NFPA

214

WATER COOLING TOWERS 1977

NATIONAL FIRE PROTECTION ASSOCIATION

470 Atlantic Avenue, Boston, MA 02210

3M-12-77-HP-FP

Printed in U.S.A.

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See Official NFPA Definitions at the back of this pamphlet.

Standard for
Water-Cooling Towers

NFPA 214–1977

Origin and Development of NFPA 214

The subject of the protection of water-cooling towers was first considered by the NFPA Committee on Building Construction in 1957 and a progress report on that subject was published in the Advance Reports of that year. In 1958, a new Committee on Water-Cooling Towers was appointed and a Tentative Standard on Fire Protection of Water-Cooling Towers proposed by the Committee was adopted by the Association in that year. Final adoption was secured in 1959. Revised editions were published in 1961, 1966, 1968, 1971, and 1976.

1977 Edition of NFPA 214

This edition of the Standard on Water-Cooling Towers was adopted at the Fall Meeting in Nov. 1977, and supersedes the 1976 edition. This edition represents a complete revision from the 1976 edition.

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Standard on
Water-Cooling Towers

NFPA 214 – 1977

Foreword

0-1 The fire record of water-cooling towers indicates the failure to recognize the extent or seriousness of the potential fire hazard of these structures both while in operation or when temporarily shut down. Cooling towers of combustible construction, especially those of the induced draft type, present a potential fire hazard even when in full operation because of the existence of relatively dry areas within the tower.

0-2 A significant percentage of fires in water-cooling towers of combustible construction are caused by ignition from outside sources such as incinerators, smokestacks, or exposure fires. Fires in cooling towers may create an exposure hazard to adjacent buildings and processing units. Therefore, distance separation from buildings and sources of ignition or the use of noncombustible construction are primary considerations in preventing these fires.

0-3 Ignition within these structures can be caused by welding or cutting operations, smoking, overheated bearings, electrical failures and other heat or spark producing sources.

0-4 Fires have also occurred during the construction of cooling towers. Measures must be taken during construction to prevent the accumulation of combustible waste materials such as wood borings, shavings, scrap lumber or other easily ignited materials. "No Smoking" regulations and strict control of welding and other heat or spark producing operations must be enforced. Wetting down combustible portions of the tower during idle periods of construction is a good fire prevention practice.

0-5 Cooling water supplied to heat exchangers used for cooling flammable gases or liquids or combustible liquids where the cooling water pressure is less than that of the material being cooled may constitute an unusual hazard to the cooling tower by the return of the flammables or combustibles to the cooling tower water distribution system.

Chapter 1 General

NOTICE

An asterisk (*) following the number or letter designating a subdivision indicates explanatory material on that subdivision in Appendix A.

1-1 Scope.

1-1.1 This standard applies to fire protection for field-erected water-cooling towers of combustible construction or those in which the fill is of combustible material. It does not apply to small factory assembled towers, the main structure of which does not exceed a volume of 2000 cubic feet (56.6 m^3).

1-1.2 Cooling tower designs that differ from the sketches and schematics illustrated in Appendix B may require special engineering judgment and design for fire protection.

1-2 Cooling Tower Classifications. (*See Figures B-1 through B-4.*)

1-2.1 Natural Draft. Air movement in these towers depends upon the difference in densities of the heated air inside the tower and the cooler air outside. Natural draft towers contain no fans or blowers.

1-2.2 Mechanical Draft. Air movement in these towers depends upon fans or blowers. If the fans or blowers are at the inlet the tower is considered forced draft. If they are at the air exit, the tower is considered induced draft.

1-2.3 Crossflow. The air flow in a crossflow tower is essentially perpendicular to the flow of water.

1-2.4 Counterflow. In a counterflow tower the water flows counter-current to the air flow.

Chapter 2 Location of Cooling Towers

2-1 Cooling towers with combustible exterior surfaces, including the deck, distribution basins, etc., shall be located at least 100 feet (30.5 m) from the following hazards:

(a) Structures or processes that emit sparks or flying brands under ordinary circumstances, such as chimneys, incinerators, flare stacks or cob burners.

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

2-2 Towers with combustible exterior surfaces and provided with fixed exposure protection in accordance with Section 5-2 may be located closer than 100 feet (30.5 m) from the hazards listed in 2-1 (a) and (b).

2-3 Towers with noncombustible exterior surfaces shall be located 40 feet (12.2 m) or more from the hazards listed in 2-1 (a) and (b).

2-4 Towers with noncombustible exterior surfaces and provided with fixed interior fire protection installed in accordance with Chapter 5 may be located closer than 40 feet (12.2 m) from the hazards listed in 2-1 (a) and (b).

2-5 Combustible cooling towers located on building roofs or other locations to which access for manual fire fighting is restricted or difficult shall be provided with a protection system in accordance with Chapter 5.

2-6* Open Areas or Spaces Under Towers.

Chapter 3 Electrical Equipment and Wiring

3-1 Installation of all electrical equipment and wiring pertaining to water-cooling towers shall be in accordance with the *National Electrical Code* (NFPA 70 – 1978 [ANSI]).

3-2* Electric motors driving fans shall be provided with overcurrent protective devices as recommended by the *National Electrical Code,* NFPA 70 – 1978.

3-3 A remote fan motor switch shall be provided to stop the fan in case of fire.

3-4 When a fire protection system is installed, provision shall be made to interlock the fan motors with the sprinkler system (*see 5-2.7.2*).

3-5 An automatic vibration controlled switch shall be provided to automatically shut down fan motors.

