ASHRAE Guideline 12-2000

ASHRAE® STANDARD

Minimizing the Risk of Legionellosis Associated with Building Water Systems

Approved by the ASHRAE Standards Committee February 5, 2000; by the ASHRAE Board of Directors February 10, 2000.

ASHRAE Guidelines are updated on a five-year cycle; the date following the standard number is the year of ASHRAE Board of Directors approval. The latest copies may be purchased from ASHRAE Customer Service, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: orders@ashrae.org. Fax: 404-321-5478. Telephone: 404-636-8400 (worldwide) or toll free 1-800-527-4723 (for orders in U.S. and Canada).

ISSN 1041-2336

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c. offering constructive criticism for improving the Standard,
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CONTENTS

ASHRAE Guideline 12-2000
Minimizing the Risk of Legionellosis Associated with Building Water Systems

1. PURPOSE

The purpose of this guideline is to provide information and guidance in order to minimize *Legionella* contamination in building water systems.

2. SCOPE

2.1 This guideline provides specific environmental and operational guidelines that will contribute to the safe operation of building water systems to minimize the risk of occurrence of Legionellosis.

2.2 This guideline is intended for use with nonresidential building systems (including but not limited to hotels, office buildings, hospitals and other health care facilities, assisted living facilities, schools and universities, commercial buildings, industrial buildings, etc.) and centralized systems in multifamily residential buildings (including but not limited to central heating/cooling systems, central domestic water systems, common area fountains, etc.). While not specifically intended for noncentralized or single-family residential building systems, some of the information may be useful for these systems.

2.3 This guideline is intended for the use of designers, installers, owners, operators, users, maintenance personnel, and equipment manufacturers.

3. ECOLOGY OF *LEGIONELLA*

3.1 Infection and Disease

The majority of Legionnaires' disease cases diagnosed and reported to the public health officials are sporadic (i.e., not occurring as part of a recognized outbreak).[1] Compared with outbreak-associated infection, much less is known about transmission of sporadic Legionellosis, although it is likely that transmission occurs by similar mechanisms. Exposure to legionellae in sporadic cases may occur in a variety of settings, including the home, the workplace, and public places visited during routine daily activities or during travel. The proportion of sporadic disease attributable to exposure in each of these settings and to various environmental sources is unknown.

Legionellae are bacteria. When legionellae are present in aquatic environments, the risk of transmission of infection to humans depends on the presence of several factors: conditions favorable for amplification of the organism, a mechanism of dissemination (e.g., aerosolization of colonized water), inoculation of the organism at a site where it is capable of causing infection, bacterial strain-specific virulence factors, and the susceptibility of the host. Over 40 species of *Legionella* have been identified; *L. pneumophila* appears to be the most virulent and is associated with approximately 90% of cases of Legionellosis. Most *L. pneumophila* infections are caused by serogroup 1; however, certain serogroup 1 strains may be more virulent. The risk of acquiring Legionnaires' disease is greater for older persons and for those who smoke tobacco or have chronic lung disease. Persons whose immune system is suppressed by certain drugs or by underlying medical conditions appear to be at particularly high risk.

3.2 Habitats

Legionellae bacteria are commonly present in natural and man-made aquatic environments. The organism is occasionally found in other sources, such as mud from streams and potting soils; however, the overall importance of nonaquatic environmental sources in human disease is not yet known. In natural water sources and municipal water systems, legionellae are generally present in very low or undetectable concentrations. However, under certain circumstances within man-made water systems, the concentration of organisms may increase markedly, a process termed "amplification." Conditions that are favorable for the amplification of legionellae growth include water temperatures of 25-42°C (77-108°F), stagnation, scale and sediment, biofilms, and the presence of amoebae. Legionellae infect and multiply within several species of free-living amoebae, as well as ciliated protozoa. The initial site of infection in humans with Legionnaires' disease is the pulmonary macrophage. These cells engulf legionellae, provide an intracellular environment that is remarkably similar to that within host protozoa, and allow for multiplication of the bacterium. Hence, legionellae may be considered protozonotic; i.e., they naturally infect free-living amoebae and incidentally infect the phagocytic cells within human lungs under certain circumstances. Although legionellae may be cultivated on special agar media in laboratory settings, growth in nature in the absence of protozoa and/or in the absence of complex microbial biofilms has not been demonstrated. Intracellular growth of legionellae within protozoa and/or within diverse microbial biofilms may be the primary means of proliferation.

There is an indication that growth of *Legionella* is influenced by certain materials. Natural rubbers, wood, and some plastics have been shown to support the amplification of *Legionella*, while other materials such as copper inhibit their growth.

Generally, *Legionella* thrive in diverse, complex microbial communities because they require nutrients and protection from the environment. Controlling the populations of protozoa and other microorganisms may be the best means of minimizing *Legionella*.[2]

3.3 Transmission of Legionnaires' Disease

Most data on the transmission of Legionnaires' disease are derived from investigations of disease outbreaks. These data suggest that, in most instances, transmission to humans occurs when water containing the organism is aerosolized in respirable droplets (1-5 micrometers in diameter) and inhaled by a susceptible host.

Prior to actual disease a number of events occur, some of which can be influenced by good engineering and maintenance practices. These events and prevention opportunities are outlined in Figure 1. The first event, survival in nature, is generally outside the scope of building engineering and management practices. The next three events—amplification, dissemination, and transmission—can be influenced by engineering design and maintenance practices. Subsequent events are influenced by the individual's health.

The most effective control for most diseases, including Legionellosis, is prevention of transmission at as many points