# COOLING TOWERS

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## 1.0 SCOPE

This data sheet describes the types, hazards, protection, and maintenance of cooling towers. Key hazards impacting the loss potential for cooling towers include: wind, fire, collapse and hail. A cooling tower is a heat removal device that uses water to transfer process waste heat into the atmosphere. All cooling towers operate on the principle of removing heat from water by evaporating a small portion of water that is recirculated through the unit. It also includes information on FM Approved (see Appendix A for definition) cooling towers that fall into one of the following categories:

A. Cooling towers of limited combustibility (fire does not continue to self-propagate, in cooling tower components, beyond the area of exposure) according to Acceptance Criteria found in FM 4930, Approval Standard for Cooling Towers. This type usually incorporates either fire retardant (FR) fill and other components in a noncombustible shell, or noncombustible fill within a FR fiberglass-reinforced plastic shell. These could include either single-cell or multi-cell cooling towers. Cooling towers of limited combustibility due to their design do not require additional capacity or redundancy.

B. Single-cell cooling towers where the fire spread through testing is shown to be limited to only a portion of the given cell according to Acceptance Criteria found in FM 4930.

C. Multi-cell cooling towers according to Acceptance Criteria found in FM 4930 with additional capacity so that, under worst-case fire conditions, a fire may burn out one cell, but be limited to that cell and not affect adjacent cells. With this type of cooling tower design, at least one additional cell is always provided so that extra capacity and reliability will always be available.

Small windborne debris damage to cooling towers is not covered in this document. Where such damage has occurred it has not hindered the operation of the cooling tower.

Protect air-cooled heat exchangers (air-fin or fin-fan units) handling ignitable liquids per Data Sheet 7-14, *Fire Protection for Chemical Plants*.

### 1.1 Hazard

Refer to *Understanding the Hazard: Fire in Cooling Towers*, FM publication P0044. For additional information on fire and other perils, refer to Section 3.4.

### 1.2 Changes

**April 2020.** This document has been completely revised. Significant changes include the following:

A. Clarified the scope of the document.

B. Added detailed information on FM Approval testing process for multi-cell cooling towers.

C. Added emphasis on wind and collapse exposures.

D. Added information on contingency planning

## 2.0 LOSS PREVENTION RECOMMENDATIONS

### 2.1 Construction and Location

#### 2.1.1 Materials for Construction

2.1.1.1 Provide FM Approved or noncombustible cooling towers.

2.1.1.2 Where combustible cooling tower components are present provide sprinkler protection. Avoid the use of combustible louvers, even on protected cooling towers, because they are not usually covered by the fire protection system and could be ignited by an exterior exposure fire. Do not use polystyrene ″eggcrate″ fill, even if sprinkler protection is provided.

#### 2.1.2 Protection Against Fire Exposure

2.1.2.1 Locate unprotected cooling towers of combustible construction, or that contain combustible fill, at least 20 ft (6 m) from each other and from the following:

A. Structures or processes that emit sparks or flying brands under normal operations (such as chimneys, incinerators, flare stacks, or cob burners).

B. Material and processes of severe fire hazard (such as petroleum processing and storage tanks, explosives manufacturing or storage, or pipelines and pumping stations for petroleum products).

2.1.2.2 When 20 ft (6 m) spacing is not provided, either install sprinkler protection in the cooling towers, or provide fire partitions of at least one-hour fire resistance between cooling towers and structures. Construct the partitions to be at least 3 ft (1 m) higher than the top of the body of the cooling tower and to extend at least 3 ft (1 m) beyond the end walls of the cooling towers. Protect all exposed openings of the cooling tower with 1/4 in. (6.4 mm) corrosion-proof wire mesh to stop burning embers from entering.

2.1.2.3 If cooling towers must be located near incinerators or stacks, use cooling towers or shells that are noncombustible, and protect openings with 1/4 in. (6.4 mm) corrosion-proof wire mesh. Ensure the net area of openings in the wire mesh are sufficiently large that fan efficiency will not be reduced.

2.1.2.4 When an unprotected cooling tower is located on the roof of a building of combustible construction, use noncombustible construction or an FM Approved cooling tower suitable for the location.

### 2.1.3 Wind Design

2.1.3.1 Provide protection against wind forces in accordance with Data Sheet 1-28, *Wind Design*. These designs encompass all ground mounted and roof mounted cooling towers. Base wind design for hyperbolic (large outdoor structures) on detailed wind tunnel testing results and appropriate design guidance from that testing taking into consideration the effects of terrain and adjacent structures.

### 2.1.4 Earthquake Design

2.1.4.1 Provide earthquake design in accordance with Data Sheet 1-2, *Earthquakes*, and the following recommendations:

A. Provide all sprinkler piping in active seismic areas with earthquake protection as specified in Data Sheet 2-8, *Earthquake Protection for Water-Based Fire Protection Systems*.

B. In those areas designated by FM as active seismic areas (see Data Sheet 1-2), design must meet, at a minimum, the recommendations of the International Building Code or local country building code. Provide design by a professional structural engineer registered to practice in the jurisdiction.

C. When a cooling tower is placed on a building 120 ft (36.6 m) or higher, tie “splash bar” or slat-type fill with wire to the supporting grids at one end.

D. When a cooling tower is added to an existing building, check the earthquake bracing system of the building to ensure it is still adequate.

## 2.2 Protection

### 2.2.1 Sprinkler Protection

Where sprinkler protection is required below, utilize a sprinkler with a K-factor of 8.0 (115) and a minimum design end-head pressure of 7 psi (50 kPa). This would be for protecting all types and sizes of cooling towers, including the package-type cooling towers if protected.

2.2.1.1 Protect counterflow induced-draft cooling towers as follows:

A. For cooling towers with combustible fill and fan deck, install sprinkler protection under the fan deck, including the fan opening, designed to provide a minimum density of 0.5 (gpm)/ft$^2$ (20 mm/min), on a deluge system (Figure 1). Spot sprinklers may still be needed above the fan deck to protect individual combustible components, such as the fan-drive motor, fan cylinder, or exhaust stacks.

B. For cooling towers using a combustible fan deck, install sprinkler protection under the deck, designed to provide minimum density of 0.35 (gpm)/ft$^2$ (14 mm/min). A wet-pipe or dry-pipe system will be satisfactory.

C. For cooling towers with metal or cementitious fill and a combustible fan deck, install sprinkler protection under the deck designed to provide a minimum density of 0.15 (gpm)/ft$^2$ (6 mm/min). A wet-pipe or dry-pipe system will be satisfactory.

2.2.1.2 Protect crossflow cooling towers with open distribution basins (Figure 2), combustible fan deck and fill as follows:

A. Install sprinklers under the fan deck designed on a deluge system to provide a minimum density of 0.35 (gpm)/ft$^2$ (14 mm/min).

B. Because there is not enough space between the open distribution basin and the fill for conventional sprinklers, use FM Approved open water spray nozzles. Locate the nozzles below the distribution basin and above the distribution deck on either the air inlet louver or drift eliminator side, discharging horizontally (Figures 2 and 3). Determine minimum flowing pressure of a nozzle by the maximum width or length of fill.

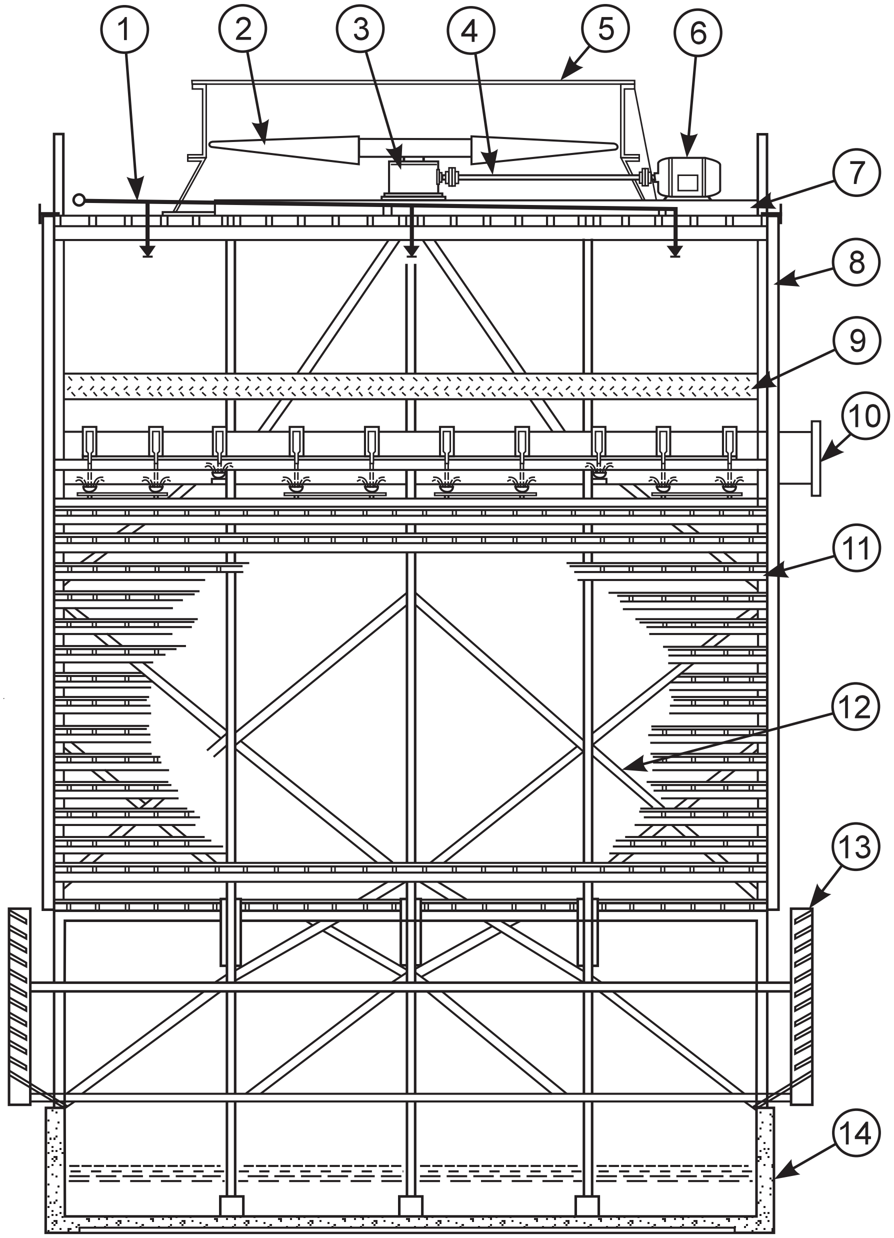
When acceptable coverage cannot be obtained from one side of the fill, provide nozzles on both sides (Figure 3), with minimum pressure based on one-half the width or length of fill, using a deluge system (Note: A recommended density cannot be given because nozzle pressure is dependent on type of nozzle and width or length of fill. Also, nozzle spacing depends on the framing of the basin.)

Remove the sealing assembly from each nozzle. Some makes of nozzles have to be installed at an angle from the horizontal as recommended by the manufacturer.

When the distribution deck is omitted, provide a horizontal space for sprinklers below the hot water basin by omitting or removing fill. Use a deluge system to provide a minimum density of 0.5 (gpm)/ft$^2$ (20 mm/min), and minimum end-head pressure of 25 psi (170 kPa). Use pendent sprinklers, and maintain a minimum of 12 in. (0.3 m) above the top of the fill to the sprinkler deflectors. When a 12 in. (0.3 m) clearance cannot be provided, use the FM Approved cooling tower nozzle arrangement.

