Section II:A. Cooling Towers, Evaporative Condensers, and Fluid Coolers

Cooling towers, evaporative condensers, and fluid coolers use a fan to move air through a recirculated water system. This allows a considerable amount of water vapor and sometimes droplets to be introduced into the surroundings, despite the presence of drift eliminators designed to limit droplet release. This water may be in the ideal temperature range for Legionnaires' disease bacteria (LDB) growth, 20°-50°C (68°-122°F). Good maintenance is necessary, both to control LDB growth and for effective operation.

Control Strategy:

How do these systems operate?

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Cooling towers, evaporative condensers, and fluid coolers reject heat from system fluids through evaporation.

- **Cooling towers** remove heat from condenser water via direct-contact evaporation in a cool air stream. This cooled water circulates through the condenser side of a mechanical refrigeration unit to absorb heat.
- **Evaporative condensers** operate similarly to cooling towers, except that the refrigerant condenser coils are inside the wet air stream and water passing over the coils directly cools the refrigerant.
- **Fluid coolers** reject heat from industrial processes, for example, computer-room air conditioners, etc. Like evaporative condensers, fluid coolers have heat-exchanger coils directly in the wet air stream.

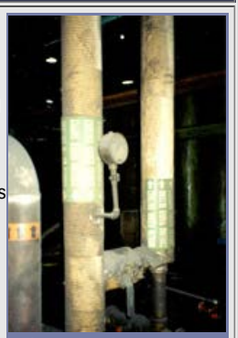

Fig. 1: Condenser water pipes used in a cooling tower for heat reduction

What to consider in the system design

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Important design features include easy access or easily disassembled components to allow cleaning of internal parts including the packing (fill). The following features should be considered in the system design:

- Enclosure of the system will prevent drift of water vapor.
- Design features that minimize the spray generated by these systems are desirable.
- System design should recognize the value of operating with low sump-water temperatures.
- Each sump should be equipped with a "bleed," and make-up water should be supplied to reduce the concentration of dissolved solids.
- **High-efficiency drift eliminators are essential for all cooling towers**
  - Older systems can usually be retrofitted with high-efficiency models.
  - A well-designed and well-fitted drift eliminator can greatly reduce water loss and potential for exposure.

How to maintain these systems

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The system should be properly monitored and maintained according to manufacturers' recommendations to prevent buildup of scale, sediment, and bio-fouling. Visual inspection and periodic maintenance of the system are the best ways to control growth of LDB and related organisms. Measurements of water quality such as total bacterial counts, total dissolved solids, and pH have not proven to be good indicators of LDB levels in cooling towers.

Biocides:

- Add chemical biocides to control LDB growth. Obtain information on appropriate biocide selection and use from equipment manufacturers or from companies experienced with the particular system used.
- High concentrations of organic matter and dissolved solids in the water will reduce the effectiveness of any biocidal agent.
- Additional information (App II:A-1) on biocides is also available.

Temperature:

- Maintain sump water at a low temperature (20°C, 68°F) to control LDB growth.


Fig. 2: Remote cooling tower sump

- Sump-water temperatures depend on tower design, heat load, flow rate, and ambient dry-bulb and wet-bulb temperatures.
- Under ideal conditions, sump-water temperatures in evaporative devices approach the ambient wet-bulb temperature, and may be low enough to limit LDB amplification.

Frequency of cleaning:

- Clean and disinfect cooling towers quarterly or at least twice a year if the unit is not used year round. Do this before initial start-up at the beginning of the cooling season and after shut-down in the fall.
- Systems with heavy bio-fouling or high levels (>100 colony forming units per milliliter, CFU/mL) of LDB may require additional cleaning. Also see Section II:E. Water Sampling Guidelines.
- Any system that has been out of service for an extended period should be cleaned and disinfected.
- New systems require cleaning and disinfecting because construction material residue can contribute to LDB growth.

Acceptable cleaning procedures are outlined as follows:


Fig. 3: Clean and disinfect per system schedule

- Inspect equipment monthly.
- Drain and clean quarterly or at least twice a year if the unit is not used year round.
- Treat circulating water for control of microorganisms, scale, and corrosion. This should include systematic use of biocides and rust inhibitors, preferably supplied by continuous feed.
- Monthly microbiologic analysis is needed to ensure control of biological contamination.

