RETURNING BUILDING WATER SYSTEMS TO SERVICE

TIP NO. 98-114-0420

PURPOSE

This document provides guidance on returning water systems to service in buildings that have been abandoned, vacated, or shut down for a prolonged period of time. When a water system is not in use, the water quality degrades; water becomes stagnant, disinfectant concentrations plummet, harmful disinfection byproduct concentrations increase, and pathogen and biofilm populations proliferate. Prior to reoccupying a building, it is necessary to take steps to ensure that the water is safe for the building's occupants.

REFERENCES

See Appendix A for a complete list of references.

APPLICABILITY

This information is intended for buildings located on military installations that have been abandoned, vacated, or shut down for a prolonged period of time. However, the guidance is appropriate for any building water system, independent of location, which has been out-of-service for a prolonged period of time.

BACKGROUND

Successful restoration of a building's water system will ensure the safety of the water within the building. Stagnant water remaining in the pipes of unoccupied buildings will likely be nonpotable and unpalatable (cloudy and discolored); the water will contain waterborne pathogens, such as nonfecal coliforms, nontuberculous mycobacteria, and other gram-negative bacteria that can cause infection and illness to humans. A bacteria of significant concern in hospital settings is *Legionella,* which can cause Legionnaires' disease. Legionnaires' disease can result in severe pneumonia requiring hospitalization with a case-fatality rate of 10% for community acquired cases; the case-fatality rate rises to 25% for nosocomial acquired cases. Nosocomial infections are those acquired during a stay at a hospital. Risk factors for nosocomial pneumonia include: recent surgery, intubation and mechanical ventilation, aspiration, and use of respiratory therapy equipment.

Legionella is commonly present in natural bodies of water. Certain environmental conditions within a building's water system, such as water temperatures within a specific range (25–42°C [77–108°F]), sediment in water tanks or pipes, and scale or biofilm present in pipes, allow for the amplification of *Legionella* populations. *Legionella* is transmitted to humans via aerosolized water or when contaminated water is aspirated (water is breathed into the lungs). In general, any water fixture or piece of medical equipment that aerosolizes water or produces a spray has the potential to transmit *Legionella* to humans. Outbreaks of Legionnaires' disease have been attributed to cooling towers, potable hot water systems (showers and faucets), decorative fountains, whirlpool hot tubs, humidifiers, and ice machines.

PLANNING

Returning a building water system to service requires a team effort by different entities on the installation. It is important to designate someone to manage and coordinate the effort, which includes flushing water mains, disinfecting and flushing the building water system, and testing water quality. Regardless of who manages the effort, the installation's Public Health (PH) personnel need to coordinate with Directorate of Public Works (DPW) personnel. If there is an operational medical treatment facility on the installation, then PH also needs to coordinate with Infection Control personnel.

FLUSHING EXTERNAL WATER MAINS

Flushing external water mains is necessary prior to initiating disinfection procedures within the building because it ensures that water of optimal quality will be used when the building water system is restarted. Flush fire hydrants within an appropriate radius (sequentially from those closest to the water supply source to those hydrants located further down the line) to ensure fresh water is present in the water mains servicing the building. The installation's DPW is typically responsible for conducting routine flushing operations and should conduct emergency or special flushing operations as well.

WATER SYSTEM COMPONENTS

Prior to placing the building's water system back in use, it is necessary to inspect certain components of the system to ensure that they are working properly. Many components of the system will also require cleaning and disinfection. For disinfection procedures, use of an U.S. Environmental Protection Agency (EPA)-registered disinfectant is preferred; otherwise, use a bleach solution with one-third cup of bleach per gallon of water. Components of the water system that require inspecting, cleaning, and/or disinfection are listed below.

Backflow Prevention Devices. DPW or facilities maintenance personnel should inspect backflow prevention devices and regular flow valves to ensure they are working properly and are not leaking.

