QUESTIONS REGARDING HOUSEHOLD WATER USE

Updated June 2013

Q: **Does the water chemistry (pH, mineral content) change as a result of chloramine addition?**

A: Chloramination, as practiced by the SFPUC, does not affect pH or mineral content.

Q: **Why aren't tap water and bottled water monitored by the same agency? Is bottled water better than tap water?**

A: Soft drinks and bottled water are monitored by the federal Food and Drug Administration (FDA) and the California Department of Public Health (CDPH). Tap water is regulated by the USEPA and the CDPH. The act of bottling the water legally makes the water a packaged product, and legally these are all regulated by the FDA, rather than the USEPA and the CDPH. The FDA and USEPA standards can differ and the USEPA regulations and the testing requirements are more stringent than those required of the bottled water by the FDA. Bottled water is oftentimes tap water that has been passed through additional filtration, GAC adsorption, and disinfection steps. However, this does not mean that bottled water is necessarily better than tap water.

50 million empty water bottles are thrown away or recycled every day in America (Morris, 2007), which equals over 18 billion water bottles annually. The manufacture of a single bottle requires more water than the bottle will ultimately hold. The transport of these bottles over hundreds or even thousands of miles adds to the disproportionate ecological impact of bottled water. Many brands of bottled water are superior to tap water and can offer a valuable alternative, particularly when traveling or after a disaster (e.g., earthquake). But economically, environmentally, and in many cases even with respect to disease prevention, they fall short as a replacement for tap water (Morris, 2007). Many plastic water bottles end up in landfills and in the oceans where biodegradation may literally take thousands years contributing to environmental pollution and degradation. SFPUC has designed, built and operates a very efficient water conveyance system, which additionally produces hydroelectric power.

Q: **How much bleach should be added to water for emergency storage? How long to keep water in a closed container as part of earthquake preparedness?**

A: Emergency preparedness recommendations are to store an appropriate amount of tap water (as specified by the emergency preparedness brochure) in plastic, airtight, clean containers in a dark cool place. Tap water may be stored without bleach addition and kept for up to six months before it should be replaced. At the time of usage 16 drops of bleach should be added to each gallon of water. The water should be mixed and left to stand for 30 minutes prior to use. In case chlorine odor is objectionable, lemon, lime, or orange juice or fruit (all of which remove chlorine) may be used to improve flavor after allowing 30 minutes for disinfection.

Q: **According to labels for household products, mixing bleach and ammonia is dangerous. Why is it safe for drinking water?**

A: Levels of ammonia and chlorine in household products are extremely concentrated (i.e., several orders of magnitude higher than in tap water). It is always dangerous to mix concentrated chemicals together because proportions of the chemicals and the conditions of chemical reactions cannot be controlled in a household setting. Many side reactions can occur when mixing concentrated household cleaning products and irritants may be formed in these side reactions. That is why these products are clearly labeled with warnings. Conversely, trained and licensed operators carefully add chlorine and ammonia sequentially into the large volumes of continually flowing water at a treatment plant so that the chemical concentrations at the point of mixing are already low and stable. Dissolution of chemicals and formation of chloramine is almost instantaneous and easy to control using on-line instrumentation. Water delivered to customers has chlorine concentrations of 2.3 mg/L Cl_2 (parts per million), and total ammonia 0.5 mg/L NH_3-N to ensure slight excess of ammonia to stabilize monochloramine. These are current SFPUC chlorine and ammonia target levels, which may change depending on the operational needs.

Q: **Can one be exposed to chlorine disinfectants in public swimming pools?**

A: Yes, one can be exposed to irritants in swimming pools. Dichloramine and trichloramine may be present in swimming pools where chloramine needs to be converted back to chlorine to provide a stronger biocide necessary for water in contact with multiple bathers.