Chapter 4 Internal Combustion Engine Driven Fans

4-1 Electric motors or steam turbines are the preferred drives to operate fans on cooling towers. When neither is available, internal combustion engines may be used provided they are installed, used and maintained in accordance with the *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines,* NFPA 37 – 1975.

Chapter 5 Fire Protection

5-1 General.

5-1.1* The following are some of the factors to be considered in determining the extent and method of fire protection of induced draft and natural draft cooling towers:

(a) Importance to continuity of operation.
(b) Size and construction of tower.
(c) Type of tower.
(d) Location of tower.
(e) Water supply.
(f) Value of tower.

5-1.2* Depending on factors indicated above where a fire protection system is required, one of the following general types of systems shall be used:

(a) Open head deluge system.
(b) Closed head dry pipe system.
(c) Wet pipe automatic sprinkler system.

5-1.3 **Complete Plans and Data Required.** A complete plan showing piping arrangement, location of sprinklers, fixed detectors, operating equipment such as valves, deluge valves, etc., together with hydraulic calculations, water requirements and water supply information, shall be submitted to the authority having jurisdiction for approval before installation. Plans shall be drawn to scale and include the details necessary to indicate clearly all of the equipment and its arrangement. Plans shall show location of new work with relation to existing structures, cooling towers and water supplies. Plans shall include a note listing the types of materials used in the system.

5-2 Fire Protection System Design.

5-2.1 Types of Systems.

5-2.1.1 The counterflow tower design lends itself to either closed or open head systems. Therefore, wet pipe, dry pipe, or deluge systems may be used. Where water supplies are adequate, the deluge system provides a higher degree of protection.

5-2.1.2 The crossflow design is such that it is difficult to locate sprinklers in the most desirable spots for both water dis-

tribution and heat detection. This situation can be solved by separating these two functions and using separate water discharge and detection systems. The open head deluge system does this and, therefore, is the type to be used in crossflow towers.

5-2.2 Minimum Rate of Application.

5-2.2.1 Under the fan decks of counterflow towers the rate of application of water shall be 0.5 gpm per square foot (20.4 $l/min:m^2$) (including fan opening).

5-2.2.2 Under the fan decks of crossflow towers, the rate of application of water shall be 0.33 gpm per square foot (13.45 $l/min:m^2$) (including fan opening).

5-2.2.3 Over the fill areas of crossflow towers, the rate of application of water shall be 0.5 gpm per square foot (20.4 $l/min:m^2$).

5-2.3 Types and Locations of Discharge Outlets.

5-2.3.1 In counterflow towers, the discharge outlets shall be located under the fan deck and fan opening (*see Figures B-5 through B-8*).

5-2.3.2 In crossflow towers, the discharge outlets protecting the plenum area shall be located under the fan deck and in the fan opening. Discharge outlets protecting the fill shall be located under the distribution basin on either the louver or drift eliminator side, discharging horizontally through the joist channels (*see Figures B-9 through B-12*). On towers with a fill air travel greater than 18 feet (5.5 m), the outlets shall be located on opposite sides of the basins, in alternate joist channels. Where joist channels are wider than 2 feet (.6 m), more than one discharge device may be required per joist channel.

5-2.3.3* On towers having extended fan decks which completely enclose the distribution basin, the discharge outlets protecting the fill area shall be located over the basin, under the extension of the fan deck. These discharge outlets shall be open directional spray nozzles arranged to discharge .35 gpm per square foot (14.26 $l/min:m^2$) directly on the distribution basin, and .15 gpm per square foot (6.11 $l/min:m^2$) on the underside of the fan deck extension (*see Figures B-13 and B-14*).

5-2.4 Pipe Sizing.

5-2.4.1 Pipe sizing shall be based on hydraulic calculations to give an even distribution of water throughout the protected area. The flow from any one discharge outlet shall not vary from the specified rate of application by more than 15 per-

cent above the specified density, and no outlet shall discharge less than the specified density.

5-2.4.2 Hydraulic calculations shall be made in accordance with Chapter 7 of the *Standard for the Installation of Sprinkler Systems,* NFPA 13 – 1976.

5-2.5 Strainers. Strainers are required for systems utilizing nozzles with waterways less than nominal ⅜-inch (9.5 mm). (*See Water Spray Fixed Systems for Fire Protection, NFPA No. 15 – 1977, for further details.*)

5-2.6* Heat Detectors. (*See applicable sections of Standard on Automatic Fire Detectors, NFPA 72E – 1974, for additional information.*)

5-2.6.1 Where deluge systems are used, an adequate number of heat detectors shall be installed.

5-2.6.2 In mechanical induced-draft towers, heat detectors shall be located under the fan deck at the circumference of the fan opening and under the fan opening when necessary to comply with the following spacing requirements. (*For extended fan decks, see 5-2.6.3.*)

5-2.6.2.1 Fixed-temperature detectors shall be spaced not over 8 feet (2.4 m) apart in any direction including the fan opening. Temperature ratings shall be selected in accordance with operating conditions, but shall be no less than intermediate.

5-2.6.2.2 Rate-of-rise detectors shall be spaced not over 15 feet (4.6 m) apart in any direction. In pneumatic-type systems, for detectors inside the tower, there shall be no more than one detector for each mercury check in towers operating in cold climates, and two detectors for each mercury check in towers used during the warm months only or the year round in warm climates. There shall be no more than four detectors for each mercury check when the detectors are located outside the tower.

5-2.6.3 On towers having extended fan decks which enclose the distribution basin, detectors shall be located under the fan deck extension in accordance with standard indoor spacing rules for the type detectors used (*see NFPA 72E*).

