



T: 0131 244 0224 | F: 0131 244 0743
E: regulator@dwqr.org.uk
www.dwqr.org.uk

Douglas Millican
Chief Executive
Scottish Water
Castle House
6 Castle Drive
DUNFERMLINE
KY11 8GG

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Dear Douglas

Information Letter 1/2014

Monitoring of radioactivity in Scottish drinking water

1. Purpose

The purpose of this letter is to confirm Scottish Water's agreed approach to monitoring radioactivity in order to meet the requirements of the Water Supply (Water Quality) (Scotland) Regulations 2001, hereafter referred to as "The Regulations". The procedures are also summarised in the appended flowchart. The letter additionally informs Scottish Water of the requirements of the new European Directive concerning the monitoring of radioactive substances in drinking water: Council Directive 2013/51/Euratom .

2. General requirements

2.1 The Regulations require sampling of water supplies for the determination of radioactivity. Sampling will be undertaken at the audit frequency specified in Table 2 or Table 3 of Schedule 3. Analysis is required for tritium as an individual radionuclide, which is effectively a screening parameter for the presence of contamination by artificial radionuclides. Monitoring for total indicative dose (TID) is routinely achieved by screening total gross alpha and gross beta activities. The TID calculation is only carried out if the specified screening values for gross alpha, gross beta or tritium are exceeded.

2.2 In many water supplies the gross beta activity is primarily due to the presence of potassium-40, a naturally occurring radioactive isotope of potassium. Potassium-40 is specifically excluded from the calculation of total indicative dose. Where there is reason to suspect that the screening value for gross beta activity in a particular Supply zone may be exceeded, Scottish Water will concurrently monitor that zone for potassium.

3. Initial screening

3.1 Initial screening for gross alpha and gross beta at the frequencies specified in The Regulations determines the need to analyse for specific radionuclides, and calculate the TID. Tritium is also monitored at audit frequencies. It is highly unlikely that the prescribed concentration of 100Bq/l will ever be exceeded. In the event of failure, advice will be sought from radiochemistry specialists on any further analysis that may be required.

3.2 Sources of raw water in Scotland are more likely to be affected by naturally-occurring alpha emitting radionuclides such as ^{234}U , ^{238}U or ^{226}Ra than other forms of radioactivity, particularly ground water abstracted from granitic aquifers. Radionuclides in water supplies that emit beta particles include the naturally occurring radionuclides ^{40}K , ^{210}Pb and ^{210}Bi , (all of which are excluded from the estimation of TID under the Drinking Water Directive), and artificial radionuclides such as ^{60}Co (cobalt-60), ^{90}Sr (strontium-90) and ^{137}Cs (caesium-137), which are very unlikely to be found at detectable levels. Gross beta activity tends to be dominated by ^{40}K . Drinking water in Scotland is generally low in dissolved salts, including potassium, so the measured beta activity is likely to be very low.

4. Actions Following Initial Screening

4.1 If the initial screening carried out by Scottish Water determines that the gross alpha and the gross beta are less than 0.1 Bq/l and 1.0 Bq/l respectively, Scottish Water will assume that the TID is less than the parametric indicator value of 0.1 mSv/year and no further radiological investigation will be carried out. If the gross alpha activity equals or exceeds 0.1 Bq/l or the gross beta activity equals or exceeds 1.0 Bq/l, further investigation will be carried out, as described below, which may culminate in analysis for specific radionuclides, which will be defined by taking into account all relevant information about likely sources of radioactivity.

4.2 TID is a measure of annual radioactivity dose, so if the criteria on gross activity are only exceeded for a short time, the TID limit of 0.1 mSv/year might not be exceeded. If the screening criterion for either gross alpha (0.1 Bq/l) or gross beta (1.0 Bq/l) activity is exceeded, Scottish Water will first check the validity of the result. Data from other samples analysed in the same batch and from control samples will be used to demonstrate that the procedure and the measurement instrumentation are working properly. Calibration and background verification checks will be carried out and if a sufficient amount of the original sample is available, a repeat analysis will be carried out.

4.3 Once the validity of the initial results has been established, Scottish Water will schedule further samples from the supply zone at a minimum frequency of once a week, for a minimum duration of 5 weeks. The first sample will be collected within 7 days of the original result being known. Sufficient sample will be collected to enable individual radionuclide analysis to be carried out if required and all resamples will be retained until a final assessment of the results is made.

