the water upwards into the air. Properly designed spray nozzles break the water into small drops, but not into a mist. Since the objective is to cool the pond water, the individual drops must be heavy enough to fall back into the pond and must not float away in the air. The water surface exposed to the air passing over the pond becomes the integrated area of all the small drops. The spray pond requires about one-fiftieth of the space required by the cooling pond to dissipate the same quantity of heat with equal results, due to four factors: (1) the speed with which the drops are propelled into the air and fall back into the water basin; (2) the increased wind velocity at a point above the surrounding obstruction; (3) the increased volume of air delivery due to the greater vertical cross-section of air permissible; and (4) the vastly increased area of contact between water and air.[2]

Spray pond effectiveness is increased by: (1) elevating the nozzles to a higher point above the surface of the water in the basin; (2) increasing the spacing between nozzles of any one capacity; (3) using smaller capacity nozzles to decrease the concentration of water per unit area; and (4) using smaller nozzles and increasing the pressure to maintain the same concentration of water per unit area.

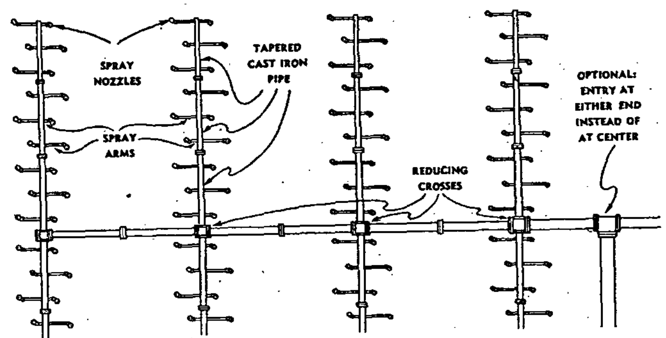

Fig. 4. Typical Nozzle Arrangement for a Spray Pond

It is usual practice to locate the nozzles from 5 to 12 feet above the surface of the water (dependent also upon depth of water and curb level) with water supply at 5 to 7 psig pressure at the nozzles. Nozzles spray from 25 to 60 gpm each, and the nozzles are spaced so that the average water delivered to the surface varies from 0.1 gpm (small ponds) to 0.4 gpm (large ponds) per square foot. See Table 2 for additional spray pond design data. Best results are obtained by placing the nozzles in a long, relatively narrow area, located broadside to the wind.

Louver fences, to prevent the carrying of entrained water beyond the edge of a spray pond by the air on the leeward side, are required for all roof locations and for ground locations where space is restricted; the outer nozzles should be located at least 20 ft from the edge of the basin. Such fences up to 12 ft in height usually are constructed of horizontal overlapping louvers supported between vertical posts. The air, in passing between these louvers, tends to be freed of the larger drops of water. The louvers also restrict the flow of air, particularly at the higher wind velocities, thus reducing the possibility of water being carried from the spray cloud. The height of an effective fence should be equal to the height of the spray cloud. Algae formations may be a nuisance in a spray pond. Such growths are minimized by the periodic addition of bromine, chlorine, chlorinated lime, copper sulfate, or various blends of chlorophenates (see Chapter 43).

The performance of a spray pond is limited because of space requirements and the probable high cost of piping and pumping. Water-cooling towers, however, allow the designer a wider range of performance within a given space because of the possibility of altering the smaller physical dimensions or varying the water concentration, measured in gallons per (minute) (square foot of tower area). In most cooling towers the water is broken up into drops many times, whereas with the spray pond it is broken up only once and, consequently, in the latter the rate of cooling diminishes rapidly as the temperature of the surface of the drop approaches the wet-bulb temperature of the ambient air.

Table 2. Spray Pond Design Data

Conventional Up-Spray System

	Units	Standard	Minimum	Maximum
Water capacity per nozzle	gpm	35 to 50	25	60
Nozzles per 12 ft length of pipe		6	4	6
Height of nozzles above water level	ft	6	5	12
Nozzle pressure	psig	6	5	7
Size of nozzles and nozzle arms	in.	2	1½	2
Distance between spray lateral piping	ft	25	13	38
Distance nozzles from pond side unfenced	ft	25 to 35	20	50
Distance nozzles from pond side fenced	ft	15 to 20	15	25
Height of louver fence	ft	12	12	12
Depth pond basin	ft	4 to 5	2	—
Friction loss allowed per 100 ft pipe	ft	1 to 3	—	—
Design wind velocity	mph	5	3	—

ATMOSPHERIC COOLING TOWERS

Spray-filled atmospheric cooling towers are used for open-area installations because of their dependence upon the velocity and direction of the wind. Operation is not so limited as with spray ponds, but the design is generally based on a 3 mph wind, and the performance falls off rapidly as the ambient air velocity decreases. These towers require less basin area, less piping, and no more mechanical equipment than spray ponds, but these savings may be largely offset by the extra cost of the structure. The drift nuisance is similar to that of spray ponds. The word *tower* used in this connection is a misnomer, as the design simulates a narrow spray pond with length twice the width, or more, having elevated nozzles and a high louver fence. As usually built, the nozzles spray downward from the top of the structure, and the distance from the center of the nozzle system to the louvers on either side is not more than half the distance that the nozzles are elevated above the water-collecting basin. Heights range from 6 to 15 ft, with the total width of the structure usually not greater than the height. Loadings range from 0.6 to 1.5 gpm per sq ft of tower area, and hence require about one-fourth the area of an equivalent spray pond. As the louvers are wetted continuously, they add to the surface of water exposed to the cooling air. The spray-filled atmospheric tower is shown in Fig. 5.