Exception: Where the fan deck extension is 16 feet (4.9 m) or less and this dimension is the length of the joist channel then only one row of detectors centered on and at right angles to the joist channels is required. Spacing between detectors shall be in accordance with the Standard on Automatic Fire Detectors, NFPA 72E – 1974.

5-2.6.4* Heat barriers shall be installed under the extended fan deck to separate deluge systems when total number of systems exceeds the number for which water supply was designed. Heat barriers shall extend from the fan deck structure to the distribution basin dividers.

5-2.6.5 Where heat detectors are inaccessible during tower operation, an accessible test detector shall be provided for each circuit. In the case of pilot head operated systems, an inspector's test connection shall be installed on the pilot line and arranged to be accessible during tower operation.

5-2.6.6 Heat detector components exposed to corrosive vapors or liquids shall be protected by suitable materials of construction or suitable protective coatings applied by the equipment manufacturer.

5-2.7 Protection for Fan Drive Motor.

5-2.7.1 A heat detector and water discharge outlet shall be provided over each fan drive motor when the motor is so located that it is not within the protected area of the tower.

5-2.7.2 Provision shall be made to interlock the fan motors with the fire protection system so that the cooling tower fan motors will be stopped in the cell(s) for which the system is actuated. Where the continued operation of the fans is vital to the process, a manual override switch may be provided to reactivate the fan when it is determined that there is no fire.

5-2.8 Exposure Protection.

5-2.8.1 When any combustible exterior surfaces of a tower, including the fan deck, distribution basins, etc., are less than 100 feet (30.5 m) from significant concentrations of combustibles such as structures, piled material, etc., the combustible-exposed surfaces of the tower shall be protected by an automatic water spray system.

5-2.8.2 Systems for exterior protection shall be designed with the same attention and care as interior systems. Pipe sizing shall be based on hydraulic calculations. Water supply and discharge rate shall be based on a minimum 0.15 gpm per square foot (6.11 l/min:m^2) for all surfaces being protected.

5-2.9 The design and installations shall comply with the applicable sections of the *Standard for the Installation of Sprinkler Systems,* NFPA 13 – 1976.

5-3 Corrosion Protection.

5-3.1 Piping, fittings and hangers, where exposed to atmosphere and inside cooling tower cells, shall be corrosion resistant or protected against corrosion by a suitable coating.

5-3.2 Approved discharge devices are made of nonferrous material and are corrosion resistant to normal atmospheres.

Some atmospheres require special coatings on the discharge devices.

Wax-type coatings shall not be used on devices without fusible elements.

5-3.3 Special care shall be taken in the handling and installation of wax-coated or similar sprinklers to avoid damaging the coating. Corrosion-resistant coatings shall not be applied to the sprinklers by anyone other than the manufacturer of the sprinklers, except that in all cases any damage to the protective coating occurring at the time of installation shall be repaired at once using only the coating of the manufacturer of the sprinkler in an approved manner so that no part of the sprinkler will be exposed after the installation has been completed. Otherwise, corrosion will attack the exposed metal and will in time creep under the wax coating.

5-4* Hydrant Protection. Hydrants shall not be located closer than 40 feet (12.2 m) to towers.

5-5* Standpipe Protection. Towers with any combustible construction located on a building 50 feet (15.3 m) or more in height shall be provided with standpipe protection within 200 feet (61.0 m) of all parts of the tower. Sufficient hose shall be provided to reach all parts of the tower. Provision shall be made for completely draining all exposed standpipe lines in winter. Hose equipment at each standpipe hose connection on the roof shall be protected from the weather in a suitable cabinet or enclosure. (*See the Standard for the Installation of Standpipe and Hose Systems, NFPA 14 – 1976, for further details.*)

5-6 Water Supply.

5-6.1* Water supply for towers two or more cells in length, with either one or two fans per cell, shall be adequate to supply all discharge outlets in two largest adjacent cells or systems simultaneously at the specified rate of application.

Exception: The water supply for one system may be considered adequate when tight continuous partitions having a fire resistance rating of 20 minutes or more when tested in accordance with

NFPA 251 – 1972, Fire Tests of Building Construction and Materials, are provided between systems.

5-6.2 Water supplies shall be sufficient to include a minimum of 500 gallons per minute (1892.5 *l*/min) for hose streams in addition to the sprinkler requirement.

5-7* Lightning Protection. Lightning protection, where provided, shall be installed in accordance with the provisions of the *Lightning Protection Code,* NFPA 78 – 1977.

5.8 Earthquake Protection. Where provided, earthquake resistant construction shall be in accordance with applicable sections of the *Standard for the Installation of Sprinkler Systems,* NFPA 13 – 1976.

Chapter 6 Maintenance

6-1 Areas around towers located on the ground shall be kept free of grass, weeds, brush, or combustible waste materials.

6-2 Smoking shall not be permitted on or adjacent to any cooling tower of combustible construction. Signs to this effect shall be posted and maintained and this regulation strictly enforced.

6-3 Forced- and induced-draft towers in continuous operation shall be checked frequently for excessive heating in motors.

6-4 At least semiannually the fan assemblies including the motors and speed reducers shall be checked, both during operation and when shut down, for excessive wear or vibration, improper lubrication, corrosion, or other features that could result in failure.

6-5 Where work on the tower requires welding or cutting, it shall be done in accordance with the *Standard for the Installation and Operation of Oxygen-Fuel Gas Systems for Welding and Cutting,* NFPA 51 – 1977.

6-6* Combustible cooling towers are particularly susceptible to ignition when they are shut down for repairs and other reasons and the wood becomes dried out. During these periods all automatic fire protection on the tower shall be operable, or if the tower is not so protected, special protection shall be provided until the tower is back in service.