Chlorine is a stronger disinfectant than chloramine, especially at lower pH. Pool water differs from drinking water because it receives a great many nitrogen compounds in the form of perspiration and urine. From these materials, urea is hydrolyzed to form ammonia. Pool may exhibit chlorine odors and users may experience stinging of the eyes especially in indoor pools and at the water surface. The chlorine odor and eye stinging are often attributed to overchlorination. In actuality, chlorine odor in pools is a symptom of inadequate chlorine addition and/or improper pH control (Connell, 1997). The proper course of action is to increase the chlorine feed rate and chlorine dose, and to operate the pool in the chlorine residual range. A recent study of indoor and outdoor recreational swimming pools did not detect monochloramine (the distribution system disinfectant used by SFPUC) in samples from laboratory experiments or swimming pools (Li and Blatchley, 2007).

Current research supports the relationship between exposure to trichloramine in indoor swimming pools and adverse effects such as asthma and upper respiratory tract irritation in recreational swimmers, lifeguards and pool attendants.(Li and Blatchley, 2007; White, 1999; Bernard et al., 2003; Thickett et al., 2002), The exposure of bathers to chlorine compounds in public swimming pools can usually be minimized by proper pool maintenance, although additional treatment may be necessary (Li and Blatchley, 2007). Proper ventilation at indoor pools, pH between 7.2 and 7.5, and sufficient chlorine dose minimizes this exposure. Showering before entering the pool reduces the input of contaminants in public pools. In addition, some pools use more expensive disinfection processes such as ozone or UV to reduce exposure to irritants altogether. (CDC, 2013)

Q: **Can one be exposed to chlorine disinfectants in the home shower or bath?**

A: Exposures via respiration do not occur from bathing or showering with chloraminated drinking water. Under the slightly alkaline pH conditions typical for drinking water systems, neither chlorine nor chloramine present in drinking water at low concentrations should be appreciably lost to the air from the water in the shower or bath. Showering with chloraminated water poses little risk because monochloramine does not easily enter the air. (USEPA, 2009)

Chloramine is completely dissolved in the water and chlorine would be primarily in its dissolved ionized form of hypochlorite ion. Neither chlorine nor chloramine is highly volatile under these conditions even in hot water. Tests conducted by SFPUC in chloraminated bath and shower water at moderate bathing temperature (100 degree F, 38 degree C) indicate a loss of total chlorine of only 3% in the bath to 6% in the shower. This is consistent with expected results for monochloramine. In cold water (67 degree F, 20 degree C), the loss of chloramine in the shower or bath was within the measurement error (i.e., insignificant). Conversely, the loss of chlorine in similar tests was 12 – 18%, at water temperatures between 65 and 105 degree F. In very hot water directly from the heater at 135 degree F, 100% chlorine was lost in the shower versus only 14% chloramine. Monochloramine is much less volatile, as compared with dichloramine, trichloramine or chlorine. Dichloramine is somewhat volatile (20%) but cannot form under typical conditions in the distribution system. Trichloramine is 100% volatile but cannot form in the chloraminated drinking water in the absence of chlorine (White, 1999). Other reactions may be taking place when water is exposed to air in the shower; for example, reactions with oxygen in the air could be responsible for measured differences.

Chloramination is expected to reduce an overall exposure of the bathers to residual chlorine from the water in home bathrooms, as compared with chlorinated distribution systems. Chloramination is also effective in controlling the formation of volatile trihalomethanes (THMs) such as chloroform, a chlorination by-product. People may get significant inhalation exposure to THMs when showering in water with high concentrations of chloroform (Backer et al., 2007). Chloroform concentrations in San Francisco’s water were reduced at least 50% as a result of chloramination.

Water at home contains relatively low concentrations of the disinfectants. Any concerns about exposure can be further minimized by increasing ventilation in the bathroom (e.g., opening a window in the bathroom), taking a bath instead of a shower (less contact between water and air), and reducing water temperature (i.e., taking a warm shower or bath instead of using hot water).