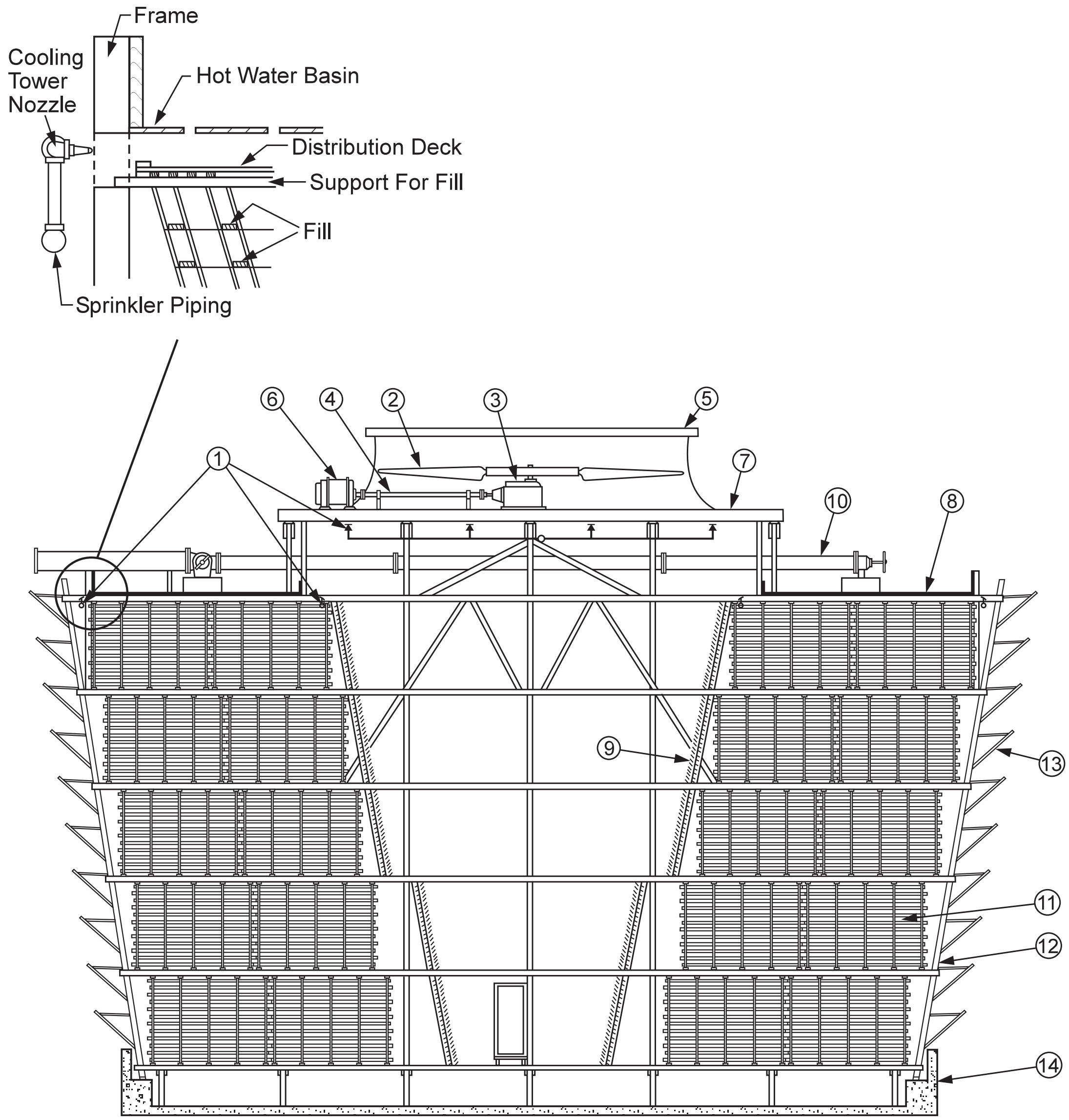
C. In crossflow cooling towers with closed distribution basins, protect the combustible fill (Fig. 4) by supplying fire protection water to the hot water basin and utilizing the normal distribution system of the cooling tower (target nozzles or slatted distribution deck). Install fire protection water to the basin on a deluge system arranged to provide a minimum density of 0.5 (gpm)/ft$^2$ (20 mm/min). Use wide-angle nozzles (180° water spray) in the space between the extension of the fan deck and the hot water basin. Where the fan deck extension is noncombustible, ensure the wide-angle nozzles discharge the full minimum density of 0.5 (gpm)/ft$^2$ (20 mm/min). Where the fan deck extension is combustible, provide additional nozzles on the underside of the fan deck extension to provide a minimum density of 0.1 (gpm)/ft$^2$ (4 mm/min). Design the wide-angle nozzles to supply a minimum density of 0.4 (gpm)/ft$^2$ (16 mm/min).

To clarify, two layers of protection for a combustible fan deck extension are required. Protection is needed directly beneath the fan deck extension, and then additional protection beneath this to protect the combustible fill in a non-FM Approved cooling tower.




1. Sprinkler Piping
2. Fan
3. Speed Reducer
4. Drive Shaft
5. Fan Cylinder
6. Drive Motor
7. Fan Deck
8. Shell
9. Drift Eliminators
10. Water-Inlet Pipe
11. Combustible Fill
12. Framing
13. Air-Inlet Louvers
14. Water Basin

*Fig. 1. Typical cross section of a counterflow induced-draft cooling tower*




1. Sprinkler Piping
2. Fan
3. Speed Reducer
4. Drive Shaft
5. Fan Cylinder
6. Drive Motor
7. Fan Deck
8. Hot-Water Basin
9. Drift Eliminators
10. Water-Inlet Pipe
11. Combustible Fill
12. Framing
13. Air-Inlet Louvers
14. Water Basin

*Fig. 2. Typical cross section of a crossflow induced-draft cooling tower (open hot water basin)*

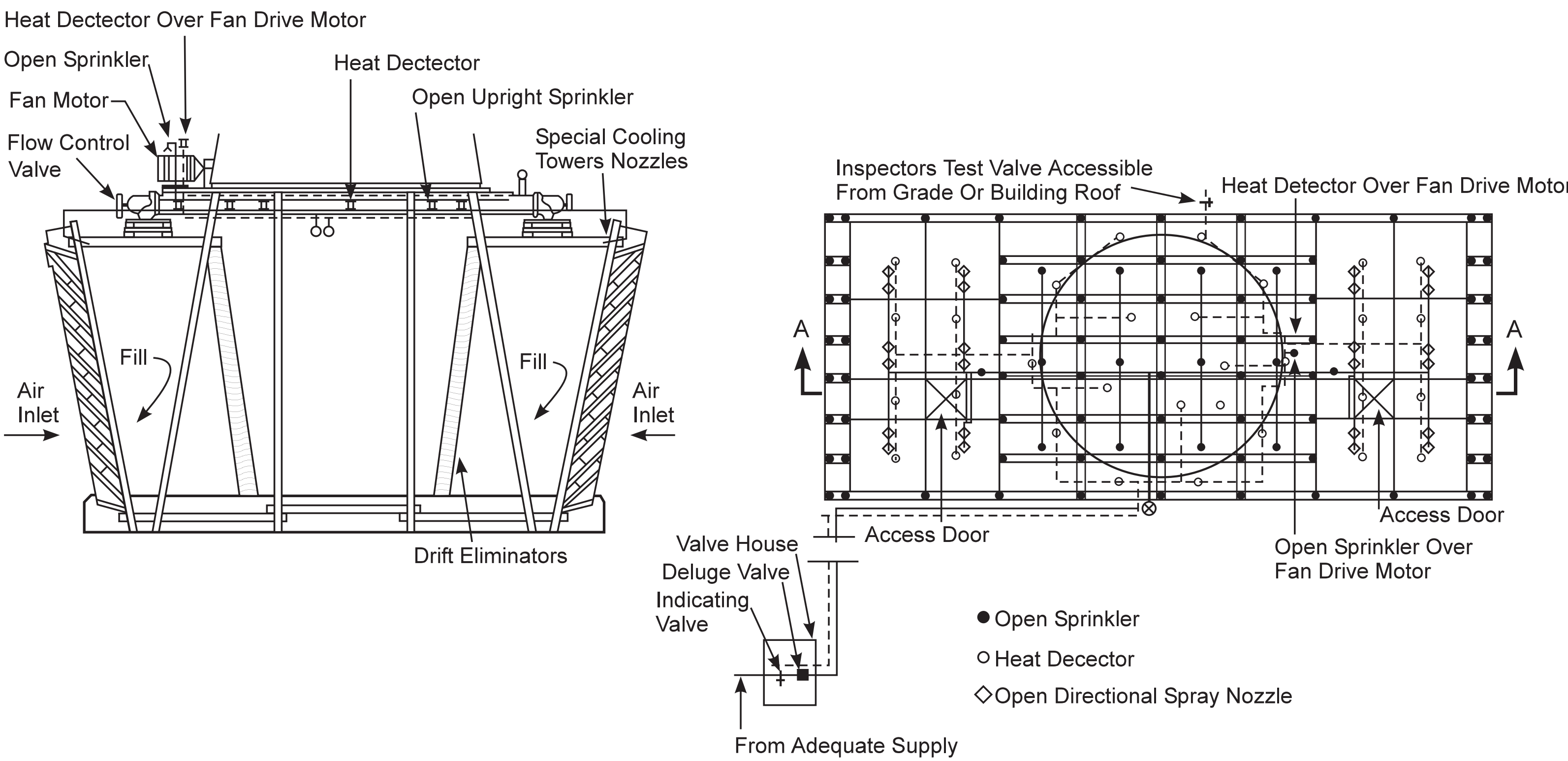
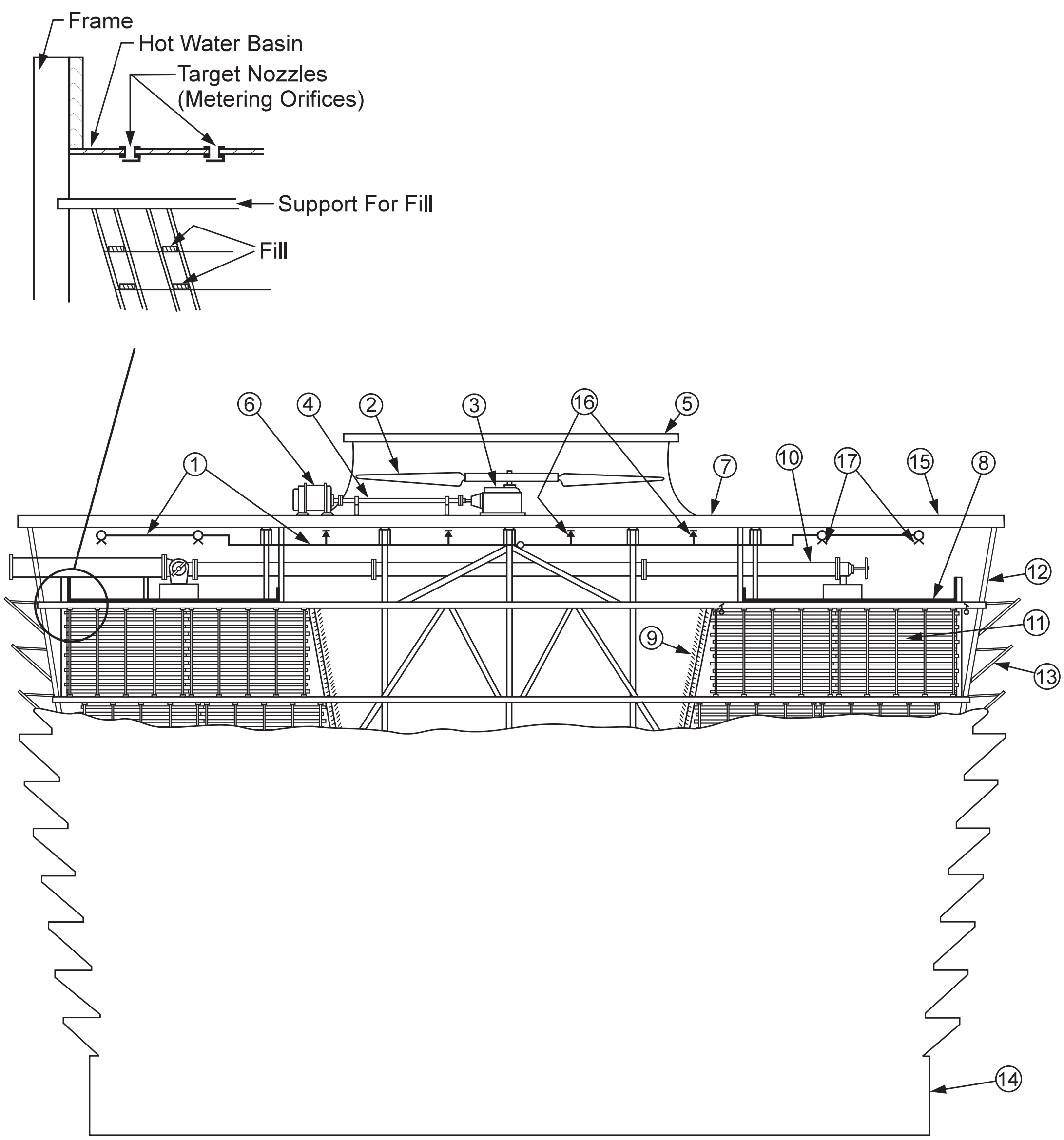



*Fig. 3. Typical deluge fire protection arrangement for crossflow cooling towers*




1. Sprinkler Piping
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5. Fan Cylinder
6. Drive Motor
7. Fan Deck
8. Hot-Water Basin
9. Drift Eliminators
10. Water-Inlet Pipe
11. Combustible Fill
12. Framing
13. Air-Inlet Louvers
14. Water Basin
15. Fan Deck Extention
    (Hot Water Basin Cover)
16. Upright Sprinklers
17. Spray Nozzles

*Fig. 4. Typical cross section of a crossflow induced-draft cooling tower (covered hot water basin)*

D. Where geometry permits, use upright sprinklers in the space between the extension of the fan deck and the distribution basin. Consider the depth and spacing of joists and beams for all installations to ensure compliance with clearance recommendations.

E. Where the fill is non-combustible, a wet- or dry-pipe system will be satisfactory for protection of the fan deck, with a minimum density of 0.2 (gpm)/ft$^2$ (8 mm/min).