Water Treatment Systems. If water treatment occurs within the building, ensure that treatment systems are cleaned and/or maintained properly. Examples of maintenance procedures may include: replacing pretreatment filters and water softener chemicals, backwashing carbon tanks, or cleaning and disinfecting reverse osmosis membranes.

Water Storage Tanks. Thoroughly drain, clean, and disinfect all water storage tanks. Once hot water tanks are cleaned and disinfected, maintain domestic hot water at a minimum of 60°C (140°F) to ensure delivery of hot water at a minimum of 50°C (122°F) to all outlets. If there is a hot water recirculation loop, ensure that pipes are insulated. Water returned to the water tank via recirculation should also be 50°C. Cold water should be stored below 20°C (68°F).

Fixtures. Clean and disinfect all faucets and shower heads. If aerators are present in the fixtures, remove and disinfect all faucets and shower heads.

Ice Machines and Drinking Fountains. Clean, disinfect, and replace filters in ice machines and drinking fountains.

Point of Use Filters. Replace point-of-use filters.

Decorative Fountains. Drain and clean decorative fountains.

Cooling Towers. Cooling towers have been implicated in many outbreaks of Legionnaires' disease, and studies have shown that detectable levels of *Legionella* are present in most devices. The following procedures must be followed when restarting these systems:

- Drain the system.
- Clean and disinfect the entire system. Hold chlorine residual at 4–5 milligrams per liter (mg/L) at a pH of 7.0 to 7.6 for 6 hours.
- Inspect the drift eliminators, and clean and replace as needed.
- Treat the water within the system to minimize microbial growth, corrosion, scale, and sediment. Consider alternating between two biocides to avoid the growth of resistant strains of microbes.

Special Considerations for Medical Facilities. If the building is or is going to be temporarily used as a medical facility, consider additional precautions to protect patient populations.

- **Fixtures.** Consider permanently removing aerators in high-risk patient areas; otherwise, clean and disinfect the aerators monthly. If needed, install preset thermostatic mixing valves to avoid scalding at point of use; ensure that the warm water section of pipe between the control valve and showerhead is self-draining.
- **Decorative Fountains, Hot Tubs, and Therapy Pools.** Do not place decorative fountains back in use as the health risks to patients outweigh the aesthetic benefits associated with these fixtures. Only place hot tubs and/or therapy pools back in use if they are essential to patient care.

INTERIOR PIPE DISINFECTION

The DPW or facilities maintenance personnel must flush stagnant water from the building and then disinfect the potable water system. The two commonly used emergency decontamination methods are thermal disinfection (superheating) and shock chlorination. There are pros and cons to each method, which are noted in the procedures for each method. Based on recent guidance documents, shock chlorination is the preferred approach; however, characteristics of the building and the capability of personnel also need to be considered. Regardless of the disinfection method used, it is important to flush every outlet (even rarely used fixtures such as emergency showers and eye washes) in a sequential manner until water of adequate temperature or chlorine concentration is flowing. Following disinfection (whether it is via

superheating or shock chlorination), implement a flushing program whereby all fixtures not regularly used are flushed for 5 minutes twice a week. Note that flushing needs to occur if there is a lag between disinfection and building occupancy.

Thermal Disinfection. This disinfection method entails increasing the building hot water temperature to 65°C (149°F), distributing it to all fixtures, and then flushing the system for an appropriate period of time (between 10 and 30 minutes). While this method does not require special equipment or supplies, it is labor-intensive and time consuming. It is important to note that this method is only effective when the most distant outlets receive water that is hot enough throughout the entire flushing process, which necessitates sufficient hot water heating capacity. Also, thermal disinfection will not disinfect downstream of thermostatic mixer valves. Procedures for conducting thermal disinfection effectively and safely are summarized below:

- Maintain water heater temperatures between 71 and 77°C (160–170°F) while progressively flushing each outlet in the system for up to 30 minutes at 65°C (149°F), ensuring that the most distant outlets are flushed last.

- If flushing multiple outlets simultaneously, ensure that the temperature and flow capacity of the water heater is not exceeded.

