this timescale depending on the method they are using. Therefore if this timescale cannot be met due to the location of the nearest accredited laboratory, local authorities are advised to use laboratories which carry out non-accredited radon analysis in preference to exceeding the required timescale.

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5 Tritium

Schedule 3 paragraph 2 prescribes the monitoring requirements for tritium, which has a specified value of 100Bq/l.

Monitoring for tritium, or other artificial radionuclides must be carried out where:

- a) There is a man-made (anthropogenic) source of tritium or other artificial radionuclides present in the catchment. Natural Resource Wales can advise where there have been radioactive spills containing this; and
- b) The risk assessment and other surveillance programmes or investigations indicates that the level of radioactivity due to tritium exceeds, or is likely to exceed, the specified value. The local water company or Natural Resources Wales may be able to provide information to be taken into account during the risk assessment. Monitoring should be carried out at the frequency specified in Table 3 in Part 2 of Schedule 2 (see flow diagram).

Annex 1 provides some possible sources of artificial radioactive substances. Where an anthropogenic source of tritium or other artificial radionuclides is identified, it may have been documented as a result of a specific contamination event or permitted discharge. In either case, other relevant bodies (NRW, PHW) may have carried out surveillance programmes or investigations during a clean-up exercise or to demonstrate that the levels did not pose an environmental threat. Data from these investigations can inform the risk assessment for the water supply.

If the level of tritium activity or other artificial radionuclides detected exceeds 100Bq/l, then the Local Authority should carry out further investigations to identify the source, and undertake monitoring for individual artificial radionuclides. Advice may be taken from PHW as to whether it is a risk to health and therefore a Regulation 20 Notice is required.

6 Indicative dose

Schedule 3 paragraph 3 prescribes the monitoring requirements for indicative dose (ID), which has a specified value of 0.1mSv. Indicative dose is a calculation that takes into account all radioactivity found in drinking water. The value assigned (0.1mSv) represents a very low level of risk that would not give rise to any detectable adverse health effect (Guidelines for Drinking Water Quality, World Health Organisation, 4th Edition). When radiation interacts with body tissues and organs, the radiation dose received is a function of factors such as the type of radiation, the part of the body affected and the exposure pathway. This means that 1Bq of radiation will not always deliver the same radiation dose, therefore indicative dose has been developed to take into account the differences between different types of radiation.

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Details regarding the monitoring of indicative dose can be found in Schedule 3, Part 3 of the Regulations. Monitoring for ID is not required if it is unlikely to exceed 0.1mSv, regardless of the source of the radioactivity. Indicative dose is normally monitored by proxy through the measurement of gross alpha and gross beta activity as a basic indicator, which provides what are known as screening values. However, it can also be monitored using certain radionuclides based on what has been identified in the risk assessment.

Gross alpha activity has a maximum limit of 0.1 Bq/l, while gross beta activity has a maximum limit of 1.0 Bq/l. Where these values are exceeded, local authorities should carry out an investigation to determine the individual radionuclides, and calculate ID to see if it has or is likely to be exceeded. Schedule 4, Part 3 of the Regulations give details of which radionuclides should be analysed and provides the limits for them. A flow diagram has been provided to assist this investigation. The local water company may also have information on average levels in the same supply area, in addition they may also have carried out the investigation to calculate the indicative dose value. If the source of the radioactivity is thought to be natural, then only arrange for the natural radionuclides to be analysed. If it is thought that the source is artificial then all the radionuclides should be analysed. If additional information suggests a radionuclide not listed may be the cause then this should also be included in the suite. This investigation is usually carried out once and provides an indicative dose. This investigation is usually carried out once and provides an indicative dose. Where this ID value is less than 0.1mSv then there is no concern, and further monitoring for gross alpha and gross beta is not required.

The local authority should note any changes in the levels of gross alpha and gross beta. Where changes do occur then an additional investigation should be carried out to review whether the ID remains below 0.1mSv. Local authorities should use all relevant information about likely sources of radioactivity when deciding which radionuclides to monitor.

If the calculated ID exceeds 0.1mSv, or if the concentration of any radionuclide being monitored is detected at greater than 20% of the derived concentration, then advice should be sought from Public Health England or Public Health Wales depending on the location of the supply. If the level of radioactivity increases, then the ID should be reassessed.