2.2.1.3 When cooling towers have more than 37 ft (11.3 m) of fill height, a time lag of approximately three minutes occurs from activation of the sprinkler system before sprinkler water, discharged at the top of the fill, begins to wet the material at the bottom of the fill. If sprinkler protection is needed, provide one or more horizontal spaces in the fill stack to allow for installation of an intermediate level (or levels) of sprinklers. When the fill height exceeds 37 ft (11.3 m), provide one level of intermediate sprinklers for each intermediate 25 ft (7.6 m) of fill height. (For cooling towers less than 37 ft [11.3 m], nozzles at top only; 37-50 ft [11.3-15.2 m], nozzles at top and one layer of intermediate sprinklers; 50-75 ft [15.2-22.9 m], nozzles at top and two layers of intermediate sprinklers, etc.). Use pendent-type heads for the intermediate sprinklers with the sprinkler deflectors a minimum of 1 ft (0.3 m) above the top of the lower fill. Design the sprinkler protection on a deluge system hydraulically to provide a minimum density of 0.5 (gpm)/ft$^2$ (20 mm/min) at each level, with a minimum end-head pressure of 25 psi (170 kPa).

2.2.1.4 Where sprinkler protection is provided at a cooling tower, also provide one sprinkler over each fan-drive motor (Figures 3 and 5). Additionally, provide sprinklers over any fan blades, fan cylinders, exhaust stacks, etc., unless they are noncombustible. These spot sprinklers can be fed through a deluge system or closed head wet pipe sprinklers.

Do not provide sprinkler protection over combustible fan cylinders of an air cooled condenser as these are of different design than fan cylinders for a cooling tower. However, ensure there are no unprotected ignition sources beneath the air cooled condenser such as storage, trailers, transformers, and even cables running up concrete columns beneath these fans.

2.2.1.5 Where protection is to be provided for fill areas of cooling towers, place the protection in service before the fill is installed, to protect the fill during construction or retrofit.

2.2.1.6 Protect cooling towers having noncombustible fill and drift eliminators, but with combustible end walls and/or exhaust stacks, as follows:

A. Install open-head side-wall sprinklers 6 in. (15 cm) below the top and within 12 in. (30 cm) from the inside surfaces of each combustible wall. Use FM Approved 190°F (88°C) rated heat-sensitive cables to activate sprinklers. Space the sprinklers every 7 ft (2.13 m) and provide at least 20 (gpm) (75 l/min) per head. Arrange sprinklers to face the surface area to be protected.

B. If the stack is more than 15 ft (4.6 m) high, provide sprinkler protection in accordance with Data Sheet 7-78 Section 2.2, Industrial Exhaust Systems. Use FM Approved 190°F (88°C) rated heat-sensitive cables to activate the sprinkler system.

2.2.1.7 Even if the combustible fill is protected, the inside surfaces of combustible end walls still need protection. Typically, the arrangement of sprinkler protection for the fill will not reach the combustible end walls for effective protection so additional protection is generally needed.

2.2.1.8 Where sprinkler protection is provided within a cooling tower interlock the fan to shut down upon sprinkler discharge.

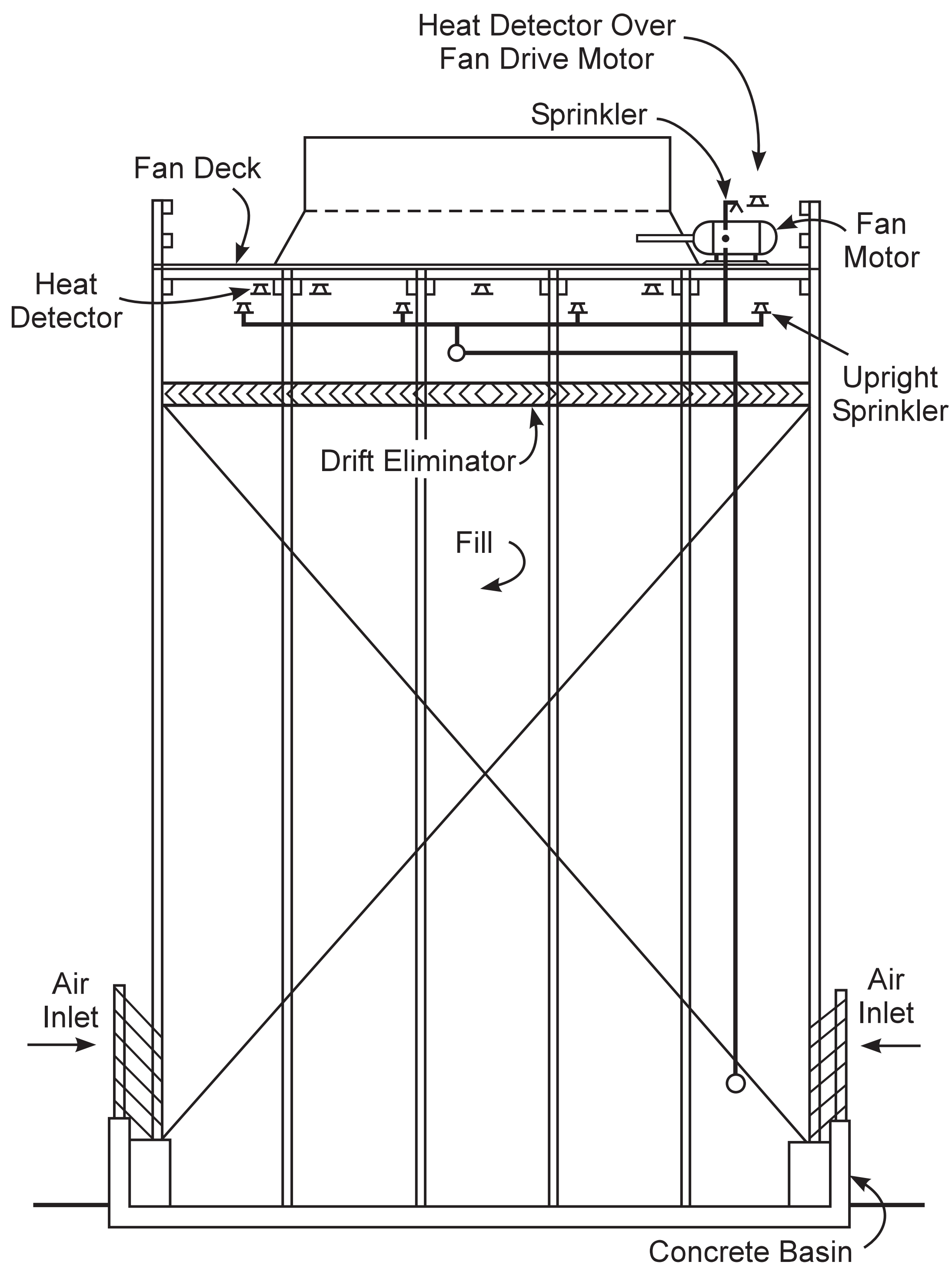


*Fig. 5. Typical deluge or dry-pipe fire protection arrangement for counterflow cooling towers*

### 2.2.2 Water Supply

2.2.2.1 Provide an adequate water supply to simultaneously supply all discharge outlets in the two largest, adjacent sprinkler systems.

2.2.2.2 When there are two or more sprinkler systems and the water supply is only adequate to supply one system at a time, separate the sprinkler systems by one of the following methods providing a fire resistance of not less than 20 minutes:

A. Provide reinforced-concrete partitions between sections of the cooling tower individually protected by separate sprinkler systems.

B. Provide tight, continuous partitions of 1/2 in. (12.7 mm) thick cementitious board or other noncombustible material on both sides of wood or steel (stainless or galvanized) studs.

C. Provide tight, continuous partitions of 1/2 in. (12.7 mm) thick plywood on both sides of wood studs. Arrange the plywood so all joints are over studs, or use tongue-and-groove plywood.

D. Provide tight, continuous partitions of 3/4 in. (19 mm) thick nominal tongue-and-groove wood plank on both sides of wood studs. Use a type of wood that is resistant to rot.

E. Provide any other water-resistive partitions with a fire resistance of not less than twenty minutes.

F. Install partitions to extend from 1 ft (0.3 m) below the operating water level of the cold-water basin to the underside of the fan deck (counterflow cooling towers) or distribution basin (crossflow cooling towers). Where the fan deck covers the distribution basin (crossflow cooling towers), install heat barriers under the deck to separate sprinkler systems if their total demand exceeds the water supply. Extend heat barriers from the fan deck structure to the distribution deck dividers. Acceptable materials are 3/16 in. (4.8 mm) thick cementitious board or 3/8 in. (9.5 mm) plywood on one side of the wood studs. Arrange the heat barriers to be in line vertically with the partitions below. Have any openings in the partitions suitably sealed or caulked.

Other cooling tower designs may create additional problems. Study each cooling tower to ensure that (1) flame cannot spread from one sprinklered area to another before the sprinklers have controlled the fire, and (2) flow of hot gases will not open sprinklers in more than one system.

2.2.2.3 Include a minimum of 500 gal/min (1900 L/min) for hose streams in addition to sprinkler requirements in design of water supplies.

2.2.2.4 Provide an adequate water supply of at least 2-hour duration for sprinklers and hose streams.

### 2.2.3 Sprinklers and Piping

2.2.3.1 Use FM Approved, corrosion-resistant sprinklers where the atmosphere may be corrosive. Any FM Approved nozzle listed in the ″Open Water-Spray Nozzles″ category is acceptable.

2.2.3.2 Precautions are recommended if exposed to strongly corrosive process water.

2.2.3.3 If possible, locate piping on the cooling tower exterior. Nipple sprinklers through the fan deck (counterflow induced draft) or the fan deck extension (crossflow covered distribution basin).

2.2.3.4 Use piping, fittings, and hangers resistant to any expected corrosive atmosphere, or paint the piping. Also paint exposed threads of galvanized steel pipe.

2.2.3.5 Provide risers to sprinkler systems in cooling towers with four-way bracing at the top of the riser to protect for normal operating vibrations or water hammers. Also, provide a mechanical groove coupling within 2 ft (0.6 m) of the top of the riser.

### 2.2.4 Hydrants and Standpipes

2.2.4.1 Provide hydrant protection within 200 ft (61 m) of all parts of combustible cooling towers on the ground or on buildings less than 60 ft (18.3 m) high. Locate hydrants at least 40 ft (12 m) from cooling towers.

2.2.4.2 Provide standpipe protection on roofs within 200 ft (61 m) of all parts of combustible cooling towers located on buildings 60 ft (18.3 m) or higher. Preferably locate standpipes in stair towers, but if they must be in the open on roofs, locate them not less than 40 ft (12 m) from cooling towers. Make provisions to completely drain all exposed standpipe lines where subject to freezing. Provide hose equipment in a waterproof cabinet at each standpipe hose connection on a roof.

2.2.4.3 Provide stairways or ladders at convenient locations for accessibility to the cooling tower roof or top surface of the fill section of hyperbolic cooling towers.

### 2.2.5 Deluge System Actuating Devices

2.2.5.1 Where deluge systems are used, install an adequate number of heat detectors. Locate them in the path of natural air flow through the cooling tower. (Refer to Data Sheet 5-48, *Automatic Fire Detectors*.)

2.2.5.2 For crossflow mechanical-draft cooling towers, use either line-type heat detectors on the opposite face of the drift eliminators from the fill, or spot detectors located as in Recommendation 2.2.5.3. For crossflow natural-draft cooling towers, use line-type heat detectors. Run the wires from the top of the eliminators to within 4 ft (1.2 m) of the bottom of the eliminators, spaced not more than 15 ft (4.6 m) apart (Figure 6). Spot detectors will not be effective in crossflow natural-draft cooling towers.

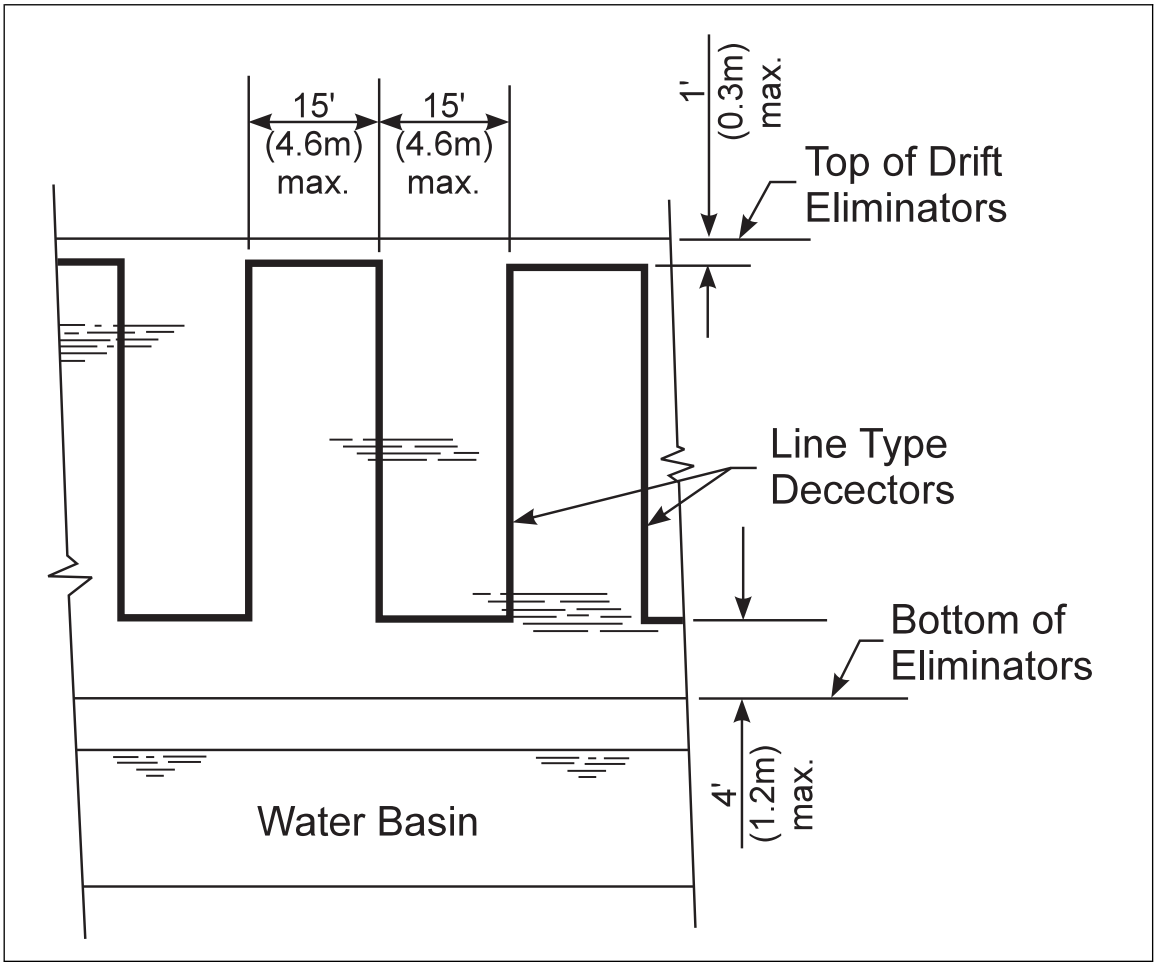


*Fig. 6. Recommended arrangement of line-type detectors when used on the plenum side of drift eliminators in crossflow cooling towers*

