Fact Sheet

DISTRIBUTION SYSTEM MANAGEMENT

Lead and Copper

Impacts from Lead and Copper Corrosion

Quick Facts

- Lead and copper can cause a variety of physical and mental health effects. The EPA published the Lead and Copper Rule to minimize their levels in drinking water.
- The rule requires all community water systems and non-transient non-community water systems to comply with action levels and sampling/monitoring requirements.
- While lead and copper release can be controlled, corrosion science is complex and utilities must remain vigilant.

Overview

Lead and copper in service lines and household plumbing are the primary drinking water corrosion contaminants of concern. The U.S. Environmental Protection Agency's (EPA) Lead and Copper Rule regulates the concentrations of lead and copper allowed in water and provides a framework for reduction.

Corrosion science is complex. Various control strategies exist for each of these metals, and utilities with elevated lead and copper levels should be aware of research that can help. Utilities in compliance with the Rule need to remain vigilant to changes that could impact lead and copper release.

Lead Background

Lead is a naturally occurring element found in the earth's crust, air, soil and water. It was also a component of household paint before 1978. Even at low levels it can be toxic to humans. Lead can cause a variety of physical and mental health problems in healthy adults. Children under six and pregnant women are particularly susceptible.

Most lead enters drinking water through corrosion of household plumbing, including lead service lines and piping, lead-based solder, and brass components. Lead corrosion is complex (EPA 2016a).

Copper Background

Like lead, copper is a naturally occurring element found in the earth's crust, air, and water. It is also found in food. People who drink water containing copper in excess of 1.3 milligrams per liter may experience short-term nausea. Long-term exposure can affect the liver and kidneys, and people with Wilson's disease can be more sensitive.

Copper is rarely found in source water and mainly enters drinking water through corrosion of household plumbing. Copper corrosion is also complex. Copper release can differ, whether it is released through non-uniform corrosion (pinhole leaks, erosion, galvanic, and microbiologically induced) or through uniform corrosion. In new piping, before a scale can form, copper levels are more likely to be elevated (EPA 2016b).

Lead and Copper Rule

In 1991, to protect public health by minimizing lead and copper levels in drinking water, the EPA published the Lead and Copper Rule. All community water systems (CWSs) and non-transient non-community water systems (NTNCWSs) are subject to the rule requirements (EPA 2016c). Under the rule, both lead and copper have action levels—levels at which a water utility must take action (see Table 1).

All CWSs and NTNCWSs are required to monitor taps for lead and copper. The standard requires first-draw samples at taps in homes and buildings that are at high risk of lead and copper contamination. If an action level is exceeded in more than 10% of samples collected at customers' taps, further treatment is required. Systems must conduct monitoring every six months, unless they qualify for reduced monitoring. An EPA Quick Reference Guide helps clarify some of the Rule's complexities (EPA 2016c). Proposed revisions to the Lead and Copper Rule are expected to be released in 2017 (EPA 2015). The EPA released its Lead and Copper Rule Revisions White Paper in late October 2016, which contains a preview of the possible revisions (EPA 2016d).

Reduction of Lead in Drinking Water Act

In 2014, Congress enacted the Reduction of Lead in Drinking Water Act to reduce the allowable lead content of wetted surfaces in drinking water pipes, pipe fittings, and plumbing fixtures. The Act changed the definition of "lead free" from 8% to a weighted average of no more than 0.25% in the wetted surface material. It also established requirements for calculating lead content and created exemptions on certain plumbing products (EPA 2014).