6-7 Access to the top of water-cooling towers for fire fighting and maintenance shall be provided by an approved stairway or ladder. Towers in excess of 120 feet (36.6 m) in any dimension shall be provided with not less than two means of access remote from each other.

6-8 Motors, speed reduction units and drive shafts shall be accessible for servicing and maintenance.

Appendix A

This Appendix is not a part of this NFPA Standard on Water-Cooling Towers, NFPA 214–1977, but is included for informational purposes only.

The following notes, bearing the same number as the text of the *Water-Cooling Tower Standard* to which they apply, contain useful explanatory material.

A-2-6 Open areas or space between a combustible cold water basin and the ground or roof of a building upon which it is located should be effectively screened to prevent the accumulation of waste combustible material under the tower, or to prevent the use of such areas or space under the tower for the storage of combustible material. Fire protection may be installed in lieu of screening.

A-3-2 Motors should be totally enclosed to protect them from dirt or moisture and to prevent sparks from reaching adjacent combustible construction.

A-5-1.1 Fire records for mechanical forced-draft towers do not indicate the general need for automatic fire protection systems. However, exposure protection may be necessary as provided in 5-2.8.

A-5-1.2 Antifreeze Sprinkler Systems. The use of antifreeze sprinkler systems in cooling towers is not recommended. While in theory this type of system would function, the use of antifreeze systems in cooling towers presents problems not encountered in the usual antifreeze application.

Due to the inaccessibility of the piping during normal operation of the cooling tower, it is practically impossible to do any maintenance work or to make routine inspections. The corrosion problem can be quite serious in cooling towers, and leaks in the system will not readily become apparent. This would result in loss of the antifreeze solution and could result in freezing up of the system.

Local ordinances in many areas prohibit the use of these systems.

A-5-2.3.3 Care should be taken in the application of nozzle types. Location of nozzle from surfaces to be protected shall be guided by the particular nozzle's discharge characteristics. Care should also be taken in the selection of nozzles to obtain water-

ways which are not easily obstructed by debris, sediment, sand, etc., in the water.

A-5-2.6 Due to the extremely humid atmosphere and potential corrosive conditions in cooling towers it is very difficult to maintain electrical detection equipment. Experience has shown that even with weather proof equipment and wiring practices an electrical system will have problems. Therefore, the information in the subparagraphs of this section is based on the use of detectors operating on pneumatic or hydraulic principles.

A-5-2.6.4 Acceptable materials are $\frac{3}{8}$-inch (9.5 mm) plywood or $\frac{3}{16}$-inch (4.8 mm) ACB on one side of studs.

A-5-4 Hydrant protection should be provided within 200 feet (61.0 m) of all parts of towers having combustible construction located on the ground or on buildings less than 50 feet (15.3 m) in height. A hose house and standard hose house equipment should be provided at each hydrant. (*See standard for Outside Protection, NFPA 24 – 1977, for further details.*)

A-5-5 Standpipes should preferably be located in stair towers. If located on an open roof, they should not be closer than 40 feet (12.2 m) to the cooling tower.

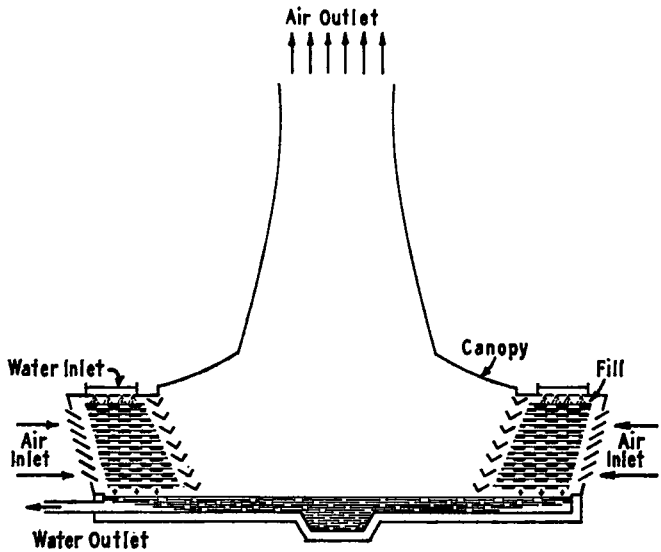
A-5-6.1 Types of construction which meet this requirement are: $\frac{1}{2}$-inch (12.7 mm) ACB, $\frac{1}{2}$-inch (12.7 mm) plywood or $\frac{3}{4}$-inch (19.1 mm) T & G when installed on both sides of wood studs.

A-5-7 Towers located on roofs of buildings in certain geographical locations may be particularly susceptible to lightning damage.

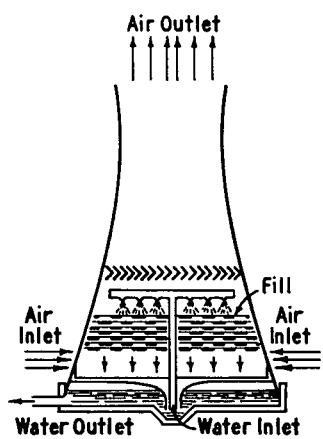
A-6-6 Examples of special protection are watchmen or intermittent wetting, or both.

Appendix B

This Appendix is not a part of this Standard on Water-Cooling Towers, NFPA 214-1977, but is included for informational purposes only.

