



UK Health  
Security  
Agency

# Lead and PFAS in drinking water

Stephen Robjohns 2021

# Lead drinking water regulatory limits or Guidance value

Authority	Regulatory Limit or Guideline value (micrograms/litre)
England and Wales Regulatory limit	10
World Health Organization Guideline value	10
Current EU Regulatory limit	10
Future EU Regulatory limit	5 (within 15 years – by 2036)

# Basis for regulatory limit

- No 'safe' level of exposure to lead has been identified
- Exposure to lead should be as low as reasonably practicable (ALARP)
- The WHO Guideline value is based on the principle of ALARP and pragmatic achievability

[Lead is rarely present in tap water due to the dissolution from natural sources, but arises from lead drinking water pipes, solder and fittings in building plumbing systems. Mainly present in properties built pre 1970s]

# Adverse health effects from lead exposure

- A variety of potential effects (depending on amount and duration of exposure)
- Neurological
- Cardiovascular
- Reproductive effects (e.g. birth defects, premature birth, and fetal growth restriction)
- 3 key health effects with no identified threshold (no 'safe' level)
- Neurodevelopmental effects (reduced IQ) - children
- Increased blood pressure – adults
- Adverse kidney effects - adults

# UKHSA advice for exceedance of the regulatory limit

- Pregnant women, infants and young children are particularly advised to avoid drinking and cooking with water containing lead above the regulatory limit of 10 µg/L
- We recommend that all individuals should not drink or cook with tap water containing lead above a concentration of 10 µg/L on a regular or long-term basis
- We recommend not using water containing lead above 10 µg/L for making up infant formula

[The use of bottled water for making up infant formula is not recommended, as it may not be sterile. However, where there is a need to use bottled water for infant feed, it should be boiled (to sterilise) and the label should be checked to ensure it does not contain more than 200 milligrams per litre (mg/L) of sodium or 250 mg/L of sulphate. Appropriate advice can be obtained from the NHS website ([NHS](#))]

# No threshold effects – dose response

- The European Food Safety Authority (EFSA) have estimated:
- Intake of approximately 0.5 micrograms/kilogram of body weight/day is associated with a 1% reduction in child full scale IQ score
- Intake of approximately 1.5 micrograms/kilogram of body weight/day is associated with a 1% increase in systolic blood pressure
- Intake of approximately 0.63 micrograms/kilogram of body weight/day is associated with a 10% increase in the prevalence of chronic kidney disease

[Note the above all relate to the lower 95% confidence interval of Benchmark dose calculations]

# WRc cost benefit analysis of long term lead reduction

- Health impacts of IQ detriment, cardiovascular effects (high blood pressure) and chronic kidney disease were valued in terms of lifetime earnings, deaths, morbidity etc. under different scenarios
- The report provides economic evidence (in terms of a cost benefit analysis) for the need to replace lead up to the compliance point (kitchen tap), particularly in high risk zones



WRc/DWI Long-term strategies to reduce lead exposure from Drinking water- [Long-term Strategies to Reduce Lead Exposure from Drinking Water - Drinking Water Inspectorate \(dwi.gov.uk\)](#)

# Water UK lead reduction strategy group

- A cross sector group has been formed by Water UK including representatives from the Water Industry, the Drinking Water Inspectorate, Defra and Public Health organisations (e.g. UKHSA and PHW) to work towards a strategy and management options to reduce lead exposure from drinking water over the long term

# Perfluoroalkyl and Polyfluoroalkyl substances (PFAS)

- Perfluoroalkyl and polyfluoroalkyl substances (PFAS) include a large group of synthetic organofluorine chemicals. These are known for their water, grease and stain repellent properties. They have been used in many products - non-stick, water proof materials, textiles, and firefighting foam
- Some PFAS, such as perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) have high regulatory restrictions (i.e. banned or being phased out of use)
- They have at least one fully fluorinated methyl (-CF<sub>3</sub>) or methylene (-CF<sub>2</sub>-) group
- Once in the environment, they are very persistent (and mobile), which means they will continue to be present in the environment for many years

# Perfluoroalkyl and Polyfluoroalkyl substances (PFAS)

- There is concern over some of these substances because they are persistent in the environment, accumulate in the body over time and may be toxic at low levels of exposure (PBT)
- PFOS and PFOA, are classified as Toxic, accumulate in living organisms and pose a risk to human health and the environment. A third PFAS, PFHxS (perfluorohexane sulfonate) is also being considered for global controls. Similar PFAS may have similar properties

# Perfluoroalkyl and Polyfluoroalkyl substances (PFAS)

- Environment agency research indicates that PFAS may be widely present in surface and groundwater. This indicates a potential risk to human health
- The EA is undertaking a programme of groundwater monitoring using new fully quantitative analytical techniques for about 40 individual PFAS, which should provide an improved understanding of the levels in the environment. Research is ongoing to identify sources and pathways of PFAS into the environment

