METHOD STATEMENT

Determinand:
Determination of Gross Alpha and Gross Beta

Matrix:
Sample Types: Raw, Potable, Surface and Ground waters.

Principle of Method:
This method uses the Berthold LB770 10 channel counter, which is calibrated using ^{241}Am (alpha) and ^{40}K (beta). This method is primarily an empirical screening method where the calibration protocol defines the results.

Gas Filled Proportional Counters

Gas filled proportional counters are particularly suited to low level alpha measurements because they can be built with a large detection area and a very low background.

Gas filled proportional counters are also used to measure very low energy beta particles and very low energy x rays ie short absorption range particles because of the low density of the gas used. The radiation causes ionisation of the gas, which is detected as a charge. Only a fraction of the energy goes into ionization, the rest produces excitation, which does not contribute any charge. The total number of ion pairs produced is a measure of the total energy absorbed in the gas.

The charge produced from the initial ions is amplified by further collisions of these ions with the gas during their travel towards to the collector electrodes which driven by the applied potential. There is a range of operating voltages over which the amplified charge remains directly proportional to the energy absorbed in the detector. A counter operating in this range is called a proportional counter. Proportional counters typically amplify the initial charge by a thousand times or more.

Gas filled proportional detectors distinguish between alpha and beta particles through pulse-height discrimination. Alpha particle generate hundreds of times more ionisation than beta particles and so the signal obtained from these two types of particles are easily separated by pulse-height discrimination. Proportional counters normally use a low flow of gas to avoid impurities building up from “out gassing” which compromise performance.

Water sources may contain small and variable quantities of natural radioactivity from the decay of uranium, thorium and their daughters, together with potassium 40K. Radioactive decay is generally accompanied by the emission of low level α and β particles. The sample is concentrated, sulphated and ignited at 350 ± 10 ºC. A counting source is prepared from the dried solids and the gross alpha and beta activity is measured using a gas flow proportional counting system.

The Water Supply (Water Quality) Regulations 2000 stipulate that for water to be considered potable gross alpha is <0.1 Bq/l and gross beta is <1.0 Bq/l. If one or both of these levels are exceeded further speciation analysis will be required.

These guideline values, which are lifetime consumption values, are specified assuming that only the most toxic radionuclides likely to be present in significant quantities namely ^{90}Sr (beta) and ^{226}Ra (alpha) are contributing to the gross radioactivity of the drinking water.

Interferences:
Cosmic radiation will interfere with both α and β activity, this has been eliminated as far as possible by lead shielding around the counter. There is a certain amount of spillover, whereby some α particles are detected as β rays. A correction factor was programmed into the instrument during set-up to account for this. The % spillover should be recalculated each time an alpha calibration is performed and then checked on a yearly basis.

Performance of the Method:
***Range of Application**:*

The range of application is LOD - 12.5Bq/l for Alpha and LOD - 100Bq/l for Beta.

The reporting limits for the samples will vary according to the individual residue masses obtained, but they will never be less than the values for the blank.

Limit of Detection

Berthold 1 :	Gross Alpha	0.0157 Bq/l
	Gross Beta	0.0042 Bq/l.
Berthold 2 :	Gross Alpha	0.0098 Bq/l
	Gross Beta	0.0090 Bq/l.

Uncertainty of measurement:

This is different for each sample and is given by the formula $\sqrt{(x^2 + y)} \times 100\%$
where x is the uncertainty of measurement of counting (converted from % to decimal) and is reported by the instrument (typically twice the square root of the number of counts seen divided by the number of counts seen) and y is given below.
y = (error of sample measurement in measuring cylinder)^2 + (error of counting efficiency)^2 + (error in weighing of sample residue)^2 + (confidence interval of reference standard)^2

References:

Methods for the Examination of Waters and Associated Materials. Measurement of Alpha and Beta activity of water and sludge samples. The Determination of Radon-222 and Radium-226. The Determination of Uranium (including General X-ray Fluorescent Spectrometric Analysis) 1985-5, ISBN 011751909X

The Berthold LB770 instruction manual.

Water Quality-Sampling-Part 3: Guidance on the Preservation and Handling of Water Samples. BS EN ISO 5667-3-2012.