4.4 If the average gross activity for the samples taken over the resampling period exceeds either of the specified criteria, specific radionuclide analysis will be carried out on the resample giving the highest gross alpha activity. If the average gross activity lies below the specified criteria, individual radionuclide analysis will not be carried out, but the zone will be sampled for gross alpha and beta activity once a month. If there is no increase in activity over the next 12 months, standard audit sampling frequencies will be resumed. If there is a further breach of the specified criteria, a further period of weekly sampling will be initiated.

4.5 It is highly likely that any activity in Scottish drinking water samples is due to natural alpha emitting radionuclides. If individual radionuclide analysis is deemed necessary as a result of the gross alpha criterion being exceeded, unless there is reason to suspect manmade contamination, the samples will be sent to an appropriate ISO17025 accredited laboratory to be analysed for uranium isotopes ^{234}U , ^{235}U and ^{238}U , radium isotope ^{226}Ra and polonium isotope ^{210}Po . If a source of artificial radioactivity is suspected, a decision on which radionuclides to look for will be made by Scottish

Water on the basis of available information on the likely source of contamination, including the RIFE report issued by SEPA.

4.6 In the event a drinking water sample exceeds the gross beta criterion, potassium analysis will be carried out and the activity contribution due to potassium-40 will be subtracted (see 1.3). If the gross beta activity criterion is still exceeded, a decision on which radionuclides to look for will be made by Scottish Water, again on the basis of available information on the likely source of contamination including the RIFE report issued by SEPA. The samples will be sent to an appropriate ISO17025 accredited laboratory for analysis.

4.7 The average value of the individual radionuclide analysis for all resamples will be assessed using the following equation:

$$\sum_{i=1}^n \frac{C_i (obs)}{C_i (ref)} \leq 1$$

$C_i(obs)$ = observed concentration of radionuclide i $C_i(ref)$ = reference activity concentration of radionuclide i (Table 1 below) n = number of radionuclides detected.

Where the result returned by the equation is $<0.1\text{mSv/year}$, no further investigation is required. Standard audit sampling frequencies will be resumed.

4.8 If, as a result of the assessment it seems likely that the TID will exceed 0.1 mSv/year , further sampling for individual radionuclide analysis will be carried out at weekly intervals. Scottish Water will inform DWQR, having sought expert advice on the potential implications for public health, and what remedial action may be required.

