



# TECHNICAL NOTES on Brick Construction

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## Technical Notes 43 - Passive Solar Heating with Brick Masonry - Part 1 Introduction June 1981

**Abstract:** Brick masonry passive solar energy systems can be used to significantly reduce the use of fossil fuels for heating and cooling buildings. The basic concepts and necessary considerations for the design of passive solar heating systems are discussed. The basic concepts involve the incorporation of the passive solar heating system into the architectural design of the intended use and operation of the building. Consideration of environmental factors is also discussed.

**Key Words:** attached sunspaces, bricks, buildings, cavity wall systems, climatology, conservation, direct gain systems, energy, masonry, passive solar heating systems, solar radiation, system operation, thermal storage walls.

### INTRODUCTION

Energy conservation and fuel consumption have become a major concern in recent years. Much of the nation's fuel is used in the heating of buildings. The use of solar heating systems will help to reduce this consumption of non-renewable energy resources. Solar energy is an immediately available renewable energy source. Most buildings can easily be designed to benefit from solar heating.

Two types of solar energy systems may be used to heat buildings, active and passive. Active solar heating systems are those which require mechanical equipment for operation. Pumps and other mechanical devices are required to circulate liquids or gases through solar collectors, to storage media, and then to transfer the collected heat to the occupied spaces of the building.

Passive solar heating systems do not require the use of mechanical equipment. The heat flow in passive solar heating systems is by natural means: radiation, convection, and conductance. The thermal storage is in the structure itself. Although passive solar heating systems do not require mechanical equipment for operation, this does not mean that fans or blowers may not, or should not, be used to assist the natural flow of thermal energy. The passive systems assisted by mechanical devices are referred to as "hybrid" heating systems.

Passive solar systems utilize basic concepts incorporated into the architectural design of the building. They usually consist of: buildings with rectangular floor plans, elongated on an East-West axis; a glazed South-facing wall; a thermal storage media exposed to the solar radiation which penetrates the South-facing glazing; overhangs or other shading devices which sufficiently shade the South-facing glazing from the summer sun; and windows on the East and West walls, and preferably none on the North walls. Passive solar systems do not have a high initial cost or long-term payback period, both of which are common with many active solar heating systems.

This *Technical Notes* introduces the general features and requirements for the development and application of passive solar heating systems. Passive solar cooling systems are discussed in *Technical Notes* 43C. Due to the variations in building type and environment which must be considered, it is not normally feasible for passive solar systems to be the sole source of heat in most climatological areas. Construction details are provided in *Technical Notes* 43G.



**Passive Solar Building with Thermal Storage Wall Under Construction**

**FIG. 1**



**Combined Thermal Storage Wall System and Attached Sunspace**

**FIG. 2**

## **ENVIRONMENTAL DATA AND REQUIREMENTS**

Many environmental factors must be considered to fully utilize the concepts of passive solar heating systems. Environmental data is given in Tables 1 and 2 of this *Technical Notes*.

### **Temperature**

Exterior design temperatures are important considerations in developing passive solar heating systems. The size of the system will depend upon daily, monthly and annual temperature fluctuations. In mild, sunny climates, the required glazing and thermal storage areas may be relatively small. In temperate, cloudy climates, the required glazing area may be small, but the thermal storage requirements may be greater. In colder climates, the amount of glazing and thermal storage is usually large.

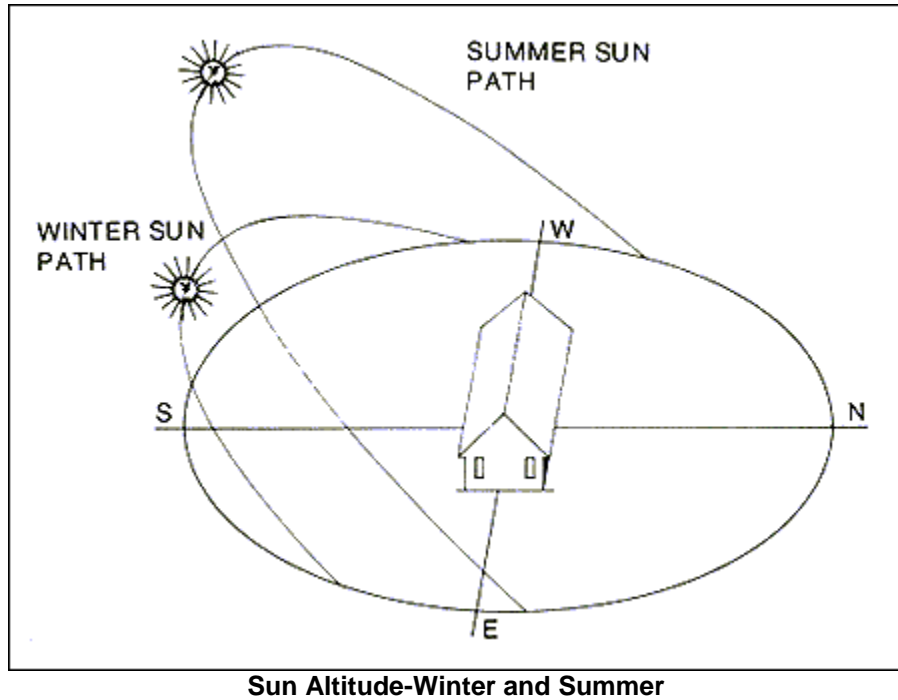
The average monthly heating degree days are related to exterior temperature conditions. These values are necessary to determine the total monthly thermal load of the building. Average monthly heating degree days and exterior temperatures are given in Table 2 at the end of this *Technical Notes*.

### **Latitude**

Latitude is important to determine the amount of solar radiation and the appropriate summertime shading provided by overhangs and other devices. The further North the building is to be located, the less winter solar radiation it will receive. This is because the sun is above the horizon for a shorter period of time and the solar radiation must penetrate more of the atmosphere. Values of solar radiation at various latitudes are given in Table 1.

At higher latitudes, the sun appears lower in the sky. At these latitudes, where the position (altitude) of the sun in the sky is low, larger overhangs are required to shade the South-facing wall from the summer sunlight. Figure 3 shows how the altitude of the sun changes from winter to summer, demonstrating how the South-facing wall may

be shaded from summer solar radiation and still be exposed to winter solar radiation by using an overhang. The length of projection required to shade a South-facing wall from the summer sun is given in Table 3.



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bProjection greater than 20 ft required.

## Solar Radiation Data

Solar radiation data is required to determine the amount of radiation transmitted through the South-facing glazing. Actual average solar radiation data for various geographical locations is given in Table 2. The amount of solar radiation is dependent on climate, elevation and latitude. Clear day solar radiation for various latitudes is given in Table 1.

## Orientation

Orientation is extremely important in the design of passive solar buildings. The best performance will usually result when the passive solar system faces true South. True South may be obtained from isogonic (magnetic variation) charts developed by the United States Department of Commerce, Coast and Geodetic Survey, or by consulting a local land surveyor.

When the passive solar system faces true South, the system will be exposed to the maximum amount of winter solar radiation. Deviations of more than  $30^{\circ}$  East or West of true South are *not* recommended, especially where maximum performance is desired.

## Site Topography

The topography of the site is of major concern. If the South-facing wall of the building is shaded by natural or man-made elements, it will probably not be feasible to consider passive solar systems. An ideal siting for a passive solar building is to be bermed into a South-facing slope. This provides a South wall exposed to the sun, and a North wall protected from environmental changes by the earth berm. Berming the North wall of the building should be done cautiously to avoid problems caused by ground water and earth pressure.

## BUILDING TYPE AND USE

In addition to environmental considerations building type and use are very important in developing and applying passive solar heating systems. Building type and use are flexible requirements which allow the designer to make appropriate adaptations to the structure to provide the desired energy performance.

### **Thermal Load Requirements**

Thermal load requirements are important in the selection and sizing of passive solar heating systems. The effects of building type and use on the thermal load are determined by the interior design temperature and the allowable temperature fluctuation. A warehouse may not require the same interior design temperature as a residential structure. Many commercial buildings are only occupied during daylight hours and do not have to maintain the higher interior working hour temperatures overnight. In many applications, the passive solar heating systems may provide similar performance as conventional heating systems with night-time setbacks.

Another aspect which affects the requirements of the building's use is human comfort. Passive solar systems provide conditions which contribute to human comfort. The brick storage areas of the system are warm. When surrounded by warm surfaces, the human body receives radiation from the warm surfaces. This permits the occupants to feel comfortable at lower interior air temperatures because heat is radiated *to* the body rather than *from* the body.

### **Glazing and Lighting Quality**

The amount of natural lighting required will affect the selection of the type of passive solar heating system. Fabrics and even the glazing material itself may suffer from ultraviolet degradation when exposed to direct sunlight. In applications such as studios, admitting large quantities of diffuse solar radiation provides appropriate lighting.

The amount of glazing for most conventional structures is typically determined by the need or desire to provide contact with the exterior or to meet building code egress requirements. This is not usually a primary design consideration for the passive solar heating system

### **Material Properties**

Massive brick masonry is recommended for thermal storage because of its inherent ability to store heat. Typically, brick exposed to direct sunlight should be of a dark color wherever it is to perform as a thermal storage media. The American Society of Heating, Refrigerating and air-conditioning Engineers (ASHRAE) defines dark colors as dark blue, red, brown and green. The properties of brick as related to passive solar applications are discussed in *Technical Notes* 43D.

### **System Operation**

Passive solar heating systems may be shaded from the summer sun by fixed, adjustable or removable shading devices. Adjustable or removable overhangs or shading devices require operation, but permit the optimum use of the winter sun and can completely eliminate any solar exposure on the South-facing glass in the summer.

The performance of passive solar systems may be greatly enhanced by the use of night insulation. The insulation may be applied on the interior in the form of drapes or panels. Insulation may also serve as reflector panels or shading devices. Reflector-insulating panels may be hinged at the base of the South-facing glazing so that, when opened during the day, they reflect additional solar radiation through the glazing and when closed, provide night insulation. Night insulation may be operated manually or automatically.

### **Building Design and Appearance**

There is no reason for passive solar heating systems to have an extremely unconventional design or appearance. The only required variations are: additional South-facing wall glazing, reduced glazing on the East and West walls, and preferably no glazing on the North wall; sufficient overhang or some other shading device to prevent the South-facing glazing from being exposed to the summer sun; and interior brick masonry. The interior brick masonry exposed to direct sunlight is used as the thermal storage component of the passive solar energy system. Additional interior brick masonry unexposed to direct sunlight is used to provide a thermal flywheel which reduces interior temperature fluctuations.

## Spatial Requirements

The spatial requirements may dictate the type of system used. The depth of penetration of solar radiation into the structure may affect the system type selected. Buildings should be arranged with a longitudinal East-West orientation to maximize the solar exposure of the South-facing glazing. This minimizes the distance from the South wall to the North wall, across which the thermal energy from the passive solar energy system has to be distributed. Building energy performance may be increased by heating the North wall with solar radiation entering through the South-facing glazing.

## DIRECT GAIN SYSTEMS

The direct gain system is simple and often used. The system consists of South-facing glazing which allows winter sunlight to enter the habitable spaces of the building. This thermal energy is stored in brick floors and walls. A schematic of a direct gain system is shown in Fig. 4. The South-facing glazing may be windows (operable or fixed), or glass doors. The brick masonry exposed to the solar radiation should generally be a dark color and 4 to 8 in. thick. All walls or other components not exposed to solar radiation should have light-colored surfaces.

In the direct gain system, the South-facing glazing permits sunlight to strike the brick masonry construction. The brick masonry, because of its color, mass and thermal properties, provides the thermal storage for the system. The brick masonry absorbs the thermal energy from the sunlight striking its surface. The heat, which is stored during the daylight hours, is released gradually. The heat that is reflected from the brick masonry provides heat to the habitable space during the daylight hours. The light-colored surfaces reflect the heat radiated or reflected from the brick masonry to the air and surroundings in the habitable space. If large amounts of heat are required during the daytime hours and less during night-time hours, this may be accomplished by using lighter colors of brick masonry.