Where gross alpha and/or gross beta activity is monitored, the detection of any unusually high level of activity should be investigated, and samples taken for individual radionuclides to identify any change to the calculated ID. Sometimes spurious results can occur, in these instances resamples should be taken and analysed as soon as possible.

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Paragraph 12 of Part 4 of Schedule 3 includes a provision for the Welsh Ministers to set alternative screening values for gross alpha activity and gross beta activity where it can be demonstrated that the alternative values are in compliance with an ID of 0.1mSv. The Inspectorate will review local authority's data where the existing gross alpha and/or gross beta screening values are regularly exceeded to determine whether moving to more relaxed screening values may be appropriate, depending on ID and risk to public health. In particular, the Inspectorate will consider whether a screening value of up to 0.5Bq/l for gross alpha activity, consistent with the WHO guideline value, may be more appropriate. Further guidance will be provided about this at a future date.

Local authorities should always use laboratories that are accredited to carry out the analysis of the parameters in question. The Inspectorate has updated its list of accredited laboratories on its website to include the laboratories which are accredited for radon and/or tritium analysis and calculation of ID.

7 Useful documentation and research

Environment Agency *Radionuclide handbook*

Part 1 is an introduction to radioactivity, Part 2 is detailed information on radionuclides.

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/291128/sp3-101-sp1b-e-e.pdf

Public Health England *UK Recovery Handbooks for Radiation Incidents 2015 Drinking Water Supplies Handbook Version 4.*

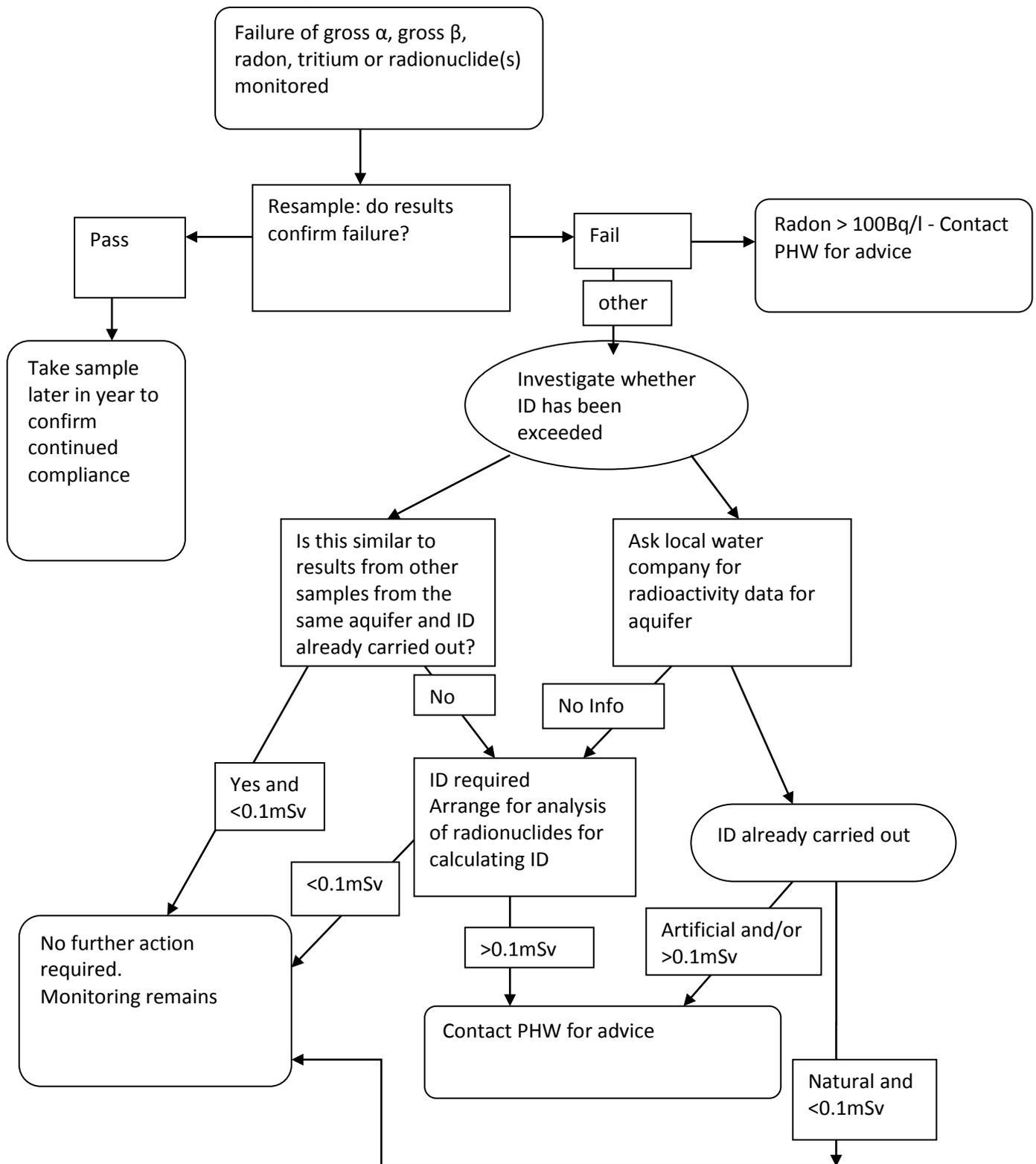
This provides the process and guidance for water source/supplies that fail radioactive parameter.