Lead Service Lines and Galvanic Corrosion

Many lead service lines were installed across the United States from the early 1900s until they were banned in 1986. Water systems that are unable to reduce their

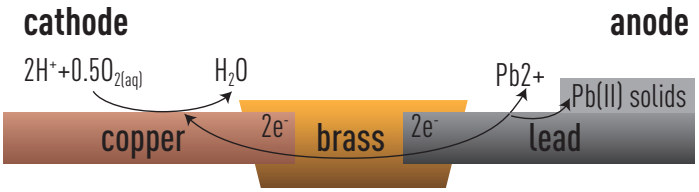
Table 1. Copper and lead regulatory framework

	Lead	Copper
Action Level (mg/L)	0.015 (based on treatment feasibility)	1.3 (based on health for prevention of nausea)
Maximum Contaminant Level	N/A	N/A
Maximum Contaminant Level Goal (mg/L)	0	1.3 (based on aesthetics or taste and staining)
Secondary Maximum Contaminant Level (mg/L)	N/A	1.0

Source: EPA 2008

lead levels after implementing various treatment techniques are required to replace at least 7% of lead service lines in their distribution systems annually.

A utility is not required to replace sections of service lines that are privately owned (see Figure 1), which results in a Partial Lead Service Line Replacement that can cause galvanic corrosion to occur. Typically, lead pipe is replaced with copper pipe and the dissimilar metallic pipe materials are connected to restore drinking water service. This condition creates an electrochemical or galvanic cell, which can accelerate corrosion of the lead pipe via galvanic connection to copper (Welter et al. 2013).



Source: Welter et al. 2013

Figure 1. The chemistry of galvanic corrosion

Lead and Copper Corrosion Control

Lead and copper corrosion can vary significantly from one utility to the next, and even within the same distribution system. Water quality factors that can significantly affect lead and copper corrosion include pH, alkalinity, orthophosphate concentration, and disinfectant residual (Brown et al. 2013).

A WRF report, *Lead and Copper Corrosion*, was developed to help utilities navigate the complexities and control of lead and copper corrosion. It provides information on corrosion control effects, treatment process effects, specific water chemistry effects, and material effects on lead and copper release (WRF 2016).

References

Brown, R. A., N. E. McTigue, and D. A. Cornwell. 2013. "Strategies for Assessing Optimized Corrosion Control Treatment of Lead and Copper." *Jour. AWWA*, 105 (5): 62-75.

EPA (U.S. Environmental Protection Agency). 2008. Lead and Copper: A Quick Reference Guide. EPA 816-F-08-018. Washington, D.C.: EPA Office of Water. https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=60001N8P.txt.

———. 2014. "Lead." Accessed February 25, 2014. http://www2.epa.gov/lead.

———. 2015. Report of the Lead and Copper Rule Working Group to the National Drinking Water Advisory Council. Washington, D.C.: EPA. Accessed May 1, 2016. https://www.epa.gov/sites/production/files/2016-01/documents/ndwaclcrwgfinalreportaug2015.pdf.

———. 2016a. "Ground Water and Drinking Water: Basic Information about Lead in Drinking Water." Accessed May 1, 2016 https://www.epa.gov/your-drinking-water/basic-information-about-lead-drinking-water.

———. 2016b. "Copper." Accessed May 1, 2016. https://safewater.zendesk.com/hc/en-us/sections/202346427.

———. 2016c. "Drinking Water Requirements for States and Public Water Systems: Lead and Copper Rule." Accessed May 1, 2016. https://www.epa.gov/dwreginfo/lead-and-copper-rule.

———. 2016d. *Lead and Copper Rule Revisions White Paper*. Washington, D.C.: EPA Office of Water. https://www.epa.gov/sites/production/files/2016-10/documents/508_lcr_revisions_white_paper_final_10.26.16.pdf.

Welter, G., D., Giammar, Y. Wang, and A. Cantor. 2013. *Galvanic Corrosion Following Partial Lead Service Line Replacement*. Project #4349. Denver, Colo: Water Research Foundation.

Welter, G., D., Giammar, Y. Wang, and A. Cantor. 2013. *Galvanic Corrosion Following Partial Lead Service Line Replacement*. Project #4349. Denver, Colo: Water Research Foundation.

WRF (Water Research Foundation). 2016. *Lead and Copper Corrosion: An Overview of WRF Research*. Denver, Colo.: Water Research Foundation.

Last updated July 2017