

TABLE 1. AVERAGE MAXIMUM WATER MAIN TEMPERATURES<sup>a</sup>

| STATE  | CITY           | TEMP. F | STATE | CITY           | TEMP. F |
|--------|----------------|---------|-------|----------------|---------|
| Ala.   | Birmingham     | 84      | Mass. | Boston         | 80      |
|        | Mobile         | 73      |       | Cambridge      | 70      |
| Ariz.  | Phoenix        | 81      |       | Fall River     | 76      |
|        | Tucson         | 80      |       | Lowell         | 50      |
| Calif. | Anaheim        | 60      |       | Lynn           | 68      |
|        | Berkeley       | 69      |       | New Bedford    | 70      |
|        | Fresno         | 72      |       | Salem          | 68      |
|        | Fullerton      | 75      |       | Worcester      | 76      |
|        | Glendale       | 68      | Mich. | Detroit        | 77      |
|        | Los Angeles    | 75      |       | Flint          | 70      |
|        | Oakland        | 69      |       | Grand Rapids   | 80      |
|        | Ontario        | 70      |       | Highland Park  | 77      |
|        | Pasadena       | 82      |       | Jackson        | 56      |
|        | Pomona         | 75      |       | Kalamazoo      | 53      |
|        | Riverside      | 78      |       | Lansing        | 64      |
|        | Sacramento     | 72      |       | Saginaw        | 82      |
|        | San Bernardino | 65      | Minn. | Duluth         | 55      |
|        | San Diego      | 82      |       | Minneapolis    | 80      |
|        | San Francisco  | 62      |       | St. Paul       | 77      |
|        | Whittier       | 75      | Mo.   | Jefferson City | 82      |
| Colo.  | Denver         | 75      |       | Kansas City    | 84      |
| Conn.  | Bridgeport     | 66      |       | St. Joseph     | 84      |
|        | Hartford       | 73      |       | St. Louis      | 85      |
|        | New Haven      | 76      |       | Springfield    | 70      |
|        | Waterbury      | 72      | Nebr. | Lincoln        | 87      |
| D. C.  | Washington     | 84      |       | Omaha          | 87      |
| Del.   | Wilmington     | 83      | Nev.  | Reno           | 61      |
| Fla.   | Jacksonville   | 80      | N. H. | Manchester     | 76      |
|        | Miami          | 80      | N. J. | Jersey City    | 63      |
|        | Tampa          | 77      |       | Newark         | 74      |
| Ga.    | Atlanta        | 87      |       | Paterson       | 78      |
|        | Macon          | 80      |       | Trenton        | 79      |
| Ill.   | Chicago        | 76      | N. Y. | Albany         | 68      |
|        | Cicero         | 76      |       | Buffalo        | 75      |
|        | Evanston       | 73      |       | Jamaica        | 56      |
|        | Peoria         | 67      |       | Mt. Vernon     | 74      |
|        | Rockford       | 59      |       | New Rochelle   | 75      |
|        | Springfield    | 82      |       | New York       | 72      |
| Ind.   | Evansville     | 86      |       | Rochester      | 70      |
|        | Gary           | 75      |       | Schenectady    | 60      |
|        | Indianapolis   | 80      |       | Syracuse       | 74      |
|        | South Bend     | 61      |       | Utica          | 69      |
|        | Terre Haute    | 82      |       | Yonkers        | 70      |
| Iowa   | Cedar Rapids   | 78      | N. C. | Asheville      | 74      |
|        | Des Moines     | 77      |       | Charlotte      | 85      |
|        | Sioux City     | 62      |       | Winston-Salem  | 82      |
| Kans.  | Concordia      | 57      | N. M. | Albuquerque    | 65      |
|        | Kansas City    | 86      | Ohio  | Akron          | 76      |
|        | Topeka         | 88      |       | Canton         | 50      |
|        | Wichita        | 72      |       | Cincinnati     | 84      |
| Ky.    | Louisville     | 85      |       | Cleveland      | 74      |
| La.    | Baton Rouge    | 85      |       | Columbus       | 82      |
|        | New Orleans    | 85      |       | Dayton         | 60      |
| Me.    | Augusta        | 60      |       | Lakewood       | 82      |
| Md.    | Baltimore      | 75      |       | Springfield    | 72      |
|        |                |         |       | Toledo         | 83      |

<sup>a</sup>These averages taken from various city water main locations, with some actual values slightly higher and some lower than values shown.

