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Cooling with Ventilation

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Preface

In keeping with the national energy policy goal of fostering an adequate supply of energy at a reasonable cost, the United States Department of Energy (DOE) supports a variety of programs to promote a balanced and mixed energy resource system. The mission of the DOE Solar Building Research and Development Program is to support this goal by providing for the development of solar technology alternatives for the buildings sector. It is the goal of the Program to establish a proven technology base to allow industry to develop solar products and designs for buildings that are economically competitive and can contribute significantly to building energy supplies nationally. Toward this end, the Program sponsors research activities related to increasing the efficiency, reducing the cost, and improving the long-term durability of passive and active solar systems for building water and space heating, cooling, and daylighting applications. These activities are conducted in four major areas: (1) Advanced Passive Solar Materials Research, (2) Collector Technology Research, (3) Cooling Systems Research, and (4) Systems Analysis and Applications Research.

Advanced Passive Solar Materials Research. This activity area includes work on new aperture materials for controlling solar heat gains and for enhancing the use of daylight for building interior lighting purposes. It also encompasses work on low-cost thermal storage materials that have high thermal storage capacity and can be integrated with conventional building elements, and work on materials and methods to transport thermal energy efficiently between any building exterior surface and the building interior by non-mechanical means.

Collector Technology Research. This activity area encompasses work on advanced low-to-medium temperature (up to 180°F useful operating temperature) flat-plate collectors for water and space heating applications, and medium-to-high temperature (up to 400°F useful operating temperature) evacuated tube/concentrating collectors for space heating and cooling applications. The focus is on design innovations using new materials and fabrication techniques.

Cooling Systems Research. This activity area involves research on high performance dehumidifiers and chillers that can operate efficiently with the variable thermal output and delivery temperatures associated with solar collectors. It also includes work on advanced passive cooling techniques.

Systems Analysis and Applications Research. This activity area encompasses experimental testing, analysis, and evaluation of solar heating, cooling, and daylighting systems for residential and nonresidential buildings. This involves system integration studies, the development of design and analysis tools, and the establishment of overall cost, performance, and durability targets for various technology or system options.

This document, *Cooling With Ventilation*, presents design guidelines and the results of research conducted under systems analysis and applications research. The design guidelines contained in this publication represent the first in a series of technical guidelines and calculation procedures being prepared for solar buildings. In a cooperative effort, the Passive Solar Industries Council, the National Association of Home Builders, Los Alamos National Laboratory, and the Solar Energy Research Institute are developing a simplified calculation process for designing passive solar residences. Initially, this calculation procedure will be available for Raleigh, North Carolina.

Contents

Chapter 1
Introduction

This document addresses the design of buildings using solar technologies integrated with air-conditioning to meet cooling needs in climates that seasonally experience both high temperatures and high humidity. Low-energy envelope design strategies that complement air-conditioning are emphasized. The material deals primarily with detached single-family residences, although the principles are applicable to multistory apartment and condominium buildings and to small office and commercial buildings. Home builders and both present and future homeowners should find the contents useful.

Low-energy solutions discussed include natural ventilation, fans, radiant barriers, and window shading. Much is devoted to natural ventilation since this document is an outgrowth of natural-ventilation research funded by the Solar Buildings Technology Program of the U.S. Department of Energy. The data and material, for the most part, are specifically for the Southeast U.S. (North Carolina and southward) because practical low-energy solutions for the heat and humidity of the Southeast are limited to the techniques discussed here, although other approaches are under study. In the Southwest, many other solutions (e.g., evaporative cooling and high-mass buildings coupled with night ventilative or radiative cooling) are possible in addition to those discussed here.

A set of recommendations to homebuilders in hot and humid climates is provided in Chapter 2. Each recommendation is derived from more detailed information in following chapters, and guidance to the chapter that discusses the subject is provided.

Cooling problems are different from heating problems; the sun is a liability rather than a benefit. East and west building sides receive low-angle direct sun and are more difficult to shade than north or south sides. Cooling load sources and strategies to reduce them are discussed in Chapter 3. Considerable material on radiant barriers and overhangs is presented in this chapter. Chapter 4 provides guidelines for selection and use of ceiling fans, the most energy-efficient and cost-effective strategy in the Southeast.

Chapters 5 through 8 are devoted to natural ventilation. Emphasis is on understanding airflow in and around buildings so that building protrusions can be used to take advantage of the wind to improve ventilation. Complete floor plans of some well-ventilated houses are presented, and innovative ventilation schemes that involve roof-level apertures are discussed. The use of a whole-house fan is described in Chapter 9.

Throughout the document, material that should be of particular interest to professional home builders has been highlighted by **boldface** type. The main text is followed by a reference section, a bibliography, and two appendices. Appendix A provides a sizing method for windows to attain a given airflow rate through a house. Appendix B provides average wind-related data for selected cities in the southern Gulf and southeastern Atlantic coast states of the U.S.

Chapter 2
Recommendations to Builders

Strategies for house design in areas of the U.S. that experience both high temperature and high humidity are the subject of this document. Since the results grew out of a study on natural ventilation funded by the Passive Solar Cooling Program of the Department of Energy, natural ventilation techniques are emphasized. Of all passive cooling techniques, natural ventilation holds the most promise in the Southeast. The following design tips are derived from more detailed information provided in the remainder of the report, and the chapter containing that information is given in parentheses.

Cooling Need Reduction Strategies (Chapter 3)

Properly sized roof overhangs reduce summer solar heating on windows and walls. They are effective on all sides of buildings in the Southeast, though they do not reduce peak loads in early morning or late afternoon. In winter, excess overhang on the south side will reduce beneficial heat gains and are not recommended where such gains are useful. Proper overhang width increases the further south a house is located.

Reflective window films provide shading for single-paned glass on east and west building sides. If winter heating is required, window films should not be used on south-facing glass. Such films applied to the inside of double-paned glass on east and west sides may lead to glass breakage and should be avoided.

Radiant barriers are excellent devices to reduce heat gain, particularly heat gain through an attic. Radiant barrier systems are aluminum foil-faced products that are installed in attics and walls, with an adjacent airspace.

A roof radiant barrier, placed in the airspace between a sun-heated roof and the cooler attic floor, eliminates most radiant heat transfer across the attic airspace. A roof barrier system with R-19 ceiling insulation is more effective than R-30 ceiling insulation as far north as Baltimore. Roof barrier systems should be installed in an attic in a manner to avoid dust accumulation on the reflective surface since dust reduces performance. Cooling needs can be reduced by up to 10%, with payback in less than five years.

An exterior wall radiant barrier and accompanying airspace will decrease interior-exterior temperature differences in summer but increase them in winter. But, where heat gain is a problem most of the year, winter liabilities are more than offset by summer benefits. Wall radiant barrier systems are recommended for east and west walls only and for climates with fewer than 2000 heating degree days per year.

For large houses, two separate central air-conditioning systems can be established; one in a zone designed for daytime activities and the other for nighttime use. Afternoon and evening activity zones should be located on the east side of the house.

Air-Circulation Fans (Chapter 4)

For every degree Fahrenheit a house thermostat is raised, air-conditioning costs are reduced by 7-10%. Since an air-circulation fan (ceiling, paddle, or portable) allows a thermostat increase of about 4°F with no decrease in human comfort, it can provide up to 40% savings in cooling costs. Payback in three to five years can be readily acheived.

In rooms with normal 8-ft ceilings, a ceiling fan should be installed with a minimum clearance of 8 to 10 in. between ceiling and fan; less clearance may not provide satisfactory air circulation. In a room with sloped or high ceilings, a ceiling fan should be mounted 7 ft. 6 in. to 8 ft above the floor.

Natural Ventilation (Chapters 5 and 6)

Natural ventilation can reduce air-conditioning needs between 10% and 50%, depending on climate and house type. Savings will be highest for homes with the best thermal integrity.

Natural ventilation should be used to create air changes in a house to remove heat; fans should be used to create airspeed for occupant cooling. In this way, a house can be designed both for ventilation during mild weather and for backup heating and cooling during inclement weather. Strategic location of small windows can provide sufficient airflow to exhaust house heat so that interior temperatures remain comfortable.

In the humid Southeast, ventilation may introduce excessive moisture into a house and cause air-conditioners to run longer to extract moisture. When temperatures rise, an air-conditioner, once started, will run longer to extract the moisture. Therefore, savings from ventilation could be reduced. This topic is under intensive research, and experimental and theoretical analyses are currently underway. Definitive answers are not yet available, but the following observations are made.

1. If a house is to be maintained at 78°F or less and ceiling fans are not used, then it is probably not a good idea to ventilate at night and air-condition during the day during the extremely humid months of July and August (and September in central and south Florida).

2. If ceiling fans are used and occupants would like to ventilate as much as possible during the humid months, then furnishings, drapes, carpets, and wall papers that do not absorb much moisture should be used (e.g., rattan rather than upholstered furniture and low-permeability paints and finishes). This will reduce the potential for humidity absorption and buildup in a house caused by ventilation. When the air-conditioner is turned on, it may not have to run unusually long to extract the moisture.

Windows placed in a building's windward and leeward sides promote cross ventilation. Cross ventilation can also be achieved with windows placed on adjacent walls.

In tract housing, close building placement can have a substantial effect on wind flow patterns. For a typical house, the leeward wake extends roughly four times the ground-to-eave height, or about 36 ft. If building gaps are 36 ft or more in the wind direction, normal ventilation patterns will hold. This will be true for typical 75-ft by 100-ft lots if house rows face the wind or are angled, at most, 45 degrees from it.

Wing walls are exterior devices that augment airflow in corner rooms and in rooms with windows on one wall only. Wing walls are placed at window edges and extend from ground to eaves. Properly placed single-sash casement windows can create a similar effect.

Strategically placed trees on east and west sides of a house can effectively block summer sun and are highly recommended. Shrubbery, trees, and fencing can be placed to catch and redirect the wind in a manner similar to wing walls, but expert design assistance is required to achieve real wind control. Under most circumstances, landscaping is best used for aesthetics and shading and only secondarily for wind control.

Areas of strong negative pressure created on the roof by wind flow, especially those near roof ridges, can be used as exhaust areas. Louvers and clerestory windows can be used as high-level vents, though protection against rain entry must be carefully considered. Several innovative roof venting schemes have been devised.

Window Design (Chapter 7)

Since fixed-glass windows do not contribute to natural ventilation, use of awning, projection, or casement windows is recommended. Awning or projection windows are preferred to casement windows for rain protection and minimum building protrusion, but poorly made awning windows do not seal well and have reliability problems with their crank mechanisms.

Jalousie windows are the most versatile type for air control but are not recommended because of poor sealing which allows air infiltration in cold weather and when air conditioning is in use. A seasonal second window covering can be used, but this requires occupant agreement and participation.

To ventilate low-mass houses (frame or inside-insulated concrete block), windows should be positioned as far apart as possible so that air does not short circuit between inlet and outlet. For homes with massive heat-storage walls, an inlet window should be placed close to such walls to provide airflow for best heat transfer. Since wind directions vary considerably, windows should be located to capture wind from two or three prevailing directions rather than from one direction only.

Total window area needed depends on required airflow. For a recommended 30 air changes per hour (ACH), total operable window areas of 10-15% of floor area should suffice, depending on location. This window area is not excessive if 100% operable windows are used. With sliding windows, where 50% of the window is fixed, it is imposssible to attain good natural ventilation with moderate window areas.

Naturally Ventilated Home Designs (Chapter 8)

A conventional, single-story house design, rotated to north, south, east, and west orientations, is described in Chapter 8, and effects of various design features on natural ventilation are described. An additional single-story, west-facing design is also described. The intent is not to provide "best" passive solar designs but to show how small homes can be designed and oriented to take advantage of local winds.

Whole-House Fans (Chapter 9)

Where open windows do not provide adequate ventilation because of poor building orientation, dense housing, poorly located vegetation, or concerns for security, a whole-house exhaust fan may be an attractive solution. A whole-house fan pulls air in from all open windows and exhausts it through the ceiling and attic.

Windows need not be fully open for proper ventilation but can be securely blocked open 4-5 in. With insect screening, total open-window area should be three times the whole-house fan opening area. Attic vents must be larger than normal with a free-exhaust area of about twice the whole-house fan area.

Chapter 3

The Cooling Load: Sources and Reduction Strategies

Data are presented on the variation of cooling load with climate for the southeastern and middle Atlantic sections of the United States, and cooling load sources are analyzed in this chapter. This is followed by a discussion of appropriate conservation strategies to reduce these sources. Strategies discussed are window shading and radiant barriers.

Sources

The air-conditioning cooling load in a building results from the rate at which heat enters or is generated. Heat gain can be classified by the manner in which the heat enters (solar radiation through windows, conduction through walls and roofs, body heat from occupants, etc.) and by whether the heat is sensible (temperature) or latent (humidity). The sensible cooling load is defined as the rate at which heat must be removed to maintain air temperature at the thermostat setpoint. The latent cooling load results from moisture removal from the building by the air-conditioner. Details on the nature and the determination of the cooling load can be found in Chapter 26 of the *Handbook of Fundamentals of the American Society of Heating, Refrigerating and Air-Conditioning Engineers* (ASHRAE 1985).

To illustrate climatic variations in cooling load, a typical modern, small (1500 ft^2) slab-on-grade frame house for various southern and eastern cities (Figure 3.1 and Table 3.1) has been analyzed as the base case. It is typical of those built today in north Florida, Georgia, and similar environs and has a fair amount of window shading and other conservation measures. Cooling load sources were calculated for a house thermostat setting of 78°F and an air-conditioner with a seasonal energy efficiency ratio (SEER) of 8.0. The cooling months were assumed to be those for which the average monthly dry bulb temperature exceeded 73°F. This resulted in the cooling months shown in Table 3.2.

The analysis assumed that all houses were naturally ventilated to the extent that there was no cooling load when the ambient temperature dropped below 73°F. Air-conditioner energy usage (in kilowatt-hours) under these assumptions is shown in Figure 3.2. The figure shows specific kWh values for each city under the three-digit city code. It also shows kWh contours. At an electricity cost of 8 cents/kWh, cooling costs range from about $80 per season in the New York/Philadelphia region to about $500 per season in Miami and the lower Gulf coast of Texas. As expected, cooling costs are a significant problem in the Southeast and the Gulf coast.

To analyze the source of these loads, analyses were performed for the base case house using an hourly computer program (Fairey et al. 1986) Figure 3.3 shows pie charts of cooling load sources for Orlando, Miami, Atlanta, and Houston. As expected, latent loads are high.

Most of the cooling load originates from sources that are difficult to control. Infiltration accounts for between 20% and 30% of the load. The assumed design infiltration rate of 0.75 air changes per hour (ACH) probably cannot be reduced too much (maybe to 0.5) without potentially endangering the occupants' health. Very tight houses with forced-ventilation heat exchangers are unlikely to provide acceptable solutions since most of the load is latent. Moreover, houses in the South are usually built to facilitate interaction with the mostly pleasant outdoors.

Internal gain (heat generated by occupants, lighting, appliances, etc.) accounts for about 30% of the load. Average occupancy and appliance use was modelled. It might be possible to reduce this source by the use of microwave ovens or flourescent lighting, very efficient refrigerators, placing stoves on outside walls, dining out more often, or by other such means. However, such reductions are strictly dependent upon occupant preferences.

Cooling Load Reduction Strategies

Window Shading

After infiltration and internal gain, the next greatest source of cooling load is solar heat gain through windows. House windows used in the base case analysis are double paned, and shades provide for 58% solar shading. An additional reduction in solar gain is provided by the 2-ft overhang. At occupant discretion, further reduction in solar gain can be

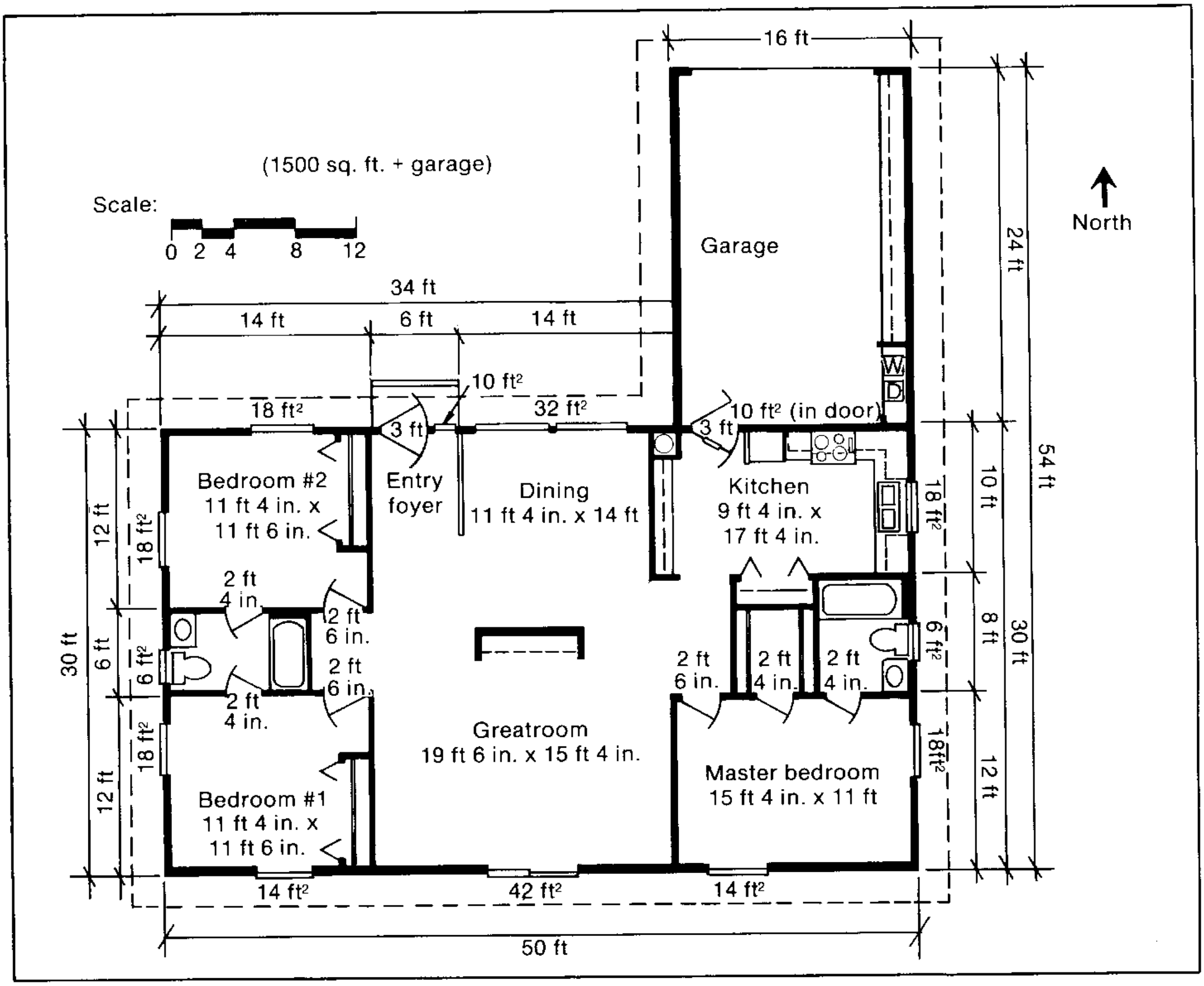


Figure 3.1. Base Case Residence Analyzed for Cooling Load Calculations

Table 3.1 Building Envelope Characteristics

Window glass
  Double glazed, with shades to block out 58% of the solar heat gain

Roof
  Slope = 5:12(22.6) on trusses at 24 in. o.c.
  Solar absorptance = 0.80; emissivity = 0.90
  Roof overhang = 2 ft on all sides

Walls
  Type: 2 x 4 frame at 16 in. o.c. with R-11 batt infill
  Solar absorptance = 0.75; emissivity = 0.90

Floors
  Single story slab on grade; 1500 ft^2

Ceiling
  Type: 8 ft high with R19 fiber insulation

Infiltration
  Average = 0.75 air change rate per hour (ACH)

Table 3.2 Cooling Months for Various Cities

City	Cooling Months
New York, NY	July - August
Washington, DC	July - August
Raleigh, NC	June - August
Atlanta, GA	June - August
Dallas, TX	June - September
Houston, TX	June - September
Jacksonville, FL	May - September
Orlando, FL	May - October
Miami, FL	April - October

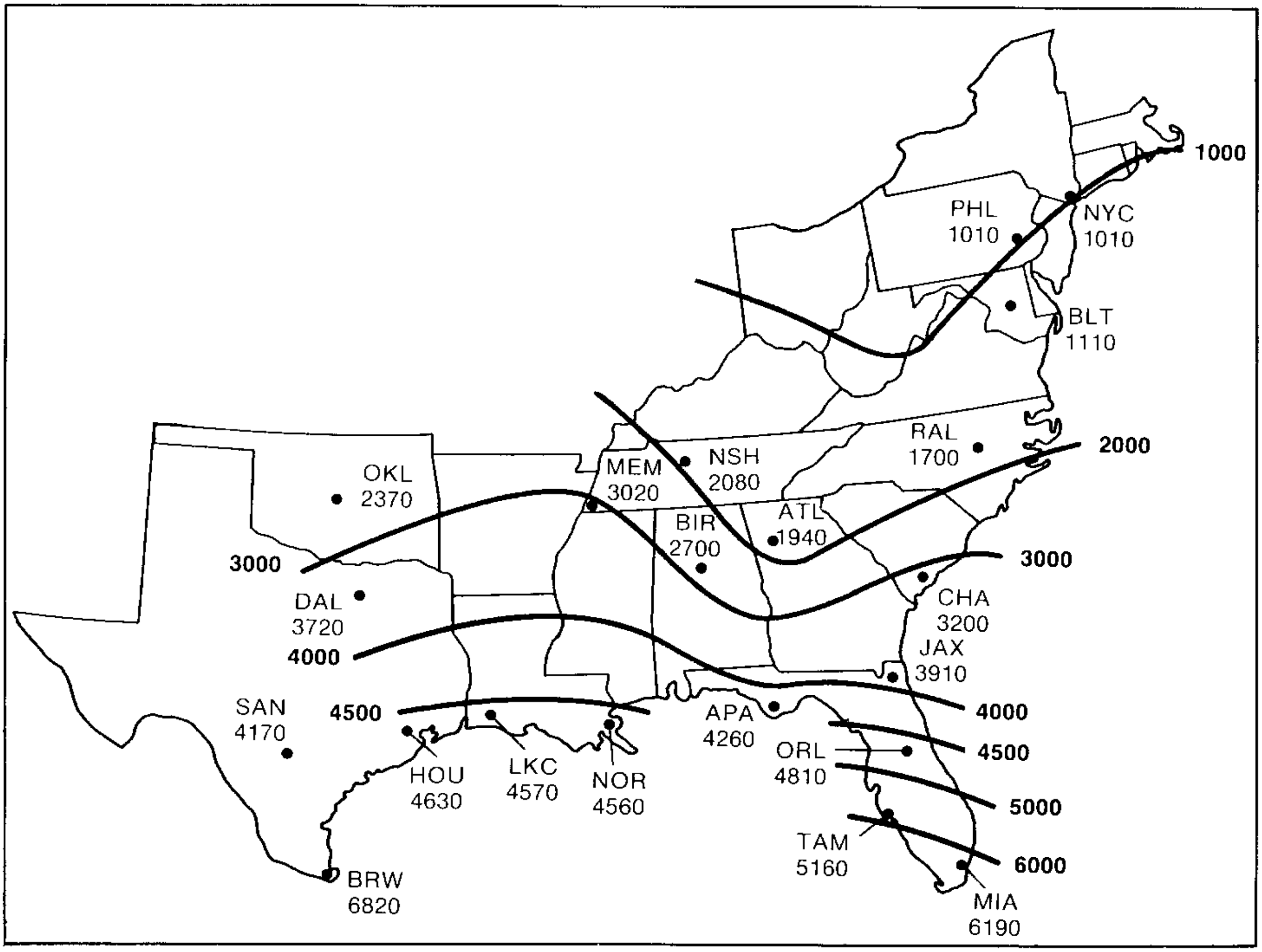


Figure 3.2. Seasonal Air-Conditioning kWh Requirements for the Base Case House in Various Southeastern Cities (A/C SEER = 8.0, Nominal Natural Ventilation)

achieved at low cost by use of reflective drapery linings or venetian blinds. At higher cost, such options as insulated and reflective interior shutters or such exterior devices as awnings, sunscreens, Bahama shutters (awnings without side flaps; see Figure 3.4) and large overhangs are effective.

About 10% of base-case cooling energy requirements can be saved by providing 80% shading instead of the 58% for the base case (Fairey et al. 1986). Such large shading percentages can be provided by the external shading devices in Figure 3.4 or by large overhangs which also provide rain protection for open windows. Overhangs significantly reduce summer heat gain even on the east and west sides of a building. Table 3.3 shows findings on overhang effectiveness for Jacksonville. **Overhangs are effective for all directions in the Southeast U.S. because of the large amount of diffuse radiation that is blocked out along with the direct solar radiation. Although effective in saving energy, horizontal overhangs are not very effective in reducing peak loads in the early morning or late afternoon.** Peak heat gain values (Q_g) in Table 3.3 also illustrate the severity of solar gain through east and west glass compared to north and south glass. Vertical fins, slats, and eggcrate structures can also be designed to provide effective shading and peak-hour heat gain reductions for east and west exposures.

Large overhangs on the south side are not recommended since they will reduce beneficial winter heat gain. Recommended south overhang factors for various north latitudes are presented in Table 3.4. Tables 3.3 and 3.4 were prepared using hourly weather data. Because of afternoon clouds, west facade gains are a little less than east facade gains. However, afternoon solar gain is usually perceived as most intense because of the high mean radiant temperature of the house at that time. Recommended overhang widths on east, west, and north sides are at least as great as those for the south side.

Reflective window films can also reduce solar gain through glass. For locations with some winter heating requirements, window films should not be used on

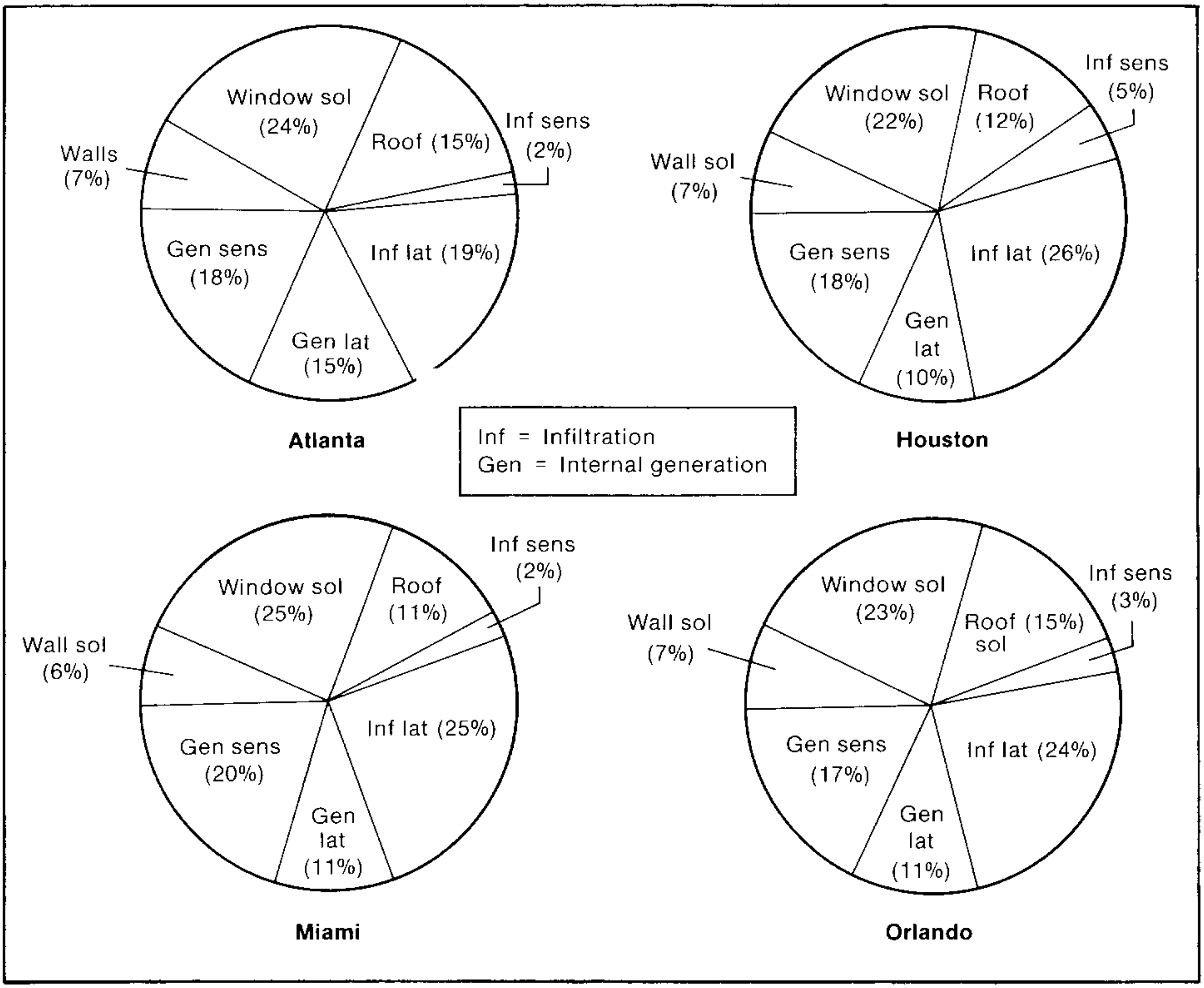


Figure 3.3. Comparison of Air-Conditioner Load Sources in Four Different Climates for Frame Base Case House at T_{stat}=78°F

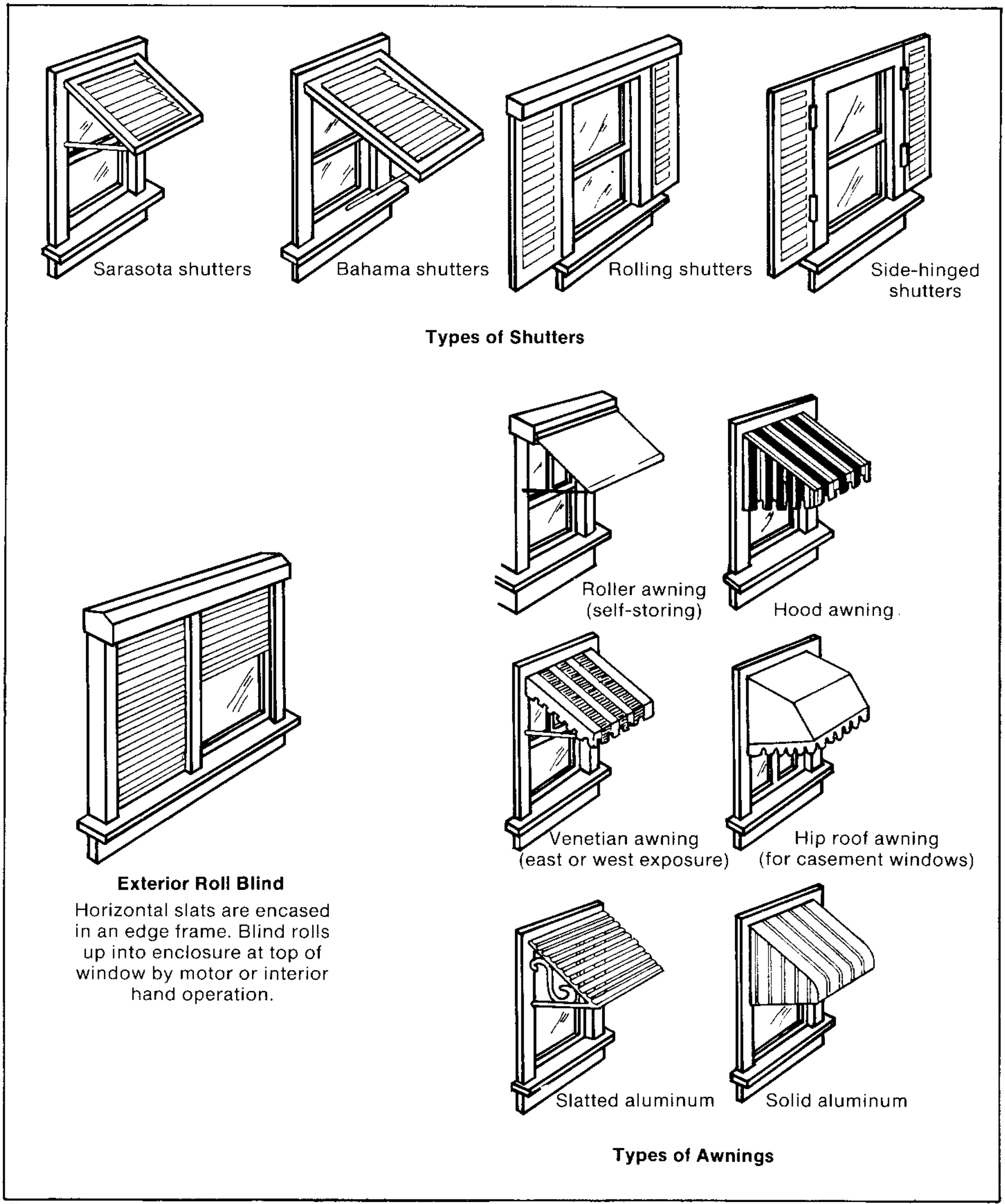
south-facing glass. Because of small solar loading on north glass, window shading devices may not be cost-effective on the north side. Also note that window films applied to the inside of double-paned glass on east and west sides may cause overheating and glass breakage. For single-paned glass on east and west sides, however, reflective window films can be a viable shading strategy, though exterior shading is usually better. Shade trees on east and west sides are another excellent strategy.

Radiant Barriers

Roofs and walls account for about 20% of the cooling load (Figure 3.3). Adding conventional insulation will do little to reduce this contribution to the load. Therefore, wall and roof insulation levels should be determined from winter heating considerations. An excellent low-cost way to reduce heat gain, particularly through an attic, is by use of radiant barrier systems. Radiant barrier systems are aluminum foil-faced products that are installed in attics and walls, with an adjacent airgap. An attic radiant barrier by itself can save about 10% of the cooling load for the base case house in Orlando. Use of attic and wall radiant barriers combined can save about 15% of the base case load. Attic radiant barriers also create cooler attics; this increases attic utility for summer storage and reduces heat gain into attic-mounted air-conditioning ducts. Radiant barrier attics are also effective in keeping usually uninsulated garage spaces cool during the summer.

Radiant barriers can be difficult to apply because their principles of operation are not always what one expects. One is accustomed to dealing with radiation in the solar spectrum, much of which is visible. Radiant barriers, however, function in the long-wave, far-infrared spectrum which is invisible.

A material's response to far-infrared radiation can be different from its response to sunlight. Since a large



Exterior Roll Blind

Horizontal slats are encased in an edge frame. Blind rolls up into enclosure at top of window by motor or interior hand operation.

Figure 3.4. Exterior Shading Devices for Windows

Table 3.3 Peak Cooling Season (June-Aug) Shading Effectiveness of Overhangs in Jacksonville, Lat = 30.5 North (McCluney and Chandra 1984)

(Shading effectiveness of 1.0 implies complete shading)

Facade Orientation	Overhang Q_g (KBtu/ft^2)	Length, ft					
		1	2	3	4	6	10
N	36	0.16	0.33	0.46	0.55	0.67	0.79
NE	54	0.17	0.35	0.49	0.59	0.73	0.84
E	67	0.16	0.35	0.50	0.60	0.74	0.86
SE	57	0.21	0.43	0.58	0.67	0.78	0.80
S	39	0.22	0.39	0.50	0.58	0.69	0.80
SW	55	0.21	0.42	0.57	0.67	0.77	0.86
W	63	0.16	0.35	0.50	0.60	0.74	0.85
NW	52	0.17	0.35	0.49	0.59	0.72	0.83
Horizontal skylight	139						

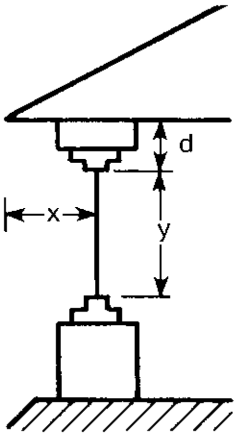
Notes: 1. These calculations assume that the overhang is infinitely wide, that the window height is 4 ft and is located 4 in. below the overhang (see geometry in Table 3.4 figure).

2. Q_g = Peak seasonal (June-August) solar heat gain through vertical, single-paned, unshaded windows in kBtu/ft^2 of glass area. Multiply Q_g by 0.85 to get numbers for clear, double-paned windows. For completeness, the heat gain through horizontal single-paned skylights is also given.

3. (1 - shading effectiveness) x Q_g = solar heat gain through shaded windows.

Table 3.4 Recommended South Overhang Factors for Various North Latitudes

North Latitude	Typical City	Full Shade Required	Overhang Factor, f [f = x/(y + d)]
26	Miami, FL	Feb 21 - Oct 21	0.77
28	Orlando, FL	Mar 6 - Oct 6	0.68
30	Jacksonville, FL	Mar 21 - Sep 21	0.58
32	Savannah, GA	Apr 6 - Sep 6	0.49
34	Atlanta, GA	Apr 21 - Aug 21	0.40
36	Raleigh, NC	Apr 21 - Aug 21	0.45



Notes:

1. These recommendations are only for the window and overhang geometries shown. Example: For a 4-ft high window located 4 in. below the overhang line, the required overhang, x, in Orlando = f x (y + d), or 0.68 x (4 ft, 4 in.) = 2 ft, 11 in., or about 3 ft.

2. The effect of shading by south overhangs is symmetrical about June 21. This can conflict with the end of the heating season in northern latitudes. Moreover, south overhangs are not as effective for northern latitudes. (The required overhang for Raleigh is greater than Atlanta for the same season). Thus, no recommendations are given for latitudes greater than 36 degrees north.

percentage of sunlight is in the visible range, materials are characterized by color and clarity. For example, it is known that white paint reflects more solar radiation than black paint does. But, in the far-infrared band, white paint absorbs slightly more radiation than black paint does. This surprising fact shows that one cannot judge a material's far-infrared properties by sight. Figure 3.5 compares the solar and far-infrared characteristics of some common opaque building materials.

Transparent materials also respond differently to solar and far-infrared radiation. Common window glass, for example, transmits more than 85% of incident sunlight but absorbs more than 85% of the far-infrared radiation that strikes it.

Radiant Barrier Roof Systems

An attic offers excellent potential for use of radiant barrier systems since the roof is the surface most exposed to solar radiation and since most of the heat transmitted to the attic floor by the roof comes by radiation. The airspace that separates the hot roof surface from the attic floor (and building ceiling) prevents heat movement downward by conduction, and there will be no convection downward from the roof to the ceiling since heated air rises.

A radiant barrier (layer of foil), placed in the airspace between the hot roof deck and the cooler attic floor (insulation), eliminates most radiant heat transfer across the attic airspace. Under peak-day conditions,

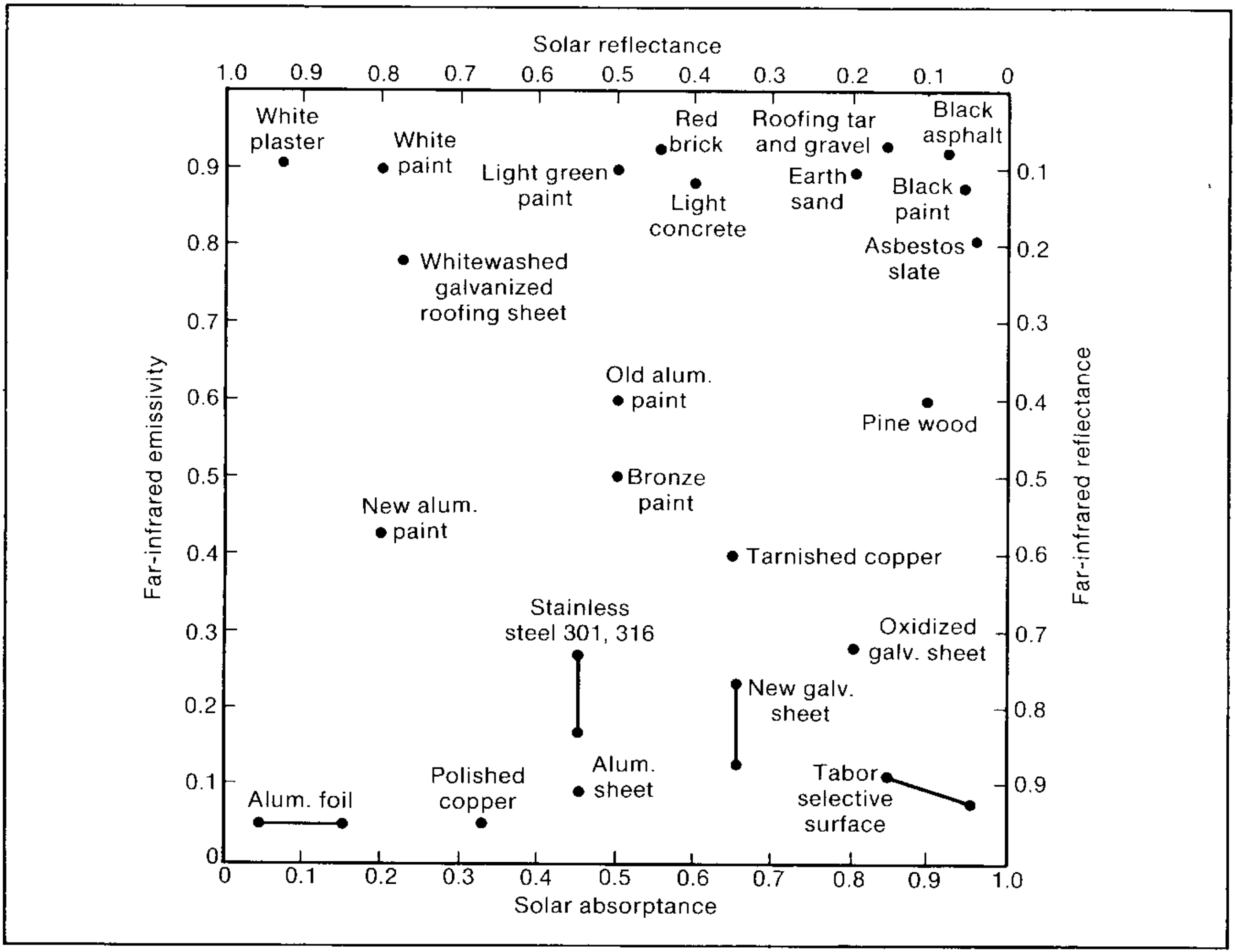


Figure 3.5. Solar and Far-Infrared Characteristics of Some Common Opaque Building Materials

total heat transfer downward through attics can be reduced by more than 40% (Fairey 1982 and Fairey 1986). When roofs enhanced with radiant barriers are compared with standard roof systems in full-scale tests, striking differences in performance are noted (Figure 3.6). For a standard roof, the air temperature a few inches above the ceiling insulation is cooler than both the insulation surface and a point one inch down into the insulation. **This illustrates two important phenomena of heat transfer in attics: (1) all downward heat transfer across a standard attic airspace must occur by infrared radiation, and (2) attic air is acting to cool ceiling insulation by upward convection even in unvented attics in summer.** When attic heat transfer is upward (winter condition), convective forces augment radiant heat transfer; when heat transfer is downward (summer condition), convective forces work in the direction opposite to the predominant flow of heat.

When a radiant barrier is added to a standard attic, a significant reduction in insulation surface and attic air temperature is noted. The driving force of the heat transfer through the ceiling (top-of-insulation temperature minus ceiling-surface temperature) is impressively reduced by the radiant barrier (Figure 3.6). Measured ceiling fluxes describe an equivalent 42% reduction in heat flow into the room. It is significant to note that the presence of the radiant barrier results in an insulation top-surface temperature that does not exceed the attic air temperature. This is not true for the standard attic where radiation from the hot roof forces insulation temperature above attic air temperature.

Heat transferred upward through an attic during winter will not be affected as much as during summer because a greater part of total upward heat transfer occurs by convection. **Thus, roof radiant barriers are more effective for cooling than for heating and can be of great benefit in a southern climate. In a typical southern home, a roof radiant barrier should reduce the annual cooling load by 10-12%. Reductions in the winter heating load are on the order of 9-14%.** The higher cooling season percentage value is for Atlanta and the lower is for Miami, but

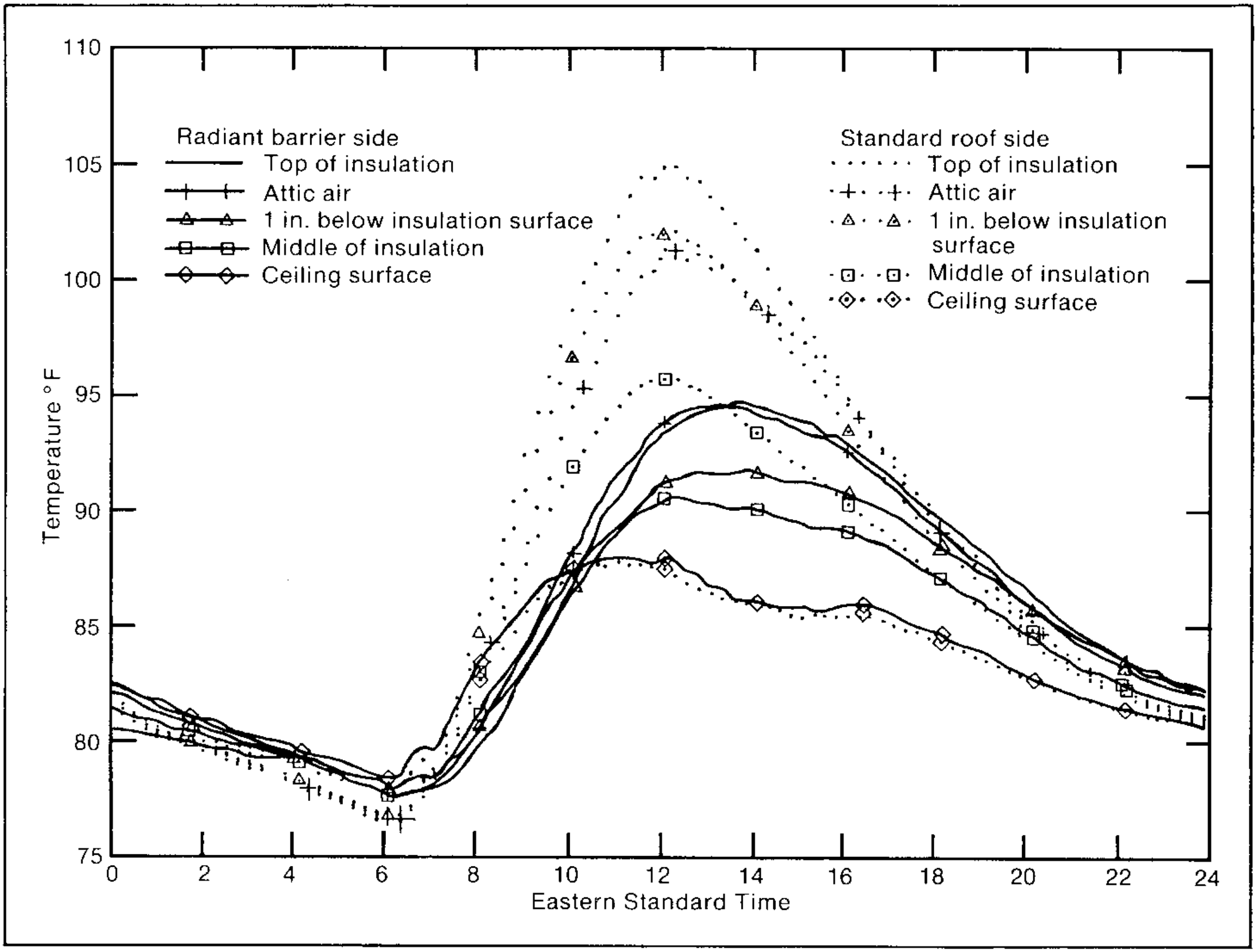


Figure 3.6. Measured Temperatures for Radiant Barrier System Roof vs. Standard Roof (Both Ceilings With 6 in. Fiberglass Insulation)

since the cooling load increases as one moves south, total savings are largest in Miami. For heating, the higher percentage saving applies to Miami, where the heating load is very small, and the smaller percentage saving is for Atlanta.

Radiant Barrier Wall Systems

Overall radiant barrier system performance in a wall is less dependent on heat flow direction than it is in a roof. There are seasonal performance variations of radiant barrier wall systems. In both winter and summer, an exterior radiant barrier airspace will drastically reduce the "sol-air effect," which is caused by solar radiation that strikes the exterior surface of the building and thus raises the surface temperature above that of the ambient air. This effect increases heat gain into the building in summer but reduces heat loss in winter.

An external airspace and radiant barrier together will decrease the effective temperature difference in summer but increase it in winter. But in the deep south, where heat gain is a problem most of the year, winter liabilities are more than offset by summer benefits.

Radiant Barriers and Climate

Since sol-air effects vary with time of day, season, orientation, and ambient conditions, many radiant barrier systems are climate-dependent. Exterior radiant barrier systems are most beneficial on roofs and east and west walls in summer. Their greatest winter liability occurs on south walls.

Computer studies and full-scale measurements show roof radiant barrier systems to be beneficial in both winter and summer. Analysis shows that R-19 ceiling insulation, plus a radiant barrier system, outperforms R-30 ceiling insulation as far north as Baltimore. Radiant barrier systems increase net daily ceiling heat loss in winter, but when night heating loads are high, radiant barriers significantly reduce heat loss. Because of this match between building load and beneficial performance, radiant barrier systems produce a reduction in building load even though there is an increase in net daily ceiling heat loss. Figure 3.7 gives the relationship between ceiling heat loss and building load for the month of February in Jacksonville. Figure 3.8 shows measured conditions in full-scale, side-by-side tests of R-19 versus R-19 with a radiant barrier. Since the predominant building load is at night, the beneficial performance of radiant barriers at night overcomes their poorer daytime performance. There is good evidence that the model* is predicting reality since results compare well to measured performance (see Chandra et al. 1984).