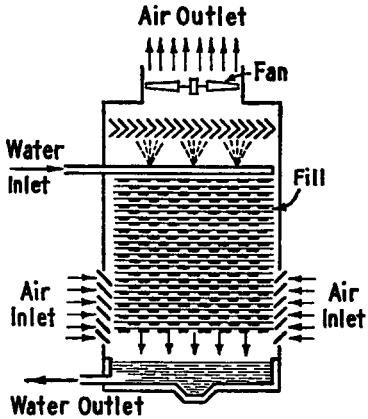


Crossflow hyperbolic tower

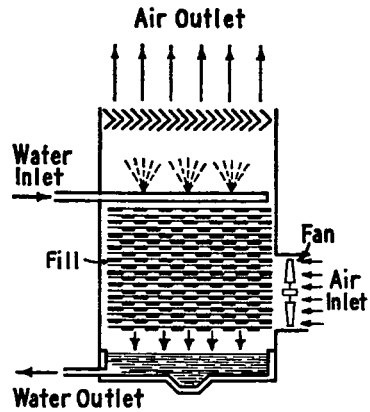


Counterflow hyperbolic tower

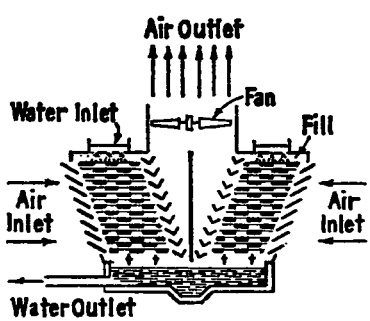
Figure B-1 Types of natural-draft towers.



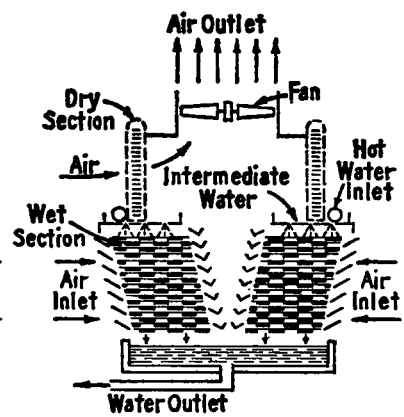
Induced draft counterflow tower



Forced draft tower



Induced draft crossflow tower



Induced draft wet-dry crossflow tower

Figure B-2 Types of mechanical-draft towers.

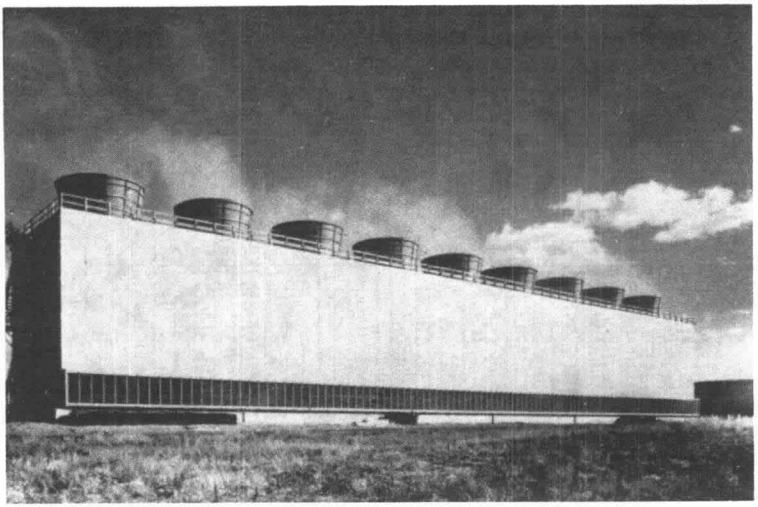


Figure B - 3 Typical induced-draft counterflow water-cooling tower.

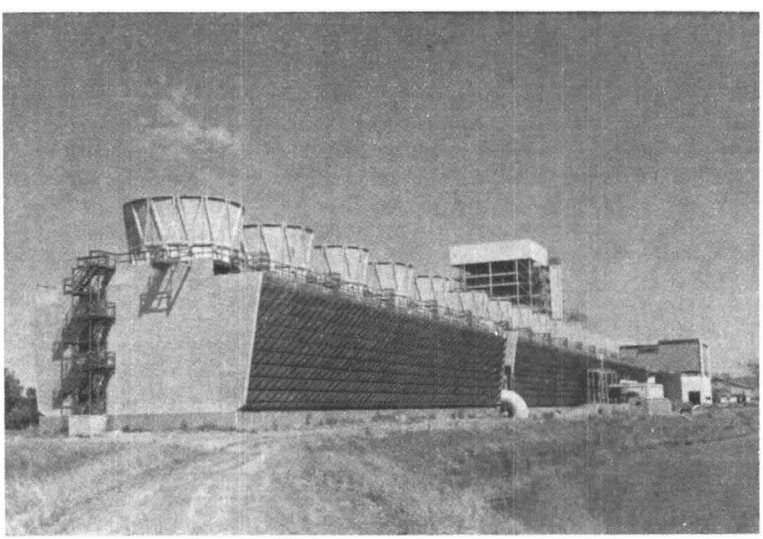


Figure B - 4 Typical induced-draft crossflow water-cooling tower.