2.2.5.3 Where spot detectors are used in crossflow or counterflow cooling towers, locate them under the fan deck, around the circumference of the fan opening, and space them in accordance with the following:

A. Space rate-of-rise detectors not more than 15 ft (4.6 m) apart. In pneumatic-type detection systems, with detectors inside the cooling tower and using mercury checks, use no more than one detector per mercury check in cooling towers operating year round in cold climates. Use no more than two detectors per mercury check in cooling towers used during the warm months only, or year round in warm climates.

Use no more than four detectors for each mercury check when the detectors are located outside the cooling tower.

B. Space fixed temperature detectors not more than 8 ft (2.4 m) apart in any direction. Select temperature ratings in accordance with operating conditions, but no less than intermediate (because of expected high temperatures).

C. FM Approved “pilot” sprinklers are suitable for use as fixed temperature detectors. This type of detection system uses automatic sprinklers to release pressure from a pilot air or water line controlling the valves. Space and install the pilot sprinklers in accordance with sprinkler system installation guidelines.

2.2.5.4 Where heat detectors are inaccessible during cooling tower operation, provide test detectors, accessible from the ground or roof, for each circuit. With pilot sprinkler detection, provide an inspector’s test valve accessible from grade or building roof on each pilot system.

2.2.5.5 Use corrosion resistant heat detector components if they will be exposed to corrosive vapors or liquids.

## 2.3 Operation and Maintenance

The completion of cooling tower structural inspections are of extreme importance to prevent an ensuing structural collapse or wind damage to the cooling tower. These recorded inspections should be performed by a qualified contractor or client personnel. These inspections should include the cooling tower exterior as well as interior, and focus on things such as deteriorated structural members, corroded sprinkler heads and piping, the cold water basin, drift eliminators, fan blades, etc. As part of an asset integrity program, conduct the inspections at least every six months or at every major scheduled cooling tower outage. See Data Sheet 9-0, *Asset Integrity* for guidance on developing an asset integrity program.

### 2.3.1 Inspection, Testing and Maintenance

2.3.1.1 As part of the asset integrity program, inspect mechanical-draft cooling towers weekly. After being placed in service following nightly or weekend shutdowns, the cooling tower should be inspected immediately for any abnormal conditions. Inspection from the fan deck will enable the cooling tower operator to detect excessive heat, noise, or vibration. If observed, make a more complete inspection of the entire cooling tower.

2.3.1.2 Every six months, ensure a qualified contractor or client personnel makes an inspection of mechanical-draft cooling towers while the cooling tower is in operation and while shut down. Check the condition of mechanical equipment. Replace worn or deteriorated parts. Pay particular attention to the items listed in Table 1.

2.3.1.3 Every six months, make a detailed inspection of the structure for collapse potential, to detect: rotted, badly corroded, or otherwise defective framing, loose or badly corroded bolts, or deteriorated foundations. Inspect the condition of the sprinkler system.

2.3.1.4 Test heat detectors every six months. Measure the loop resistance of line-type heat detectors semi-annually. For pilot sprinkler systems, use the test valve to trip the deluge system during the test. Trip test the deluge system in conjunction with testing of heat detectors or by the use of the test valve for pilot sprinkler systems when applicable. Ensure the pilot sprinkler system properly holds air pressure and check this on an annual basis. (Refer to Data Sheet 2-81, *Fire Safety Inspections and Sprinkler System Maintenance* for further detail).

2.3.1.5 Post instructions for stopping the fan, in case of fire, at convenient locations near the cooling tower and at control switches. Instruct the emergency response team on the following:

- How to stop the fan
- The need for continuing water flow through the cooling tower evaporating system
- The method of starting the flow in case of fire during a shutdown perio

*Table 1. Preventive Maintenance Schedule for Key Cooling Tower Components*

| *Component* | *Weekly* | *Monthly* | *Seasonal Shutdown* | *Seasonal Startup* |
|---|---|---|---|---|
| Fan motor | — | Check mounting bolts | Clean and cover | Lubricate if required, tighten mounting bolts. |
| Speed reducer | Check oil level, visual inspection. | Check oil level, check mounting bolts. | Overfill with oil, clean and cover. | Refill with oil and tighten mounting bolts |
| Fan wheel | Visual inspection, remove foreign matter. | Check bolts, check set screws. | Clean and cover. | Clean and paint hub, check blade pitch. After adjusting pitch, adequately torque bolts and lock-wire in place. |
| Drive shaft | Visual inspection | Check shaft alignment. | Clean and cover. | Realign. |
| Distribution system | Remove foreign matter. | Remove foreign matter. | Drain and clean. | Inspect and clean. |
| Cold-water basin | Remove foreign matter. | Remove foreign matter. | Drain and clean. | Inspect and clean. |
| Sump and screen | Remove foreign matter. | Remove foreign matter. | Drain line and shut off. | Inspect and clean. |
| Float valve | Visual inspection | Check valve operation. | Drain line and shut off. | Check operation. |
| Overflow Connections | Visual check | Visual check, tighten bolts. | — | Tighten bolts. |

2.3.1.6 Provide noncombustible air-intake filters on crossflow cooling towers to keep leaves and other debris from getting drawn into the cooling tower resulting in the fouling of fill, sumps, or strainers.

2.3.1.7 Ensure all electrical testing, including maintenance of cooling tower pumps and motors, is completed per requirements of Data Sheet 5-20, *Electrical Testing*.

2.3.1.8 Every six months, visually inspect for any potential damage to wind exposure including items such as anchors and securement of the casing/wall panels.

### 2.3.2 Wetting Idle Wood Sections

2.3.2.1 For a combustible cooling tower circulate water sufficiently to wet the inside surfaces before the fans are started.

2.3.2.2 Wet idle wood sections by circulating water at intervals sufficient to keep the wood from drying out.

### 2.3.3 Collapse

2.3.3.1 Continually treat water in the cooling system to maintain effective concentrations of treatment chemicals. Carefully design the treatment system to prevent damage from biological growth, corrosive products, and sedimentary deposits.

2.3.3.2 To prevent ice formation on cooling towers during the winter months, rotate the fans in reverse, which provides heat (from the warm water) to melt the ice. This procedure is particularly effective in counterflow cooling towers whose enclosed sides retain heat. Follow manufacturers' instructions on frequency and duration.

2.3.3.3 For crossflow cooling towers, provide a constant distance between louvers and fill at all levels. This constant distance will result in a uniform light water cascade down the inboard edge of the louvers, which protects the fill from ice formation and possible damage.

## 2.4 Utilities

### 2.4.1 Electrical Equipment and Wiring

2.4.1.1 Install all electrical equipment and wiring pertaining to water cooling towers, including the arrangement of cooling tower pumps and fan motors, in accordance with the National Electrical Code (NFPA 70) or applicable local electrical codes.

2.4.1.2 Provide motors rated for outdoor use to protect them from dirt or moisture and to prevent sparks from reaching adjacent combustible construction.

2.4.1.3 Arrange a closed circuit alarm system to operate when the fire protection system is tripped; interlock the system to stop the cooling tower fan. Provide a key-operated bypass switch to take the fans off the circuit for testing the system. Provide an alarm activated by the fire detection system in a constantly attended location so the fan can be shut down manually.

2.4.1.4 Provide an accessible, manually operated fan shutoff switch for emergencies.

2.4.1.5 If practical, arrange the process water pumps so the pumps will start automatically and pump into the fire protection system if the deluge valve operates. It is preferable to not utilize the process water pumps for the fire protection system and instead provide an independent fire protection system.

2.4.1.6 Provide high-vibration cutout switches and oil level safety shutdown devices on the cooling towers to guard against a major mechanical failure, which could cause extensive downtime for repair, as well as potential safety issues from damaged fan blades or drive shafts.

### 2.4.2 Lightning Protection

2.4.2.1 Provide lightning protection for hyperbolic cooling towers, cooling towers on tall buildings, and for other cooling towers in lightning-prone areas (Refer to Data Sheet 5-11, *Lightning and Surge Protection for Electrical Systems*).

### 2.4.3 Cooling Equipment Capacity

2.4.3.1 Evaluate the capacity and provide redundant cell capacity if needed for critical cooling equipment when supporting high-value processes. Review each cooling tower installation, to verify the adequacy, of the extra cooling tower capacity, if required, for the intended purpose and as part of the acceptance process.

## 2.5 Ignition Source Control

2.5.1 Do not permit smoking on or adjacent to any cooling tower of combustible construction or one that contains combustibles. Post signs to this effect and strictly enforce this requirement.

2.5.2 Explore alternatives to hot work on cooling towers. If there is no alternative to hot work in the proximity of combustible cooling tower materials, use the FM hot work permit system.

2.5.3 Install any temporary wiring that may be necessary during repairs in accordance with Article 305 of the National Electrical Code, NFPA 70, or applicable local electrical codes.

2.5.4 Pay attention to ignition sources when a cooling tower has been drained. One scenario could be a basin water electric heater igniting an FRP water basin.

## 2.6 Contingency Planning

### 2.6.1 Equipment Contingency Planning

When a cooling tower breakdown would result in an unplanned outage to site processes and systems considered key to the continuity of operations, develop and maintain a documented, viable cooling tower equipment contingency plan per Data Sheet 9-0, *Asset Integrity*. See Appendix C of that data sheet for guidance on the process of developing and maintaining a viable equipment contingency plan. Also refer to sparing, rental, and redundant equipment mitigation strategy guidance in that data sheet.

If the equipment contingency plan relies on the use of rental cooling towers, then a contractual arrangement is needed. Consider the terms and conditions of the contract, including provisions for widespread events clause (Force majeure clauses).

One key aspect of the success of rental cooling towers involves arranging the piping systems and electrical systems in advance as part of their design to ensure quick hook-up of a replacement cooling tower. On all cooling towers, provide a blind flange on the cooling tower supply and return lines to facilitate use with rental cooling towers where they are being relied on as part of the equipment contingency plan. A flange or downstream isolation valve will ensure the cooling tower can be isolated from the supply line.

2.6.2 In addition, include the following elements in the equipment contingency planning process specific to cooling towers:

A. Processes:

1) Cooling capacity needed vs. rentals available
2) Shift to other in-house sources (e.g., public water)
3) Shift to other sites (e.g., data center)
4) Margin-of-error (capacity vs minimum requirements)
5) Environmental permitting requirements (out-of-limits, penalties)

B. Siting:

1) Space availability for ganging units
2) Temporary connection compatibility
3) Electrical compatibility
4) Pumping requirements (flow rates, elevations, etc.)

### 2.7 FM Approved Cooling Tower Designs

2.7.1 Ensure FM Approved cooling towers are designed and installed as specified and in accordance with any limitations in the Approval Guide.

## 3.0 SUPPORT FOR RECOMMENDATIONS

### 3.1 Cooling Tower Applications

Cooling towers are used to cool process water. Warm water is distributed in the cooling tower by spray nozzles, splash bars, or filming-type fill in a manner that exposes a very large water surface area to atmospheric air, thus cooling it. The atmospheric air is circulated either by fans, convective currents, natural wind currents, or the induction effect from sprays.

