Boil Water Response - Information for the Public Health Professional

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Boil Water Orders and Notices are often used by health agencies and drinking water utilities in response to conditions that create a potential for biological contamination in drinking water. Common reasons for a boil water response include loss of pressure in the distribution system, loss of disinfection and other unexpected water quality problems. Often these result from other events such as water line breaks, treatment disruptions, power outages, floods and other severe weather.

The standard recommendation for boiling water is a **FULL ROLLING BOIL** for **ONE MINUTE** and **COOL BEFORE USE**. The term rolling boil facilitates communication and assures that an effective pasteurization temperature is reached to kill or inactivate waterborne pathogens. Some agencies recommend boiling for longer periods, but this extra time is not necessary and can cause unnecessary power demand and increase safety concerns.

Because some users (e.g. immunocompromised individuals) may be more susceptible to illness from water borne pathogens, public health officials need to react swiftly to address potential water quality problems. However, public health officials must also be conscious of unnecessarily alarming the public, causing undue economic disruption, and eroding the public perception of safe tap water. Whenever possible, alternate methods to address water quality concerns, such as isolating problem water and opening interconnections with neighboring systems, should be used to avoid unnecessary boil water responses. More specific directions on these steps and when a boil water response may be necessary are provided in Department guidance and regulations.

A boil water response is NOT appropriate when chemical contamination is present. This may increase exposure to chemicals such as nitrates and solvents by concentration in the boiled water or by volatilization into the breathing zone. Boiling water is also NOT appropriate to address gross levels of contamination (e.g. raw sewage or high turbidity) when particulate matter can impair the effectiveness of boiling. Under these conditions, alternate water sources must be used.

WATERBORNE PATHOGENS

There are many disease causing organisms that consumers could be exposed to through ingestion and contact with contaminated drinking water. The more common pathogens that can be found in drinking water are as follows:

Protozoa: Protozoa are microorganisms that can live in animals, people and the environment. Many protozoa have life cycle stages that include cysts and oocysts. The cysts and oocysts are generally resistant to normal residual chlorine levels, but are more readily deactivated by ultraviolet (UV) disinfection. Most protozoa, including cyst and oocyst stages, will be removed by water filtration devices capable of removing 1 micron particles (i.e. microfiltration). In New York State, diseases caused by species of *Giardia, Cryptosporidium,* and amoebae must be reported to the NYSDOH.

Bacteria: Bacteria are usually killed by normal chlorine residual levels. Most bacteria will be removed by microfiltration ("<"1 micron) and most will be effectively deactivated by ultraviolet (UV) disinfection, although some species may require increased UV doses. Bacterial spores can be resistant to normal chlorine disinfectant levels and some are resistant to UV. Small bacteria and spores may pass through filters at the microfiltration level. Bacteria that can cause waterborne illness include *Escherichia coli;* and species of *Salmonella, Vibrio, Shigella,* and *Camphylobacter*.

Viruses: Viruses are rapidly inactivated by normal chlorine residual levels. But their small size, typically less than 0.01 microns, allows viruses to pass through 1 micron filters. In addition, some viruses are resistant to inactivation by exposure to UV light. Hence, ordinary water filtration and UV disinfection may not provide adequate viral treatment and viruses are usually controlled with chemical disinfection. Viruses that can cause waterborne illnesses include: *Hepatitis* A,Adenoviruses, *Hepatitis* E, Enteroviruses (including Polio-, Echo and Coxsackie viruses), Rotaviruses, and Caliciviruses.

BOILING AND PASTEURIZATION

Boiling water kills or inactivates viruses, bacteria, protozoa and other pathogens by using heat to damage structural components and disrupt essential life processes (e.g. denature proteins). Boiling is not sterilization and is more accurately characterized as pasteurization. Sterilization kills all the organisms present, while pasteurization kills those organisms that can cause harm to humans. Cooking food is also a form of pasteurization. For pasteurization to be effective, water or food must be heated to at least the pasteurization temperature for the organisms of concern and held at that temperature for a prescribed interval.

The effectiveness of pasteurization is directly related to temperature and time. Milk is commonly pasteurized at 149°F/65°C for 30 seconds, or 280°F/138°C for at least two seconds. A study of the effectiveness of pasteurization of milk intentionally contaminated with *Cryptosporidium* found that five seconds of heating at 161°F/72°C rendered the oocysts non-infectious.