Recordkeeping:

- Document operations and maintenance in a log book. Log books should list dates of inspections and cleanings, water-quality test results, LDB outbreak investigations, and maintenance.
- Maintain an up-to-date description of the operating system (which includes all components cooled by the system) and details of the make-up water to the system.
- Written procedures for proper operation and maintenance of the system should indicate the use of scale and corrosion inhibitors and antifoaming agents. Written records of biocide or chlorine use should be readily available.

How often to test these systems for LDB following identification of contamination

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Outbreak Protocol:

After a contaminated system has been treated, sampling can be used to verify the effectiveness of the treatment. Subsequent testing of cooling-system water at the following intervals can verify that there is no significant re-growth of LDB:

1. Test weekly for the first month after return to operation.
2. Test every two weeks for the next two months.
3. Test monthly for the next three months.

How to collect water samples

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Water Sampling Protocol: Sampling information specific to cooling towers, evaporative condensers, and fluid coolers is provided below. For more information about water sampling, please refer to Section II:E. Water Sampling Guidelines.


Fig. 4: Taking a water sample from a storage tank

- Collect water samples before starting decontamination and at other times identified above.
- Sample the incoming (make-up) water supply to the cooling tower, evaporative condenser, or fluid cooler.
- Sample any storage tanks or reservoirs in the system such as chilled-water return tanks or header tanks.
- Sample the basin or sump of the cooling tower at a location distant from the incoming make-up water.
- Sample the water returning from the circulation system at the point of entry to the tower.
- If a biocide is used, follow the manufacturer's instructions for proper neutralization.

Interpretations Guidelines:

- The OSHA suggested guideline for LDB concentration in cooling towers, evaporative condensers, and fluid coolers is less than 10 CFU per milliliter.
  - If LDB concentrations are below 10 CFU per milliliter and no LDB were detected in swab or other samples, no further monitoring for LDB is necessary. Continue the maintenance program as long as the system is in use.
  - If water concentrations exceed 10 CFU per milliliter or LDB were detected in other samples, take steps to identify the source of contamination or amplification and treat the system.
    See How to treat a contaminated water system.
    - Sample the water system monthly until the source of contamination is identified and adequately treated. Once LDB concentrations remain below 10 CFU for a three-month period, sampling may be stopped.

How to treat a contaminated water system

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Please note: Collect water samples before starting decontamination and after completion.

1. Clean and disinfect the entire cooling system, including attached chillers and/or storage tanks (sumps) as follows:
    - Shut off the cooling tower fans.
    - Keep makeup water valves open and the circulation pumps operating.
    - Close outdoor air intake vents located within 30 meters of the cooling tower.
    - "Shock" treat cooling tower water at 50 mg/L free residual chlorine.
    - Add dispersant.
    - Maintain 10 mg/L chlorine for 24 hours.
    - Drain system.
    - Refill and repeat the previous four steps once.
    - Inspect system for visual evidence of bio-film. If found, repeat the first four steps again.
    - Perform mechanical cleaning (cooling tower design may require modified procedures).
    - Refill system, bring chlorine to 10 mg/L, and circulate for one hour.
    - Flush system.
    - Refill with clean water in accordance with an effective water treatment program; the unit is now ready to be returned to service.
2. Identify and eliminate all water leaks into the cooling water system
3. Sample the cooling water for analysis of CFU of *L. pneumophila*
    - The unit may be put into service provided the medical monitoring program has been implemented.
    - If sample culture results indicate detectable levels of *L. pneumophila,* repeat chlorination and resample the water.

Additional information:

- Guidelines for Prevention of Nosocomial Pneumonia. Centers for Disease Control and Prevention (CDC), Morbidity and Mortality Weekly Report (MMWR) 46(RR-1);1-79, (1997, January 3). See Appendix D, Procedure for Cleaning Cooling Towers and Related Equipment.
- Industry Resources. Association of Water Technologies (AWT).
    - Legionella 2003: An Update and Statement by the Association of Water Technologies (AWT) [964 KB PDF, 33 pages]

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