Table 3.5 compares energy savings attained by adding R-11 ceiling insulation or by adding a radiant barrier to an R-19 base case ceiling. The radiant barrier produces winter savings in all climates and outperforms the R-30 ceiling, on an annual basis, in all climates analyzed except Chicago. An air-conditioner with a rated SEER of 8.0 was used in the analyses, and heating coefficient of performance (COP) was varied by climate type to reflect heating systems typical of that climate. Simple paybacks and return on investment, given in the table, are calculated based on a power charge of 8.5 cents/kWh and an installed incremental cost of 20 cents/ft^2 for both the additional R-11 blown insulation and the radiant barrier. The installed cost of the radiant barrier system ($320) is slightly higher than that for the R-30 ceiling insulation ($300) because the radiant barrier is assumed to be installed at the roof plane (1600 ft^2) as opposed to the ceiling plane (1500 ft^2) where the insulation is installed.

Seven different wall systems have been tested at full scale. Five contained radiant barrier systems and two did not. Exterior radiant barrier systems show

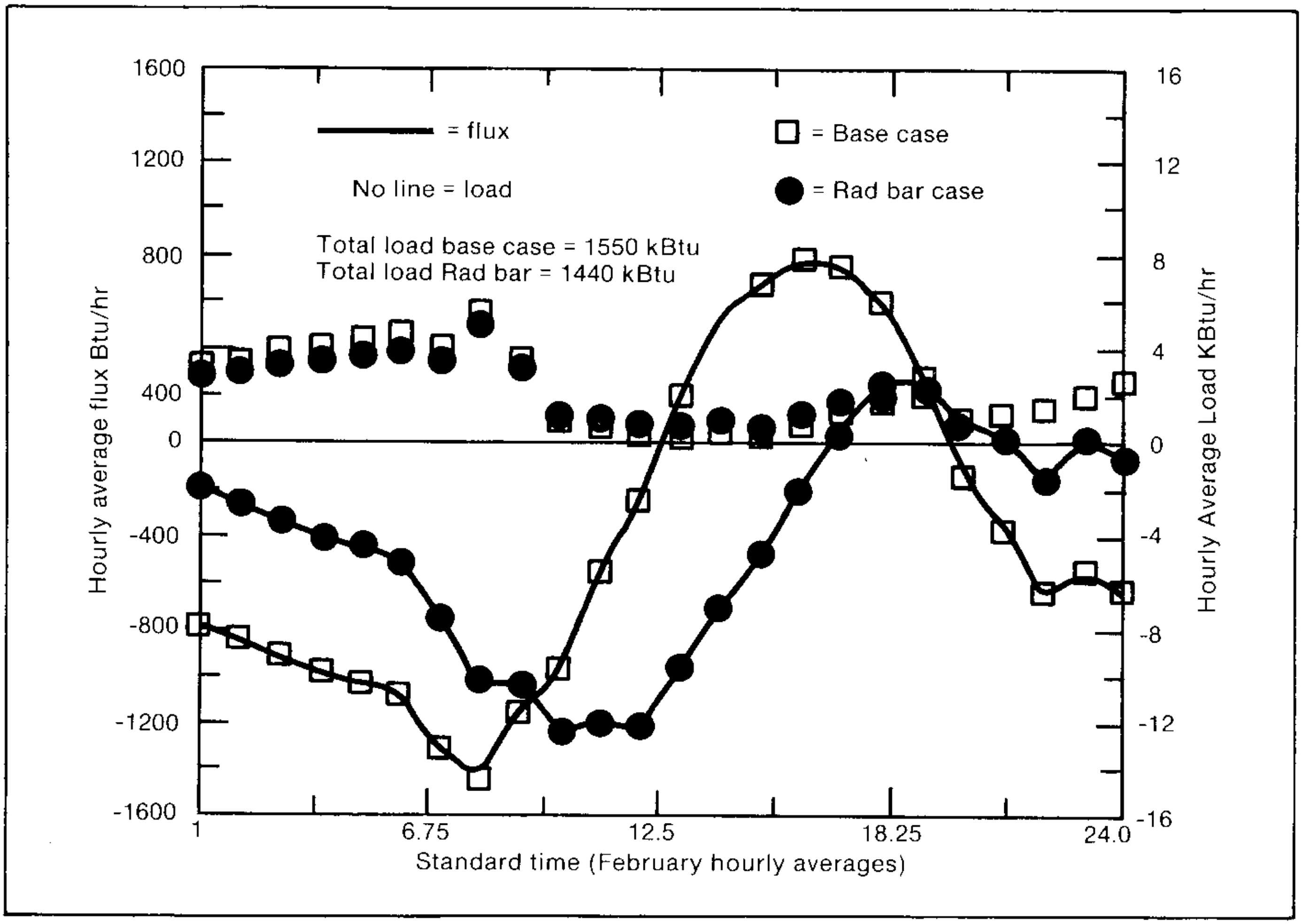


Figure 3.7 Whole-House Hourly Average Ceiling Flux and Heating Loads for Jacksonville in February (Typical Cooling Year Data)

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*An in-house Florida Solar Energy Center model called MADTARP: an enhanced version of the NBS-developed TARP program. See Fairey et al. 1986 for further information.

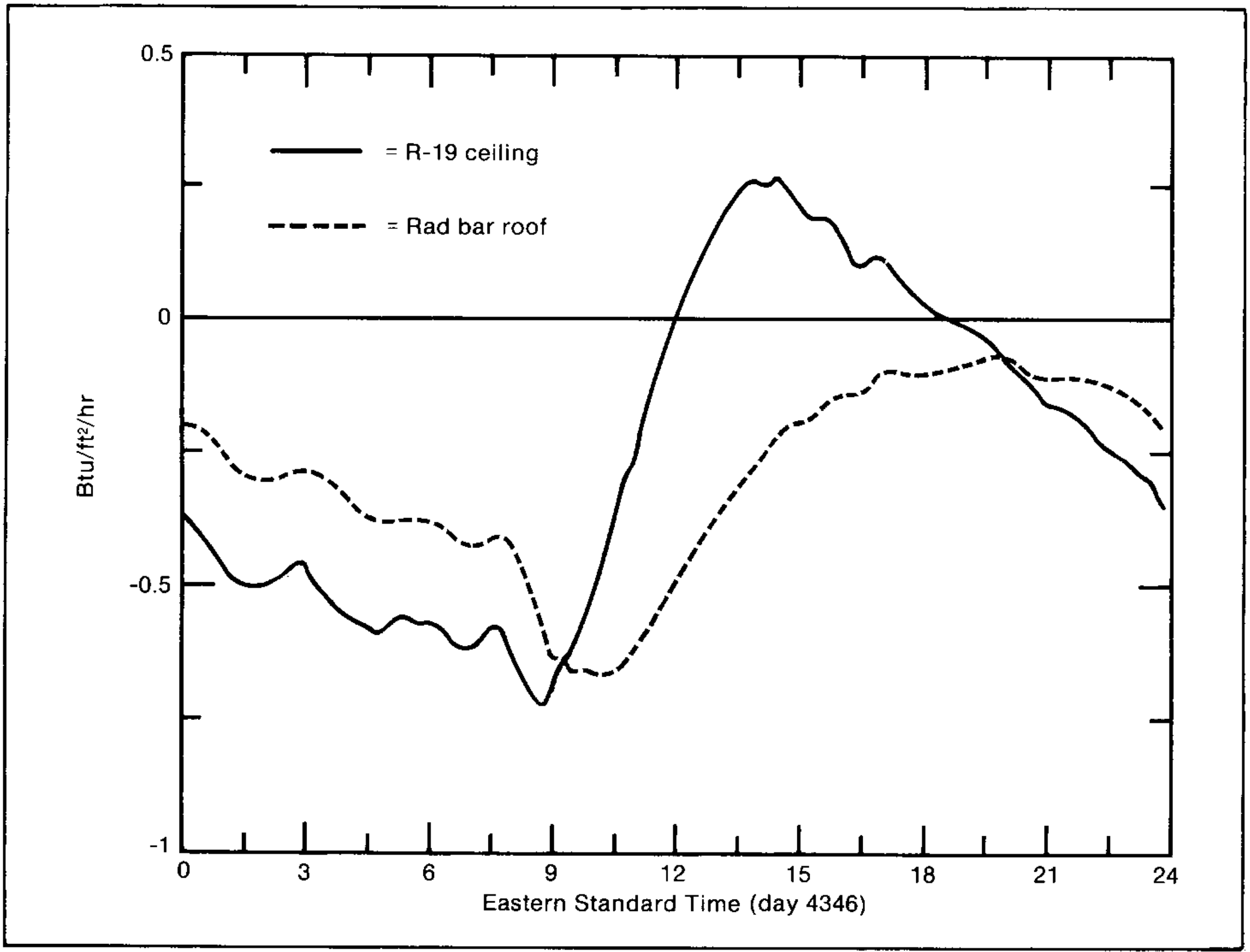


Figure 3.8 Passive Cooling Laboratory Attic Test Cells - Ceiling Heat Flux Over Time for Winter Day

Table 3.5 Comparison of Savings in Seasonal Cooling and Heating Costs From Addition of Radiant Barrier Roof Zones and Additional R-11 Insulation to a Standard R-19 Attic System

City	kWh Savings						Annual Cost Savings @ $.085/kWh		Simple Paypack in years		Return on Invst. 15 yr. Life 5% Fuel Infl. Rate	
	Cooling		Heating		Annual							
	R-11	RB	R-11	RB	R-11	RB	R-11	RB	R-11 @300.00	RB @320.00	R-11	RB
Miami, FL (heat COP=1)	272.4	537.7	29.3	38.1	301.7	575.8	$25.64	$48.94	11.7	6.5	8%	17%
Orlando, FL (heat COP=1)	243.7	491.0	128.9	137.7	372.6	628.7	$31.67	$53.44	9.5	6.0	11%	19%
Jacksonville, FL (heat COP=2)	217.1	426.9	99.6	99.6	316.7	526.5	$26.92	$44.75	11.1	7.2	8%	16%
Houston, TX (heat COP=2)	202.1	389.1	121.6	95.2	323.7	484.3	$27.51	$41.17	10.9	7.8	9%	14%
Atlanta, GA (heat COP=2)	155.3	341.8	224.2	162.6	379.5	504.4	$32.25	$42.87	9.3	7.4	11%	15%
Baltimore, MD (heat COP=2)	124.8	282.8	372.1	249.1	496.9	531.9	$42.24	$45.21	7.1	7.1	16%	16%
Chicago, IL (heat COP=2)	94.1	211.2	474.7	278.4	568.8	489.6	$48.34	$41.61	6.2	7.7	18%	14%

significant seasonal and wall-type performance variations, but interior radiant barrier systems show neither. Interior systems maintained an apparent thermal resistance between R-5 and R-6 at both seasonal extremes in all wall types. As a consequence, they appear to be an effective thermal resistance strategy for a wide range of climate conditions. (This strategy should be avoided if massive wall systems are coupled to a building's interior for thermal storage benefits.)

For climates with severe cooling needs and limited heating requirements, exterior radiant barrier systems can perform better than interior systems; this is especially true for peak-load performance. **However, because of their seasonal performance variations, climatic considerations must be emphasized for exterior systems. With these criteria, general climate guidelines for the use of radiant barriers have been developed (Figure 3.9). Attic or roof radiant barrier systems are likely to be effective where there are 3000 or fewer annual heating degree days and 2000 or more annual cooling degree days (both measured at a base temperature of 65°F). Note that these climate considerations are conservative in comparison to the data presented in Table 3.5.**

Requirements are more stringent for radiant barrier wall systems. Winter penalties are high for south walls with exterior radiant barriers; shading is a better alternative. North walls usually are unlikely candidates because they get little direct sun. But for unshaded east and west walls, radiant barrier construction is an effective option in climates with 2000 or fewer heating degree days and 2500 or more cooling degree days.

Venting of east and west walls is suggested only where there are small winter loads (700 or fewer heating degree days) and severe summer problems (3500 or more cooling degree days). In climates where there are 200 or fewer heating degree days and 3500 or more cooling degree days, vented radiant barriers could be justified for all exterior walls.

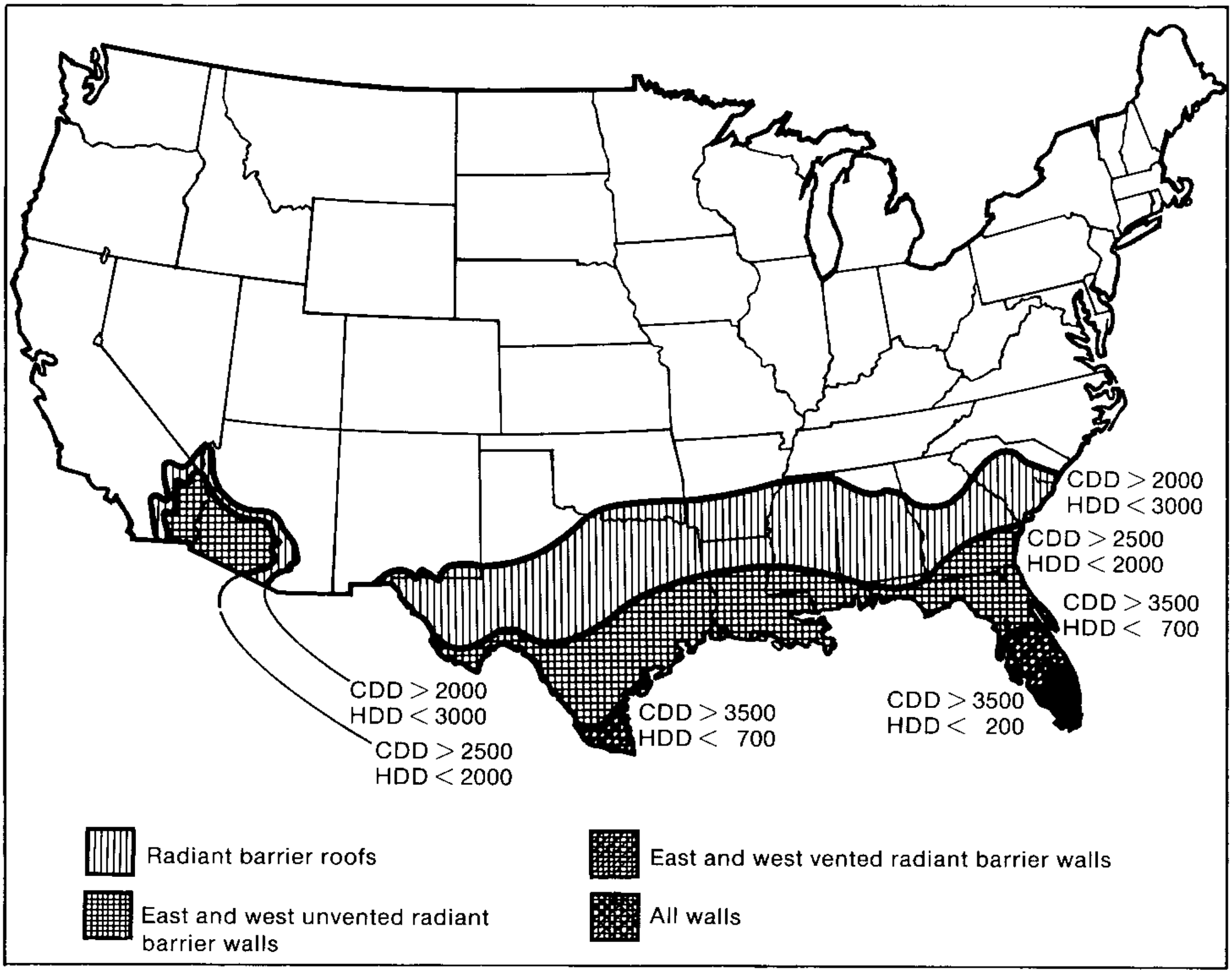


Figure 3.9. Climatic Region Recommendations for Use of Radiant Barriers

Barriers and Building Type

Exterior radiant barriers apply best to skin-load-dominated buildings, such as homes, rather than to internal-load-dominated structures such as office buildings. Multistory commercial buildings are not good candidates since they do not have dominating roof loads. Even multistory residences located in borderline climates may not warrant radiant barrier protection.

Certain large buildings, however, can benefit from radiant barrier construction. For example, some open-bay manufacturing buildings will benefit from interior radiant barriers if radiant transfer between the occupants and the building's skin dominates comfort conditions. In the same way, radiant barriers can be used in agricultural buildings that shelter livestock (most living things are excellent sinks for radiant heat).

Radiant barriers can reduce energy consumption and/or improve comfort in many buildings. The radiant barrier strategy and construction technique, however, will have to respond to individual building needs.

Roof Barrier Construction Techniques

Most roof types already contain an attic or airspace that can accommodate an effective radiant barrier system. In new construction it should be easy to install radiant barrier systems regardless of roof pitch. Figure 3.10 shows three possible generic locations for radiant barriers in attics. When first installed, there will be no significant difference in the effectiveness of these locations. In time, location No. 3 will suffer because of dust accumulation which decreases performance. Dust can't collect on the underside of the radiant barriers at locations No. 1 or No. 2.

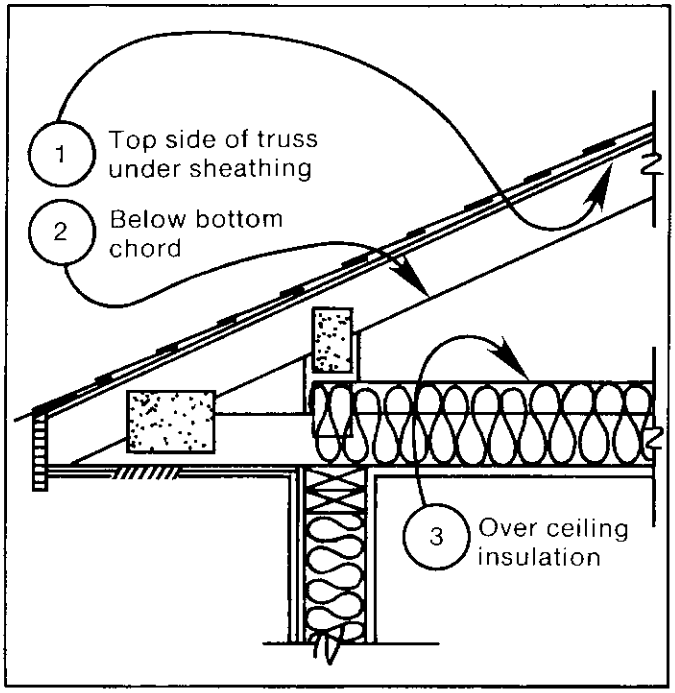


Figure 3.10. Typical Attic Section with Three Possible Locations for a Radiant Barrier

Location No. 2 is slightly better for two reasons. First, it can have two radiant barrier surfaces (top and bottom). Second — and more important — it offers the potential for ventilating the space between the radiant barrier and hot roof deck, thus keeping the roof cooler. This results in an attic air temperature somewhat closer to the conditioned space temperature in both winter and summer. As with location No. 3, dust could collect on the top of a radiant barrier at location No. 2, but a radiant barrier surface facing downward will perform as well as one facing upward. Therefore, for reasons of dust accumulation, use location No. 1 or No. 2 and depend on the down side for radiation control.

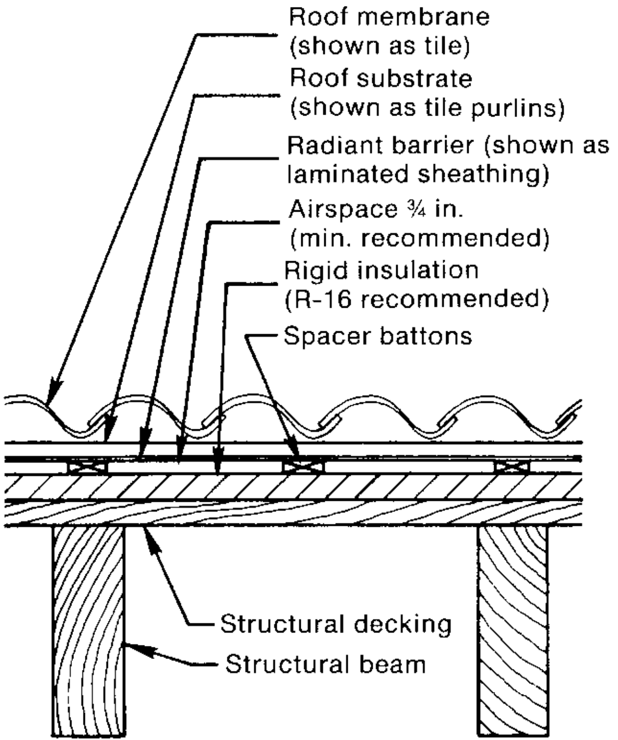
In new construction, an alternative might offer the advantages of location No. 2 and the construction ease of location No. 1. This places the radiant barrier on top of the roof rafters (or trusses) before roof decking is applied. It is installed so that it droops 2 to 3 in. below the upper surface of the roof structure. When roof decking is applied, an airspace separates it from the radiant barrier as in location No. 2. Also, this airspace can be vented. As with location No. 2, the most reflective radiant barrier surface should face downward toward the attic airspace.

It is important to remember that an airspace must exist next to the aluminum surface. Thus, in location No. 1 the aluminum must face down to be effective. The aluminum foil, for example, cannot be sandwiched between the roof decking and the roofing felt since there will be no airspace next to the foil. Economics are against use of more than one sheet of radiant barrier product in an attic. If double-sided barrier material (aluminum foil, with airspaces, on both sides) is available and costs not much more than single-sided, it may be used. Testing of double-sided versus single-sided barrier products shows no difference in performance at location No. 2 (Fairey 1986).

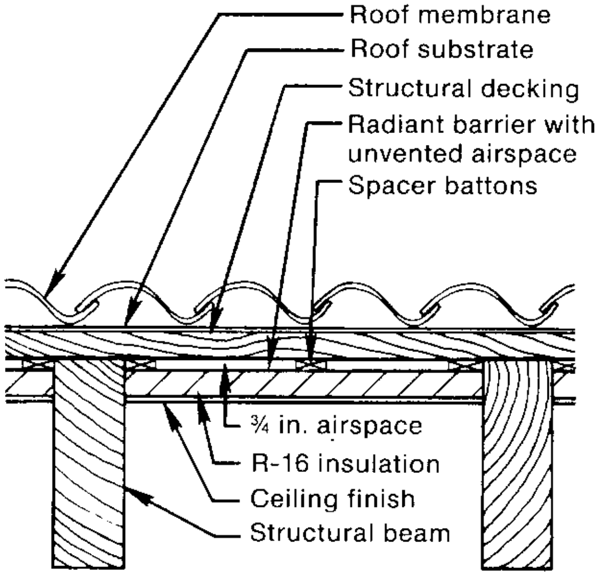
It is not necessary to form airtight seals with radiant barriers; radiant energy travels in a straight line THROUGH the air but not IN the air. In fact, if location No. 3 (Figure 3.9) is chosen, one should use a perforated foil product that will allow the free passage of vapor out of the insulation during winter. This may also apply to location No. 1 in some cases because the barrier is in contact with the roof decking. Location No. 2 should not have moisture condensation problems since it has an airspace on both sides of the radiant barrier.

Roofs with structures exposed to the living space, such as exposed-beam cathedral ceilings, usually

require special treatment. One alternative (Figure 3.11a) is a "vent-skin" roof construction — two distinct sheathing layers bound an airspace that is vented with ambient air. The second alternative (Figure 3.11b) should not be vented. An approach similar to the first alternative may be used when retrofitting a roof with low pitch and limited attic access space. A true vent-skin roof, akin to the first alternative, may also be used in conventional construction, but this is not considered as cost-effective as a simple attic radiant barrier system because of additional material requirements and limited additional performance benefits.



(a) True vent-skin system for exposed beam and decking construction



(b) Radiant barrier under roof system for exposed beam construction

Figure 3.11. Constructions for Exposed-Beam Cathedral Ceilings

Roofs of commercial buildings are different from residential roofs. They are usually flat built-up roofs constructed of steel rather than wood. Commercial buildings often have suspended ceilings above which are mechanical ductwork, electrical wiring, and lighting systems. In many such buildings, roof and ceiling sections are poorly insulated and may have high infiltration rates.

An alternative to common commercial roofing practice takes advantage of radiant barrier protection and places the ceiling plenum inside the conditioned space (Figure 3.12). If the ceiling plenum is still used for mechanical system ductwork, then duct losses will be greatly reduced. In addition, by incorporating the continuous vapor barrier below the bar joists, the ceiling plenum can serve as an effective common return system, simplifying mechanical system design problems. The space above the rigid insulation can be ventilated for thermal and moisture control. This radiant barrier roof system can provide considerable energy savings in single-story commercial buildings where space conditioning is required.

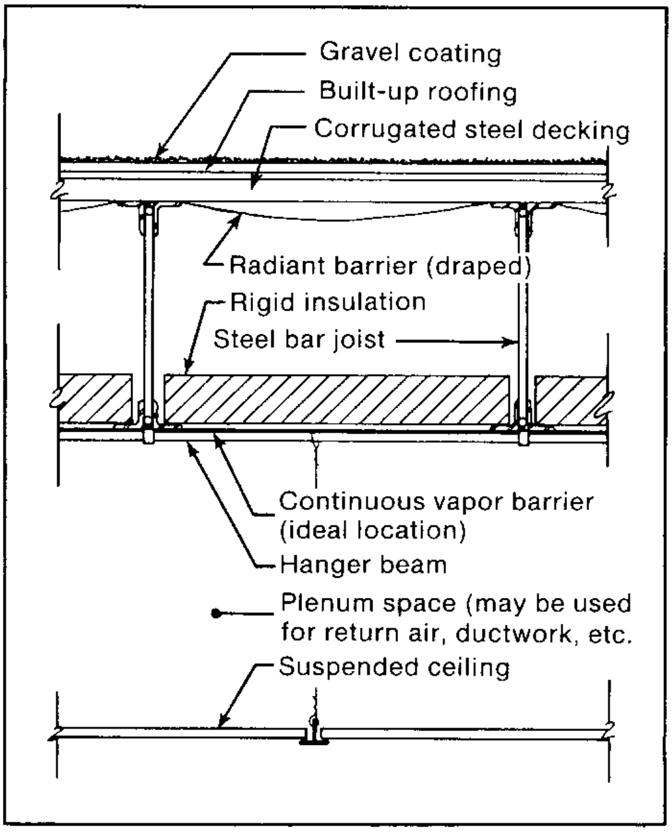


Figure 3.12. Detail of Ideal Radiant Barrier Construction for Typical Flat-Roof Commercial Building

Wall Barrier Construction Techniques

As noted, a radiant barrier must face an airspace to work. Since a wall, unlike a roof, does not usually have an airspace, one must be created. For a retrofit, this probably is done more easily on the outside than on the inside of the wall for either wood-frame or block construction. Interior systems are particularly applicable to frame-wall construction in northern environments where they can provide both thermal protection and a superior interior vapor barrier.

Massive walls used as thermal storage for passive systems obviously should not use internal radiant barrier systems. For energy conservation, however, where there is either no effective passive contribution or where thermal storage is provided by an alternative means, interior radiant barrier systems can provide the most cost-effective conservation alternative for concrete-block wall systems. An interior radiant barrier system for block-wall construction uses standard building materials and standard construction practice to arrive at a superior thermal system (Figure 3.13). The airspace may be used as a chaseway for electrical wiring without significant performance degradation.

Exterior radiant barrier systems are more climate-dependent than interior systems. For severe summer climates, however, they offer superior performance. Figure 3.14 shows the necessary parts of an effective system. Only one airspace and radiant barrier are shown. This is all that is needed if other wall insulation is present. If not, multiple-layer products can be used. These provide increased resistance to heat flow in the same manner as multiple-glazed windows do.

Unlike interior systems, an exterior radiant barrier airspace can be vented or unvented. In summer, venting will improve cooling performance; the airspace temperature will remain low. Figure 3.15 shows a system for venting an exterior radiant barrier airspace with ambient air. Because it is a vent skin, this wall system provides convective cooling of the airspace. Ideally, when the airspace is warmed

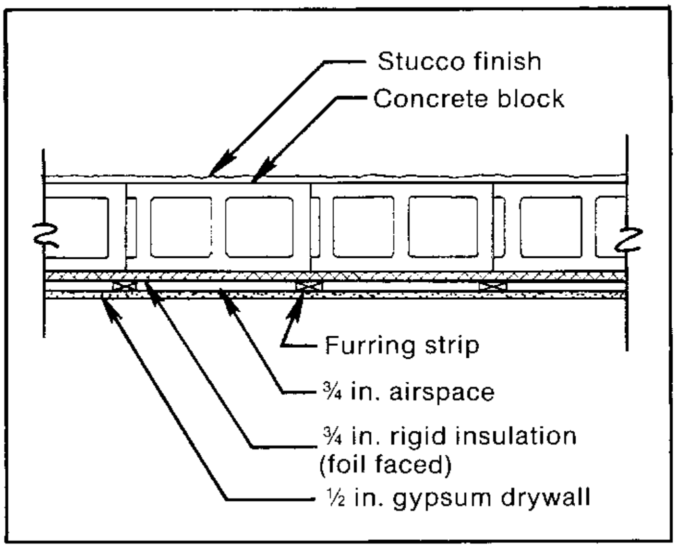


Figure 3.13. Plan View of Interior Radiant Barrier System as Applied to Concrete-Block Construction

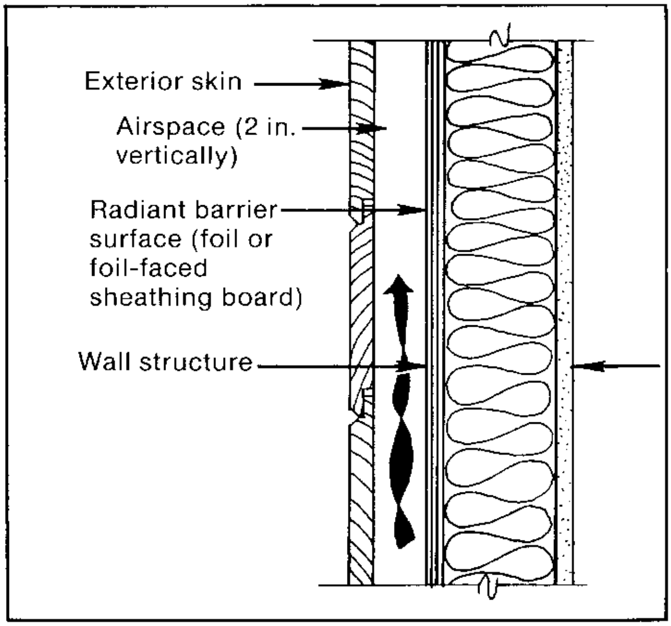


Figure 3.14. Partial Studwall Section With Required Components of an Effective Radiant Barrier System

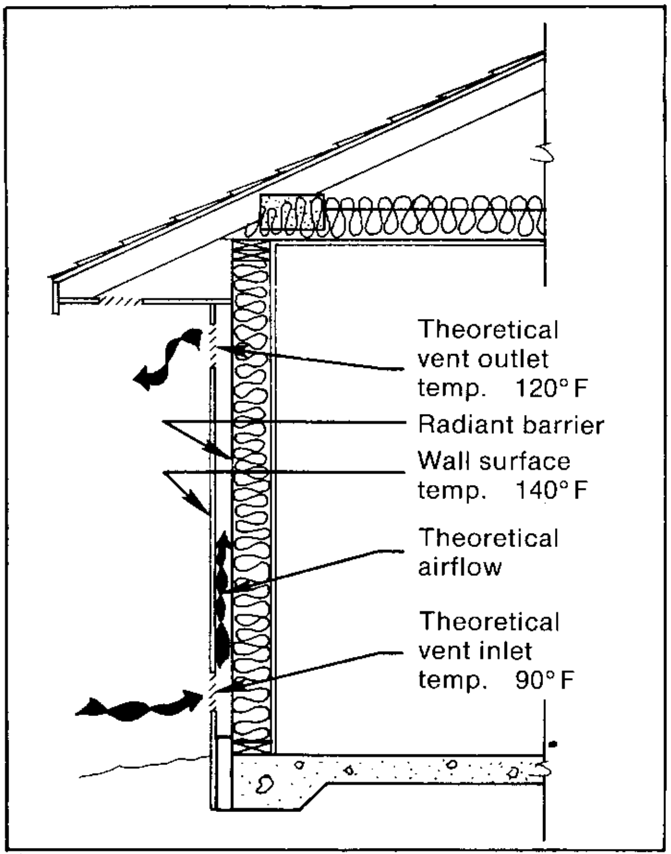


Figure 3.15. Vent-Skin Wall Section (Wind Pressure Affects Air-Flow More Than Stack Effect)

by the hot exterior skin, the air rises in the cavity and exhausts through the outlet. This draws in cooler outside air through the bottom vent.

In practice, wind effects will quickly overcome any buoyancy pressure and will easily offset the thermal "stack" effect in this wall system. In addition, there is a potential for water damage caused by rain intrusion at the upper vent. To avoid these problems, the inlet and outlet vents should be located in different wind regimes. Figure 3.16 shows how this is done by directing the air at the top of the wall into the attic and out through a ridge vent. The outlet (roof ridge vent) is now in a lower pressure zone than is the inlet (bottom wall vent), and, regardless of wind direction and fluctuations, the air in the wall and roof will always move upward. The stronger wind-driven force now works in parallel with the natural thermal stack force, so the warmest air in the vent skin will be continuously removed at the roof ridge vent. This will flush the vent-skin airspace with the ambient air that enters at the bottom wall vent. Figure 3.17 suggests a method of providing a bottom wall vent.

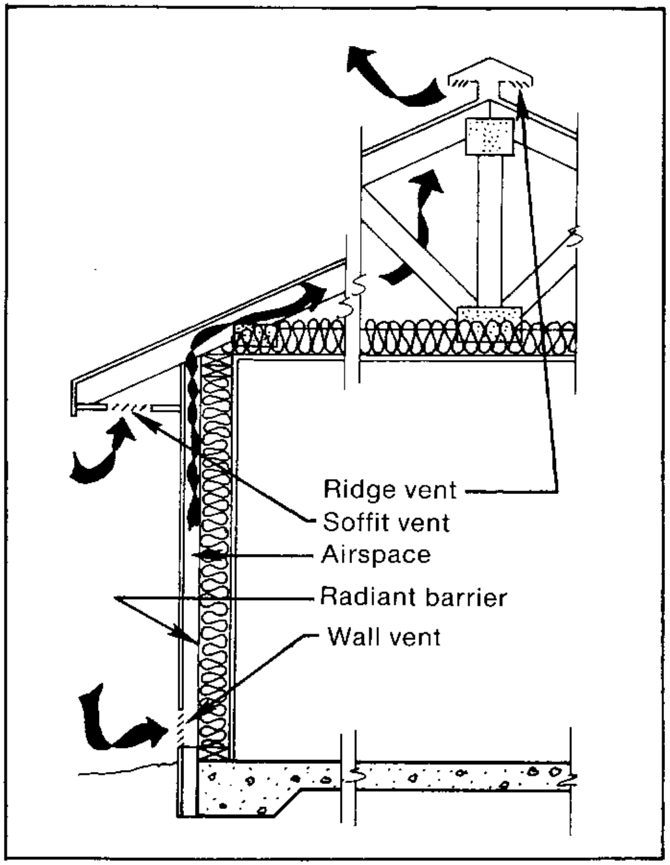


Figure 3.16. Improved Vent-Skin Wall (Wind and Stack Effect Work Together)

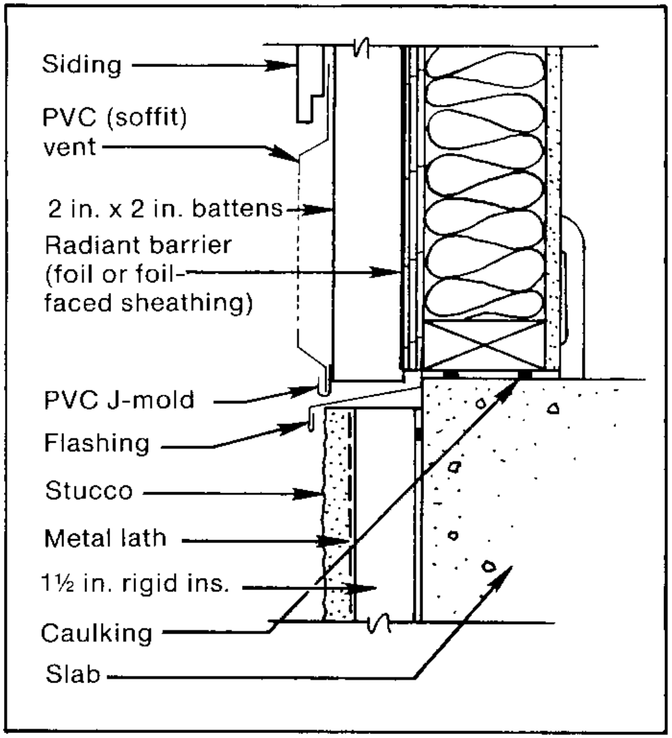


Figure 3.17. Detail of Bottom Inlet Vent-Skin Stud Wall With Radiant Barrier

Chapter 4

Air-Circulation Fans

Introduction

One easy way to reduce cooling costs is to increase the thermostat setting. Calculations indicate that for every degree Fahrenheit the thermostat is raised, air-conditioning costs are reduced from 7% to 10%. In the hot climates of Florida and the Gulf Coast, the savings approach 7%; in the moderate climates of North Carolina and Washington D.C., the savings approach the 10% figure. Air-circulation fans (ceiling, paddle, or portable fans) allow a thermostat increase of about 4°F (thus, saving between 28% and 40% of the cooling costs, depending on the climate) with no decrease in human comfort (see Figure 4.1). Increased airspeed created by a circulation fan increases body cooling. Thus, in the presence of a fan that creates a 150-200 ft/min airspeed, a person would be as comfortable at 82°F as he or she would be at 78°F without air circulation (see discussion below). Most homes in the Southeast, even when air-conditioned, have high humidity levels [greater than 60% relative humidity (RH)]. In such situations, air motion produced by a fan creates a distinct sense of comfort. Recommended ceiling fan sizes for various room sizes are shown in Table 4.1.

In rooms with normal 8-ft-high ceilings, a ceiling fan should be installed with a minimum clearance of 10 in. between ceiling and fan. Less clearance may not provide satisfactory air circulation. In a room with sloped or high ceilings, a ceiling fan should be mounted 7 ft. 6 in. to 8 ft above the floor. (An article in the October 1984 issue of *Popular Science* provides tips on mounting ceiling fans in difficult places.) Where ceiling fans may not be practical (e.g., kitchens) portable fans can be used. An oscillating portable fan should be chosen over a fixed portable type since the former will consume about one third as much electricity as the latter for the same comfort level (see Table 4.2). Wall-mounted oscillating fans can be installed where counter space is at a premium.

Table 4.1 Ceiling Fan Sizing Chart

Largest dimension of room	Minimum fan diameter, in.
12 ft or less	36
12-16 ft	48
16-17.5 ft	52
17.5-18.5 ft	56
18.5 ft or more	2 fans

A fan with low power consumption and easy controls provides the greatest potential savings. Table 4.2 shows that the power consumption of a good fan is negligible.

Table 4.2 Power Consumption of Fans (Watts)

	Fan Speed Setting		
	High	Medium	Low
1. Ceiling fan, 48 in.	75	40	15
2. Oscillating portable, 12 in.	42	34	27
3. Box fan, 20 in.	160	104	74

Human Comfort

The effect of air motion on summertime human comfort has been studied by many investigators (see, for example, ASHRAE 55-1981; Fanger 1970, pp. 36-42; Gagge and Nevins 1977). Later investigators have generally validated the early work by Fanger, although tests at relative humidity levels of 60% to 80% have not been conducted. Figure 4.1, based on Fanger's comfort equations, shows optimum summer comfort lines for various airspeed levels for rooms where mean radiant temperature equals dry-bulb temperature. Occupants are clothed in summertime clothing (trousers, open-neck short sleeve shirt, socks, shoes) and are performing light office-type work. Optimum comfort lines are dashed for relative humidity less than 20% (where health problems may arise) and for relative humidity greater than 80% (where mold and mildew could occur). The still-air (20 ft/min) line shows that, at 60% relative humidity, optimum comfort will be attained at 76°F. Optimum comfort implies a Fanger predicted mean vote (PMV) of 0; i.e., 95% of the population will be comfortable. The comfort zone for PMV = 0.5 and still air is indicated by the shaded zone; i.e., 90% of the population will be comfortable if space conditions are maintained within that zone. The PMV = 0.5 comfort zone boundaries for airspeeds between 150 and 300 ft/min can be obtained by connecting the dotted and square symbols, respectively.

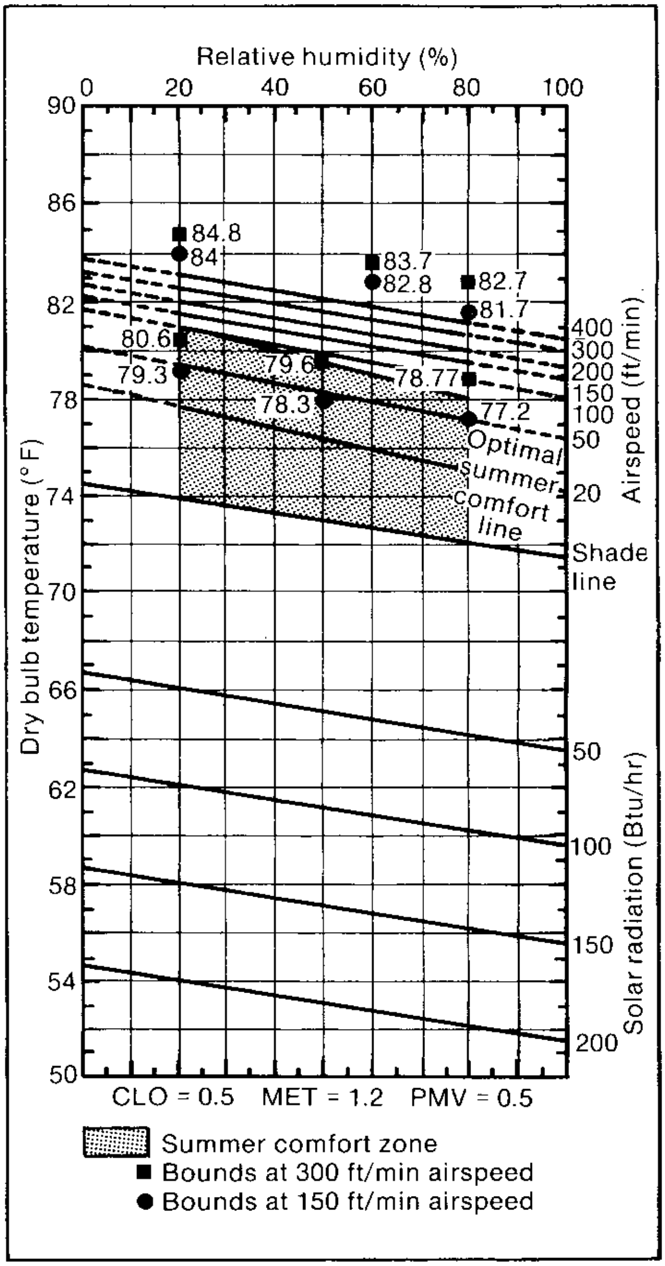


Figure 4.1. Comfort Chart Showing Change in Optimal Comfort Line for Various Air Speeds

The ASHRAE recommended upper limit of airspeed is 160 ft/min. Above that, loose papers may be disturbed. As can be seen from Figure 4.1, such airspeeds permit one to maintain a space 4°F hotter (80°F at 60% RH) and still maintain optimum comfort. The 4°F increase in allowable space temperature when using fans is also allowed by the ASHRAE comfort standard. Figure 4.2 shows airspeeds obtained under a 48-in. ceiling fan in a closed room with no furnishings. The fan blows air downward to the floor. The air travels along the floor, up the walls, along the ceiling, and is then taken in by the fan. Thus, there is a "wall jet" near the surfaces, as shown by the greater airspeeds near the walls in Figure 4.2. This effect tends to improve the surface-to-room heat transfer.

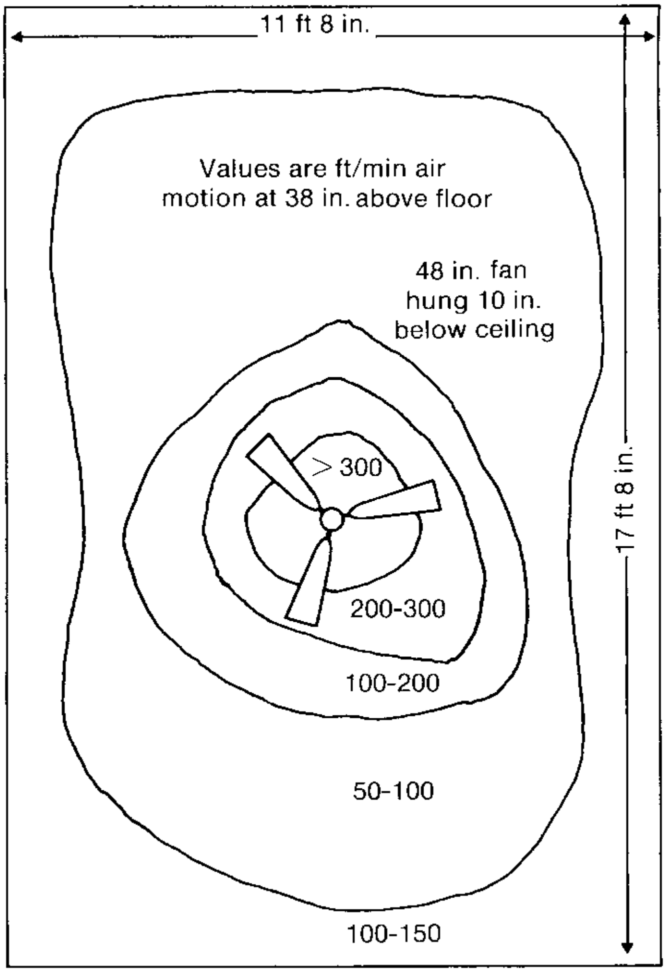


Figure 4.2. Approximate Airflow Patterns From a Ceiling Fan in a Room With No Furniture. Fan Speed Set at Maximum. Ceiling Height = 8 ft.

A ceiling fan will produce effective airspeeds for a distance of up to one fan-blade diameter away from the center of the fan. Airspeed contours in section view are given by Aynsley et al. (1977). Fan airspeeds are available from manufacturers' data.

A New Concept Using Ceiling Fans

A frequent problem in the Southeast during the summer is low windspeeds at night. Even if occupants are willing to tolerate the humidity, low nighttime windspeeds result in poor airflow. This can result in house temperatures at night 3-5°F warmer than those outside even if the windows are open. Similar situations exist at moderate windspeeds if the room is not cross-ventilated. One way to alleviate the situation is to use whole-house fans to create airflow and continue to use ceiling or portable fans for airspeed and occupant cooling. Whole-house fans are discussed in Chapter 9.

An alternative solution uses ceiling fans to create both airflow and airspeed. Operable ceiling vents above the ceiling fan are used (Figure 4.3). Insulated

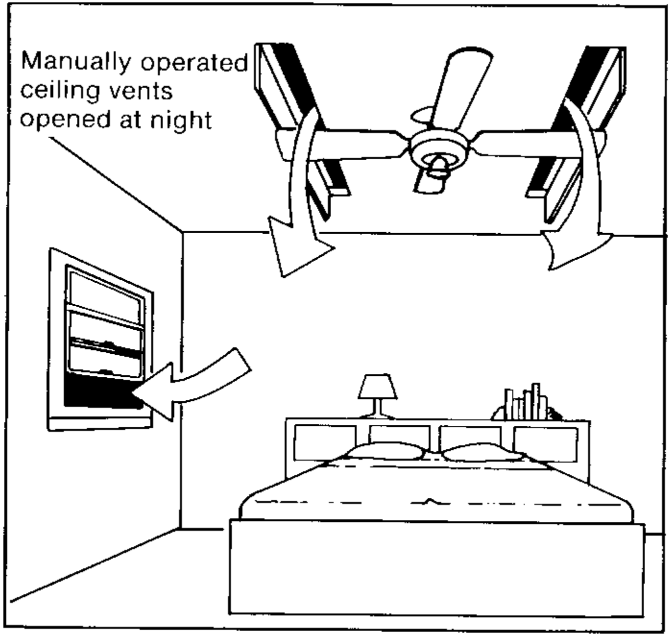


Figure 4.3. Attic-Coupled Ceiling Fan for Nighttime Cooling

vent shutters are operated manually and are kept closed during the day (hot attic) so that the ceiling fan can operate normally. A moderately vented attic (with ridge and soffit vents or with wind turbines and soffit and gable vents) will cool down to within 1°F of the ambient temperature by 11 p.m. The ceiling vents are then opened to pull cool air in from the attic and exhausts it through an open window in the bedroom. This concept is especially useful for rooms with only one window. The ceiling vents should be positioned (as shown in Figure 4.3) such that the vents are positioned near the fan blade tips. The shutters should open as shown to maintain a small clearance between blade and shutter.

Hot air is also drawn into the house during the winter day. Shutters should seal tightly to prevent night heat loss from the room to the cooled attic. Because of the risk of pulling loose fibers in from the attic, it is recommended that this concept not be used in attics with blown-in insulation.

Experiments were conducted in a nominal 12-ft x 18-ft x 8-ft room, with a 48-in. ceiling fan. The 4-ft, 6-in. x 7-in. attic vents were created as shown in Figure 4.3. The window was a 3-ft, 9-in. x 12-in. hole in the wall, with a clear aperture area of 3.67 ft^2. Tests showed that on a windless morning (wind speed $<$ 0.5 mph) the room without fan assist had four ACH; with ceiling fan on, 20 ACH were created.

During windy nights, the ceiling vents and an open window create good cross ventilation even if the ceiling fan is not operating. Thirty to forty ACH have been measured in the test room with the fan off and wind speeds of 6-8 mph when the wind direction made the window an inlet.

Chapter 5
Natural Ventilation

Introduction

Historically, natural ventilation has been a prime method for summer cooling in the hot humid Southeast. Summer humidities are high, and ambient temperatures are moderate-to-high. Temperatures rarely exceed 95°F; above this temperature, air motion across human skin produces discomfort. Thus, were it not for the high humidity, a properly shaded and ventilated house could be kept reasonably comfortable with fans. Most homes use air-conditioning principally to overcome humidity.

Local tropical architecture suggests the use of one-room, deep cross-ventilated houses with good shading and large operable windows, but such an arrangement is not compatible with efficient air-conditioning, winter heating, and small lot sizes. Thus, one must consider design techniques that promote natural ventilation in small compact houses with moderate window areas (approximately 12% of floor area).