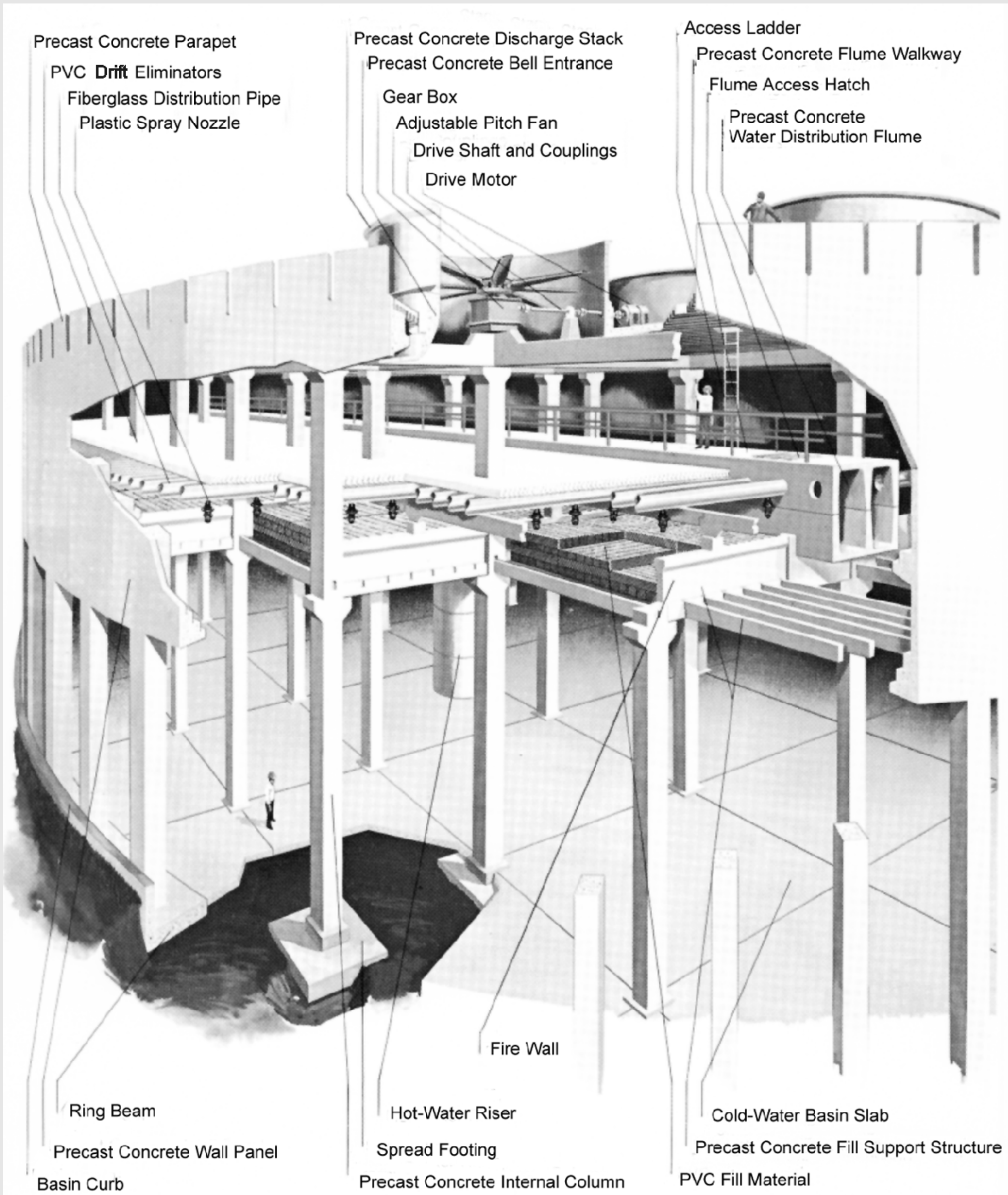


*Fig. C-1. Precast concrete round multi-fan mechanical draft cooling tower (Courtesy Zurn Industries Inc.)*

### 3.1.1 FM Approved Cooling Towers vs. Those That Are Not FM Approved

This data sheet includes information on both FM Approved cooling towers and those that are not FM Approved that fall into one of the following categories:

A. Cooling towers of limited combustibility (fire does not self-propagate in cooling tower components beyond the area of exposure) according to acceptance criteria in FM 4930. This type usually incorporates either fire retardant (FR) fill and other components in a noncombustible shell, or noncombustible fill within an FR fiberglass-reinforced plastic shell. These could include single-cell or multi-cell cooling towers. Cooling towers of limited combustibility due to their design do not require additional capacity or redundancy.

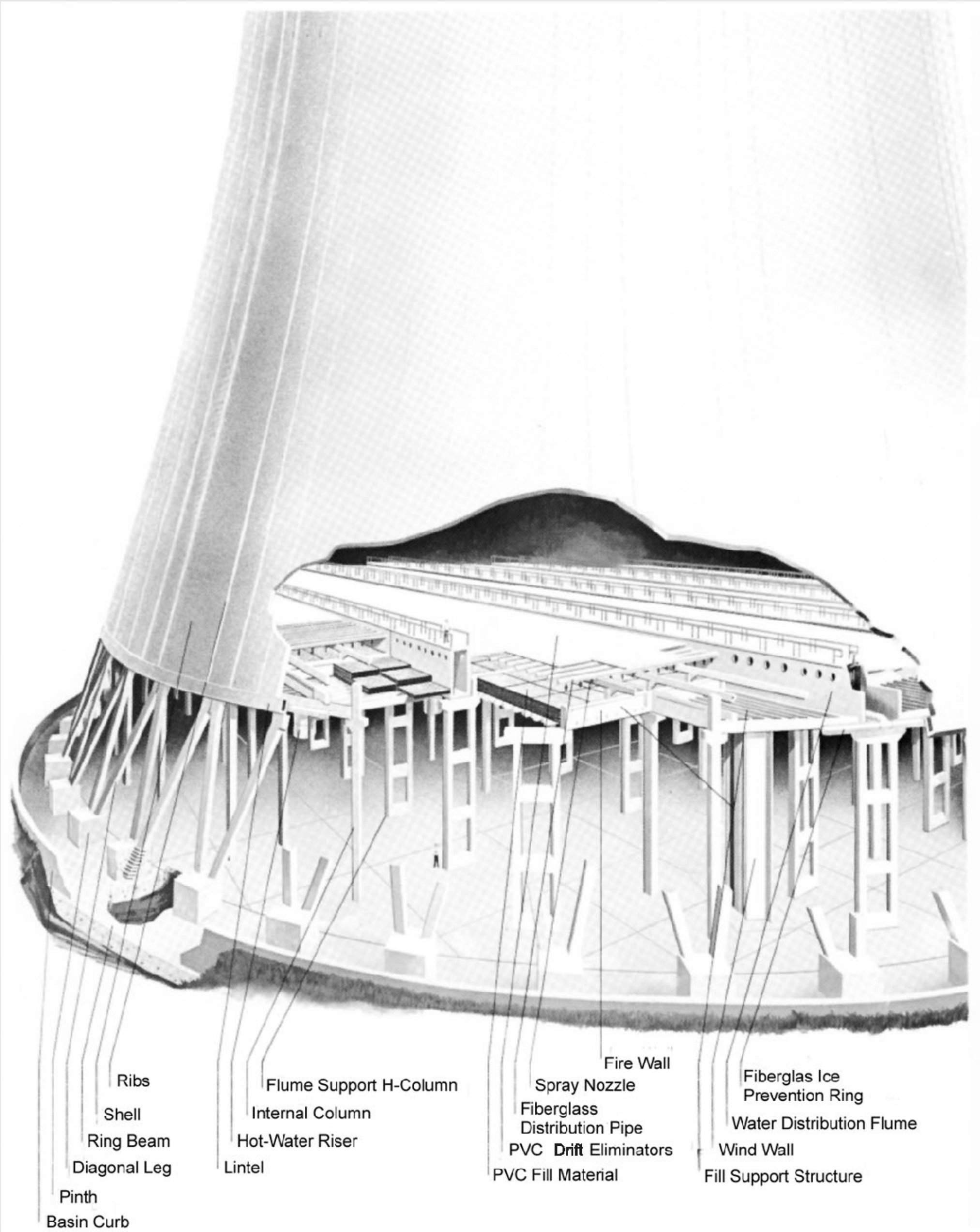


*Fig. C-2. Precast concrete natural-draft hyperbolic cooling tower (Courtesy Zurn Industries Inc.)*

B. Single-cell cooling towers, where the fire spread through testing, is shown to be limited to only a portion of a given cell according to Acceptance Criteria found in FM 4930.

C. Multi-cell cooling towers, with additional capacity so that, under worst-case fire conditions, a fire may burn out one cell, but be limited to that cell and not affect adjacent cells. With this type of cooling tower design, at least one additional cell is always provided so that extra capacity and reliability will always be available. FM Approval testing of multi-cell cooling towers confirms that the fire will be contained to a given cell.

All types of FM Approved cooling towers have been tested in full-scale fire tests and shown to be acceptable without automatic sprinkler protection. See the Approval Guide for further details on FM Approved cooling towers. FM Approvals does not Approve cooling tower fill or cooling tower components (drift eliminators, fan decks, etc.). They only Approve the cooling tower as an assembly based on full-scale fire testing of the complete cooling tower assembly.

### 3.2 Types of Cooling Towers

Figure 7 shows the types and main parts of common cooling towers.

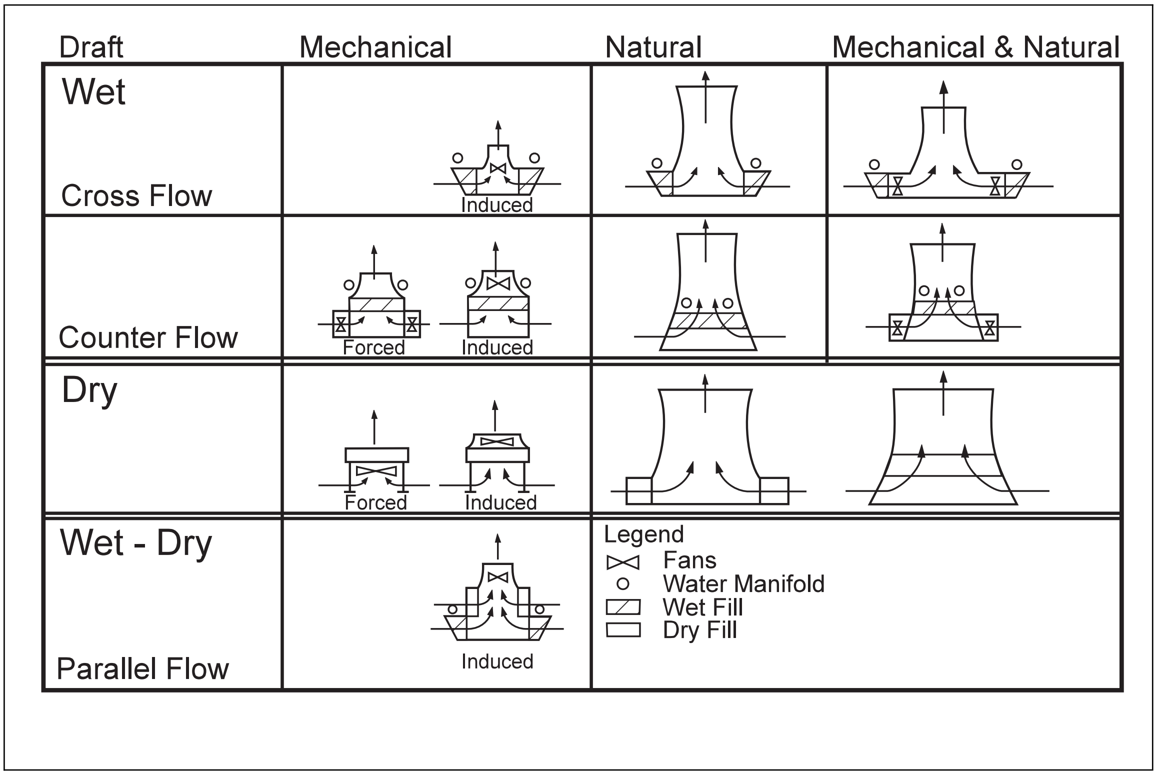


*Fig. 7. Types of important cooling towers in use*

#### 3.2.1 Wet or Dry

In wet cooling towers the water to be cooled is exposed directly to the airstream, while in dry cooling towers it is run through piping similar to a radiator. Some cooling towers may have a wet section and, above it, a dry section. Either or both portions of such cooling towers may be used at any time depending on load requirements and atmospheric conditions.

#### 3.2.2 Mechanical Draft or Natural Draft

In mechanical-draft cooling towers the cooling air is moved by fans, usually electrically driven. In natural-draft cooling towers air movement is provided by the stack effect resulting from the difference in density between two interconnected columns of air at different temperatures. The latter are called “hyperbolic” cooling towers because the stack generally is a thin, reinforced concrete shell with a surface generated by revolving a hyperbola about a vertical axis. A few cooling towers have been constructed of steel with approximately the same shape. Some cooling towers combine natural and mechanical draft, using natural draft normally and a combination of the two when atmospheric conditions warrant.

#### 3.2.3 Counterflow or Crossflow

In a counterflow cooling tower the cooling air moves upward against the falling water, while in a crossflow cooling tower the cooling air moves horizontally across the falling water. Either type may use mechanical or natural draft.

### 3.2.4 Induced-Draft or Forced-Draft

Induced-draft cooling towers are mechanical-draft cooling towers with a fan, usually located at the top of the cooling tower. Air is drawn out of the cooling tower after it has entered through louvers in the sides. They may be either the crossflow or counterflow types. A forced-draft cooling tower has a fan at the base of the cooling tower, which blows outside air through the dripping water and out the open top of the cooling tower. Forced-draft cooling towers usually are small.

