Optimized Corrosion Control Treatment Primer

Background

Lead and copper enter drinking water primarily through plumbing materials, including water distribution systems and home plumbing. Lead can cause damage to the brain and kidneys, and can interfere with the production of red blood cells that carry oxygen to all parts of your body. The greatest risk of lead exposure is to infants, young children, and pregnant women. Scientists have linked the effects of lead on the brain with lowered IQ in children. Adults with kidney problems and high blood pressure can be affected by low levels of lead more than healthy adults. Lead is stored in the bones, and it can be released later in life. During pregnancy, the child receives lead from the mother's bones, which may affect brain development. Copper is an essential nutrient, and elevated levels of copper in drinking water has been shown to cause stomach and intestinal distress. Persons with Wilson's disease may be at a higher risk of health effects due to copper than the general public.

On June 7, 1991, EPA published a regulation to control lead and copper in drinking water. This regulation is known as the Lead and Copper Rule (LCR) and is comprised of four major components:

- corrosion control treatment;
- source water treatment;
- lead service line replacement; and
- public education.

This document focuses on the first component, which requires public water systems (PWSs) subject to the LCR to minimize lead and copper levels at consumers' taps by controlling corrosion in the distribution system. CCT can come in many forms, including the addition of chemicals (e.g. orthophosphates) to create a barrier between the pipes and the drinking water, or the modification of drinking water chemistry (such as ph and hardness) to inhibit the potential for corrosion.

One of the primary sources of lead and copper contamination in drinking water is associated with the corrosion of piping and solder. Corrosion (a chemical reaction causing the dissolution of a material into its environment) of pipes and solder in a distribution system can cause lead and copper concentrations to increase as the metals are leached into the water supply.

The LCR set action levels for lead and copper, 0.015 mg/L and 1.3 mg/L respectively. An action level is typically a contaminant concentration that, if exceeded in one or more samples (in the case of LCR more than 10% of customer taps sampled), requires a regulated entity to undertake additional actions to control corrosion. In the event that PWS exceeds the Action levels; a small (serving $\leq$ 3,300 people) or medium sized (serving between 3,301 and 50,000 people) PWS is required to optimize their corrosion control treatment (CCT) while insuring that the treatment does not cause the water system to violate any National Primary Drinking Water Regulations (NPDWRs).

The LCR specifies the steps that PWSs and Primacy Agencies must complete to demonstrate that PWSs have optimized their corrosion control treatment, and the amount of time allowed for the completion of each step. Under the current rule, the system's CCT steps consist of:

- Provide system CCT recommendation to the Primacy Agency

- Conduct a study of the recommended CCT[1]
- Install CCT
- Conduct follow up monitoring for two consecutive monitoring periods
- Conduct monitoring to comply with Optimal Water Quality parameters[2] (if set by the Primacy Agency)

Additionally all large PWSs not deemed to have "optimal corrosion control" as per 40 CFR 141.81(b)(2) and (b)(3) were required to optimize their corrosion control treatment as part of the existing Lead and Copper Rule. A summary of the system requirements and Primacy Agency decisions and associated deadlines under the current rule are provided in Exhibit 1 below.

In the existing regulations, if a PWS performs optimization of their CCT and still has exceedances of the action levels, the PWS may be required to replace lead service lines (pipes connecting the water distribution system to some homes) in order to limit the amount of contamination found in drinking water.

The PWS must also collect lead and copper samples to determine if there are significant levels of lead or copper in the water leaving the treatment plant to determine if treatment to remove any lead or copper is needed, and must provide public education material to consumers, health-care providers and other entities on lead health effects and measures that consumers can take to reduce their lead exposure.

OCCT Challenges/Issues

Since the promulgation of the Lead and Copper Rule, and the initial optimization of corrosion control, systems have faced the ongoing challenge of continuing to maintain optimal corrosion control while making necessary adjustments to treatment processes or system operations unrelated to corrosion control to comply with other NPDWRs.

Determining whether treatment is optimized can be challenging, given the variety among systems in their distribution system composition, water qualities and other circumstances. While some changes are well understood for their potential to adversely affect lead and copper levels, such as fluctuations or changes in pH or alkalinity, others are more complex and involve factors like the quantity and type of disinfectant used or the chemical composition of the protective scales within the lead service lines.

EPA is revisiting the CCT requirements to examine if additional study and treatment modifications can effectively reduce chronic Action Level exceedances in tap monitoring without requiring time consuming and costly lead service line replacements.

[1] PWSs are required to evaluate three options pH adjustment to limit the water ability to corrode the pipes, precipitation of calcium to create a barrier on the pipes, and corrosion inhibitor use (e.g. orthophosphates).

