

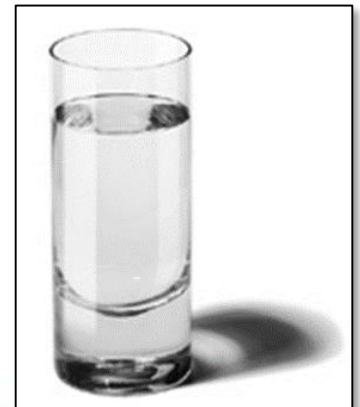
Radioactive Substances in Drinking Water

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Environmental Protection Agency.

EPA National Water Event, Galway, June 20-21, 2018

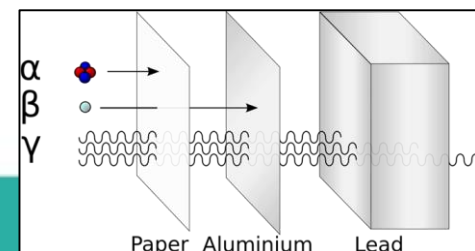
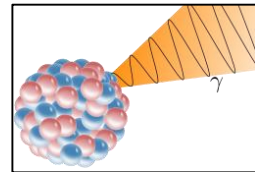
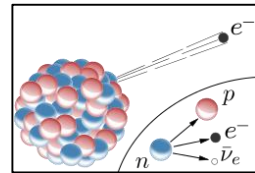
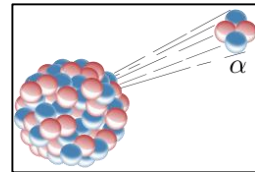
Presentation outline

1. Introduction
 - i. Radioactivity (α , β , γ), sources & exposure via water
2. Statutory Requirements
 - i. E-DWD; Radon & Indicative Dose parametric values
3. National Surveillance Monitoring Programme for Radioactive Substances in DW
 - i. 2017-2022 Monitoring Programme
 - ii. Failure Protocol
4. Exceedance - Enforcement Actions & Remediation
5. National Emergency Plan for Nuclear Accidents
6. Summary



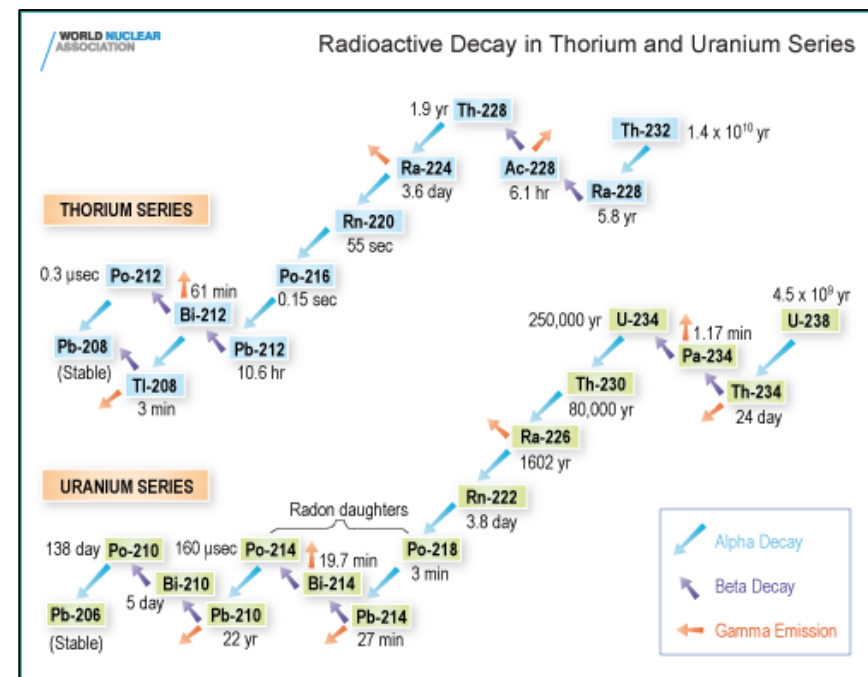
1. α , β , γ radiation

- Most atoms are stable, but certain **unstable atoms** have excess internal energy, with the result that the nucleus can undergo a spontaneous change ('radioactive decay') **emitting excess energy** as radiation (α , β , γ)
- α particles consist of **two protons and two neutrons** (helium nucleus)
- β particles are fast-moving **electrons** ejected from the nucleus
- γ rays represent **energy** transmitted in a wave without the movement of material, like heat/light
- When ionising radiation strikes a living organism's cells, it may cause injury