Except near the windows, small window areas alone are not likely to produce sufficiently high interior airspeeds for occupant cooling. Strategic location of small windows can provide sufficient airflow to exhaust heat from a house so that interior temperatures are comfortable. Air-circulating fans (paddle, ceiling, oscillating) are recommended for occupant cooling in all rooms of the house.

Natural ventilation should be used only to create volumetric flow; i.e., air exchanges, to remove heat from a house. Fans are to be be used to create airspeed for occupant cooling. Thus, a house can be designed both for ventilation during mild weather and for backup cooling or heating during inclement weather. Small windows will not create excessive loads on the mechanical equipment, and ceiling fans will continue to save energy even when the air-conditioner is on.

When winds are inadequate or when adjacent houses block prevailing winds, natural ventilation may be insufficient; a whole-house fan should be used to provide airflow for heat removal. Whole-house fan selection guidelines are presented in Chapter 9. Unless grossly oversized, whole-house fans will not provide adequate airspeeds for occupant cooling, though selective window opening can provide some cooling in a particular room. It is a good substitute for natural ventilation but is not a proper substitute for a ceiling fan. Even with a whole-house fan, an air-circulation fan should be provided in all rooms, or the concept suggested at the end of Chapter 4, which combines the functions of a ceiling fan and a whole-house fan, should be substituted.

Savings From Ventilation

The savings from ventilation depend on many factors: (1) average air change rate per hour produced by ventilation, which is a function of building geometry and windspeeds or whole-house fan capacity, (2) building construction [low mass or high mass], (3) the climate, and (4) the temperature and humidity at which a house is maintained.

Consider data collected on a low-mass, 3 bedroom/2 bath house, continuously vented by a whole-house fan at 15 ACH. Typical internal and solar gains are present, and humidity is not of concern. The data (Figure 5.1) show that 15 ACH keeps the house an average of 2.5°F hotter than outdoors, although peak indoor afternoon temperature can be 5°F hotter than outdoors. Since the indoor-to-outdoor temperature difference is inversely proportional to ACH, one can assume that for ACH values of 30 and 7.5, average temperature differences will be 1.25°F and 5°F, respectively. An ACH of 7.5 is likely to be available in any house with open windows; hence, that level was assumed in the base case house. It was also assumed that there will be no cooling load if the ambient temperature drops below 73°F (78°F is the house set point). Figure ~~5.1~~ 5.2 was prepared on this basis.

Since good ventilation occurs at 30 ACH, the permissible temperature difference would be 1.25°F. Thus, to maintain the house at 78°F, one could ventilate whenever the ambient temperature is 76.75°F or lower. In cities with humid climates, 12-25% savings is possible from good ventilation (Figure 5.2). Percentage of savings increases as one moves north since cooling loads occur primarily during the day and since more daylight hours remain below the 76.75°F criteria. However, total savings is greater in the South since base loads are much higher. From the results in Figures 3.2 and 5.2, savings in Miami due to ventilation would be approximately (6190 x 11.8%) 730 kWh while those in Baltimore would be approximately (1110 x 25.5%) 280 kWh for the cooling season.

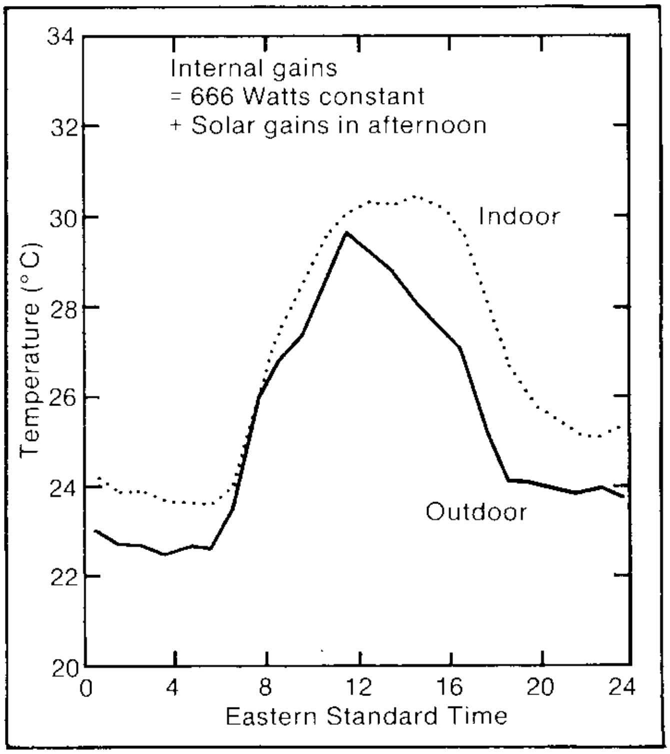


Figure 5.1. Indoor and Outdoor Temperatures in a 24-hour ventilated Low-Mass Residence at the Florida Solar Energy Center, With an Average Ventilation Rate of 15 ACH. (Data for Oct. 9, 1982)

Multiplication of kWh savings by local utility cost/kWh will give seasonal dollar savings.

A recent study of various building types (Fairey et al. 1986) indicates ventilation energy savings substantially higher than those in Figure 5.2. For an energy-efficient frame building with no east or west windows, with roof and wall radiant barriers, and with reduced infiltration and internal load, energy savings are increased 50% over those in the figure. A massive building with exterior wall insulation doubled the energy savings in Figure 5.2. Energy-efficient buildings reduce the base cooling load and can take advantage of ventilation cooling better than typical buildings.

Figures 3.2 and 5.2 were prepared with 78°F as the desired house temperature. If the house is kept at a higher temperature (e.g., 80°F or 82°F), then, depending on climate, an additional 7% to 10% savings in cooling costs can be obtained per degree F of thermostat increase, as noted at the beginning of Chapter 4.

Although a naturally ventilated house with moderate window area will not have high airspeeds, it will have higher room airspeeds than a closed and air-conditioned house. An increase in airspeed from 20 ft/min (the still-air value) to 50 ft/min allows a 2°F increase in space temperature with no sacrifice in

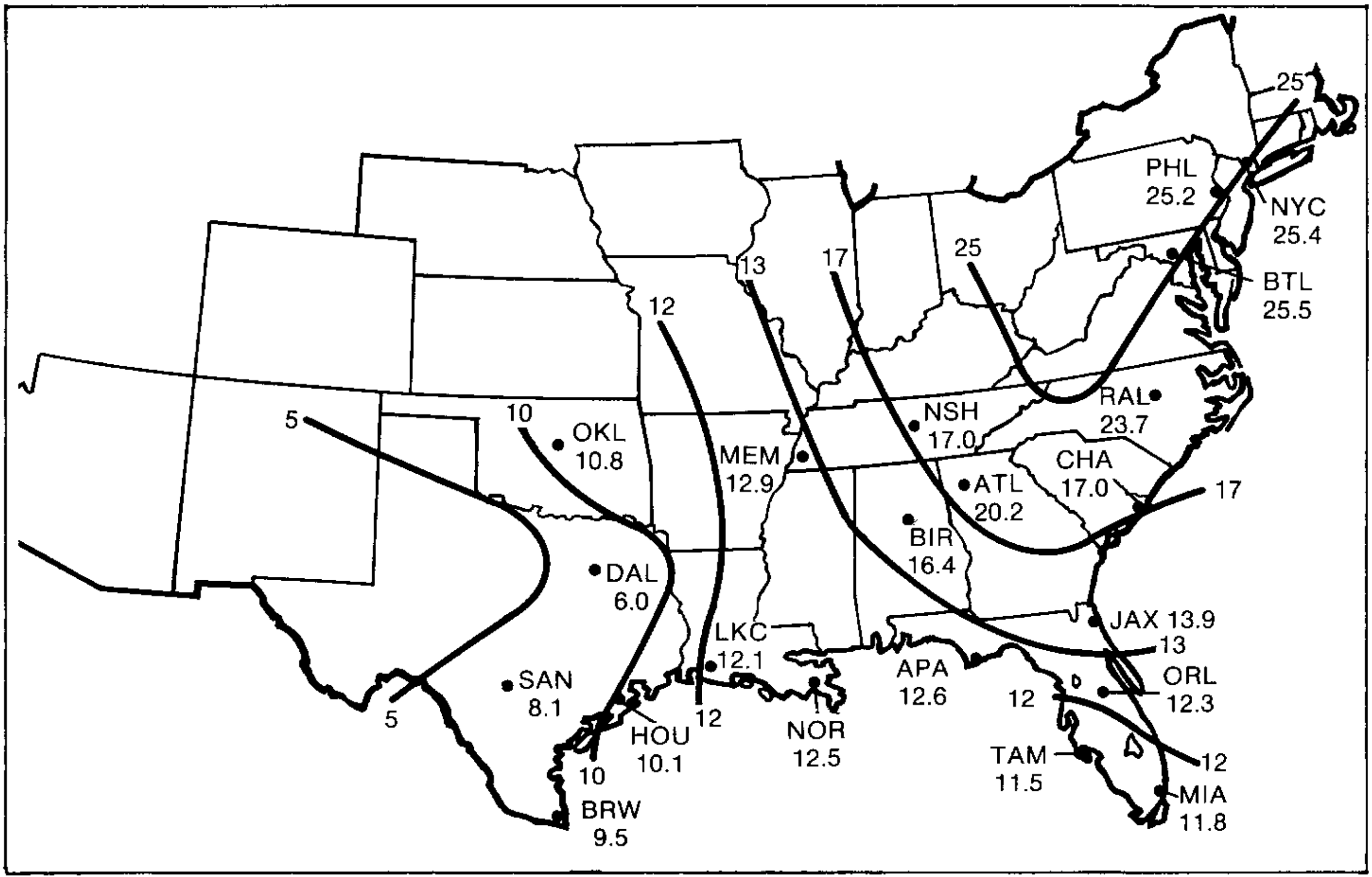


Figure 5.2. Percent Savings in Cooling Costs Possible From Good Natural Ventilation

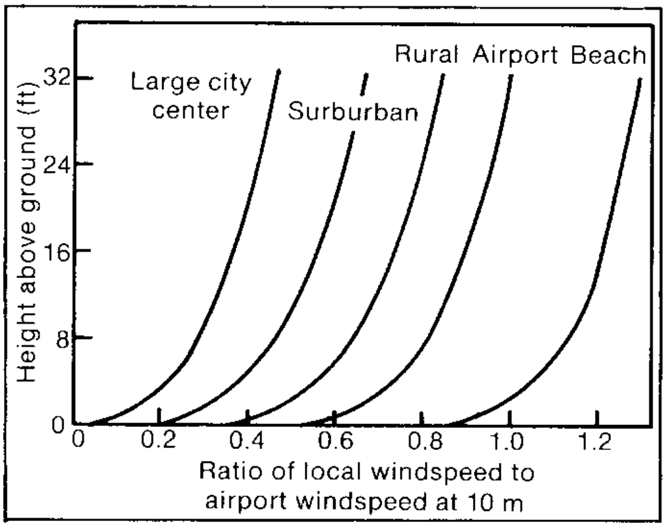


Figure 5.3. Windspeed Variation With Height for Various Terrains

comfort (see Figure 4.1). On average, natural ventilation can provide room airspeeds of 50 ft/min. Thus, without the use of fans, a ventilated house can be kept at 80°F with the same comfort level as an unventilated house at 78°F. An additional 14-20% (7-10% per degree F) savings may be attributed to natural ventilation beyond that presented in Figure 5.2.

The ventilation-savings map in Figure 5.2 shows decreasing percentage savings as one moves to the Southwest because the low-mass frame house analyzed there would have a cooling load primarily in the daytime. Daytime temperatures are very high in the arid Southwest; thus, the potential for daytime ventilation is small. At night, when temperatures are cool, there is hardly any cooling load. This brings an important design point into focus. In the Southwest, a low-mass house is a thermal liability. A high-mass house will do much better because it can be ventilated at night and closed during the day; high internal mass can carry most of the daytime load.

So far, humidity has not been addressed. In the Southeast, during the extremely humid months, ventilation may introduce excessive moisture into a house. When temperatures rise, an air-conditioner, once started, will run longer to extract the moisture. Therefore, any savings from ventilation could be reduced. This topic is under intensive research, and experimental and theoretical analyses are currently underway. Definitive answers are not yet available, but the following observations are made.

1. If a house is to be maintained at 78°F or less and ceiling fans are not used, then it is probably not a good idea to ventilate at night and air-condition during the day during the extremely humid months of July and August (and September in central and south Florida).
2. If ceiling fans are used and occupants would like to ventilate as much as possible during the humid months, then furnishings, drapes, carpets, and wall papers that do not absorb much moisture should be used (e.g., rattan rather than upholstered furniture and low-permeability paints and finishes). This will reduce the potential for humidity absorption and buildup in a house caused by ventilation. When the air-conditioner is turned on, it may not have to run unusually long to extract the moisture.

Characteristics of the Wind

Wind patterns follow several general trends. Windspeed increases from mid-morning until it reaches a maximum in the afternoon and early evening. Then it decreases to a minimum in the late night and early morning hours. The night-average windspeed is usually about 75% of the 24-hr-average windspeed reported by weather bureaus. Appendix B provides a summary of airport windspeed and direction data, along with other climatological data, for southeastern U.S. cities.

Windspeed increases with height and is generally recorded at an anemometer height of 10 meters above ground; it is zero at ground level. Its increase with height depends on the type of terrain (Figure 5.3). Windspeed at window level is much greater at the beach than it is in a suburban location. The profiles in Figure 5.3 have been drawn from civil engineering correlations for strong winds. For natural ventilation practice, the ratio of local-to-airport windspeeds is probably smaller than that indicated, but definitive data are not available. Note that Figure 5.3 is just for terrain. **The presence of neighboring buildings reduces windspeeds even more at window level. Considerable fluctuations in wind direction occur in natural wind, particularly in surburban and rougher terrains. In suburbia it is common for wind direction to fluctuate rapidly 20 to 45 degrees from the average direction. Thus, an easterly wind can come anywhere from the northeast to the southeast. This has considerable design significance, as will be seen in later chapters. In the presence of buildings, wind profiles become highly random for heights below building eaves. There is usually no clear profile below eave height.**

In addition to prevailing breezes, land and sea breezes arise in temperate island locations and in some coastal locations. During the day the land is heated, hot air rises, and cooler sea breezes blow toward land. The process is reversed at night. As land cools below sea temperature, a land breeze is created in a direction opposite to the daytime sea breeze. The interaction of land and sea breezes with prevailing trade winds significantly changes the overall windspeed and direction in coastal locations of many islands (e.g., Hawaii, and Puerto Rico). This day-to-night shift in wind direction must be taken into account, when appropriate, in the design of naturally ventilated buildings.

Chapter 6

Principles of Airflow in and Around Buildings

Basic Principles

An understanding of airflow around buildings is necessary in order to design well-ventilated buildings. Figure 6.1 shows, in plan view, airflow past a solid building. The wind is slowed and creates a positive pressure on the windward face. A cushion of air on the windward face diverts the wind to the building's sides, and the flow separates from the building at the windward face corner. High-speed flow along the side walls creates a negative pressure (suction). A large slow-moving eddy develops on the leeward face, with a suction smaller than that on the sidewalls.

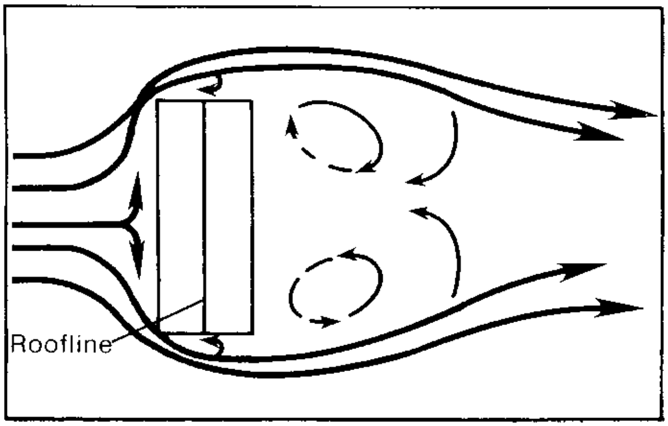


Figure 6.1. Airflow Past a Solid Building (Plan View)

If windows are placed in the windward and leeward sides, the building will be cross-ventilated (Figure 6.2). Note the eddys that develop against the main airflow direction. Cross-ventilation can be further improved by placing two outlets of total area equal to the inlet on the building sidewalls rather than on the leeward wall. Ventilation improves because of stronger suction at the sidewall, and more recirculation will be set up in the room because of air inertia (Figure 6.3). Winds frequently shift directions and can strike the building at various angles. For such oblique winds, ventilation will be better for rooms with windows on three adjacent walls (Figure 6.4) than for those with windows on two opposite walls (Figure 6.5).

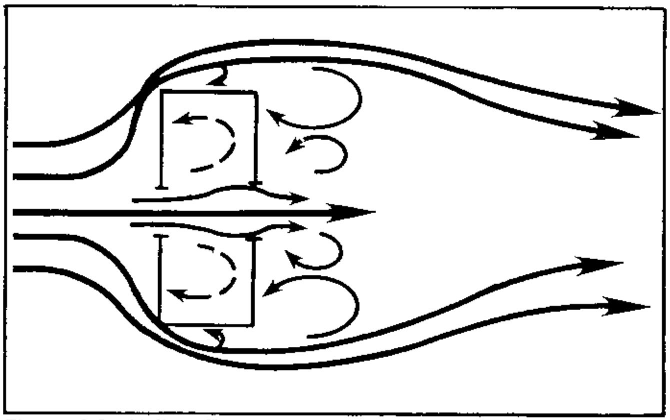


Figure 6.2. Airflow Through a Building Ventilated by Windward and Leeward Windows

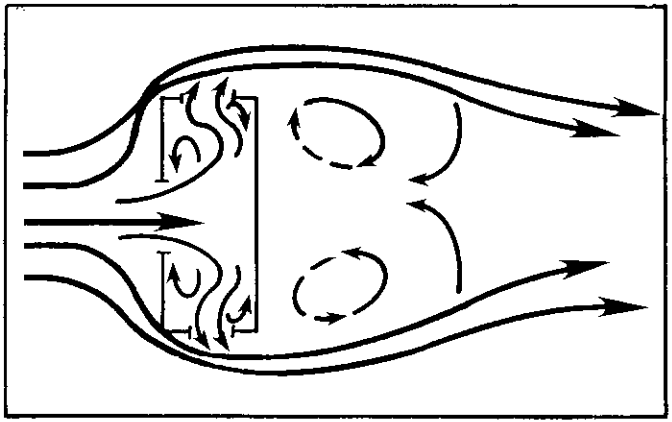


Figure 6.3. Airflow Through a Building Ventilated by Windward and Side Windows

Figures 6.2 through 6.5 illustrate airflow patterns in cross-ventilated rooms. Windows on two walls do not guarantee good cross-ventilation (Figure 6.6). The stronger suction of the sidewall windows will generally create outlets. However, since both the sidewalls and the leeward wall are under suction, ventilation will be minimal.

As an example of airflow in multiroom buildings, consider flow patterns in a ventilated arrangement of five rooms (Figure 6.7). Room A of the five is the best ventilated since the inlet is located in the highest pressure zone and the outlet is in a negative pressure

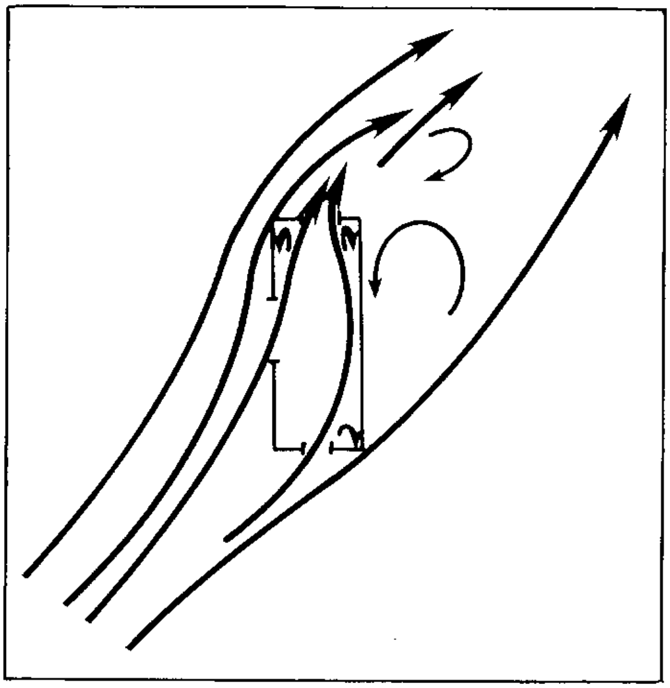


Figure 6.4. Airflow Through a Building With Windows at Adjacent Walls for Oblique Winds (Excellent Ventilation)

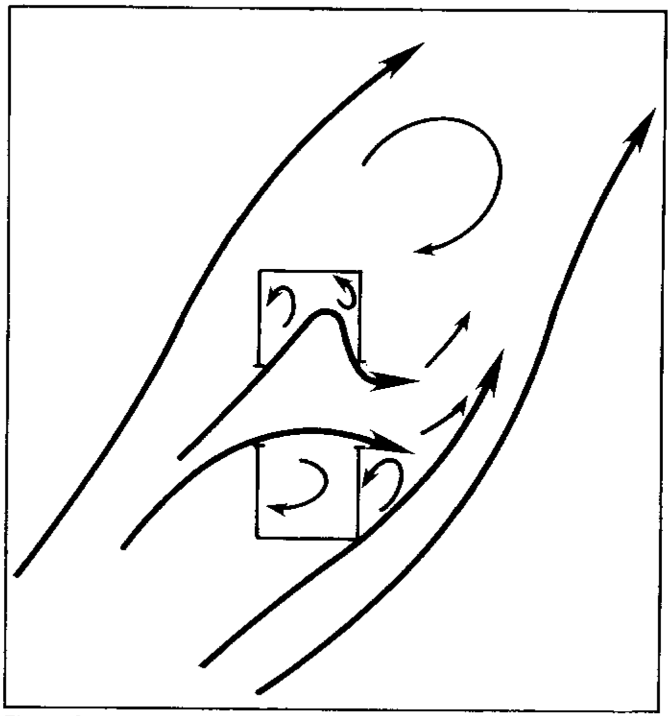


Figure 6.5. Airflow Through a Building With Windows on Opposite Walls for Oblique Winds (Good Ventilation)

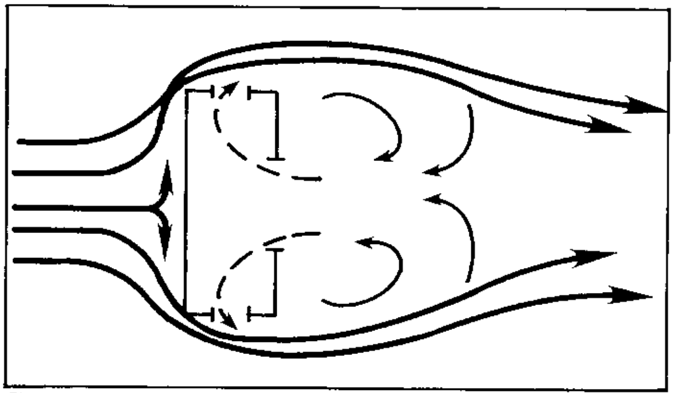


Figure 6.6. Airflow Through a Building With all Windows on Leeward or Sidewalls (Poor Ventilation Since all Windows are Under Suction)

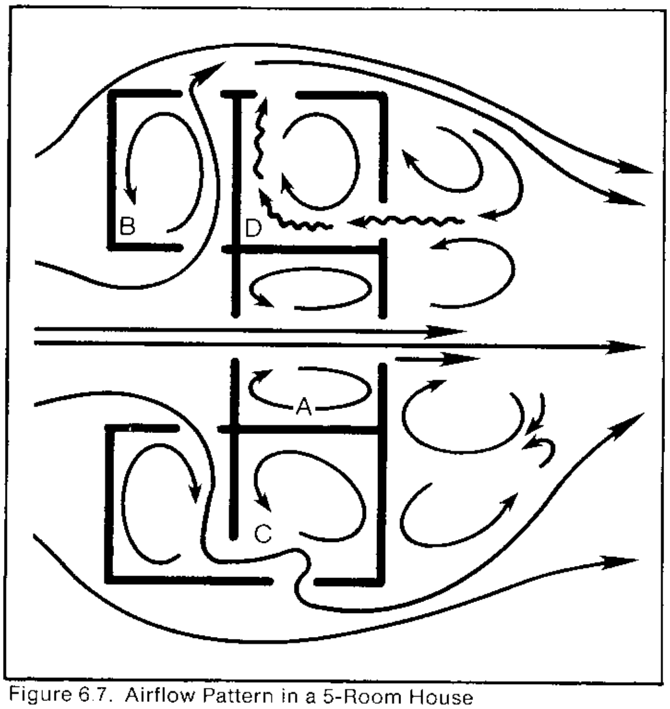


Figure 6.7. Airflow Pattern in a 5-Room House

zone (although not in the highest suction region). Room B is almost as well ventilated, with inlet and outlet located in the highest pressure and suction zones. Air has to change directions twice, which results in slightly less airflow than in room A. However, if the wind is at a slight angle to the building face, then room B may be better ventilated than room A.

In room C the partition wall reduces ventilation, and there are some still corners. Room D is the least ventilated because both inlet and outlet are in suction regions. However, the flow direction is as shown because the side wall has a higher suction than the leeward wall.

Effects of Grouping Buildings

All previous building ventilation patterns have been shown for an isolated building. **In tract housing, buildings are placed close to each other, and the effects of neighboring buildings can be significant. The extent of the leeward wake depends on building** shape and wind direction. For a typical house, the wake extends roughly four times the ground-to-eave height, or about 36 ft (Figure 6.8), as tested by Evans (1957). Therefore, if the gap between buildings is 36 ft or more in the direction of the wind, the general wind direction will remain roughly unchanged, and the ventilation diagrams will be valid. This will generally be the case if house rows face the wind or are at 45 degrees to it at most. This will be true for typical 75-ft x 100-ft lots (Figure 6.9). The only effect of building grouping here is to reduce windspeed at leeward buildings. However, if the wind were from the east, all houses would be poorly ventilated because they would be in the wake of each other.

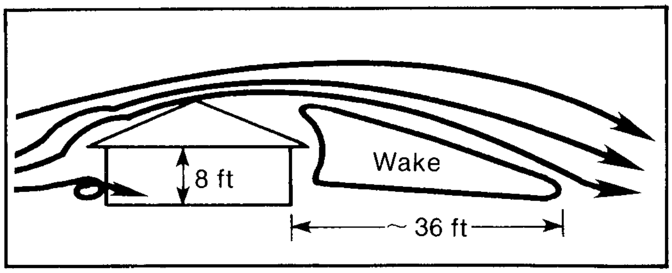


Figure 6.8. Wake of a Typical House

Ventilation Augmentation by Wing Walls

Many residences and large buildings have rooms with only one external wall. These rooms are difficult to ventilate effectively. With one window in such a room, ventilation will be negligible even if the wind impinges directly on the window since there are no distinct inlets and outlets. Ventilation can be improved somewhat if two windows are used, placed as far apart as possible. Ever-present fluctuations in the natural wind direction will create moderate amounts of pressure difference across the two windows, particularly if the wind direction is perpendicular to the windows (Figure 6.10).

Airflow in rooms with two windows can be further augmented by devices called wing walls that are added to the building's exterior at the inner edges of the windows. These create positive pressure over

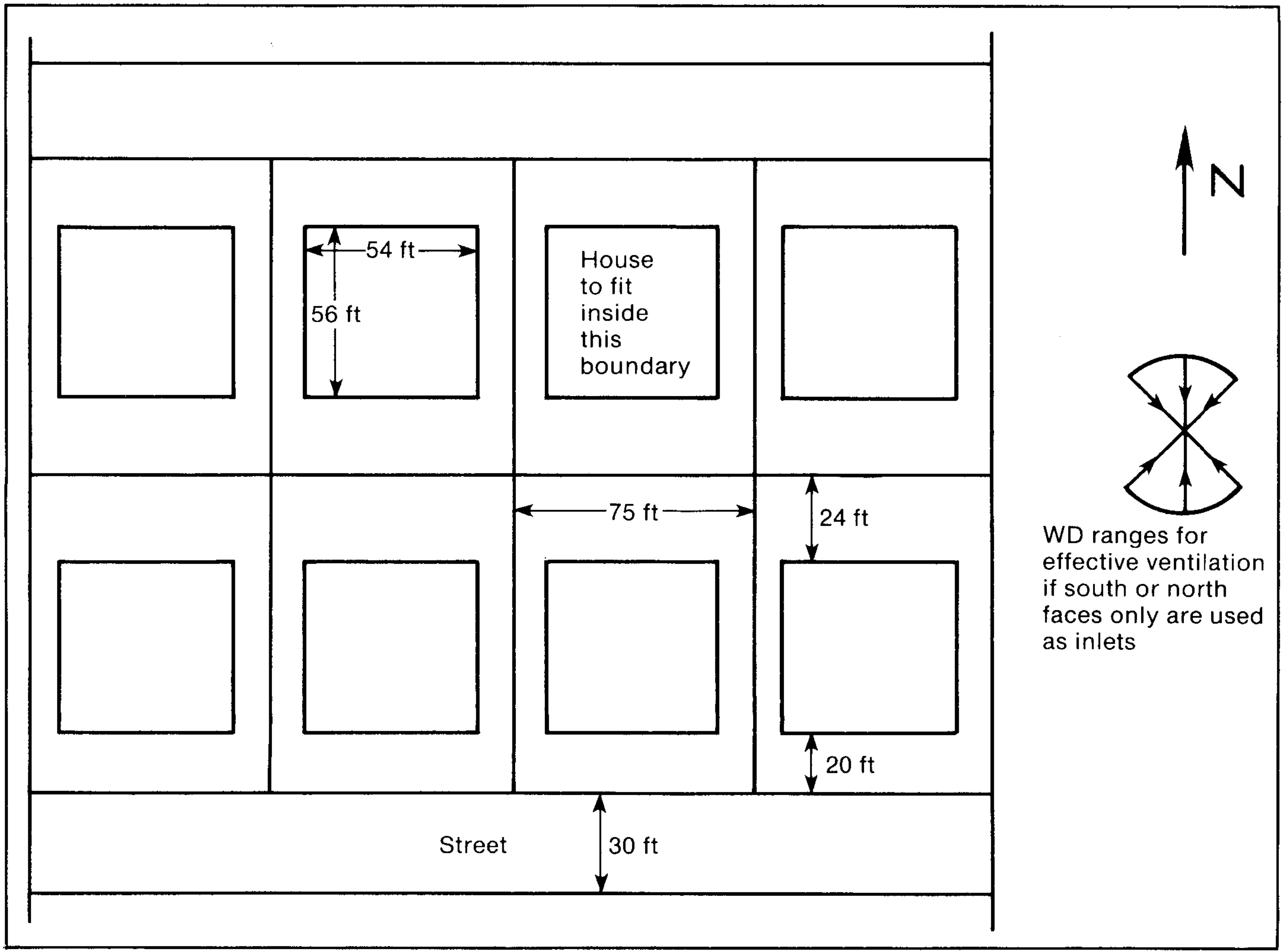


Figure 6.9. Subdivision Layout for 75 ft x 100 ft Lots

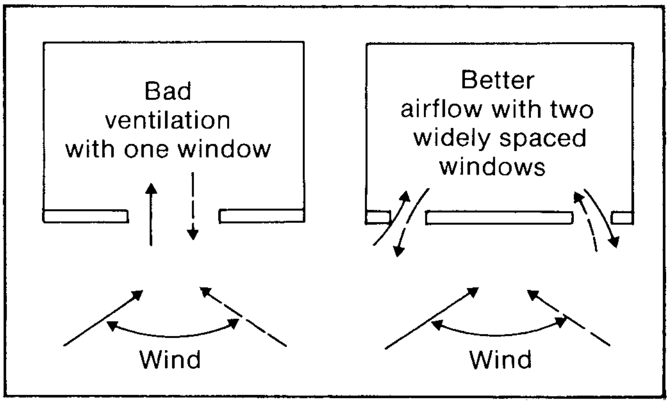


Figure 6.10. Two Windows Ventilate Better Than One in Rooms With One Outside Wall

one window and negative pressure over the other, achieving cross-ventilation of the room (Figure 6.11). Wing walls should extend from the ground to the eaves. However, properly placed single-sash casement windows can create a similar effect. Wind directions for which wing walls are effective are also shown in Figure 6.11. Note that wing walls are effective only for windward windows; they will not affect airflow at windows on the leeward side.

Experiments conducted at the Florida Solar Energy Center (FSEC), using the residential-scale Passive Cooling Laboratory (PCL), investigated airflow in rooms with windows on one wall only, both with and without wing walls. The results are summarized below. The experiments were performed in the southeast room of the PCL (Figures 6.12 and 6.13). The wing walls are shown adjacent to the 3 ft, 11 in. wide by 3 ft high window apertures. The internal room dimensions are 17 ft, 7 in. x 11 ft, 8 in. x 8 ft, 1 in. high; each window area is equal to 5.7% of the floor area and 8.3% of the east wall containing the two windows. Note that these "windows" are actually holes in the wall with no glazing. Wood doors, the size of the opening, are used to open and close the apertures. The upward-sloping window overhangs were in place for all experiments. Room airflow was measured by the sulfur hexafluoride tracer-gas decay technique. Outside windspeed (WS) and wind direction (WD) were measured simultaneously at a height of 10 meters. Measured airflow was converted to an equivalent inlet airspeed (u) by dividing the airflow by the inlet area. Since the inlet and outlet areas are equal, u is also the average outlet airspeed. Values of u were made nondimensional by dividing by WS.

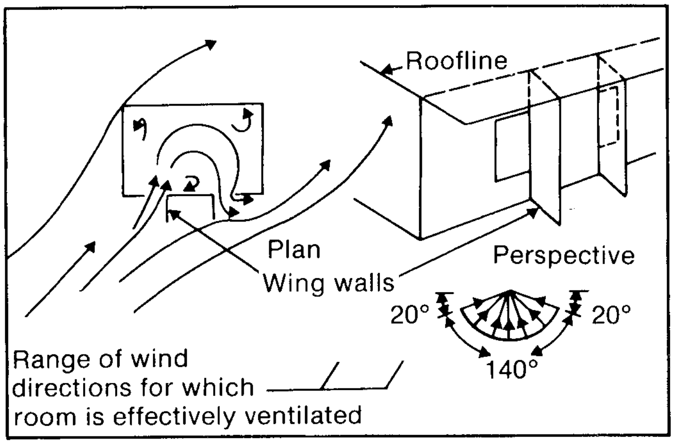


Figure 6.11. Good Ventilation Through Windows on One Wall When Wing Walls are Added

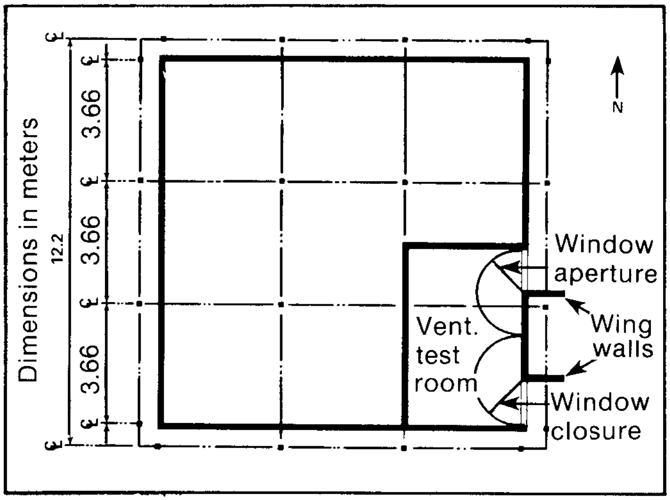


Figure 6.12. Plan View of FSEC Passive Cooling Laboratory (PCL) Showing Location of Test Room and Wing Walls

Results are plotted as room airflow (expressed as u/WS) against wind direction (WD) (Figure 6.14). If airflow is solely a result of pressure difference across inlets and outlets, then airflow should be proportional to WS. Thus, one would expect a unique curve when u/WS is plotted against WD. Data scatter is a result of wind turbulence. Nevertheless, improvement because of wing walls is evident. The solid line is consistently better than the dashed line when the windows are windward; i.e., when WD is between 0 and 180 degrees (see inset, which clarifies wind directions). Unequal peak values in the solid line reflect the corner placement of the apertures. The southern aperture is directly at a corner around which air escapes, creating reduced pressure; the northern aperture is next to a flat wall that traps air, creating increased pressure. Pressure differences between inlet and outlet are greater when the wind is from the northeast (0-90 degrees) and less when the wind is from the southeast (90-180 degrees). For WD between 180 and 360 degrees, when the windows are on the leeward side of the building, there is insignificant difference in room airflow with or without wing walls.

Airflow in the room without wing walls improves for northeast (WD=45 degrees) to east (WD=90 degrees) winds and then declines and flattens out as the WD increases beyond 150 degrees or so (south/southeast winds). This increase in airflow over the baseline is believed to be casued by the creation of a pressure differential across inlets and outlets caused by fluctuating wind direction. As the WD fluctuates, the windows switch roles, alternating as inlet and outlet

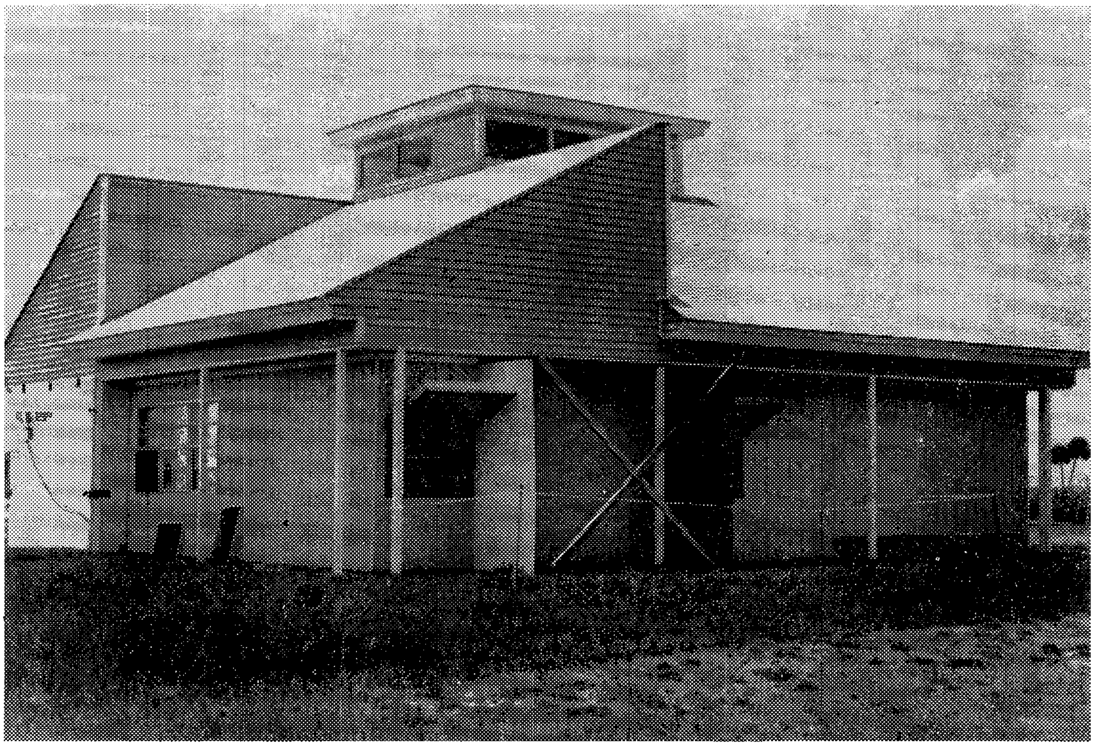
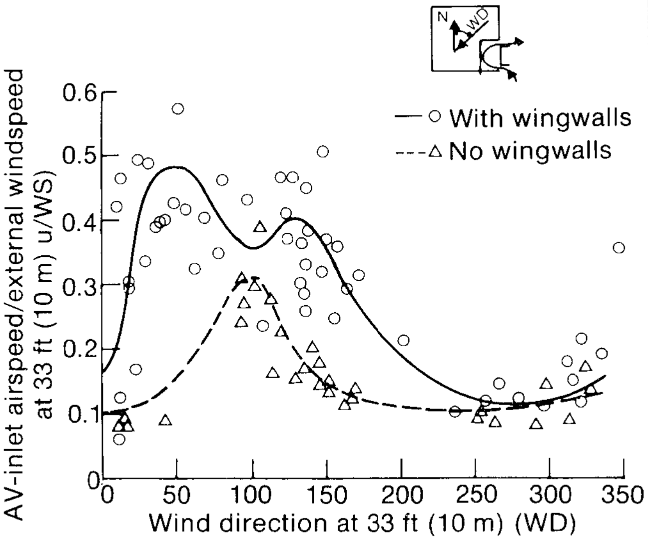


Figure 6.13. Southeast View of PCL Showing Wing Walls and Overhang Over the Two Windows in the East Wall



WS = windspeed
WD = wind direction
u = inlet airspeed (airflow divided by inlet area)

Figure 6.14. Airflow Data Sets With and Without Wing Walls Obtained in Full-Scale PCL Experiments (Solid and Dashed Lines Indicate Authors' Opinion of Data Trends)

and improving room airflow. These alternations of inlet and outlet were confirmed by smoke-flow visualizations. Oscillations are most frequent for easterly winds (WD approximately 90 degrees), thus, the peak in airflow.

An interesting result for the no-wing wall case is the minimum value of u/WS of about 0.1. For this case, with a clear aperture area of only 5.6% of the floor area, the inlet airspeed is 1/10 the 10-meter-high WS value. This corresponds to 3.7 room air changes per hour (ACH) for every mph of outside WS. Therefore, in a 7 mph wind, one would get 26 ACH for this room just by having two windows and no cross-ventilation. Of course, cross-ventilation is a much more powerful ventilation mechanism. With wing walls, which turn the room into a cross-ventilated one for WD between 20 and 160 degrees, the u/WS value averages around 0.4. Thus, for every mph of outside WS, one gets about 15 ACH. The double peak in the curve is caused by the highest pressure differences across the windows occurring at oblique wind directions of about 55 and 150 degrees. For WD of approximately 90 degrees, one would expect minimal mean pressure difference across the windows. However, significant airflow does occur because of WD fluctuations that create pressure fluctuations and good ventilation, both with and without wing walls, as explained earlier.

Design Strategies Using Wing Walls

When ventilating rooms with various wing wall strategies, effectiveness is limited to wind directions that cause one window to be in a positive pressure zone and the other to be in a negative pressure zone.

Figure 6.15 shows expected ventilation results for several wing wall configurations or patterns, all drawn for southwest winds only. Actual wind directions for which wing walls would be effective are shown by wind direction bands. In some cases the best strategy is difficult to define, and windows and

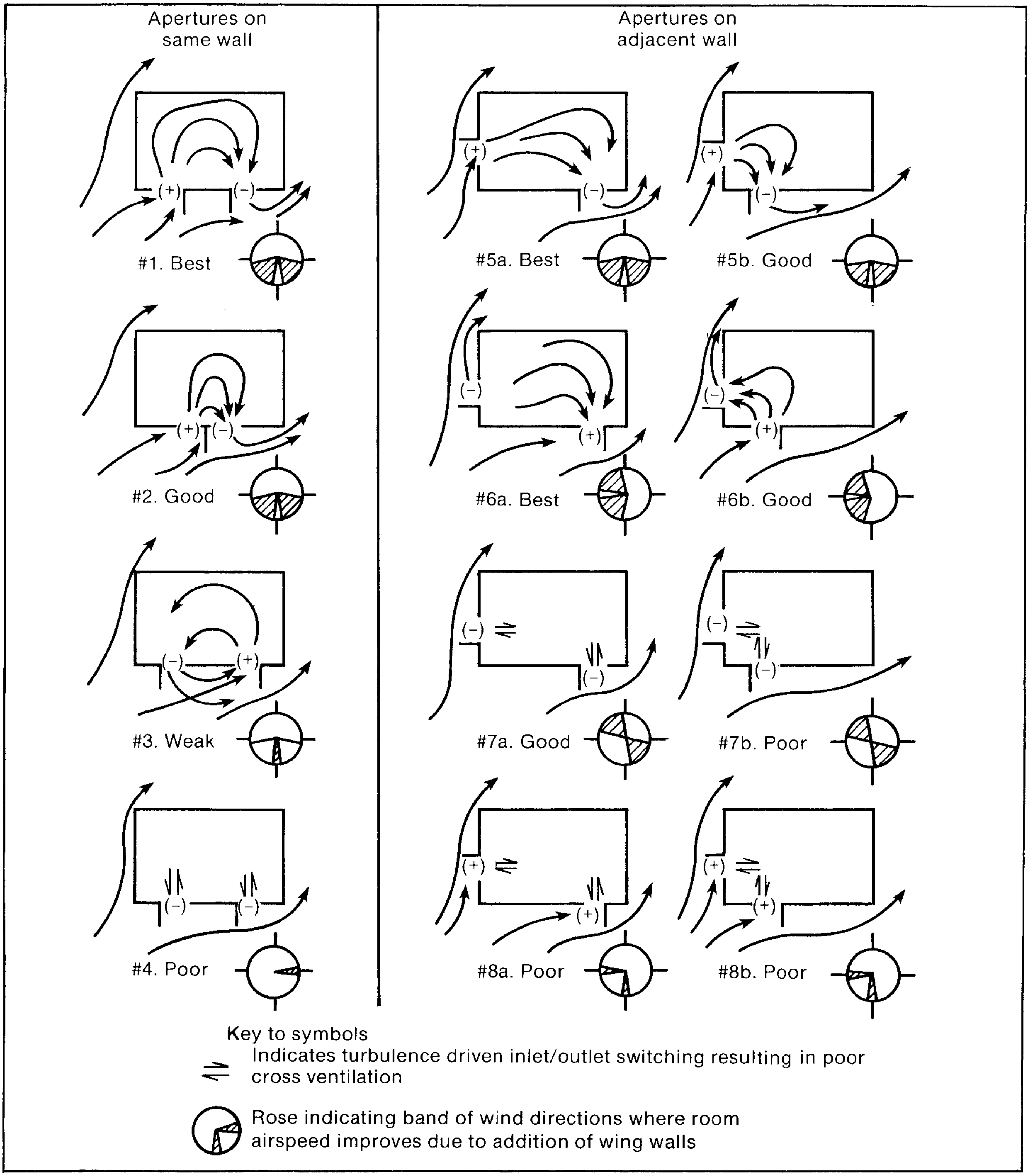


Figure 6.15 Wing Wall Design Strategies. Airflow Patterns for Different Wing Wall/Window Combinations

their wing walls must be specifically placed to take advantage of a given site condition. For example, pattern No. 7a in Figure 6.15 would prove to be an excellent, if not the best, design decision where alternating northwest and southeast breeze patterns occur (e.g., a land breeze by night and a sea breeze by day) as indicated by the wind direction band. On the other hand, if this pattern is adopted for a predominant southwest wind direction, it will be a design failure. Pattern No. 7b is considered to be poor in all wind directions because of extensive short circuiting caused by the close proximity of the windows. Airflow will occur only through that small corner of the room.

These patterns also illustrate the benefit in overall room airflow gained through the window separation (No. 5 and No. 6, a versus b, and No. 1 versus No. 2). However, pattern No. 2 is helpful in situations where rows of small rooms allow only single-sided ventilation in double-loaded corridor designs. For larger rooms, where spacing permits, pattern No. 1 should be used. Wing walls can become significant elements of design and unity in such buildings.

In general, wing wall protrusions should be equal to open window width. However, protrusions equal to half window width also will work well. Figure 6.16 provides recommended dimensions and minimum separation distances between multiple sets of wing walls. No minimums are given for window placement with respect to internal partition walls since these would depend on the desired cooling strategy (i.e., whether one wants to cool the partition wall or wants to direct airflow into the room). Complete residential designs employing wing wall strategies are described in Chapter 7.

Trees and Landscaping to Channel the Wind

Strategically placed dense trees on the east and west side of a house can effectively block the summer sun. Vegetation, however, can also reduce airflow. Airspeed reduction can be 30-40% near a tree depending on canopy size. Architectural drawings occasionally show shrubbery or trees redirecting or catching the wind in a manner similar to the wing wall effect discussed earlier (Figure 6.17). Fencing or dense shrubs may accomplish this, but field data substantiating this effect are not available. Shrubbery effectiveness is reduced by a leaf's tendency to bend and align itself with the wind instead of serving as a stiff redirecting barrier. The use of solid fencing or walls, rather than trees or shrubs, for redirecting wind is recommended.

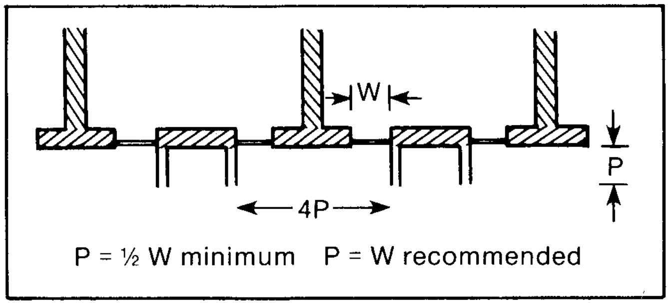


Figure 6.16. Recommended Wing Wall Dimensions and Separations

Proper planting of trees can be effective as a community strategy. For example, older parts of St. Augustine, Florida are effectively shaded by tall spreading trees. The trees allow breezes to pass at the first three stories while providing shade to these lower building levels and to pedestrian walkways.

Airflow on Roofs and Whole-House Roof Ventilators

Because of compact floor plans and internal walls, modern houses are often difficult to cross-ventilate. In some situations, roof apertures may be useful. Note that this discussion is about whole-house ventilation through roof apertures and not attic ventilation.