Q: **Is there a Material Safety Data Sheet for chloramine?**

A: There is no Material Safety Data Sheet (MSDS) for chloramine because chloramine is not sold commercially and is not available in a concentrated form either as a liquid or solid. In the SFPUC system, chloramine is generated on-site from chlorine and ammonia; therefore SFPUC does not need to have an MSDS for chloramine but does have the MSDS for chlorine and ammonia, as these are the materials that employees handle. SFPUC currently adds 2.3 mg/L of chlorine and 0.5 mg/L of ammonia to form a target chloramine residual of 2.3 mg/L. To put the MSDS information in its proper context, the maximum levels for these chemicals in the drinking water will likely not exceed 4 mg/L for chlorine and 1 mg/L for ammonia. The concentration of chlorine that employees work with is about 13% or 163,000 mg/L, and for ammonia is about 19.0% or 176,000 mg/L.

Information contained on MSDS sheets should be interpreted in context. The US Occupational Safety and Health Administration (OSHA) requires companies to provide an MSDS if they use a material in their workplace. The MSDS is aimed at protecting workers from acute exposure to concentrated chemicals, and has little relevance for drinking water consumers. In addition, there is very little oversight in the quality of data contained in an MSDS and the mere existence of an MSDS does not imply high quality of information. Customers have sometimes brought up an MSDS for chloramine-T, which comes up in Internet searches for chloramine. Chloramine-T is sold commercially, but it is an antiseptic with a different chemical formula of (sodium p-toluenesulfonchloramine), and it is not used for drinking water disinfection.

Q: **Can chloramine promote the growth of bacteria in home point of use devices?**

A: Regrowth of bacteria in *well-maintained* point-of-use devices (POUD) should not be a concern within the SFPUC service area.

The regrowth of bacteria in customers' plumbing is controlled if there is adequate disinfectant residual (no stagnation and proper maintenance of point of use devices). Based on the review of SFPUC water quality data, chloramine disinfectant residuals are more stable in the San Francisco water system than chlorine and chloramine better controls regrowth of coliform and heterotrophic plate count (HPC) bacteria in the distribution system than chlorine. The study of *Legionella* occurrence in SFWS conducted by the Centers of Disease Control and Prevention (CDC), SFPUC, SF Department of Public Health, California Department of Public Health and the California Emerging Infections Program reported by Flannery et al. (2006) showed that chloramine virtually eliminated *Legionella* in large buildings in San Francisco.

Strickhouser et al. (2006) evaluated the regrowth of *Legionella pneumofila* and *Mycobacterium avium* under conditions of increased temperature of 37 degree C simulating the conditions of the water heaters. The samples were spiked with domestic water heater water and outdoor pond water. No regrowth of bacteria was detected for samples with chlorine above 0.25 mg/L and chloramine above 0.4 mg/L. The regrowth of bacteria occurred in samples without the disinfectant and especially for samples with the high levels of free ammonia (1 mg/L), simulating the conditions of stagnant water with no disinfectant residual.

The Surface Water Treatment Rule (SWTR, USEPA 1989a) specifies a minimum disinfectant residual of 0.2 mg/L for chlorine and 0.4 mg/L for chloramine in the distribution system. These disinfectant concentrations may control bacterial growth in the bulk water but may be inadequate to control biofilm bacterial growth. There is evidence that a chloramine residual can exert better control of biofilm bacterial growth than does chlorine (Flannery et al, 2006). Maintaining an adequate disinfectant residual limits the extent of development of a biofilm, but the disinfectant residual necessary to do so varies with changes in source water quality and with the performance of treatment processes in removing particulates, nutrients, and microorganisms. Maximum biofilm bacterial densities occur when disinfectant residual is low or nonexistent, whereas lower biofilm densities occur when disinfectant residuals in the bulk water are maintained within 1.6 to 1.8 mg/L (AWWA, 2006c). SFPUC maintains chloramine disinfectant in San Francisco Water System storage reservoirs between 1.5 and 2.3 mg/L. Typical levels of free ammonia in the SFPUC distribution system are less than 0.1 mg/L N. Given these results, regrowth of bacteria in well-maintained point-of-use devices (POUD) should not be a concern within the SFPUC service area.