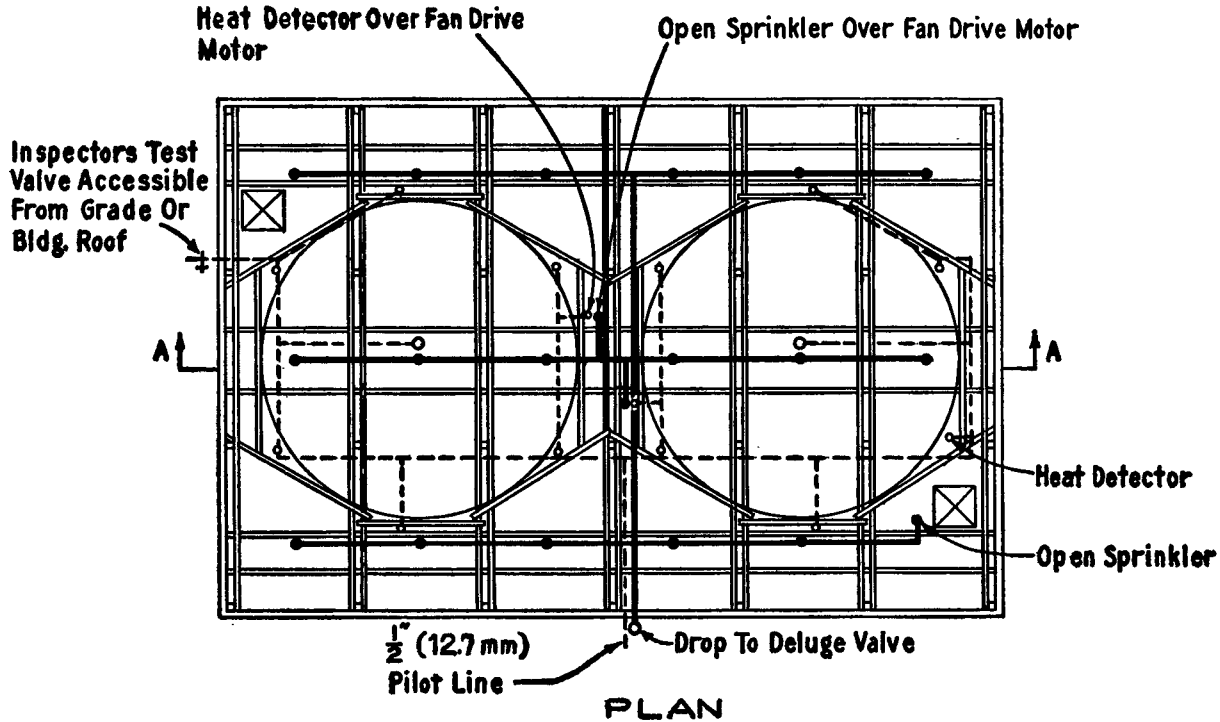
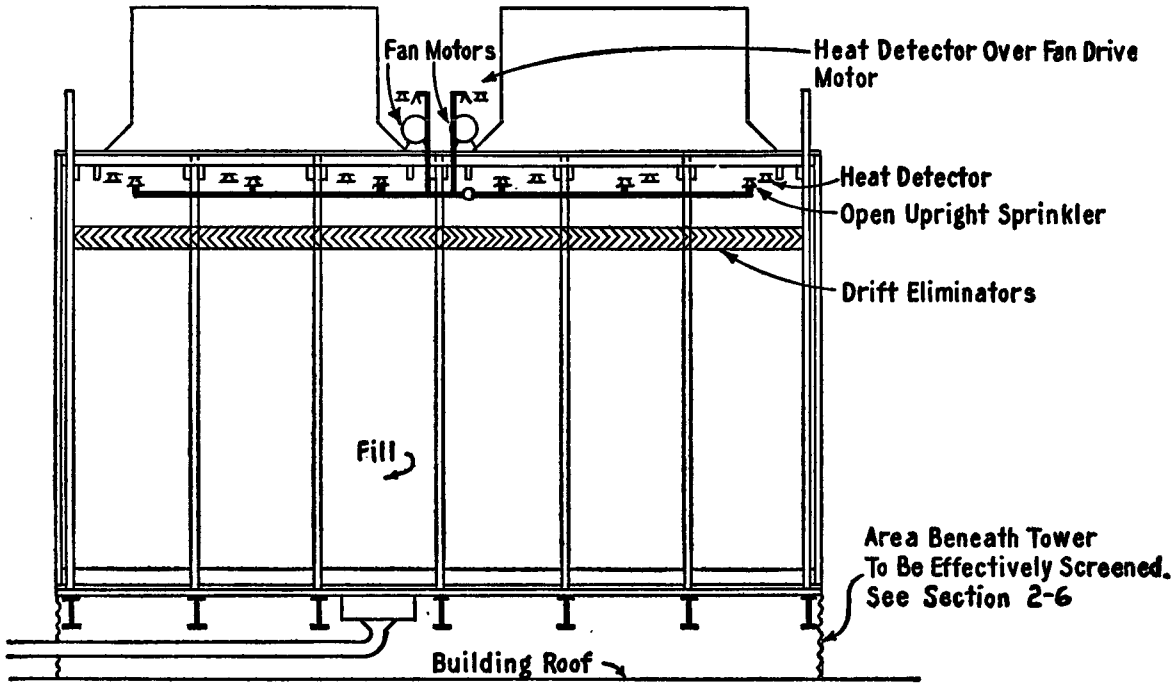


Figure B-5 Typical deluge fire protection arrangement for counterflow towers.



SECTION A – A

Figure B - 6 Typical deluge fire protection arrangement for counterflow towers.