Figure 6.18 shows airflow patterns, in elevation, past a building with no apertures. The high-pressure region on the windward face creates two flows. A downward vortex is created near the ground which produces airflow away from the building. The upper half of the flow goes over the roof. The upward flow separates at the roof edge and creates a strong negative pressure on the eaves. Flow, however,

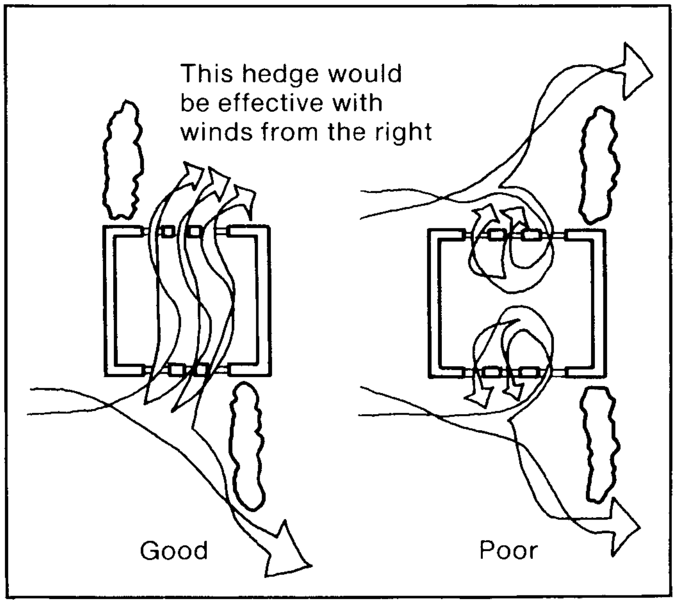


Figure 6.17. Windbreaks to Promote Cross Ventilation (left). The Design at Right is Poor and Will not Cross Ventilate.

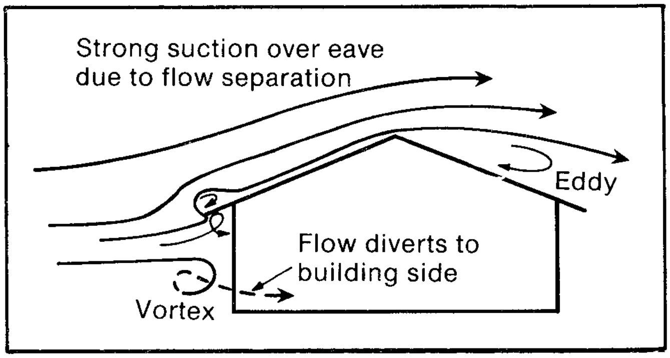


Figure 6.18. Airflow Past a Building (Side Elevation) With a 5 in 12 Roof Pitch (Flow Pattern Will be Similar for any Roof Pitch Greater Than 3 in 12)

remains attached over most portions of the windward roof and separates again at the roof peak. For flat or low-pitch roofs (2 in 12 or less) flow may remain separated over the entire roof (Figure 6.19).

Areas of strong negative pressure created on the roof top, especially those near roof ridges, can be used as exhaust areas (Figure 6.20). The top 18 inches of partition walls in the living space are louvered to allow airflow. Even without a roof-level aperture, these louvers can improve ventilation at the expense of some acoustical privacy. In this design, room A will ventilate as shown. Because of strong roof suction, the window in room B may occasionally be an inlet (dotted arrow), although most of the time it will be an outlet (solid arrow). The exhaust space above ceiling level is likely to act as an exhaust at all times. Since roof cupolas are difficult to protect against rainstorms, operable windows are shown in the cupola. Opening and closing of such windows are difficult. Louvers and similar devices at the cupola will not protect against severe rainstorms and, consequently, are not recommended. In this design, wind-driven ventilation will act with the rise of hot air since outlets are at the top.

Another possible type of high-level vent is a clerestory window (Figure 6.21). When winds are from the left, the design will ventilate as shown by the solid arrows; the wind effect helps the chimney effect. However, if winds are from the right, a clerestory window will act as an inlet and the room windows as outlets; daytime hot air adjacent to the roof may be forced into the house. Thus, single-sided clerestory ventilation may not be very effective in all situations.

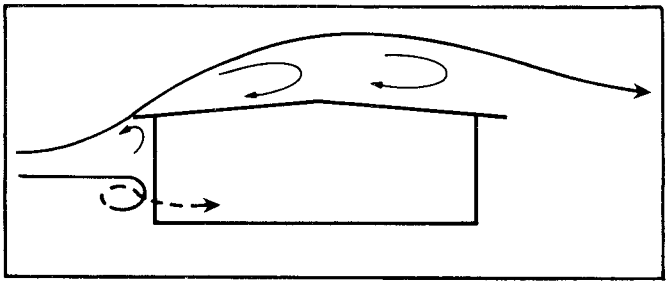


Figure 6.19. Airflow Past a Solid Building With Roof Pitch Less than 2 in 12 (Note That the Airflow is Separated Over the Entire Roof)

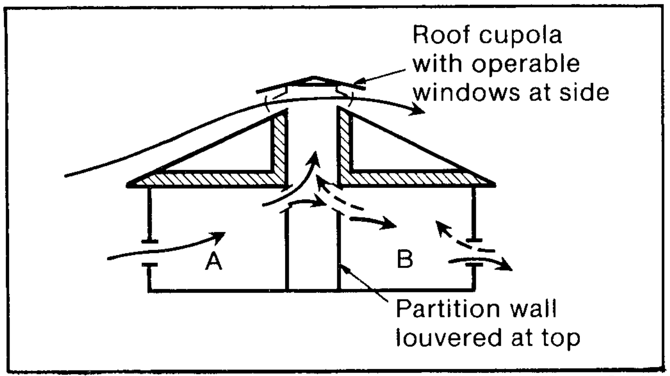


Figure 6.20. Whole-House Ventilation Through Roof Level Outlet Windows and Low Inlet Windows (Dotted Arrow Shows Alternate Possible Flow Path)

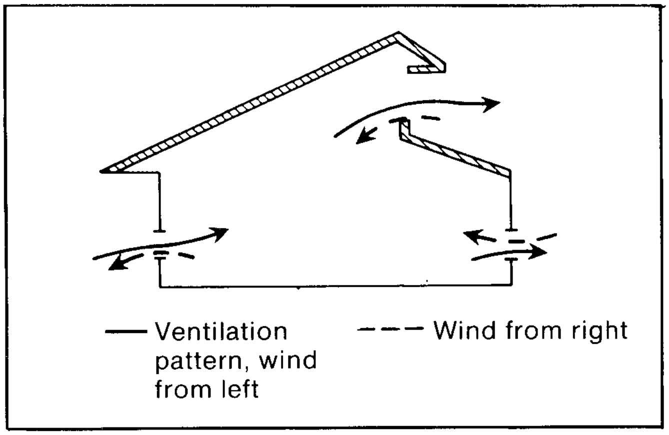


Figure 6.21. Whole-House Ventilation Through Clerestory Windows

Innovative Ventilators

The earliest example of innovative ventilator designs are Iranian Wind Towers (Bahadori 1978). Three experimental and unique ventilator designs are described here to provide additional ideas. Further development and testing is needed before construction can be recommended.

The first design is called "La Sucka," since it always provides a suction at the rooftop outlet. La Sucka (Figure 6.22) uses simple backdraft dampers made from 3-mil plastic film mounted on a screened frame. These dampers close off ventilation-shaft apertures on the windward side of the ventilator but allow outlets on the leeward and adjacent sides of the ventilator to remain fully open. As wind direction and pressure distributions change, opposing dampers open and close and produce a constant outflow of air through the ventilator. Long ridge-mounted ventilators are constructed with dampers on their long sides while square or hexagonal-shaped ventilators should be constructed with dampers on all faces.

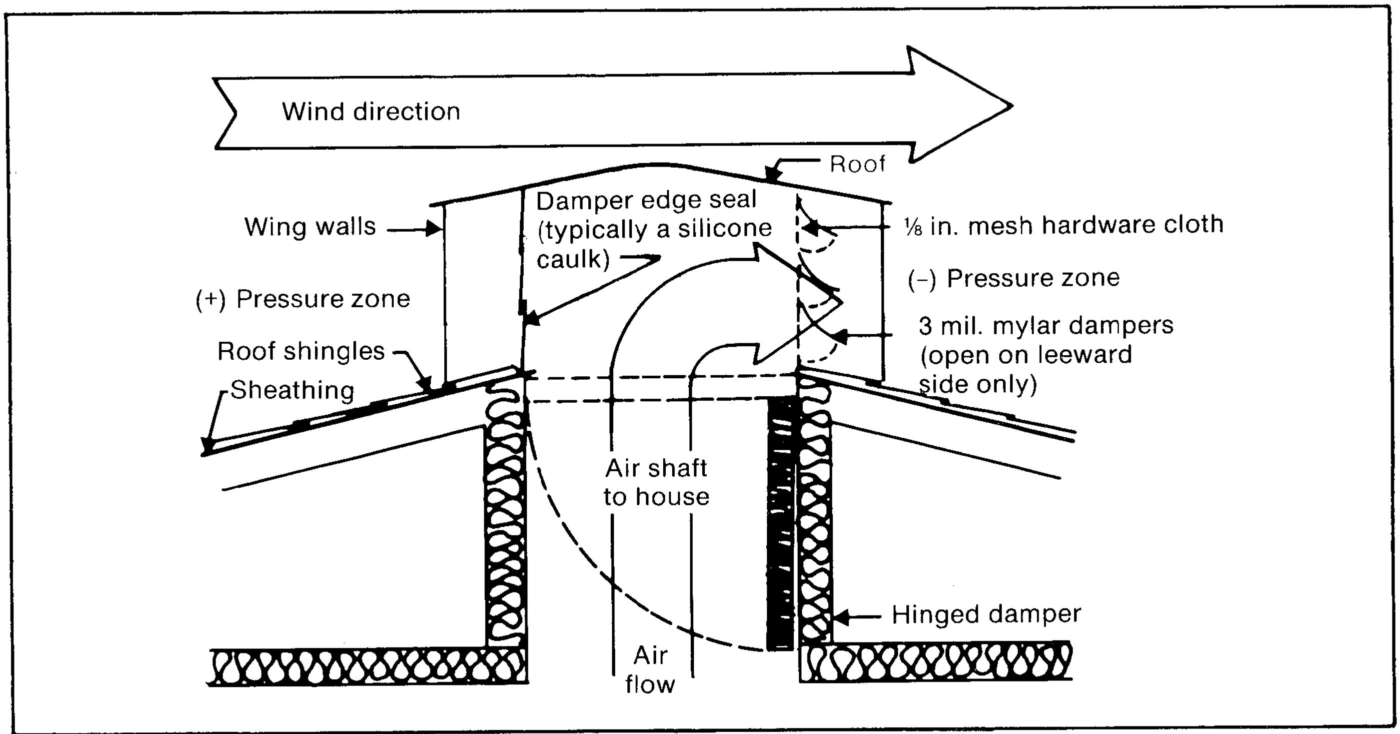


Figure 6.22. "La Sucka," a Natural Ventilation Device Employing Opposed Backdraft Dampers

Tests show La Sucka to be as effective as a suction ventilator (Figure 6.20). The chief advantage of the design is that it is automatically rainproof since the windward dampers are always closed. In practice, rainproofing by La Sucka has not been fully realized with completely exposed dampers because in high winds the plastic dampers occasionally tear and sometimes stick to themselves when wet. Until better materials are tested, dampers must be shielded with exterior rain louvers. An additional problem is noise created by the flutter. See Fairey (1981) for a detailed description of a La Sucka retrofit on an existing residence.

Concern about security has spurred development of two windowless house ventilator designs. The WIN (windowless night) ventilator (Figure 6.23) has been shown in scale-model tests to be effective. The key to successful ventilation is to lower the central rib about 1 ft below ceiling level. Major problems are

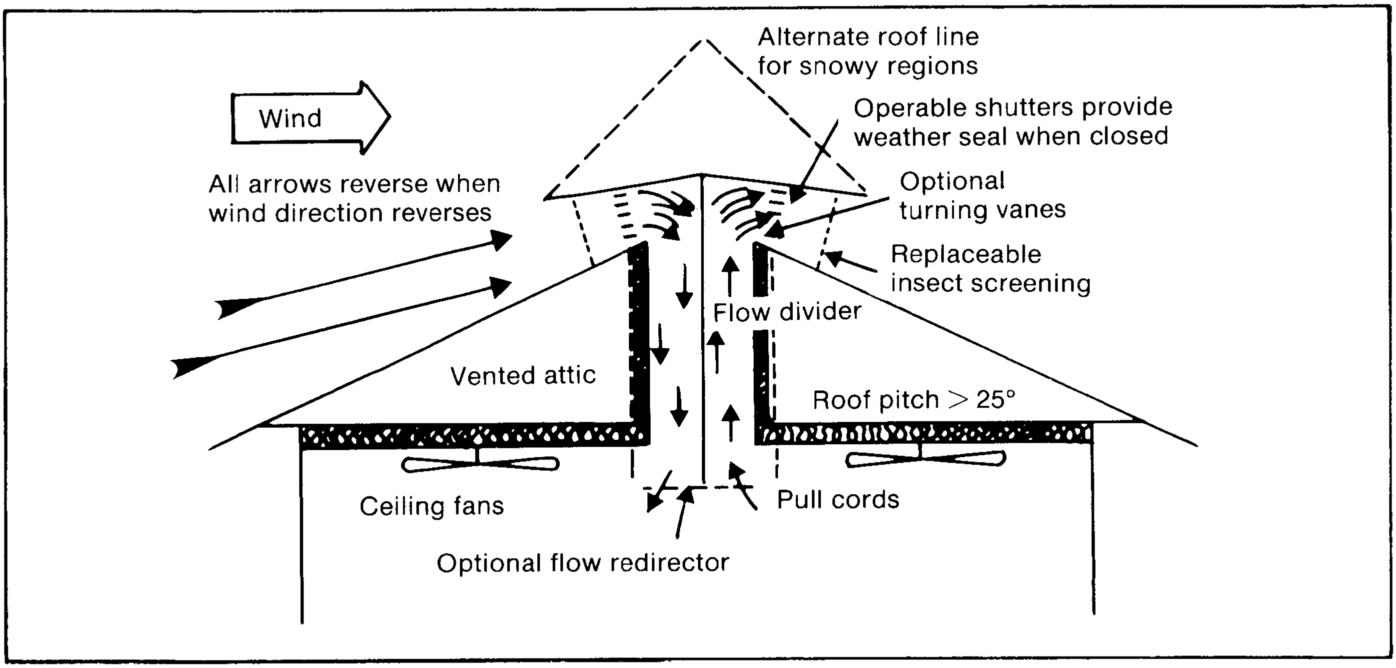


Figure 6.23. Windowless Night (WIN) Ventilator

rain protection and night-only operation. Day operation is not possible since hot air adjacent to the roof will enter the building.

The windowless double-ceiling ventilator (Figures 6.24 and 6.25) is multidirectional and has better rain protection and aesthetic appeal than the WIN design. It consists of a ceiling plenum created by a double-ceiling arrangement. Positive and negative pressures are generated over alternate apertures by ceiling partitioning. Wing wall use should improve performance in southeast and northwest winds. Scale-model tests, however, show this design to be inferior to other designs.

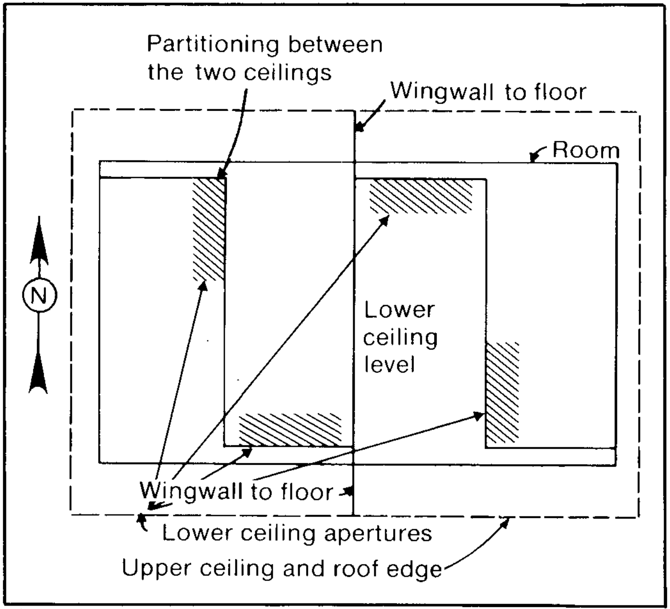


Figure 6.24. Plan View of Windowless Double-Ceiling Ventilator

Cost-effectiveness of these three designs is not yet established. The security problem addressed by the last two can be alleviated by decorative iron window grills, common in many parts of the world and becoming popular in the southern U.S.

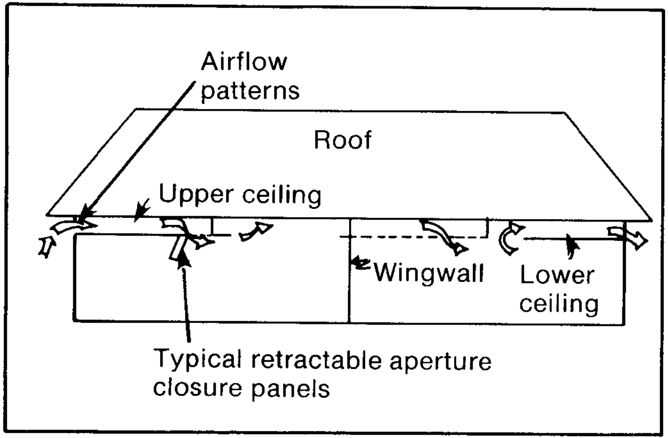


Figure 6.25. Elevation View of Windowless Double-Ceiling Ventilator

Chapter 7

Window Design and Airspeeds in Naturally Ventilated Rooms

Although necessary for aesthetics and fire egress, windows are a thermal liability in the summer since they permit solar gain and have low R-value. The only positive energy aspect of windows in summer is that they permit natural ventilation. This chapter discusses window types, shapes, location, and sizing for natural ventilation. Data are presented on room airspeeds attainable in naturally ventilated rooms.

Window Types

Various residential window types are shown in Figure 7.1. Since fixed glass contributes nothing to natural ventilation, the use of awning, projection, or casement windows is recommended. The jalousie type is not recommended since it leaks and causes excessive infiltration when closed. Any window should have good weatherstripping and be constructed to minimize infiltration. For rain protection and minimum building protrusion, awning or projection windows are recommended over casement windows. Fire egress requirements and wing wall considerations, however, may dictate a casement window in some rooms.

Window tests conducted by Holleman (1951) utilized full-scale and wind-tunnel analyses of double-hung, projection, and casement windows. Other window types were tested, in model form only, in the uniform-speed wind tunnel. The tests showed that projection windows maintained a horizontal airflow pattern in the room when fully open (about a 30 degree angle to the horizontal) caused by the open slot created between the top of the window and the top of the sash. However, under less than fully open conditions, airflow was deflected upward (Figure 7.2). Many conventional awning windows will always direct airflow upward since there is no slot between sash and frame. Because of the wing wall effect, casement windows admitted approximately the same amount of air when the outside air direction was from an angle as when it was perpendicular to the window wall (Figure 7.2). With double-hung, single-hung, and sliding windows, researchers found that air entered the openings and continued inside in the same direction as the outside wind.

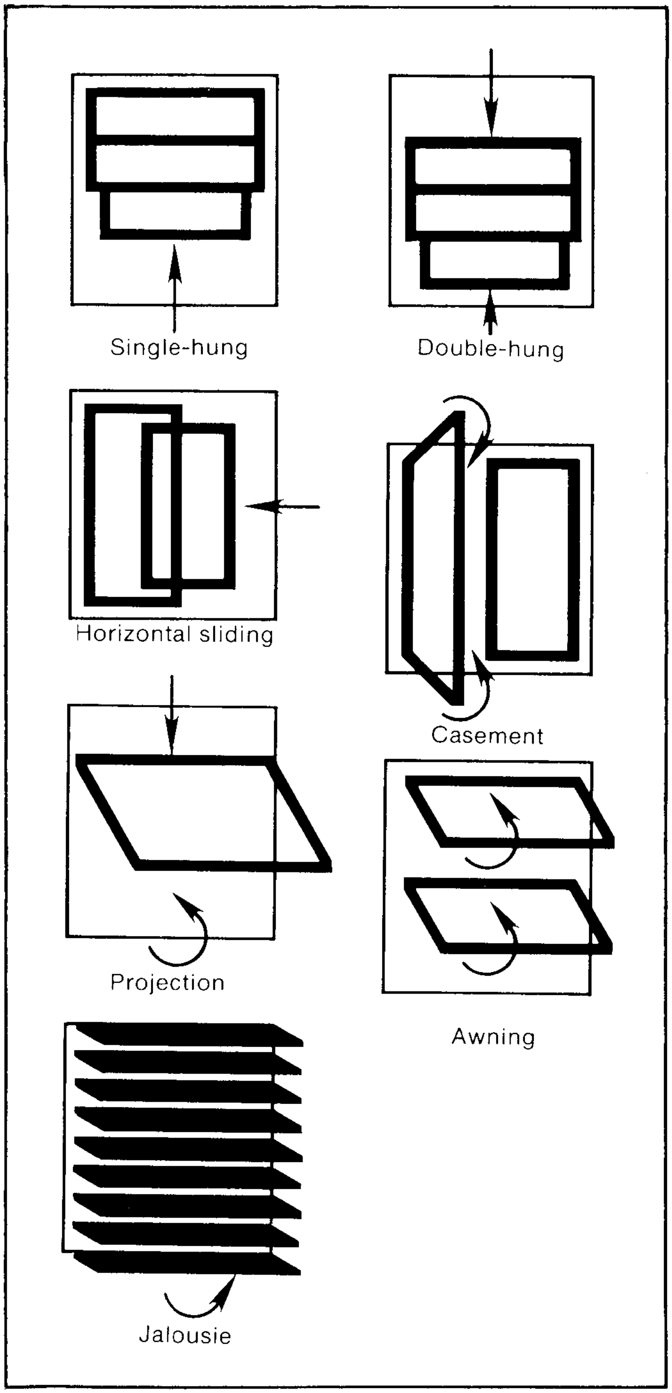


Figure 7.1 Window Types

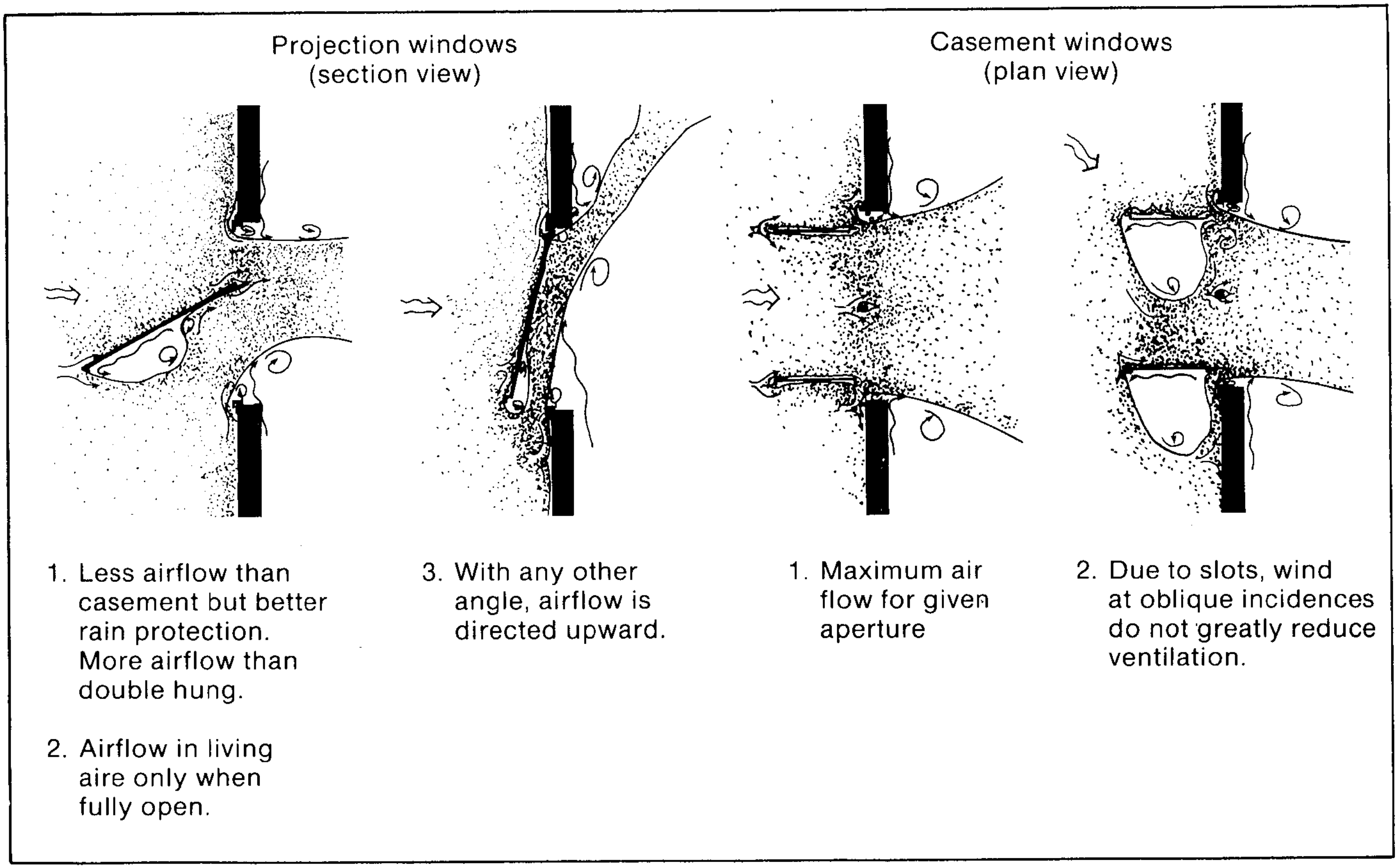


Figure 7.2 Airflow Patterns Through Windows

Jalousies were the most versatile window type for air-control qualities. Regardless of exterior wind angle, jalousies directed room air to the angle at which the louvers were adjusted. Unfortunately, jalousie windows are difficult to seal properly and allow significant air infiltration during cold months or when air-conditioning is desired. They are not recommended where mechanical conditioning equipment will be used unless additional seasonal window coverings are used. Because such use requires significant owner operation, it is not highly recommended. Well-made awning and projection windows are recommended for rain protection and low wind blockage. Note, however, that poorly made awning windows do not seal well, and their crank mechanisms have had reliability problems. Moreover, they may interfere with certain types of window treatment.

Although most windows are approximately square, other aperture shapes (e.g., a horizontal slot in the wall) are possible. Wind-tunnel tests by Sobin (1981) measured room airspeeds in scale models at sitting height as a percentage of outside air velocity and as a function of wind direction (Figure 7.3). Horizontal windows, with widths eight times their height, were superior to square or vertical windows. Note that horizontal windows not only produce more room airflow but also do it over a wider range of incidence angles. Thus, in locations where prevailing wind directions shift, horizontal window shapes will be better than vertical or square windows with the same area. If wing walls are used, vertical windows are recommended.

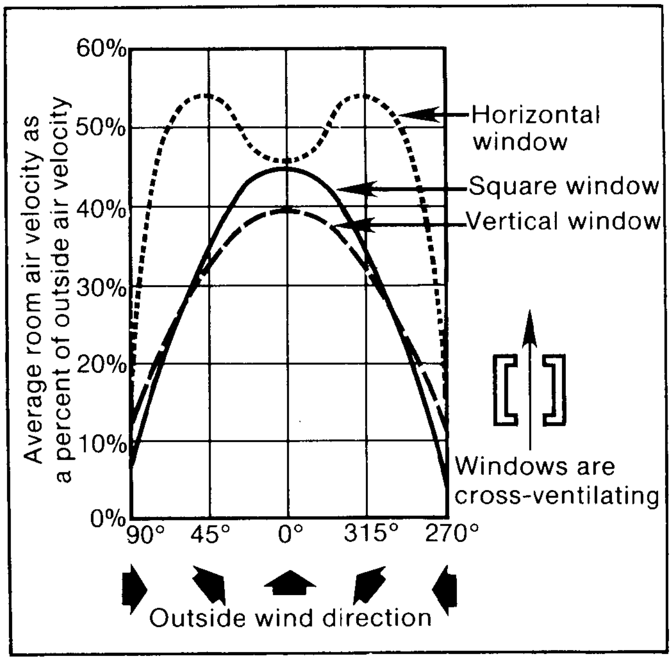


Figure 7.3. Window Shape Performance in Relation to Wind Direction

Note, however, that these results are based on a limited number of room airspeed tests and not on total airflow measurements. Moreover, more recent results from Sobin (1983) indicate that the superiority of horizontal windows is much less if the aspect ratio (width-to-height ratio) is reduced below 8:1. In the authors' opinion, horizontal apertures will be superior to vertical windows but not to the extent depicted in Figure 7.3.

Window Location

In general, for ventilating low-mass houses (e.g., frame homes or inside-insulated concrete-block homes), window location is not critical. Windows should generally be positioned as far apart as possible so that air does not short circuit between inlet and outlet. In Figure 6.15, No. 1 over No. 2, No. 5a over No. 5b, etc., are recommended. Window placement in low-mass houses should be to maximize room air mixing so that all surfaces give up their heat to room air that will be exhausted. With ceiling fans running, stratification is usually negligible so there is no need to direct airflow in a certain direction. Thus, in one-story designs, there is no need to locate some windows low to catch cool air or high to exhaust hot air. In two-story designs, windows should first be located to account for high and low pressure areas and then located low for inlet and high for exhaust.

For massive homes with one or two massive walls (e.g., a Trombe wall or massive partition walls) inside the house to store heat, window location becomes important. If the objectives are to provide night ventilation and to wash the massive wall with airflow to increase heat transfer, then inlets should be positioned close to the wall to create a "wall jet." This can be done by positioning one edge of the inlet window close to the wall (Figure 7.4). Outlet window location does not significantly alter room airspeed patterns, so inlet location is more important than outlet location to control room airflow.

Window Sizing

Airflow increases in rooms as window size increases. An inlet smaller than the outlet creates higher inlet velocities; an outlet smaller than the inlet creates low but more uniform airspeed through the room. Room airflow depends on the effective area (A) and is primarily controlled by the smaller of inlet and outlet areas (A_i and A_o). The effective area is given by

$$A = A_o A_i / \sqrt{(A_o^2 + A_i^2)}$$

A is always smaller than either A_i or A_o. Increasing either inlet or outlet only is less beneficial than increasing both. **In other words, for a given amount of total aperture area, it is best to have equal inlet and outlet areas.**

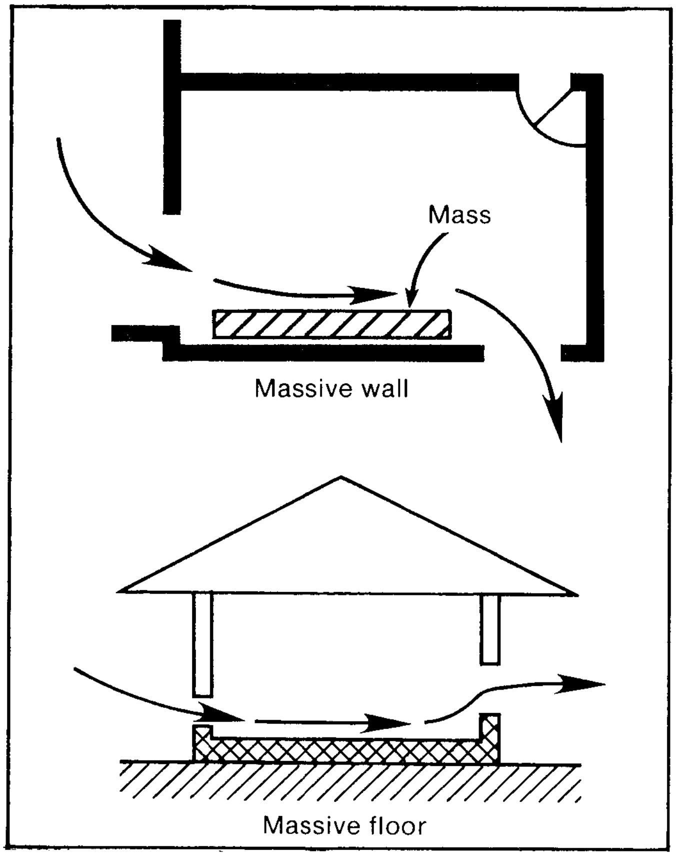


Figure 7.4. Window Locations to Create Wall Jets to Wash Massive Elements

Total window area needed depends on required airflow. A design goal of 30 air changes per hour (ACH) for the design month is suggested. This results in a total operable window area on the order of 10-15% of the floor area for various geographic locations. A detailed window-sizing procedure is given in Appendix A. Note that 10-15% operable window area is not excessively large if 100% operable windows are used. With sliding windows, where 50% of the window is fixed, it will be impossible to attain good natural ventilation with moderate window areas.

The 10-15% figure includes insect screening; i.e., 10-15% operable window area with insect screening will provide 30 ACH under design conditions. Although insect screening reduces airflow, it is a necessity during the summer in the Southeast. Givoni (1976) found that screening an entire balcony would provide more airflow in the room than screening a window alone (Figure 7.5).

Airspeeds in Naturally Ventilated Rooms

Many room airspeed data have been collected by studying naturally ventilated models in wind tunnels. Texas A&M researchers (Evans 1979) pioneered

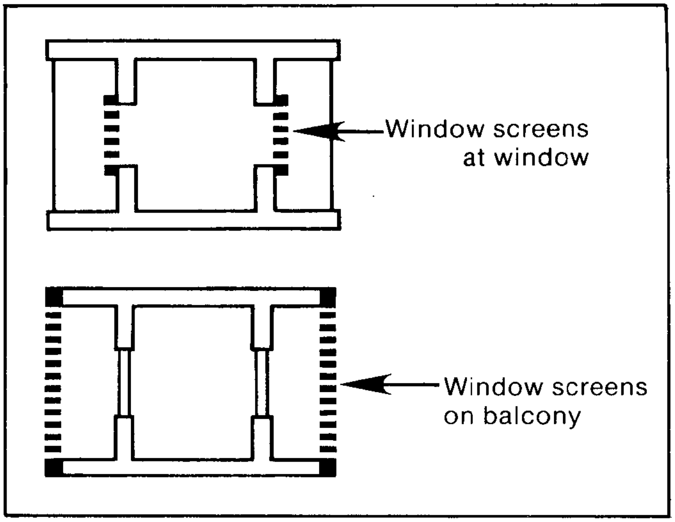
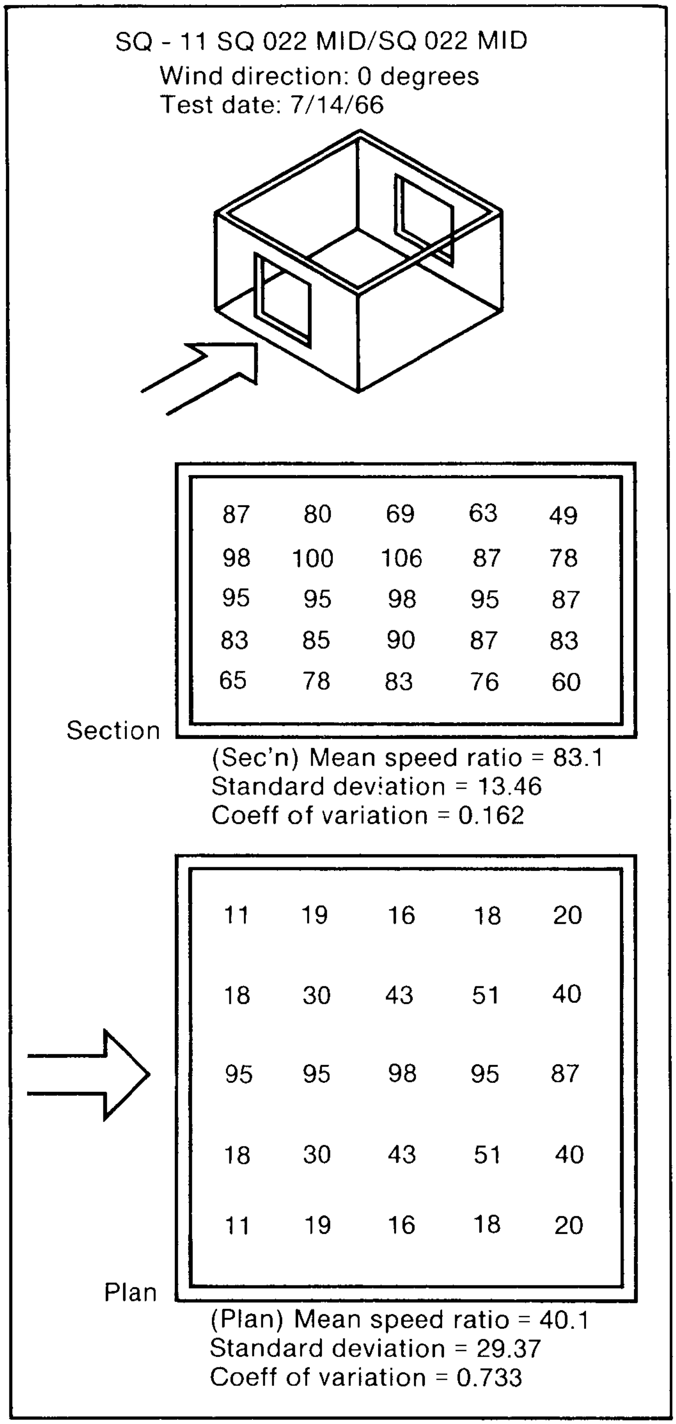


Figure 7.5. Screening the Balcony is More Effective Than Screening the Window

this type of research, and data are available from Givoni (1982, 1968, 1976), Aynsley et al. (1977), and Sobin (1983).

Sobin recently completed an exhaustive analysis of wind-tunnel data for about 120 various window geometries to determine the effect of window shape, size, and location on room airspeed. Results are airspeed ratios, expressed as a percent (internal-to-external airspeeds, both speeds measured at the same height as the internal measurement; i.e., 4 ft above floor level, full scale) and measured at several locations inside the wind-tunnel model. Sample data sheets are shown in Figures 7.6 and 7.7. Complete results are available from Sobin. The Sobin and Givoni results provide an insight into airflow patterns arising from large-aperture windows.

Note that, on average, 30-40% of the outside wind is available in the room at window level for large-aperture models (total inlet plus outlet clear area equal to 24% of floor area). This suggests that in locations with steady prevailing breezes and no harsh winter weather (Puerto Rico, Hawaii), one-room-deep naturally ventilated and shaded houses can provide adequate airspeed for occupant cooling without fans. At these high airspeeds, air change rates will be more than 100, so heat rejection will not be a problem either. As mentioned earlier, such large window areas are impractical on the United States mainland.



SQ - 11 SQ 022 MID/SQ 022 MID
Wind direction: 0 degrees
Test date: 7/14/66

Section

87	80	69	63	49
98	100	106	87	78
95	95	98	95	87
83	85	90	87	83
65	78	83	76	60

(Sec'n) Mean speed ratio = 83.1
Standard deviation = 13.46
Coeff of variation = 0.162

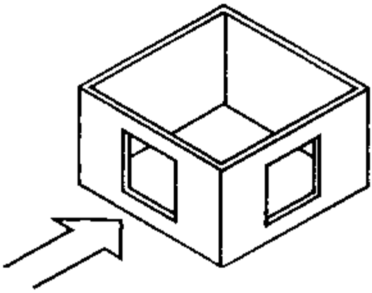
Plan

11	19	16	18	20
18	30	43	51	40
95	95	98	95	87
18	30	43	51	40
11	19	16	18	20

(Plan) Mean speed ratio = 40.1
Standard deviation = 29.37
Coeff of variation = 0.733

Figure 7.6. Sample Data Sheet From Sobin. Airspeeds in a Cross-Ventilated Room With Apertures on Opposite Walls. Numbers are Percentages of Outside Windspeed at Wall Mid-Height.

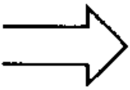
SQ - 11 SQ 022 MID/SQ sidewall
Wind direction: 0 degrees
Test date: 7/30/66



Section

80	49	24	14	33
74	60	26	20	28
69	60	27	20	29
65	60	24	17	28
76	46	23	22	29

(Sec'n) Mean speed ratio = 40.1
Standard deviation = 20.89
Coeff of variation = 0.521



Plan

14	22	26	27	19
15	18	19	20	26
69	60	27	20	29
27	43	67	36	30
29	34	34	44	32

(Plan) Mean speed ratio = 31.5
Standard deviation = 14.65
Coeff of variation = 0.465

Figure 7.7. Sample Data Sheet From Sobin. Airspeeds in a Cross-Ventilated Room With Apertures on Adjacent Walls. Numbers are Percentages of Outside Windspeed at Wall Mid-Height.

Chapter 8

Naturally Ventilated Home Designs

This chapter presents general ventilation strategies for various room locations, followed by several floor plans for well-ventilated compact houses. Emphasis will be on integration of natural ventilation strategies into conventional single-story housing. Strategies to reduce the need for cooling, such as window shading, ceiling fans, and radiant barriers (Chapters 3 and 4), should be considered before enhancing natural ventilation as discussed in this chapter.

Room Ventilation Strategies

Room location can be categorized as one of six types (Figure 8.1). Shape and exact position may vary, but rooms will typically have either 0, 1, or 2 exterior walls and be either on the windward or leeward side or in the building interior. The three generic windward rooms will cross-ventilate even with the interior door closed (Figure 8.2).

Wing walls (see Chapter 6) or properly located casement windows are crucial to the success of these designs and are suggested for room type 1 with prevailing southeast winds. An optional wing wall to enhance ventilation is suggested for room type 3, but the room will ventilate fairly well for southeast winds and quite well without a wing wall for east winds.

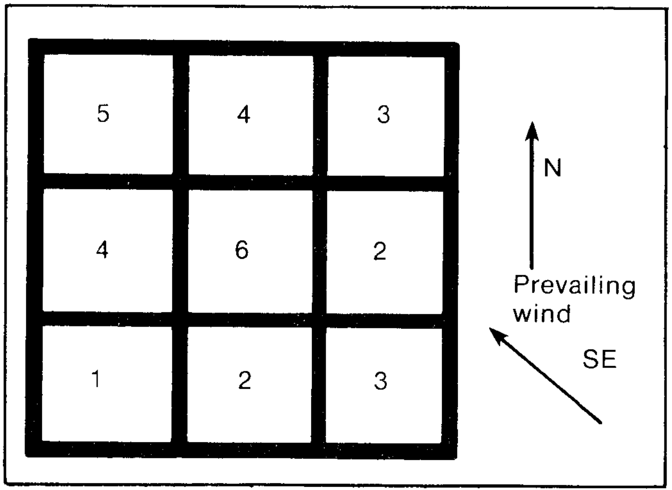
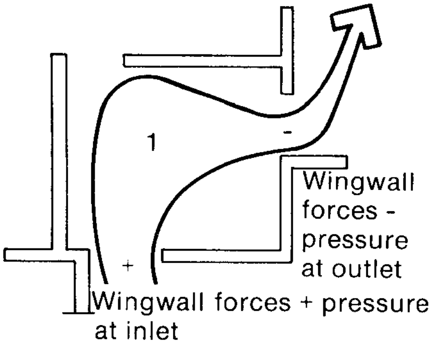
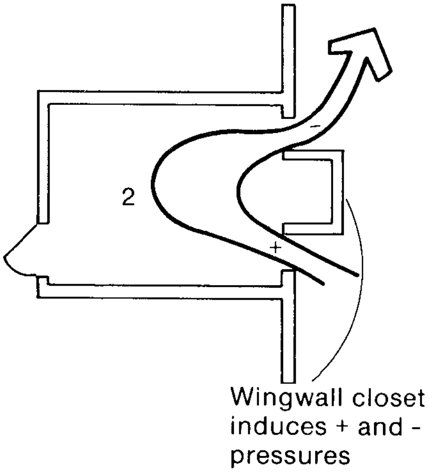


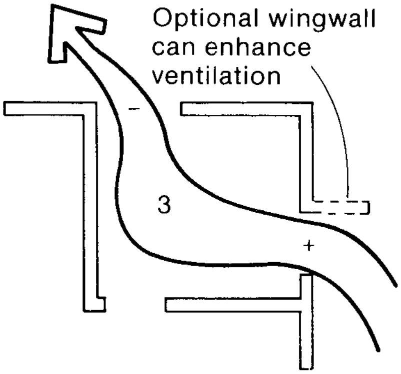
Figure 8.1. Room Location Categories With Regard to Prevailing Winds



(a) Room type 1



(b) Room type 2



(c) Room type 3

Figure 8.2. Strategies for Ventilating Windward Rooms for Southeasterly Winds

The area between two adjacent wing walls can become a closet or space for a bed headboard or a sofa, and wing wall construction and exterior surface materials can be highly varied. A designer can vary detailing and create new versions of the wing wall/window relationship so long as the basic principles are not violated.

For leeward room locations 4 through 6, interior doors and wall vents are required to provide adequate ventilation. Even then, ventilation will be poorer than that for windward rooms. Cross-ventilation without wing walls can be used when the building has a room (or space) which is open from front to back or to the sides of the house. A screen door at the entry can frequently cross-ventilate the living area.

Example House Plans

Four small-home plans designed for 75-ft-wide lots are presented in Figures 8.3, 8.5, 8.8, and 8.10. These

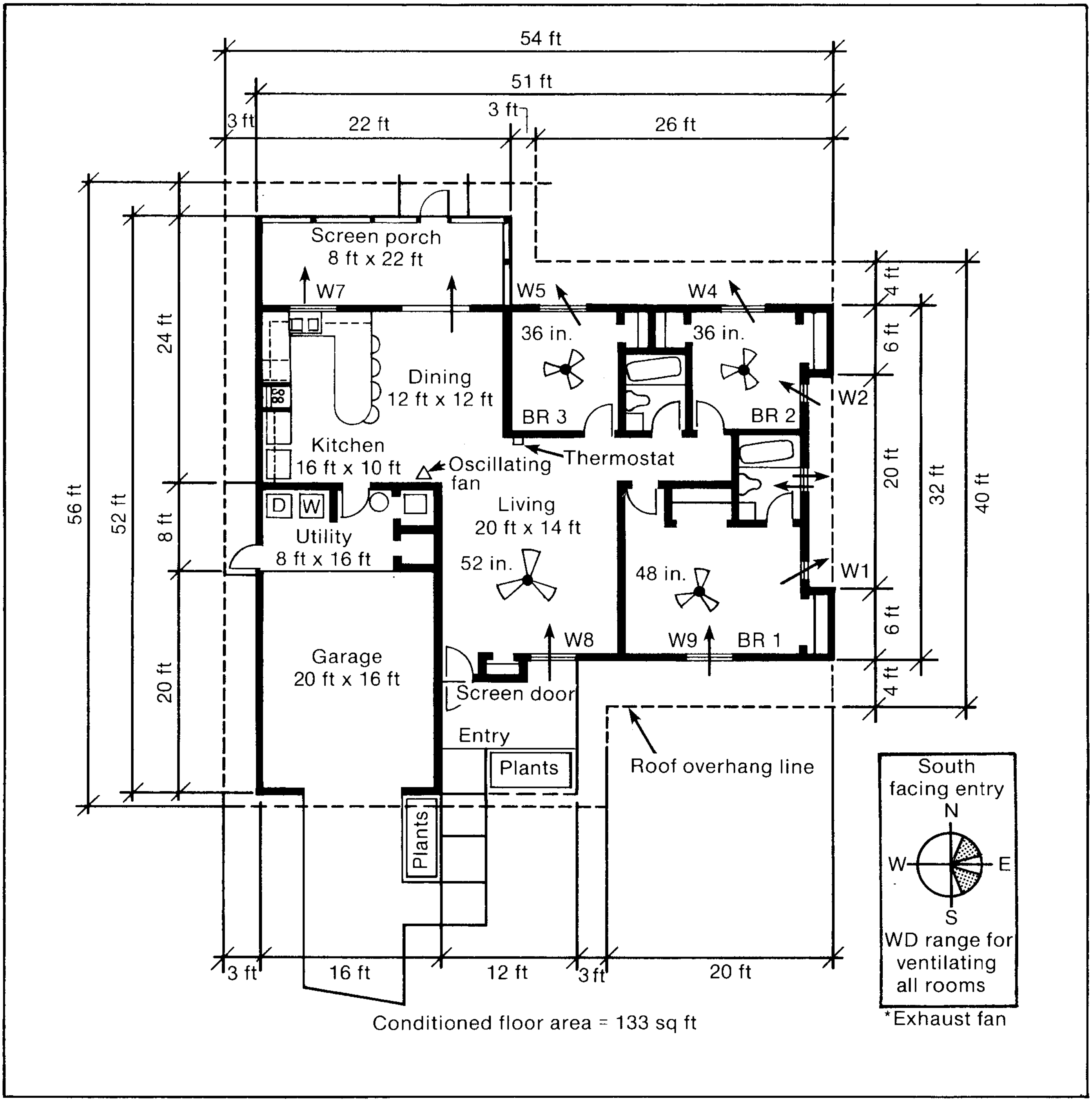


Figure 8.3. A House Plan for South-Facing Lots

illustrate application of airflow principles to practical designs for small homes. Details of wall and roof construction and of insulation levels are not given. Homes have been designed for prevailing east-southeast and southeast winds. Wind directions for which the designs are most effective are shown in each figure. The first four plans, each with 1334 ft^2 of floor area, are actually the same design rotated to correspond to particular lot orientations and to demonstrate the capability of one design to satisfy ventilation needs independent of lot orientation.

Figure 8.3 shows the floor plan for a south-facing lot. Solar gain from the west is minimized by not using windows. The garage east wall acts as a wing wall to deflect southeast winds into the house; the solid west wall of the screened porch serves a similar function for northeast winds. Closets in BR1 and BR2 are designed to act as wing walls also. The wing wall in BR1 creates a negative pressure on window 1 (W1) and makes it an exhaust, and the wing wall next to W2 makes it an inlet. Bedroom 3 cannot be directly cross-ventilated; the door must be left open in order to cross-ventilate. If the door is closed, then ventilation through the kitchen can be improved further. Arrows in windows indicate natural airflow patterns likely for southeast winds with all internal doors closed (except for the BR3 door). A screen door at the entrance and opening other doors will further improve cross-ventilation. The perspective view (Figure 8.4) clarifies roof lines. The screened-porch roof (not shown) is an integral part of the whole roof. Outdoor model tests of this design show that it ventilates quite well for all wind directions because of the many protrusions that help induce positive and negative pressure zones as natural wind direction fluctuates randomly.

Ceiling fans are used in many rooms. A wall-mounted oscillating fan is proposed to induce air motion in kitchen and dining areas. The kitchen range should have an exhaust fan vented to the outside through a roof vent, and bathrooms should have individual exhaust vents. The thermostat for the heating/cooling unit should be located on an inside wall rather than on a wall to the garage for better comfort and less frequent adjustment. Heating and cooling ducts should run in the conditioned area rather than in the attic. The wall between the garage and the conditioned space should be insulated.