Environment Agency Poly and perfluoroalkyl substances (PFAS): sources, pathways and environmental data [Poly- and perfluoroalkyl substances \(PFAS\): sources, pathways and environmental data: summary - GOV.UK \(www.gov.uk\)](https://www.gov.uk/government/publications/poly-and-perfluoroalkyl-substances-pfas-sources-pathways-and-environmental-data-summary)

# DWI Guidance on PFOS and PFOA

Tier	Regulatory requirement	Guidance concentration	Minimum action
Tier 1	Regulation 27 (Risk assessment)	Potential hazard	Ensure considered as part of risk assessment
Tier 2	Regulation 10 (sampling: further provisions)	>0.01 microg/L	Consult with local health professionals; monitor levels in drinking water
Tier 3	Regulation 4(2) Wholesomeness	>0.1 microg/L	As tier 2; and reduce concentrations below 0.1 microg/L as soon a practical
Tier 4	Water industry (Suppliers' information) Direction 2020	>1.0 microg/L	As tier 3; and consult with health professionals; reduce within 7 days

# Recast EU Drinking Water Directive

Parameter	Regulatory limit (microg/L)	
Specific PFAS	0.1	About 20 considered potential concern for health (perfluoroalkylated acids)
Total PFAS	0.5	Analytical method not yet agreed

# Adverse health effects of PFAS

- Laboratory animals
- Effects on the liver
- Immune system
- Neurodevelopmental
- Reproduction and development
- Human epidemiological data
- Immune system
- Increased cholesterol
- Increased levels of a liver enzyme
- Limited evidence for association with cancer

# European Food Safety Authority (EFSA)

- EFSA have derived a Tolerable Weekly Intake (TWI) for the sum of perfluorooctanoic sulfonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), and perfluorohexane sulfonic acid (PFHxS) - greatest contribution to human serum levels
- Grouped together due to similar chemical properties and toxicological effects
- TWI for the sum of these four is 4 nanograms/kg bw/week
- The UK Expert Committee on Toxicity is currently considering the EFSA opinion and will publish a statement

# Uncertainties over health risk assessment of PFAS

- Lack of toxicological data for many (most) PFAS
- Animal toxicology studies are difficult to interpret in terms of human exposure
- PFAS behave differently in animals compared to humans
- Shorter chain PFAS behave differently in the body compared to longer chain PFAS
- Reported effects in human epidemiological studies are variable (not always consistent)
- Analytical difficulties (e.g. cross-contamination)

# UKHSA research on PFAS

- UKHSA is involved with a literature review of the toxicity of PFAS (HPRU research project with Imperial college)
- UKHSA is planning to assess human exposure (Human biomonitoring) as part of a HPRU research project with Imperial college. This data should be available in 2023

# Thank you

- Useful References

Agency for Toxic Substances and Disease Registry Toxicological profile for perfluoroalkyls - [Toxicological Profile for Perfluoroalkyls \(cdc.gov\)](https://www.cdc.gov/toxicology/chemicals/perfluoroalkyls.html)

DWI Guidance on water supply and PFOS and PFOA - [PFOS-PFOA-guidance-2021.pdf \(dwi.gov.uk\)](https://www.dwi.gov.uk/publications/pfos-pfoa-guidance-2021.pdf)

Compendium of chemical hazards Lead: toxicological overview - [Lead: health effects, incident management and toxicology - GOV.UK \(www.gov.uk\)](https://www.gov.uk/guidance/lead-health-effects-incident-management-and-toxicology)

Environment Agency Poly and perfluoroalkyl substances (PFAS): sources, pathways and environmental data [Poly- and perfluoroalkyl substances \(PFAS\): sources, pathways and environmental data: summary - GOV.UK \(www.gov.uk\)](https://www.gov.uk/guidance/poly-and-perfluoroalkyl-substances-pfas-sources-pathways-and-environmental-data-summary)

European Food Safety Authority Scientific opinion on lead in food 2010 - [Scientific Opinion on Lead in Food | EFSA \(europa.eu\)](https://www.efsa.europa.eu/en/efsajournal/doc/2424/1)

European Food Safety Authority Scientific opinion on PFAS in food 2020 - [PFAS in food: EFSA assesses risks and sets tolerable intake | EFSA \(europa.eu\)](https://www.efsa.europa.eu/en/efsajournal/doc/5712/1)

WRc/DWI Long-term strategies to reduce lead exposure from Drinking water- [Long-term Strategies to Reduce Lead Exposure from Drinking Water - Drinking Water Inspectorate \(dwi.gov.uk\)](https://www.dwi.gov.uk/publications/long-term-strategies-to-reduce-lead-exposure-from-drinking-water)