Direct gain systems provide rapid temperature increases in the habitable space and may have large temperature fluctuations. This is because such systems often must be designed to prevent overheating. The systems may have limited amounts of brick masonry exposed to the winter sunlight. This is especially true in the lower latitudes where the winter sun has a higher altitude. This may be overcome by providing clerestories to obtain solar radiation on the North wall, as shown in Fig. 4.

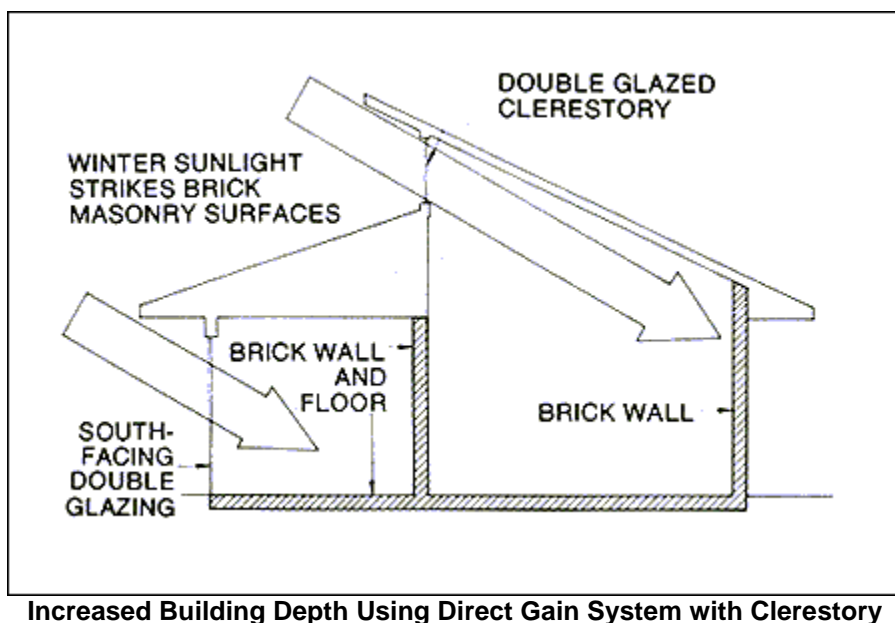
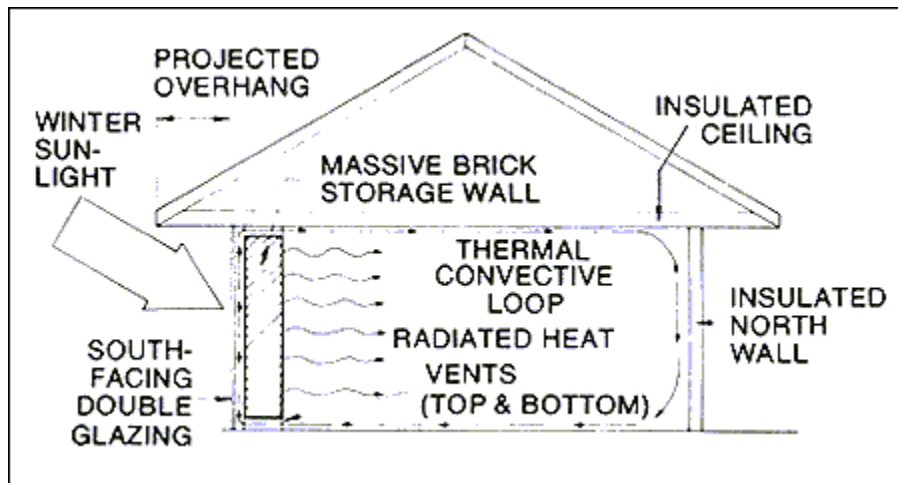


FIG. 4

Ultraviolet degradation is of the greatest concern when direct gain systems are utilized. Materials subject to ultraviolet degradation should not be exposed to direct sunlight. This may become an inconvenience in the living areas heated by direct gain. The walls and floors exposed to the sunlight and used for thermal storage should not be covered. Wall hangings and carpet greatly decrease the performance of the system.

## THERMAL STORAGE WALL SYSTEMS

The thermal storage wall system, often referred to as a Trombe Wall System, is schematically represented in Fig. 5. The thermal storage wall may be vented, as shown in Fig. 5, and provide heat by radiation and convection, or it may be unvented and supply heat by radiation alone. A thermal storage wall system is shown on the left of Fig. 2. It consists of glazing, usually spaced 2 to 4 in. on the exterior of a South-facing wall, constructed of brick masonry. The massive brick wall, usually 10 to 18 in. thick, may be loadbearing, or non-loadbearing.



Vented Thermal Storage Wall System

FIG. 5

The winter sunlight penetrating the South glazing heats the brick, the heat slowly penetrates the brick wall and warms the interior. Thermal storage walls may have sufficient heat storage to maintain comfortable temperatures in buildings for periods up to three completely overcast days. The thermal storage wall systems have considerably less temperature fluctuation than do direct gain systems, but usually do not achieve the same high initial interior temperatures.

The massive brick thermal storage wall prevents ultraviolet degradation of materials contained in the living space because solar radiation does not directly enter the habitable space. The performance may be substantially increased by providing vents at the top and bottom of the brick wall to provide convection in addition to the heat radiated from the interior face of the wall. Vented walls may be used to decrease the temperature fluctuations and increase the maximum temperature achieved in the living space. Fig. 1 shows a vented thermal storage wall under construction. When venting the storage wall system, vents with automatic or manual closures should be used so that the system does not reverse at night, creating a heat loss.

If controlled vents are not installed on the vented thermal storage wall systems, night insulation is essential to prevent heat losses at night. Night insulation may be required on unvented thermal storage walls and those with controlled vents to increase the efficiency of the system.

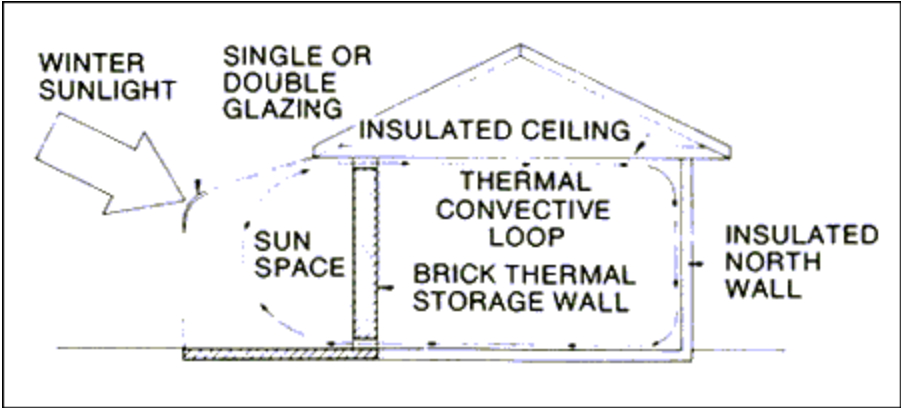
## COMBINED SYSTEMS

The best thermal performance and living conditions result by combining the thermal storage wall system and the direct gain system. This combination permits some direct sunlight into the living spaces, achieves higher interior temperatures than the thermal wall system alone, provides less temperature fluctuation than the direct gain system alone and provides natural lighting. The combination essentially utilizes the best of the two systems.

## ATTACHED SUNSPACES

Attached sunspaces are a combination of the components of the direct gain system and the thermal storage wall system, as shown in Fig. 2 on the right, and in Fig. 6. The sunspace is a room, or space, which typically has both a glass roof and a glass South-facing wall. The East and West walls may also be glass. The floor is similar to that of the direct gain system. It consists of 4 to 8-in. thick brick masonry. The North wall is a 10 to 18-in. thick brick thermal storage wall. The room is vented or ducted to other areas of the structure. With the assistance of fans and

blowers, the structure is heated by the extreme temperatures achieved in the sunspace. The sunspace usually has severe temperature fluctuations and is often unbearably hot during daylight hours. They do require removable shading devices to prevent solar gains in the summer. They will also require night insulation if they are to become useable living space in the evening hours.



Attached Sunspace

FIG. 6

## **CAVITY WALL SYSTEM**

The cavity wall system, shown in Fig. 7, is a modification of the double envelope system. The concept of the cavity wall system is that the South-facing thermal storage wall heats up and creates a convective loop around the entire building envelope. The warmed air space minimizes the temperature differential from the interior of the building through the inner wythe of the cavity wall. There are no generally accepted design procedures for this type of system presently available. Some experts in the passive solar design field feel that the increased thermal



performance may be accounted for by the insulation in the interior and exterior shells of the double envelope system. Others feel that there is no convective loop occurring, i.e., the air between the double envelope shells is stagnant.

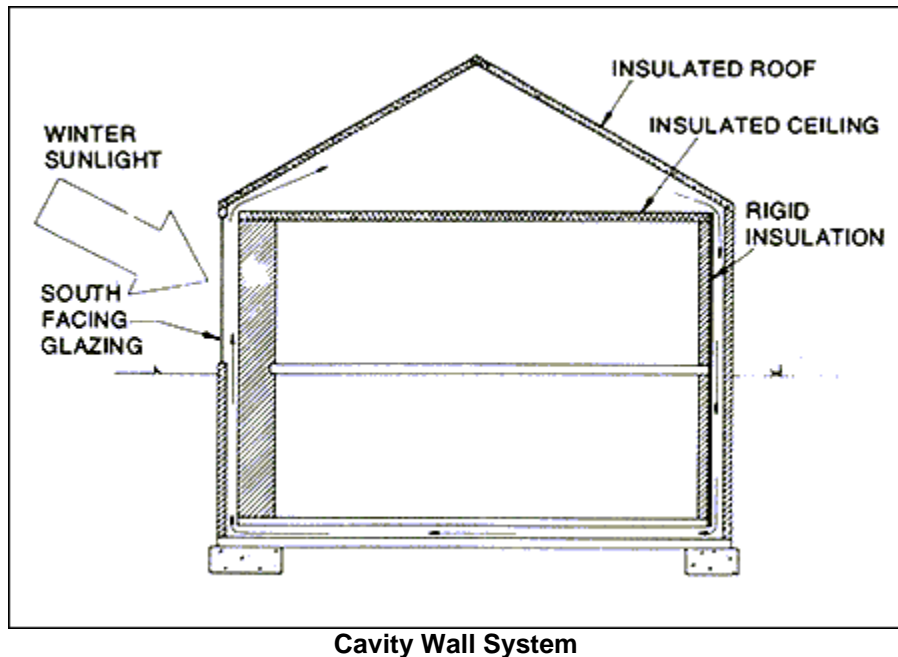


FIG.7

The use of a properly constructed, insulated brick cavity wall on the North side of the building could be used to provide a moderate heat loss to drive the convective loop through the air space in the building envelope. This would reduce the temperature of the air being circulated through the cavity, but the air should still reach high enough temperatures as it passes through the air space of the thermal storage wall system to provide a net heat gain.

Since there is still considerable controversy regarding this type of system, and since accurate performance analysis is not easily accomplished, these systems should only be designed and constructed with the appropriate awareness of the expected and achievable performance level of the system.

### METRIC CONVERSION

Because of the possible confusion inherent in showing dual unit systems in the calculations, the metric (SI) units are not given in this *Technical Notes*. Table 13 in *Technical Notes 4* provides metric (SI) conversion factors for the more commonly used units.

### SUMMARY

This *Technical Notes* has provided general information concerning passive solar heating systems. It has described several passive solar heating systems, the basic principles of their operation and general design consideration. This introduction to passive solar heating systems hopefully provides sufficient familiarization with concepts so that the design of such systems will be understood. Passive solar cooling is discussed in *Technical Notes 43C*. The material properties of brick masonry, as related to passive solar energy systems, is provided in *Technical Notes 43D*. Details and construction information are provided in *Technical Notes 43G*.

