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HACCP for Building Water Systems

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Many techniques, principles and processes are utilized to assure the safety of water supplies, from protection and treatment at the source, to the distribution system, to treatment at the point of entry and point of use. Hazard Analysis and Critical Control Point (HACCP) methodology is another tool that can be effectively applied to building water systems to help assure safety. The HACCP approach, which consists of a structured, systematic, cost-effective risk management process best known for its successful use in food safety, has proven effective for preventing harm associated with premise plumbing, cooling towers and other water systems in buildings.

Background

Every year, tens of thousands of preventable injuries and deaths are caused by exposure to microbial, chemical and physical hazards from building water systems. Microbial risks associated with building water systems are especially challenging to control. In the US, the water treated and distributed by community water systems generally complies with US EPA regulations and is safe for its intended use. However, microorganisms can enter plumbing systems in small numbers, attach to the inside surfaces of pipes and equipment, form a biofilm and amplify to very large numbers. Characteristics of building water systems conducive to microbial colonization include extensive networks of relatively small-diameter pipes that provide high surface-area-to-volume ratios, in which water can become tepid and stagnate for long periods of time. In addition, water in buildings is processed in many ways. For example, it may be conditioned, filtered, stored, heated, cooled and distributed. Processing alters the quality of the water, which increases the likelihood of microbial growth. Pathogens that have colonized the plumbing infrastructure may eventually be released into the environment (for example, through showerheads) and broadcast as infectious bioaerosols. Inhalation, especially by susceptible persons, can result in life-threatening, sometimes fatal, infection.

Specific microorganisms of concern include the protozoa *Acanthamoeba*, the bacteria *Acinetobacter, Elizabethkingeria (Flavobacterium), Escherichia coli, Klebsiella, Legionella,* nontuberculous mycobacteria (NTM), *Pseudomonas, Stenotrophomonas* and the fungi *Aspergillus* and *Fusarium*. Of these, the best known is *Legionella*. *Legionella* spp. are gram-negative, rod-shaped, non-spore-forming bacteria found in a wide range of freshwater environments in relatively low numbers.[1] However, *Legionella* spp. thrive in certain human-made water environments, such as cooling towers, premise plumbing and pipes, and spas.

Although all *Legionella* spp. are considered potentially pathogenic for humans, *L. pneumophila* is the major waterborne pathogen responsible for Legionnaires' disease,[1] a serious pneumonic illness that accounts for the majority of all reported waterborne disease outbreaks in the US.[2] The Centers for Disease Control and Prevention has estimated there are as many as 18,000 cases of Legionnaires' disease annually;[3] the Occupational Safety and Health Administration has estimated that Legionnaires' disease results in about 4,000 deaths each year. The incidence of reported Legionnaire's disease has been on the rise since it was first reported in 1976.

HACCP overview

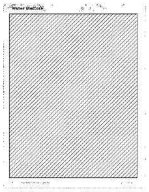
HACCP methodology is a structured, systemic, cost-effective paradigm best known for its successful, widespread use in food safety. HACCP identifies specific, potentially hazardous agents and specifies measures for control to help ensure safety. HACCP is now mandated in the US for certain food production processes and has become the standard for food safety management systems around the world. However, most food safety applications of HACCP in the US are voluntary.

HACCP for building water systems has not been widely used in the US, due in part to the impression that HACCP is useful only for food safety. However, the application of HACCP to public water supplies was first proposed in 1994[4] and has been successfully implemented by a number of entities:

- HACCP-based water safety programs developed by the World Health Organization have proved effective for preventing waterborne disease associated with building water systems.
- In 2010, a HACCP water management program was developed and implemented at the Mayo Clinic in Rochester, MN, yielding significant improvements in building water system safety.[5]
- Since 2000, CDC has recommended HACCP-based practices for facilities that have had outbreaks of Legionnaire's disease. There have been no subsequent outbreaks in buildings following the recommended protocols.

The seven principles of HACCP are:

1) Hazard analysis is a structured, systemic evaluation of the processes in building water systems to identify conditions that contribute to hazards from identified chemical,



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physical and microbial agents of concern.

2) Critical control points are the specific locations in the building water system where controls are applied to prevent, eliminate or reduce hazardous conditions to an acceptable level.
3) Critical limits are the prescribed quantitative parameters for the chemical or physical control measure applied at each critical point.
4) Monitoring procedures are the means, methods and frequency used to measure and document parameters at the critical control points.
5) Corrective actions are the procedures that must be implemented within a specified time period when monitoring indicates that the parameters at a critical control point are not within critical control limits.
6) Record keeping and documentation include creating and maintaining complete, accurate, written descriptions of all aspects of the HACCP program.
7) Verification and validation. Verification, a quality-assurance function, is the confirmation that the HACCP plan is being implemented as designed. Validation, a quality-control function, provides confirmation that the implementation of the HACCP plan is maintaining conditions throughout the system at the intended levels and that the hazards are under control.

From these seven basic principles of HACCP for building water systems, 12 steps are followed in the implementation of the HACCP program. These steps include the establishment of the HACCP team, analysis and description of the building water systems, development and confirmation of the process flow diagrams, a systemic hazard analysis and establishment of critical control points, critical limits, a monitoring plan, corrective actions, a verification and validation schedule and documentation/record keeping procedures.

Conclusion

The application of HACCP to building water safety is invaluable for protecting the overall health, safety and well-being of the public. Such programs have proven effective and practical for controlling the growth and dispersal of clinically significant pathogens in building water systems.

References

1. World Health Organization. 2011. *Microbial Fact Sheets. Guidelines for Drinking-water Quality. Fourth Edition.*

2. Centers for Disease Control and Prevention. 2011. *Morbidity and Mortality Weekly Report (MMWR),* Surveillance for Waterborne Outbreaks Associated with Drinking Water–United States, 2007–2008. www.cdc.gov/mmwr/preview/mmwrhtml/ss6012a4.htm.

3. Centers for Disease Control and Prevention. 2013. *Legionella (Legionnaires' Disease and Pontiac Fever).* www.cdc.gov/legionella/qa-media.html.

4. Havelaar, A.H. 1994. HACCP and Drinking Water Supply. *Food Control, Volume 5, Number 3.*

5. Krageschmidt, D.A.; Kubly, A.F.; Browning, M.S.; Wright, A.J.; Lonneman, J.D.; Detmer, M.J. and McCoy, W.F. 2013. A Comprehensive Water Management Program for Multi-campus Healthcare Facilities. Accepted for publication in *Infection Control and Hospital Epidemiology.*

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