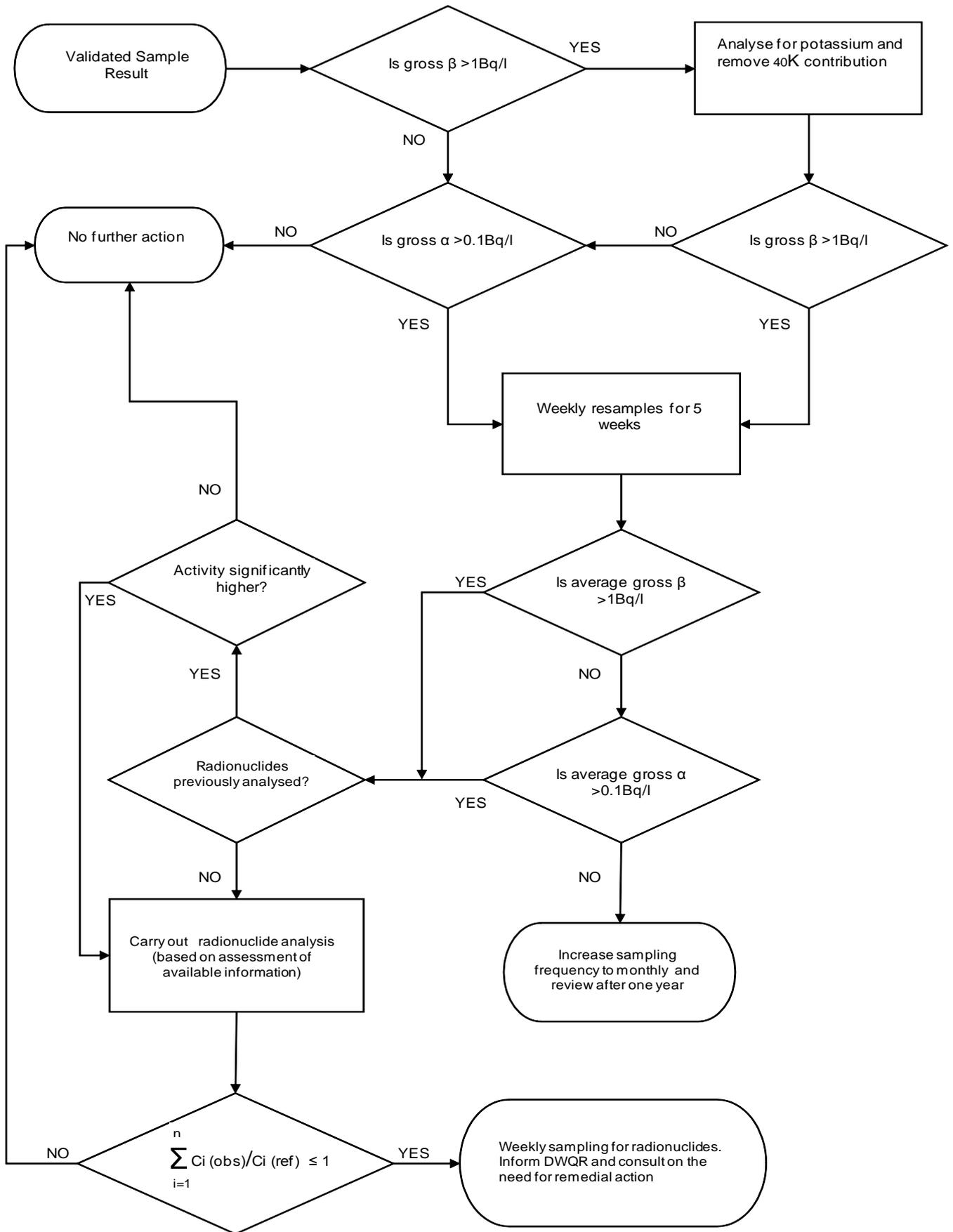
4.9 A few drinking water sources in Scotland may routinely exceed a gross alpha activity of 0.1Bq/l due to natural background radioactivity. For such sources, if the initial assessment, based on individual radionuclide analysis indicates that the TID is unlikely to be exceeded, the zone will continue to be sampled at standard audit sampling frequency. Further individual radionuclide analysis will not be carried out unless there is a significant increase in gross alpha activity.

4.10 On a monthly basis, as part of the Table 2 information return, Scottish Water will report gross alpha, gross beta and tritium activities to DWQR for all samples taken to comply with the Water Supply, Water Quality (Scotland) Regulations 2001. In addition, at the end of every year, Scottish Water will write to DWQR with a report on all results that exceeded the gross alpha or beta activity criteria in the preceding year and the action taken in each case.

Table 1. Reference concentrations of radionuclides, which are the concentrations that would give rise to a TID of 0.1mSv/year if consumed at 2 litres per day.

Radionuclide		Half life	Ref. Concn. Bq/l
¹⁴ C	Carbon-14	5730 y	240
³² P	Phosphorus-32	14.29 d	57
³³ P	Phosphorus-33	25.4 d	571
³⁵ S	Sulphur-35	87.44 d	1054
⁶⁰ Co	Cobalt-60	5.27 y	40
⁹⁰ Sr	Strontium-90	29.12 y	4.9
⁹⁵ Zr	Zirconium-95	63.98 d	144
⁹⁵ Nb	Niobium-95	35.15 d	236
⁹⁹ Tc	Technetium-99	213000 y	214
^{99m} Tc	Technetium-99m	6.02 h	6227
¹⁰⁶ Ru	Ruthenium-106	368.2 d	20
¹²⁵ Sb	Antimony-125	2.77 y	125
¹²⁵ I	Iodine-125	60.14 d	9
¹²⁹ I	Iodine-129	1.57 10 ⁷ y	1
¹³¹ I	Iodine-131	8.04 d	6.2
¹³⁴ Cs	Caesium-134	2.062 y	7.2
¹³⁷ Cs	Caesium-137	30 y	11
¹⁴⁴ Ce	Cerium-144	284.3 d	26.34
²¹⁰ Pb	Lead-210	22.3 y	0.20
²¹⁰ Bi	Bismuth-210	5.012 d	105.37
²¹⁰ Po	Polonium-210	138.38 d	0.11
²²⁶ Ra	Radium-226	1600 y	0.5
²²⁸ Ra	Radium-228	5.75 y	0.2
²³⁴ U	Uranium-234	244500 y	2.8
²³⁸ U	Uranium-238	4.468 10 ⁹ y	3.0
²²⁸ Th	Thorium-228	1.913 y	0.60
²³⁰ Th	Thorium-230	7.7 10 ⁴ y	2.80
²³² Th	Thorium-232	1.405 10 ¹⁰ y	3.04
²³⁹ Pu/ ²⁴⁰ Pu	Plutonium-239 / 240	2.41 10 ⁴ y / 6537 y	0.6
²⁴¹ Am	Americium-241	432.2 y	0.7