This *Technical Notes* does *not* and is *not* intended to provide information for specific designs and applications, but rather offers general information to assist in the consideration and use of brick masonry in passive solar heating systems. The decision to use these concepts in the design specific applications is *not* within the purview of the Brick Institute of America, and must rest with the owner or designer of any specific project.

| Month  | Normal Temperature (Deg F) <sup>1</sup> |               |         | Normal Degree Days <sup>2</sup> | Total Hemispheric Mean Daily Solar Radiation | Month                                    | Normal Temperature (Deg F) <sup>1</sup> |                       |               | Normal Degree Days <sup>2</sup> | Total Hemispheric Mean Daily Solar Radiation | Month                                       | Normal Temperature (Deg F) <sup>1</sup> |         |                       | Normal Degree Days <sup>2</sup> | Total Hemispheric Mean Daily Solar Radiation |
|--|---|---------------|---------|---------------------------------|--|--|---|-----------------------|---------------|---------------------------------|--|---|---|---------|-----------------------|---------------------------------|--|
|  | Daily Maximum                           | Daily Minimum | Monthly |                                 |  |  | Base 65 Deg F Heating                   | Base 65 Deg F Heating | Daily Maximum |                                 |  |   | Daily Minimum                           | Monthly | Base 65 Deg F Heating |                                 |  |
| <b>ALABAMA</b>                               |   |               |         |                                 |  | <b>ALABAMA (continued)</b>               |   |                       |               |                                 |  | <b>ALASKA</b>                               |   |         |                       |                                 |  |
| Birmingham Latitude 33° 34' N Elevation 636' |   |               |         |                                 |  | Mobile Latitude 30° 41' N Elevation 220' |   |                       |               |                                 |  | Fairbanks Latitude 64° 49' N Elevation 453' |   |         |                       |                                 |  |
| JAN  | 54.3                                    | 34.1          | 44.2    | 654                             | 706.6  | JAN                                      | 61.1                                    | 41.3                  | 51.2          | 451                             | 828.2  | JAN   | -2.2                                    | -21.6   | -11.9                 | 2384                            | 30.1   |
| FEB  | 57.7                                    | 36.1          | 46.9    | 517                             | 967.1  | FEB                                      | 64.1                                    | 43.9                  | 54.0          | 337                             | 1099.6                                       | FEB   | 9.3                                     | -14.3   | -2.5                  | 1890                            | 221.4  |
| MAR  | 64.8                                    | 41.8          | 53.3    | 389                             | 1296.1                                       | MAR                                      | 69.5                                    | 49.2                  | 59.4          | 221                             | 1407.5                                       | MAR   | 23.3                                    | -4.3    | 9.5                   | 1720                            | 674.2  |
| APR  | 75.3                                    | 51.0          | 63.2    | 116                             | 1673.5                                       | APR                                      | 78.0                                    | 57.7                  | 67.9          | 40                              | 1721.7                                       | APR   | 40.4                                    | 17.3    | 28.9                  | 1083                            | 1193.9                                       |
| MAY  | 82.5                                    | 58.4          | 70.5    | 20                              | 1856.9                                       | MAY                                      | 85.0                                    | 64.5                  | 74.8          | 0                               | 1872.1                                       | MAY   | 58.8                                    | 35.7    | 47.3                  | 549                             | 1603.6                                       |
| SEP  | 84.7                                    | 63.0          | 73.9    | 6                               | 1454.6                                       | SEP                                      | 86.5                                    | 68.4                  | 77.5          | 0                               | 1449.4                                       | SEP   | 54.4                                    | 34.4    | 44.4                  | 618                             | 709.4  |
| OCT  | 75.8                                    | 50.8          | 63.3    | 137                             | 1210.8                                       | OCT                                      | 79.7                                    | 58.0                  | 68.9          | 39                              | 1298.7                                       | OCT   | 33.5                                    | 16.9    | 25.2                  | 1234                            | 292.6  |
| NOV  | 64.0                                    | 40.1          | 52.1    | 391                             | 857.9  | NOV                                      | 69.5                                    | 47.5                  | 58.5          | 211                             | 955.1  | NOV   | 11.7                                    | -6.2    | 2.8                   | 1866                            | 74.1   |
| DEC  | 55.5                                    | 34.9          | 45.2    | 614                             | 661.4  | DEC                                      | 63.0                                    | 42.8                  | 52.9          | 385                             | 759.2  | DEC   | -1.5                                    | -19.3   | -10.4                 | 2337                            | 2.5  |
| ANN  | 73.6                                    | 51.2          | 62.4    | 2844                            | 1344.7                                       | ANN                                      | 77.3                                    | 57.4                  | 67.4          | 1684                            | 1384.7                                       | ANN   | 36.3                                    | 15.0    | 25.7                  | 14344                           | 767.8  |