### 3.2.5 Induced-Draft Counterflow (Combustible)

Figure 1 shows a typical induced-draft, counterflow cooling tower. The fan is at the top of the cooling tower. Air enters through the louvers (13) at the base of the cooling tower, flows upward through the fill (11) and drift eliminators (9), and then is discharged through the fan cylinder (5). Generally, the fill and drift eliminators are combustible. Warm water enters at the inlet (10) and is discharged over the combustible fill. The water passes through the fill and approximately 2% to 3% is evaporated. The other 97% to 98% is cooled and falls to the basin (14). Water droplets, called drift, carried in the updraft are largely trapped by the drift eliminators and returned to the basin. Dead air spaces outside the flow of air create dry sections below the deck on the walls and within the fill. There is sufficient space below the fan deck for installation of a sprinkler system (1).

### 3.2.6 Induced-Draft Counterflow (Noncombustible)

Figure 8 shows another type of induced-draft, counterflow cooling tower. This cooling tower differs from that shown in Figure 1 in that the shell is reinforced concrete and the fill consists of vertically hung sheets of cementitious board. This type of cooling tower generally contains little combustible material.

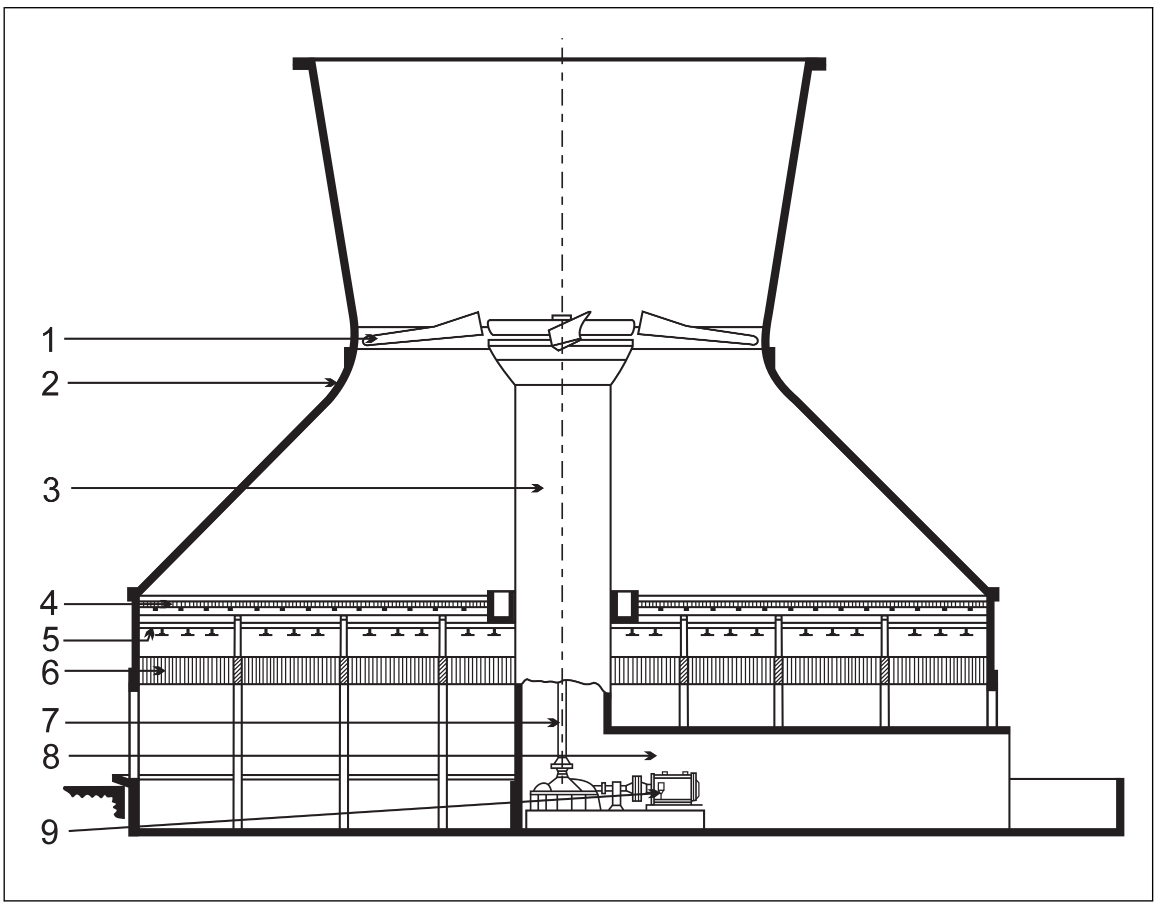


*Fig. 8. Cross section of a counterflow induced-draft cooling tower (An alternate design to that shown in Figure 1.)*

### 3.2.7 Induced-Draft Crossflow (Open Basin)

Figure 2 shows a typical induced-draft, crossflow cooling tower. The fan (2) is at the top of the cooling tower.

In this cooling tower, the lower portion of the drift eliminators, fan deck, and the walls below the fan deck are out of the direct flow of moist air and may be dry. Other elements of a cooling tower, that are wet while the cooling tower is in service, will dry out when the cooling tower is shut down.

Sprinklers can be installed below the fan deck to protect such areas. Sprinklers will also protect the drift eliminators while the cooling tower is shut down.

There is not sufficient space between the top of the fill (11) and the distribution basin (8) for conventional sprinkler protection. The fill can be protected during the periods it may be dry by providing special nozzles FM Approved for this use outside of the fill area. The nozzles direct water across the space below the basin. Recommendations of the manufacturer of the FM Approved nozzles must be followed for satisfactory water distribution. Minimum nozzle pressure will depend on the width and length of the fill and the design of the distribution deck. Water demand is difficult to estimate because it is dependent on pressure rather than density. With wide fill areas, nozzles may be placed on both sides of the fill so the water will be directed over the entire top surface.

In the latest designs of crossflow cooling towers, the distribution deck is omitted and target nozzles (metering orifices) are fitted to the hot water basin. (See detail in Figure 4.) With an open basin and no distribution deck, sprinkler protection can be provided only by removing or omitting fill below the basin as needed for clearance and using upright sprinklers below the basin. If no fill can be omitted, a cooling tower nozzle FM Approved for this purpose can be used.

### 3.2.8 Induce-Draft Crossflow (Closed Basin)

Figure 4 shows an induced-draft, crossflow cooling tower with a covered hot water basin (8). This is similar to the cooling tower shown in Figure 2, except the fan deck has been extended to cover the basin.

### 3.2.9 Hyperbolic Crossflow and Counterflow

Figure 9 shows a typical hyperbolic crossflow cooling tower. The fill area can be similar to either Figure 2 or Figure 4. Except for the replacement of the fan with a natural draft stack, the problems of protecting the fill are similar to those of mechanical-draft crossflow cooling towers. Detection presents special problems with hyperbolic cooling towers because of lack of a fan deck.

Figure 10 shows a typical hyperbolic counterflow cooling tower. This type is similar to that in Figure 8 with the fan and drive removed. Although the cooling tower construction is noncombustible, the presence of combustible fill may warrant the consideration of fire protection on a case-by-case basis. Usually there are not sufficient combustibles present for a recommendation for fixed fire protection.

### 3.2.10 Forced Draft

Figure 11 shows a typical forced-draft cooling tower. Forced-draft cooling towers are usually counterflow, as illustrated. The loss experience for such cooling towers is good. The fan and drive are located below the fill and exterior to the cooling tower proper. Also, the frame is usually noncombustible, and there are few dry areas while the cooling tower is in operation. Such cooling towers are usually of low value.

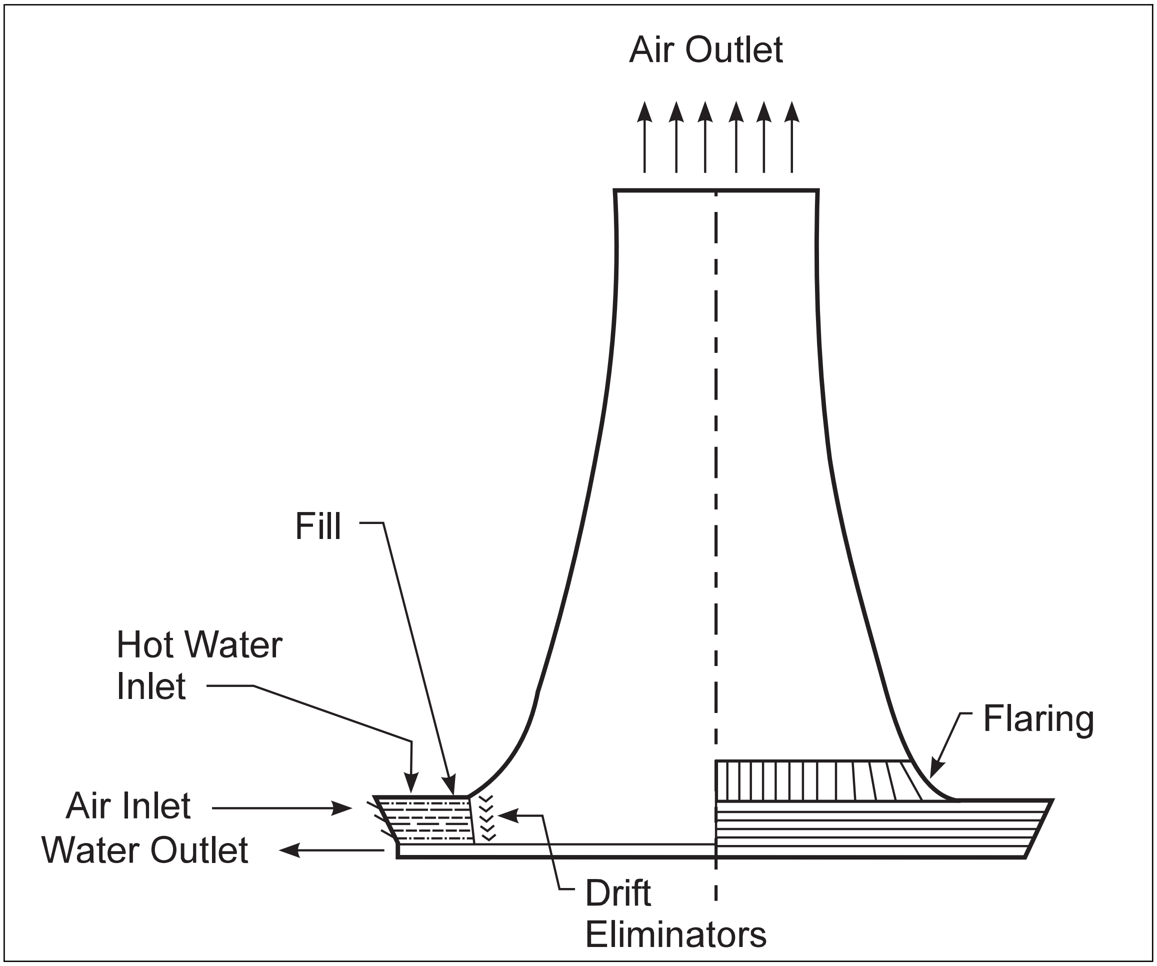


*Fig. 9. Crossflow hyperbolic cooling tower.*

### 3.2.11 Dry Cooling Towers

In a dry cooling tower, the water is run through piping similar to a radiator or condenser (Figure 12). Nearly all large dry-cooling tower technology has been developed in Europe, where a number of installations have been operating successfully. Dry cooling towers generally do not pose a fire hazard because they are of noncombustible construction.

Lately, dry cooling towers have attracted considerable attention in the United States and may become more popular as available water supplies become scarcer.

Air-cooled heat exchangers (also called air-fin or fin-fan units) are similar in construction. These are commonly used in chemical processing facilities for cooling or condensing many types of fluids, including ignitable liquids. These can pose severe fire challenges and should be constructed and protected per Data Sheet 7-14, *Fire Protection for Chemical Plants*.

### 3.2.12 Wet/Dry Cooling Towers

Cooling towers that usually contain a conventional mechanical-draft unit in combination with an air-cooled (finned-tube) heat exchanger (Fig. 13) are wet/dry cooling towers. They are used either for reduction of the discharge vapor plume or for water conservation. The hot, moist plumes discharged from cooling towers are especially dense in cool weather. On some installations, the lessening of these plumes is required to avoid restricted visibility on roadways, bridges, and buildings.

These cooling towers can pose fire hazards if the wet section is built of combustible material.