Although, some bacterial spores not typically associated with water borne disease are capable of surviving boiling conditions (e.g. clostridium and bacillus spores), research shows that water borne pathogens are inactivated or killed at temperatures below boiling (212°F or 100°C). In water, pasteurization is reported to begin at temperatures as low as 131°F/55°C for protozoan cysts. Similarly, it is reported that one minute of heating to 162°/72°C and two minutes of heating at 144°/62°C will render Cryptosporidium oocysts non-infectious. Other studies report that water pasteurized at 150°F/65°C for 20 minutes will kill or inactivate those organisms that can cause harm to humans. These include: *Giardia, Cryptosporidium, Endameba,* the eggs of worms, *Vibrio cholera, Shigella, Salmonella* bacteria, those that cause typhoid, the enterotoxogenic strains of *E. coli, Hepatitis* A and rotaviruses. It is also reported that a 99.999% kill of water borne microorganisms can be achieved at 149°F/65°C in five minutes of exposure.

Water will boil at different temperatures under different conditions (e.g. lower temperatures at higher elevations, higher temperatures in pressure vessels), however these differences are not a significant factor for boil water responses. Water in an open vessel will boil at about 212°F/100°C in New York. Even on the top of Mt. Marcy, NY where the elevation is more than one mile above sea level, water boils at about 203°F/95°C and is adequate for disinfecting water.

CHEMICAL DISINFECTION

In cases where boiling water is not possible or practical and alternate water sources are not available, chemical disinfection may be a viable substitute. Chemical disinfection may be appropriate when boiling is not possible due to power outages, and is also an appropriate way to prepare water for non-ingestion uses such as washing dishes and personal hygiene. However, chemical disinfection by itself may not be as effective as boiling for pathogen control as some protozoans, such as *Cryptosporidium* in the cyst form, are resistant to both chlorine and iodine based disinfectants.

Chemical disinfection should not be relied on to produce water for ingestion when gross levels of contamination or high levels of protozoans or turbidity may be present (e.g. raw sewage contamination). Under these conditions, alternate sources must be used for any water to be ingested or used in food preparation.

Some chemical disinfectants are readily available as household chemicals (e.g. regular unscented chlorine bleach) or by purchase from pharmacies and outdoor stores (e.g. iodine tincture). Chemical disinfection can be accomplished on site by adding a specific amount of chemical to each gallon of questionable water and allowing the water to sit for a sufficient contact period before use. If the water is very cold, it should be warmed first or the contact time should be increased. To help reduce the taste and smell of chemical disinfectants, water can be aerated after the contact time is reached by pouring it back and forth between a pair of clean containers.

Disinfection methods using ordinary household chemicals can be found at Disinfecting Tap Water. Disinfection with bleach should use regular, unscented bleach. Bleach that is scented, splash free or splash less should not be used due to additives in the bleach. Additionally, Clorox regular unscented bleach is certified in conformance with National Sanitation Foundation (NSF) Standard 60, which regulates the quality and purity of chemicals used for drinking water applications.

WATER TREATMENT DEVICES

Many water treatment devices are available for use in homes and commercial buildings, but few of them can be considered effective for pathogen removal. Many of these devices will have little or no effect on pathogens. An improperly maintained or ignored treatment device may actually add biological contamination to the water that passes through it.

It is impractical to assess all of the treatment systems available, due to the sheer number available on the market and the proprietary nature of some of the processes. The following information is provided as a general overview for the public health professional.

Point-of-use treatment units are manufactured and installed to treat water for use at a single location. Typical of point-of-use units are kitchen devices that treat only the water that comes out of the kitchen tap or water supplied to a nearby ice maker. There are also hand held treatment units such as water pitchers with a small integral filtration or carbon unit. Point-of-use devices installed in the kitchen will have no effect on potential exposures to water contaminants from bathroom sinks, showers, outside faucets, etc.. Often treatment systems are installed on part of a buildings plumbing, e.g. water softener on the hot water side, and these too are considered point-of-use. Specific types of treatment are discussed below.

Point-of-entry treatment units are applied where water enters a home or commercial building and are installed to treat all of the water used at that location. Specific types of treatment are discussed below.

Water Softeners & Ion Exchange Units - Water softeners and other ion exchange devices are not effective for removing pathogens and should never be used as a substitute for disinfection by boiling.

Carbon Treatment Units - Carbon treatment provides effective removal of many chemicals, but is not effective for removing pathogens and should not be used as a substitute for disinfection by boiling. Improperly maintained carbon units in particular can actually increase the biological contamination in water that passes through it.

Aerators - Aeration and oxidation units are often found in homes to treat water that has objectionable taste and odors, like sulfur compounds and chlorine, and to control nuisance minerals such as iron and manganese. Aerators are also used to remove radon. These provide no pathogen control and should never be used as a substitute for disinfection by boiling.

Green Sand Filtration - Green sand units are chemical treatment devices designed to remove inorganic chemicals by oxidation. Though these units are called "filters" and have a sand media, they cannot be relied on to remove pathogens and should never be used as a substitute for disinfection by boiling.