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/433689/PHE-CRCE-018_Drinking_Water_Supplies_Handbook_2015.pdf

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8 Flow diagram for radioactive parameter failures



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Annex 1

Origin	Nuclide	Derived concentration (Bq/l) ¹	Half life	µg/l	Uses	Emits	WHO guideline limits µg/l as the element
Natural	U-238	3.0	4.468x10 ⁹ y	241.2		alpha and γ	30
Natural	U-234	2.8	2.455x10 ⁵ y	0.0121		alpha and γ	30
Natural	Ra-226	0.5	1,600y	1.37x10 ⁻⁵	Formerly used in self-luminous paints for watches, nuclear panels, aircraft switches, clocks, and instrument dials. Used as a radiation source in some industrial radiography devices to check for flawed metallic parts.	alpha and γ	
Natural	Ra-228	0.2	5.75y	1.98x10 ⁻⁸		beta	
Natural	Pb-210	0.2	22.23y	7.06x10 ⁻⁸	Used as a tracer for the behaviour of heavy metals in the soil-stream-estuary system.	alpha, beta and γ	10
Natural	Po-210	0.1	138.38d	3.53x10 ⁻⁸	Used in anti-static applications.	alpha and γ	
Artificial	C-14	240	5,700y	1.45x10 ⁻³		beta	
Artificial	Sr-90	4.9	28.80y	9.59x10 ⁻⁷	In industry as a radioactive source for thickness gauges. Heat source for electric power. Radiotherapy.	beta	
Artificial	Pu239/ Pu-240	0.6	2.41x10 ⁴ y/ 6,561y	2.61x10 ⁻⁴ 7.14x10 ⁻⁵	Power and heat source.	alpha and γ	

¹These precise values are calculations for a dose of 0.1mSv as an annual intake of 730 litres and taken from Euratom dose coefficients from Annex III, Table A of Directive 96/29/Euratom. Other radionuclides can be calculated using this basis, additionally, more up to date information may be used to update this information.

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Origin	Nuclide	Derived concentration (Bq/l) ¹	Half life	µg/l	Uses	Emits	WHO guideline limits µg/l as the element
Artificial	Am-241	0.7	432.6y	5.52x10 ⁻⁶	Commonly used in smoke detectors.	alpha and γ	

Origin	Nuclide	Derived concentration (Bq/l) ²	Half life	µg/l	Uses	Emits	WHO guideline limits µg/l as the element
Artificial	Co-60	40	5.27y	9.55x10 ⁻⁷	Radiotherapy. Industrial radiography. Food irradiation.	beta and γ	
Artificial	Cs-134	7.2	2.064y	1.50x10 ⁻⁷		beta and γ	
Artificial	Cs-137	11	30.05y	3.42x10 ⁻⁶	Medical radiation therapy devices for treating cancer. Industrial gauges.	beta and γ	
Artificial	I-131	6.2	8.023d	1.34x10 ⁻⁹	Medical radiotherapy.	beta and γ	

This is not an exhaustive list, but represents the most common isotopes associated to radioactivity sources.

²These precise values are calculations for a dose of 0.1mSv as an annual intake of 730 litres and taken from Euratom dose coefficients from Annex III, Table A of Directive 96/29/Euratom. Other radionuclides can be calculated using this basis, additionally, more up to date information may be used to update this information.