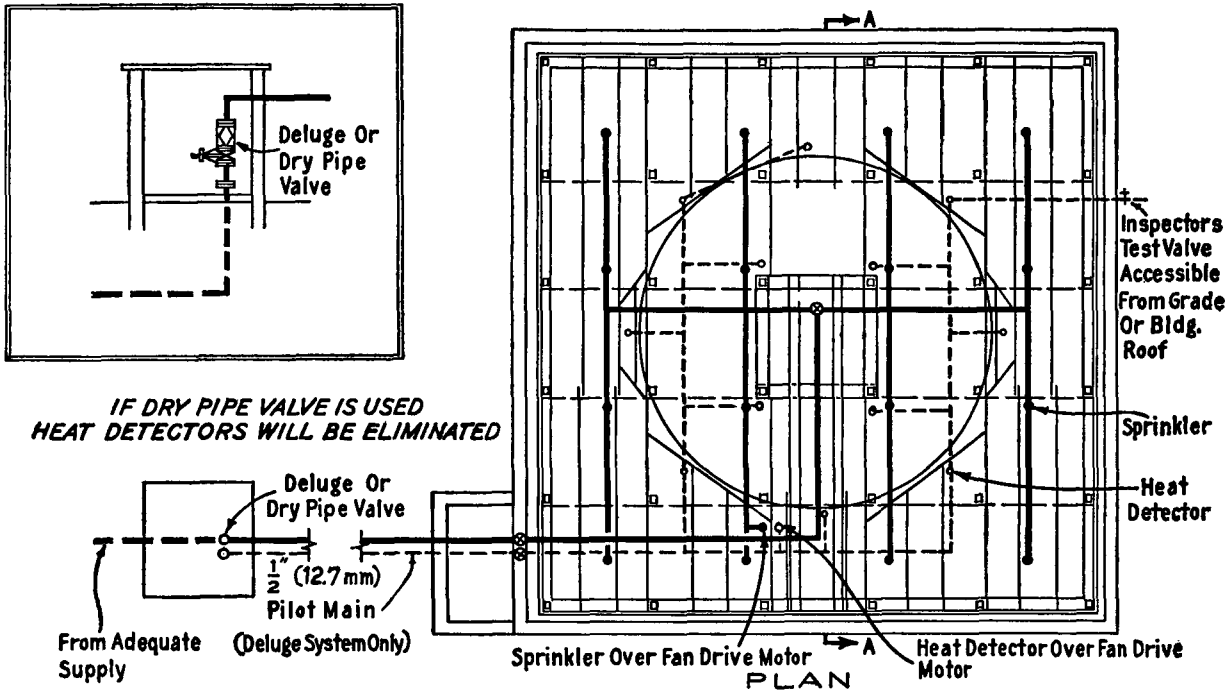


Figure B - 7 Typical deluge or dry pipe fire protection arrangement for counterflow towers.

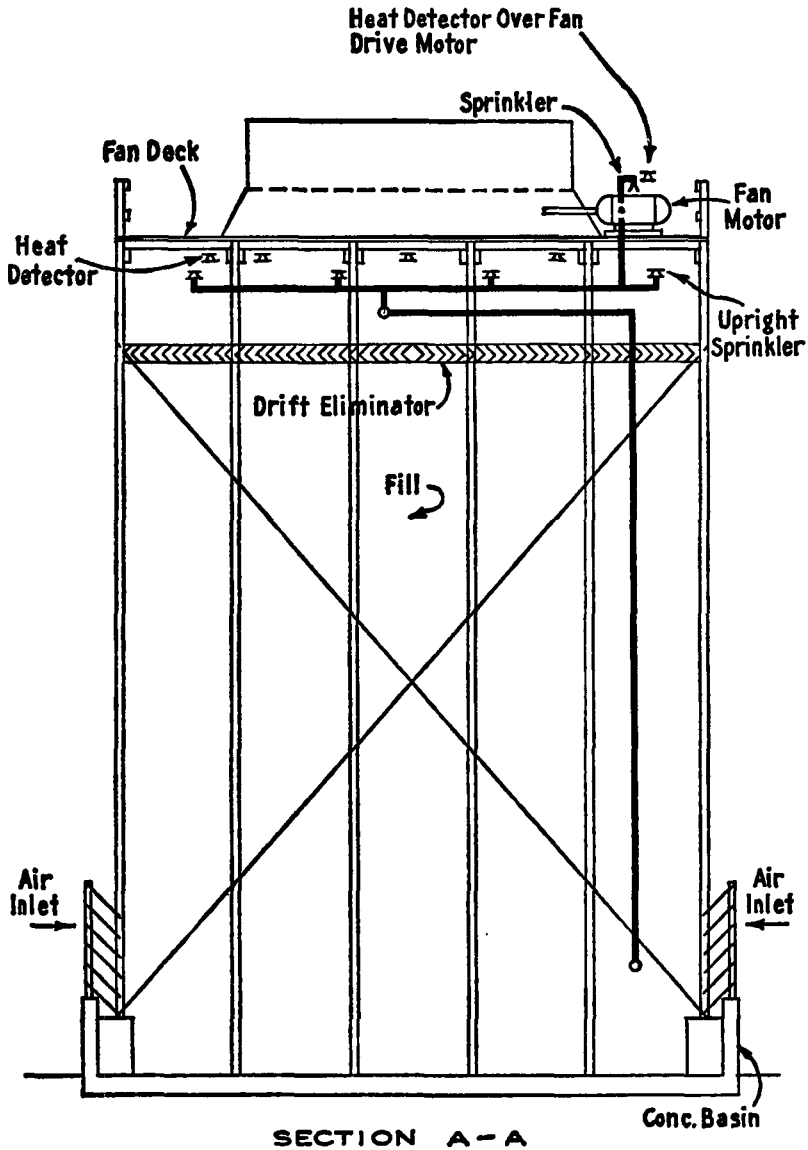


Figure B-8 Typical deluge or dry pipe fire protection arrangement for counterflow towers.