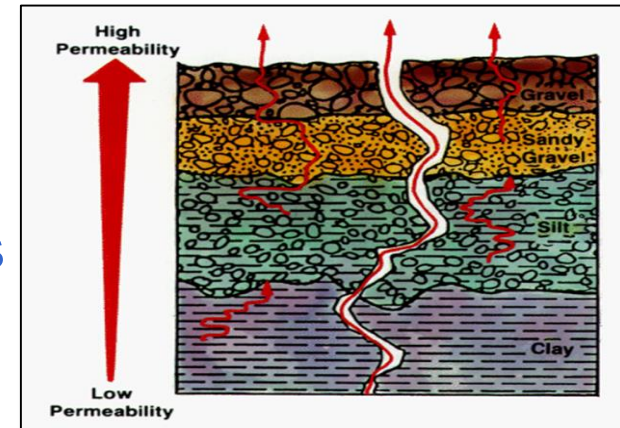
1. Radioactivity

- Radionuclides are ubiquitous, **naturally occurring trace elements** in rocks and soils as a consequence of the radioactive decay of uranium-238 (U-238) and thorium-232 (Th-232)
- The most common radionuclides found in groundwater are ions of the U-238 and Th-232 decay series;
 - radon-222, radium-226, radium-228, uranium-234 and uranium-238



1. Radon exposure routes in water

- As radon is a **gas**, it can move freely through porous media such as soil or fragmented rock
- Where pores are saturated, radon **diffuses** into the water
- The dissolved radon is **transported** in groundwater/aquifers and can find its way into **drinking water supplies**
- In surface waters, radon readily **diffuses to atmosphere**
- In Ireland, the majority of drinking water supplies derive from surface water (82%), the remainder from groundwater (10%) and springs (8%)



2. Statutory Requirements and International Commitments

- Radiological Protection Act, (Number 9 of 1991)
- Commission Recommendation 2000/473/Euratom - Art. 35 & 36
 - Continuous monitoring of levels of radioactivity in the environment
- 2001/928/Euratom - Protection of the public against exposure to radon in drinking water supplies.
 - EC DWD transposed into Irish law (S.I. 278 of 2007)
 - Two indicative standard parameters for radioactivity are established:
 - Tritium concentration
 - Total Indicative Dose (ID); Screening levels for **gross alpha** and **gross beta activity**
- 2013/51/EURATOM (S.I. 160 of 2016) - Protection of the public regarding radioactive substances in water



2. E-DWD Radon, ID and Tritium parameters

- S.I. 160 of 2016 on protection against exposure to radon in drinking water supplies
 - MSs may choose to adjust the parametric value for radon between 100 and 1000 Bq/L. Remedial action is required above 1000 Bq/L
 - Irish Limit – 500Bq/L
- Monitoring of ID shall be carried out where a source of artificial or elevated natural radioactivity is present
 - Screening strategy for ID is gross α and gross β or individual radionuclides. ID criteria: <0.1 mSv/y
 - The directive provides nuclide specific derived concentration values for this annual dose
- Tritium monitoring is required where a source of tritium or other artificial radionuclides is present (no significant sources in IE)

3. National Surveillance Monitoring Programme 2017 - 2022

- Monitoring all supplies with a volume $>10\text{m}^3$ per day/one serving a population $>10,000$ /largest supply in a county
- Measure samples from major water supplies in rotation so that supplies from **every county covered over 6 years**
- Samples analysed for **ID on each supply** and **radon if required** (GW, Spring water and mixed sources only)
- Subsequent analyses for individual radionuclides if ID exceeded; **U-234/238, Ra-226/228, Po-210, Pb-210**
- Sampling carried out by LAs
- Scheduled on an annual basis



3. Number and type of water supplies to be monitored (based on 2015 supply data)

- A risk based approach to monitoring taking into consideration:
 - The population served
 - The volume supplied (m³/day)
 - The type of water supply i.e. **surface water** or **ground water** supply

Volume of Supplies to be monitored (m ³ /day)	Surface Water	Ground Water	Spring Water	Mixed	Supplies to be monitored
Volume > 10,000	29	0	1	0	30
1,000 < Volume ≤ 10,000	133	40	20	28	221
100 < Volume ≤ 1,000	180	186	68	34	468
10 < Volume ≤ 1000	74	378	70	6	528
Total	416	604	159	68	1,247

