

COOLING TOWER MANUAL



Chapter 13

INSPECTION OF COOLING TOWERS

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FOREWORD

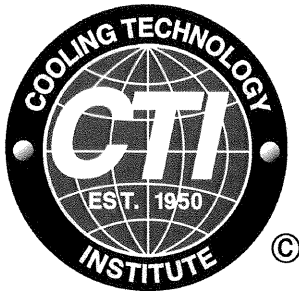
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This guideline document summarizes the best current state of knowledge regarding the specific subject. This document represents a consensus of those individual members who have reviewed this document, its scope and provisions. It is intended to aid all users or potential users of cooling towers.

Approved by the CTI Executive Board



This document has been reviewed and approved as part of CTI's Five Year Review Cycle. This document is again subject to review in 2009

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Inspection of Cooling Towers

Section 1. Scope

13.1 The equipment and materials in a cooling tower are subjected to a harsh environment and usually a less than ideal inspection program. This chapter deals with the cooling tower inspection format, associated equipment and material problems, and suggested inspection and maintenance procedures.

The "Cooling Tower Inspection Format" has been developed as an operational maintenance tool and record of general tower conditions. The inspection format is meant to be used in conjunction with Tower Manufacturer's operation and maintenance manuals. It utilizes CTI Publications such as Bulletin WMS-104 "Wood Maintenance," for the analysis of types of deterioration found in cooling towers, as well as a standardized rating system for the degree of deterioration.

The frequency at which the inspections should be performed is dependent on the users individual preference based on operational or general maintenance criteria.

Normally each manufacturer will recommend inspection intervals based on past experience records. The inspection procedures used may vary from user to user. CTI Bulletin WMS-104 records three basic procedures and observation techniques for wood consisting of visual, strength, touch and probe. These methods can be augmented by additional technical sampling for water analysis, timber and component part cross section sampling, E modulus testing, etc.

Section 2. Definitions

13.2 For definitions of terms used in this chapter see Chapter 1 of the Cooling Tower Manual, "Cooling Tower Operations".

Section 3. Pre-Inspection Safety Considerations

13.3 Prior to the start of the inspections, discussions should be held between plant forces, inspector(s), water treatment personnel, and any other party involved in the inspection site. The purpose of these discussions should be to address all of the hazards involved, and to determine how best to mitigate the risks associated with those hazards during the inspection.

- A. Chemical Injection.** It is common practice to disable the injection system for a sufficient time period to allow chemicals to reach safe levels. It may be advisable to determine whether the chemical concentrations in the circulating water exceed safe concentrations during normal operation. The MSDS Sheet should be consulted to determine safe concentration levels. If normal operating concentrations are within safe levels, consideration can be given to bypassing this step.
- B. Eye Protection.** It is common practice for a plant owner to require eye protection in all operating and maintenance areas. This is in recognition of the hazards that projectiles and other foreign objects pose to the eyes. However, in an

atmosphere such as that which is typically present within an operating cooling tower, there is an additional hazard present – the atmosphere is usually saturated sufficiently to fog the lenses of these safety glasses. Consideration should be given to the risk from the reduction of vision from this fogging effect.

- C. Fall Protection.** Fall protection is required by OSHA and local plant requirements. Several methods of fall protection are available, each with situations that make it the appropriate choice for use. Harnesses are limited by the availability of solid anchor points. Retractable lifelines may pose hazards if the person is pulled over sharp surfaces or over the structure typical inside of cooling towers. Each situation must be evaluated to determine the best method.
- D. Lock Out/Tag Out.** All rotating equipment and water distribution systems must be de-energized prior to entry.
- E. Permits.** Each plant's procedure for confined space entry permitting and work permitting should be followed.
- F. Biological Activity Protection.** The primary biological agent known to present any risk to human health in a cooling tower system is *Legionella pneumophila*, commonly known as Legionnaires' Disease. For further information on *Legionella pneumophila*, refer to the paper, "Legionellosis Guideline: Best Practices for Control of Legionella", available at www.cti.org. Other biological risks should be evaluated on a case by case basis.
- G. Site Specific Contamination Issues.** Other issues may need to be addressed prior to the start of the inspection. This includes but is not limited to process contaminants, adjacent operating units or plant sites, or any other contaminant sources specific to the site.

Section 4. Inspection of Wood Members of Cooling Towers

13.4 Cells should be checked at regular intervals so that each cell in the complex is inspected at least once a year. Additional inspections should be made after high winds, seismic events, chemical excursions, major mechanical events, etc. See also manufacturer's recommendations.

Inspections should include the following observations:

- A. Visual** – The general appearance of the lumber and the depth to which loose or punky materials could be scraped off with a dull instrument. What to look for-
 - 1. Chemical Surface Attack** can be caused by a number of different chemicals. Excessive chlorinating is usually the chief offender; however, excessive concentrations of carbonate alkalinity in the tower circulating water for prolonged periods will also cause this attack. Chemical attack is observed as wood delignification due to the selective removal of lignin, which is the cellulose fiber-binding agent. It follows,

then, that this attack is most prevalent in the flooded tower fill and areas frequently wetted with water, such as the structural members. Chemical attack is a thin-layer surface attack and can be detected and checked before serious damage occurs, provided periodic inspection are given the tower and corrective measures are taken when this type of attack is discovered. For additional information, see Bulletin WMS-104 "Wood Maintenance".