| Month   | Normal Temperature (Deg F)* |               |         | Normal Degree Days*   | Total Hemispheric Mean Daily Solar Radiation | Month  | Normal Temperature (Deg F)* |               |         | Normal Degree Days*   | Total Hemispheric Mean Daily Solar Radiation | Month   | Normal Temperature (Deg F)* |               |         | Normal Degree Days*   | Total Hemispheric Mean Daily Solar Radiation |
|---|-----------------------------|---------------|---------|-----------------------|--|--|-----------------------------|---------------|---------|-----------------------|--|---|-----------------------------|---------------|---------|-----------------------|--|
|   | Daily Max-min               | Daily Min-max | Monthly | Base 65 Deg F Heating | Btu/ft²                                      |  | Daily Max-min               | Daily Min-max | Monthly | Base 65 Deg F Heating | Btu/ft²                                      |   | Daily Max-min               | Daily Min-max | Monthly | Base 65 Deg F Heating | Btu/ft²                                      |
| <b>ARIZONA</b>                                |                             |               |         |                       |  | <b>CALIFORNIA (continued)</b>                  |                             |               |         |                       |  | <b>WASHINGTON, D.C.</b>                       |                             |               |         |                       |  |
| Phoenix Latitude 33° 26' N Elevation 1112'    |                             |               |         |                       |  | San Francisco Latitude 37° 37' N Elevation 16' |                             |               |         |                       |  | JAN 41.2 23.0 32.1 1020 572.0                 |                             |               |         |                       |  |
| JAN   | 64.8                        | 37.6          | 51.2    | 428                   | 1021.3                                       | JAN  | 55.3                        | 41.2          | 48.3    | 518                   | 707.6  | FEB   | 43.4                        | 24.1          | 33.8    | 874                   | 815.3  |
| FEB   | 69.3                        | 40.8          | 55.1    | 292                   | 1374.1                                       | FEB  | 58.6                        | 43.8          | 51.2    | 386                   | 1009.3                                       | MAR   | 52.7                        | 30.9          | 41.8    | 719                   | 1125.0                                       |
| MAR   | 74.5                        | 44.8          | 59.7    | 185                   | 1814.1                                       | MAR  | 61.0                        | 44.9          | 53.0    | 372                   | 1455.1                                       | APR   | 65.0                        | 41.1          | 53.1    | 357                   | 1458.9                                       |
| APR   | 83.6                        | 51.8          | 67.7    | 60                    | 2354.8                                       | APR  | 63.5                        | 47.0          | 55.3    | 291                   | 1920.0                                       | MAY   | 74.5                        | 50.6          | 62.6    | 131                   | 1718.1                                       |
| MAY   | 92.9                        | 59.6          | 76.3    | 0                     | 2676.5                                       | MAY  | 66.6                        | 49.9          | 58.3    | 210                   | 2225.6                                       | SEP   | 78.7                        | 55.0          | 66.9    | 43                    | 1340.0                                       |
| SEP   | 98.4                        | 69.1          | 83.8    | 0                     | 2015.4                                       | SEP  | 73.6                        | 54.5          | 64.1    | 66                    | 1742.0                                       | OCT   | 68.2                        | 43.5          | 55.9    | 291                   | 1003.8                                       |
| OCT   | 87.6                        | 56.8          | 72.2    | 17                    | 1576.5                                       | OCT  | 70.3                        | 51.6          | 61.0    | 137                   | 1226.1                                       | NOV   | 55.6                        | 33.7          | 44.7    | 609                   | 650.9  |
| NOV   | 74.7                        | 44.8          | 59.8    | 182                   | 1150.5                                       | NOV  | 63.3                        | 47.2          | 55.3    | 291                   | 821.4  | DEC   | 43.3                        | 24.7          | 34.0    | 961                   | 481.1  |
| DEC   | 66.4                        | 38.5          | 52.5    | 388                   | 932.0  | DEC  | 56.3                        | 42.9          | 49.7    | 474                   | 642.2  | ANN   | 64.7                        | 42.7          | 53.7    | 5010                  | 1208.4                                       |
| ANN   | 85.1                        | 55.4          | 70.3    | 1552                  | 1869.4                                       | ANN  | 65.1                        | 48.7          | 56.9    | 3042                  | 1552.8                                       | <b>FLORIDA</b>                                |                             |               |         |                       |  |
| Tucson Latitude 32° 07' N Elevation 2556'     |                             |               |         |                       |  | <b>COLORADO</b>                                |                             |               |         |                       |  | Jacksonville Latitude 30° 30' N Elevation 29' |                             |               |         |                       |  |
| JAN   | 63.5                        | 38.2          | 50.9    | 442                   | 1099.0                                       | Denver Latitude 39° 45' N Elevation 5332'      |                             |               |         |                       |  | JAN   | 64.6                        | 44.5          | 54.6    | 348                   | 899.9  |
| FEB   | 67.0                        | 39.9          | 53.5    | 333                   | 1432.0                                       | JAN  | 43.5                        | 16.2          | 29.9    | 1088                  | 840.1  | FEB   | 66.9                        | 45.7          | 56.3    | 282                   | 1164.3                                       |
| MAR   | 71.5                        | 43.6          | 57.6    | 243                   | 1864.3                                       | FEB  | 46.2                        | 19.4          | 32.8    | 902                   | 1127.0                                       | MAR   | 72.2                        | 50.1          | 61.2    | 176                   | 1521.7                                       |
| APR   | 80.7                        | 50.3          | 65.5    | 81                    | 2363.0                                       | MAR  | 50.1                        | 23.8          | 37.0    | 868                   | 1530.4                                       | APR   | 79.0                        | 57.1          | 68.1    | 24                    | 1855.7                                       |
| MAY   | 89.6                        | 57.5          | 73.6    | 0                     | 2671.4                                       | APR  | 61.0                        | 33.9          | 47.5    | 525                   | 1879.3                                       | MAY   | 84.6                        | 63.9          | 74.3    | 0                     | 1956.3                                       |
| SEP   | 93.1                        | 67.1          | 80.1    | 0                     | 1978.8                                       | MAY  | 70.3                        | 43.6          | 57.0    | 253                   | 2134.9                                       | SEP   | 86.0                        | 70.4          | 78.2    | 0                     | 1442.3                                       |
| OCT   | 83.8                        | 56.4          | 70.1    | 29                    | 1601.9                                       | SEP  | 77.7                        | 47.8          | 62.8    | 120                   | 1726.8                                       | OCT   | 79.2                        | 61.7          | 70.5    | 19                    | 1223.1                                       |
| NOV   | 72.2                        | 44.8          | 58.5    | 221                   | 1208.4                                       | OCT  | 66.8                        | 37.2          | 52.0    | 408                   | 1300.5                                       | NOV   | 71.4                        | 51.0          | 61.2    | 161                   | 996.0  |
| DEC   | 64.8                        | 39.1          | 52.0    | 403                   | 995.8  | NOV  | 53.3                        | 25.4          | 39.4    | 768                   | 883.5  | DEC   | 65.6                        | 45.1          | 55.4    | 317                   | 817.6  |
| ANN   | 81.5                        | 54.1          | 67.8    | 1752                  | 1872.3                                       | DEC  | 46.2                        | 18.9          | 32.6    | 1004                  | 731.8  | ANN   | 78.1                        | 58.7          | 68.4    | 1327                  | 1438.2                                       |
| <b>ARKANSAS</b>                               |                             |               |         |                       |  | Pueblo Latitude 38° 17' N Elevation 4721'      |                             |               |         |                       |  | <b>GEORGIA</b>                                |                             |               |         |                       |  |
| Little Rock Latitude 34° 44' N Elevation 266' |                             |               |         |                       |  | JAN  | 45.5                        | 14.7          | 30.1    | 1082                  | 894.3  | Atlanta Latitude 33° 39' N Elevation 1033'    |                             |               |         |                       |  |
| JAN   | 50.1                        | 28.9          | 39.5    | 791                   | 731.3  | FEB  | 49.8                        | 19.6          | 34.7    | 848                   | 1171.6                                       | JAN   | 51.4                        | 33.4          | 42.4    | 701                   | 717.6  |
| FEB   | 53.8                        | 31.9          | 42.9    | 619                   | 1002.8                                       | MAR  | 54.9                        | 25.0          | 40.0    | 775                   | 1563.8                                       | FEB   | 54.5                        | 35.5          | 45.0    | 560                   | 968.9  |
| MAR   | 61.8                        | 38.7          | 50.3    | 470                   | 1312.7                                       | APR  | 66.4                        | 36.9          | 51.7    | 405                   | 1956.0                                       | MAR   | 61.1                        | 41.1          | 51.1    | 443                   | 1303.6                                       |
| APR   | 73.5                        | 49.9          | 61.7    | 139                   | 1610.7                                       | MAY  | 75.5                        | 46.6          | 61.1    | 148                   | 2162.5                                       | APR   | 71.4                        | 50.7          | 61.1    | 144                   | 1686.2                                       |
| MAY   | 81.4                        | 58.1          | 69.8    | 21                    | 1929.3                                       | SEP  | 81.5                        | 50.8          | 66.2    | 55                    | 1779.5                                       | MAY   | 79.0                        | 59.2          | 69.1    | 27                    | 1853.8                                       |
| SEP   | 85.8                        | 60.8          | 73.3    | 5                     | 1518.0                                       | OCT  | 70.7                        | 38.2          | 54.5    | 335                   | 1360.9                                       | SEP   | 81.2                        | 63.4          | 72.3    | 8                     | 1422.0                                       |
| OCT   | 76.0                        | 48.7          | 62.4    | 143                   | 1228.3                                       | NOV  | 56.5                        | 25.1          | 40.8    | 726                   | 953.8  | OCT   | 72.5                        | 52.3          | 62.4    | 137                   | 1199.9                                       |
| NOV   | 62.4                        | 38.1          | 50.3    | 441                   | 847.2  | DEC  | 48.2                        | 17.7          | 33.0    | 992                   | 782.2  | NOV   | 61.9                        | 40.8          | 51.4    | 408                   | 882.9  |
| DEC   | 51.2                        | 31.1          | 41.6    | 725                   | 673.7  | ANN  | 67.9                        | 37.7          | 52.8    | 5394                  | 1622.7                                       | DEC   | 52.7                        | 34.3          | 43.5    | 667                   | 674.2  |
| ANN   | 72.6                        | 49.3          | 61.0    | 3354                  | 1404.4                                       | <b>CONNECTICUT</b>                             |                             |               |         |                       |  | ANN   | 70.3                        | 51.3          | 60.8    | 3095                  | 1345.3                                       |
| <b>CALIFORNIA</b>                             |                             |               |         |                       |  | Hartford Latitude 41° 56' N Elevation 180'     |                             |               |         |                       |  | Savannah Latitude 32° 08' N Elevation 52'     |                             |               |         |                       |  |
| Los Angeles Latitude 33° 56' N Elevation 105' |                             |               |         |                       |  | JAN  | 33.4                        | 16.1          | 24.8    | 1246                  | 477.5  | JAN   | 61.1                        | 38.7          | 49.9    | 483                   | 794.7  |
| JAN   | 63.5                        | 45.4          | 54.5    | 331                   | 926.1  | FEB  | 35.7                        | 17.9          | 26.8    | 1070                  | 714.7  | FEB   | 63.6                        | 40.5          | 52.1    | 379                   | 1043.8                                       |
| FEB   | 64.1                        | 47.0          | 55.6    | 270                   | 1214.0                                       | MAR  | 44.6                        | 26.6          | 35.6    | 911                   | 978.5  | MAR   | 69.5                        | 46.4          | 58.0    | 256                   | 1398.5                                       |
| MAR   | 64.3                        | 48.6          | 56.5    | 267                   | 1618.7                                       | APR  | 58.9                        | 36.5          | 47.7    | 519                   | 1315.0                                       | APR   | 77.8                        | 54.3          | 66.1    | 63                    | 1761.4                                       |
| APR   | 65.9                        | 51.7          | 58.8    | 195                   | 1950.9                                       | MAY  | 70.3                        | 46.2          | 58.3    | 226                   | 1568.5                                       | MAY   | 84.8                        | 61.8          | 73.3    | 0                     | 1852.3                                       |
| MAY   | 68.4                        | 55.3          | 61.9    | 114                   | 2059.6                                       | SEP  | 74.5                        | 51.0          | 62.8    | 106                   | 1154.5                                       | SEP   | 85.4                        | 66.9          | 76.2    | 0                     | 1363.7                                       |
| SEP   | 75.7                        | 61.6          | 68.7    | 23                    | 1681.4                                       | OCT  | 64.3                        | 40.8          | 52.6    | 384                   | 852.9  | OCT   | 78.2                        | 55.9          | 67.1    | 60                    | 1216.7                                       |
| OCT   | 72.9                        | 57.5          | 65.2    | 77                    | 1317.0                                       | NOV  | 50.6                        | 31.9          | 41.3    | 711                   | 497.3  | NOV   | 69.3                        | 44.9          | 57.1    | 253                   | 941.1  |
| NOV   | 69.6                        | 51.3          | 60.5    | 158                   | 1003.9                                       | DEC  | 36.8                        | 19.6          | 28.2    | 1141                  | 385.1  | DEC   | 62.1                        | 38.7          | 50.4    | 458                   | 753.7  |
| DEC   | 66.5                        | 47.3          | 56.9    | 279                   | 848.5  | ANN  | 59.6                        | 38.6          | 49.1    | 6350                  | 1058.3                                       | ANN   | 76.8                        | 54.9          | 65.9    | 1952                  | 1364.5                                       |
| ANN   | 69.2                        | 54.1          | 61.7    | 1819                  | 1593.8                                       | <b>DELAWARE</b>                                |                             |               |         |                       |  | <b>IDAHO</b>                                  |                             |               |         |                       |  |
| Sacramento Latitude 38° 31' N Elevation 26'   |                             |               |         |                       |  | Wilmington Latitude 39° 40' N Elevation 79'    |                             |               |         |                       |  | Boise Latitude 43° 34' N Elevation 2868'      |                             |               |         |                       |  |
| JAN   | 53.0                        | 37.1          | 45.1    | 617                   | 596.9  | JAN  | 40.2                        | 23.8          | 32.0    | 1023                  | 571.4  | JAN   | 36.5                        | 21.4          | 29.0    | 1116                  | 485.3  |
| FEB   | 59.1                        | 40.4          | 49.8    | 426                   | 939.4  | FEB  | 42.2                        | 24.9          | 33.6    | 879                   | 827.0  | FEB   | 43.8                        | 27.2          | 35.5    | 826                   | 839.7  |
| MAR   | 64.1                        | 41.9          | 53.0    | 372                   | 1458.4                                       | MAR  | 51.1                        | 32.0          | 41.6    | 725                   | 1149.2                                       | MAR   | 51.6                        | 30.5          | 41.1    | 741                   | 1304.1                                       |
| APR   | 71.3                        | 45.3          | 58.3    | 227                   | 2003.6                                       | APR  | 63.0                        | 41.5          | 52.3    | 381                   | 1480.1                                       | APR   | 61.4                        | 36.5          | 49.0    | 480                   | 1826.9                                       |
| MAY   | 78.8                        | 49.8          | 64.3    | 120                   | 2434.8                                       | MAY  | 73.1                        | 51.6          | 62.4    | 128                   | 1710.2                                       | MAY   | 70.6                        | 44.1          | 57.4    | 252                   | 2276.7                                       |
| SEP   | 87.7                        | 55.3          | 71.5    | 5                     | 1906.7                                       | SEP  | 78.2                        | 57.6          | 67.9    | 32                    | 1317.7                                       | SEP   | 77.6                        | 48.5          | 63.1    | 127                   | 1737.2                                       |
| OCT   | 77.1                        | 49.5          | 63.3    | 101                   | 1314.9                                       | OCT  | 67.8                        | 46.5          | 57.2    | 254                   | 983.9  | OCT   | 64.7                        | 39.4          | 52.1    | 406                   | 1137.8                                       |
| NOV   | 63.6                        | 42.4          | 53.0    | 360                   | 781.9  | NOV  | 55.2                        | 36.2          | 45.7    | 579                   | 644.6  | NOV   | 48.9                        | 30.7          | 39.8    | 756                   | 628.3  |
| DEC   | 53.3                        | 38.3          | 45.8    | 595                   | 538.4  | DEC  | 43.0                        | 26.3          | 34.7    | 939                   | 488.6  | DEC   | 39.1                        | 25.0          | 32.1    | 1020                  | 437.2  |
| ANN   | 73.2                        | 47.4          | 60.3    | 2843                  | 1642.9                                       | ANN  | 63.7                        | 44.3          | 54.0    | 4940                  | 1207.7                                       | ANN   | 62.6                        | 39.1          | 50.9    | 5833                  | 1495.5                                       |

\*Based on 1941-1970 Period. Zeros appearing for all values appearing in these columns signify that 1941-1970 period normals were not available.

