



# TENORM for Oil & Gas Operations

Naturally Occurring Radioactive Material (NORM) is found everywhere. Because these materials are prevalent in the natural environment, NORM is often exempted from regulation. When NORM is used for commercial purposes, and its radioactivity content is modified, it is classified as a Technologically Enhanced Naturally Occurring Radioactive Material (TENORM), which is often regulated because it results in a man-made concentration that is higher than the original NORM. TENORM can be a byproduct of hydraulic fracturing operations, as the extraction process concentrates the naturally occurring nuclides.

TestAmerica has been providing a full suite of TENORM radiochemistry testing services to the Oil and Gas Operations sector for more than 10 years. We provide a variety of analytical options for the determination of radioactive constituents in groundwater, produced water, soil and solid waste. With more than 40 years of radiochemistry testing expertise, TestAmerica provides full service radiochemistry testing support for samples from shale formations throughout the United States. Our team of experts assists in determining the best technical approach to meet your program's data needs.

## Analytical Methods and Options

Parameter	Method	Groundwater (baseline)	Produced Water	Soil, Waste & Sludge
Gross Alpha/Beta	EPA 900.0/ SW846 9310	X	X	X
Gamma Spec – NORM List	EPA 901.1, HASL 300		X	X
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Total Uranium and Thorium	SW846 6020A		X	X
Isotopic Uranium and Thorium	HASL 300	X		X
Lead-210	EERF PB-01	X		
Radium-226	EPA 903.0, HASL 300	X		
Radium-228	EPA 904.0, HASL 300	X		

## Process Influences on TENORM

Residual waste materials include drill cuttings, produced waters, scale (piping/tubing/valves), sludge and contaminated equipment. The level of radioactivity in waste is dependent upon a number of factors including geology, formation (type/conditions), type of operation, and the age of the production well.

Generally, flow back water contains a relatively high amount of total dissolved solids, sometimes higher than 250,000 mg/L. Other components of flow back water include: Barium (>4,000 mg/L), Calcium (>31,000 mg/L), Strontium (>2,000 mg/L), Iron (>100 mg/L) and Ra-226 (>10,000 pCi/L).

Process influences include:

- Calcium, Strontium, Barium, and Radium are dissolved, later precipitating out, leading to the presence of Ra-226, Ra-228, Ra-224 and progeny
- Radon-222 can migrate with water or in the gaseous phase
- Separation from the Ra-226 parent can occur (in dry export gas phase)
- Radon-222 decays to longer-lived Pb-210, which may plate out on the walls of piping, tanks, etc.
- Po-210 will sometimes preferentially plate out
- Concentrations of Ra-226/Ra-228/Progeny can vary over time in produced water

# Analytical Methodology

TestAmerica's team of experts is available to assist you with all of your NORM and TENORM testing. We assist with proper method selection, provide all of the sampling supplies necessary for your program, as well as 24/7 access to data through TotalAccess®. Method options and approaches include:

## Radium-226

Radium-226 by gamma spec is traditionally reported using a 21 day in-growth period, and is reported from its daughter, Bismuth-214. The Bismuth-214 primary energy line has a high abundance and is relatively free from interferences, making it ideal for reporting Radium-226.

## Fast Turn Radium-226

For projects that require the fast delivery of data, Radium-226 can be analyzed without in-growth using Radium-226's direct primary energy line. There are potential data biases when using this approach. Any Uranium-235 present in the sample will lead to a high bias Radium-226 result. Clients should evaluate site specific information and data to assess the Uranium-235 potential. Depending on the project's action levels and Uranium-235 potential, a high bias in results may be acceptable.

## Uranium and Thorium

TestAmerica offers multiple options for the determination of Uranium and Thorium to meet the needs of multiple environmental applications. Analytical options include:

- Isotopic Uranium and Thorium by Alpha Spectroscopy
- Isotopic Uranium by ICP-MS
- Total Uranium and Thorium by ICP-MS

Long-lived U-238/Th-232 is normally not mobile in formation water, and may or may not be seen for down hole or surface solids and drill cuttings.

## Potassium-40

Analysis of Potassium-40 is dependent upon the matrix of the sample.

- For water samples, use ICP or ICP-MS to detect total potassium, then convert to Potassium-40.
- For solid samples, utilize Gamma Spectroscopy to determine Potassium-40.

## Gamma Spec NORM Library

The Gamma Spec NORM library includes:

- Ac-227
- Ac-228
- Bi-212
- Bi-214
- Pb-210
- Pb-212
- Pb-214
- K-40
- Pa-231
- Ra-226
- Ra-228
- Tl-208
- Th-232
- Th-234
- U-235
- U-238



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# TestAmerica

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