A reverse image of the floor plan is used for a north-facing lot (Figure 8.5). An important feature is the solid west wall of the screened porch which deflects a southeast wind into the house. Awning windows (Figure 8.6) are recommended for all windows in all

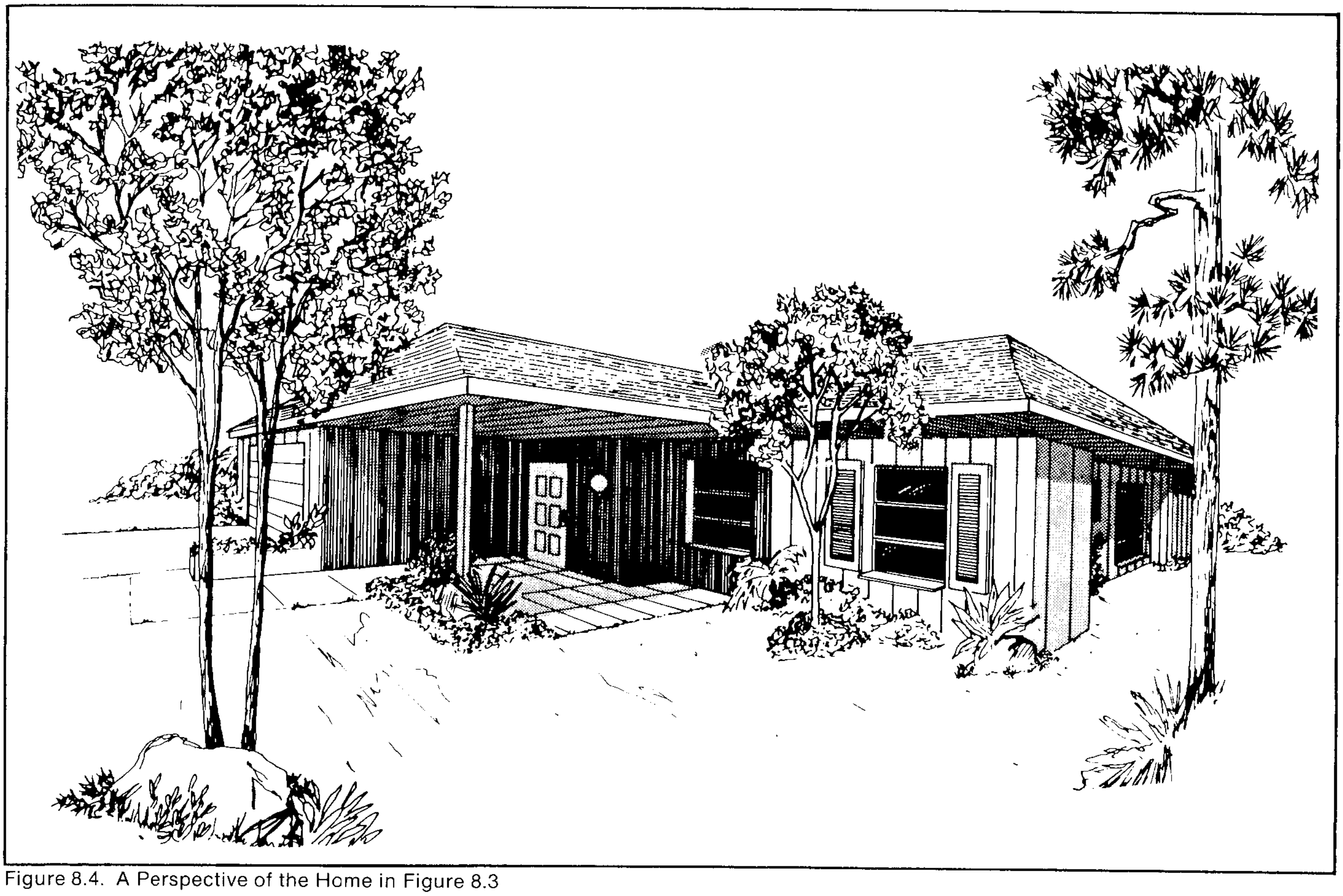


Figure 8.4. A Perspective of the Home in Figure 8.3

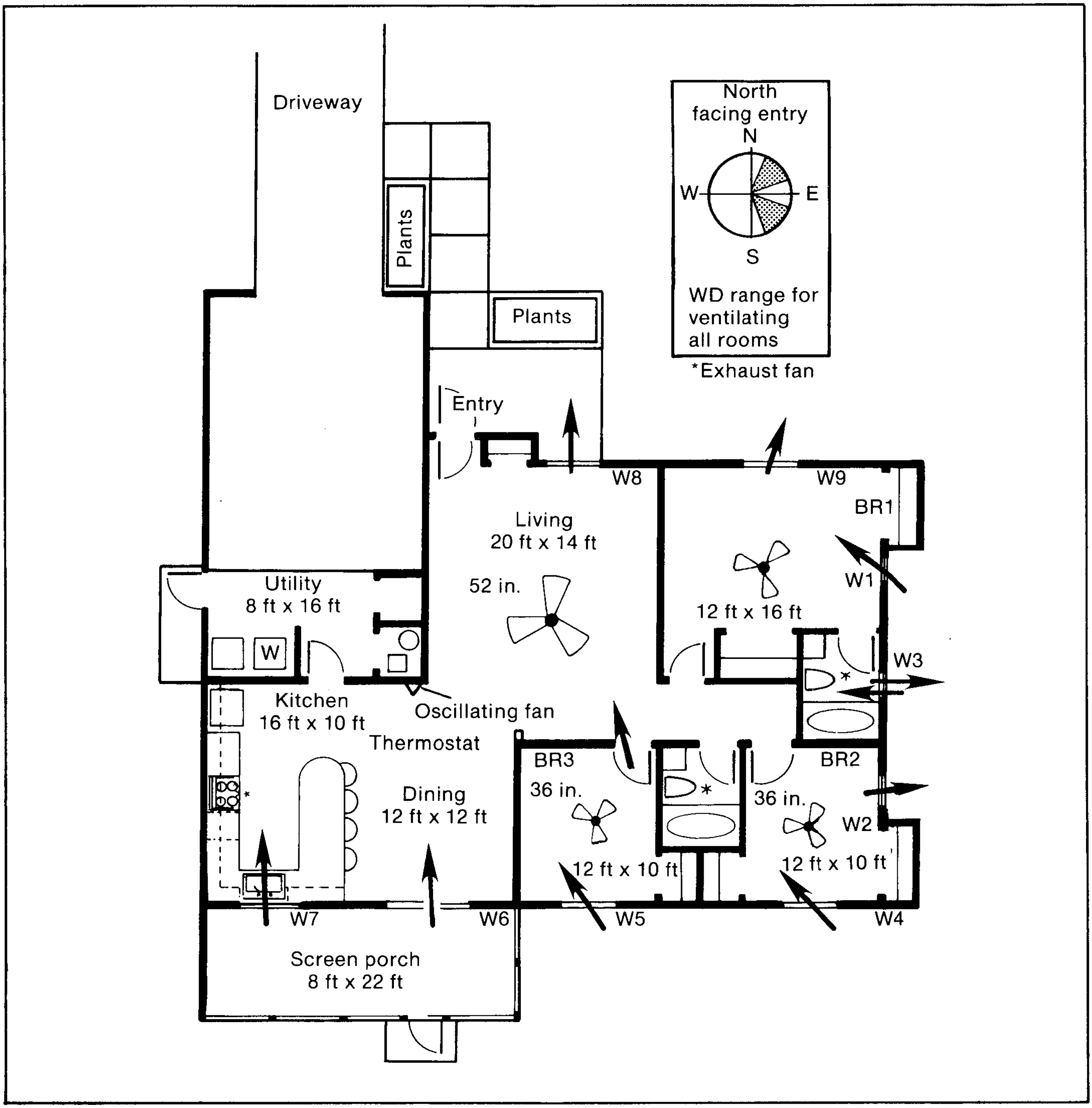


Figure 8.5. A House Plan for North-Facing Lots

plans. They should be of good quality that seal well when closed. Awning windows are recommended over horizontal or vertical sliding windows for better rain protection and to maximize open-window area for a given glass area. Example calculations in Appendix A show that this house in Orlando will require a total operable screened window area equal to 12% of the floor area, or 160 ft^2. A sliding glass door and an entry door provide 21 ft^2 each. The remaining 118 ft^2 are provided by windows. Recommended window sizes and vertical placements in the wall are shown in Figure 8.6. Windows near the wing walls should be vertical to minimize wing wall protrusion from the building.

In these designs, windows on the east or west side are required for good ventilation, but they must be protected from the sun in the morning or afternoon. At a minimum, they should have reflective film, but do not use such film on double-paned glass. An aluminized reflective roller shade, which can be kept up in winter to allow sunlight into the house, is better yet. The best heat-gain prevention scheme for east or west windows is exterior operable awnings, shutters, or sun screens (Figure 8.7). Large overhangs are another solution, as discussed in Chapter 3, and shade trees on the east and west sides would also be excellent.

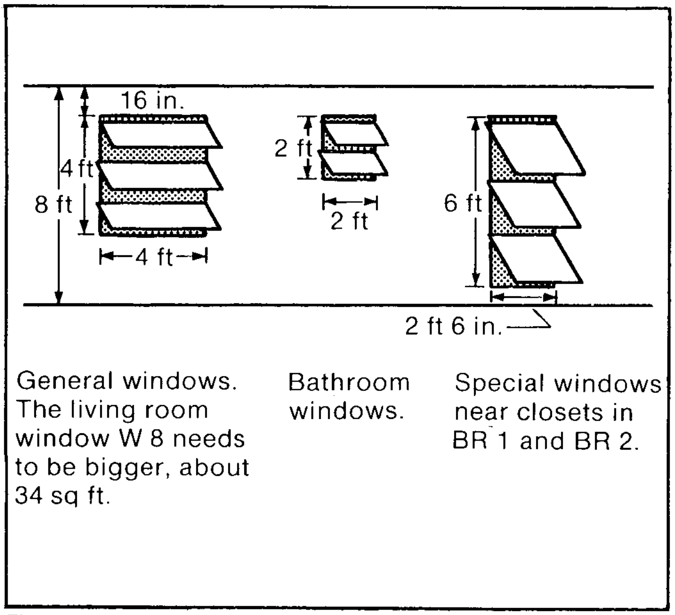


Figure 8.6. Recommended Window Types and Sizes

The south-facing plan, rotated 90 degrees, is used for a west-facing lot (Figure 8.8). Wing walls located on the south wall work on the same principle as before (Figure 8.3). Bedroom 1 is ventilated by the wing wall at W1; BR2 is ventilated by W4 and the wing wall at W2; and BR3 is ventilated by leaving the door to the hallway open.

Another small (1360 ft^2) home design for west-facing lots (Figure 8.9) has better west sun protection and does not require west windows. The master bedroom is ventilated by a French door or by a large casement window (W1) augmented by the dressing-room wall and the leeward window W9. Wing walls are integrated into closets in bedrooms 2 and 3. The second bedroom is ventilated by windows on both external walls, with a wing wall on W4 to make that window an outlet. A wing wall is not provided on W3 since it would block ventilation for northeast winds. In this design, all three bedrooms are cross-ventilated for southeasterly winds.

The north-facing plan, rotated 90 degrees, is used for east-facing lots (Figure 8.10). The garage acts as a wing wall to direct airflow into the building by creating a high-pressure zone on the east wall.

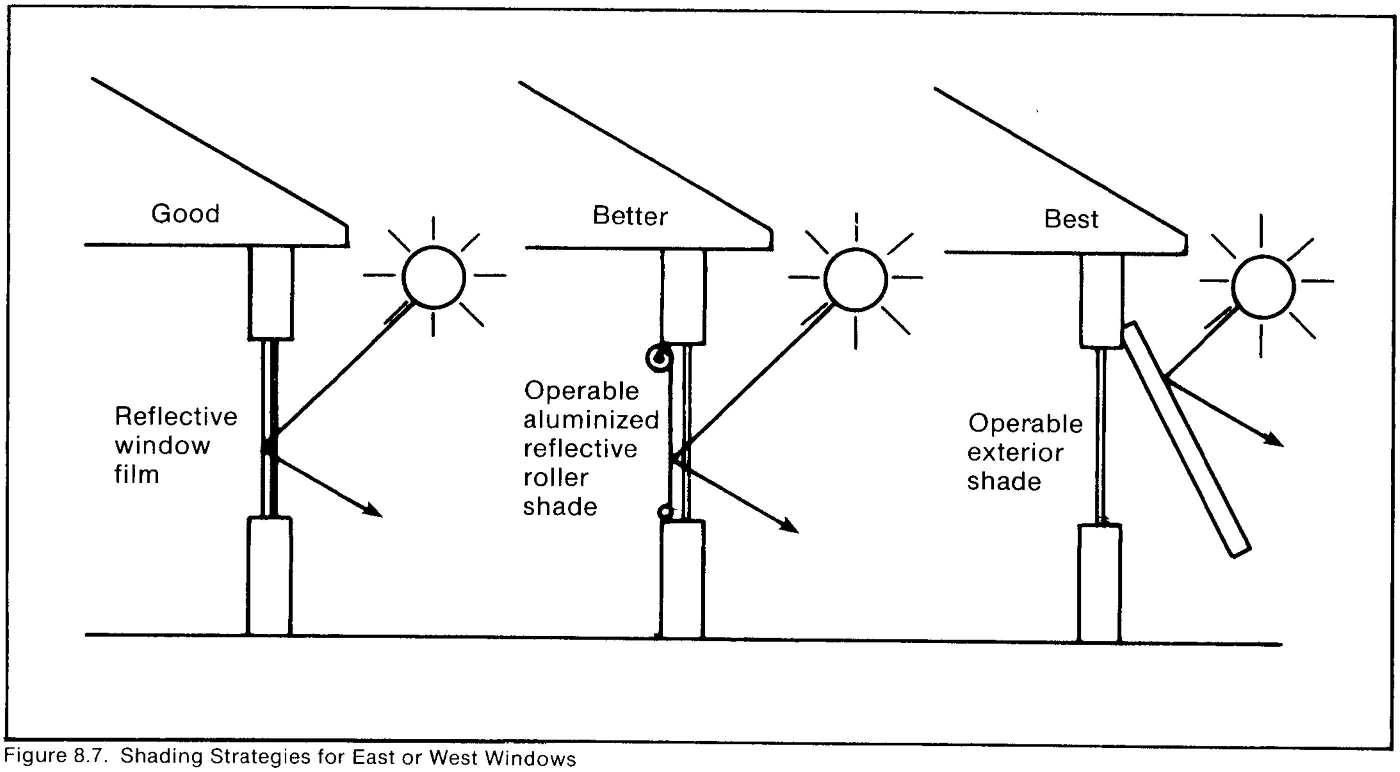


Figure 8.7. Shading Strategies for East or West Windows

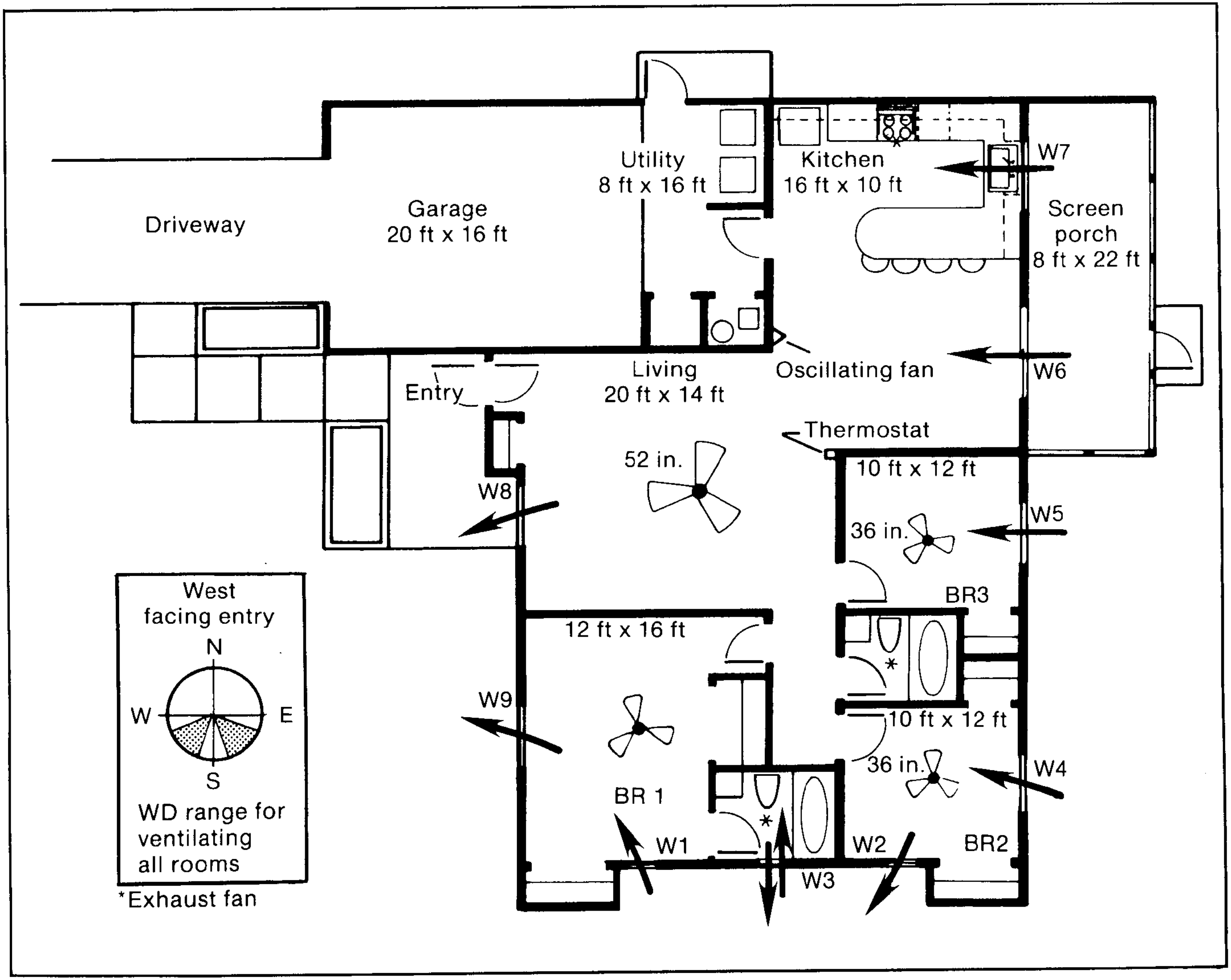


Figure 8.8. A House Plan for West-Facing Lots

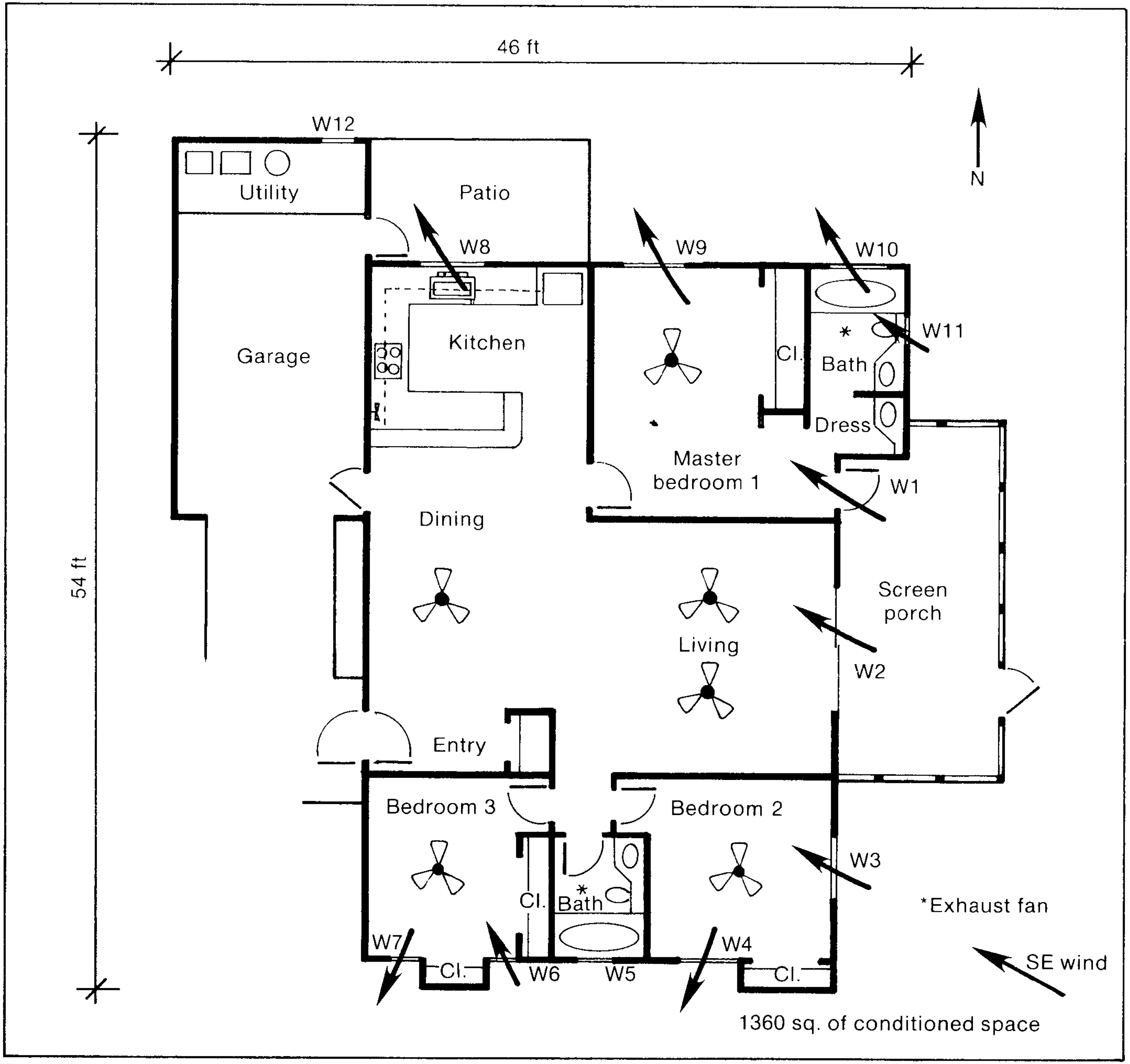


Figure 8.9. A Design for West-Facing Lots

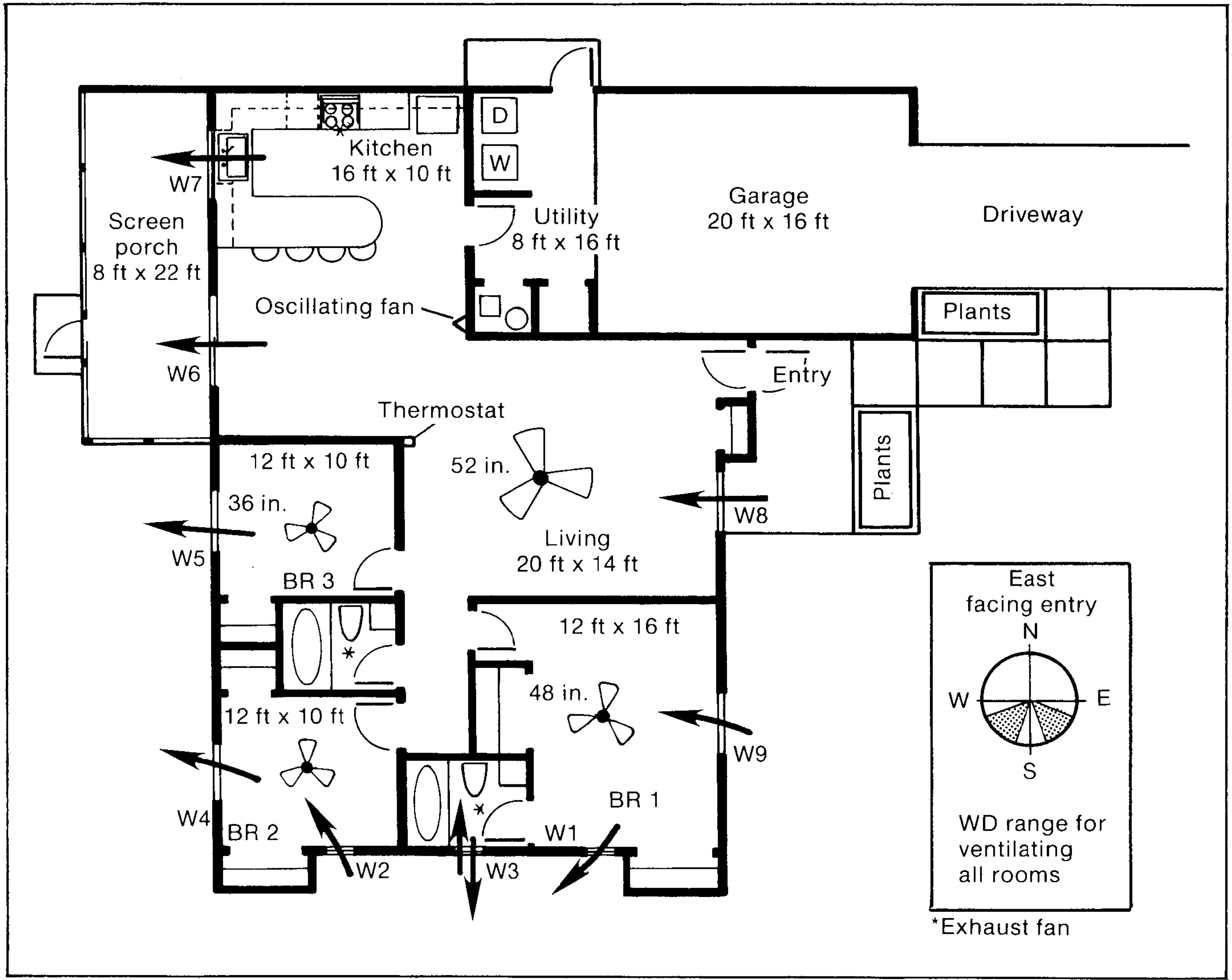


Figure 8.10. A House Plan for East-Facing Lots

Chapter 9

Whole-House Fans

Open windows sometimes may not provide adequate ventilation because of improper building orientation with regard to prevailing winds or dense housing. Moreover, open windows are not secure unless measures such as iron grillwork are used. In such cases, a whole-house fan (WHF) may be an attractive, if somewhat noisy, solution (Figure 9.1). A whole-house fan can consume between 300 and 500 watts of electricity, depending on size.

A whole-house fan should be used for cooling as a substitute for natural ventilation. Although a whole-house fan creates some air motion, it cannot be relied upon solely for occupant cooling. Ceiling fans and oscillating fans are recommended, even in a house with a whole-house fan. The whole-house fan pulls air in from all open windows and exhausts it through the ceiling and attic (Figure 9.1). It should be centrally located so that it draws in air from all around the house.

It is recommended that a whole-house fan be sized to provide 20 air changes per hour to the house. The cubic feet per minute (cfm) rating required is obtained by multiplying house volume (floor area square footage times ceiling height, in feet) by 0.33. Select a fan that has a cfm rating equal to or greater than that calculated. For example, a 1300 ft^2 home with an 8 ft ceiling has a volume of 1300 x 8 = 10,400 ft^3. The cfm rating required is 0.33 x 10,400 = 3432. A 24-in.-diameter WHF should usually be adequate. Note that this should be the cfm rating at 0.1-in. water static pressure (SP) drop and not the free-air cfm without any pressure drop. If the cfm rating does not state the pressure drop, then assume that it is for free-air. For fan selection, de-rate the free-air cfm by 20% to get the 0.1-in. SP rating.

It is not necessary to open windows all the way to ventilate with a whole-house fan. They can be opened 4-5 in. and fixed in a secure position by stops or window locks. Total open window area should be approximately twice the fan open area (a 20-in. blade diameter WHF has an open area of 3.14 x 400/4 = 314 in.^2) if there is no insect screen over the window. If insect screening is used, then total open-window area should be three times the WHF open area.

Attic vents must be larger than normal for effective WHF ventilation. Free-exhaust area should again be approximately twice the WHF area. Two wind turbines in addition to soffit and gable vents should be sufficient, or a continuous ridge vent may be considered. For further details on whole-house fan installation and purchase, see Birch (1980).

An interesting WHF installation is suggested by John Belisle of Merritt Island, Florida. In his house, the WHF is installed backwards to pull air in from the attic and exhaust it through the windows; i.e., airflow direction is reverse that in Figure 9.1. The WHF cannot be run during the day because of the hot attic, but winds during the day are usually higher than those at night, so open windows generally provide adequate daytime ventilation.

At night, when the attic reaches the ambient temperature (by about 11 p.m. daylight time), the WHF is operated with only bedroom windows open, so it exhausts through these windows. This keeps small insects outside since they cannot enter the house. With a regular WHF installation or regular natural ventilation, these tiny insects (called "no see-ems" in Florida) come through ordinary window insect screening and make life miserable for the occupants. Apparently, they cannot get into the attic through the small openings in normal aluminum soffit vents widely used these days. Thus, the installation of the WHF backwards has considerable merit for those interested primarily in night-only ventilation. The attic-coupled ceiling fan described in Chapter 4 is another variation on this theme.

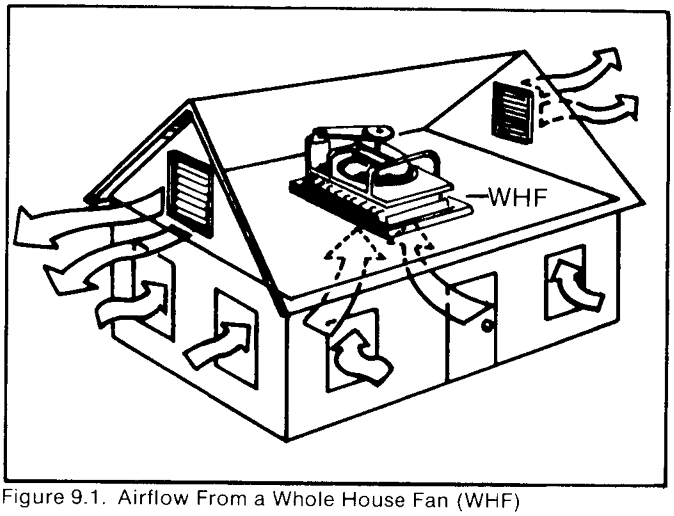


Figure 9.1. Airflow From a Whole House Fan (WHF)

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Appendix A

Window Sizing Methodology

This appendix presents a tabular method for sizing windows in a house. It can be used to estimate the total operable window area required as a percentage of the house floor area. For a two-story house, the calculations should be done for each floor. This procedure assumes that the inlet and outlet areas are equal. Equal areas maximize the airflow, and this procedure can be safely used for slight differences; e.g., inlet = 40% of the total area. For widely different inlet and outlet areas, see a different procedure based on pressure coefficients (Chandra 1983). The procedure and accompanying tables follow. A sample calculation is presented at the end.

Form for Calculating Window Areas in Naturally Ventilated Houses

Project ______________________________

Analyst ______________________________

1. House conditioned floor area = ______ (1) ft^2

2. Average ceiling height = ______ (2) ft

3. House volume

   = ______ (Step 1) x ______ (Step 2) = ______ (3) ft^3

4. Design air change rate/hr = (recommended value is 30) ______ (4) ACH

5. Required airflow rate, cfm

   = ______ (Step 3) x ______ (Step 4) ÷ 60 = ______ (5) cfm

6. Design month = ______ (6)

   (Recommended months = May for Florida and the Gulf Coast
   = June for more northern southeast cities)

7. Nearest city location with weather data = ______ (7)

8. From weather data in Appendix B, determine windspeed (WS) and wind direction (WD) for design month

8a. WS = ________________ mph
(8a)

8b. WD = ________________
(8b)

9. From prevailing wind direction and building orientation, determine incidence angle on windward wall. Incidence angle = ________________ degrees
(9)

10. From Table A1, determine inlet-to-site 10 meter windspeed ratio = ________________
(10)

11. Determine windspeed correction factors

11a. For house location and ventilation strategy, determine terrain correction factor from Table A2 = ________________
(11a)

11b. For neighboring buildings, determine neighborhood convection factor from Table A3 = ________________
(11b)

Assume h = 8 ft, =
g = 24 ft

11c. If sizing windows for the second floor or for house on stilts, use a height multiplication factor of 1.15. Otherwise, use 1.0. Selected value = ________________
(11c)

12. Determine overall windspeed correction factor

= ________________ x ________________ x ________________ = ________________
Step 11a, Step 11b, Step 11c, (12)

13. Determine site windspeed in ft/min

= ________________ x ________________ x 88 = ________________ ft/min
Step 8a, Step 12, (13)

14. Determine window inlet airspeed

= ________________ x ________________ = ________________ ft/min
Step 13, Step 10, (14)

15. Determine net aperture inlet area

= ________________ ÷ ________________ = ________________ ft^2
Step 5, Step 14, (15)

16. Determine total inlet + outlet area, insect screened. Assumes fiberglass screening with a porosity of 0.6

= 2 x ________________ x 1.67 = ________________ ft^2
Step 15, (16)

17. Since typical window or door framing is about 20% of the gross area, determine gross total operable area required as

= 1.25 x ________________ = ________________ ft^2
Step 16, (17)

18. Determine gross operable area as a % of floor area

= ________________ ÷ ________________ x 100 = ________________ %

Step 17 — Step 1 — (18)

Note: This gross operable area requirement can be met the by same area of windows if the windows are 100% operable (awning, casement, hopper, etc.). The window area required will be twice this value if single-hung or sliding windows are used which have only 50% of the area as operable.

Sample Calculations

The first house plan discussed in Chapter 8 (Figure 8.3) is analyzed. Orlando weather data are used. The calculations follow.

Form for Calculating Window Areas in Naturally Ventilated Houses

Project ______________________________

Analyst ______________________________

1. House conditioned floor area = 1334 ft^2 (1)

2. Average ceiling height = 8 ft (2)

3. House volume
   = 1334 (Step 1) x 8 (Step 2) = 10,672 ft^3 (3)

4. Design air change rate/hr = (recommended value is 30) 30 ACH (4)

5. Required airflow rate, cfm
   = 10,672 (Step 3) x 30 (Step 4) ÷ 60 = 5336 cfm (5)

6. Design month = May (6)

   (Recommended months = May for Florida and the Gulf Coast
   = June for more northern southeast cities)

7. Nearest city location with weather data = Orlando (7)

8. From weather data in Appendix B, determine windspeed (WS) and wind direction (WD) for design month

   8a. WS = 8.8 mph (8a)

   8b. WD = SE (8b)

9. From prevailing wind direction and building orientation, determine incidence angle on windward wall. Incidence angle = about 10 degrees (9)

10. From Table A1, determine inlet-to-site 10 meter windspeed ratio = 0.35 (10)

11. Determine windspeed correction factors

11a. For house location and ventilation strategy, determine terrain correction factor from Table A2 = 0.67 (11a)

11b. For neighboring buildings, determine neighborhood convection factor from Table A3 = 0.77 (11b)

Assume h = 8 ft, =
g = 24 ft

11c. If sizing windows for the second floor or for house on stilts, use a height multiplication factor of 1.15. Otherwise, use 1.0. Selected value = 1.0 (11c)

12. Determine overall windspeed correction factor

= 0.67 (Step 11a) x 0.77 (Step 11b) x 1.0 (Step 11c) = 0.52 (12)

13. Determine site windspeed in ft/min

= 8.8 (Step 8a) x 0.52 (Step 12) x 88 = 403 (13) ft/min

14. Determine window inlet airspeed

= 403 (Step 13) x 0.35 (Step 10) = 141 (14) ft/min

15. Determine net aperture inlet area

= 5336 (Step 5) ÷ 141 (Step 14) = 37.8 (15) ft^2

16. Determine total inlet + outlet area, insect screened. Assumes fiberglass screening with a porosity of 0.6

= 2 x 37.8 (Step 15) x 1.67 = 126 (16) ft^2

17. Since typical window or door framing is about 20% of the gross area, determine gross total operable area required as

= 1.25 x 126 (Step 16) = 156 (17) ft^2

18. Determine gross operable area as a % of floor area

= 158 (Step 17) ÷ 1334 (Step 1) x 100 = 11.8 (18) %

Note: This gross operable area requirement can be met the by same area of windows if the windows are 100% operable (awning, casement, hopper, etc.). The window area required will be twice this value if single-hung or sliding windows are used which have only 50% of the area as operable.

Table A1. Inlet-to-Site 10 Meter Windspeed Ratios (WSR)

Wind Incidence Angle, degrees	WSR
0 - 40	0.35
50	0.30
60	0.25
70	0.20
80	0.14
90	0.08

Notes:

1. Incidence angle is 0 when winds are perpendicular to a building face; i.e., when the wind is directly entering a window.

2. These results are a compilation of wind tunnel test data obtained by Vickery (1983). Vickery measured airflow through ventilated models and found that there was negligible change in airflow with wind incidence up to 40°. Although Vickery measured near zero airflow at 90°, it has been determined from full-scale testing that there is some ventilation even in leeward rooms. The ratio of best-to-worst airflow in a room was about 4:1. These field data and the Vickery data were combined to arrive at the Table 1 values.

Table A3. Neighborhood Correction Factor (NCF)

Wall height of typical upwind buildings, h = ____________ ft

Gap between proposed building and adjacent upwind building, g = ____________ ft

Ratio g/h = ____________

Ratio g/h	NCF
0	0.00
1	0.41
2	0.63
3	0.77
4	0.85
5	0.93
6 or more	1.00

Note: These NCF values are obtained by extrapolating wind tunnel data obtained by Lee (1980)

Table A2. Terrain Correction Factor (TCF) for Wind Speed

Terrain Type	TCF 24-hr ventilation	Night-only ventilation
1. Oceanfront or > 3 miles water in front	1.30	0.98
2. Airports, or flatlands with isolated-wall separated buildings (e.g., farmhouse)	1.00	0.75
3. Rural	0.85	0.64
4. Suburban or industrial	0.67	0.50
5. Center of large city	0.47	0.35

Notes:

1. The TCFs for 24-hr ventilation are from standard civil engineering practice (e.g., Sherman 1982). These were developed for high-wind situations and may not be applicable for low windspeeds. In the absence of real data, the authors recommend using the suburban value for most housing calculations involving natural ventilation.

2. The night-only TCFs are 0.75 times the 24-hr value. This was arrived at by analyzing hourly windspeeds at night for Florida cities.

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Appendix B
Climatic Data for the Southern Gulf and Southeastern Atlantic Coast States

This Appendix contains long-term average climatic data for the southern Gulf and southeastern Atlantic coast states of the U.S. It is a compilation of National Weather Bureau data and has been extracted from the publication, "Local Climatological Data: Annual Summary with Comparative Data," available for about 300 cities from: Publications, National Climatic Data Center, Federal Building, Asheville, North Carolina 28801; phone (704) 259-0682.

Data have been presented for 49 humid cities in the states of Alabama, Florida, Georgia, Louisiana, North Carolina, South Carolina, and Texas. For this document, the specific data needed are the monthly average windspeed and wind direction to perform Appendix A calculations. For most cities, wind data have been collected at airport locations and Appendix A, Table 2 correction factors must be used to estimate local windspeeds at the homesite.

Birmingham, Alabama Municipal Airport

Month	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind					Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
	Normal			Extremes						Water equivalent							Snow, Ice pellets				Hour	Hour	Hour	Hour		thru 1963	Fastest mile				
	# Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	00 (Local time)	06 (Local time)	12 (Local time)	18 (Local time)	Mean speed m.p.h.	Prevailing direction	Speed m.p.h.	Direction	Year		
(a)				40		40					40		40		34		40		34		20	20	20	20	40	15	34	34		34	34
J	52.7	33.0	42.9	81	1949	-4	1966	685	0	5.23	11.00	1949	1.09	1981	5.81	1949	6.6	1982	4.5	1948	76	80	62	65	8.4	S	49	W	1975	42	6.9
F	57.3	35.2	46.3	83	1962	3	1958	532	8	4.72	17.67	1961	1.20	1968	6.57	1961	2.3	1960	2.3	1960	71	78	55	56	8.9	N	59	SE	1960	50	6.5
M	65.2	42.1	53.7	89	1982	11	1980	368	18	6.62	15.80	1980	1.79	1967	7.05	1970	1.5	1983	0.7	1957	73	79	54	53	9.3	S	65	SW	1955	55	6.5
A	75.2	50.4	62.8	90	1955	26	1973	110	44	5.00	13.75	1979	1.35	1967	5.08	1966	T	1971	T	1971	77	83	52	52	8.5	S	56	SW	1956	63	5.8
M	81.6	58.3	70.0	99	1962	35	1944	36	191	4.53	11.10	1969	1.15	1951	4.63	1969	0.0		0.0		84	86	56	58	6.8	S	65	NW	1951	66	5.9
J	87.9	65.9	77.0	102	1954	42	1966	0	360	3.61	8.44	1963	0.67	1968	3.85	1957	0.0		0.0		84	86	57	60	6.2	SSW	56	SW	1957	65	5.9
J	90.3	69.8	80.1	106	1980	51	1967	0	468	5.39	13.70	1950	0.30	1983	4.39	1968	0.0		0.0		85	88	61	65	5.7	SSW	57	SW	1960	59	6.4
A	89.7	69.1	79.5	103	1947	51	1946	0	450	3.85	10.85	1967	0.82	1955	5.13	1952	0.0		0.0		86	89	61	66	5.4	NE	50	NW	1956	63	5.8
S	84.6	63.6	74.1	100	1980	37	1967	7	280	4.34	10.43	1977	T	1955	5.03	1977	0.0		0.0		85	88	60	69	6.4	ENE	50	SE	1951	61	5.6
O	74.8	50.4	62.6	94	1954	27	1956	137	62	2.64	7.52	1977	0.11	1963	3.75	1977	T	1955	T	1955	83	87	55	70	6.2	ENE	43	W	1955	66	4.6
N	63.7	40.5	52.1	84	1961	5	1950	387	0	3.64	15.25	1948	0.42	1949	4.87	1948	1.4	1950	1.4	1950	80	84	57	68	7.4	N	52	N	1944	55	5.7
D	55.9	35.2	45.6	80	1951	1	1962	601	0	4.95	13.98	1961	0.81	1980	5.29	1961	8.0	1963	8.4	1963	77	81	61	68	8.0	NNW	41	SE	1954	46	6.5
YR	73.2	51.1	62.2	106	JUL 1980	-4	JAN 1966	2863	1881	54.52	17.67	FEB 1961	T	SEP 1955	7.05	MAR 1970	8.0	DEC 1963	8.4	DEC 1963	80	84	58	63	7.3	S	65	SW	MAR 1955	58	6.0

Huntsville, Alabama Huntsville-Madison County

Month	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind					Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
	Normal			Extremes						Water equivalent							Snow, Ice pellets				Hour	Hour	Hour	Hour		thru 1963	Fastest mile				
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	00 (Local time)	06	12	18	Mean speed m.p.h.	Prevailing direction	Speed m.p.h.	Direction	Year		
(a)				16		16					16		16		16		16		16		16	16	16	16	16		16	16			16
J	49.4	31.0	40.2	76	1972	-4	1982	769	0	5.17	10.92	1982	1.71	1970	4.90	1982	4.3	1982	3.6	1975	78	81	66	69	9.4		44	26	1978		7.0
F	53.9	33.2	43.6	77	1982	6	1981	606	7	4.79	9.57	1971	0.59	1978	3.86	1971	2.8	1980	1.8	1980	74	80	59	61	9.6		43	26	1976		6.6
M	61.9	40.6	51.3	84	1982	6	1980	441	16	6.78	17.00	1980	2.70	1982	7.70	1973	2.1	1968	2.1	1968	74	81	57	58	10.2		46	12	1969		6.8
A	73.0	50.0	61.5	90	1971	28	1983	136	31	4.92	10.02	1982	1.84	1976	3.85	1983	T	1973	T	1973	75	81	52	53	9.2		44	18	1970		6.0
M	79.9	57.6	68.8	92	1970	36	1971	41	159	4.60	11.88	1983	3.06	1970	5.90	1983	0.0		0.0		83	86	57	60	7.8		37	31	1974		6.1
J	86.8	65.3	76.1	101	1969	45	1972	0	333	3.74	7.30	1976	0.77	1968	4.46	1969	0.0		0.0		84	87	56	60	7.0		38	35	1974		5.6
J	89.4	69.1	79.3	102	1980	54	1972	0	443	5.05	9.44	1973	0.79	1983	4.47	1975	0.0		0.0		86	88	59	64	6.2		43	27	1969		5.9
A	89.2	67.9	78.6	102	1983	55	1976	0	422	3.11	4.37	1961	0.93	1973	2.49	1980	0.0		0.0		86	89	58	66	5.8		40	32	1974		5.4
S	83.5	62.0	72.8	96	1978	40	1981	12	246	3.99	9.78	1980	0.55	1982	3.99	1980	0.0		0.0		87	90	60	69	6.6		43	23	1968		5.9
O	73.4	49.1	61.3	89	1982	29	1982	166	51	2.90	12.06	1975	0.77	1971	6.04	1975	0.0		0.0		82	86	55	65	7.6		32	33	1972		5.1
N	61.6	39.4	50.5	83	1982	15	1976	435	0	4.24	11.53	1977	1.82	1971	3.33	1973	0.8	1974	0.8	1974	79	83	58	65	8.5		35	13	1980		6.0
D	53.0	33.6	43.3	77	1978	-1	1983	673	0	5.43	11.74	1983	0.91	1980	5.81	1973	1.0	1974	1.0	1974	76	80	62	67	9.6		39	32	1976		6.6
YR	71.2	49.9	60.6	102	AUG 1983	-4	JAN 1982	3279	1708	54.74	17.00	MAR 1980	0.55	SEP 1982	7.70	MAR 1973	4.3	JAN 1982	3.6	JAN 1975	80	84	58	63	8.1		46	12	MAR 1969		6.1

Mobile, Alabama Bates Field

Month	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind					Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
	Normal			Extremes						Water equivalent							Snow, Ice pellets				Hour	Hour	Hour	Hour		thru 1963	Fastest mile				
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	00 (Local time)	06	12	18	Mean speed m.p.h.	Prevailing direction	Speed m.p.h.	Direction	Year		
(a)				42		42					42		42		42		42		42		21	21	21	21	35	14	25	25			35
J	60.6	40.9	50.8	84	1949	7	1982	469	29	4.59	10.40	1978	0.98	1968	8.34	1965	3.5	1955	3.5	1955	78	81	61	69	10.5	N	44	18	1959		6.6
F	63.9	43.2	53.6	82	1981	11	1951	342	23	4.91	11.89	1983	1.31	1948	5.37	1981	3.6	1973	3.6	1973	76	80	55	62	10.7	N	46	23	1960		6.2
M	70.3	49.8	60.1	90	1946	21	1943	191	39	6.48	15.58	1946	0.59	1967	6.52	1951	1.6	1954	1.6	1954	80	83	55	63	11.0	N	40	27	1962		6.2
A	78.3	57.7	68.0	92	1943	36	1973	43	133	5.35	17.69	1955	0.48	1954	13.36	1955	0.0		0.0		82	87	53	62	10.4	S	44	01	1964		5.8
M	84.9	64.8	74.9	100	1953	43	1960	0	307	5.46	15.08	1980	0.45	1962	8.00	1981	0.0		0.0		83	86	54	62	8.9	S	51	32	1963		5.8
J	90.2	70.8	80.5	102	1952	56	1966	0	465	5.07	13.07	1961	1.19	1966	7.38	1961	0.0		0.0		84	86	55	65	7.7	S	44	05	1959		5.8
J	91.2	73.2	82.2	104	1952	60	1947	0	533	7.74	19.29	1949	1.72	1983	5.34	1975	0.0		0.0		86	88	60	71	6.9	S	46	18	1960		6.6
A	90.7	72.9	81.8	102	1968	59	1956	0	521	6.75	12.05	1969	2.35	1972	6.62	1969	0.0		0.0		87	90	61	73	6.7	NE	63	14	1969		6.0
S	87.0	69.3	78.2	99	1980	42	1967	0	396	6.56	13.61	1957	0.58	1963	8.55	1979	0.0		0.0		85	88	59	71	7.9	NE	63	09	1979		5.8
O	79.4	57.5	68.5	93	1963	32	1957	50	158	2.62	6.72	1975	T	1978	4.30	1967	0.0		0.0		82	85	52	66	8.2	N	46	36	1964		4.4
N	69.3	47.9	58.6	87	1971	22	1950	218	26	3.67	13.65	1948	0.25	1960	7.02	1975	T	1966	T	1966	82	85	56	70	9.3	N	37	36	1959		5.3
D	63.1	42.9	53.1	81	1974	8	1983	382	13	5.44	11.38	1953	1.29	1980	5.50	1968	3.0	1963	3.0	1963	79	83	61	71	10.1	N	38	32	1959		6.2
YR	77.4	57.6	67.5	104	JUL 1952	7	JAN 1982	1695	2643	64.64	19.29	JUL 1949	T	OCT 1978	13.36	APR 1955	3.6	FEB 1973	3.6	FEB 1973	82	85	57	67	9.0	N	63	09	SEP 1979		5.9