| Month  | Normal Temperature (Deg F) |               |         | Normal Degree Days* | Total Hemispheric Mean Daily Solar Radiation | Month  | Normal Temperature (Deg F) |               |         | Normal Degree Days* | Total Hemispheric Mean Daily Solar Radiation | Month                                       | Normal Temperature (Deg F) |               |         | Normal Degree Days* | Total Hemispheric Mean Daily Solar Radiation |                       |               |         |
|--|----------------------------|---------------|---------|---------------------|--|--|----------------------------|---------------|---------|---------------------|--|---|----------------------------|---------------|---------|---------------------|--|-----------------------|---------------|---------|
|  | Daily Maximum              | Daily Minimum | Monthly |                     |  |  | Daily Maximum              | Daily Minimum | Monthly |                     |  |   | Daily Maximum              | Daily Minimum | Monthly |                     |  | Daily Maximum         | Daily Minimum | Monthly |
|  | Base 65 Deg F Heating      |               | DuB*    |                     |  |  | Base 65 Deg F Heating      |               | DuB*    |                     |  |   | Base 65 Deg F Heating      |               | DuB*    |                     |  | Base 65 Deg F Heating |               | DuB*    |
| <b>ILLINOIS</b>                                |                            |               |         |                     |  | <b>KANSAS (continued)</b>                    |                            |               |         |                     |  | <b>MARYLAND</b>                             |                            |               |         |                     |  |                       |               |         |
| Chicago Latitude 41° 47' N Elevation 623'      |                            |               |         |                     |  | Wichita Latitude 37° 39' N Elevation 1339'   |                            |               |         |                     |  | Baltimore Latitude 39° 11' N Elevation 154' |                            |               |         |                     |  |                       |               |         |
| JAN  | 31.5                       | 17.0          | 24.3    | 1262                | 507.0  | JAN  | 41.4                       | 21.2          | 31.3    | 1045                | 783.9  | JAN   | 41.9                       | 24.9          | 33.4    | 980                 | 586.9  |                       |               |         |
| FEB  | 34.6                       | 20.2          | 27.4    | 1053                | 759.5  | FEB  | 47.1                       | 25.4          | 36.3    | 804                 | 1058.2                                       | FEB   | 43.9                       | 25.7          | 34.8    | 846                 | 840.0  |                       |               |         |
| MAR  | 44.6                       | 29.0          | 36.8    | 874                 | 1106.9                                       | MAR  | 55.0                       | 32.1          | 43.6    | 671                 | 1405.5                                       | MAR   | 53.0                       | 32.5          | 42.8    | 688                 | 1162.2                                       |                       |               |         |
| APR  | 59.3                       | 40.4          | 49.9    | 453                 | 1459.0                                       | APR  | 68.1                       | 45.1          | 56.6    | 275                 | 1782.5                                       | APR   | 65.2                       | 42.4          | 53.8    | 340                 | 1487.9                                       |                       |               |         |
| MAY  | 70.3                       | 49.7          | 60.0    | 208                 | 1788.9                                       | MAY  | 77.1                       | 55.0          | 66.1    | 90                  | 2035.8                                       | MAY   | 74.8                       | 52.5          | 63.7    | 110                 | 1713.9                                       |                       |               |         |
| SEP  | 75.8                       | 56.0          | 65.9    | 57                  | 1353.9                                       | SEP  | 81.9                       | 59.2          | 70.6    | 32                  | 1616.1                                       | SEP   | 79.0                       | 57.9          | 68.5    | 27                  | 1330.3                                       |                       |               |         |
| OCT  | 65.0                       | 45.6          | 55.4    | 316                 | 968.9  | OCT  | 71.3                       | 47.9          | 59.6    | 211                 | 1249.8                                       | OCT   | 68.3                       | 46.4          | 57.4    | 250                 | 997.6  |                       |               |         |
| NOV  | 48.1                       | 32.6          | 40.4    | 738                 | 565.6  | NOV  | 55.8                       | 33.8          | 44.8    | 606                 | 870.8  | NOV   | 56.1                       | 36.0          | 46.1    | 567                 | 660.3  |                       |               |         |
| DEC  | 35.3                       | 21.6          | 28.5    | 1132                | 401.5  | DEC  | 44.3                       | 24.6          | 34.5    | 946                 | 689.9  | DEC   | 43.9                       | 26.6          | 35.3    | 921                 | 499.3  |                       |               |         |
| ANN  | 59.4                       | 41.8          | 50.6    | 6127                | 1215.1                                       | ANN  | 67.6                       | 45.6          | 56.6    | 4687                | 1502.3                                       | ANN   | 65.1                       | 44.8          | 55.0    | 4729                | 1215.0                                       |                       |               |         |
| <b>INDIANA</b>                                 |                            |               |         |                     |  | <b>KENTUCKY</b>                              |                            |               |         |                     |  | <b>MICHIGAN</b>                             |                            |               |         |                     |  |                       |               |         |
| Indianapolis Latitude 39° 44' N Elevation 807' |                            |               |         |                     |  | Louisville Latitude 38° 11' N Elevation 489' |                            |               |         |                     |  | Detroit Latitude 42° 25' N Elevation 627'   |                            |               |         |                     |  |                       |               |         |
| JAN  | 36.0                       | 19.7          | 27.9    | 1150                | 495.6  | JAN  | 42.0                       | 24.5          | 33.3    | 983                 | 545.5  | JAN   | 31.7                       | 19.2          | 25.5    | 1225                | 417.4  |                       |               |         |
| FEB  | 39.3                       | 22.1          | 30.7    | 960                 | 746.9  | FEB  | 45.0                       | 26.5          | 35.8    | 818                 | 789.3  | FEB   | 33.7                       | 20.1          | 26.9    | 1067                | 680.4  |                       |               |         |
| MAR  | 49.0                       | 30.3          | 39.7    | 784                 | 1037.4                                       | MAR  | 54.0                       | 34.0          | 44.0    | 661                 | 1102.0                                       | MAR   | 43.1                       | 27.6          | 35.4    | 918                 | 1000.2                                       |                       |               |         |
| APR  | 62.8                       | 41.8          | 52.3    | 387                 | 1398.4                                       | APR  | 66.9                       | 44.8          | 55.9    | 286                 | 1466.7                                       | APR   | 57.6                       | 38.6          | 48.1    | 507                 | 1399.0                                       |                       |               |         |
| MAY  | 72.9                       | 51.5          | 62.2    | 159                 | 1688.0                                       | MAY  | 75.6                       | 53.9          | 64.8    | 105                 | 1719.8                                       | MAY   | 68.5                       | 48.3          | 58.4    | 238                 | 1715.9                                       |                       |               |         |
| SEP  | 77.7                       | 54.9          | 66.3    | 63                  | 1324.0                                       | SEP  | 80.5                       | 57.7          | 69.1    | 35                  | 1361.2                                       | SEP   | 74.2                       | 54.8          | 64.5    | 80                  | 1253.2                                       |                       |               |         |
| OCT  | 67.0                       | 44.3          | 55.7    | 302                 | 977.0  | OCT  | 70.3                       | 45.9          | 58.1    | 241                 | 1042.2                                       | OCT   | 63.4                       | 45.2          | 54.3    | 342                 | 876.1  |                       |               |         |
| NOV  | 50.5                       | 32.8          | 41.7    | 699                 | 579.1  | NOV  | 54.9                       | 35.1          | 45.0    | 600                 | 652.8  | NOV   | 47.7                       | 34.4          | 41.1    | 717                 | 477.8  |                       |               |         |
| DEC  | 38.7                       | 23.1          | 30.9    | 1057                | 416.6  | DEC  | 44.1                       | 27.1          | 35.6    | 911                 | 487.9  | DEC   | 35.4                       | 23.8          | 29.6    | 1097                | 343.5  |                       |               |         |
| ANN  | 62.2                       | 42.4          | 52.3    | 5577                | 1165.0                                       | ANN  | 65.9                       | 45.3          | 55.6    | 4645                | 1215.7                                       | ANN   | 58.3                       | 41.4          | 49.9    | 6228                | 1120.0                                       |                       |               |         |
| <b>LOUISIANA</b>                               |                            |               |         |                     |  | <b>MINNESOTA</b>                             |                            |               |         |                     |  |   |                            |               |         |                     |  |                       |               |         |
| Baton Rouge Latitude 30° 32' N Elevation 75'   |                            |               |         |                     |  | Duluth Latitude 46° 50' N Elevation 1417'    |                            |               |         |                     |  |   |                            |               |         |                     |  |                       |               |         |
| JAN  | 61.5                       | 40.5          | 51.0    | 451                 | 785.1  | JAN  | 17.6                       | -0.6          | 8.5     | 1751                | 388.6  |   |                            |               |         |                     |  |                       |               |         |
| FEB  | 64.5                       | 43.2          | 53.9    | 335                 | 1054.1                                       | FEB  | 22.1                       | 2.0           | 12.1    | 1481                | 672.8  |   |                            |               |         |                     |  |                       |               |         |
| MAR  | 70.6                       | 48.7          | 59.7    | 208                 | 1379.4                                       | MAR  | 32.6                       | 14.4          | 23.5    | 1287                | 1034.5                                       |   |                            |               |         |                     |  |                       |               |         |
| APR  | 79.0                       | 57.7          | 68.4    | 33                  | 1681.2                                       | APR  | 47.8                       | 29.3          | 38.6    | 792                 | 1372.8                                       |   |                            |               |         |                     |  |                       |               |         |
| MAY  | 85.2                       | 64.3          | 74.8    | 0                   | 1871.2                                       | MAY  | 60.0                       | 38.8          | 49.4    | 484                 | 1642.6                                       |   |                            |               |         |                     |  |                       |               |         |
| SEP  | 87.2                       | 67.7          | 77.5    | 0                   | 1464.4                                       | SEP  | 64.0                       | 44.8          | 54.4    | 318                 | 1095.0                                       |   |                            |               |         |                     |  |                       |               |         |
| OCT  | 80.4                       | 56.6          | 68.5    | 54                  | 1301.1                                       | OCT  | 54.3                       | 36.2          | 45.3    | 611                 | 724.8  |   |                            |               |         |                     |  |                       |               |         |
| NOV  | 70.3                       | 46.9          | 58.6    | 208                 | 920.4  | NOV  | 35.3                       | 21.4          | 28.4    | 1098                | 380.7  |   |                            |               |         |                     |  |                       |               |         |
| DEC  | 63.7                       | 42.0          | 52.9    | 381                 | 736.8  | DEC  | 22.5                       | 6.3           | 14.4    | 1569                | 291.7  |   |                            |               |         |                     |  |                       |               |         |
| ANN  | 77.9                       | 56.9          | 67.4    | 1670                | 1378.5                                       | ANN  | 48.1                       | 29.1          | 38.6    | 9756                | 1064.3                                       |   |                            |               |         |                     |  |                       |               |         |
| <b>MAINE</b>                                   |                            |               |         |                     |  | <b>MISSISSIPPI</b>                           |                            |               |         |                     |  |   |                            |               |         |                     |  |                       |               |         |
| Portland Latitude 43° 39' N Elevation 62'      |                            |               |         |                     |  | Jackson Latitude 31° 29' N Elevation 331'    |                            |               |         |                     |  |   |                            |               |         |                     |  |                       |               |         |
| JAN  | 31.2                       | 11.7          | 21.5    | 1349                | 450.3  | JAN  | 58.4                       | 35.8          | 47.1    | 569                 | 753.5  |   |                            |               |         |                     |  |                       |               |         |
| FEB  | 33.3                       | 12.5          | 22.9    | 1179                | 681.9  | FEB  | 61.7                       | 37.8          | 49.8    | 442                 | 1026.4                                       |   |                            |               |         |                     |  |                       |               |         |
| MAR  | 40.8                       | 22.8          | 31.8    | 1029                | 969.6  | MAR  | 68.7                       | 43.4          | 56.1    | 313                 | 1369.1                                       |   |                            |               |         |                     |  |                       |               |         |
| APR  | 52.8                       | 32.5          | 42.7    | 669                 | 1303.9                                       | APR  | 78.2                       | 53.1          | 65.7    | 74                  | 1708.4                                       |   |                            |               |         |                     |  |                       |               |         |
| MAY  | 63.6                       | 41.7          | 52.7    | 381                 | 1567.4                                       | MAY  | 85.0                       | 60.4          | 72.7    | 6                   | 1940.8                                       |   |                            |               |         |                     |  |                       |               |         |
| SEP  | 69.9                       | 47.4          | 58.7    | 200                 | 1157.8                                       | SEP  | 88.0                       | 64.0          | 76.0    | 0                   | 1509.2                                       |   |                            |               |         |                     |  |                       |               |         |
| OCT  | 60.2                       | 38.0          | 49.1    | 493                 | 822.4  | OCT  | 80.1                       | 51.5          | 65.8    | 91                  | 1271.4                                       |   |                            |               |         |                     |  |                       |               |         |
| NOV  | 47.5                       | 29.7          | 38.6    | 792                 | 459.3  | NOV  | 68.5                       | 42.0          | 55.3    | 301                 | 901.6  |   |                            |               |         |                     |  |                       |               |         |
| DEC  | 34.9                       | 16.4          | 25.7    | 1218                | 362.9  | DEC  | 60.5                       | 37.3          | 48.9    | 504                 | 708.8  |   |                            |               |         |                     |  |                       |               |         |
| ANN  | 55.3                       | 34.7          | 45.0    | 7498                | 1050.6                                       | ANN  | 77.1                       | 52.8          | 65.0    | 2300                | 1408.6                                       |   |                            |               |         |                     |  |                       |               |         |
| <b>MASSACHUSETTS</b>                           |                            |               |         |                     |  | <b>MISSOURI</b>                              |                            |               |         |                     |  |   |                            |               |         |                     |  |                       |               |         |
| Boston Latitude 42° 22' N Elevation 16'        |                            |               |         |                     |  | St. Louis Latitude 38° 42' N Elevation 486'  |                            |               |         |                     |  |   |                            |               |         |                     |  |                       |               |         |
| JAN  | 35.9                       | 22.5          | 29.2    | 1110                | 475.5  | JAN  | 41.4                       | 21.2          | 31.3    | 1045                | 783.9  |   |                            |               |         |                     |  |                       |               |         |
| FEB  | 37.5                       | 23.3          | 30.4    | 969                 | 709.6  | FEB  | 47.1                       | 25.4          | 36.3    | 804                 | 1058.2                                       |   |                            |               |         |                     |  |                       |               |         |
| MAR  | 44.6                       | 31.5          | 38.1    | 834                 | 1016.4                                       | MAR  | 55.0                       | 32.1          | 43.6    | 671                 | 1405.5                                       |   |                            |               |         |                     |  |                       |               |         |
| APR  | 56.3                       | 40.8          | 48.6    | 492                 | 1325.8                                       | APR  | 68.1                       | 45.1          | 56.6    | 275                 | 1782.5                                       |   |                            |               |         |                     |  |                       |               |         |
| MAY  | 67.1                       | 50.1          | 58.6    | 218                 | 1620.5                                       | MAY  | 77.1                       | 55.0          | 66.1    | 90                  | 2035.8                                       |   |                            |               |         |                     |  |                       |               |         |
| SEP  | 72.2                       | 56.7          | 64.5    | 76                  | 1259.9                                       | SEP  | 81.9                       | 59.2          | 70.6    | 32                  | 1616.1                                       |   |                            |               |         |                     |  |                       |               |         |
| OCT  | 63.2                       | 47.5          | 55.4    | 301                 | 889.6  | OCT  | 71.3                       | 47.9          | 59.6    | 211                 | 1249.8                                       |   |                            |               |         |                     |  |                       |               |         |
| NOV  | 51.7                       | 38.7          | 45.2    | 594                 | 502.9  | NOV  | 55.8                       | 33.8          | 44.8    | 606                 | 870.8  |   |                            |               |         |                     |  |                       |               |         |
| DEC  | 39.3                       | 26.6          | 33.0    | 992                 | 403.0  | DEC  | 44.3                       | 24.6          | 34.5    | 946                 | 689.9  |   |                            |               |         |                     |  |                       |               |         |
| ANN  | 58.7                       | 43.8          | 51.3    | 5621                | 1104.7                                       | ANN  | 67.6                       | 45.6          | 56.6    | 4687                | 1502.3                                       |   |                            |               |         |                     |  |                       |               |         |