Physical / Mechanical Filtration - Physical filtration can be capable of effective pathogen removal and is used widely by water utilities for this purpose. Reverse osmosis is a form of filtration that uses specialized membranes and is addressed below.

Many water filtration devices are marketed for home and commercial building use. Most of the available filter units use replaceable filter cartridges or bags, and some use membranes. The ability of a filter to remove pathogens is directly related to the size of the pores in the filter material, the quality of the unit, and the operation and maintenance of the unit. Filters rated for removal of particles that are one micron (a.k.a. micrometer, or 10-6 meter) or less in diameter are often referred to as microfilters. Filters of this size can remove the majority of water borne pathogens (protozoans and most bacteria), however, viruses are much smaller than one micron and may not be adequately removed by microfilter units.

Public water systems that utilize cartridge filters in New York State, use cartridges that are rated for one micron absolute by a third party vendor and often utilize a chlorine disinfectant to inactivate viruses. The absolute rating means the filter removes 99.99% of the particulates for the rated size, and certification by a third party vendor (e.g. NSF, WQA or UL) to this level of performance increases the certainty of the performance, as well as the quality of the equipment and materials. Nominally rated cartridges, or other rating criteria provided by manufacturers vary from each manufacturer and often do not meet this standard.

Reverse Osmosis - Reverse Osmosis (RO) is a form of filtration that works by forcing water under pressure through a specialized membrane. The pores in the membranes are sized so that water molecules pass though, but all particulates as well as larger molecules are removed. This type of filter is often rated by molecular size rather than by microns. A RO unit is capable of removing all waterborne pathogens and could be considered an acceptable substitute for disinfection by boiling if it is certified under ANSI/NSF standard 058 for "Cyst Removal", and it is under the control and operation of a certified water treatment plant operator or qualified nephrology technician (i.e. dialysis technician). However, because RO units are prone to fouling if turbidity levels are elevated, continuous operation during a boil water event may be difficult to accomplish without appropriate pretreatment.

It should be noted that most RO units are also equipped with carbon pre-filters to protect the membranes from chlorine and large particulate.

ADVANCE PREPARATION

Advance preparation is key to effectively implementing a boil water response as a public health protection measure. To assist with this, the Bureau of Water Supply Protection has prepared a series of checklists and Frequently Asked Questions (FAQs) that address issues that arise when boil water events occur. These documents were prepared for different target audiences and should be used by public health staff to answer questions and as informational handouts for the public. Some water customers will have issues that are addressed in more than one of these FAQs (e.g. hospitals that are also food service establishments).

Other advanced preparation items that can help both utilities and public health professionals ensure effective implementation of a boil water response include:

- Accurate identification and mapping of service areas
- Pre-identification of critical users (e.g. hospitals, schools, daycare centers, nursing homes/assisted living facilities, medical offices)
- Contact information for critical users (valid for off hours/24 hours a day)
- Contact information for public media (radio, newspaper, television)
- Water system emergency contacts (valid for off hours/24 hours a day)
- Up to date water supply emergency response plans
- Contact information for certified bulk haulers in the area

ALTERNATE WATER SOURCES

Boiling is the most reliable method the public can use to disinfect their drinking water and should be the first option for on-site disinfection. However, it may not always be possible or practical to boil water. Power outages may leave consumers unable to boil, and boiling may not be practical to meet some water needs. If needs are critical and cannot be discontinued, alternate water sources or other disinfection methods may be necessary. Generally, water used by the public for drinking and food preparation during a boil water event should be obtained in the following order of preference, depending on the scope of the affected area and incident specific conditions:

- Boiled (and then cooled) tap water
- Bottled water (certified for distribution in NY)
- Alternate public water supply (water from another public water supply that is not operating under a boil water notice)
- Bulk water arranged by a water utility or emergency agency
- Water chemically disinfected on-site

Roadside springs are not a sure source of safe drinking water, since they are seldom monitored and no one is in charge of keeping them safe. Roadside spring water that is used for drinking or food preparation should be boiled (and then cooled) before use.

Chemical disinfection is limited in effectiveness and is not appropriate for very turbid (muddy) water, or where raw sewage or other fecal matter may be present. In this case only use an alternate source of water. Chemical disinfection is discussed in greater detail in a previous section.

RECOVERY

When a boil water response has ended, recovery actions needed at consumer locations are often overlooked. Contaminated water may remain in plumbing lines, tanks, ice makers, and other equipment and can sicken consumers. Information should be provided to consumers to inform them of the need to flush and/or disinfect pipes, tanks and equipment. No single set of recommendations for flushing or disinfection can apply to all users, however, checklists and fact sheets are available from the Department to help consumers implement the final protective steps needed to assure the return to potable water.

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