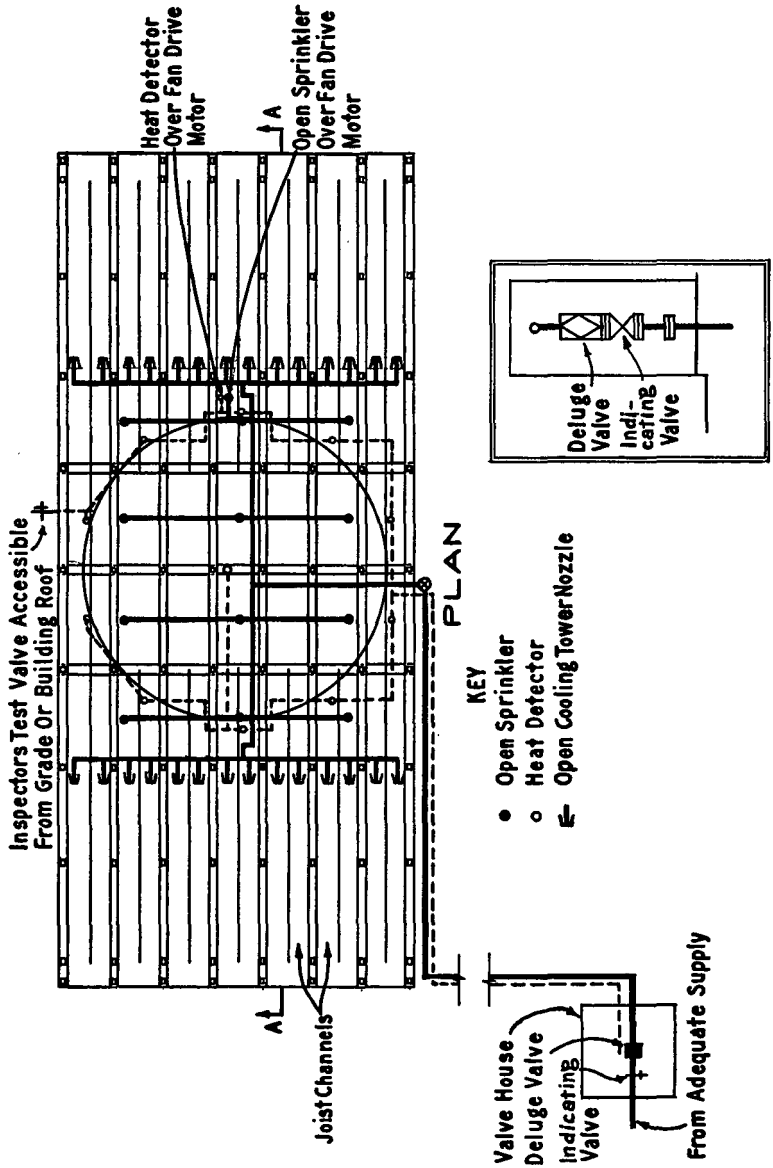


Figure B-9 Typical deluge fire protection arrangement for crossflow towers.

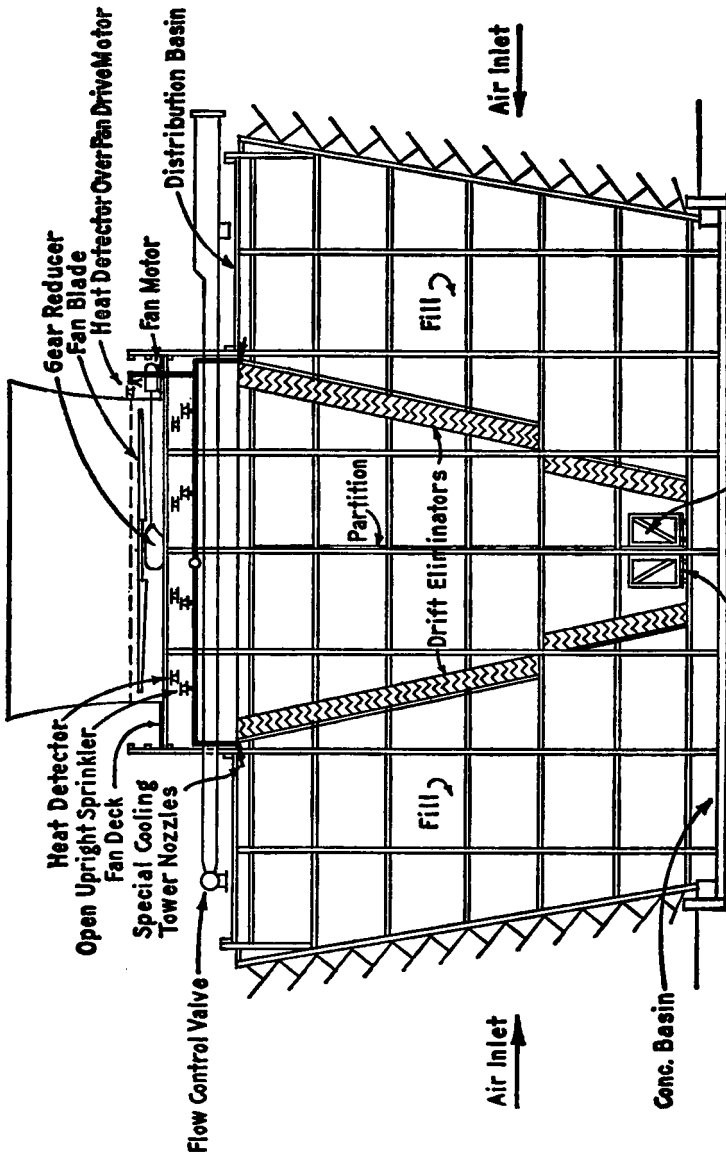


Figure B - 10 Typical deluge fire protection arrangement for crossflow towers.