Montgomery, Alabama Dannelly Field

Month	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind					Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset.
	Normal			Extremes						Water equivalent							Snow, Ice pellets				Hour	Hour	Hour	Hour		thru 1963	Fastest mile				
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	00 (Local time)	06	12	18	Mean speed m.p.h.	Prevailing direction	Speed m.p.h.	Direction	Year		
(a)				39		39					39		39		39		39		39		20	20	20	20	39	19	39	39		33	39
J	57.0	36.4	46.7	83	1949	4	1982	580	13	4.20	7.58	1947	0.72	1954	4.73	1965	6.0	1977	3.0	1977	76	80	61	64	7.9	NW	72	W	1975	47	6.6
F	60.9	38.8	49.9	85	1962	10	1951	439	17	4.51	13.38	1961	1.47	1947	5.95	1982	3.1	1973	3.1	1973	72	79	55	57	8.4	S	45	W	1981	54	6.2
M	68.1	45.5	56.8	89	1954	19	1980	284	30	5.92	10.83	1958	2.00	1967	7.12	1958	T	1983	T	1983	74	82	54	55	8.5	NW	60	SW	1952	58	6.2
A	77.0	53.3	65.2	91	1972	31	1950	72	78	4.38	15.64	1964	0.88	1965	4.59	1957	0.0		0.0		77	85	52	56	7.4	S	54	SE	1952	65	5.6
M	83.6	61.1	72.4	98	1953	40	1971	10	240	4.00	12.01	1978	1.14	1962	6.36	1978	0.0		0.0		82	87	55	59	6.2	S	51	NW	1978	65	5.7
J	89.8	68.4	79.1	105	1954	49	1956	0	423	3.45	9.89	1946	0.33	1979	6.99	1946	0.0		0.0		83	87	55	59	5.9	S	51	NW	1953	66	5.6
J	91.5	71.8	81.7	105	1952	59	1947	0	518	4.78	8.92	1956	1.58	1952	4.52	1970	0.0		0.0		86	89	60	66	5.8	SW	51	E	1954	63	6.2
A	91.2	71.1	81.2	104	1983	57	1968	0	502	3.17	10.42	1974	0.78	1958	5.03	1961	0.0		0.0		87	90	60	68	5.2	ENE	43	SW	1951	65	5.6
S	86.9	66.4	76.7	101	1980	39	1967	0	351	4.72	10.62	1953	0.44	1954	8.81	1953	0.0		0.0		85	88	57	67	6.0	NE	42	NW	1975	62	5.5
O	77.5	53.1	65.3	100	1954	26	1952	86	95	2.27	9.06	1959	0.01	1978	4.25	1964	0.0		0.0		83	87	53	65	5.7	NE	40	W	1965	66	4.6
N	67.0	43.0	55.0	87	1975	13	1950	307	7	2.98	21.32	1948	0.32	1949	8.17	1948	T	1971	T	1971	81	86	55	66	6.6	NW	46	S	1957	56	5.4
D	59.8	37.9	48.9	85	1982	5	1983	499	0	4.78	11.35	1961	1.36	1955	4.27	1953	1.0	1963	1.0	1963	77	82	59	66	7.3	NW	46	SW	1956	50	6.1
YR	75.9	53.9	64.9	105	JUN 1954	4	JAN 1982	2277	2274	49.16	21.32	NOV 1948	0.01	OCT 1978	8.81	SEP 1953	6.0	JAN 1977	3.1	FEB 1973	80	85	56	62	6.7	S	72	W	JAN 1975	59	5.8

Apalachicola, Florida Municipal Airport

Month	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind					Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
	Normal			Extremes						Water equivalent							Snow, Ice pellets				Hour	Hour	Hour	Hour		thru 1951	Fastest mile				
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	01	07	13	19	Mean speed m.p.h.	Prevailing direction	Speed m.p.h.	Direction	Year		
																					(Local time)										
(a)				54		54					54		54		54		54		54		29	33	29	33	39	22	47	47		48	50
J	60.5	45.1	52.8	79	1957	14	1966	401	23	3.51	8.25	1964	0.04	1957	3.77	1935	0.4	1977	0.4	1977	84	86	67	79	8.3	N	48	E	1960	59	5.7
F	62.4	46.9	54.7	80	1957	21	1951	311	23	3.64	9.19	1960	0.38	1938	3.74	1940	1.2	1958	1.2	1958	84	86	66	77	8.7	N	42	E	1969	62	5.5
M	68.0	53.4	60.7	85	1982	22	1980	168	35	4.04	14.33	1959	0.71	1939	8.17	1948	T	1980	T	1980	86	86	66	77	9.0	SE	54	E	1931	65	5.7
A	75.1	60.7	67.9	90	1967	37	1977	30	117	3.25	12.14	1983	0.09	1942	7.76	1964	0.0		0.0		86	86	65	74	8.6	SE	51	SE	1933	74	4.8
M	81.7	67.3	74.5	96	1953	47	1981	0	295	2.94	8.70	1974	0.25	1983	7.07	1959	0.0		0.0		87	84	65	72	7.7	SE	47	SE	1937	78	4.6
J	86.6	72.9	79.8	101	1930	56	1977	0	444	4.81	18.32	1965	0.30	1977	5.34	1949	0.0		0.0		86	85	67	74	7.2	SW	55	E	1972	72	5.2
J	88.0	75.0	81.5	102	1932	63	1981	0	512	7.09	17.95	1975	0.75	1976	6.75	1975	0.0		0.0		87	86	71	76	6.5	W	63	N	1930	64	6.1
A	88.0	74.7	81.4	99	1956	66	1968	0	508	7.53	21.08	1970	1.85	1951	5.67	1950	0.0		0.0		87	88	77	77	6.5	SW	59	NE	1939	63	5.9
S	85.3	72.3	78.9	96	1932	50	1967	0	417	8.66	22.55	1946	0.60	1972	11.71	1932	0.0		0.0		86	88	70	78	7.9	NE	67	E	1947	65	5.6
O	78.2	62.1	70.2	93	1941	39	1977	24	185	3.19	12.09	1959	0.01	1935	6.32	1965	0.0		0.0		83	86	63	76	8.0	NE	56	NW	1941	74	4.0
N	69.2	52.7	61.0	87	1935	24	1950	154	34	2.82	9.00	1947	0.04	1931	5.84	1930	0.0		0.0		83	85	63	77	8.0	N	47	SE	1948	67	4.5
D	63.0	47.0	55.0	82	1931	13	1962	320	10	3.50	7.87	1953	0.30	1955	4.15	1931	T	1952	T	1952	84	86	68	78	8.0	N	42	SE	1945	57	5.7
YR	75.5	60.8	66.2	102	JUL 1932	13	DEC 1962	1408	2603	54.98	22.55	SEP 1946	0.01	OCT 1935	11.71	SEP 1932	1.2	FEB 1958	1.2	FEB 1958	85	86	67	76	7.9	N	67	E	SEP 1947	67	5.3

Daytona Beach, Florida Regional Airport

Month	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind					Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
	Normal			Extremes						Water equivalent							Snow, Ice pellets				Hour	Hour	Hour	Hour		thru 1963	Fastest mile				
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	01	07	13	19	Mean speed m.p.h.	Prevailing direction	Speed m.p.h.	Direction	Year		
																					(Local time)										
(a)				40		40					40		40		40		40		40		39	39	39	39	38	18	35	35			35
J	68.4	47.4	57.9	85	1957	19	1981	264	44	2.37	7.10	1979	0.15	1950	3.64	1977	T	1977	T	1977	85	87	59	77	9.0	NW	43	26	1978		5.8
F	69.3	48.2	58.8	88	1962	24	1958	214	41	3.11	9.13	1960	0.29	1944	4.39	1971	T	1951	T	1951	83	86	57	72	9.8	NNW	44	20	1960		5.7
M	74.6	53.6	64.1	91	1977	26	1980	116	88	2.99	7.75	1953	0.25	1956	5.74	1953	0.0		0.0		83	86	55	70	10.0	SSW	44	23	1957		5.7
A	80.0	59.1	69.6	96	1968	35	1950	14	152	2.25	7.12	1949	T	1967	4.03	1982	0.0		0.0		83	85	54	69	9.8	E	46	18	1953		5.1
M	84.8	65.3	75.1	100	1953	44	1971	0	313	3.38	12.33	1976	0.08	1965	4.22	1947	0.0		0.0		85	85	57	71	9.1	E	40	25	1961		5.4
J	87.8	70.5	79.2	102	1944	54	1975	0	426	6.41	15.19	1966	1.03	1981	6.28	1966	0.0		0.0		88	87	63	76	8.3	SW	40	26	1965		6.2
J	89.6	72.5	81.1	102	1981	60	1981	0	499	5.52	14.58	1944	1.07	1976	3.90	1967	0.0		0.0		89	88	65	78	7.6	SSW	40	25	1963		6.3
A	89.0	72.8	80.9	99	1956	65	1957	0	493	6.34	19.89	1953	2.01	1963	4.76	1974	0.0		0.0		90	90	67	80	7.3	E	50	11	1949		6.2
S	86.9	72.1	79.5	99	1944	52	1956	0	435	6.68	15.20	1979	0.42	1972	6.34	1964	0.0		0.0		88	89	67	80	8.5	E	58	11	1960		6.4
O	81.2	65.1	73.2	95	1959	41	1954	0	259	4.62	13.00	1950	0.19	1967	9.29	1953	0.0		0.0		85	86	63	77	9.3	NE	53	05	1950		5.7
N	74.8	55.5	65.2	89	1948	27	1950	83	89	2.59	10.96	1972	T	1967	5.83	1979	0.0		0.0		85	87	60	78	8.7	NW	37	27	1963		5.2
D	69.8	49.2	59.5	86	1978	19	1983	209	39	2.20	11.98	1983	0.06	1956	5.22	1983	T	1962	T	1962	85	87	61	79	8.8	NW	40	34	1954		5.8
YR	79.7	60.9	70.3	102	JUL 1981	19	DEC 1983	900	2878	48.46	19.89	AUG 1953	T	NOV 1967	9.29	OCT 1953	T	JAN 1977	T	JAN 1977	86	87	61	76	8.8	E	58	11	SEP 1960		5.8

Fort Myers, Florida Page Field

Month	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind					Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
	Normal			Extremes						Water equivalent							Snow, Ice pellets				Hour	Hour	Hour	Hour		thru 1963	Fastest mile				
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	01	07	13	19	Mean speed m.p.h.	Prevailing direction	Speed m.p.h.	Direction	Year		
																					(Local time)										
(a)				44		44					44		44		44		44		44		22	22	22	22	37	10	34	34			35
J	74.3	52.5	63.4	88	1982	28	1981	150	100	1.89	7.45	1979	0.00	1950	2.63	1983	0.0		0.0		85	88	57	73	8.5	E	40	25	1958		5.0
F	75.1	53.1	64.1	92	1962	30	1956	120	94	2.06	10.82	1983	T	1944	2.60	1969	0.0		0.0		84	88	55	70	9.1	E	39	25	1958		4.9
M	79.8	57.8	68.8	93	1980	33	1980	39	156	2.85	18.58	1970	0.03	1974	7.92	1970	0.0		0.0		84	89	52	67	9.4	SW	46	35	1970		4.9
A	84.5	61.7	73.1	95	1946	39	1950	0	243	1.52	7.66	1941	T	1970	3.82	1943	0.0		0.0		84	89	48	64	9.0	E	39	20	1958		4.6
M	88.7	67.0	77.9	99	1953	50	1945	0	400	4.11	10.32	1968	0.34	1962	5.33	1980	0.0		0.0		85	88	50	66	8.2	E	40	22	1965		5.0
J	90.1	72.0	81.1	103	1981	61	1955	0	483	8.72	20.10	1974	1.99	1980	6.67	1959	0.0		0.0		88	88	59	74	7.4	E	46	12	1966		6.1
J	91.0	74.1	82.6	101	1942	66	1950	0	546	8.57	15.28	1941	2.28	1964	4.06	1965	0.0		0.0		88	88	60	75	6.8	ESE	45	18	1952		6.4
A	91.2	74.4	82.8	100	1942	65	1957	0	552	8.58	16.73	1981	3.98	1963	6.73	1967	0.0		0.0		88	89	61	78	6.8	E	39	25	1957		6.4
S	89.6	73.8	81.7	96	1980	63	1956	0	501	8.56	16.60	1969	2.33	1972	9.34	1962	0.0		0.0		88	90	62	77	7.7	E	92	05	1960		6.3
O	85.2	67.7	76.5	94	1941	45	1957	0	357	3.86	12.04	1959	0.05	1963	10.85	1951	0.0		0.0		86	89	57	74	8.5	NE	45	23	1953		5.1
N	80.0	59.5	69.8	91	1979	34	1970	25	169	1.35	3.85	1972	T	1944	3.34	1960	0.0		0.0		87	89	56	74	8.3	NE	31	27	1963		4.7
D	75.6	53.7	64.7	90	1978	26	1962	107	98	1.57	5.42	1940	0.10	1956	3.00	1969	0.0		0.0		87	89	57	75	8.2	NE	35	33	1967		4.9
YR	83.8	63.9	73.9	103	JUN 1981	26	DEC 1962	441	3699	53.64	20.10	JUN 1974	0.00	JAN 1950	10.85	OCT 1951	0.0		0.0		86	89	56	72	8.2	E	92	05	SEP 1960		5.4

Jacksonville, Florida International Airport

	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind						
	Normal			Extremes						Water equivalent							Snow, Ice pellets				Hour	Hour	Hour	Hour		thru 1963	Fastest mile				
Month	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	01	07	13	19	Mean speed m.p.h.	Prevailing direction	Speed m.p.h.	Direction	Year	Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
																					(Local time)										
(a)				42		42					42		42		42		42		42		47	47	47	47	34	14	30	30		32	34
J	64.6	41.7	53.2	85	1947	13	1981	396	30	3.07	7.29	1964	0.06	1950	3.02	1963	T	1982	T	1982	84	87	57	74	8.4	NW	41	NW	1971	58	6.0
F	66.8	43.3	55.1	88	1962	19	1943	302	25	3.48	8.85	1970	0.52	1962	6.22	1970	1.5	1958	1.5	1958	82	85	53	68	9.4	WSW	52	NE	1963	61	5.8
M	73.3	49.3	61.3	91	1974	23	1980	166	51	3.72	10.18	1973	0.18	1945	7.12	1970	T	1980	T	1980	82	86	50	65	9.2	NW	44	SW	1971	67	5.8
A	79.7	55.7	67.7	95	1968	35	1975	21	102	3.32	11.61	1973	0.17	1942	8.25	1973	0.0		0.0		84	86	48	65	8.9	SE	48	W	1973	72	5.2
M	85.2	63.0	74.1	100	1967	45	1973	0	282	4.91	10.43	1966	0.61	1953	5.40	1975	0.0		0.0		85	85	50	67	8.3	WSW	62	N	1975	70	5.5
J	88.9	69.1	79.0	103	1954	55	1981	0	420	5.37	12.90	1967	2.19	1950	5.93	1968	0.0		0.0		87	87	57	73	8.1	SW	76	NE	1967	63	6.1
J	90.7	71.8	81.3	105	1942	61	1972	0	505	6.54	16.21	1960	1.97	1977	10.09	1966	0.0		0.0		88	88	58	75	7.3	SW	49	SW	1950	61	6.3
A	90.2	71.8	81.0	102	1954	64	1950	0	496	7.15	16.24	1968	1.92	1942	7.93	1968	0.0		0.0		90	91	60	78	7.0	SW	52	NE	1969	60	6.2
S	86.9	69.4	78.2	100	1944	48	1981	0	396	7.26	19.36	1949	1.02	1961	10.17	1950	0.0		0.0		90	91	62	80	7.8	NE	82	N	1964	55	6.5
O	79.7	59.2	69.5	96	1951	36	1977	21	160	3.41	13.44	1956	0.16	1942	6.66	1956	0.0		0.0		89	91	58	79	8.3	NE	72	E	1950	57	5.5
N	72.4	49.2	60.8	88	1961	21	1970	164	38	1.94	7.85	1947	T	1970	5.44	1969	0.0		0.0		87	89	56	78	8.0	NW	60	S	1950	61	5.2
D	66.3	43.2	54.8	84	1981	11	1983	332	15	2.59	7.09	1945	0.04	1956	3.75	1983	T	1962	T	1962	86	88	58	78	8.1	NW	62	N	1963	56	6.0
YR	78.7	57.2	68.0	105	JUL 1942	11	DEC 1983	1402	2520	52.77	19.36	SEP 1949	T	NOV 1970	10.17	SEP 1950	1.5	FEB 1958	1.5	FEB 1958	86	88	56	73	8.2	NW	82	N	SEP 1964	62	5.8

Key West, Florida International Airport

	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind						
	Normal			Extremes						Water equivalent							Snow, Ice pellets				Hour	Hour	Hour	Hour		thru 1963	Fastest mile				
Month	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	01	07	13	19	Mean speed m.p.h.	Prevailing direction	Speed m.p.h.	Direction	Year	Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
																					(Local time)										
(a)				31		31					35		35		35		35		35		32	35	35	35	30	3	7	7		24	31
J	71.8	65.6	68.7	85	1960	41	1981	49	164	1.74	17.64	1983	0.03	1960	10.32	1983	0.0		0.0		81	82	69	77	12.1	NE	38	35	1979	73	5.1
F	74.8	65.3	70.1	85	1982	47	1958	37	180	1.92	4.46	1965	0.02	1948	2.54	1966	0.0		0.0		78	81	67	75	12.3	SE	39	12	1983	76	4.8
M	78.6	69.5	74.1	87	1977	49	1980	6	288	1.31	6.57	1983	T	1971	3.10	1968	0.0		0.0		78	79	66	73	12.5	SE	46	26	1980	82	4.5
A	82.0	73.4	77.7	89	1965	55	1950	0	381	1.49	12.83	1948	0.00	1959	3.64	1976	0.0		0.0		76	77	64	71	12.7	ESE	58	01	1980	84	4.4
M	84.9	76.2	80.6	91	1953	66	1960	0	484	3.22	12.90	1960	0.12	1945	8.89	1960	0.0		0.0		77	77	65	72	10.9	ESE	32	32	1983	80	5.2
J	87.3	78.5	82.9	94	1952	68	1961	0	537	5.04	14.43	1972	0.90	1981	6.17	1982	0.0		0.0		79	78	68	73	9.8	SE	35	19	1982	74	6.2
J	88.9	80.0	84.5	95	1951	69	1952	0	605	3.68	11.69	1970	0.54	1961	3.05	1970	0.0		0.0		77	77	66	71	9.8	ESE	32	13	1980	77	6.3
A	88.9	79.6	84.3	95	1957	68	1952	0	598	4.80	11.34	1945	2.25	1969	3.90	1977	0.0		0.0		78	78	67	73	9.5	ESE	35	19	1981	75	6.3
S	86.5	78.6	82.6	94	1951	70	1960	0	528	6.50	18.45	1963	1.70	1951	6.65	1963	0.0		0.0		80	81	70	76	10.0	ESE	38	13	1981	70	6.6
O	84.4	75.8	80.1	93	1962	60	1957	0	468	4.76	21.57	1969	0.74	1972	8.47	1971	0.0		0.0		80	82	69	76	11.2	ENE	35	07	1981	70	5.7
N	79.6	71.4	75.5	88	1964	49	1959	0	315	3.23	27.67	1980	0.13	1961	23.28	1980	0.0		0.0		80	83	69	76	12.0	ENE	37	36	1976	70	5.1
D	75.2	66.8	71.0	86	1978	45	1983	22	208	1.73	4.97	1983	0.07	1981	4.60	1959	0.0		0.0		81	83	69	77	12.1	NE	39	26	1983	71	5.1
YR	81.9	73.4	77.7	95	AUG 1957	41	JAN 1981	114	4756	39.42	27.67	NOV 1980	0.00	APR 1959	23.28	NOV 1980	0.0		0.0		79	80	68	74	11.2	ESE	58	01	APR 1980	75	5.4

Lakeland, Florida Florida Citrus Mutual Bldg.

	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind						
	Normal			Extremes						Water equivalent							Snow, Ice pellets				Hour	Hour	Hour	Hour	§		Fastest mile				
Month	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year					Mean speed m.p.h.	Prevailing direction	Speed m.p.h.	Direction	Year	Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
																					(Local time)										
(a)				37		37					37		37		37		37		37						12	18				24	28
J	70.5	51.0	60.8	85	1947	25	1977	188	58	2.32	8.74	1948	0.12	1950	3.88	1945	1.0	1977	1.0	1977					7.3	NE				62	5.2
F	72.0	52.2	62.1	88	1962	28	1970	170	89	2.52	6.59	1963	0.17	1945	3.92	1971	T	1951	T	1951					7.8	NE				65	5.2
M	76.2	56.3	66.3	91	1977	30	1943	83	123	4.02	12.94	1960	0.78	1949	6.96	1960	0.0		0.0						7.8	W				67	5.3
A	81.8	62.1	72.0	95	1968	40	1950	9	219	2.57	8.48	1959	0.00	1967	4.41	1941	0.0		0.0						7.7	E				74	4.7
M	86.8	67.1	77.0	99	1945	54	1971	0	372	3.44	9.68	1957	0.13	1953	4.36	1968	0.0		0.0						6.9	E				72	5.2
J	89.7	71.3	80.5	100	1977	63	1949	0	465	6.70	14.86	1968	1.87	1948	10.12	1945	0.0		0.0						6.2	E				63	6.3
J	90.4	72.7	81.6	101	1942	66	1947	0	515	8.09	15.67	1960	3.09	1961	6.66	1960	0.0		0.0						5.7	S				61	6.5
A	90.4	73.3	81.9	98	1961	63	1957	0	524	7.18	15.57	1948	3.40	1942	6.20	1949	0.0		0.0						5.5	NE				61	6.3
S	88.0	72.3	80.2	97	1944	61	1947	0	456	6.06	11.68	1947	0.81	1972	6.34	1960	0.0		0.0						6.6	NE				59	6.1
O	82.4	66.1	74.3	94	1959	43	1957	0	288	2.84	6.72	1952	0.04	1974	4.99	1944	0.0		0.0						7.2	NE				65	5.0
N	76.0	57.5	66.8	89	1946	28	1970	72	126	1.60	5.94	1941	T	1960	3.97	1963	0.0		0.0						6.9	NE				66	4.6
D	71.5	52.5	62.0	86	1977	20	1962	156	63	2.09	5.33	1941	0.09	1944	4.88	1949	0.0		0.0						6.9	NE				63	5.0
YR	81.3	62.9	72.1	101	JUL 1942	20	DEC 1962	678	3298	49.43	15.67	JUL 1960	0.00	APR 1967	10.12	JUN 1945	1.0	JAN 1977	1.0	JAN 1977					6.9	NE				65	5.5

Miami, Florida International Airport

	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind					Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
	Normal			Extremes						Water equivalent							Snow, Ice pellets				Hour	Hour	Hour	Hour		thru 1963	Fastest mile				
Month	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	01 (Local time)	07	13	19	Mean speed m.p.h.	Prevailing direction	Speed m.p.h.	Direction	Year		
(a)				41		41					41		41		41		41		41		19	19	19	19	34	15	26	26		7	35
J	75.0	59.2	67.1	87	1982	31	1977	76	141	2.08	6.66	1969	0.04	1951	2.68	1973	0.0		0.0		80	84	60	69	9.4	NNW	46	24	1978	67	5.3
F	75.8	59.7	67.8	89	1982	32	1947	62	140	2.05	8.07	1983	0.01	1944	5.73	1966	0.0		0.0		79	83	57	66	10.1	ESE	41	25	1983	66	5.3
M	79.3	64.1	71.7	92	1977	32	1980	14	222	1.89	7.22	1949	0.02	1956	7.07	1949	0.0		0.0		77	82	57	65	10.5	SE	46	04	1966	77	5.4
A	82.4	68.2	75.3	96	1971	46	1971	0	309	3.07	17.29	1979	0.05	1981	16.21	1979	0.0		0.0		75	79	55	64	10.6	ESE	33	36	1980	81	5.3
M	85.1	71.9	78.5	94	1956	53	1945	0	419	6.53	18.54	1968	0.44	1965	11.59	1977	0.0		0.0		79	81	60	70	9.6	ESE	52	32	1980	72	5.9
J	87.3	74.6	81.0	98	1944	65	1951	0	480	9.15	22.36	1968	1.81	1945	8.20	1977	0.0		0.0		84	86	66	75	8.2	SE	37	13	1967	76	6.8
J	88.7	76.2	82.4	98	1983	69	1950	0	539	5.98	13.51	1947	1.77	1963	4.55	1952	0.0		0.0		82	85	63	72	7.9	SE	38	18	1962	80	6.6
A	89.2	76.5	82.8	98	1954	68	1950	0	552	7.02	16.88	1943	1.65	1954	6.92	1964	0.0		0.0		83	87	66	74	7.8	SE	74	36	1964	76	6.6
S	87.8	75.7	81.8	95	1954	68	1983	0	504	8.07	24.40	1960	2.63	1951	7.58	1960	0.0		0.0		85	89	67	77	8.1	ESE	69	06	1965	75	6.8
O	84.2	71.6	77.9	95	1980	51	1943	0	400	7.14	21.08	1952	1.25	1977	9.95	1948	0.0		0.0		83	87	64	73	9.2	ENE	41	05	1966	73	6.0
N	79.8	65.8	72.8	89	1958	39	1950	5	239	2.71	13.15	1959	0.09	1970	7.93	1959	0.0		0.0		81	85	61	71	9.5	N	32	09	1981	67	5.4
D	76.2	60.8	68.5	87	1978	33	1983	42	150	1.86	6.39	1958	0.13	1968	4.38	1964	0.0		0.0		79	83	59	70	9.2	N	38	32	1967	66	5.3
YR	82.6	68.7	75.6	98	JUL 1983	31	JAN 1977	199	4095	57.55	24.40	SEP 1960	0.01	FEB 1944	16.21	APR 1979	0.0		0.0		81	84	61	70	9.2	ESE	74	36	AUG 1964	73	5.9

Orlando, Florida International Airport

	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind					Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
	Normal			Extremes						Water equivalent							Snow, Ice pellets				Hour	Hour	Hour	Hour		thru 1963	Fastest mile				
Month	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	01 (Local time)	07	13	19	Mean speed m.p.h.	Prevailing direction	Speed m.p.h.	Direction	Year		
(a)				41		41					41		41		41		11		11		19	20	20	20	35	15	34	34			35
J	71.7	49.3	60.5	87	1963	20	1981	212	73	2.10	6.48	1979	0.15	1950	3.42	1979	T	1977	T	1977	84	87	55	68	9.0	NNE	42	25	1953		5.6
F	72.9	50.0	61.5	90	1962	28	1970	172	74	2.83	8.32	1983	0.10	1944	4.38	1970	0.0		0.0		83	86	52	63	9.8	S	46	25	1969		5.6
M	78.3	55.3	66.8	92	1970	25	1980	68	124	3.20	10.54	1960	0.16	1956	5.03	1960	0.0		0.0		83	87	50	61	10.0	S	45	29	1955		5.6
A	83.6	60.3	72.0	96	1968	39	1954	0	214	2.19	6.27	1982	0.14	1977	3.07	1982	0.0		0.0		83	87	46	57	9.5	SE	50	02	1956		5.1
M	88.3	66.2	77.3	102	1945	49	1945	0	381	3.96	10.36	1976	0.43	1961	3.18	1980	0.0		0.0		85	88	49	62	8.8	SE	46	17	1981		5.4
J	90.6	71.2	80.9	100	1950	60	1951	0	477	7.39	18.28	1968	1.97	1948	8.40	1945	0.0		0.0		88	89	57	72	8.1	SW	64	32	1970		6.4
J	91.7	73.0	82.4	100	1961	64	1981	0	539	7.78	19.57	1960	3.53	1981	8.19	1960	0.0		0.0		89	90	59	75	7.4	S	46	14	1961		6.5
A	91.6	73.4	82.5	100	1980	64	1957	0	543	6.32	16.11	1972	2.92	1980	5.29	1949	0.0		0.0		90	92	60	77	7.2	S	50	32	1957		6.4
S	89.7	72.5	81.1	97	1977	56	1956	0	483	5.62	15.87	1945	0.43	1972	9.67	1945	0.0		0.0		90	91	60	78	7.8	ENE	46	24	1969		6.5
O	84.4	65.4	74.9	95	1962	43	1957	0	307	2.82	14.51	1950	0.35	1967	7.74	1950	0.0		0.0		86	88	56	73	8.7	N	48	05	1950		5.5
N	78.2	56.8	67.5	89	1980	29	1950	47	122	1.78	6.55	1980	0.03	1967	4.03	1951	0.0		0.0		86	88	54	72	8.7	N	46	26	1968		5.0
D	73.1	50.9	62.0	90	1978	20	1983	157	64	1.83	5.33	1983	T	1944	3.61	1969	0.0		0.0		86	87	57	72	8.7	NNE	32	07	1968		5.6
YR	82.8	62.0	72.4	102	MAY 1945	20	DEC 1983	656	3401	47.83	19.57	JUL 1960	T	DEC 1944	9.67	SEP 1945	T	JAN 1977	T	JAN 1977	86	88	55	69	8.6	S	64	32	JUN 1970		5.8

Pensacola, Florida Regional Airport

	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind					Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
	Normal			Extremes						Water equivalent							Snow, Ice pellets				Hour	Hour	Hour	Hour			Fastest mile				
Month	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	00 (Local time)	06	12	18	Mean speed m.p.h.	Prevailing direction	Speed m.p.h.	Direction	Year		
(a)				20		20					20		20		20		20		20		18	18	18	18	20		13	13		5	17
J	60.6	42.7	51.7	80	1975	8	1982	445	33	4.47	13.41	1978	0.60	1981	5.44	1978	2.5	1977	1.5	1977	79	81	63	72	9.0		35	27	1978	48	6.6
F	63.6	44.8	54.2	82	1972	19	1970	327	24	4.90	11.66	1966	1.07	1980	4.70	1982	1.9	1973	1.9	1973	77	80	58	67	9.4		32	09	1983	53	5.7
M	69.2	51.4	60.4	85	1974	22	1980	184	42	5.66	12.96	1979	0.87	1967	11.10	1979	T	1980	T	1980	80	82	59	69	9.7		32	10	1983	61	6.2
A	76.7	59.3	68.0	89	1981	37	1973	29	119	4.45	15.52	1964	0.67	1971	7.51	1964	0.0		0.0		82	85	57	67	9.5		35	20	1973	63	5.6
M	83.7	66.3	75.0	96	1964	48	1979	0	310	3.87	8.35	1969	0.30	1965	4.74	1970	0.0		0.0		84	86	59	67	8.5		32	29	1973	67	5.6
J	89.0	72.1	80.6	100	1978	57	1966	0	468	5.75	17.68	1978	0.86	1979	6.77	1970	0.0		0.0		83	86	60	68	7.5		32	33	1972	67	5.4
J	90.1	74.4	82.3	106	1980	61	1967	0	536	7.18	20.36	1979	1.69	1970	5.14	1975	0.0		0.0		85	88	64	71	6.9		35	02	1975	57	6.2
A	89.6	73.9	81.8	100	1972	63	1967	0	521	7.04	13.09	1967	3.10	1972	4.73	1978	0.0		0.0		86	90	66	74	6.5		35	05	1979	58	6.1
S	86.6	70.9	78.7	98	1980	43	1967	0	411	6.75	11.53	1975	0.96	1978	10.02	1967	0.0		0.0		83	87	62	71	7.6		53	10	1979	60	5.5
O	79.3	59.5	69.4	92	1973	37	1982	35	171	3.52	12.01	1970	0.00	1978	4.98	1967	0.0		0.0		79	84	55	68	7.9		29	11	1970	71	4.4
N	69.4	49.8	59.7	85	1973	25	1976	192	33	3.42	6.54	1975	0.30	1981	3.59	1975	0.0		0.0		81	83	59	73	8.3		35	21	1972	64	5.1
D	63.2	44.4	53.8	81	1978	11	1983	359	12	4.15	9.58	1982	0.57	1980	4.52	1964	T	1963	T	1963	80	82	64	74	9.0		32	24	1975	49	6.1
YR	76.8	59.1	68.0	106	JUL 1980	8	JAN 1982	1571	2680	61.16	20.36	JUL 1979	0.00	OCT 1978	11.10	MAR 1979	2.5	JAN 1977	1.9	FEB 1973	82	85	60	70	8.3		53	10	SEP 1979	60	5.7

Tallahassee, Florida Municipal Airport

Month	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind					Pct of possible sunshine	Mean sky cover, tenths, sunrise to sunset
	Normal			Extremes						Water equivalent							Snow, Ice pellets				Hour	Hour	Hour	Hour		thru 1963	Fastest mile				
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	01	07	13	19	Mean speed m.p.h.	Prevailing direction	Speed m.p.h.	Direction	Year		
																					(Local time)										
(a)				23		23					23		23		23		23		23		22	22	22	22	22	2	24	24			22
J	63.4	39.9	51.6	82	1972	8	1981	491	25	4.66	11.68	1975	0.40	1969	3.75	1976	T	1977	T	1977	85	86	59	73	7.2	N	46	23	1963		6.3
F	65.9	41.2	53.6	85	1962	14	1971	341	22	5.00	11.50	1964	1.21	1976	6.04	1981	0.4	1973	0.4	1973	84	87	54	64	7.7	S	40	09	1969		5.9
M	72.7	47.3	60.2	90	1967	20	1980	191	42	5.60	13.57	1973	1.29	1967	7.16	1962	T	1980	T	1980	86	89	52	61	8.0	S	48	27	1964		6.1
A	80.0	54.0	67.1	95	1968	29	1971	48	111	4.13	13.13	1973	0.55	1972	4.73	1964	0.0		0.0		88	91	48	50	7.3	S	35	27	1961		5.9
M	86.0	62.0	74.0	98	1962	34	1971	0	279	5.16	11.66	1976	T	1965	4.50	1979	0.0		0.0		89	91	51	61	6.4	E	40	29	1961		5.6
J	90.1	68.8	79.5	100	1969	49	1972	0	435	6.55	12.62	1965	2.09	1977	6.75	1966	0.0		0.0		90	91	55	67	6.1	S	44	03	1966		5.9
J	90.9	71.5	81.2	103	1980	57	1967	0	502	8.75	20.12	1964	2.35	1983	8.99	1964	0.0		0.0		93	94	62	74	5.4	SW	36	23	1963		6.5
A	90.6	71.6	81.1	100	1980	61	1969	0	499	7.30	15.73	1977	2.45	1983	3.39	1961	0.0		0.0		93	95	62	76	5.2	E	58	02	1962		6.1
S	87.8	68.8	78.3	99	1962	40	1967	0	399	6.45	15.92	1969	0.11	1972	9.47	1969	0.0		0.0		91	94	60	75	6.1	ENE	44	36	1963		6.0
O	80.4	56.4	68.4	93	1971	30	1973	38	143	3.10	11.79	1976	T	1961	5.95	1964	0.0		0.0		88	91	53	72	6.5	N	30	34	1961		4.6
N	71.5	46.0	58.8	88	1961	13	1970	210	24	3.31	10.44	1976	0.08	1971	4.98	1976	0.0		0.0		88	90	54	77	6.3	N	37	29	1963		5.1
D	65.3	40.7	53.0	84	1971	10	1962	383	11	4.58	12.65	1964	0.89	1980	9.24	1964	T	1976	T	1976	86	88	58	77	6.7	N	32	15	1969		6.0
YR	78.7	55.7	67.2	103	JUL 1980	6	JAN 1981	1652	2492	64.59	20.12	JUL 1964	T	MAY 1965	9.47	SEP 1969	0.4	FEB 1973	0.4	FEB 1973	88	91	56	70	6.6	N	58	32	AUG 1962		5.8

Tampa, Florida International Airport

Month	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind					Pct of possible sunshine	Mean sky cover, tenths, sunrise to sunset
	Normal			Extremes						Water equivalent							Snow, Ice pellets				Hour	Hour	Hour	Hour		thru 1963	Fastest mile				
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	01	07	13	19	Mean speed m.p.h.	Prevailing direction	Speed m.p.h.	Direction	Year		
																					(Local time)										
(a)				37		37					37		37		37		37		37		20	20	20	20	37	14	31	31		36	37
J	70.0	49.5	59.8	84	1975	22	1981	228	66	2.17	8.02	1948	T	1950	3.29	1953	0.2	1977	0.2	1977	85	86	59	73	8.8	N	35	29	1959	65	5.6
F	71.3	50.4	60.8	88	1971	24	1958	186	68	3.04	7.95	1963	0.21	1950	3.68	1981	T	1951	T	1951	83	86	56	69	9.4	E	50	32	1954	66	5.5
M	76.2	56.1	66.2	91	1949	29	1980	87	124	3.46	12.64	1959	0.06	1956	5.20	1960	T	1980	T	1980	83	86	55	67	9.7	S	43	29	1956	71	5.5
A	81.9	61.1	71.6	93	1975	40	1971	0	202	1.82	6.59	1957	T	1981	3.70	1951	0.0		0.0		82	87	51	61	9.5	ENE	37	29	1961	75	5.0
M	87.1	67.2	77.1	98	1975	49	1971	0	375	3.38	17.64	1979	0.17	1973	11.84	1979	0.0		0.0		82	86	53	62	8.9	E	46	36	1958	75	5.2
J	89.5	72.3	80.9	98	1977	63	1972	0	477	5.29	13.75	1974	1.86	1951	5.53	1974	0.0		0.0		84	87	60	69	8.2	E	67	31	1964	67	6.7
J	90.0	74.2	82.2	97	1964	63	1970	0	533	7.35	20.59	1960	1.65	1981	12.11	1960	0.0		0.0		85	88	63	73	7.4	E	58	32	1963	62	6.7
A	90.3	74.2	82.2	98	1975	67	1973	0	533	7.64	18.59	1949	2.35	1952	5.37	1949	0.0		0.0		87	91	65	76	7.2	ENE	38	11	1961	60	6.7
S	88.9	72.8	80.9	96	1972	57	1981	0	477	6.23	13.98	1979	1.20	1972	4.67	1950	0.0		0.0		86	91	62	75	8.0	ENE	56	34	1960	60	6.5
O	83.7	65.1	74.5	94	1959	40	1964	0	295	2.34	7.36	1952	0.16	1979	2.54	1968	0.0		0.0		85	88	57	71	8.7	NNE	38	02	1953	64	5.2
N	76.9	56.4	66.7	90	1971	23	1970	65	116	1.87	6.12	1963	T	1960	4.22	1963	0.0		0.0		86	88	57	74	8.5	NNE	43	29	1963	65	5.0
D	71.6	50.9	61.3	86	1978	18	1962	173	58	2.14	6.66	1950	0.21	1956	3.28	1969	0.0		0.0		85	88	59	74	8.7	N	45	36	1953	62	5.6
YR	81.4	62.5	72.0	98	JUN 1977	18	DEC 1962	739	3324	46.73	20.59	JUL 1960	T	APR 1981	12.11	JUL 1960	0.2	JAN 1977	0.2	JAN 1977	84	88	58	70	8.6	E	67	31	JUN 1964	66	5.7

West Palm Beach, Florida Palm Beach International Airport

Month	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind					Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
	Normal			Extremes						Water equivalent							Snow, Ice pellets				Hour	Hour	Hour	Hour		thru 1963	Fastest mile				
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	01	07	13	19	Mean speed m.p.h.	Prevailing direction	Speed m.p.h.	Direction	Year		
																					(Local time)										
(a)				47		47					45		45		45		38		38		19	19	19	19	41	14	34	34			35
J	74.5	55.9	65.2	89	1942	27	1977	92	99	2.71	11.01	1983	0.22	1960	5.36	1957	T	1977	T	1977	80	82	58	72	9.8	NW	48	29	1955		5.8
F	75.3	56.2	65.8	90	1949	32	1978	86	108	2.62	8.71	1983	0.29	1948	4.70	1966	0.0		0.0		79	81	56	69	10.4	SE	46	29	1956		5.7
M	79.3	60.8	70.1	94	1977	30	1980	18	176	2.69	16.78	1982	0.33	1956	8.80	1982	0.0		0.0		77	80	55	67	10.8	SE	51	27	1957		5.6
A	82.5	65.1	73.8	99	1971	45	1971	0	264	3.21	18.26	1942	0.04	1967	15.23	1942	0.0		0.0		75	77	54	65	10.9	E	55	32	1958		5.4
M	85.7	69.5	77.6	96	1971	53	1940	0	391	6.02	15.22	1976	0.39	1967	7.04	1958	0.0		0.0		78	78	59	70	9.8	ESE	45	27	1954		5.9
J	88.1	72.7	80.4	98	1980	62	1965	0	462	7.92	17.91	1966	1.07	1952	9.21	1945	0.0		0.0		84	83	66	76	8.1	ESE	71	09	1957		6.7
J	89.7	74.2	82.0	101	1942	66	1937	0	527	6.06	17.74	1941	1.22	1961	5.83	1972	0.0		0.0		84	84	63	74	7.5	ESE	46	34	1974		6.6
A	90.1	74.6	82.5	98	1963	65	1957	0	543	5.76	13.52	1950	2.16	1955	5.89	1949	0.0		0.0		83	84	63	75	7.6	ESE	86	13	1964		6.6
S	88.4	74.3	81.4	97	1937	66	1938	0	492	9.29	24.86	1960	2.73	1939	8.71	1950	0.0		0.0		84	86	66	78	8.6	ENE	58	36	1979		6.9
O	84.4	70.1	77.3	95	1959	46	1968	0	381	7.77	18.74	1965	1.20	1972	9.59	1955	0.0		0.0		80	83	62	74	10.0	ENE	74	16	1964		6.2
N	79.6	63.5	71.6	91	1941	36	1950	9	207	3.39	14.63	1982	0.23	1970	5.89	1982	0.0		0.0		80	82	60	73	10.0	ENE	35	34	1959		5.7
D	75.7	58.2	67.0	90	1941	30	1983	57	119	2.26	8.73	1949	0.06	1968	5.26	1955	0.0		0.0		79	81	59	73	9.9	NNW	36	07	1958		5.6
YR	82.8	66.3	74.6	101	JUL 1942	27	JAN 1977	262	3769	59.72	24.86	SEP 1960	0.04	APR 1967	15.23	APR 1942	T	JAN 1977	T	JAN 1977	80	82	60	72	9.5	ESE	86	13	AUG 1964		6.1

Athens, Georgia Municipal Airport

Month	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind					Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
	Normal			Extremes						Water equivalent							Snow, Ice pellets				Hour	Hour	Hour	Hour		thru 1963	Fastest mile				
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	01 (Local time)	07	13	19	Mean speed m.p.h.	Prevailing direction	Speed m.p.h.	Direction	Year		
(a)				40		40					40		40		40		40		40		28	28	28	28	28	8	28	28			35
J	52.2	32.6	42.4	80	1975	-1	1966	701	0	4.85	9.47	1960	0.64	1981	3.86	1969	5.1	1982	5.0	1948	76	81	58	64	8.5	NW	52	25	1959		6.2
F	55.9	34.2	45.1	79	1982	5	1958	557	0	4.16	9.24	1961	0.75	1978	3.58	1981	4.7	1979	4.0	1952	71	78	55	59	9.0	WNW	52	20	1961		5.9
M	63.6	41.0	52.4	88	1974	11	1980	402	12	5.81	10.93	1964	1.88	1982	4.41	1964	8.7	1983	8.7	1983	72	81	53	57	8.9	NW	50	24	1974		6.0
A	73.6	49.7	61.7	90	1981	27	1950	130	31	4.04	9.54	1964	0.69	1950	3.87	1979	0.0		0.0		73	82	51	54	8.5	WNW	47	23	1957		5.5
M	80.7	58.1	69.4	97	1962	37	1971	30	167	4.78	11.34	1959	0.55	1951	5.54	1959	0.0		0.0		82	86	54	61	7.1	ENE	35	16	1968		5.7
J	86.8	65.2	76.0	104	1954	45	1972	0	330	4.00	13.21	1967	0.87	1958	9.93	1967	0.0		0.0		84	87	56	63	6.6	SW	40	25	1957		5.7
J	89.3	68.9	79.2	104	1977	55	1967	0	440	5.18	10.53	1964	0.93	1947	4.14	1964	0.0		0.0		87	90	59	68	6.2	SW	35	32	1983		6.0
A	88.8	68.2	78.5	107	1983	54	1968	0	419	3.64	7.43	1961	0.09	1951	3.05	1969	0.0		0.0		88	92	59	70	5.7	SW	40	16	1959		5.5
S	82.9	62.9	72.9	99	1957	36	1967	0	242	3.58	7.09	1970	0.52	1954	5.34	1956	0.0		0.0		87	92	60	73	6.4	NE	37	15	1980		5.6
O	73.6	50.5	62.1	98	1954	24	1952	129	39	2.70	7.73	1964	T	1963	4.70	1964	0.0		0.0		83	89	55	68	6.8	NE	29	07	1956		4.6
N	63.3	40.9	52.1	86	1961	7	1950	387	0	3.32	14.98	1948	0.33	1950	4.05	1948	2.2	1968	2.2	1968	78	85	54	65	7.4	NW	35	29	1957		5.1
D	54.7	34.7	44.7	78	1971	2	1962	629	0	4.09	8.45	1945	1.03	1965	4.33	1972	3.0	1971	3.0	1971	76	82	58	66	8.1	ENE	43	29	1957		5.9
YR	72.1	50.6	61.4	107	AUG 1983	-1	JAN 1966	2965	1680	50.15	14.98	NOV 1948	T	OCT 1963	9.93	JUN 1967	8.7	MAR 1983	8.7	MAR 1983	80	85	56	64	7.5	NW	52	20	FEB 1961		5.7

Atlanta, Georgia Hartsfield Atlanta Intl. Airport

Month	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind					Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
	Normal			Extremes						Water equivalent							Snow, Ice pellets				Hour	Hour	Hour	Hour		thru 1963	Fastest mile				
	# Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	01 (Local time)	07	13	19	Mean speed m.p.h.	Prevailing direction	Speed m.p.h.	Direction	Year		
(a)				35		35					49		49		49		49		49		23	23	23	23	45	14	7	7		48	49
J	51.2	32.6	41.9	79	1949	-5	1982	716	0	4.91	10.82	1936	0.84	1981	3.91	1973	8.3	1940	8.3	1940	75	78	60	64	10.6	NW	46	23	1978	48	6.4
F	55.3	34.5	44.9	79	1980	5	1958	563	0	4.43	12.77	1961	0.77	1978	5.67	1961	4.4	1979	4.2	1979	69	75	54	56	10.9	NW	36	17	1977	54	6.2
M	63.2	41.7	52.5	85	1982	10	1960	400	12	5.91	11.66	1980	2.44	1974	5.09	1976	7.9	1983	7.9	1983	69	78	51	54	10.9	NW	38	30	1980	57	6.2
A	73.2	50.4	61.8	91	1980	26	1973	133	37	4.43	11.86	1979	1.45	1950	5.58	1979	T	1971	T	1971	70	79	50	52	10.1	NW	36	32	1982	65	5.6
M	79.8	58.7	69.3	95	1953	37	1971	37	170	4.02	8.37	1980	0.32	1936	5.13	1948	0.0		0.0		78	83	54	58	8.6	NW	44	27	1981	68	5.7
J	85.6	65.9	75.8	101	1952	46	1956	5	329	3.41	7.52	1939	0.74	1944	3.41	1943	0.0		0.0		81	85	57	62	8.0	NW	40	30	1977	67	5.8
J	87.9	69.2	78.6	105	1980	53	1967	0	422	4.73	11.26	1948	0.76	1980	5.44	1948	0.0		0.0		86	89	61	68	7.5	SW	39	06	1977	63	6.3
A	87.6	68.7	78.2	102	1980	56	1964	0	409	3.41	8.69	1967	0.50	1976	5.05	1940	0.0		0.0		86	90	61	68	7.1	NW	30	07	1979	65	5.8
S	82.3	63.6	73.0	98	1954	36	1967	7	247	3.17	7.52	1983	0.26	1954	5.46	1956	0.0		0.0		84	89	61	69	8.0	ENE	37	27	1980	63	5.5
O	72.9	51.4	62.2	95	1954	28	1976	130	44	2.53	7.53	1966	T	1963	3.46	1982	0.0		0.0		78	84	53	64	8.5	NW	28	31	1977	68	4.6
N	62.6	41.3	52.0	84	1961	3	1950	394	0	3.43	15.72	1948	0.41	1939	4.11	1935	1.0	1968	1.0	1968	75	81	55	63	9.1	NW	33	08	1977	60	5.3
D	54.1	34.8	44.5	77	1971	0	1983	636	0	4.23	9.92	1961	0.69	1979	3.85	1961	2.5	1963	2.2	1963	74	79	59	64	9.9	NW	32	31	1977	50	6.2
YR	71.3	51.1	61.2	105	JUL 1980	-5	JAN 1982	3021	1670	48.61	15.72	NOV 1948	T	OCT 1963	5.67	FEB 1961	8.3	JAN 1940	8.3	JAN 1940	77	83	56	62	9.1	NW	46	23	JAN 1978	61	5.8

Augusta, Georgia Bush Field

Month	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind					Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
	Normal			Extremes						Water equivalent							Snow, Ice pellets				Hour	Hour	Hour	Hour		thru 1963	Fastest mile				
	# Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	01 (Local time)	07	13	19	Mean speed m.p.h.	Prevailing direction	Speed m.p.h.	Direction	Year		
(a)				33		33					33		33		33		33		33		19	19	19	19	33	13	33	33			33
J	56.7	33.2	45.0	80	1975	1	1982	626	6	3.99	8.48	1960	0.75	1981	3.61	1960	1.5	1982	1.5	1982	79	83	55	67	7.1	W	36	23	1978		6.2
F	60.1	35.0	47.5	86	1962	9	1973	495	5	4.04	7.67	1961	0.69	1968	3.59	1962	14.0	1973	13.7	1973	76	81	49	59	7.7	WNW	40	30	1982		5.8
M	67.6	42.0	54.8	88	1974	12	1980	332	16	4.92	11.92	1980	0.88	1968	5.31	1967	1.1	1980	1.1	1980	76	83	48	56	8.0	WNW	52	23	1972		6.1
A	76.8	49.5	63.2	93	1980	26	1982	92	38	3.31	8.43	1961	0.60	1970	3.96	1955	0.0		0.0		79	85	46	55	7.6	SE	39	32	1962		5.4
M	83.7	58.3	71.0	99	1964	35	1971	17	203	3.73	9.61	1979	0.48	1951	4.44	1981	0.0		0.0		85	87	50	61	6.5	SE	48	28	1967		5.9
J	89.1	65.6	77.4	105	1952	47	1972	0	372	3.88	7.28	1973	1.56	1979	5.08	1981	0.0		0.0		86	86	52	63	6.1	SE	62	08	1965		5.9
J	91.4	69.6	80.6	107	1980	55	1951	0	484	4.40	11.43	1967	1.44	1983	3.71	1979	0.0		0.0		87	87	55	67	5.9	SE	48	33	1970		6.2
A	90.9	68.9	79.9	108	1983	54	1968	0	462	3.98	9.91	1964	0.65	1980	5.98	1964	0.0		0.0		90	91	56	72	5.5	SE	45	18	1953		5.7
S	85.6	63.5	74.6	101	1957	36	1967	0	288	3.53	9.51	1975	0.61	1967	4.93	1969	0.0		0.0		90	92	56	77	5.6	NE	35	32	1959		5.8
O	76.9	50.1	63.5	97	1954	22	1952	107	61	2.02	6.90	1959	T	1953	2.67	1964	0.0		0.0		87	89	49	76	5.8	NW	40	18	1977		4.7
N	67.5	40.3	53.9	90	1961	15	1970	338	0	2.07	6.18	1957	0.09	1960	2.63	1955	T	1968	T	1968	83	87	49	71	6.1	NW	40	27	1954		5.1
D	59.2	34.6	46.9	82	1982	5	1981	561	0	3.20	8.65	1981	0.32	1955	3.12	1970	0.9	1958	0.9	1958	80	84	53	70	6.7	NW	34	25	1954		5.9
YR	75.5	50.9	63.2	108	AUG 1983	1	JAN 1982	2568	1935	43.07	11.92	MAR 1980	T	OCT 1953	5.98	AUG 1964	14.0	FEB 1973	13.7	FEB 1973	83	86	51	66	6.5	SE	62	08	JUN 1965		5.8