| Month  | Normal Temperature (Deg F)° |               |         | Normal Degree Days°   | Total Hemispheric Mean Daily Solar Radiation | Month  | Normal Temperature (Deg F)° |               |         | Normal Degree Days°   | Total Hemispheric Mean Daily Solar Radiation | Month  | Normal Temperature (Deg F)° |               |         | Normal Degree Days°   | Total Hemispheric Mean Daily Solar Radiation |
|--|-----------------------------|---------------|---------|-----------------------|--|--|-----------------------------|---------------|---------|-----------------------|--|--|-----------------------------|---------------|---------|-----------------------|--|
|  | Daily Maximum               | Daily Minimum | Monthly | Base 65 Deg F Heating | Btu/ft²                                      |  | Daily Maximum               | Daily Minimum | Monthly | Base 65 Deg F Heating | Btu/ft²                                      |  | Daily Maximum               | Daily Minimum | Monthly | Base 65 Deg F Heating | Btu/ft²                                      |
| <b>MISSOURI</b>                                |                             |               |         |                       |  | <b>NEVADA</b>                                  |                             |               |         |                       |  | <b>NEW YORK</b>                                  |                             |               |         |                       |  |
| Kansas City Latitude 39° 18' N Elevation 1033' |                             |               |         |                       |  | Las Vegas Latitude 36° 05' N Elevation 2178'   |                             |               |         |                       |  | Albany Latitude 42° 45' N Elevation 292'         |                             |               |         |                       |  |
| JAN  | 35.7                        | 18.4          | 27.1    | 1175                  | 647.9  | JAN  | 55.7                        | 32.6          | 44.2    | 645                   | 978.0  | JAN  | 30.4                        | 12.5          | 21.5    | 1349                  | 456.5  |
| FEB  | 41.4                        | 23.1          | 32.3    | 916                   | 894.7  | FEB  | 61.3                        | 36.9          | 49.1    | 451                   | 1339.5                                       | FEB  | 32.7                        | 14.3          | 23.5    | 1162                  | 688.4  |
| MAR  | 50.7                        | 30.6          | 40.7    | 753                   | 1202.9                                       | MAR  | 67.8                        | 41.7          | 54.8    | 324                   | 1823.5                                       | MAR  | 42.6                        | 24.2          | 33.4    | 980                   | 985.9  |
| APR  | 64.7                        | 43.7          | 54.2    | 336                   | 1575.0                                       | APR  | 77.5                        | 50.0          | 63.8    | 126                   | 2319.0                                       | APR  | 58.0                        | 35.7          | 46.9    | 543                   | 1335.2                                       |
| MAY  | 74.2                        | 54.0          | 64.1    | 127                   | 1872.6                                       | MAY  | 87.5                        | 59.0          | 73.3    | 10                    | 2646.3                                       | MAY  | 69.7                        | 45.7          | 57.7    | 253                   | 1569.9                                       |
| SEP  | 78.8                        | 57.1          | 68.0    | 50                    | 1452.4                                       | SEP  | 94.8                        | 65.4          | 80.1    | 0                     | 2037.3                                       | SEP  | 73.7                        | 50.1          | 61.9    | 135                   | 1170.3                                       |
| OCT  | 68.2                        | 46.9          | 57.6    | 259                   | 1092.3                                       | OCT  | 81.0                        | 53.1          | 67.1    | 74                    | 1539.8                                       | OCT  | 62.8                        | 40.0          | 51.4    | 422                   | 817.3  |
| NOV  | 51.4                        | 33.1          | 42.3    | 681                   | 737.3  | NOV  | 65.7                        | 40.8          | 53.3    | 357                   | 1085.5                                       | NOV  | 48.1                        | 31.1          | 39.6    | 762                   | 457.1  |
| DEC  | 39.3                        | 23.3          | 31.3    | 1045                  | 561.5  | DEC  | 56.7                        | 33.7          | 45.2    | 614                   | 880.5  | DEC  | 34.1                        | 17.7          | 25.9    | 1212                  | 355.9  |
| ANN  | 63.5                        | 43.8          | 53.7    | 5357                  | 1340.0                                       | ANN  | 79.2                        | 52.4          | 65.8    | 2601                  | 1864.2                                       | ANN  | 58.1                        | 37.1          | 47.6    | 6888                  | 1065.8                                       |
| St. Louis Latitude 38° 45' N Elevation 564'    |                             |               |         |                       |  | Reno Latitude 39° 30' N Elevation 4400'        |                             |               |         |                       |  | Buffalo Latitude 42° 56' N Elevation 705'        |                             |               |         |                       |  |
| JAN  | 39.9                        | 22.6          | 31.3    | 1045                  | 627.4  | JAN  | 45.4                        | 18.3          | 31.9    | 1026                  | 800.4  | JAN  | 29.8                        | 17.6          | 23.7    | 1280                  | 348.9  |
| FEB  | 44.2                        | 26.0          | 35.1    | 837                   | 885.6  | FEB  | 51.1                        | 23.0          | 37.1    | 781                   | 1149.9                                       | FEB  | 31.0                        | 17.7          | 24.4    | 1137                  | 546.4  |
| MAR  | 53.0                        | 33.5          | 43.3    | 682                   | 1204.7                                       | MAR  | 56.0                        | 24.6          | 40.3    | 766                   | 1649.4                                       | MAR  | 39.0                        | 25.2          | 32.1    | 1020                  | 888.5  |
| APR  | 67.0                        | 46.0          | 56.5    | 272                   | 1564.2                                       | APR  | 64.0                        | 29.6          | 46.8    | 546                   | 2159.3                                       | APR  | 53.3                        | 36.4          | 44.9    | 603                   | 1314.9                                       |
| MAY  | 76.0                        | 55.5          | 65.8    | 103                   | 1871.3                                       | MAY  | 72.2                        | 37.0          | 54.6    | 328                   | 2523.1                                       | MAY  | 64.3                        | 45.9          | 55.1    | 321                   | 1596.5                                       |
| SEP  | 80.1                        | 59.1          | 69.6    | 35                    | 1459.2                                       | SEP  | 81.8                        | 38.6          | 60.2    | 168                   | 1997.7                                       | SEP  | 70.8                        | 52.3          | 61.6    | 138                   | 1151.8                                       |
| OCT  | 69.8                        | 48.4          | 59.1    | 224                   | 1099.8                                       | OCT  | 70.0                        | 30.5          | 50.3    | 456                   | 1431.0                                       | OCT  | 60.2                        | 42.7          | 51.5    | 419                   | 784.4  |
| NOV  | 54.1                        | 35.9          | 45.0    | 600                   | 718.3  | NOV  | 56.3                        | 23.9          | 40.1    | 747                   | 912.3  | NOV  | 46.1                        | 33.5          | 39.8    | 756                   | 403.3  |
| DEC  | 42.7                        | 26.5          | 34.6    | 942                   | 530.6  | DEC  | 46.4                        | 19.6          | 33.0    | 992                   | 705.5  | DEC  | 33.6                        | 22.2          | 27.9    | 1150                  | 283.3  |
| ANN  | 65.6                        | 46.2          | 55.9    | 4750                  | 1326.6                                       | ANN  | 67.0                        | 31.7          | 49.4    | 6022                  | 1760.7                                       | ANN  | 55.0                        | 39.1          | 47.1    | 6927                  | 1034.3                                       |
| <b>MONTANA</b>                                 |                             |               |         |                       |  | <b>NEW HAMPSHIRE</b>                           |                             |               |         |                       |  | <b>NEW YORK CITY</b>                             |                             |               |         |                       |  |
| Billings Latitude 45° 48' N Elevation 3570'    |                             |               |         |                       |  | Concord Latitude 43° 12' N Elevation 344'      |                             |               |         |                       |  | New York City Latitude 40° 47' N Elevation 187'  |                             |               |         |                       |  |
| JAN  | 31.2                        | 12.5          | 21.9    | 1336                  | 486.0  | JAN  | 31.3                        | 9.9           | 20.6    | 1376                  | 459.5  | JAN  | 38.5                        | 25.9          | 32.2    | 1017                  | 500.4  |
| FEB  | 37.1                        | 17.7          | 27.4    | 1054                  | 763.0  | FEB  | 33.8                        | 11.3          | 22.6    | 1187                  | 686.1  | FEB  | 40.2                        | 26.5          | 33.4    | 885                   | 721.0  |
| MAR  | 42.1                        | 23.1          | 32.6    | 1004                  | 1189.5                                       | MAR  | 42.4                        | 22.1          | 32.3    | 1014                  | 973.6  | MAR  | 48.4                        | 33.7          | 41.1    | 741                   | 1037.1                                       |
| APR  | 55.8                        | 33.4          | 44.6    | 612                   | 1526.3                                       | APR  | 56.7                        | 31.7          | 44.2    | 624                   | 1317.1                                       | APR  | 60.7                        | 43.5          | 52.1    | 387                   | 1363.9                                       |
| MAY  | 65.7                        | 43.3          | 54.5    | 333                   | 1912.8                                       | MAY  | 68.6                        | 41.5          | 55.1    | 315                   | 1582.2                                       | MAY  | 71.4                        | 53.1          | 62.3    | 137                   | 1636.2                                       |
| SEP  | 71.3                        | 46.5          | 58.9    | 221                   | 1470.0                                       | SEP  | 72.4                        | 46.5          | 59.5    | 182                   | 1140.2                                       | SEP  | 76.8                        | 59.9          | 68.4    | 29                    | 1213.7                                       |
| OCT  | 61.0                        | 37.5          | 49.3    | 487                   | 986.8  | OCT  | 62.3                        | 36.3          | 49.3    | 487                   | 817.1  | OCT  | 66.8                        | 50.6          | 58.7    | 209                   | 895.3  |
| NOV  | 45.0                        | 26.4          | 35.7    | 879                   | 561.4  | NOV  | 47.9                        | 28.1          | 38.0    | 810                   | 462.7  | NOV  | 54.0                        | 40.8          | 47.4    | 528                   | 532.9  |
| DEC  | 35.8                        | 17.7          | 26.8    | 1184                  | 421.2  | DEC  | 34.6                        | 14.9          | 24.8    | 1246                  | 362.1  | DEC  | 41.4                        | 29.5          | 35.5    | 915                   | 404.0  |
| ANN  | 57.3                        | 35.3          | 46.3    | 7265                  | 1324.7                                       | ANN  | 57.5                        | 33.7          | 45.6    | 7360                  | 1053.0                                       | ANN  | 62.3                        | 46.7          | 54.5    | 4848                  | 1098.9                                       |
| <b>NEBRASKA</b>                                |                             |               |         |                       |  | <b>NEW JERSEY</b>                              |                             |               |         |                       |  | <b>NORTH CAROLINA</b>                            |                             |               |         |                       |  |
| Great Falls Latitude 47° 28' N Elevation 3661' |                             |               |         |                       |  | Newark Latitude 40° 42' N Elevation 29'        |                             |               |         |                       |  | Charlotte Latitude 35° 13' N Elevation 768'      |                             |               |         |                       |  |
| JAN  | 29.3                        | 11.6          | 20.5    | 1380                  | 420.5  | JAN  | 38.5                        | 24.3          | 31.4    | 1042                  | 551.7  | JAN  | 52.1                        | 32.1          | 42.1    | 710                   | 719.0  |
| FEB  | 35.9                        | 17.2          | 26.6    | 1075                  | 720.2  | FEB  | 40.2                        | 24.9          | 32.6    | 907                   | 793.0  | FEB  | 54.9                        | 33.1          | 44.0    | 588                   | 971.0  |
| MAR  | 40.4                        | 20.6          | 30.5    | 1070                  | 1170.4                                       | MAR  | 48.8                        | 32.4          | 40.6    | 756                   | 1108.7                                       | MAR  | 62.2                        | 39.0          | 50.6    | 461                   | 1317.5                                       |
| APR  | 54.5                        | 32.3          | 43.4    | 648                   | 1488.7                                       | APR  | 56.7                        | 31.7          | 44.2    | 624                   | 1317.1                                       | APR  | 72.7                        | 48.9          | 60.8    | 145                   | 1695.0                                       |
| MAY  | 65.0                        | 41.5          | 53.3    | 367                   | 1847.6                                       | MAY  | 61.2                        | 42.2          | 51.7    | 399                   | 1448.6                                       | MAY  | 82.0                        | 57.4          | 68.8    | 34                    | 1855.6                                       |
| SEP  | 70.0                        | 44.6          | 57.3    | 260                   | 1378.5                                       | MAY  | 71.6                        | 52.1          | 61.9    | 143                   | 1687.1                                       | SEP  | 80.2                        | 61.9          | 72.0    | 10                    | 1415.6                                       |
| OCT  | 59.4                        | 37.1          | 48.3    | 524                   | 924.6  | SEP  | 77.0                        | 58.6          | 67.8    | 34                    | 1272.9                                       | OCT  | 73.1                        | 50.3          | 61.7    | 152                   | 1173.4                                       |
| NOV  | 43.4                        | 25.7          | 34.6    | 912                   | 497.6  | OCT  | 66.9                        | 48.1          | 57.5    | 243                   | 950.9  | NOV  | 62.4                        | 39.6          | 51.0    | 420                   | 865.5  |
| DEC  | 34.7                        | 18.2          | 26.5    | 1194                  | 336.2  | NOV  | 54.2                        | 38.2          | 46.2    | 564                   | 596.2  | DEC  | 52.5                        | 32.4          | 42.5    | 698                   | 672.4  |
| ANN  | 55.9                        | 33.8          | 44.9    | 7652                  | 1262.3                                       | DEC  | 41.5                        | 27.4          | 34.5    | 946                   | 454.4  | ANN  | 71.2                        | 49.7          | 60.5    | 3218                  | 1344.4                                       |
| <b>NEW MEXICO</b>                              |                             |               |         |                       |  | <b>NEW YORK STATE</b>                          |                             |               |         |                       |  | <b>RALEIGH-DURHAM</b>                            |                             |               |         |                       |  |
| North Omaha Latitude 41° 22' N Elevation 1325' |                             |               |         |                       |  | Albuquerque Latitude 35° 03' N Elevation 5312' |                             |               |         |                       |  | Raleigh-Durham Latitude 35° 52' N Elevation 440' |                             |               |         |                       |  |
| JAN  | 29.1                        | 11.2          | 20.2    | 1389                  | 634.0  | JAN  | 46.9                        | 23.5          | 35.2    | 924                   | 1016.5                                       | JAN  | 51.0                        | 30.0          | 40.5    | 760                   | 693.9  |
| FEB  | 34.8                        | 16.1          | 25.5    | 1106                  | 892.1  | FEB  | 52.6                        | 27.4          | 40.0    | 700                   | 1342.0                                       | FEB  | 53.2                        | 31.1          | 42.2    | 638                   | 943.1  |
| MAR  | 44.1                        | 25.1          | 34.6    | 942                   | 1222.5                                       | MAR  | 59.2                        | 32.3          | 45.8    | 595                   | 1767.6                                       | MAR  | 61.0                        | 37.4          | 49.2    | 502                   | 1275.1                                       |
| APR  | 61.0                        | 38.9          | 50.0    | 456                   | 1558.4                                       | APR  | 70.1                        | 41.4          | 55.8    | 282                   | 2228.4                                       | APR  | 72.2                        | 46.7          | 59.5    | 180                   | 1644.3                                       |
| MAY  | 71.4                        | 50.4          | 60.9    | 186                   | 1872.6                                       | MAY  | 79.9                        | 50.7          | 65.3    | 58                    | 2538.1                                       | MAY  | 79.4                        | 55.4          | 67.4    | 48                    | 1808.3                                       |
| SEP  | 75.2                        | 53.6          | 64.4    | 99                    | 1373.2                                       | SEP  | 83.4                        | 56.7          | 70.1    | 7                     | 1971.7                                       | SEP  | 81.5                        | 59.7          | 70.6    | 12                    | 1377.1                                       |
| OCT  | 65.9                        | 42.8          | 54.4    | 342                   | 1049.8                                       | OCT  | 71.7                        | 44.7          | 58.2    | 218                   | 1546.7                                       | OCT  | 72.4                        | 48.0          | 60.2    | 186                   | 1105.4                                       |
| NOV  | 47.4                        | 28.3          | 37.9    | 813                   | 644.1  | NOV  | 57.1                        | 31.8          | 44.5    | 615                   | 1133.7                                       | NOV  | 62.1                        | 37.8          | 50.0    | 450                   | 812.1  |
| DEC  | 34.3                        | 17.0          | 25.7    | 1218                  | 511.2  | DEC  | 47.5                        | 24.9          | 36.2    | 893                   | 927.7  | DEC  | 51.9                        | 30.5          | 41.2    | 738                   | 635.6  |
| ANN  | 59.4                        | 39.3          | 49.4    | 6601                  | 1320.5                                       | ANN  | 70.0                        | 43.5          | 56.8    | 4292                  | 1827.5                                       | ANN  | 70.4                        | 47.8          | 59.1    | 3514                  | 1295.5                                       |