- Following thermal disinfection, maintain hot water system temperatures >60°C (140°F) in all hot water lines and maintain an adequate concentration of disinfectant residual (0.2–0.5 mg/L).

- After the water temperature has returned to normal, collect water samples from multiple locations, including the most distant outlets, and test water quality. Repeat the sampling procedure approximately 2 weeks later to determine if short-term control has been achieved.

Shock Chlorination. Shock chlorination entails injecting elevated concentrations of chlorine into the building's water system to achieve 2–3 mg/L of free chlorine throughout the system with a contact time between 2 and 24 hours. This method may be the only option for buildings where the most distant outlets cannot reach the temperature required for thermal disinfection. Shock chlorination can lead to increased corrosion of metal pipes or fixtures if applied incorrectly or too frequently. The efficacy of chlorine can be decreased by pH >7, with significant loss of effectiveness at pH >8. Also, use caution when exercising this method to avoid exposure to high disinfectant levels. Procedures for conducting shock chlorination effectively and safely are summarized below:

- If possible, shut off and bypass water treatment equipment (e.g., water softeners, carbon filters).

- Correct areas that may allow *Legionella* growth (e.g., sediment in tanks, stagnant water, or rubber fixtures and fittings).

- Add enough chlorine to achieve a free chlorine residual between 2–3 mg/L throughout the system, which may require chlorination of the water heater or tank to levels between 20 and 50 mg/L. Maintain the water pH between 7.0 and 8.0.

- Flush each outlet until the odor of chlorine is detected.

- Allow the chlorine to remain in the system for a minimum of 2 hours (but not to exceed 24 hours).

- Flush the system until the residual chlorine is returned to its normal level (typically between 0.2 and 0.5 mg/L).

- After the residual chlorine concentration has returned to normal, collect water samples from multiple locations, including the most distant outlets, and test water quality. Repeat the sampling procedure approximately 2 weeks later to determine if short-term control has been achieved.

- Inspect and monitor the plumbing system for pipe damage.

TESTING WATER QUALITY

Following system disinfection and flushing, collect samples to check the water quality. Test for temperature, pH, free chlorine, and any other desired parameters. Also, test for the presence of total coliforms and *E. coli* to determine if the water is sanitary for consumption. The PH personnel should also implement heterotrophic plate count (HPC) testing on each floor of the building when the building is reoccupied. Although HPC tests are not an indicator of health risk, they are used to measure the variety of bacteria common in the water and can show where microbial regrowth is occurring within a distribution system. The PH and infection control personnel should also consider testing for *Legionella* if the building will be used to house an immunocompromised population.

TIMEFRAME

A minimum of 4 days will be required to return the building water system to service prior to reoccupation. It will likely take longer to flush the pipes as well as clean and disinfect all the fixtures in larger buildings with more complex water systems. A sample timeline is shown below and additional considerations that may increase the timeframe follow.

- Day 1: Flush water mains via hydrant flushing.

- Day 2: Clean and disinfect all fixtures and other equipment as appropriate. Disinfect the water supply via shock chlorination or thermal disinfection.

- Day 3: If applicable, verify that chlorine residuals have decreased to normal levels (0.5 ppm), and collect water samples for coliform testing (minimum 22-hour incubation time).

- Day 4: Obtain, read, and report coliform test results.

Two factors that could extend the time frame follow: (1) depending on how long the system has been dormant, the state may have additional sampling requirements, and (2) if conducting testing specific to *Legionella*, the turnaround time to obtain results is more than a week.

ENVIRONMENTAL MONITORING

Once the system is placed back into operation, DPW and/or PH personnel will need to perform ongoing maintenance activities. Initially these activities may need to be conducted more frequently than for a well-established water system. Consider more frequent periodic testing of disinfectant residual and heterotrophic plate counts at multiple locations throughout the building. Disinfectant residual concentrations should be between 0.2 and 0.5 mg/L, and HPC should be less than 500 colony forming units per milliliter [CFU/mL].

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APPENDIX A
REFERENCES

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