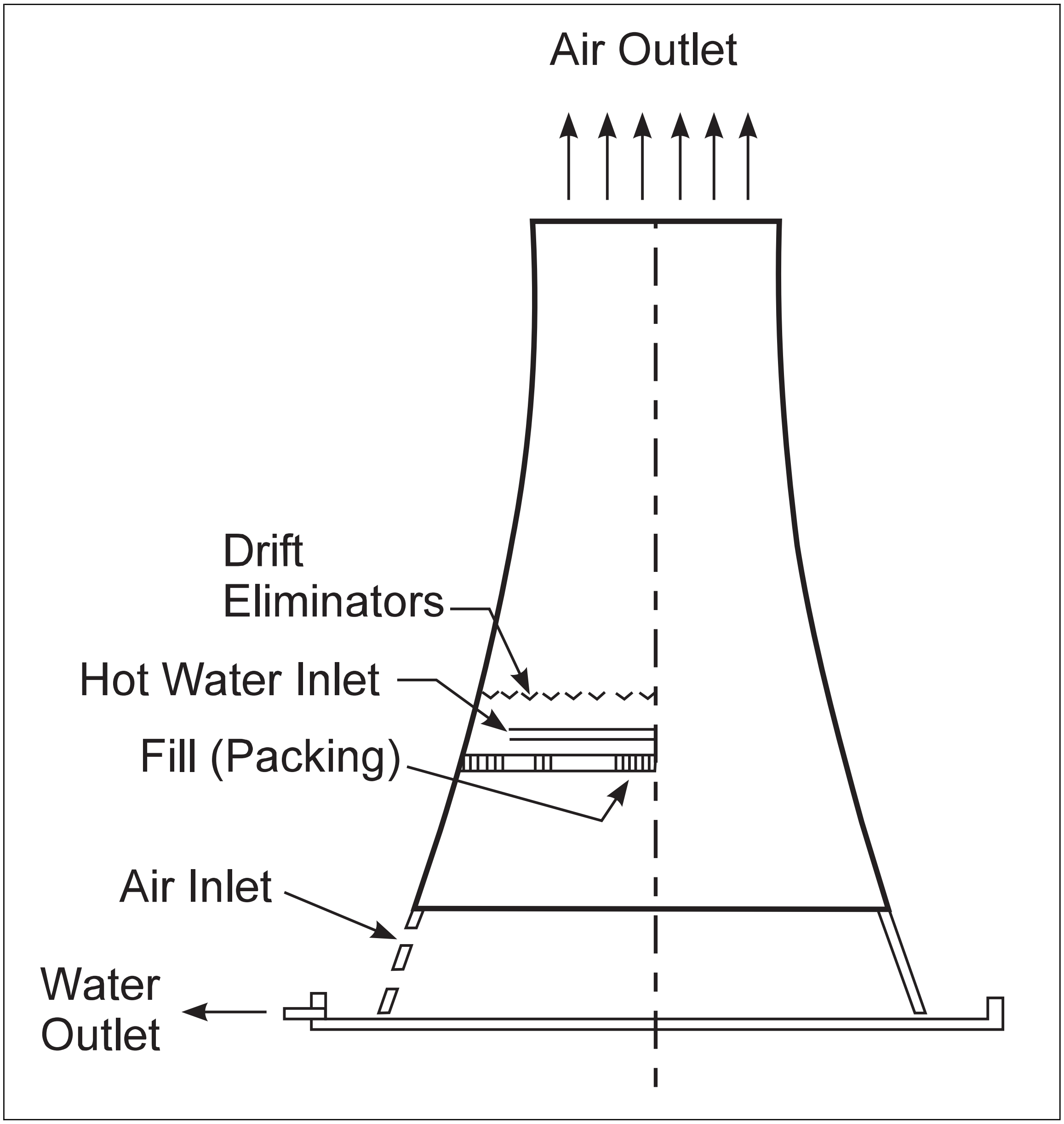


*Fig. 10. Counterflow hyperbolic cooling tower.*

### 3.3 Materials of Construction

Materials commonly found in cooling tower construction are selected to resist the generally corrosive conditions. These materials can be wood, concrete, plastic, or metal. Cooling towers of combustible construction present a potential fire hazard. This hazard exists both when the cooling tower is shut down and when the cooling tower is in operation because of relatively dry areas within the cooling tower. The use of engineered plastic cooling towers is significantly increasing because they generally require much less maintenance and are more energy-efficient than cooling towers with galvanized steel shells.

**Wood.** Wood is used for all static components, excluding hardware. Redwood and fir predominate, usually with post-fabrication pressure treatment with preservative chemicals that prevent the attack of wood-destructive organisms, such as termites or fungus. However, these woods still pose a fire hazard, unless they have been FM Approved as being fire-retardant materials. At the present time there are no FM Approved fire-retardant wood products.

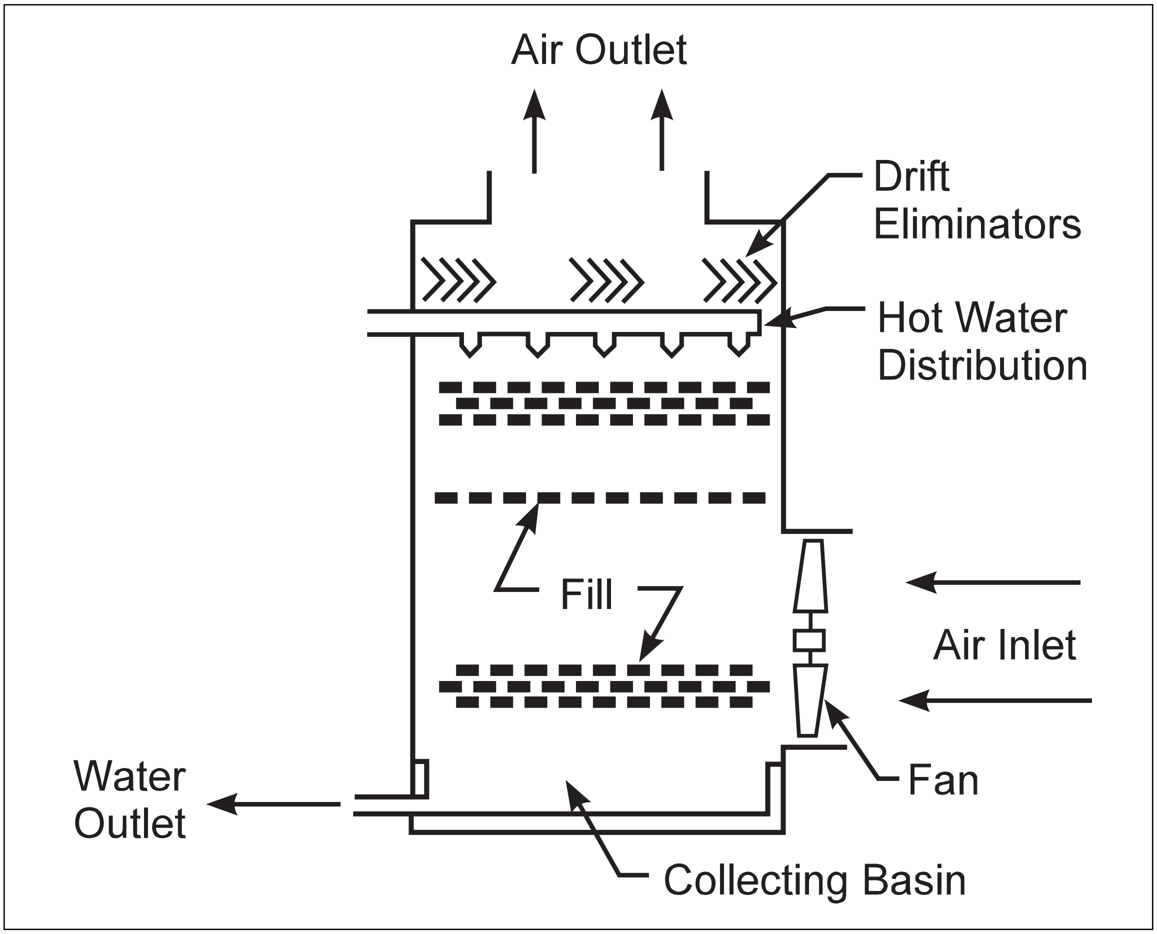


*Fig. 11. Typical forced draft cooling tower (counterflow)*

**Plastics.** Fiberglass-reinforced plastic materials have broad use, especially for complex-shaped components, such as piping, fan cylinders, fan blades, and structural connecting members. Polypropylene, ABS (acrylonitrile-butadiene-styrene), and other plastics are used as fill bars and flow orifices. All of these materials pose fire hazards and the need for protection must be evaluated when they are used in cooling towers.

The use of PVC is increasingly popular. Some FM Approved cooling towers utilize PVC materials as louvers, fills, and drift eliminators without the need for sprinkler protection. These materials are not considered interchangeable, so any deviation from the materials Approved for use with a given cooling tower must be evaluated and may require sprinkler protection.

Sheets of neoprene-asbestos are often formed for fill and eliminators. Reinforced plastic mortar is finding use in larger piping systems coupled with neoprene O-ring-gasketed ball and socket joints. These materials have not been tested by FM Approvals. Consequently, in cases where these materials are used, they must be evaluated individually to determine the fire hazard and protection warranted.

**Concrete, Masonry and Tile.** Concrete is typically specified for the cold water basin of field-erected cooling towers and is finding wide use in piping, casing, and as structural elements of large cooling towers, primarily in the power industry. Special tiles and masonry generally are used where aesthetic considerations are important. Cementitious board has been used for casing, louvers, eliminators, and fill to meet noncombustible requirements.

**Metals.** Steel with galvanized zinc coating may be specified for small and medium size installations.

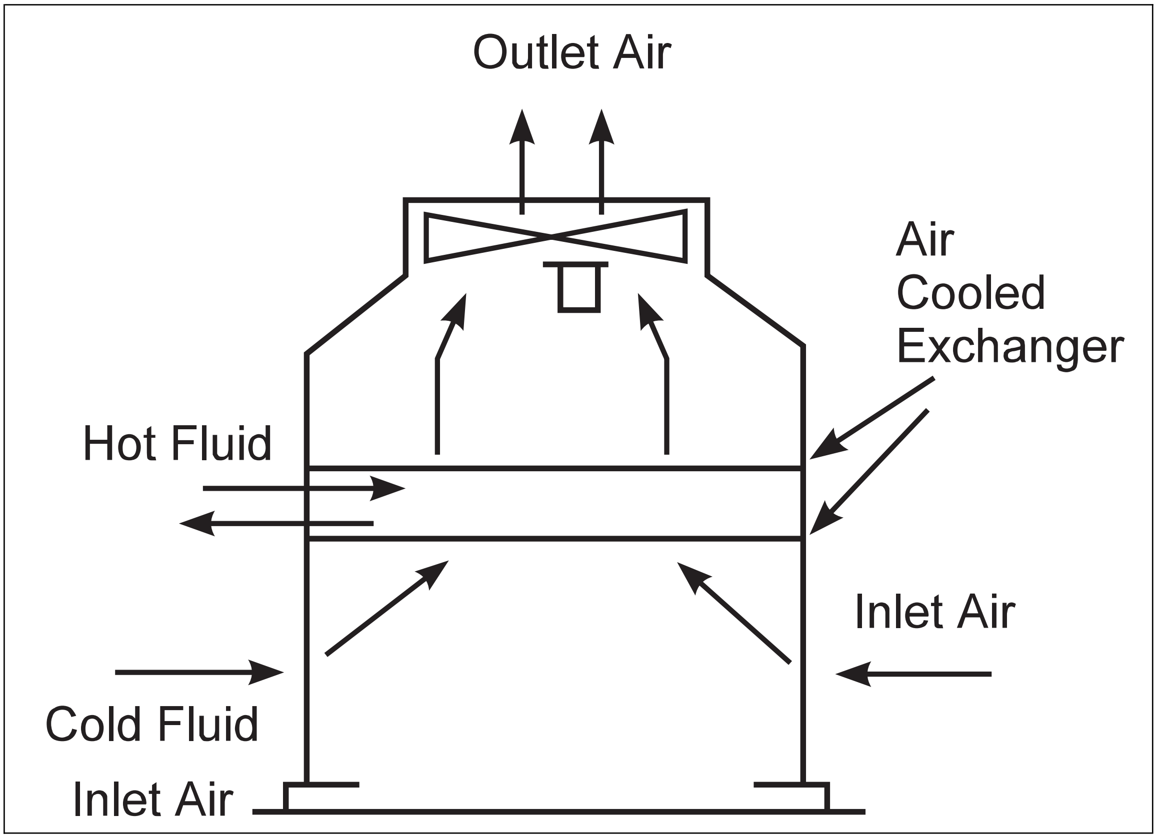


*Fig. 12. Dry cooling tower*

### 3.4 Design Considerations

#### 3.4.1 Fire

An understanding of the construction of a cooling tower is helpful in recognizing the nature and location of potential fire hazards. A wood cooling tower and its components are supported by framing, generally treated redwood or Douglas fir. Noncombustible cooling towers generally use reinforced concrete supports. The shell of natural-draft (hyperbolic) units is independently supported by diagonal, reinforced-concrete columns on a ring foundation.

The fan cylinders on mechanical-draft cooling towers (or the hyperbolic shell on natural-draft units) provide the exit for air flow. Fan cylinders can be of wood, fiberglass, corrosion-resistant metal, or reinforced concrete.

The fan deck, which supports the fan cylinders and related fan assemblies, is usually made of wood. Because the fan deck is drier than any other part of the cooling tower and is the most accessible to ignition sources, the wood is often covered with asbestos cement or other noncombustible material.

The cooling tower fill presents the most serious fire potential in a cooling tower, especially if combustible materials are used. This is where the cooling action occurs by means of heat transfer and evaporation, and it is where most effort in fire prevention, detection, and suppression must be directed. Fill will be wet while the cooling tower is in operation but dries out when the cooling tower is shut down. Plastic fill does not absorb moisture and dries faster than wood fill. During shutdown, all combustible fill is dry enough to burn.