Columbus, Georgia Metropolitan Airport

Month	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind					Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
	Normal			Extremes						Water equivalent							Snow, Ice pellets				Hour	Hour	Hour	Hour			Fastest mile				
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	01 (Local time)	07 (Local time)	13 (Local time)	19 (Local time)	Mean speed m.p.h.	Prevailing direction	Speed m.p.h.	Direction	Year		
(a)				38		38					38		38		38		38		38		18	38	38	38	25		25	25			38
J	56.9	35.4	46.2	83	1949	3	1966	593	10	4.52	10.22	1947	0.87	1954	4.27	1978	2.0	1982	1.4	1977	79	85	60	70	7.3		37	25	1974		6.6
F	60.6	37.0	48.8	83	1962	11	1973	460	7	4.52	9.41	1961	1.22	1951	5.77	1981	14.0	1973	14.0	1973	76	83	55	62	8.0		52	20	1960		6.2
M	68.0	43.9	56.0	89	1982	16	1980	299	20	5.96	12.53	1952	1.40	1967	5.30	1966	1.0	1980	1.0	1980	79	85	52	58	8.1		44	27	1963		6.2
A	77.4	51.9	64.7	92	1970	28	1950	84	75	4.50	11.67	1953	0.86	1967	5.74	1981	T	1971	T	1971	79	85	49	55	7.3		40	29	1963		5.4
M	83.8	60.2	72.0	97	1962	39	1963	9	226	4.44	8.45	1959	0.22	1962	4.61	1957	0.0		0.0		84	85	51	60	6.5		39	23	1971		5.7
J	89.4	67.6	78.5	104	1978	44	1956	0	405	4.16	10.83	1967	1.24	1979	3.68	1959	0.0		0.0		83	86	53	62	6.1		55	29	1971		5.7
J	91.1	71.0	81.0	104	1977	59	1967	0	496	5.50	13.24	1971	1.74	1957	5.32	1955	0.0		0.0		87	90	58	69	5.5		52	36	1962		6.4
A	90.8	70.5	80.7	102	1983	57	1952	0	487	4.02	10.07	1977	0.96	1956	6.80	1977	0.0		0.0		88	91	57	70	5.3		47	18	1959		5.6
S	86.0	65.9	76.0	99	1957	38	1967	0	330	3.59	6.94	1951	0.42	1955	4.25	1971	0.0		0.0		87	90	57	71	6.4		38	36	1963		5.7
O	77.0	53.1	65.1	96	1954	24	1952	83	86	2.07	8.09	1964	0.00	1963	5.63	1964	0.0		0.0		84	90	52	72	6.5		26	23	1963		4.5
N	67.0	42.7	54.9	86	1961	10	1950	313	10	3.06	12.45	1948	0.31	1956	4.80	1977	T	1975	T	1975	84	88	54	72	6.4		37	31	1973		5.3
D	59.5	37.2	48.4	82	1977	4	1962	515	0	4.75	9.39	1953	0.43	1955	4.41	1970	T	1981	T	1981	81	85	58	72	7.0		35	22	1969		6.1
YR	75.6	53.0	64.4	104	JUN 1978	3	JAN 1966	2356	2152	51.09	13.24	JUL 1971	0.00	OCT 1963	6.80	AUG 1977	14.0	FEB 1973	14.0	FEB 1973	83	87	55	66	6.7		55	29	JUN 1971		5.8

Macon, Georgia Lewis B. Wilson Airport

Month	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind					Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
	Normal			Extremes						Water equivalent							Snow, Ice pellets				Hour	Hour	Hour	Hour		thru 1963	Fastest mile				
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	01 (Local time)	07 (Local time)	13 (Local time)	19 (Local time)	Mean speed m.p.h.	Prevailing direction	Speed m.p.h.	Direction	Year		
(a)				35		35					35		35		35		35		35		19	19	19	19	35	15	33	33		35	35
J	57.6	35.5	46.6	84	1949	3	1966	580	10	4.26	8.30	1964	0.69	1954	4.44	1962	3.7	1955	3.7	1955	79	83	59	65	8.3	WNW	47	SW	1959	54	6.3
F	61.1	37.9	49.2	85	1962	9	1973	452	9	4.56	9.32	1983	0.59	1976	5.17	1981	16.5	1973	16.5	1973	76	83	54	58	8.9	WNW	60	NE	1960	59	6.0
M	68.6	44.2	56.5	95	1949	14	1980	287	24	5.18	11.90	1980	1.26	1968	3.94	1970	1.1	1980	1.1	1980	77	85	52	56	9.4	WNW	60	W	1982	63	6.1
A	78.2	52.3	65.3	94	1970	31	1983	60	69	3.51	8.42	1964	0.53	1972	3.65	1955	0.0		0.0		79	86	49	53	8.9	WNW	57	SE	1957	69	5.4
M	85.0	60.3	72.7	99	1967	40	1971	10	249	3.79	11.77	1957	0.32	1956	5.37	1976	0.0		0.0		83	87	51	58	7.7	NW	65	SE	1952	70	5.7
J	90.4	67.3	78.9	106	1954	46	1972	0	417	3.83	9.06	1965	0.99	1954	4.97	1965	0.0		0.0		85	87	53	61	7.3	NW	56	NW	1954	69	5.8
J	92.2	70.6	81.4	108	1980	54	1967	0	508	4.46	9.04	1953	1.21	1952	2.69	1965	0.0		0.0		87	90	58	67	6.9	SW	59	SE	1954	64	6.4
A	91.9	70.0	81.0	105	1980	55	1952	0	496	3.64	7.09	1973	1.13	1980	2.96	1959	0.0		0.0		89	92	58	69	6.4	NE	70	S	1961	69	5.7
S	86.8	65.1	76.0	102	1980	35	1967	0	335	3.29	8.82	1953	0.41	1970	4.60	1956	0.0		0.0		89	93	59	72	7.0	NE	40	NW	1954	64	5.8
O	78.0	52.3	65.2	100	1954	26	1952	86	92	1.98	9.39	1959	0.00	1963	5.35	1970	0.0		0.0		85	89	52	67	7.0	NE	32	NW	1959	69	4.6
N	68.1	42.5	55.3	88	1961	10	1950	299	8	2.32	6.96	1983	0.43	1956	2.98	1983	0.2	1950	0.2	1950	82	87	52	66	7.3	WNW	54	SW	1957	63	5.1
D	60.2	37.1	48.7	82	1972	5	1962	505	0	4.04	10.39	1972	0.58	1955	4.50	1972	0.5	1963	0.5	1963	79	83	56	67	7.9	NW	50	NW	1967	56	6.0
YR	76.5	52.9	64.7	108	JUL 1980	3	JAN 1966	2279	2217	44.86	11.90	MAR 1980	0.00	OCT 1963	5.37	MAY 1976	16.5	FEB 1973	16.5	FEB 1973	83	87	54	63	7.7	WNW	70	S	AUG 1961	63	5.8

Savannah, Georgia Municipal Airport

Month	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind					Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
	Normal			Extremes						Water equivalent							Snow, Ice pellets				Hour	Hour	Hour	Hour		thru 1963	Fastest mile				
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	01 (Local time)	07 (Local time)	13 (Local time)	19 (Local time)	Mean speed m.p.h.	Prevailing direction	Speed m.p.h.	Direction	Year		
(a)				33		33					33		33		33		33		33		19	19	19	19	33	13	29	29		33	33
J	60.3	37.9	49.2	84	1957	9	1966	507	17	3.09	7.18	1967	0.51	1957	2.80	1967	2.0	1977	1.3	1977	78	82	54	66	8.6	WNW	46	NW	1955	55	6.1
F	63.1	40.0	51.6	86	1962	14	1958	387	12	3.17	7.92	1964	1.16	1968	3.46	1964	3.6	1968	3.6	1968	75	80	50	60	9.3	NE	44	WNW	1960	58	6.0
M	69.9	46.8	58.4	91	1974	20	1980	243	38	3.83	9.57	1959	0.18	1955	4.65	1959	T	1983	T	1983	78	82	48	59	9.3	WNW	42	W	1976	62	6.0
A	77.8	54.1	66.0	95	1967	32	1962	42	72	3.16	7.74	1961	0.71	1969	5.62	1976	0.0		0.0		79	83	46	58	8.8	SSE	40	N	1963	70	5.5
M	84.2	62.3	73.3	100	1953	39	1963	0	261	4.62	10.08	1957	0.51	1953	5.67	1976	0.0		0.0		84	86	52	64	7.7	SW	42	N	1965	67	5.9
J	88.6	68.5	78.6	103	1954	53	1966	0	406	5.69	14.39	1963	0.84	1954	4.06	1963	0.0		0.0		86	87	56	69	7.5	SW	66	E	1953	64	6.2
J	90.8	71.5	81.2	104	1980	61	1972	0	502	7.37	20.10	1964	1.35	1972	6.36	1957	0.0		0.0		88	89	59	73	7.1	SW	51	SE	1951	62	6.5
A	90.1	71.4	80.8	104	1954	61	1966	0	490	6.65	14.94	1971	1.02	1980	7.04	1971	0.0		0.0		89	91	61	76	6.6	SW	58	N	1954	62	6.1
S	85.6	67.6	76.6	98	1983	43	1967	0	348	5.19	13.47	1953	0.36	1972	6.80	1979	0.0		0.0		88	90	60	76	7.2	NE	58	E	1979	57	6.4
O	77.8	55.9	66.9	94	1954	28	1952	58	117	2.27	8.54	1959	0.02	1963	3.57	1959	0.0		0.0		84	87	53	73	7.5	NNE	37	NE	1952	64	5.0
N	69.5	45.5	57.5	89	1961	15	1970	240	15	1.89	4.91	1972	0.15	1966	5.02	1969	0.0		0.0		82	85	51	71	7.5	NNE	34	W	1957	62	5.2
D	62.5	39.4	51.0	83	1971	9	1983	444	10	2.77	5.60	1977	0.40	1955	3.47	1964	T	1980	T	1980	79	82	54	69	8.0	NE	37	NW	1962	54	6.0
YR	76.7	55.1	65.9	104	JUL 1980	9	DEC 1983	1921	2290	49.70	20.10	JUL 1964	0.02	OCT 1963	7.04	AUG 1971	3.6	FEB 1968	3.6	FEB 1968	83	85	54	68	7.9	SW	66	E	JUN 1953	62	5.9

Baton Rouge, Louisiana Ryan Airport

	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind					Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
	Normal			Extremes						Water equivalent							Snow, Ice pellets				Hour	Hour	Hour	Hour		thru 1963	Fastest mile				
Month	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	00 (Local time)	06	12	18	Mean speed m.p.h.	Prevailing direction	Speed m.p.h.	Direction	Year		
(a)				33		33					33		33		33		33		33		24	24	24	24	32	12	21	21			32
J	61.1	40.5	50.8	82	1957	10	1982	466	26	4.58	9.93	1966	1.15	1971	4.08	1975	0.6	1973	0.5	1973	81	85	65	67	9.1	N	35	27	1983		6.8
F	64.5	42.7	53.6	85	1962	20	1958	342	23	4.97	14.51	1966	0.70	1962	4.72	1979	1.8	1973	1.8	1973	78	84	59	60	9.5	NE	35	25	1970		6.3
M	71.6	49.4	60.5	91	1963	20	1980	187	47	4.59	12.73	1973	0.54	1955	6.07	1973	T	1980	T	1980	79	85	57	59	9.5	SE	35	13	1964		6.3
A	79.2	57.5	68.4	92	1952	37	1975	32	134	5.59	14.84	1980	0.38	1976	12.08	1967	0.0		0.0		83	88	56	59	9.0	SE	35	25	1964		6.2
M	85.2	64.3	74.8	98	1953	44	1954	0	304	4.82	10.70	1953	0.63	1963	4.96	1954	0.0		0.0		84	90	57	60	7.8	SE	48	17	1967		5.8
J	90.6	70.0	80.3	103	1954	55	1972	0	459	3.11	12.25	1983	0.12	1979	3.96	1962	0.0		0.0		85	91	58	64	6.7	SE	40	03	1964		5.5
J	91.4	72.8	82.1	101	1960	58	1967	0	530	7.07	10.98	1963	2.05	1962	4.26	1969	0.0		0.0		87	91	62	70	6.0	W	41	03	1980		6.2
A	90.8	72.0	81.4	102	1962	59	1967	0	508	5.05	13.31	1977	1.32	1980	6.21	1983	0.0		0.0		88	92	62	71	5.6	E	37	32	1975		5.8
S	87.4	68.3	77.9	97	1963	43	1967	0	387	4.42	13.95	1977	0.09	1953	6.31	1973	0.0		0.0		88	91	61	70	6.7	NE	58	06	1965		5.5
O	80.1	56.3	68.2	94	1952	32	1957	48	147	2.63	9.46	1964	T	1978	8.38	1964	0.0		0.0		85	88	54	65	6.7	NE	40	33	1964		4.4
N	70.1	47.2	58.7	86	1971	21	1976	218	29	3.95	10.35	1977	0.25	1967	4.67	1973	T	1976	T	1976	85	88	58	68	7.8	N	31	33	1977		5.7
D	63.8	42.3	53.1	85	1982	11	1983	380	11	4.99	15.94	1982	1.94	1978	8.28	1982	T	1983	T	1983	82	86	63	68	8.4	SE	30	18	1966		6.2
YR	78.0	57.0	67.5	103	JUN 1954	10	JAN 1982	1673	2605	55.77	15.94	DEC 1982	T	OCT 1978	12.08	APR 1967	1.8	FEB 1973	1.8	FEB 1973	84	88	59	65	7.7	SE	58	06	SEP 1965		5.9

Lake Charles, Louisiana Municipal Airport

	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind					Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
	Normal			Extremes						Water equivalent							Snow, Ice pellets				Hour	Hour	Hour	Hour		thru 1963	Fastest mile				
Month	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	00 (Local time)	06	12	18	Mean speed m.p.h.	Prevailing direction	Speed m.p.h.	Direction	Year		
(a)				19		19					22		22		22		22		22		19	19	19	19	22	2	22	22		2	22
J	60.8	42.2	51.5	80	1982	15	1982	442	24	4.25	12.69	1974	0.78	1971	3.60	1972	4.0	1973	4.0	1973	86	87	69	77	10.2	N	58	32	1962	49	7.0
F	64.0	44.5	54.3	83	1972	22	1981	324	24	3.88	6.75	1969	0.80	1962	3.28	1963	0.3	1968	0.3	1968	84	86	63	69	10.4	S	40	25	1971	45	6.2
M	70.5	50.8	60.7	86	1974	25	1980	184	51	3.05	9.01	1980	0.27	1971	4.91	1973	T	1968	T	1968	86	88	62	69	10.7	S	40	18	1973	61	6.7
A	77.8	58.9	68.4	92	1965	34	1971	29	131	4.06	10.95	1973	0.52	1978	5.50	1973	0.0		0.0		88	90	62	67	10.3	S	44	06	1973	65	6.6
M	84.1	65.6	74.9	94	1977	49	1978	0	307	5.14	20.71	1980	0.34	1978	16.88	1980	0.0		0.0		90	92	62	68	8.9	S	43	32	1973	79	5.9
J	89.4	71.4	80.4	98	1969	58	1979	0	462	4.19	14.42	1981	0.84	1969	7.09	1981	0.0		0.0		90	92	62	67	7.5	SSW	38	16	1974	79	5.3
J	91.0	73.5	82.3	102	1980	61	1967	0	536	5.55	13.19	1979	0.48	1962	6.36	1979	0.0		0.0		91	93	64	71	6.5	SSW	35	12	1974	83	6.2
A	90.8	72.8	81.8	100	1980	61	1967	0	521	5.39	17.36	1962	0.77	1976	14.10	1962	0.0		0.0		91	93	64	72	6.1	SSW	46	11	1964	81	5.8
S	87.5	68.9	78.2	96	1964	47	1967	0	396	5.21	19.96	1973	1.01	1962	11.20	1979	0.0		0.0		90	92	63	74	7.2	ENE	40	36	1971	85	5.4
O	80.8	57.7	69.3	92	1977	36	1980	45	178	3.47	17.28	1970	T	1963	7.24	1970	0.0		0.0		88	90	55	71	7.6	ENE	33	27	1973	74	4.5
N	70.5	48.9	59.7	87	1978	23	1976	204	45	3.76	7.30	1974	0.11	1967	3.51	1966	T	1976	T	1976	87	88	59	75	9.0	ENE	35	32	1975	50	5.4
D	64.0	43.8	53.9	82	1978	13	1983	351	7	5.08	13.27	1967	2.07	1975	6.88	1971	T	1963	T	1963	86	88	66	77	9.5	NE	32	15	1982	44	6.4
YR	77.6	58.3	68.0	102	JUL 1980	13	DEC 1983	1579	2682	53.03	20.71	MAY 1980	T	OCT 1963	16.88	MAY 1980	4.0	JAN 1973	4.0	JAN 1973	88	90	63	71	8.7	S	58	32	JAN 1962	68	5.9

New Orleans, Louisiana New Orleans Intl. Airport

	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind					Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
	Normal			Extremes						Water equivalent							Snow, Ice pellets				Hour	Hour	Hour	Hour		thru 1963	Fastest mile				
Month	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	00 (Local time)	06	12	18	Mean speed m.p.h.	Prevailing direction	Speed m.p.h.	Direction	Year		
(a)				37		37					37		37		37		37		37		35	35	35	35	35		24	24		10	35
J	61.8	43.0	52.4	83	1982	14	1963	423	32	4.97	13.63	1978	0.54	1968	6.08	1978	0.1	1973	0.1	1973	82	85	67	72	9.4		46	21	1975	48	6.7
F	64.6	44.8	54.7	85	1972	19	1970	318	30	5.23	12.59	1983	1.02	1962	5.60	1961	2.0	1958	2.0	1958	81	84	63	67	9.8		43	26	1970	52	6.2
M	71.2	51.6	61.4	89	1982	25	1980	171	59	4.73	19.09	1948	0.24	1955	7.87	1948	T	1980	T	1980	82	84	60	65	10.0		37	18	1969	56	6.4
A	78.6	58.8	68.7	91	1948	32	1971	25	136	4.50	16.12	1980	0.28	1976	7.95	1980	0.0		0.0		84	88	60	65	9.5		35	20	1980	62	5.8
M	84.5	65.3	74.9	96	1953	41	1960	0	307	5.07	14.33	1959	0.99	1949	9.86	1959	0.0		0.0		86	89	60	65	8.1		55	36	1973	59	5.4
J	89.5	70.9	80.3	100	1954	55	1972	0	459	4.63	12.28	1975	0.23	1979	4.19	1953	0.0		0.0		86	89	62	67	6.9		48	05	1971	67	5.2
J	90.7	73.5	82.1	101	1981	60	1967	0	530	6.73	13.07	1982	1.92	1981	4.30	1966	0.0		0.0		89	91	66	73	6.1		44	13	1979	61	6.3
A	90.2	73.1	81.7	102	1980	60	1968	0	518	6.02	16.12	1977	1.68	1980	4.82	1975	0.0		0.0		88	91	66	73	5.9		42	33	1969	61	5.7
S	86.8	70.1	78.5	101	1980	42	1967	0	405	5.87	16.74	1971	0.24	1953	6.50	1971	0.0		0.0		87	89	66	74	7.2		69	09	1965	63	5.4
O	79.4	59.0	69.2	92	1977	35	1968	31	161	2.66	6.45	1959	0.00	1978	3.44	1975	0.0		0.0		84	87	59	72	7.5		40	17	1964	68	4.2
N	70.1	49.9	60.0	86	1979	24	1970	186	36	4.06	14.58	1947	0.21	1949	8.72	1975	T	1950	T	1950	84	86	61	74	8.6		32	21	1983	55	5.2
D	64.4	44.8	54.6	84	1978	14	1983	336	13	5.27	10.77	1967	1.46	1958	5.71	1982	2.7	1963	2.7	1963	83	85	66	74	9.1		46	28	1973	55	6.2
YR	77.7	58.7	68.2	102	AUG 1980	14	DEC 1983	1490	2686	59.74	19.09	MAR 1948	0.00	OCT 1978	9.86	MAY 1959	2.7	DEC 1963	2.7	DEC 1963	85	87	63	70	8.2		69	09	SEP 1965	59	5.7

Shreveport, Louisiana Shreveport Regional Airport

Month	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind					Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
	Normal			Extremes						Water equivalent							Snow, Ice pellets				Hour	Hour	Hour	Hour		thru 1963	Fastest mile				
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	00 (Local time)	06 (Local time)	12 (Local time)	18 (Local time)	Mean speed m.p.h.	Prevailing direction	Speed m.p.h.	Direction	Year		
(a)				31		31					31		31		31		31		31		31	31	31	31	31	11	21	21		31	31
J	55.8	36.2	46.0	84	1972	3	1962	597	8	4.02	10.09	1974	0.27	1971	3.18	1979	5.9	1978	5.6	1982	77	84	64	65	9.5	S	37	22	1967	48	6.8
F	60.6	39.0	49.8	89	1977	12	1978	438	12	3.46	8.57	1983	0.90	1954	3.53	1965	2.0	1978	2.0	1965	75	83	59	58	9.9	S	40	27	1965	54	6.2
M	68.1	45.8	57.0	92	1974	20	1980	282	34	3.77	7.23	1969	0.56	1966	3.63	1979	4.0	1965	4.0	1965	75	83	57	55	10.4	S	41	29	1964	56	6.4
A	76.7	54.6	65.7	91	1955	32	1975	69	90	4.71	11.19	1957	1.06	1971	7.17	1953	0.0		0.0		79	87	58	57	10.0	S	52	28	1975	55	6.4
M	83.5	62.4	73.0	95	1977	42	1960	9	257	4.70	11.78	1967	1.22	1962	5.27	1978	0.0		0.0		83	90	59	60	8.5	S	39	28	1981	62	6.0
J	90.1	69.4	79.8	101	1953	52	1977	0	444	3.54	12.39	1961	0.89	1967	4.34	1983	0.0		0.0		83	90	58	59	7.7	S	37	16	1963	70	5.3
J	93.3	72.5	82.9	106	1980	58	1972	0	555	3.56	9.46	1972	0.15	1964	4.30	1972	0.0		0.0		82	90	57	58	7.2	S	46	29	1982	73	5.3
A	93.2	71.5	82.4	107	1962	58	1956	0	539	2.52	6.83	1955	0.42	1980	4.64	1955	0.0		0.0		82	91	56	57	7.0	S	37	25	1963	71	5.1
S	87.7	66.5	77.1	103	1980	42	1967	0	363	3.29	9.59	1968	0.17	1956	5.39	1961	0.0		0.0		82	90	57	61	7.3	ENE	44	19	1965	68	5.0
O	78.9	54.5	66.7	97	1954	31	1980	76	128	2.63	7.44	1970	0.00	1963	3.88	1957	0.0		0.0		80	88	53	61	7.5	SSE	35	31	1966	69	4.6
N	66.8	44.5	55.7	88	1955	16	1976	293	14	3.77	9.49	1957	0.71	1967	5.94	1969	1.3	1980	1.3	1980	80	86	58	66	8.6	S	38	29	1975	59	5.4
D	59.2	38.2	48.7	84	1955	6	1983	505	0	3.87	10.00	1982	0.59	1981	3.35	1965	5.4	1983	5.4	1983	79	85	63	67	9.1	S	37	14	1965	53	6.1
YR	76.2	54.6	65.4	107	AUG 1962	3	JAN 1962	2269	2444	43.84	12.39	JUN 1961	0.00	OCT 1963	7.17	APR 1953	5.9	JAN 1978	5.6	JAN 1982	80	87	58	60	8.6	S	52	28	APR 1975	63	5.7

Jackson, Mississippi Allen C. Thompson Field

Month	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind					Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
	Normal			Extremes						Water equivalent							Snow, Ice pellets				Hour	Hour	Hour	Hour		thru 1963	Fastest mile				
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	00 (Local time)	06 (Local time)	12 (Local time)	18 (Local time)	Mean speed m.p.h.	Prevailing direction	Speed m.p.h.	Direction	Year		
(a)				20		20					20		20		20		20		20		20	20	20	20	20		7	7		19	20
J	56.5	34.9	45.7	82	1972	3	1982	611	13	5.00	14.10	1979	0.86	1969	5.63	1979	6.3	1982	6.0	1982	84	87	66	72	8.7		28	35	1978	47	6.7
F	60.9	37.2	49.1	84	1977	11	1970	462	17	4.48	8.35	1979	1.43	1976	3.46	1974	3.6	1968	3.6	1968	82	86	59	63	8.7		30	25	1981	55	6.1
M	68.4	44.2	56.3	89	1982	15	1980	303	34	5.86	15.13	1976	2.05	1966	3.87	1964	5.3	1968	5.3	1968	82	87	57	59	9.3		39	16	1982	59	6.3
A	77.3	52.9	65.1	92	1970	30	1971	77	80	5.85	15.53	1983	1.25	1965	8.42	1979	T	1983	T	1983	84	91	56	59	8.5		33	34	1982	62	5.9
M	84.1	60.8	72.5	99	1964	38	1971	9	241	4.83	10.82	1967	0.74	1977	3.27	1966	0.0		0.0		87	91	56	61	7.1		35	27	1979	62	5.8
J	90.5	67.9	79.2	103	1969	49	1972	0	426	2.94	7.44	1975	0.32	1973	3.24	1979	0.0		0.0		87	91	56	60	6.3		37	18	1981	70	5.3
J	92.5	71.3	81.9	106	1980	51	1967	0	524	4.40	13.25	1979	1.54	1974	5.37	1981	0.0		0.0		90	93	60	66	5.8		44	33	1982	65	5.7
A	92.1	70.2	81.2	102	1981	55	1966	0	502	3.71	7.44	1979	1.45	1980	3.98	1982	0.0		0.0		90	94	59	67	5.6		37	17	1981	64	5.4
S	87.6	65.1	76.4	104	1980	35	1967	0	342	3.55	9.61	1965	0.56	1969	5.86	1965	0.0		0.0		90	94	59	71	6.4		23	34	1982	61	5.4
O	78.6	51.4	65.0	92	1981	30	1980	98	98	2.62	9.13	1970	0.00	1963	6.99	1975	0.0		0.0		89	93	53	71	6.5		25	15	1980	67	4.3
N	67.5	42.3	54.9	88	1971	17	1976	316	13	4.18	9.98	1977	0.93	1967	4.34	1983	0.2	1976	0.2	1976	87	90	58	74	7.4		30	16	1983	55	5.5
D	60.0	37.1	48.6	84	1978	7	1983	513	0	5.40	17.70	1982	0.91	1980	6.71	1982	3.1	1963	1.8	1963	84	88	63	74	8.5		35	35	1976	49	6.3
YR	76.3	52.9	64.6	106	JUL 1980	3	JAN 1982	2389	2290	52.82	17.70	DEC 1982	0.00	OCT 1963	8.42	APR 1979	6.3	JAN 1982	6.0	JAN 1982	86	90	59	66	7.4		44	33	JUL 1982	60	5.7

Meridian, Mississippi Key Field

Month	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind					Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
	Normal			Extremes						Water equivalent							Snow, Ice pellets				Hour	Hour	Hour	Hour		thru 1963	Fastest mile				
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	00 (Local time)	06 (Local time)	12 (Local time)	18 (Local time)	Mean speed m.p.h.	Prevailing direction	Speed m.p.h.	Direction	Year		
(a)				38		38					38		38		38		38		38		19	19	19	19	24	4	24	24			38
J	56.7	34.2	45.5	83	1950	0	1962	616	12	4.99	12.14	1947	1.59	1981	4.54	1972	5.8	1948	4.7	1948	81	84	61	69	7.1	NE	30	25	1975		6.7
F	61.1	36.5	48.8	85	1982	8	1951	464	10	4.58	12.89	1961	1.67	1947	5.61	1961	3.1	1960	3.1	1960	80	84	54	59	7.4	S	35	02	1963		6.2
M	68.6	43.1	55.9	90	1974	15	1980	312	30	6.65	16.47	1976	1.27	1955	7.00	1979	1.5	1968	1.5	1968	81	86	53	56	7.9	NE	32	32	1972		6.2
A	77.7	51.4	64.6	91	1970	29	1950	85	73	5.41	16.82	1964	1.01	1976	6.36	1964	0.0		0.0		85	89	51	55	7.1	S	35	24	1981		5.8
M	84.2	59.3	71.7	99	1951	38	1971	17	224	4.20	9.79	1980	0.27	1951	5.84	1952	0.0		0.0		87	90	55	59	5.8	S	35	17	1967		5.7
J	90.4	66.4	78.4	103	1969	45	1956	0	402	3.49	7.81	1961	0.71	1968	2.65	1974	0.0		0.0		88	89	55	60	5.1	S	32	25	1962		5.5
J	92.5	70.0	81.3	107	1980	55	1967	0	505	5.32	15.29	1959	1.07	1952	6.95	1959	0.0		0.0		89	91	58	66	4.7	S	40	03	1964		6.0
A	92.1	69.1	80.6	104	1980	53	1952	0	484	3.36	8.55	1960	0.79	1951	3.37	1963	0.0		0.0		89	91	57	67	4.5	S	32	14	1968		5.3
S	87.2	64.2	75.7	103	1980	34	1967	5	326	3.57	10.24	1957	0.10	1982	4.67	1979	0.0		0.0		89	91	57	71	5.2	N	45	02	1979		5.5
O	77.8	50.0	63.9	97	1954	24	1952	118	84	2.59	10.65	1970	0.00	1963	6.04	1970	0.0		0.0		87	89	51	74	5.1	N	35	02	1969		4.4
N	67.3	40.8	54.1	87	1946	16	1976	335	8	3.48	13.93	1948	0.38	1956	4.50	1957	T	1976	T	1976	86	87	53	72	6.0	N	28	25	1983		5.5
D	60.0	36.0	48.0	82	1982	4	1962	527	0	5.66	14.79	1973	1.10	1980	8.13	1973	17.6	1963	15.0	1963	82	85	58	71	6.8	N	29	22	1964		6.2
YR	76.3	51.8	64.0	107	JUL 1980	0	JAN 1962	2479	2158	53.30	16.82	APR 1964	0.00	OCT 1963	8.13	DEC 1973	17.6	DEC 1963	15.0	DEC 1963	85	88	55	65	6.0	S	45	02	SEP 1979		5.8

Asheville, North Carolina Asheville Regional Airport

Month	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind					Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
	Normal			Extremes						Water equivalent							Snow, Ice pellets				Hour	Hour	Hour	Hour	Mean speed m.p.h.	thru 1963	Fastest mile				
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	01 (Local time)	07	13	19		Prevailing direction	Speed m.p.h.	Direction	Year		
(a)				19		19					19		19		19		19		19		19	19	19	19	19		19	19		19	19
J	47.5	26.0	36.8	78	1975	-7	1966	874	0	3.48	7.47	1978	0.45	1981	2.95	1978	17.6	1966	8.0	1983	81	85	61	69	9.7		40	34	1975	55	6.1
F	50.6	27.6	39.1	77	1977	-2	1967	725	0	3.60	7.02	1982	0.44	1978	3.47	1982	25.5	1969	11.7	1969	78	83	56	63	9.6		60	34	1972	61	5.8
M	58.4	34.4	46.4	82	1974	9	1980	577	0	5.13	9.86	1975	1.92	1982	5.13	1968	13.0	1969	10.9	1969	79	85	54	61	9.5		46	35	1969	62	6.0
A	68.6	42.7	55.7	89	1972	24	1973	283	0	3.84	7.26	1979	0.25	1976	3.06	1973	3.0	1982	3.0	1982	78	86	51	56	8.9		44	22	1970	66	5.6
M	75.6	51.0	63.3	91	1969	29	1971	114	61	4.19	8.83	1973	1.72	1970	4.95	1973	T	1979	T	1979	90	92	58	67	7.0		40	34	1971	61	6.2
J	81.4	58.2	69.8	96	1969	35	1966	23	167	4.20	6.54	1972	2.12	1975	3.54	1972	0.0		0.0		94	95	61	71	6.1		40	36	1977	64	6.1
J	84.0	62.4	73.2	96	1983	46	1967	0	254	4.43	9.92	1982	0.63	1978	4.02	1969	0.0		0.0		95	96	64	75	5.8		43	35	1966	59	6.5
A	83.5	61.6	72.6	100	1983	43	1968	0	239	4.79	11.28	1967	0.52	1981	4.12	1967	0.0		0.0		97	98	64	78	5.4		40	34	1973	55	6.2
S	77.9	55.8	66.9	92	1975	30	1967	57	114	3.96	9.12	1977	1.17	1970	3.41	1975	0.0		0.0		96	97	65	81	5.6		35	32	1980	55	6.4
O	68.7	43.3	56.0	85	1981	21	1976	286	7	3.29	7.05	1971	0.30	1978	2.95	1977	T	1977	T	1977	92	94	58	75	6.8		35	33	1972	61	5.1
N	58.6	34.2	46.4	81	1974	8	1970	558	0	3.29	7.76	1979	1.19	1981	4.03	1977	9.6	1968	5.7	1968	86	89	57	70	8.2		40	32	1974	60	5.4
D	50.3	28.2	39.3	78	1971	-7	1983	797	0	3.51	8.48	1973	0.16	1965	2.66	1973	16.3	1971	16.3	1971	83	86	60	71	9.0		44	34	1965	57	5.8
YR	67.1	43.8	55.5	100	AUG 1983	-7	DEC 1983	4294	842	47.72	11.28	AUG 1967	0.16	DEC 1965	5.13	MAR 1968	25.5	FEB 1969	16.3	DEC 1971	87	91	59	70	7.6		60	34	FEB 1972	60	5.9

Cape Hatteras, North Carolina Weather Service Building

Month	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind					Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
	Normal			Extremes						Water equivalent							Snow, Ice pellets				Hour	Hour	Hour	Hour	Mean speed m.p.h.	thru 1963	Fastest mile				
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	01 (Local time)	07	13	19		Prevailing direction	Speed m.p.h.	Direction	Year		
(a)				26		26					26		26		26		26		26		26	26	26	26	26	6	13	13		21	26
J	52.6	37.6	45.1	75	1972	11	1982	617	0	4.72	9.72	1979	1.75	1981	5.00	1979	3.5	1962	3.5	1962	79	80	68	78	12.5	NNE	32	N35	1983	49	6.2
F	53.5	37.7	45.6	76	1971	14	1958	543	0	4.11	8.45	1983	1.42	1976	2.92	1970	4.4	1978	4.4	1978	79	80	65	77	12.8	NNE	44	S04	1973	53	6.0
M	58.8	43.3	51.1	79	1977	19	1967	437	6	3.97	9.29	1983	0.98	1967	2.91	1982	8.5	1960	7.3	1980	79	80	62	76	12.3	SW	48	N02	1980	60	6.0
A	67.2	51.1	59.2	85	1967	26	1972	186	12	3.21	7.10	1962	0.59	1976	5.60	1963	0.0		0.0		81	78	59	76	12.2	SW	40	S18	1983	66	5.4
M	74.1	59.7	66.9	88	1962	39	1971	37	96	4.09	11.44	1972	0.61	1962	3.28	1958	0.0		0.0		86	82	66	79	11.2	SW	35	18	1972	61	6.1
J	80.5	67.5	74.0	95	1978	44	1966	0	270	4.22	10.80	1962	0.38	1978	6.63	1962	0.0		0.0		88	83	69	80	10.8	SSW	37	N29	1972	61	6.3
J	84.4	71.9	78.2	95	1969	54	1972	0	409	5.36	9.99	1965	0.45	1958	5.53	1967	0.0		0.0		89	85	70	82	10.3	SW	26	22	1982	62	6.5
A	84.4	72.0	78.2	94	1968	56	1979	0	409	6.11	11.73	1976	0.99	1983	8.11	1962	0.0		0.0		88	86	69	83	9.7	SW	41	16	1971	63	6.2
S	80.5	67.9	74.2	92	1978	45	1970	0	276	5.78	12.78	1979	0.73	1978	5.46	1979	0.0		0.0		85	84	67	80	10.6	NE	44	12	1971	61	5.6
O	71.7	58.1	64.9	86	1959	32	1979	76	72	4.83	11.24	1971	1.34	1973	7.67	1983	0.0		0.0		82	82	65	79	11.4	NNE	44	N02	1982	59	5.4
N	63.6	48.3	56.0	81	1971	22	1967	276	6	4.84	14.63	1962	1.23	1973	7.59	1977	T	1970	T	1970	80	82	64	78	11.1	NNE	35	29	1983	56	5.4
D	56.4	40.9	48.7	77	1982	12	1983	510	0	4.48	8.63	1962	2.07	1971	3.59	1979	2.5	1970	2.5	1970	79	81	66	78	11.8	NNE	39	N22	1972	47	6.0
YR	69.0	54.7	61.9	95	JUN 1978	11	JAN 1982	2682	1556	55.72	14.63	NOV 1962	0.38	JUN 1978	8.11	AUG 1962	8.5	MAR 1960	7.3	MAR 1980	83	82	66	79	11.4	SW	48	N02	MAR 1980	59	5.9

Charlotte, North Carolina Douglas Municipal Airport

Month	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind					Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
	Normal			Extremes						Water equivalent							Snow, Ice pellets				Hour	Hour	Hour	Hour	Mean speed m.p.h.	thru 1963	Fastest mile				
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	01 (Local time)	07	13	19		Prevailing direction	Speed m.p.h.	Direction	Year		
(a)				44		44					44		44		44		44		44		23	23	23	23	34	14	30	30		33	34
J	50.3	30.7	40.5	78	1952	-3	1940	760	0	3.80	7.44	1962	0.45	1981	3.57	1962	11.7	1962	10.2	1965	72	78	56	61	8.0	SW	56	NE	1960	55	6.2
F	53.6	32.1	42.9	81	1977	5	1958	619	0	3.81	7.59	1979	0.74	1978	2.92	1973	14.9	1979	12.0	1969	67	75	52	54	8.5	NE	54	SW	1958	60	6.0
M	61.6	39.1	50.4	90	1945	4	1980	459	7	4.83	8.76	1980	1.58	1982	3.83	1977	19.3	1960	10.3	1983	69	79	51	53	8.9	SW	49	SW	1977	63	6.1
A	72.1	48.4	60.3	93	1960	24	1960	155	14	3.27	7.64	1958	0.30	1976	3.20	1962	0.1	1982	0.1	1982	68	78	47	49	8.9	S	53	NW	1958	69	5.6
M	79.1	57.2	68.2	100	1941	32	1963	50	149	3.64	12.48	1975	0.11	1941	3.67	1975	0.0		0.0		78	83	53	58	7.6	SW	48	NW	1958	69	6.1
J	85.2	64.7	75.0	103	1954	45	1972	0	304	3.57	8.26	1961	0.67	1954	3.77	1949	0.0		0.0		81	86	57	63	6.9	SW	57	NW	1957	70	6.0
J	88.3	68.7	78.5	103	1952	53	1961	0	419	3.92	9.12	1941	0.53	1983	3.00	1949	0.0		0.0		83	88	58	66	6.6	SW	59	NW	1962	68	6.2
A	87.6	68.2	77.9	103	1983	53	1965	0	400	3.75	9.98	1948	0.61	1972	4.52	1978	0.0		0.0		84	89	58	66	6.5	S	54	NW	1954	70	5.8
S	81.7	62.3	72.0	104	1954	39	1967	10	220	3.59	10.89	1945	0.02	1954	4.74	1959	0.0		0.0		84	90	58	68	6.7	NE	47	NW	1956	67	5.8
O	71.7	49.6	60.7	98	1954	24	1962	166	33	2.72	8.33	1976	T	1953	5.34	1976	0.0		0.0		80	87	53	66	7.0	NNE	47	NW	1960	68	4.7
N	61.7	39.7	50.7	85	1961	11	1950	429	0	2.86	8.17	1948	0.46	1973	2.79	1962	2.5	1968	2.5	1968	76	83	53	62	7.2	SSW	47	NW	1957	61	5.3
D	52.6	32.6	42.6	77	1971	2	1962	694	0	3.40	7.49	1983	0.43	1965	2.87	1972	7.5	1971	7.5	1971	74	79	57	63	7.5	SW	57	NE	1954	58	5.9
YR	70.5	49.4	60.0	104	SEP 1954	-3	JAN 1940	3342	1546	43.16	12.48	MAY 1975	T	OCT 1953	5.34	OCT 1976	19.3	MAR 1960	12.0	FEB 1969	76	83	54	61	7.5	SW	59	NW	JUL 1962	65	5.8

Greensboro, High Point, Winston-Salem AP, North Carolina

	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind					Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
	Normal			Extremes						Water equivalent							Snow, Ice pellets				(Local time)					thru 1963	Fastest mile				
Month	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	Hour 01	Hour 07	Hour 13	Hour 19	Mean speed m.p.h.	Prevailing direction	Speed m.p.h.	Direction	Year		
(a)				55		55					55		55		55		55		55		20	20	20	20	55	15	30	30		55	55
J	47.6	27.3	37.5	78	1975	-7	1940	853	0	3.51	8.24	1937	0.66	1981	3.06	1936	22.9	1966	14.0	1940	76	80	57	64	8.1	SW	43	NW	1971	52	6.3
F	50.8	29.0	39.9	81	1977	-4	1936	703	0	3.37	7.04	1929	0.73	1978	3.00	1934	16.3	1979	9.3	1979	70	77	51	57	8.6	SW	51	W	1956	57	6.0
M	59.3	36.5	48.0	90	1945	5	1960	533	6	3.88	8.76	1975	1.21	1967	3.07	1932	21.3	1960	11.1	1960	71	79	52	55	9.2	SW	54	SW	1929	60	6.0
A	70.7	45.9	58.3	94	1930	21	1943	215	14	3.16	6.19	1936	0.55	1942	2.70	1944	T	1983	T	1983	71	78	48	52	8.8	SW	42	SW	1973	64	5.7
M	77.9	55.0	66.5	98	1941	32	1963	73	120	3.37	8.35	1982	0.37	1936	3.11	1978	0.0		0.0		83	84	56	63	7.6	SW	61	NW	1967	65	5.9
J	84.2	62.6	73.5	102	1954	42	1977	0	259	3.93	7.99	1965	0.32	1933	4.91	1972	0.0		0.0		86	86	58	67	6.9	SW	56	W	1940	66	6.0
J	87.4	66.9	77.2	102	1977	48	1933	0	378	4.27	12.35	1975	0.98	1953	4.43	1944	0.0		0.0		88	89	60	69	6.5	SW	63	N	1932	63	6.2
A	86.2	66.3	76.3	101	1932	47	1946	.0	350	4.19	12.53	1939	0.71	1972	4.47	1949	0.0		0.0		89	91	60	71	6.3	SW	45	W	1952	63	5.9
S	80.4	59.3	69.9	100	1954	35	1942	12	159	3.64	13.26	1947	0.13	1939	7.49	1947	0.0		0.0		88	91	59	72	6.6	NE	40	N	1934	63	5.5
O	70.1	46.7	58.4	95	1954	20	1962	221	17	3.18	9.60	1959	0.26	1963	6.24	1954	0.0		0.0		84	88	55	72	7.1	NE	43	N	1960	66	4.7
N	59.9	37.1	48.5	85	1974	10	1970	495	0	2.59	7.72	1948	0.35	1981	3.32	1962	5.9	1968	5.0	1968	77	83	52	65	7.5	SW	40	SW	1955	59	5.3
D	50.4	29.9	40.2	78	1971	0	1962	769	0	3.38	6.44	1973	0.33	1955	3.60	1958	14.3	1930	14.3	1930	77	81	57	67	7.7	SW	45	SSW	1954	54	6.0
YR	68.7	46.9	57.9	102	JUL 1977	-7	JAN 1940	3874	1303	42.47	13.26	SEP 1947	0.13	SEP 1939	7.49	SEP 1947	22.9	JAN 1966	14.3	DEC 1930	80	84	55	64	7.6	SW	63	N	JUL 1932	61	5.8

Raleigh, North Carolina Raleigh-Durham Airport

	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind					Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
	Normal			Extremes						Water equivalent							Snow, Ice pellets				(Local time)					thru 1963	Fastest mile				
Month	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	Hour 01	Hour 07	Hour 13	Hour 19	Mean speed m.p.h.	Prevailing direction	Speed m.p.h.	Direction	Year		
(a)				39		39					39		39		39		39		39		19	19	19	19	34	14	30	30		29	34
J	50.1	29.1	39.6	79	1952	-1	1977	787	0	3.55	7.52	1954	0.87	1981	2.79	1954	14.4	1955	9.0	1966	74	79	55	64	8.6	SW	41	27	1971	54	6.1
F	52.8	30.3	41.6	84	1977	5	1971	655	0	3.43	6.00	1983	1.00	1968	3.22	1973	17.2	1979	10.4	1979	70	77	51	58	8.9	SW	40	22	1966	59	5.9
M	61.0	37.7	49.3	92	1945	11	1980	496	9	3.69	7.78	1983	1.48	1949	3.70	1983	14.0	1960	9.3	1969	71	80	50	57	9.3	SW	44	32	1967	62	6.0
A	72.3	46.5	59.5	95	1980	23	1972	181	16	2.91	6.10	1978	0.23	1976	4.04	1978	1.8	1983	1.8	1983	73	81	45	53	9.0	SW	40	14	1961	64	5.6
M	79.0	55.3	67.2	97	1953	31	1977	53	121	3.67	7.67	1974	0.92	1964	4.40	1957	0.0		0.0		85	87	55	67	7.6	SW	54	20	1972	59	6.0
J	85.2	62.6	73.9	104	1954	38	1977	0	270	3.66	9.38	1973	0.55	1981	3.44	1967	0.0		0.0		87	88	57	68	6.9	SW	39	33	1977	60	5.8
J	88.2	67.1	77.7	105	1952	48	1975	0	394	4.38	10.05	1945	0.80	1953	3.89	1952	0.0		0.0		88	90	59	71	6.6	SW	69	23	1962	61	6.0
A	87.1	66.8	77.0	101	1983	46	1965	0	372	4.44	10.49	1955	0.81	1950	5.20	1955	0.0		0.0		89	92	60	75	6.3	NE	46	33	1969	61	5.9
S	81.6	60.4	71.0	104	1954	37	1983	9	189	3.29	12.94	1945	0.57	1954	5.16	1944	0.0		0.0		88	92	59	77	6.7	NE	35	23	1972	59	5.6
O	71.6	47.7	59.7	98	1954	19	1962	187	23	2.73	7.53	1971	0.44	1963	4.10	1954	0.0		0.0		85	89	54	76	7.2	NNE	73	29	1954	61	5.0
N	61.8	38.1	50.0	88	1950	11	1970	450	0	2.87	8.22	1948	0.61	1973	4.70	1963	2.6	1975	2.6	1975	78	84	51	67	7.7	SW	35	32	1969	60	5.2
D	52.7	31.2	42.0	79	1978	4	1983	713	0	3.14	6.65	1983	0.25	1965	3.18	1958	10.6	1958	9.1	1958	76	81	56	68	8.1	SW	35	21	1968	55	5.8
YR	70.3	47.7	59.0	105	JUL 1952	-1	JAN 1977	3531	1394	41.76	12.94	SEP 1945	0.23	APR 1976	5.20	AUG 1955	17.2	FEB 1979	10.4	FEB 1979	80	85	54	67	7.7	SW	73	29	OCT 1954	60	5.7

Wilmington, North Carolina New Hanover County Airport

	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind					Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
	Normal			Extremes						Water equivalent							Snow, Ice pellets				(Local time)					thru 1963	Fastest mile				
Month	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	Hour 01	Hour 07	Hour 13	Hour 19	Mean speed m.p.h.	Prevailing direction	Speed m.p.h.	Direction	Year		
(a)				32		32					32		32		32		32		32		20	20	20	20	32	12	28	28		32	32
J	55.9	35.3	45.6	82	1975	7	1981	607	6	3.64	7.08	1964	1.09	1981	3.08	1982	2.9	1965	2.8	1965	78	80	57	71	9.2	N	57	S	1953	57	6.1
F	58.1	36.6	47.4	85	1962	11	1958	498	5	3.44	8.74	1983	1.01	1976	3.20	1983	12.5	1973	11.7	1973	76	77	52	65	10.0	NW	66	SW	1956	60	5.9
M	64.8	43.3	54.1	89	1974	9	1980	350	12	4.04	8.09	1983	0.93	1967	3.31	1960	6.6	1980	5.7	1980	79	81	52	67	10.3	SSW	56	SW	1956	63	5.8
A	74.3	51.8	63.1	95	1967	30	1983	94	37	2.98	8.21	1961	0.33	1957	3.52	1961	0.0		0.0		79	79	48	64	10.5	SSW	56	NE	1958	70	5.4
M	80.9	60.4	70.7	98	1953	40	1981	10	187	4.22	9.12	1956	1.13	1983	4.95	1963	0.0		0.0		87	85	56	71	9.4	SSW	46	NE	1954	66	5.9
J	86.1	67.1	76.6	104	1952	48	1983	0	348	5.65	12.87	1962	1.36	1954	7.73	1966	0.0		0.0		88	85	60	74	8.6	SSW	54	NW	1952	65	6.2
J	89.3	71.3	80.3	102	1977	59	1972	0	474	7.44	15.12	1966	1.65	1961	5.63	1966	0.0		0.0		89	86	63	76	8.0	SSW	42	SW	1966	63	6.4
A	88.6	70.8	79.7	102	1954	55	1982	0	456	6.64	14.06	1981	1.66	1968	5.10	1981	0.0		0.0		91	89	64	80	7.5	SW	72	NE	1955	62	6.2
S	83.9	65.7	74.8	98	1975	44	1981	0	294	5.71	15.51	1955	1.07	1981	8.24	1958	0.0		0.0		90	90	63	81	7.9	N	88	N	1958	62	6.0
O	75.2	53.7	64.5	95	1954	27	1962	94	78	2.97	9.81	1964	0.17	1953	4.34	1964	0.0		0.0		87	88	57	80	8.2	N	82	SE	1954	64	5.0
N	66.8	43.9	55.4	87	1974	20	1970	295	7	3.19	7.87	1972	0.49	1973	4.82	1969	T	1976	T	1976	82	85	53	76	8.2	N	59	N	1962	65	5.0
D	59.1	37.2	48.2	81	1982	9	1983	521	0	3.43	6.57	1982	0.48	1955	3.88	1980	4.0	1970	4.0	1970	79	81	57	74	8.6	N	47	SW	1953	59	5.7
YR	73.6	53.1	63.4	104	JUN 1952	7	JAN 1981	2469	1904	53.35	15.51	SEP 1955	0.17	OCT 1953	8.24	SEP 1958	12.5	FEB 1973	11.7	FEB 1973	84	84	57	73	8.9	SSW	88	N	SEP 1958	63	5.8