| Month                                       | Normal Temperature (Deg F) <sup>a</sup> |               |         | Normal Degree Days <sup>a</sup> | Total Hemispheric Mean Daily Solar Radiation | Month   | Normal Temperature (Deg F) <sup>a</sup> |               |         | Normal Degree Days <sup>a</sup> | Total Hemispheric Mean Daily Solar Radiation | Month  | Normal Temperature (Deg F) <sup>a</sup> |               |         | Normal Degree Days <sup>a</sup> | Total Hemispheric Mean Daily Solar Radiation |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
|---|---|---------------|---------|---------------------------------|--|---|---|---------------|---------|---------------------------------|--|--|---|---------------|---------|---------------------------------|--|------|--|--|--|--|--|------|--|--|--|--|--|--------|--|--|--|--|--|
|   | Daily Maximum                           | Daily Minimum | Monthly | Base 65 Deg F Heating           | Btu/F <sup>2</sup>                           |   | Daily Maximum                           | Daily Minimum | Monthly | Base 65 Deg F Heating           | Btu/F <sup>2</sup>                           |  | Daily Maximum                           | Daily Minimum | Monthly | Base 65 Deg F Heating           | Btu/F <sup>2</sup>                           |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| <b>TENNESSEE</b>                            |   |               |         |                                 |  | <b>TEXAS (continued)</b>                          |   |               |         |                                 |  | <b>WASHINGTON</b>                                |   |               |         |                                 |  |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| Knoxville Latitude 35° 49' N Elevation 981' |   |               |         |                                 |  | Lubbock Latitude 33° 39' N Elevation 3242'        |   |               |         |                                 |  | Seattle-Tacoma Latitude 47° 27' N Elevation 400' |   |               |         |                                 |  |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| JAN   | 48.9                                    | 32.2          | 40.6    | 756                             | 620.7  | JAN   | 53.4                                    | 24.8          | 39.1    | 803                             | 1030.9                                       | JAN  | 43.4                                    | 33.0          | 38.2    | 831                             | 261.7  |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| FEB   | 52.0                                    | 33.5          | 42.8    | 630                             | 863.4  | FEB   | 57.0                                    | 28.3          | 42.7    | 624                             | 1331.7                                       | FEB  | 48.5                                    | 36.0          | 42.3    | 636                             | 495.0  |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| MAR   | 60.4                                    | 39.4          | 49.9    | 484                             | 1190.8                                       | MAR   | 63.8                                    | 34.0          | 48.9    | 508                             | 1762.0                                       | MAR  | 51.5                                    | 36.6          | 44.1    | 648                             | 849.0  |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| APR   | 72.0                                    | 48.6          | 60.3    | 173                             | 1598.9                                       | APR   | 74.8                                    | 45.1          | 60.0    | 190                             | 2167.8                                       | APR  | 57.0                                    | 40.3          | 48.7    | 489                             | 1293.5                                       |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| MAY   | 79.8                                    | 56.9          | 68.4    | 47                              | 1803.3                                       | MAY   | 82.5                                    | 54.5          | 68.5    | 29                              | 2395.9                                       | MAY  | 64.1                                    | 45.6          | 54.9    | 313                             | 1713.9                                       |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| SEP   | 82.0                                    | 61.2          | 71.6    | 10                              | 1383.2                                       | SEP   | 83.8                                    | 58.2          | 71.0    | 8                               | 1820.1                                       | SEP  | 68.7                                    | 50.4          | 59.6    | 170                             | 1147.7                                       |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| OCT   | 71.8                                    | 50.0          | 60.9    | 175                             | 1120.9                                       | OCT   | 74.7                                    | 47.3          | 61.0    | 162                             | 1468.2                                       | OCT  | 59.4                                    | 44.9          | 52.2    | 397                             | 656.2  |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| NOV   | 58.9                                    | 39.4          | 49.2    | 474                             | 758.7  | NOV   | 63.1                                    | 34.4          | 48.8    | 486                             | 1116.1                                       | NOV  | 50.4                                    | 38.8          | 44.6    | 612                             | 337.2  |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| DEC   | 49.8                                    | 33.1          | 41.5    | 729                             | 569.4  | DEC   | 55.2                                    | 27.4          | 41.3    | 735                             | 934.5  | DEC  | 45.4                                    | 35.5          | 40.5    | 760                             | 211.1  |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| ANN   | 69.8                                    | 49.5          | 59.7    | 3478                            | 1273.4                                       | ANN   | 73.6                                    | 45.8          | 59.7    | 3545                            | 1766.0                                       | ANN  | 58.8                                    | 43.3          | 51.1    | 5185                            | 1052.7                                       |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| Memphis Latitude 35° 03' N Elevation 285'   |   |               |         |                                 |  | UTAH  |   |               |         |                                 |  | Spokane Latitude 47° 38' N Elevation 2366'       |   |               |         |                                 |  |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| JAN   | 49.4                                    | 31.6          | 40.5    | 760                             | 682.7  | Salt Lake City Latitude 40° 46' N Elevation 4226' |   |               |         |                                 |  | JAN  | 31.1                                    | 19.6          | 25.4    | 1228                            | 315.0  |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| FEB   | 53.1                                    | 34.4          | 43.8    | 594                             | 944.8  | JAN   | 37.4                                    | 18.5          | 28.0    | 1147                            | 639.1  | FEB  | 39.0                                    | 25.3          | 32.2    | 918                             | 605.9  |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| MAR   | 60.8                                    | 41.1          | 51.0    | 457                             | 1278.1                                       | FEB   | 43.4                                    | 23.3          | 33.4    | 885                             | 988.7  | MAR  | 46.2                                    | 28.8          | 37.5    | 853                             | 1040.6                                       |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| APR   | 72.7                                    | 52.3          | 62.5    | 131                             | 1638.7                                       | MAR   | 50.8                                    | 28.3          | 39.6    | 787                             | 1454.3                                       | APR  | 57.0                                    | 35.2          | 46.1    | 567                             | 1494.9                                       |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| MAY   | 81.2                                    | 60.6          | 70.9    | 22                              | 1884.9                                       | APR   | 61.8                                    | 36.6          | 49.2    | 474                             | 1894.3                                       | MAY  | 66.5                                    | 42.8          | 54.7    | 327                             | 1918.0                                       |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| SEP   | 84.3                                    | 62.8          | 73.6    | 7                               | 1470.9                                       | MAY   | 72.4                                    | 44.2          | 58.3    | 237                             | 2362.4                                       | SEP  | 72.5                                    | 46.7          | 59.6    | 196                             | 1435.3                                       |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| OCT   | 74.9                                    | 51.1          | 63.0    | 142                             | 1204.5                                       | SEP   | 80.3                                    | 49.3          | 64.8    | 105                             | 1843.3                                       | OCT  | 58.1                                    | 37.5          | 47.8    | 533                             | 840.9  |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| NOV   | 61.5                                    | 40.3          | 50.9    | 423                             | 816.7  | OCT   | 66.4                                    | 38.4          | 52.4    | 402                             | 1293.3                                       | NOV  | 41.8                                    | 29.2          | 35.5    | 885                             | 397.7  |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| DEC   | 51.7                                    | 33.7          | 42.7    | 691                             | 628.6  | NOV   | 50.0                                    | 28.1          | 39.1    | 777                             | 787.9  | DEC  | 33.9                                    | 24.0          | 29.0    | 1116                            | 255.2  |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| ANN   | 71.7                                    | 51.5          | 61.6    | 3227                            | 1365.9                                       | DEC   | 39.0                                    | 21.5          | 30.3    | 1076                            | 569.8  | ANN  | 57.2                                    | 37.3          | 47.3    | 6835                            | 1223.8                                       |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| Nashville Latitude 36° 07' N Elevation 590' |   |               |         |                                 |  | VERMONT   |   |               |         |                                 |  | WEST VIRGINIA                                    |   |               |         |                                 |  |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| JAN   | 47.6                                    | 29.0          | 38.3    | 828                             | 579.6  | Burlington Latitude 44° 28' N Elevation 341'      |   |               |         |                                 |  | Charleston Latitude 36° 22' N Elevation 951'     |   |               |         |                                 |  |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| FEB   | 50.9                                    | 31.0          | 41.0    | 672                             | 823.8  | JAN   | 25.9                                    | 7.6           | 16.8    | 1494                            | 385.3  | JAN  | 43.6                                    | 25.3          | 34.5    | 946                             | 498.4  |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| MAR   | 59.2                                    | 38.1          | 48.7    | 524                             | 1129.8                                       | FEB   | 28.2                                    | 8.9           | 18.6    | 1299                            | 606.8  | FEB  | 46.2                                    | 26.8          | 36.5    | 798                             | 706.5  |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| APR   | 71.3                                    | 48.8          | 60.1    | 176                             | 1543.6                                       | MAR   | 38.0                                    | 20.1          | 29.1    | 1113                            | 940.2  | MAR  | 55.2                                    | 33.8          | 44.5    | 642                             | 1009.5                                       |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| MAY   | 79.8                                    | 57.3          | 68.5    | 45                              | 1824.8                                       | APR   | 53.3                                    | 32.6          | 43.0    | 660                             | 1296.2                                       | APR  | 67.9                                    | 43.8          | 55.9    | 