TABLE 1. AVERAGE MAXIMUM WATER MAIN TEMPERATURE<sup>a</sup> (Concluded)

| STATE   | CITY          | TEMP. F | STATE    | CITY           | TEMP. F |
|---------|---------------|---------|----------|----------------|---------|
| Okla.   | Oklahoma City | 82      | Utah     | Logan          | 44      |
|         | Tulsa         | 85      |          | Salt Lake City | 60      |
| Oreg.   | Eugene        | 60      | Va.      | Fredericksburg | 75      |
|         | Portland      | 64      |          | Lynchburg      | 73      |
| Pa.     | Altoona       | 74      |          | Norfolk        | 80      |
|         | Erie          | 75      | Wash.    | Olympia        | 58      |
|         | Johnstown     | 74      |          | Seattle        | 62      |
|         | McKeesport    | 82      |          | Spokane        | 51      |
|         | Philadelphia  | 83      |          | Tacoma         | 57      |
|         | Pittsburgh    | 67      | W. Va.   | Charleston     | 85      |
| R. I.   | Providence    | 68      |          | Huntington     | 78      |
| S. C.   | Charleston    | 80      |          | Wheeling       | 78      |
|         | Greenville    | 81      | Wis.     | La Crosse      | 54      |
|         | Spartanburg   | 78      |          | Madison        | 58      |
| S. Dak. | Rapid City    | 55      |          | Milwaukee      | 70      |
| Tenn.   | Chattanooga   | 84      |          | Racine         | 68      |
|         | Knoxville     | 89      |          |                |         |
|         | Memphis       | 70      |          |                |         |
|         | Nashville     | 90      |          |                |         |
| Texas   | Amarillo      | 65      |          |                |         |
|         | Austin        | 90      |          |                |         |
|         | Beaumont      | 86      |          |                |         |
|         | Dallas        | 86      |          |                |         |
|         | Fort Worth    | 84      |          |                |         |
|         | Galveston     | 90      |          |                |         |
|         | Houston       | 84      |          |                |         |
|         | Port Arthur   | 83      |          |                |         |
|         | San Antonio   | 76      |          |                |         |
|         | Wichita Falls | 85      |          |                |         |
|         |               |         | PROVINCE |                |         |
|         |               |         |          |                |         |
|         |               |         | Alta.    | Calgary        | 64      |
|         |               |         | B. C.    | Vancouver      | 60      |
|         |               |         | Ont.     | London         | 50      |
|         |               |         |          | Toronto        | 63      |
|         |               |         | P. E. I. | Charlottetown  | 48      |
|         |               |         | Que.     | Montreal       | 78      |
|         |               |         |          | Quebec         | 68      |

<sup>a</sup>These averages taken from various city water main locations, with some actual values slightly higher and some lower than values shown.

may be taken upstream or at a considerable distance from the discharge, to prevent mixing of the heated discharged water with the inlet water. If the source of cooling water is a city supply or a well, the discharge water may be run into the nearest sewer or open waterway. Lacking an unlimited water supply, or in cases where city water is too expensive or where the water available contains dissolved salts which would form scale on the heat-exchanging apparatus, it is necessary to recirculate the water, and to cool it after each passage through the heat-exchanger by exposure to air in an atmospheric water cooling apparatus.

Air has a capacity for absorbing heat from water when the wet-bulb temperature of the air is lower than the temperature of the water with which it is in contact. The rapidity with which this transfer of heat occurs depends upon (1) the area of water in contact with the air, (2) the relative velocity of the air and water, and (3) the difference between the wet-bulb temperature of the air and the temperature of the water. Because the changes in rate do not occur in direct proportion to changes in the governing factors, data on the performance of atmospheric water cooling equipment are largely empirical.

As the heat content of the air increases, its wet-bulb temperature rises. (See Chapter 1). Because it is impractical to leave the air in contact