3. Schedule for National Surveillance Monitoring Programme 2017 - 2022

Year	Supplies to be monitored (m ³ /day)	Estimated Number of supplies
2017	Volume > 1,000	251
2018	100 < Volume ≤ 1,000 Surface Water and Mixed Water Supplies	214
2019	100 < Volume < 1,000 Ground Water Supplies	186
2020	100 < Volume < 1,000 Spring Water Supplies & 10 ≤ Volume ≤ 100 Surface Water, Spring Water and Mixed Supplies	218
2021 2022	10 ≤ Volume ≤ 100 Ground Water Supplies	378

3. 2017 National Surveillance Monitoring Programme Summary

- 238 Public Water Schemes of volumes greater than 1000m³/day analysed.
- All supplies were analysed for ID.
- Groundwater, spring water and some mixed-source supplies were also monitored for Radon.
- All results were **below the Parametric Values** for ID (0.1 mSv/year) and Radon (500 Bq/L).

County	Schemes	County	Schemes
Cork	44	Limerick	3
Clare	7	Laois	11
Cavan	4	Meath	11
Carlow	8	Monaghan	6
Dublin	6	Mayo	6
Donegal	20	Offaly	7
Galway	20	Roscommon	13
Kildare	3	Sligo	5
Kilkenny	7	Tipperary	27
Kerry	9	Waterford	4
Leitrim	8	Westmeath	3
Longford	7	Wicklow	4
Louth	6	Wexford	11

3. Failure protocol

- Exceedance if **ID >0.1mSV/year** (Gross α > 0.1Bq/L or gross β > 1Bq/L) or **Radon >500Bq/L**
- If **ID exceedance confirmed**, analysis of the concentrations of **individual radionuclides** occurs and comparison with derived concentrations (representing 0.1mSv/yr)
- If derived conc. less than parametric value no further action required
- If parametric values **exceeded**, IW & HSE notified and **enforcement actions undertaken**

Nuclide	Derived Conc. Bq/L
Uranium-238	3.0
Uranium-234	2.8
Radium-226	0.5
Radium-228	0.2
Lead-210	0.2
Polonium-210	0.1

4. Remediation

- Alternative supply/source
- Controlled blending with another source
- Treatment



Radon-222

- Storage; $t_{1/2}$ 3.8 days
- Aeration
- Activated carbon

Uranium-234/238 & Radium-226/228

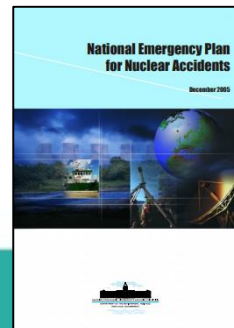
- Coagulation/ filtration
- Ion exchange
- Reverse osmosis

Lead-210 & Polonium-210

- Coagulation sedimentation & sand filtration
- Activated carbon
- Ion exchange

5. National Emergency Plan for Nuclear Accidents (NEPNA)

- Annual emergency protocol/drill **assesses** the EPA radiometric laboratory, EPA OEE, Irish Water and LA response to a nuclear accident
- Drinking Water, soil & vegetation samples (grass)
- Drinking Water is **not considered a significant risk** (distance, dilution) but **public reassurance must be provided**
 - EPA notifies IW of samples to be taken at water treatment plants serving larger populations
 - IW/LAs to take samples no later than second day of notification
 - Samples to be submitted to EPA no later than 3 days after notice
 - EPA point of contact for collection of drinking water samples for analysis in event of emergency
 - <http://www.epa.ie/radiation/emerg/nuclear/>



Summary

- 2017 - 238 Public Water Schemes of volumes $>1000\text{m}^3/\text{day}$ analysed
 - All supplies were analysed for Indicative Dose
 - GW, spring water and some mixed-source supplies tested for Radon
 - All results were **below the Parametric Values** for Indicative Dose (0.1 mSv/year) and Radon (500 Bq/L)
- EPA Drinking Water Advice Note No. 16:
 - http://www.epa.ie/pubs/advice/drinkingwater/EPADrinkingWaterAdviceNoteNo16_web%202.pdf
- EPA Drinking Water Brochure 14 - advice for radon in drinking water.
 - https://www.epa.ie/pubs/reports/radiation/RPII_Radon_Drinking_Water_Brochure_14.pdf.pdf



Radioactive Substances in Drinking Water

Thanks for you attention.

Questions or comments?