287                             | 1355.7                                       |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| SEP   | 83.5                                    | 60.5          | 72.0    | 10                              | 1397.9                                       | MAY   | 66.1                                    | 43.5          | 54.8    | 331                             | 1574.1                                       | MAY  | 76.6                                    | 52.3          | 64.5    | 113                             | 1639.4                                       |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| OCT   | 73.2                                    | 48.6          | 60.9    | 190                             | 1113.8                                       | SEP   | 70.0                                    | 48.6          | 59.3    | 191                             | 1122.2                                       | SEP  | 79.0                                    | 55.9          | 67.5    | 46                              | 1272.0                                       |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| NOV   | 59.0                                    | 37.7          | 48.4    | 498                             | 711.3  | OCT   | 58.7                                    | 38.8          | 48.8    | 502                             | 740.5  | OCT  | 69.1                                    | 44.8          | 57.0    | 267                             | 972.3  |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| DEC   | 49.6                                    | 31.1          | 40.4    | 763                             | 520.6  | NOV   | 44.3                                    | 29.7          | 37.0    | 840                             | 374.6  | NOV  | 55.8                                    | 35.0          | 45.4    | 588                             | 613.1  |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| ANN   | 70.1                                    | 48.7          | 59.4    | 3696                            | 1269.7                                       | DEC   | 30.3                                    | 14.8          | 22.6    | 1314                            | 283.2  | DEC  | 45.2                                    | 27.2          | 36.2    | 893                             | 440.1  |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| <b>TEXAS</b>                                |   |               |         |                                 |  | ANN   |   |               |         |                                 |  | ANN  |   |               |         |                                 |  |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| Dallas Latitude 32° 51' N Elevation 489'    |   |               |         |                                 |  | 54.2  |   |               |         |                                 |  | 34.5   |   |               |         |                                 |  | 44.4 |  |  |  |  |  | 7876 |  |  |  |  |  | 1020.7 |  |  |  |  |  |
| JAN   | 55.1                                    | 35.7          | 45.4    | 608                             | 821.5  | <b>VIRGINIA</b>                                   |   |               |         |                                 |  | <b>WISCONSIN</b>                                 |   |               |         |                                 |  |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| FEB   | 59.2                                    | 39.5          | 49.4    | 437                             | 1071.1                                       | Richmond Latitude 37° 30' N Elevation 164'        |   |               |         |                                 |  | Milwaukee Latitude 42° 57' N Elevation 492'      |   |               |         |                                 |  |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| MAR   | 66.4                                    | 45.2          | 55.8    | 314                             | 1421.8                                       | JAN   | 47.4                                    | 27.6          | 37.5    | 853                             | 631.9  | JAN  | 27.3                                    | 11.4          | 19.4    | 1414                            | 479.4  |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| APR   | 76.3                                    | 56.4          | 66.4    | 71                              | 1626.8                                       | FEB   | 49.9                                    | 28.8          | 39.4    | 717                             | 877.1  | FEB  | 30.3                                    | 14.6          | 22.5    | 1190                            | 736.5  |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| MAY   | 83.1                                    | 64.4          | 73.8    | 0                               | 1888.5                                       | MAR   | 58.2                                    | 35.5          | 46.9    | 569                             | 1210.4                                       | MAR  | 39.4                                    | 23.4          | 31.4    | 1042                            | 1088.8                                       |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| SEP   | 88.0                                    | 68.3          | 78.2    | 0                               | 1587.1                                       | APR   | 70.3                                    | 45.2          | 57.8    | 226                             | 1566.0                                       | APR  | 54.6                                    | 34.7          | 44.7    | 609                             | 1442.7                                       |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| OCT   | 78.4                                    | 57.5          | 68.0    | 55                              | 1276.1                                       | MAY   | 78.4                                    | 54.5          | 66.5    | 64                              | 1762.0                                       | MAY  | 65.0                                    | 43.3          | 54.2    | 348                             | 1768.4                                       |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| NOV   | 66.4                                    | 45.4          | 55.9    | 284                             | 936.4  | SEP   | 80.9                                    | 59.0          | 70.0    | 21                              | 1347.9                                       | SEP  | 71.5                                    | 50.7          | 61.1    | 140                             | 1310.3                                       |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| DEC   | 57.8                                    | 38.6          | 48.2    | 521                             | 780.1  | OCT   | 71.2                                    | 47.4          | 59.3    | 203                             | 1032.7                                       | OCT  | 61.4                                    | 40.6          | 51.0    | 440                             | 907.9  |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| ANN   | 76.0                                    | 56.3          | 66.2    | 2290                            | 1468.1                                       | NOV   | 60.6                                    | 37.3          | 49.0    | 480                             | 733.0  | NOV  | 44.4                                    | 28.5          | 36.5    | 855                             | 524.6  |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| El Paso Latitude 31° 48' N Elevation 3917'  |   |               |         |                                 |  | DEC   | 49.1                                    | 28.8          | 39.0    | 806                             | 566.7  | DEC  | 31.5                                    | 16.8          | 24.2    | 1265                            | 378.4  |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| JAN   | 57.0                                    | 30.2          | 43.6    | 663                             | 1125.1                                       | ANN   | 68.8                                    | 46.7          | 57.8    | 3939                            | 1248.0                                       | ANN  | 55.1                                    | 36.3          | 45.7    | 7444                            | 1191.2                                       |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| FEB   | 62.5                                    | 34.3          | 48.4    | 465                             | 1480.1                                       | <b>WYOMING</b>                                    |   |               |         |                                 |  | Cheyenne Latitude 41° 09' N Elevation 6142'      |   |               |         |                                 |  |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| MAR   | 68.9                                    | 40.3          | 54.6    | 328                             | 1909.3                                       | Roulette Latitude 37° 19' N Elevation 1174'       |   |               |         |                                 |  | JAN  | 38.2                                    | 14.9          | 26.6    | 1190                            | 765.8  |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| APR   | 78.5                                    | 49.3          | 63.9    | 89                              | 2363.5                                       | JAN   | 45.6                                    | 27.2          | 36.4    | 887                             | 660.5  | FEB  | 40.7                                    | 17.3          | 29.0    | 1088                            | 1067.8                                       |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| MAY   | 87.2                                    | 57.2          | 72.2    | 0                               | 2600.6                                       | FEB   | 47.9                                    | 28.3          | 38.1    | 753                             | 899.4  | MAR  | 43.5                                    | 19.6          | 31.6    | 1035                            | 1433.1                                       |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| SEP   | 87.4                                    | 61.0          | 74.2    | 0                               | 1987.1                                       | MAR   | 56.3                                    | 34.3          | 45.3    | 611                             | 1236.1                                       | APR  | 55.4                                    | 30.0          | 42.7    | 669                             | 1770.5                                       |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| OCT   | 78.5                                    | 49.5          | 64.0    | 92                              | 1639.0                                       | APR   | 67.9                                    | 43.9          | 55.9    | 283                             | 1581.5                                       | MAY  | 65.1                                    | 39.7          | 52.4    | 394                             | 1994.6                                       |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| NOV   | 66.1                                    | 37.0          | 51.6    | 402                             | 1243.7                                       | MAY   | 76.1                                    | 52.7          | 64.4    | 101                             | 1763.9                                       | SEP  | 72.8                                    | 43.5          | 58.2    | 225                             | 1667.4                                       |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| DEC   | 57.8                                    | 30.9          | 44.4    | 639                             | 1030.7                                       | SEP   | 79.3                                    | 56.5          | 68.0    | 32                              | 1358.2                                       | OCT  | 61.8                                    | 33.9          | 35.5    | 530                             | 1241.8                                       |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
| ANN   | 77.2                                    | 49.5          | 63.4    | 2678                            | 1899.7                                       | OCT   | 69.9                                    | 45.6          | 57.8    | 235                             | 1080.2                                       | NOV  | 47.5                                    | 23.5          | 35.5    | 885                             | 822.8  |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
|   |   |               |         |                                 |  | NOV   | 57.6                                    | 35.8          | 46.7    | 549                             | 764.7  | DEC  | 40.3                                    | 18.1          | 29.2    | 1110                            | 671.0  |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
|   |   |               |         |                                 |  | DEC   | 46.6                                    | 28.1          | 37.4    | 856                             | 590.8  | ANN  | 58.9                                    | 33.0          | 45.9    | 7255                            | 1490.7                                       |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |
|   |   |               |         |                                 |  | ANN   | 66.8                                    | 45.0          | 55.9    | 4307                            | 1269.5                                       |  |   |               |         |                                 |  |      |  |  |  |  |  |      |  |  |  |  |  |        |  |  |  |  |  |

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<sup>b</sup> Based on 1941 - 1970 Period. Zeros appearing for all values appearing in these columns signify that 1941 - 1970 period normals were not available.

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