The fill consists of slats or bars, supported by fiberglass or plastic-covered wire grids or other support arrangements. It is located between the hot-water basin and the cold-water collection basin at the base of the cooling tower. On a mechanical-draft unit (counterflow or crossflow), the fill runs the entire length of the cooling tower on one or both sides. On a natural-draft cooling tower, the fill circles the hyperbolic shell or sits within the lower part of the shell (counterflow cooling towers).

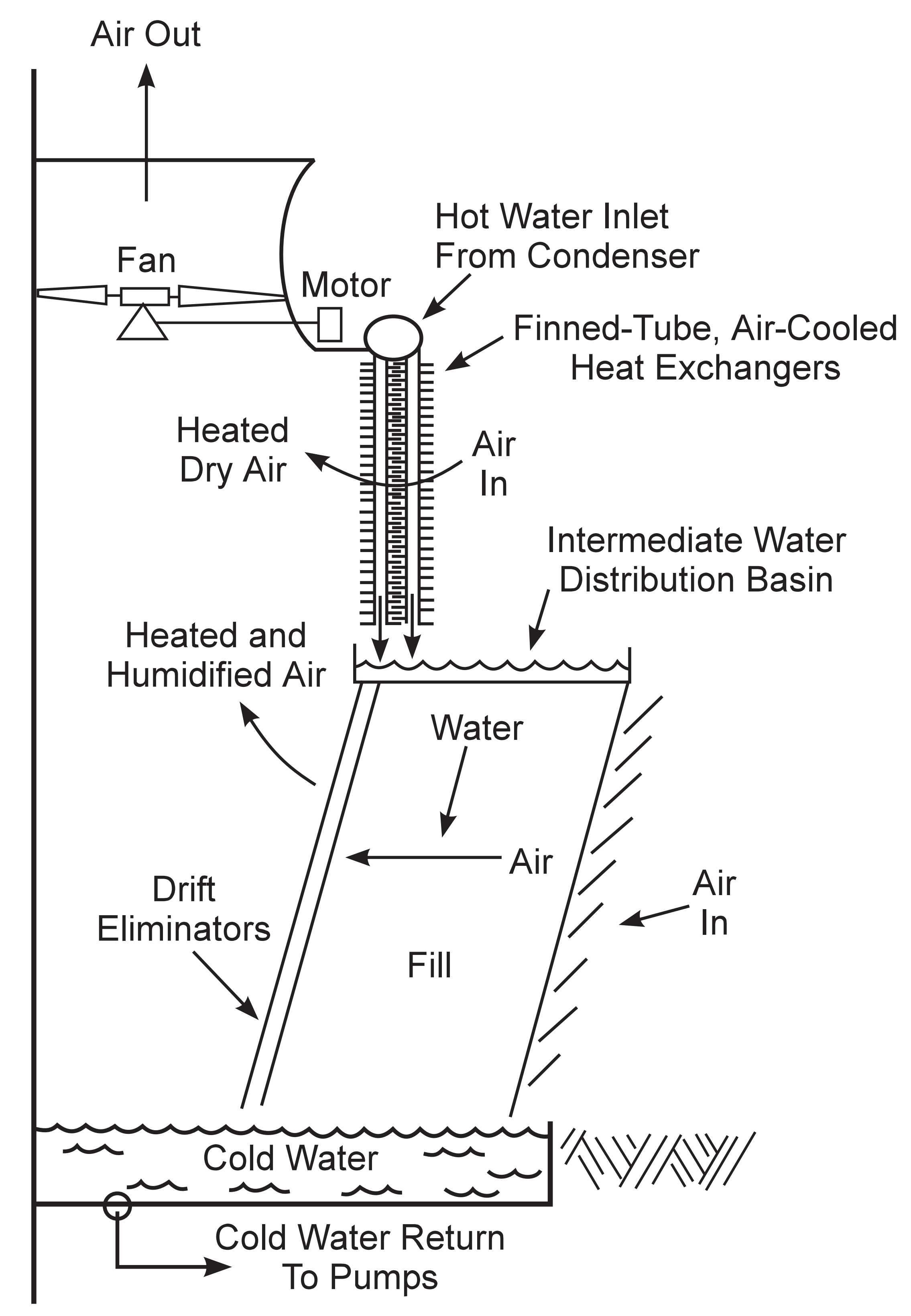


*Fig. 13. Combination wet-dry cooling tower*

Redwood had formerly been used years ago as a fill material, but plastics primarily polyvinyl chloride (PVC), polypropylene, polyethylene, and polystyrene have largely been replacing redwood. Polystyrene presents the greatest fire potential. Noncombustible fills may include stainless steel, ceramic tile and asbestos cement. Asbestos cement is not commonly used in new installations.

Drift eliminators are similar to fill, except they are arranged as baffles on rigid supports. Their purpose is to minimize the amount of water droplets carried out of the cooling tower in the air stream.

Air-inlet louvers may be made of wood, plastic, asbestos cement, or concrete. Avoid wood or other combustible material louvers; even on protected cooling towers they are not usually covered by the fire suppression system and can become exceptionally dry and prone to ignition.

Ignition within a combustible cooling tower can be caused by welding or cutting operations, smoking, overheated bearings, electrical failures, or from outside sources, such as incinerators, smoke stacks, and other heat-or spark-producing equipment. Maintenance vehicles operating in or around cooling towers can start a fire as the result of a fire in the vehicle itself.

Water used for cooling flammable gases or ignitable liquids may constitute an unusual hazard. The hazard exists when the cooling water pressure is less than that of the material being cooled. The gas or liquid can mix with the cooling water, be transported via the cooling water return line, and be released at the cooling tower distribution system where it can be ignited.

#### 3.4.2 Wind

Cooling towers have to be situated in unsheltered locations to operate efficiently. They often are located on the roofs of buildings to take advantage of the higher wind velocity. Due to their siting they can be exposed to high winds, and wind damage continues to be a key exposure to guard against.

The natural-draft (hyperbolic) cooling towers must be tall, 300 ft (91 m) or more, to function effectively. The dynamic response of such cooling towers to buffeting winds can provoke collapse and cause substantial damage to the unit.

Small package roof-mounted cooling towers are sometimes installed without sufficient anchorage. These may be blown about, causing damage to the unit and the roof.

#### 3.4.3 Earthquake

The fill in cooling towers is light and not subject to disturbance when exposed to moderate shaking. However, during one earthquake, fill in a roof-mounted cooling tower was disturbed while fill in cooling towers at ground level was undisturbed.

The hyperbolic cooling tower is a cantilever structure and can experience magnification of amplitude, as does a high-rise building.

#### 3.4.4 Collapse

Several events can lead to the collapse of a cooling tower. The actual collapse is generally caused by a combination of events.

Cooling towers often are operated intermittently, resulting in atmospheres that are alternately wet and dry. Consequently, deterioration and loss of strength of some of the cooling tower materials takes place. Especially for older wooden cooling towers, collapse potential needs to be carefully monitored over time.

Strong caustic or acidic solutions attack most materials, reducing their strength. Wood in a cooling tower can become weak by biological attack.

Air-borne particles or accumulations of small amounts of sediment introduced by makeup water can overload the cooling tower. Also, sediment deposits can appear in open sprinkler systems. Pressure differentials in the atmosphere at different points in the sprinkler system move moisture through the piping, depositing sediment along the connecting piping.

Algae, slime-forming bacteria, fungi, and other microorganisms breed easily in cooling tower systems because the water is continually being introduced to fresh supplies of organisms present either in the makeup water or in air passing through the cooling tower. These growths can form an insulating coat on heat transfer surfaces, boost the rate of corrosion, and cause the degradation of wood used in cooling towers.

Ice buildup on fill slats is a constant threat, particularly regarding localized collapse. Cooling towers may require protection against ice formation when the wet-bulb temperature is below 32°F (0°C), or during shutdown when the temperature drops below 32°F (0°C).

### 3.4.5 Lightning

Lightning is a primary natural cause of cooling tower fires. Because cooling towers are large, free-standing structures located in remote areas of a property or on tall buildings, they are ideal targets for lightning strikes.

### 3.4.6 Fire Exposure

A significant percentage of fires in cooling towers of combustible construction are caused by ignition from outside sources, such as incinerators, smoke stacks, or exposure fires. Fires in cooling towers also may create an exposure hazard to adjacent buildings and other cooling towers. Therefore, distance separation from buildings and sources of ignition, protection for the cooling towers, and the use of noncombustible construction are primary considerations in preventing these fires.

### 3.4.7 Hail

In recent years, several hail losses to cooling towers have been experienced. Consideration must be given to this issue when constructing cooling towers in areas exposed to a high incidence of hailstorms. Most of the hail damage has involved roof-mounted cooling towers and denting of the cooling tower enclosure from hail impact, as well as damage to the fan.

### 3.5 Business Interruption

A cooling tower can be critical to the operation of an entire facility. Loss of a cooling tower could result in the shutdown of some or all production.

### 3.6 Inspection, Testing and Maintenance

As with any mechanical device, a cooling tower can provide optimum thermal performance, efficient operation, fire safety, and maximum service life only through a well-administered program of regular inspection, testing and maintenance as part of the asset integrity program. Most cooling tower manufacturers will furnish operating and maintenance manuals (including parts lists for their specific units) which need to be followed closely.

## 4.0 REFERENCES

### 4.1 FM

Data Sheet 1-2, *Earthquakes*
Data Sheet 1-28, *Wind Design*
Data Sheet 2-8, *Earthquake Protection for Water-Based Fire Protection Systems*
Data Sheet 2-81, *Fire Protection System Inspection, Testing and Maintenance and Other Fire Loss Prevention Inspections*
Data Sheet 5-11, *Lightning and Surge Protection for Electrical Systems*
Data Sheet 5-20, *Electrical Testing*
Data Sheet 5-48, *Automatic Fire Detection*
Data Sheet 7-14, *Fire Protection for Chemical Plants Flammable Gas Processing Equipment and Supporting Structures*
Data Sheet 7-78, *Industrial Exhaust Systems*
Data Sheet 9-0, *Asset Integrity*

Understanding the Hazard: *Fire in Cooling Towers* (PO044)
Understanding the Benefit: *FM Approved Cooling Towers* (P11085)

FM 4930, *Approval Standard for Cooling Towers*

### 4.2 Other

National Fire Protection Association (NFPA). NFPA 70, *National Electrical Code*.

National Fire Protection Association (NFPA). NFPA 214, *Standard on Water-Cooling Towers*.

## APPENDIX A GLOSSARY OF TERMS

**FM Approved:** Products and services that have satisfied the criteria for Approval by FM Approvals. Refer to the *Approval Guide*, an online resources of FM Approvals, for a complete listing of products and services that are FM Approved.

**Package-type cooling tower:** These cooling towers are smaller in size and are factory assembled rather than field erected. The package-type units can be roof mounted or ground mounted and will typically fit on a trailer with all of it's components delivered to the site.

## APPENDIX B DOCUMENT REVISION HISTORY

The purpose of this appendix is to capture the changes that were made to this document each time it was published. Please note that section numbers refer specifically to those in the version published on the date shown (i.e., the section numbers are not always the same from version to version).

**April 2020.** This document has been completely revised. Significant changes include the following:

A. Clarified the scope of the document.

B. Added detailed information on FM Approval testing process for multi-cell cooling towers.

C. Added emphasis on wind and collapse exposures.

D. Added an appendix that contains a contingency planning outline.

**April 2017.** Interim revision. Document scope was modified to further clarify requirements for additional cooling tower capacity.

**October 2016.** Interim revision. The document scope was modified to remove the reference to multi-cell towers needing to provide at least 75% of the design thermal capacity as this has been removed as an approval requirement in FM 4930.

**April 2013.** The intent of the recommendation for protection of combustible end walls on a cooling tower was clarified. Additionally, the required thermal capacity for a multi-cell cooling tower was clarified.

**January 2013.** Several of the recommendations were clarified, and the importance of conducting structural inspections of the tower was emphasized. Additionally, separation distances for cooling towers were reduced, detail was provided on cooling equipment capacity and redundancy requirements, and strict controls were emphasized for hot work.

**April 2012.** Terminology related to ignitable liquids has been revised to provide increased clarity and consistency with regard to FM Global's loss prevention recommendations for ignitable liquid hazards.

**September 2010.** Clarification was provided for protection of combustible fan cylinders on air cooled condensers.

**January 2006.** Changes for this revision primarily involve clarification of various recommendations.

**September 2005.** Changes for this revision primarily involve clarification of various recommendations.

**May 2003.** Minor editorial changes were made for this revision.

**January 2001.** This revision of the document has been reorganized to provide a consistent format.

Information has been added on various types of FM Approved cooling towers, including recently FM Approved multi-cell towers with redundant capacity.

**June 1984.** Complete revision.

**May 1978.** First issued, supersedes Handbook Chapter 74.

## APPENDIX C NFPA STANDARD

NFPA 214, Standard on *Water-Cooling Towers*, describes sprinkler protection for water cooling towers. Data Sheet 1-6 contains recommendations for towers with fill heights greater than 37 ft (11.3 m) and criteria for new cooling tower design. Data Sheet 1-6 also contains information dealing with FM Approved cooling towers and components. These conditions are not covered in NFPA No. 214.