A Brief Overview of Radiation and Analytical Water Testing for Radiological Contaminants.

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Overview of Presentation

- What is radiation?
- What are the different types of radiation?
- How does it get into the water?
- Why do we monitor it?
- What are the testing capabilities to monitor it?
Radiation

- Transmission of energy, emitted in the form of a wave or a particle, through space.

- **Ionizing vs. Non ionizing radiation**
  - Non-ionizing radiation examples: Radio waves, microwaves, visible light.
  - Not a threat to human health.
  - Ionizing radiation ionizes atoms and molecules, and can break chemical bonds. Can be harmful to living organisms.
Major Types of Ionizing Radiation

- **Alpha Particle**
  - A helium nucleus emitted by an atomic nucleus containing 2 protons and 2 neutrons.
  - Relative to other types of radiation, it has a high electrical charge (+2) and a large mass (4 amu).

- **Beta Particle**
  - A high speed electron or positron usually emitted by an atomic nucleus undergoing radioactive decay.
  - Very small in mass (1/1837 amu).

- **Gamma Ray**
  - Penetrating, electromagnetic radiation emitted by atomic nuclei.
  - Short wavelength.
Due to its relatively high mass and charge, the alpha particle can easily be shielded.

- Does not penetrate even a piece of paper.
- Does not penetrate your skin.

However, if ingested, an alpha particle can cause a great deal of internal tissue damage.

Examples of alpha emitters:

- Radium-226, Uranium isotopes, Thorium-230
- Plutonium-239, Polonium-210
Beta Radiation

- Due to its low mass, a beta particle can usually penetrate the body.
  - Within the body, beta particle travel is limited to 1/3 inch.
  - Can cause significant damage to the lenses of the eyes.

- Can be shielded by a layer of clothing or a thin sheet of metal.

- Examples of beta emitters:
  - Strontium-90, Cesium-137, Tritium
Gamma Radiation

- Strongly penetrating: Travels through entire body.

- Can only be shielded by very dense materials such as lead.

- Examples of gamma emitters:
Demonstration: Alpha Radiation
Demonstration: Beta Radiation
Demonstration: Gamma Radiation
How does radiation get into water?

- Certain rocks have naturally occurring radioactive elements that have long half-lives. (Thousands of years)

- As they decay, other radionuclides called “daughter products” begin to form.

- These radionuclides accumulate in water sources.
Characteristic rocks of certain regions can predict what naturally occurring radionuclides might be present in water based on location.
Why do we test and monitor water?

Health risks associated with extended exposure to ionizing radiation.

EPA says there is a lifetime risk associated with drinking water that contains the maximum contaminant level for gross alpha activity and combined Radium-226 and Radium-228 activity.

- MCL – Gross Alpha: 15 pCi/L
- MCL – Combined Radium: 5 pCi/L

If 10,000 people consume 2 liters of contaminated water for 70 years

Expect to see an increase of 1 additional fatal cancer per 10,000 people.
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Testing Capabilities

- Have the capability to test for alpha, beta, and gamma emitting radionuclides.
  - 3 gas flow proportional counters with 33 total detectors.
    - Quantify gross alpha and gross beta activities.
  - 9 High purity Ge, Gamma ray spectroscopy detectors.
    - Identify and quantify gamma activities of specific radionuclides.
  - 4 alpha spectroscopy detectors.
    - Identify and quantify alpha activities of specific radionuclides.
  - 1 Liquid scintillation counter.
    - Measure Tritium and Radon-222 activities.

- Mostly perform drinking water methods, but many of our drinking water methods can be used for raw, surface, or waste water.
### Samples types we have tested
- POE, Raw, Distribution, Waste, River, Bottled

### Analytes
- Gross Alpha/Beta
- Radium 224, 226, 228
- Unsupported Pb-212
- Tritium
- Radon in water
- Uranium 234, 235, 238
- Polonium-210
- Gamma emitters
  - E.g. Cs-137, Ba-133, I-131, K-40
Radioanalytical Services Laboratory consists of 3 connected rooms.
- 2 wet chemistry laboratories to prepare samples.
- Instrumentation counting room to perform analyses.

Samples are prepared in accordance with the appropriate SOP’s. Some preparations are quick (4-6 hours) and some take 3-4 days. (e.g. Isotopic Uranium)

Once prepared, samples are submitted to the counting room for analysis.
- Some instruments have the ability to provide final results.
- Some require further calculations via Excel spreadsheets.
Examples of Prepared Samples

- Gross Alpha/Beta Evaporation
- Isotopic Uranium
- Gross Alpha Coprecipitation
- Ra-224, Ra-226, Ra-228 by Gamma Spectroscopy
- Non-destructive Gamma Spectroscopy
Gas flow proportional counter: Used to measure gross alpha and beta activities.

Alpha spectroscopy detectors: Identify and quantify alpha activity.

Liquid Scintillation Counter: Tritium and Radon.
Radioanalytical Services Instrumentation

Gamma Ray Spectroscopy: Detector shielded by lead bricks and steel.

Sample spectrum of a Proficiency Test sample
Protocol for Drinking Water Samples

- Only needed for drinking water as per EPA and NJDEP regulations, but we have used the same decision making and applied to non drinking water samples per client request.

- Shows the relationship between initial gross alpha tests and the subsequent testing showing what is contributing to the gross alpha activity.
Any Questions?

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