[2] Optimal Water Quality Parameters (OWQPs) are measurable indicators which help systems determine if they are maintaining optimal corrosion control treatment. Corrosion control treatment techniques are means specified in the rule, such as pH adjustment and the addition of corrosion inhibitors that promote the formation of insoluble scales that prevent lead and copper from leaching from pipes into the drinking water. Having proper OWQPs is the method by which EPA, States, and water systems know whether water characteristics are in the ideal range for their corrosion control methods.

EPA is considering including a system-wide assessment as part of the mandatory OCCT study requirements for systems with LSLs. In a system-wide assessment, a water system will evaluate the variability of water quality throughout the distribution system due to differences in source water quality within distinct hydraulic boundaries, different or variable residence times and multiple types of distribution system materials. This is intended to ensure the studies are comprehensive and that the proposed treatment addresses any existing or anticipated water quality, treatment or operational issues that may interfere with or limit the effectiveness of the corrosion control optimization or re-optimization.

Currently, PWSs often make CCT recommendations that are limited by compliance with other NPDWRs and/or wastewater considerations. These limitations may have lowered the upper bound pH values considered for optimal corrosion control or the upper bound on orthophosphate dose. A more holistic treatment assessment may result in a treatment strategy which changes treatment for other NPDWRs along with corrosion control in order to optimize corrosion control effectiveness. Under this approach, a higher pH and/or orthophosphate doses may be considered along with other potential treatment changes. This more extensive corrosion control evaluation would only be for systems with lead service lines.

Other potential revisions to the study elements could include:

- Revised treatment installation timelines
    - Some of the published treatment installation steps have obsolete dates and rigid deadlines which may limit or interfere with the ability of PWSs to coordinate with the State and to conduct proper treatment studies.
- Examining correlations between OWQP compliance and lead/copper levels
    - Some PWSs have demonstrated compliance with the OWQPs, but are still experiencing lead and/or copper AL exceedances.
- Revising the definition of optimal corrosion control
    - Optimal corrosion control is defined as "the corrosion control treatment that minimizes the lead and copper concentrations at users' taps…" however EPA has determined that below the AL for copper (1.3 mg/L) there are no known or anticipated adverse health effects. As such there is no public health benefit from requiring PWs to minimize copper levels further that the published AL
- Removal of the requirement for systems to study calcium hardness adjustment
    - Research has confirmed the most effective treatments for optimization of corrosion control are pH/alkalinity adjustment, and the use of orthophosphate.
- Including provisions for re-optimization of CCT prior to requiring lead service line replacement

Exhibit 1 Current Corrosion Control Treatment Steps

Requirement	Timetable for Completing Corrosion Control Treatment	
	Systems serving ≤ 50,000 people [1]	**Systems serving > 50,000[2]**
Step 1: System recommends type of treatment to be installed	6 months[3]	N/A (Part of corrosion control study)
Step 2: Primacy Agency decides whether study is required	12 months[3]	N/A (System must conduct study)
Step 3: System completes study	18 months after Primacy Agency decision to conduct study	July 1, 1994
Step 4: Primacy Agency determines type of treatment to be installed	1. **If study is required:** 6 months after study is completed 2. **If no study is required:** Serves ≤ 3,300: 24 months; Serves 3,301 - 50,000: 18 months[3]	January 1, 1995
Step 5: System installs treatment	24 months after Primacy Agency decision regarding type of treatment to be installed	January 1, 1997
Step 6: System conducts follow-up monitoring	12 months after treatment installation (2 consecutive 6-month periods)	January 1, 1998
Step 7: Primacy Agency designates OWQPs[4]	6 months after follow-up monitoring	July 1, 1998
Step 8: System conducts continued monitoring	The schedule based on whether an action level is exceeded and/or compliance with OWQP ranges or minimums	

Notes:

[1]Applies only to systems serving 50,000 or fewer with an Action Level exceedence.

[2]Applies to all systems serving > 50,000 people (except for systems with low lead and copper levels), regardless of whether they have an Action Level exceedence.

[3] Indicates the number of months *after the end of the monitoring period during which* the lead and/or copper action level was exceeded.

[4] Optimal water quality parameters (OWQPs), such as pH, alkalinity, calcium, and orthophosphate, are designated by the State based on the data that is provided by the system from the OCCT study and follow-up monitoring after treatment is installed. Once a PWS has optimized their treatment, the State specifies the operating ranges and minimum allowable values for these OWQPs to ensure that the treatment remains optimized. The Primacy Agency is not required to designate OWQPs for systems serving ≤ 50,000 that no longer exceed both ALs after installing treatment.