Radioactive Fallout in Drinking Water: What Water Utilities Need to Know

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Presentation Outline

- Background
- Properties of important radionuclides
- Fallout in drinking water (RadNet data)
- Treatment of radionuclides in water
- Waste disposal issues
- Communications with public
- Discussion: Q and A

Background

Summary of Fukushima Incident

- On March 11, 2011 a major earthquake occurred followed by 15 m tsunami
- Power supply and cooling disable at three Fukushima Dai-Ichi nuclear reactors
- The reactors were damaged and radioactive fission products were released to the environment

Radioactive Fallout

- Radioactive fallout is the deposition of radionuclides that descend from the atmosphere to the earth’s surface
- Gases and particulates are transported great distances in the atmosphere
- It takes about 18 days for radioactive materials to circle the earth
- The radioactive materials are dispersed and diluted by wind

Properties of Important Radionuclides in Fallout

Important Fission Products

- Fission products result when the ^{235}U isotope is split by a neutron in a chain reaction
- The important fission products in fallout include:
  - The cesium isotopes ^{134}Cs and ^{137}Cs
  - The strontium isotope ^{90}Sr
  - The iodine isotope ^{131}I

Chemical Properties

- Cesium
  - Metal similar to sodium (M^+)
  - Has a tendency to adsorb onto clays
- Strontium
  - Metal similar to calcium, magnesium, and barium (M^{2+})
- Iodine
  - Gas similar to chlorine (dissolves in water as HOI)
  - Occurs as iodide (I^-) and iodate (IO_3^-)
  - Can be incorporated into natural organic matter

Radioactive Properties

- The four radionuclides of interest are beta particle (electrons) and gamma ray (photon) emitters
- The drinking water Maximum Contaminant Level for beta-photon emitters is a dose based standard (4 mrem/yr combined dose for the entire group)

Picocuries vs. Millirems

- Radioactivity is the disintegrations per sec
  - Unit is picocurie (pCi) = 0.037 dps (2.22 dpm)
  - Each radionuclide has a unique decay rate and half-life
- Dose is the energy deposited in a unit mass of material (e.g., gm of tissue)
  - Unit is millirem
  - The same radioactivity of different radionuclides does not equal the same dose

Properties of Radionuclides in Fallout

Emitter	Half-life	pCi/L for 4 mrem/yr	mg/L for 4 mrem/yr
^{134}Cs	2.065 yr	80	2.3×10^{-11}
^{137}Cs	30.07 yr	200	2.3×10^{-9}
^{90}Sr	2.79 yr	8	2.4×10^{-14}
^{131}I	8.021 day	3	5.8×10^{-11}

Detection of Radionuclides in Fallout (RadNet data)

EPA's RadNet Program

- Monitors selected radionuclides at a number of sites throughout the USA
  - Routine monitoring
  - Monitoring of special events
- Media monitored include:
  - Precipitation
  - Drinking Water
  - Air
  - Milk
- Monitoring program is voluntary