FIGURE 1. Flow diagram for assessment of gross alpha/beta results



5. Requirements of new Euratom Directive

5.1 The European Council has recently agreed a new Directive under the Euratom Treaty [Council Directive 2013/51/Euratom] laying down requirements for the protection of the health of the general public with regard to radioactive substances in water intended for human consumption. The Directive was published in the Official Journal on 7th November 2013 and Member States will have two years from publication to implement its requirements.

5.2 The new Directive sets out parametric values, and frequencies and performance characteristics for analytical methods for monitoring radioactive substances in water intended for human consumption. This includes water as defined in the scope of the Drinking Water Directive 98/83/EC for drinking, cooking, food preparation or other domestic purposes supplied from a distribution network, tanker or in bottles or containers. It also includes all water used in any food production undertaking for the manufacture, processing, preservation or marketing of products or substances intended for human consumption.

5.3 The parametric values for tritium and Indicative Dose (ID) remain unchanged from the values set out in the Drinking Water Directive and national legislation i.e. 100 Bq/l and 0.1 mSv respectively. Screening for gross alpha activity and gross beta activity can continue for monitoring for ID.

5.4 A parametric value is introduced for radon of 100Bq/l. However, Member States may set a level higher than 100Bq/l but lower than 1000Bq/l which is judged inappropriate to be exceeded. Remedial action must however, be taken where radon concentrations exceed 1000Bq/l.

5.5 Monitoring frequencies are set out in the new Directive for radon, tritium and ID; however, Member States are not required to monitor where it can be demonstrated that levels of the substances are well below the respective parametric values. Demonstration will be on basis of representative surveys, monitoring data and/or other reliable information. These surveys should determine the scale and nature of likely exposure to radon in water and should include an assessment of the geology and hydrology of the area, and radioactivity of rock or soil, as well as historical data.

5.6 Where there is reason to believe that from findings of any representative surveys or from other reliable information sources that radon or other radioactive substances may be present at levels that could exceed the parametric values, monitoring must be carried out at the frequencies set down in the new Directive.

6. Future Action

6.1 In common with the other UK regulators, DWQR is reviewing the details of the new Directive to assess the implications for Scottish Water and local authorities (private supplies). Some research work will be necessary to establish the likely position regarding radon in drinking water in Scotland, prior to undertaking a targeted sample survey. DWQR is currently setting out the required scope of this research.

6.2 The outcome of this project and any other data gathering exercise that may be considered necessary, will inform whether any further surveys are required to demonstrate that a supply does not contain levels of radioactive substances at a concentration that could exceed the parametric values set out in the new Directive. Further guidance on the implementation of the new Directive requirements will be provided in due course.

6.3 Any enquiries about this letter should be addressed to Matthew Bower (0131 244 0743). This letter has been sent electronically. A copy will be sent to the Water Industry Commission for Scotland, Health Protection Scotland and DWI in Belfast and London.

Yours sincerely,



Matthew Bower
Operations Team Leader
Drinking Water Quality Regulator for Scotland

Cc: Alan Sutherland, Water Industry Commission for Scotland
Colin Ramsay, Health Protection Scotland
Margaret Herron, DWI Northern Ireland
Jeni Colbourne, DWI England and Wales