Charleston, South Carolina Municipal Airport

	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind					Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
	Normal			Extremes						Water equivalent						Snow, Ice pellets				Hour	Hour	Hour	Hour		thru 1963	Fastest mile				
Month	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	01 (Local time)	07	13	19	Mean speed m.p.h.	Prevailing direction	Speed m.p.h.	Direction	Year		
(a)				41		41					41		41		41		41		41		41	41	41	41	34	14	8	8		24	34
J	58.8	36.9	47.9	83	1950	10	1982	543	13	3.33	6.68	1966	0.63	1950	2.49	1983	1.0	1977	0.8	1966	81	83	55	71	9.2	SW	40	20	1978	58	6.2
F	61.2	38.4	49.8	86	1962	12	1973	434	9	3.37	6.35	1983	0.33	1947	3.28	1944	7.1	1973	5.9	1973	78	81	51	67	10.0	NNE	37	29	1976	62	5.9
M	68.0	45.3	56.7	90	1974	15	1980	286	29	4.38	11.11	1983	0.99	1963	6.63	1959	2.0	1969	2.0	1969	81	83	51	66	10.1	SSW	37	29	1981	67	6.0
A	76.0	52.5	64.3	93	1981	29	1944	69	48	2.58	9.50	1958	0.01	1972	4.10	1958	0.0		0.0		83	84	49	66	9.8	SSW	36	19	1983	71	5.4
M	82.9	61.4	72.2	98	1953	36	1963	6	229	4.41	9.28	1957	0.68	1944	6.23	1967	0.0		0.0		88	85	54	71	8.7	S	32	25	1978	71	6.0
J	87.0	68.0	77.6	103	1944	50	1972	0	378	6.54	27.24	1973	0.96	1970	10.10	1973	0.0		0.0		89	86	59	74	8.4	S	40	03	1981	68	6.3
J	89.4	71.6	80.5	101	1977	58	1952	0	481	7.33	18.46	1964	1.76	1972	5.81	1960	0.0		0.0		90	88	63	77	7.9	SW	36	09	1983	68	6.5
A	88.8	71.2	80.0	102	1954	56	1979	0	465	6.50	16.99	1974	0.73	1980	5.77	1964	0.0		0.0		91	90	63	79	7.4	SW	32	03	1981	66	6.2
S	84.6	66.7	75.7	99	1944	42	1967	0	321	4.94	17.31	1945	0.53	1971	8.84	1945	0.0		0.0		90	90	62	81	7.9	NNE	38	11	1979	63	6.3
O	76.8	54.7	65.8	94	1954	27	1976	76	101	2.92	9.12	1959	0.08	1943	5.77	1944	0.0		0.0		88	88	55	79	8.1	NNE	30	18	1976	66	5.1
N	68.7	44.6	56.7	88	1961	15	1950	262	13	2.18	7.35	1972	0.48	1966	5.24	1969	T	1950	T	1950	84	86	52	76	8.2	N	28	18	1983	63	5.1
D	61.4	38.5	50.0	83	1972	8	1962	471	6	3.11	7.09	1953	0.82	1944	3.40	1978	3.8	1980	3.8	1980	82	83	55	73	8.7	NNE	39	24	1975	58	6.0
YR	75.3	54.2	64.8	103	JUN 1944	8	DEC 1962	2147	2093	51.59	27.24	JUN 1973	0.01	APR 1972	10.10	JUN 1973	7.1	FEB 1973	5.9	FEB 1973	85	86	56	73	8.7	NNE	40	03	JUN 1981	66	5.9

Columbia, South Carolina Columbia Metropolitan Airport

	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind					Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
	Normal			Extremes						Water equivalent						Snow, Ice pellets				Hour	Hour	Hour	Hour		thru 1963	Fastest mile				
Month	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	01 (Local time)	07	13	19	Mean speed m.p.h.	Prevailing direction	Speed m.p.h.	Direction	Year		
(a)				36		36					36		36		36		36		36		17	17	17	17	35	14	30	30		30	35
J	56.2	33.2	44.7	84	1975	5	1970	637	8	4.38	9.26	1978	0.84	1981	2.82	1968	3.5	1982	3.3	1982	79	82	55	65	7.1	SW	46	28	1964	57	6.1
F	59.5	34.6	47.1	84	1977	5	1973	508	6	3.99	8.68	1961	0.87	1976	3.69	1962	16.0	1973	15.7	1973	75	80	49	56	7.6	SW	40	20	1966	61	5.8
M	67.1	41.9	54.5	91	1974	4	1980	346	20	5.16	10.89	1973	1.25	1949	3.59	1960	4.1	1980	4.1	1980	76	84	49	54	8.3	SW	60	27	1954	64	5.9
A	77.0	50.5	63.8	94	1970	26	1983	87	51	3.59	6.85	1979	0.81	1976	3.66	1956	0.0		0.0		77	84	44	50	8.3	SW	40	27	1961	69	5.3
M	83.8	59.1	71.5	101	1953	34	1963	22	223	3.85	8.85	1967	0.29	1951	5.57	1967	0.0		0.0		85	87	50	60	6.9	SW	46	23	1958	68	5.7
J	89.2	66.1	77.7	107	1954	45	1977	0	381	4.45	14.81	1973	1.26	1955	5.44	1973	0.0		0.0		87	87	53	62	6.6	SW	40	23	1957	67	5.8
J	91.9	70.1	81.0	107	1952	54	1951	0	496	5.35	13.87	1959	0.57	1977	5.81	1959	0.0		0.0		87	89	55	68	6.4	SW	40	35	1965	66	6.1
A	91.0	69.4	80.2	107	1983	53	1969	0.	471	5.56	16.72	1949	1.02	1976	7.66	1949	0.0		0.0		90	92	57	71	5.9	SW	44	16	1961	67	5.6
S	85.5	63.9	74.8	101	1954	40	1967	0	297	4.23	8.78	1953	0.39	1981	6.23	1953	0.0		0.0		91	93	57	74	6.1	NE	38	11	1959	65	5.7
O	76.5	50.3	63.4	101	1954	23	1952	123	74	2.55	12.09	1959	T	1963	5.46	1964	0.0		0.0		87	90	51	74	6.2	NE	27	21	1968	67	4.7
N	67.1	40.6	53.9	90	1961	12	1970	339	6	2.51	7.20	1957	0.41	1973	2.57	1976	T	1976	T	1976	83	88	50	70	6.4	SW	35	35	1967	65	4.9
D	58.8	34.7	46.7	83	1978	4	1958	567	0	3.50	8.54	1981	0.32	1955	3.18	1970	9.1	1958	8.8	1958	80	83	54	69	6.7	WSW	35	28	1975	60	5.8
YR	75.3	51.2	63.3	107	AUG 1983	4	MAR 1980	2629	2033	49.12	16.72	AUG 1949	T	OCT 1963	7.66	AUG 1949	16.0	FEB 1973	15.7	FEB 1973	83	87	52	64	6.9	SW	60	27	MAR 1954	65	5.6

Greer, South Carolina Greenville-Spartanburg Airport

	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind					Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
	Normal			Extremes						Water equivalent						Snow, Ice pellets				Hour	Hour	Hour	Hour		thru 1963	Fastest mile				
Month	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	01 (Local time)	07	13	19	Mean speed m.p.h.	Prevailing direction	Speed m.p.h.	Direction	Year		
(a)				21		21					21		21		21		21		21		21	21	21	21	21	1	21	21		21	21
J	51.0	31.2	41.1	79	1975	-6	1966	741	0	4.21	7.19	1979	0.29	1981	3.30	1982	9.1	1966	5.7	1965	73	77	55	63	7.3	NE	44	SW	1967	55	5.9
F	54.5	32.6	43.6	79	1982	8	1967	599	0	4.39	7.43	1971	0.53	1978	2.98	1973	12.3	1979	8.2	1979	69	74	51	57	7.9	NE	44	SW	1966	60	5.5
M	62.5	39.4	51.0	88	1967	11	1980	442	8	5.87	11.37	1980	1.98	1967	4.45	1963	9.3	1983	9.3	1983	69	76	50	55	8.0	SW	38	W	1963	64	5.6
A	72.6	48.3	60.5	91	1980	25	1983	154	19	4.35	11.30	1964	0.69	1976	3.76	1963	0.1	1983	0.1	1983	70	77	48	52	7.7	SW	44	SW	1970	66	5.4
M	79.7	56.9	68.3	97	1967	33	1971	41	143	4.22	8.89	1972	1.09	1965	3.58	1972	0.0		0.0		80	83	53	61	6.7	NE	36	SW	1967	60	5.9
J	85.4	64.2	74.8	99	1981	40	1972	0	297	4.77	9.59	1969	1.29	1981	4.80	1980	0.0		0.0		83	85	56	63	6.3	NE	35	NW	1969	60	5.8
J	88.2	68.2	78.2	101	1983	54	1979	0	409	4.08	12.52	1982	0.80	1977	3.89	1964	0.0		0.0		84	87	58	67	5.7	WSW	52	NE	1966	60	6.1
A	87.5	67.4	77.5	103	1983	52	1968	0	388	3.66	7.51	1967	1.16	1963	4.49	1967	0.0		0.0		86	89	58	69	5.5	NE	34	N	1973	61	5.6
S	81.7	61.7	71.7	96	1975	36	1967	7	208	4.35	11.65	1975	0.27	1978	6.21	1973	0.0		0.0		86	89	59	72	5.8	NE	31	NE	1964	61	5.6
O	72.2	49.1	60.7	88	1981	25	1976	162	29	3.49	10.24	1964	0.24	1974	4.53	1977	0.0		0.0		81	84	53	70	6.3	NE	31	NE	1964	66	4.5
N	62.1	39.6	50.9	85	1974	12	1970	423	0	3.21	5.31	1972	1.34	1973	2.83	1964	1.9	1968	1.9	1968	76	80	52	65	6.5	SW	34	NE	1974	60	5.0
D	53.5	33.2	43.4	75	1971	6	1983	670	0	3.93	8.45	1983	0.37	1965	3.00	1972	11.4	1971	11.4	1971	74	78	56	66	7.2	NE	47	NE	1963	55	5.7
YR	70.9	49.3	60.1	103	AUG 1983	-6	JAN 1966	3239	1501	50.52	12.52	JUL 1982	0.24	OCT 1974	6.21	SEP 1973	12.3	FEB 1979	11.4	DEC 1971	78	81	54	63	6.7	NE	52	NE	JUL 1966	61	5.5

Abilene, Texas Municipal Airport

Month	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind					Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
	Normal			Extremes						Water equivalent							Snow, Ice pellets				(Local time)					thru 1963	Fastest mile				
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	Hour 00	Hour 06	Hour 12	Hour 18	Mean speed m.p.h.	Prevailing direction	Speed m.p.h.	Direction	Year		
(a)				44		44					44		44		44		44		44		20	20	20	20	39	15	40	40		35	44
J	55.5	31.2	43.3	89	1943	-9	1947	673	0	0.97	4.35	1968	T	1967	2.18	1961	13.5	1973	7.5	1973	66	73	55	50	12.0	S	52	NW	1955	62	5.7
F	60.3	35.5	47.9	90	1940	1	1951	479	0	0.96	2.84	1940	0.04	1962	1.74	1940	8.4	1956	4.5	1979	66	73	54	45	12.8	S	60	NW	1956	65	5.6
M	68.6	42.6	55.6	97	1974	7	1943	321	29	1.08	5.16	1979	0.03	1963	2.23	1977	7.3	1970	6.1	1970	60	70	48	39	14.2	S	71	S	1953	69	5.4
A	77.6	52.8	65.2	99	1948	25	1973	98	104	2.35	6.80	1966	T	1961	3.75	1957	T	1980	T	1980	63	72	47	41	14.1	SSE	61	S	1951	70	5.3
M	84.1	60.8	72.5	107	1967	36	1979	11	244	3.25	13.19	1957	0.15	1956	2.85	1969	0.0		0.0		70	79	52	45	13.2	SSE	73	N	1949	69	5.4
J	91.8	69.0	80.5	109	1980	47	1964	0	465	2.52	9.60	1961	0.03	1954	3.66	1959	0.0		0.0		65	77	50	42	13.1	SSE	109	NW	1951	78	4.5
J	95.4	72.7	84.1	110	1978	55	1940	0	592	2.11	7.15	1968	T	1970	3.74	1960	0.0		0.0		57	71	45	38	11.0	SSE	63	NE	1946	79	4.4
A	94.5	71.7	83.1	109	1943	55	1961	0	561	2.47	8.18	1969	T	1943	6.30	1978	0.0		0.0		61	73	47	41	10.5	SSE	51	NW	1954	76	4.4
S	87.1	64.9	76.0	106	1952	35	1942	10	340	3.06	11.03	1974	T	1956	6.70	1961	0.0		0.0		68	78	53	49	10.5	SSE	55	SW	1954	69	4.5
O	77.6	54.1	65.9	103	1979	28	1957	91	119	2.32	10.68	1981	0.00	1952	6.08	1981	T	1980	T	1980	67	75	51	48	11.1	SSE	58	NE	1971	72	4.3
N	64.8	42.0	53.4	92	1980	14	1976	361	13	1.32	4.60	1968	0.00	1949	2.43	1975	8.1	1968	5.3	1976	69	74	53	52	11.7	S	50	N	1950	69	4.7
D	58.4	34.3	46.4	89	1955	2	1983	577	0	0.85	2.83	1960	T	1972	2.30	1946	7.8	1983	4.2	1946	65	71	52	50	12.0	SSW	56	N	1950	65	5.1
YR	76.3	52.6	64.5	110	JUL 1978	-9	JAN 1947	2621	2467	23.26	13.19	MAY 1957	0.00	OCT 1952	6.70	SEP 1961	13.5	JAN 1973	7.5	JAN 1973	65	74	50	45	12.2	SSE	109	NW	JUN 1951	71	5.0

Austin, Texas Municipal Airport

Month	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind					Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
	Normal			Extremes						Water equivalent							Snow, Ice pellets				(Local time)					thru 1963	Fastest mile				
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	Hour 00	Hour 06	Hour 12	Hour 18	Mean speed m.p.h.	Prevailing direction	Speed m.p.h.	Direction	Year		
(a)				42		42					42		42		42		42		42		22	22	22	22	42	15	38	38		42	42
J	59.4	38.8	49.1	90	1971	-2	1949	505	12	1.60	7.94	1968	0.04	1971	3.44	1965	7.0	1944	7.0	1944	73	78	61	58	9.8	S	47	N	1962	49	6.3
F	64.1	42.2	53.2	93	1954	7	1951	347	16	2.49	6.39	1958	0.28	1954	3.73	1958	6.0	1966	6.0	1966	72	79	59	52	10.2	S	57	N	1947	52	6.1
M	71.7	49.3	60.5	98	1971	18	1948	203	63	1.68	6.03	1983	T	1972	2.69	1980	2.0	1965	2.0	1965	71	79	56	49	10.9	S	44	W	1957	55	6.1
A	79.0	58.3	68.7	98	1982	35	1973	41	152	3.11	9.93	1957	0.10	1961	3.86	1942	0.0		0.0		76	83	58	54	10.6	SSE	44	NE	1957	53	6.3
M	84.7	65.1	74.9	99	1967	43	1954	0	307	4.19	9.98	1965	0.81	1960	5.66	1979	0.0		0.0		81	88	60	58	9.7	SSE	49	N	1972	57	6.2
J	91.6	71.5	81.6	105	1980	53	1970	0	498	3.06	14.96	1981	T	1967	6.50	1964	0.0		0.0		79	88	56	53	9.3	S	49	SE	1956	69	5.2
J	95.4	73.9	84.7	109	1954	64	1970	0	611	1.89	10.54	1979	0.00	1962	5.46	1961	0.0		0.0		74	87	51	46	8.4	S	43	SE	1969	76	4.7
A	95.3	73.7	84.5	106	1953	61	1967	0	605	2.24	8.90	1974	0.00	1952	4.68	1945	0.0		0.0		73	86	51	46	7.9	S	53	NW	1969	75	4.7
S	89.3	69.1	79.2	103	1956	41	1942	0	426	3.60	8.11	1942	0.07	1947	6.74	1973	0.0		0.0		78	86	56	55	7.9	S	45	NE	1961	67	5.0
O	80.8	58.7	69.8	97	1979	32	1957	37	186	3.38	12.31	1960	T	1952	7.22	1960	0.0		0.0		75	83	54	54	8.1	S	47	NW	1967	65	4.7
N	69.2	48.1	58.7	91	1951	20	1976	221	32	2.20	7.91	1946	T	1970	5.09	1974	2.0	1980	2.0	1980	76	82	57	58	9.0	S	48	NW	1951	57	5.3
D	62.8	41.4	52.1	90	1955	10	1983	406	6	2.06	5.91	1944	T	1950	4.02	1953	T	1983	T	1983	72	79	59	57	9.2	S	49	NW	1956	51	5.9
YR	78.6	57.5	68.1	109	JUL 1954	-2	JAN 1949	1760	2914	31.50	14.96	JUN 1981	0.00	JUL 1962	7.22	OCT 1960	7.0	JAN 1944	7.0	JAN 1944	75	83	56	53	9.3	S	57	N	FEB 1947	61	5.5

Brownsville, Texas International Airport

Month	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind					Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
	Normal			Extremes						Water equivalent							Snow, Ice pellets				(Local time)					thru 1963	Fastest mile				
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	Hour 00	Hour 06	Hour 12	Hour 18	Mean speed m.p.h.	Prevailing direction	Speed m.p.h.	Direction	Year		
(a)				45		45					44		44		44		44		44		17	17	17	17	41	14	36	36		41	41
J	69.7	50.8	60.3	93	1971	19	1962	216	70	1.25	5.11	1945	T	1956	2.95	1958	T	1967	T	1967	86	87	67	74	11.5	SSE	46	S	1953	42	6.9
F	72.5	53.0	62.8	94	1982	22	1951	135	73	1.55	10.25	1958	T	1954	4.98	1958	T	1973	T	1973	85	87	61	68	12.1	SSE	55	NW	1965	49	6.5
M	77.5	59.5	68.6	100	1983	32	1980	53	164	0.50	4.27	1941	T	1971	2.59	1981	T	1943	T	1943	85	87	59	67	13.5	SE	47	S	1950	51	6.7
A	83.2	66.6	74.9	100	1953	38	1980	0	297	1.57	6.62	1977	T	1983	5.20	1977	0.0		0.0		84	87	59	68	14.1	SE	52	NE	1979	57	6.6
M	87.0	71.3	79.2	102	1974	52	1970	0	440	2.15	9.12	1982	T	1978	4.56	1969	0.0		0.0		86	89	60	69	13.2	SE	66	NW	1968	65	6.1
J	90.5	74.7	82.6	101	1942	60	1975	0	528	2.70	13.06	1942	0.01	1955	8.18	1942	0.0		0.0		85	89	59	65	12.3	SE	52	E	1954	73	5.2
J	92.6	75.6	84.1	102	1939	68	1937	0	592	1.51	9.43	1976	T	1982	4.25	1976	0.0		0.0		85	90	55	62	11.5	SE	37	SE	1972	80	4.8
A	92.8	75.4	84.1	102	1962	63	1967	0	592	2.83	9.56	1975	0.02	1974	5.48	1980	0.0		0.0		85	90	56	63	10.4	SE	57	NW	1945	76	5.0
S	89.8	73.1	81.4	104	1947	55	1942	0	492	5.24	19.26	1967	0.07	1959	12.19	1967	0.0		0.0		86	89	61	68	9.4	SE	69	NE	1967	68	5.3
O	84.4	66.1	75.3	96	1977	44	1939	0	322	3.54	17.12	1958	0.34	1961	6.67	1954	0.0		0.0		85	88	59	69	9.5	SE	47	NE	1960	65	4.8
N	77.0	58.3	67.7	94	1969	33	1976	55	136	1.44	6.26	1957	0.01	1949	3.64	1957	T	1976	T	1976	84	86	60	71	10.7	SSE	42	NW	1961	52	5.7
D	71.9	52.6	62.3	94	1977	20	1983	150	66	1.16	9.45	1940	T	1969	5.69	1940	T	1966	T	1966	84	86	64	73	10.8	NNW	45	NW	1950	43	6.6
YR	82.4	64.8	73.6	104	SEP 1947	19	JAN 1962	609	3772	25.44	19.26	SEP 1967	T	APR 1983	12.19	SEP 1967	T	NOV 1976	T	NOV 1976	85	88	60	68	11.6	SE	69	NE	SEP 1967	61	5.9

Corpus Christi, Texas International Airport

Month	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind					Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
	Normal			Extremes						Water equivalent							Snow, Ice pellets				Hour	Hour	Hour	Hour		thru 1963	Fastest mile				
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	00 (Local time)	06	12	18	Mean speed m.p.h.	Prevailing direction	Speed m.p.h.	Direction	Year		
(a)				45		45					45		45		41		45		45		19	19	19	19	41	15	7	7		41	41
J	66.5	46.1	56.3	91	1971	14	1962	310	40	1.63	10.78	1958	0.03	1971	6.38	1958	1.2	1940	1.1	1940	85	88	69	72	12.1	SSE	37	32	1979	46	6.8
F	69.9	48.7	59.3	98	1940	18	1951	209	50	1.55	8.11	1982	T	1976	4.85	1982	1.1	1973	1.1	1973	84	88	65	66	12.9	SSE	41	15	1981	52	6.4
M	76.1	55.7	65.9	99	1976	24	1980	97	125	0.84	4.80	1974	T	1971	2.67	1945	T	1962	T	1962	84	87	62	65	14.1	SSE	38	14	1983	55	6.7
A	82.1	63.9	73.0	102	1955	33	1980	7	247	1.99	8.04	1956	T	1983	7.19	1956	0.0		0.0		87	89	64	69	14.4	SE	40	32	1983	57	6.7
M	86.7	69.5	78.1	99	1973	47	1970	0	406	3.05	9.38	1968	T	1961	4.65	1968	0.0		0.0		89	92	67	71	12.9	SE	44	17	1982	61	6.4
J	91.2	74.1	82.7	101	1980	58	1975	0	531	3.36	13.35	1973	0.03	1980	5.65	1978	0.0		0.0		89	93	63	68	11.9	SE	31	12	1983	74	5.2
J	94.2	75.6	84.9	104	1939	64	1967	0	617	1.96	11.92	1976	0.00	1957	4.61	1981	0.0		0.0		87	92	58	63	11.5	SSE	46	02	1980	82	4.9
A	94.1	75.8	85.0	103	1962	64	1967	0	620	3.51	14.79	1980	0.10	1952	8.92	1980	0.0		0.0		87	93	60	65	10.9	SSE	55	11	1980	78	4.9
S	90.1	72.8	81.5	103	1977	50	1942	0	495	6.15	20.33	1967	0.49	1981	8.76	1967	0.0		0.0		86	91	63	68	10.2	SE	38	04	1979	69	5.2
O	83.9	64.1	74.0	98	1950	40	1964	11	290	3.19	11.02	1981	0.00	1952	7.25	1960	0.0		0.0		85	89	60	69	10.1	SE	32	02	1980	69	4.7
N	75.1	54.9	65.0	95	1949	29	1969	116	116	1.55	8.53	1947	T	1949	3.44	1947	T	1979	T	1979	84	88	61	71	11.4	SSE	39	17	1983	58	5.6
D	69.3	48.8	59.1	91	1977	14	1983	220	37	1.40	7.80	1960	0.01	1950	3.86	1960	T	1983	T	1983	83	85	64	70	11.3	SSE	38	18	1982	47	6.4
YR	81.6	62.5	72.1	104	JUL 1939	14	DEC 1983	970	3574	30.18	20.33	SEP 1967	0.00	JUL 1957	8.92	AUG 1980	1.2	JAN 1940	1.1	FEB 1973	86	90	63	68	12.0	SSE	55	11	AUG 1980	63	5.8

Dallas-Fort Worth, Texas Regional Airport

Month	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind					Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
	Normal			Extremes						Water equivalent							Snow, Ice pellets				Hour	Hour	Hour	Hour		thru 1963	Fastest mile				
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	00 (Local time)	06	12	18	Mean speed m.p.h.	Prevailing direction	Speed m.p.h.	Direction	Year		
(a)				30		30					30		30		30		30		30		20	20	20	20	30	10	30	30		5	30
J	54.0	33.9	44.0	88	1969	4	1964	651	0	1.65	3.60	1968	0.13	1976	2.39	1975	12.1	1964	12.1	1964	73	79	61	59	11.1	S	53	28	1979	51	6.2
F	59.1	37.8	48.5	88	1959	9	1978	469	7	1.93	6.20	1965	0.15	1963	4.06	1965	13.5	1978	7.5	1978	72	79	59	54	11.8	S	51	36	1962	54	5.8
M	67.2	44.9	56.1	96	1974	15	1980	313	37	2.42	6.39	1968	0.10	1972	4.39	1977	2.5	1962	2.5	1962	71	80	57	51	13.0	S	55	29	1954	59	5.9
A	76.8	55.0	65.9	95	1972	30	1973	85	112	3.63	12.19	1957	0.59	1983	4.55	1957	0.0		0.0		74	83	58	54	12.7	S	55	32	1970	63	6.1
M	84.4	62.9	73.7	99	1980	41	1978	0	275	4.27	13.66	1982	0.99	1977	4.86	1965	0.0		0.0		79	87	61	58	11.0	S	55	14	1955	64	5.8
J	93.2	70.8	82.0	113	1980	51	1964	0	510	2.59	7.85	1981	0.40	1964	3.11	1966	0.0		0.0		73	85	55	50	10.7	S	52	32	1955	70	4.8
J	97.8	74.7	86.3	110	1980	59	1972	0	660	2.00	11.13	1973	0.09	1965	3.76	1975	0.0		0.0		67	80	49	44	9.4	S	65	36	1961	81	4.2
A	97.3	73.7	85.5	108	1964	56	1967	0	636	1.76	6.85	1970	T	1980	4.05	1976	0.0		0.0		68	81	51	45	9.0	S	73	36	1959	77	4.2
S	89.7	67.5	78.6	105	1953	45	1983	0	408	3.31	9.52	1964	0.22	1983	4.76	1965	0.0		0.0		75	85	57	54	9.3	S	53	11	1961	76	4.7
O	79.5	56.3	67.9	102	1979	29	1980	56	146	2.47	14.18	1981	T	1975	5.91	1959	0.0		0.0		73	82	54	55	9.6	S	44	27	1957	64	4.6
N	66.2	44.9	55.6	89	1955	20	1959	300	18	1.76	6.23	1964	0.20	1970	2.83	1964	5.0	1976	4.8	1976	73	80	56	58	10.6	S	50	34	1957	61	5.1
D	58.1	37.4	47.8	88	1955	5	1983	533	0	1.67	6.99	1971	0.17	1981	3.10	1971	2.6	1963	2.5	1963	72	78	58	58	11.1	S	53	32	1968	59	5.5
YR	76.9	55.0	66.0	113	JUN 1980	4	JAN 1964	2407	2809	29.45	14.18	OCT 1981	T	AUG 1980	5.91	OCT 1959	13.5	FEB 1978	12.1	JAN 1964	73	82	56	53	10.8	S	73	36	AUG 1959	66	5.2

Galveston, Texas Post Office Building

Month	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind					Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
	Normal			Extremes						Water equivalent							Snow, Ice pellets				Hour	Hour	Hour	Hour		thru 1963	Fastest mile				
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	00 (Local time)	06	12	18	Mean speed m.p.h.	Prevailing direction	Speed m.p.h.	Direction	Year		
(a)				113		113					113		113		113		113		113		44	96	66	96	93		112	112		92	
J	59.2	47.9	53.6	77	1969	11	1886	376	23	2.96	10.39	1899	0.02	1909	5.38	1923	2.5	1973	2.5	1973	83	85	77	80	11.6		53	S	1915	48	
F	60.9	50.2	55.6	83	1932	8	1899	282	18	2.34	8.29	1881	0.09	1954	6.55	1952	15.4	1895	15.4	1895	82	84	74	77	11.8		60	N	1927	51	
M	66.4	56.5	61.4	85	1879	26	1980	160	48	2.10	9.49	1973	0.06	1953	8.10	1973	T	1932	T	1932	84	85	74	79	11.9		50	SE	1952	55	
A	73.3	64.9	69.1	92	1953	38	1938	19	142	2.62	11.04	1904	0.01	1887	9.23	1904	0.0		0.0		85	86	75	80	12.1		68	NW	1983	60	
M	79.8	71.6	75.7	93	1911	52	1954	0	332	3.30	10.79	1975	T	1978	7.71	1975	0.0		0.0		83	84	73	77	11.5		66	W	1959	67	
J	85.1	77.2	81.2	99	1918	57	1903	0	486	3.48	15.49	1919	T	1907	12.56	1961	0.0		0.0		80	81	70	73	10.7		62	SE	1921	75	
J	87.3	79.1	83.2	101	1932	66	1910	0	564	3.77	18.74	1900	T	1962	14.35	1900	0.0		0.0		80	81	70	73	9.8		68	NW	1943	72	
A	87.5	78.8	83.2	100	1924	67	1966	0	564	4.40	19.08	1915	0.00	1902	10.86	1981	0.0		0.0		78	81	69	73	9.4		91	E	1915	70	
S	84.6	75.4	80.0	96	1927	52	1942	0	450	5.82	26.01	1885	0.04	1924	11.65	1961	0.0		0.0		78	81	68	74	10.1		100	NE	1900	68	
O	77.6	67.7	72.7	94	1952	41	1925	10	248	2.60	17.78	1871	T	1952	14.10	1901	0.0		0.0		75	80	65	71	10.3		66	SE	1949	72	
N	68.3	57.6	63.0	85	1886	26	1911	139	79	3.23	16.18	1940	0.03	1903	9.01	1940	0.0		0.0		81	83	72	77	11.2		54	N	1950	60	
D	62.3	51.2	56.8	80	1918	14	1983	267	13	3.62	10.28	1887	0.23	1889	5.43	1954	0.2	1924	0.2	1924	82	85	76	79	11.3		50	NW	1954	49	
YR	74.4	64.8	69.6	101	JUL 1932	8	FEB 1899	1253	2967	40.24	26.01	SEP 1885	0.00	AUG 1902	14.35	JUL 1900	15.4	FEB 1895	15.4	FEB 1895	81	83	72	76	11.0		100	NE	SEP 1900	63	

Houston, Texas Intercontinental Airport

Month	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind					Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
	Normal			Extremes						Water equivalent							Snow, Ice pellets				Hour	Hour	Hour	Hour		thru 1963	Fastest mile				
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	00 (Local time)	06	12	18	Mean speed m.p.h.	Prevailing direction	Speed m.p.h.	Direction	Year		
(a)				14		14					14		14		14		14		14		14	14	14	14	14	15	14	14		14	14
J	61.9	40.8	51.4	84	1975	12	1982	442	20	3.21	7.68	1974	0.36	1971	2.39	1980	2.0	1973	2.0	1973	84	87	65	70	8.3	NNW	32	31	1978	43	7.0
F	65.7	43.2	54.5	85	1982	20	1981	314	20	3.25	5.23	1979	0.38	1976	1.65	1980	2.8	1973	1.4	1980	84	88	60	61	8.7	SSE	35	29	1974	50	6.4
M	72.1	49.8	61.0	90	1974	22	1980	175	51	2.68	8.52	1972	1.21	1971	7.47	1972	0.0		0.0		84	88	60	61	9.5	SSE	35	10	1979	47	6.9
A	79.0	58.3	68.7	92	1981	31	1973	32	143	4.24	10.92	1976	0.43	1983	8.16	1976	0.0		0.0		88	90	60	63	9.4	SSE	45	14	1978	51	6.7
M	85.1	64.7	74.9	95	1978	44	1978	0	307	4.69	14.39	1970	0.79	1977	5.11	1981	0.0		0.0		89	93	60	64	8.2	SSE	46	23	1983	57	6.2
J	90.9	70.2	80.6	103	1980	52	1970	0	468	4.06	13.46	1973	0.26	1970	6.61	1973	0.0		0.0		88	92	59	62	7.6	SSE	45	30	1973	65	5.5
J	93.6	72.5	83.1	104	1980	62	1972	0	561	3.33	8.10	1979	1.42	1971	3.99	1973	0.0		0.0		87	93	58	63	6.8	S	46	10	1969	67	5.7
A	93.1	72.1	82.6	107	1980	62	1970	0	546	3.66	9.42	1983	1.40	1980	6.83	1981	0.0		0.0		90	94	60	65	6.0	SSE	51	08	1983	64	5.7
S	88.7	68.1	78.4	100	1980	48	1975	0	402	4.93	11.35	1976	0.80	1975	7.98	1976	0.0		0.0		91	94	62	70	6.8	SSE	37	05	1982	62	5.6
O	81.9	57.5	69.7	94	1981	33	1976	36	181	3.67	9.31	1973	0.05	1978	4.06	1970	0.0		0.0		90	92	56	71	6.6	ESE	35	32	1973	63	5.0
N	71.6	48.6	60.1	89	1978	19	1976	201	54	3.38	8.91	1982	1.54	1970	3.62	1981	T	1979	T	1979	87	90	59	74	7.8	SSE	37	33	1972	53	5.5
D	65.2	42.7	54.0	83	1978	11	1983	349	8	3.66	7.33	1971	0.64	1973	3.43	1971	0.0		0.0		84	87	61	71	8.1	SSE	35	31	1973	57	6.5
YR	79.1	57.4	68.3	107	AUG 1980	11	DEC 1983	1549	2761	44.77	14.39	MAY 1970	0.05	OCT 1978	8.16	APR 1976	2.8	FEB 1973	2.0	JAN 1973	87	91	60	66	7.8	SSE	51	08	AUG 1983	56	6.0

Port Arthur, Texas Jefferson County Airport

Month	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind					Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
	Normal			Extremes						Water equivalent							Snow, Ice pellets				Hour	Hour	Hour	Hour		thru 1963	Fastest mile				
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	00 (Local time)	06	12	18	Mean speed m.p.h.	Prevailing direction	Speed m.p.h.	Direction	Year		
(a)				30		30					30		30		30		30		30		21	23	23	23	30	10	25	25		26	30
J	61.7	42.1	51.9	81	1982	14	1962	431	25	4.18	9.57	1961	0.60	1971	4.92	1961	3.0	1973	3.0	1973	86	88	69	77	11.1	N	50	S	1957	42	7.0
F	65.4	44.3	54.9	84	1962	20	1981	306	23	3.71	11.76	1959	0.36	1954	5.05	1965	4.4	1960	4.4	1960	85	88	63	70	11.6	S	62	SE	1969	52	6.3
M	71.8	51.0	61.4	87	1974	25	1980	167	56	2.93	9.35	1979	0.06	1955	6.04	1979	1.4	1968	1.4	1968	86	88	62	69	12.0	S	66	SW	1964	52	6.6
A	78.5	59.4	69.0	93	1955	36	1980	23	143	4.05	15.30	1973	0.35	1965	10.09	1973	0.0		0.0		87	90	64	71	12.1	S	60	NW	1966	52	6.7
M	85.0	66.1	75.6	97	1977	46	1954	0	329	4.50	11.39	1983	0.10	1978	7.66	1983	0.0		0.0		90	92	64	70	10.4	S	74	SW	1971	64	6.1
J	90.5	71.8	81.2	100	1954	57	1975	0	486	3.96	14.05	1961	0.76	1980	10.20	1961	0.0		0.0		91	93	63	70	8.9	S	72	NW	1957	69	5.3
J	92.5	73.7	83.1	103	1980	61	1967	0	561	5.37	18.71	1959	0.63	1956	10.56	1979	0.0		0.0		92	94	66	72	7.7	S	66	SW	1963	65	5.9
A	92.2	73.3	82.8	107	1962	62	1967	0	552	5.45	17.26	1966	0.98	1968	8.45	1966	0.0		0.0		92	93	66	72	7.4	S	73	E	1964	63	5.8
S	88.6	69.8	79.2	100	1980	45	1967	0	426	6.13	21.96	1980	0.50	1953	17.16	1980	0.0		0.0		90	92	65	74	8.5	NE	56	SW	1968	62	5.5
O	81.5	58.9	70.2	95	1977	35	1957	33	194	3.63	15.09	1970	0.00	1963	8.06	1970	0.0		0.0		88	90	58	72	8.8	N	65	NW	1956	67	4.7
N	71.4	49.8	60.6	88	1978	22	1976	190	58	4.33	10.84	1977	0.15	1967	7.26	1961	T	1976	T	1976	87	89	61	75	10.2	N	60	NE	1963	57	5.6
D	65.0	44.4	54.7	84	1978	15	1983	327	8	4.55	17.98	1982	1.32	1954	9.98	1982	T	1983	T	1983	87	89	67	77	10.6	N	69	S	1953	47	6.3
YR	78.7	58.7	68.7	107	AUG 1962	14	JAN 1962	1477	2861	52.79	21.96	SEP 1980	0.00	OCT 1963	17.16	SEP 1980	4.4	FEB 1960	4.4	FEB 1960	88	91	64	72	10.0	S	74	SW	MAY 1971	58	6.0

San Angelo, Texas Mathis Field

Month	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind					Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
	Normal			Extremes						Water equivalent							Snow, Ice pellets				Hour	Hour	Hour	Hour		thru 1963	Fastest mile				
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	00 (Local time)	06	12	18	Mean speed m.p.h.	Prevailing direction	Speed m.p.h.	Direction	Year		
(a)				36		36					36		36		36		36		36		23	23	23	23	34	14	35	35			35
J	58.7	32.2	45.5	90	1969	5	1982	605	0	0.64	3.65	1961	0.00	1967	2.49	1961	9.0	1978	7.4	1978	68	75	52	48	10.3	SW	44	27	1960		5.5
F	63.3	36.1	49.7	90	1957	1	1951	428	0	0.84	2.86	1958	0.01	1974	1.92	1958	5.8	1973	4.1	1966	66	75	49	42	10.9	SSW	48	29	1960		5.3
M	71.5	43.4	57.5	97	1974	8	1980	274	42	0.79	5.00	1953	T	1972	4.65	1953	3.1	1962	3.1	1962	60	70	43	36	12.4	SSW	58	27	1961		5.2
A	80.2	53.4	66.8	103	1972	25	1973	73	127	1.75	5.10	1977	0.10	1967	3.32	1971	T	1980	T	1980	62	74	44	37	12.2	S	75	28	1969		5.2
M	86.3	61.5	73.9	107	1960	35	1967	5	281	2.52	7.10	1957	0.26	1962	2.56	1975	0.0		0.0		69	81	49	42	11.3	S	60	02	1963		5.3
J	93.4	69.3	81.4	110	1969	48	1964	0	492	1.88	6.01	1982	0.07	1956	2.86	1961	0.0		0.0		66	80	49	41	11.2	S	57	02	1955		4.3
J	96.5	72.0	84.3	111	1960	58	1968	0	598	1.22	7.21	1959	T	1970	2.95	1959	0.0		0.0		59	76	43	36	9.8	S	40	03	1981		4.3
A	95.4	71.2	83.3	107	1969	55	1961	0	567	1.85	8.13	1971	T	1959	3.00	1971	0.0		0.0		63	78	45	40	9.2	S	43	02	1949		4.2
S	88.0	65.0	76.5	107	1952	42	1981	0	350	3.04	11.00	1980	T	1983	6.25	1980	0.0		0.0		72	83	54	49	9.1	S	52	34	1981		4.6
O	79.2	54.0	66.6	100	1951	29	1980	75	125	2.05	8.68	1981	0.00	1952	5.11	1959	0.0		0.0		74	82	52	50	9.4	S	60	29	1960		4.3
N	67.2	42.0	54.6	93	1980	13	1979	326	14	0.97	3.55	1968	0.00	1950	2.16	1975	8.8	1968	5.8	1968	73	80	52	52	9.9	SW	66	29	1958		4.6
D	61.2	34.7	48.0	91	1954	-1	1983	527	0	0.64	2.70	1979	T	1973	2.02	1980	1.9	1967	1.4	1967	70	77	50	50	10.0	W	43	30	1965		5.0
YR	78.4	52.9	65.7	111	JUL 1960	-1	DEC 1983	2313	2596	18.19	11.00	SEP 1980	0.00	JAN 1967	6.25	SEP 1980	9.0	JAN 1978	7.4	JAN 1978	67	78	49	44	10.5	S	75	28	APR 1969		4.8

San Antonio, Texas International Airport

Month	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind					Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
	Normal			Extremes						Water equivalent							Snow, Ice pellets				Hour	Hour	Hour	Hour		thru 1963	Fastest mile				
	# Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	00 (Local time)	06	12	18	Mean speed m.p.h.	Prevailing direction	Speed m.p.h.	Direction	Year		
(a)				42		42					41		41		41		41		41		41	41	41	41	41	15	7	7		41	41
J	61.7	39.0	50.4	89	1971	0	1949	463	10	1.55	8.52	1968	0.04	1971	3.18	1968	4.7	1949	4.7	1949	76	80	60	57	9.2	N	35	31	1979	48	6.3
F	66.3	42.4	54.3	92	1959	6	1951	319	19	1.86	6.43	1965	0.03	1954	2.34	1965	3.5	1966	3.5	1966	75	80	57	52	9.9	NE	35	01	1981	52	6.1
M	73.7	49.8	61.8	100	1971	19	1980	178	78	1.33	4.19	1957	0.03	1961	2.36	1945	T	1978	T	1978	72	79	54	47	10.6	SE	35	36	1980	57	6.2
A	80.3	58.8	69.6	100	1982	33	1983	28	166	2.73	9.32	1957	0.14	1955	4.88	1977	0.0		0.0		76	83	57	51	10.7	SE	39	35	1979	55	6.4
M	85.5	65.5	75.5	101	1967	44	1954	0	326	3.67	11.24	1972	0.17	1961	6.53	1972	0.0		0.0		81	88	59	55	10.3	SE	43	02	1983	55	6.4
J	91.8	72.0	81.9	105	1980	53	1964	0	507	3.03	10.44	1973	0.01	1967	6.18	1951	0.0		0.0		80	88	56	51	10.2	SE	35	10	1978	67	5.5
J	94.9	74.3	84.6	106	1954	62	1967	0	608	1.92	8.19	1942	T	1944	6.97	1958	0.0		0.0		75	87	52	45	9.3	SSE	48	09	1979	74	5.1
A	94.6	73.7	84.2	106	1962	61	1966	0	595	2.69	11.14	1974	0.00	1952	5.57	1950	0.0		0.0		74	86	51	46	8.6	SE	35	07	1980	73	4.9
S	89.3	69.4	79.4	102	1951	41	1942	0	432	3.75	15.78	1946	0.06	1947	7.28	1973	0.0		0.0		78	86	55	52	8.5	SE	42	18	1977	67	5.2
O	81.5	58.9	70.2	98	1979	33	1980	41	202	2.88	9.56	1942	T	1952	5.29	1942	0.0		0.0		77	84	53	53	8.5	N	31	02	1977	64	4.9
N	70.7	48.2	59.5	91	1962	21	1976	199	34	2.34	6.01	1977	T	1966	4.87	1977	0.3	1957	0.3	1957	76	81	55	56	8.9	N	37	33	1983	55	5.4
D	64.6	41.4	53.0	90	1955	9	1983	378	6	1.38	4.51	1965	0.03	1950	2.89	1944	0.2	1964	0.2	1964	76	80	57	57	8.7	N	30	36	1983	50	6.0
YR	79.6	57.8	68.7	106	AUG 1962	0	JAN 1949	1606	2983	29.13	15.78	SEP 1946	0.00	AUG 1952	7.28	SEP 1973	4.7	JAN 1949	4.7	JAN 1949	76	83	55	52	9.4	SE	48	09	JUL 1979	60	5.7

Victoria, Texas Victoria Regional Airport

Month	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind					Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
	Normal			Extremes						Water equivalent							Snow, Ice pellets				Hour	Hour	Hour	Hour		thru 1963	Peak Gust				
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	00 (Local time)	06	12	18	Mean speed m.p.h.	Prevailing direction	Speed m.p.h.	Direction	Year		
(a)				23		23					23		23		23		23		23		19	22	22	22	22		21	21			22
J	63.6	43.1	53.4	88	1971	14	1982	386	27	1.87	5.21	1979	0.02	1971	3.65	1980	1.2	1973	1.2	1973	84	86	65	68	10.6		55	-	1963		7.0
F	67.1	45.9	56.5	90	1962	20	1981	268	30	2.24	5.42	1969	0.27	1974	2.63	1969	1.0	1973	1.0	1973	83	86	60	62	11.0		54	N	1981		6.5
M	73.8	52.8	63.3	95	1971	21	1980	140	87	1.34	4.44	1970	0.18	1971	2.60	1983	0.0		0.0		82	86	58	60	11.7		59	N	1970		6.9
A	80.2	61.5	70.9	98	1963	35	1980	18	195	2.61	9.43	1969	0.24	1983	8.57	1969	0.0		0.0		85	88	60	64	11.9		60	E	1969		7.2
M	85.6	67.7	76.7	101	1964	49	1978	0	363	4.47	14.08	1968	1.00	1971	8.45	1972	0.0		0.0		87	91	61	66	10.7		63	NW	1975		6.7
J	90.8	73.1	82.0	100	1980	59	1979	0	510	4.53	12.68	1973	T	1980	9.30	1977	0.0		0.0		88	92	59	64	9.6		62	S	1971		5.7
J	93.7	75.2	84.5	104	1964	62	1967	0	605	2.58	10.47	1983	0.07	1982	4.22	1983	0.0		0.0		87	92	57	61	8.8		99	-	1963		5.7
A	93.7	74.7	84.2	107	1962	63	1967	0	595	3.33	7.30	1974	0.34	1965	6.14	1964	0.0		0.0		86	91	57	62	8.3		67	-	1963		5.8
S	89.3	70.9	80.1	99	1982	51	1983	0	453	6.24	19.05	1978	1.11	1982	8.51	1967	0.0		0.0		87	91	61	67	8.4		54	N	1976		5.7
O	82.8	61.0	71.9	95	1962	36	1980	20	234	3.31	10.16	1981	0.34	1964	5.05	1981	0.0		0.0		86	90	56	65	8.7		60	W	1977		5.0
N	73.0	51.5	62.3	92	1963	24	1976	150	69	2.24	8.68	1982	0.02	1981	6.63	1982	0.2	1976	0.2	1976	86	88	58	68	9.7		48	N	1983		5.6
D	66.7	45.4	56.1	88	1964	14	1983	291	16	2.14	6.97	1975	0.36	1972	6.12	1975	T	1969	T	1969	84	86	62	69	10.2		52	N	1973		6.8
YR	80.0	60.2	70.1	107	AUG 1962	14	DEC 1983	1273	3184	36.90	19.05	SEP 1978	T	JUN 1980	9.30	JUN 1977	1.2	JAN 1973	1.2	JAN 1973	85	89	60	65	10.0		99	-	JUL 1963		6.2

Waco, Texas Madison Cooper Airport

Month	Temperatures °F							Normal Degree days Base 65 °F		Precipitation in inches											Relative humidity pct.				Wind					Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
	Normal			Extremes						Water equivalent							Snow, Ice pellets				Hour	Hour	Hour	Hour		thru 1963	Fastest mile				
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Heating	Cooling	Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Maximum monthly	Year	Maximum in 24 hrs.	Year	00 (Local time)	06	12	18	Mean speed m.p.h.	Prevailing direction	Speed m.p.h.	Direction	Year		
(a)				41		41					41		41		41		41		41		20	20	20	20	34	14	35	35			38
J	56.6	35.7	46.2	88	1971	-5	1949	591	8	1.69	5.83	1961	0.03	1971	2.24	1961	7.0	1949	7.0	1949	77	83	64	62	11.7	S	49	32	1952		6.3
F	61.6	39.4	50.5	90	1954	5	1949	415	9	2.04	4.55	1944	0.17	1972	3.03	1977	4.8	1966	4.8	1966	76	82	61	57	12.0	S	58	36	1954		6.0
M	69.5	46.6	58.1	100	1971	15	1948	257	43	1.99	6.84	1945	0.04	1956	3.07	1946	1.0	1962	1.0	1962	73	81	58	52	13.1	S	65	27	1952		5.9
A	77.6	56.5	67.1	101	1963	27	1975	71	134	3.79	13.37	1957	0.12	1983	5.09	1957	0.0		0.0		76	84	61	56	13.0	S	62	36	1953		6.2
M	84.2	64.2	74.2	99	1949	37	1981	0	288	4.73	15.00	1965	0.72	1945	7.18	1953	0.0		0.0		79	87	62	58	11.9	S	60	36	1952		6.0
J	92.1	71.5	81.9	109	1980	52	1964	0	507	2.58	12.06	1961	0.27	1953	4.21	1947	0.0		0.0		74	84	54	50	11.6	S	69	09	1961		4.9
J	96.5	75.2	85.9	108	1957	61	1970	0	648	1.78	8.58	1971	T	1963	4.49	1973	0.0		0.0		67	80	48	43	10.7	S	60	36	1953		4.3
A	96.7	74.5	85.6	112	1969	60	1967	0	639	1.95	8.91	1974	T	1952	4.80	1958	0.0		0.0		68	81	48	45	9.9	S	60	05	1951		4.3
S	89.7	68.6	79.2	106	1977	40	1983	0	426	3.18	7.29	1970	0.00	1956	4.57	1957	0.0		0.0		75	85	55	53	9.5	S	60	32	1952		4.7
O	80.3	57.2	68.8	101	1979	29	1980	46	164	3.06	9.36	1973	0.00	1952	5.72	1974	0.0		0.0		75	83	55	56	9.9	S	52	34	1960		4.6
N	67.9	46.1	57.0	92	1948	17	1976	265	25	2.24	6.24	1952	0.13	1970	4.26	1952	0.8	1980	0.8	1980	77	83	58	61	10.8	S	62	29	1953		5.2
D	60.3	38.5	49.5	91	1955	7	1983	481	0	1.92	7.03	1960	0.04	1950	3.11	1945	2.0	1946	2.0	1946	76	82	61	62	11.2	S	52	32	1954		5.7
YR	77.8	56.2	67.0	112	AUG 1969	-5	JAN 1949	2126	2891	30.95	15.00	MAY 1965	0.00	SEP 1956	7.18	MAY 1953	7.0	JAN 1949	7.0	JAN 1949	74	83	57	55	11.3	S	69	09	JUN 1961		5.3