RadNet Stations in PNW

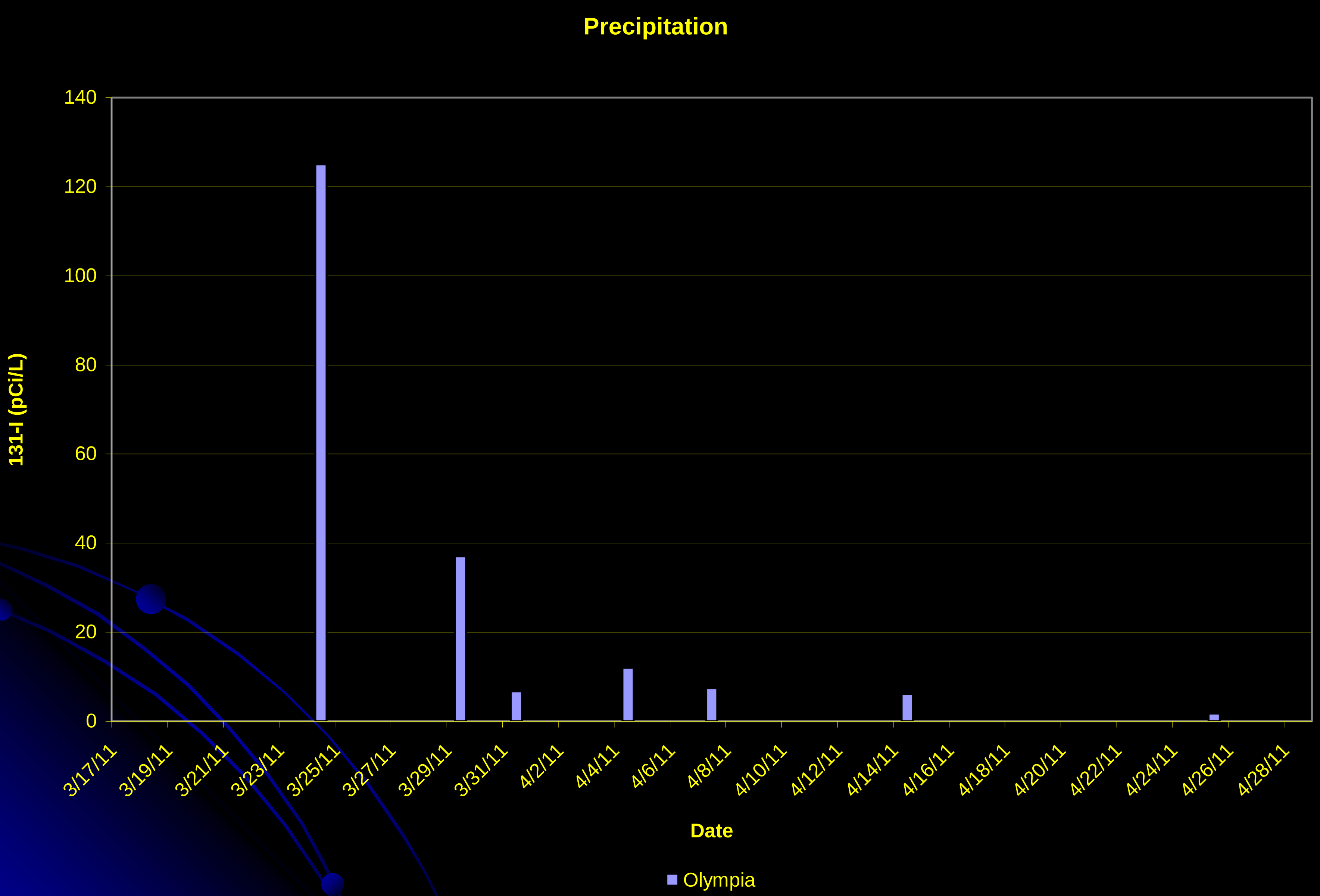
- Idaho
  - Boise (drinking water, precipitation, air)
  - Idaho Falls (drinking water)
- Oregon
  - Portland (drinking water, milk)
- Washington
  - Olympia (precipitation, milk)
  - Richland (drinking water)
  - Seattle (Drinking water, air)
  - Spokane (milk)
  - Tacoma (milk)

Drinking Water Results

- Boise – 0.2 pCi/L ^{131}I
- Idaho Falls – ND
- Portland – ND
- Richland – 0.23 pCi/L ^{131}I
- Seattle - ND

Precipitation Results

- Boise
  - 11.2 pCi/L ^{134}Cs
  - 11.6 pCi/L ^{137}Cs
  - 242 pCi/L ^{131}I
- Portland
  - 86.8 pCi/L ^{131}I
- Olympia
  - ND - 125 pCi/L ^{131}I


Precipitation
131-I (pCi/L)
0
20
40
60
80
100
120
140
3/17/11
3/19/11
3/21/11
3/23/11
3/25/11
3/27/11
3/29/11
3/31/11
4/2/11
4/4/11
4/6/11
4/8/11
4/10/11
4/12/11
4/14/11
4/16/11
4/18/11
4/20/11
4/22/11
4/24/11
4/26/11
4/28/11
Date
Olympia

Treatment of Radionuclides in Water

“Best Available Technology” (BATs)

- Best Available Technologies for beta particle and photon radioactivity
  - Ion exchange
  - Reverse osmosis
- These technologies are not normally installed at most water treatment plants

Conventional Treatment

- Conventional treatment (coagulation, flocculation, sedimentation, filtration) has limited ability to remove radionuclides in fallout
  - ^{134}Cs and ^{137}Cs that is attached to particulate matter will be removed
  - ^{90}Sr is poorly removed unless softening is practiced
  - ^{131}I may be removed if it is associated with natural organic matter.

Conventional Treatment Modifications

- Addition of powdered clays may improve removal of ^{134}Cs and ^{137}Cs
- Addition of phosphate may co-precipitate ^{90}Sr
- Addition of powdered activated carbon or use of granular activated carbon usually improves ^{131}I removal
- Removals are quite variable.

Waste Disposal Issues

Disposal Issues

- Radionuclides accumulating in sludge or other residuals (e.g., activated carbons) could trigger handling these residuals as low level radioactive wastes (dependent on landfill screening requirements)
- If ^{131}I is the radionuclide of concern, may be able to wait a few months to dispose of in landfill

Communications with the Public

Communications Issues

- Public perception of radioactivity
  - Tend to see radioactivity as a binary issue: either its their or not there
  - Generally do not consider (or understand) radioactivity concentration or dose
  - Need reassurance that drinking water is safe

Communications Issues

- Response to public
  - Message must be credible
  - Utilities need help from state and federal (EPA) agencies to help alleviate public concerns
  - Message needs to be consistent
  - Benchmark to drinking water MCL or exposure to natural radiation (~300 mrem/yr)

Communication Issues

- EPA statement on finding trace amounts of ^{131}I in drinking water (about 0.2 pCi/L): “Even an infant would have to drink 7,000 liters of this water to receive a radiation dose equivalent to a day’s worth of natural background exposure we experience continuously from natural sources of radiation in our environment.”

Questions?

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