2. Biological Surface Attack (or soft rot) is caused by fungi that selectively attack cellulose of very damp wood, leaving primarily lignin. This attack is characterized by a dark appearance and a brash condition of the wood surface. The wood surface becomes "punky" or checked. The active growth of the wood-destroying fungi is confined to the surface layers and remains superficial unless the wood is allowed to dry out frequently.

3. Biological Internal Attack occurs below the surface of the wood particularly around areas of exposed end grain (holes, cuts, etc.), and often goes undetected until the infection has spread widely, resulting in serious structural damage. The decay can be white rot, attacking both cellulose and lignin and leaving a spongy or stringy mass, or a brown rot, attacking primarily cellulose and leaving a brown cube like pattern. This type of attack is more apt to occur in the warm, moist, but non-flooded portions of the tower.

4. Iron Rot is a chemical attack caused by the formation of iron salts around corroding ferrous parts in contact with wood. The wood in the adjacent zone has a charred appearance and may also be more susceptible to fungal attack. Since connections are affected in many cases, extensive repairs may be required. See also Chapter 9 – "Materials of Construction for Cooling Towers".

5. Structural – Besides inspecting the wood elements for chemical and biological attack, inspection for split, cracked, or bowing columns, sagging braces, and loss of any elements in the structure should be noted. It is very important to look for loose bolts in braces and column connectors. Any loose bolts should be tightened immediately. Particular attention should be paid to cracks through bolted joints. The breaking strength of drift eliminator boards and splash boards can be tested by hand to determine brashness. Also the softening of the surface and the depth of penetration of a probe should be noted as an indication of strength. MOE testing, of members removed from the tower, could also be done to determine the extent of deterioration but generally, deterioration is not uniform.

B. Touch – Feel on the surface of the lumber to see if the surface is fibrous or deteriorating.

C. Probe – The ease with which a probe penetrates heavier members and the depth of this penetration. Also the type fracture made on breaking out is used as an indication of the type of deterioration or its absence in the interior. In inspecting for internal decay, a probe such as a blunted ice

pick or a screwdriver is useful. A firm pressure will cause the point of such an instrument to penetrate about a ¼ inch into sound wood. If internal decay is present, the probe will break through the sound wood and penetrate into the softer decayed area.

D. Reporting Method - Chart Figure 13.1 can be used in determining when to conduct an inspection.

If the assigned purpose of the inspection was simply to document the condition of the cooling tower, the "Cooling Tower Inspection Checklist" could be used to do so, and can be supplemented with whatever text documentation is deemed necessary. The documentation could show the size and length of each element requiring attention, as well as its location. Recommendations for immediate or short-term scheduled repairs may also be attached. Recommendations for longer term repairs, upgrades, or other recommendations from the inspector, may be attached as well. Priorities should be established considering factors such as safety, operation, immediate needs, etc.

Section 5. Inspection of Fiber Reinforced Plastic (FRP) Structural Members of Cooling Towers

13.5 A cooling tower structure assembled from high quality, high performance FRP laminates, designed properly with adequate UV and weather protection, should give an owner long, low maintenance service. The principal concerns of composite structures that can affect the structure's life are sun (UV), sag (creep), shear stress, connections, and freezing. One advantage to FRP structural components as compared to other building materials is that it normally will give significant warning before it reaches the point of failure. If a member becomes over stressed due to excessive loads, the first indication will be excessive or accelerated deflection or creep of the over stressed member.

FRP towers should be checked at regular intervals so that each cell in the complex is inspected at least once a year in conjunction with a preventive maintenance program. Additional inspections should also be made after high winds, seismic events, operational transients (temperature, chemistry, hydraulic), major mechanical events, etc. Also consult the manufacturer's recommendations.

A. Visual

UV Damage – Some degree of fading and chalking is to be expected. Damage from the effects of the sun's ultraviolet radiation can be identified by the presence of fiber blooming (exposed glass fibers) in areas subject to direct exposure to the sun. Fading and chalking are not indications of structural damage due to UV deterioration

Deflection and Deformation – The principal concern of deflected or deformed structural members is whether or not the deformity is causing excessive stress on the connections. If deflections or deformations in excess of those allowed by CTI ESG-151(02) are observed, the cause of the deformity should be determined.

Structural Damage and Cracking – FRP members should be inspected for damage, cracking, or potential structural failure.

Connections – Principal problems associated with connection points are stress cracking, bolt hole elongation, and loose hardware. Extra effort should be made to search for these problems in heavily loaded members of the structure. Refer to CTI ESG-151(02) for further information. Care should be taken when correcting loose bolting to avoid over-torquing per manufacturer standard.

Freeze Damage – Freeze damage can be identified by looking for cracking at the base of the structural member. If weep holes in hollow members are present, they should be checked to make sure that they are open for drainage.

Chemical Attack – Chemical attack, while highly unlikely, can be identified by the existence of localized fiber blooming.

B. Reporting Method – (Same as 13.4)