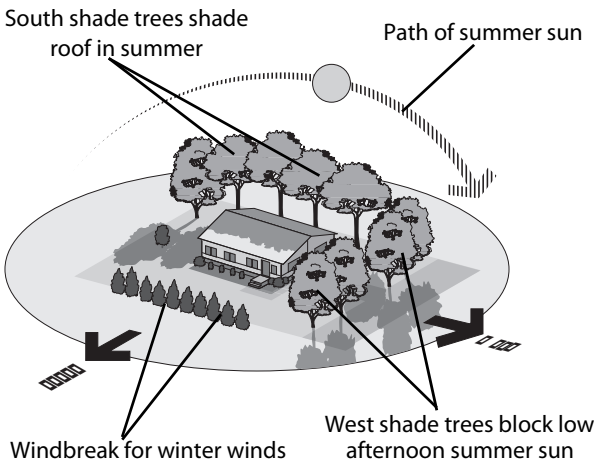
Figure 1-8 Locating a Manufactured Home



Locating a Manufactured Home - If you have the option, orient your home's long side toward the south. Provide south shade for the high summer sun during the day. Block afternoon summer sun from the west. Provide a windbreak toward the prevailing winter winds.

If you have a choice of orientation, point the home's long side toward the south. The southern wall's windows catch winter sunshine, but avoid the summer sun's most intense rays coming from overhead. With this orientation, the short sides face east and west—the directions of low-angle summer solar heat—preventing the sun from baking the home's longer walls with their greater window area. Cold winter winds commonly come from the west and northwest, so pointing your home's short sides in those directions prevents the prevailing wind from buffeting the long wall's greater surface area.

Mobile Home Parks

If you plan on siting your mobile home in a mobile home park or in a manufactured housing community, get a complete list of costs, fees, and rules. Although the difference between a mobile home park and a manufactured housing community is mostly semantic, sometimes the manufactured housing community may have newer homes and more restrictive land covenants. And, park residents may even own their own land.

Figure 1-9 Mobile Home Parks

Find out all their requirements and talk to existing tenants about conditions in the park.

Make sure you completely understand all the community's requirements. Be certain that you can live with these rules before locating your home there or buying a home in that particular park or community.

Many states have laws governing landlord/tenant relations in mobile home parks and in manufactured housing communities. The American Association of Retired Persons (AARP) has researched and written model legislation designed to protect tenants from overly restrictive rules. Your state legislator, legislative research division, law library, public library, or the AARP should be able to inform you about your state's laws.

Codes and Standards

Manufactured homes are built in factories by a national building code requiring their design to resist snow loads, wind loads, and extreme summer and winter temperatures. This national building code—known as the HUD Code—governs only their manufacture. Later additions and renovations may be regulated by local building codes.

Mobile home installation and foundations are governed by different model building codes or by state codes specially adopted for the purpose.

Figure 1-10 HUD Insulation Standards —1976 vs. 1994 — A Comparison

		1976 Thermal Standards			1994 Thermal Standards		
		Zone 1	Zone 2	Zone 3	Zone 1	Zone 2	Zone 3
Single-Wide	Ceiling	R-11	R-11	R-19	R-14	R-19	R-19
	Wall	R-7	R-7	R-13	R-11	R-13	R-19
	Windows	Single aluminum	Double aluminum	Double aluminum	Double aluminum	Double aluminum	Double wood or vinyl
	Floor	R-7	R-11	R-14	R-11	R-19	R-19
Double-Wide	Ceiling	R-11	R-11	R-19	R-14	R-22	R-22
	Wall	R-7	R-11	R-11	R-11	R-13	R-19
	Windows	Single aluminum	Double aluminum	Double aluminum	Double aluminum	Double aluminum	Double wood or vinyl
	Floor	R-7	R-11	R-19	R-14	R-19	R-22

HUD strengthened its insulation standards as of October 1994. This table gives typical R-values and window types used to meet the 1976 and 1994 HUD Code's thermal standards. Note that the climate zone map changed when the 1994 thermal standards took effect.

American National Standards Institute

In the late 1950s and early 1960s, competition between mobile home manufacturers was brisk, sales high, and quality sometimes poor. Inconsistent manufacturing led the American National Standards Institute (ANSI) to develop construction standards for mobile homes in 1963, on behalf of the Mobile Home Manufacturers' Association. By 1973, 45 states had adopted the ANSI Standard, making it the basic reference for design and construction.

In the early 1970s, reports by the Center for Automotive Safety prompted Congress to investigate mobile home construction practices. Instead of relying on sometimes spotty state-by-state enforcement, Congress opted to establish federal standards for mobile-home construction. In 1974, Congress passed the Manufactured Home Construction and Safety Standards Act. This legislation ordered the U.S. Department of Housing and Urban Development (HUD) to establish and enforce a mobile home construction code.

HUD Code

In 1976, HUD adopted its Manufactured Home Construction and Safety Standards, commonly called the HUD Code, as the nation's only applicable building code for mobile home construction. The HUD Code set minimum performance standards for roof strength, wind resistance, mechanical equipment, thermal performance, safety, and other construction details. These standards gradually came into force in the late 1970s, increasing the quality of mobile homes nationwide.

The National Conference of States on Building Codes and Standards (NCS/BCS) is HUD's code consultant and enforcer. State Administrative Agencies (SAAs) and private inspection agencies, under the direction of NCS/BCS, inspect manu-

facturers and investigate consumer complaints. You can obtain a list of SAAs from NCS/BCS (*See "Businesses and Organizations" on page 226*). Enforcement of the HUD Code is complete when the home is delivered. After that, local codes may regulate future additions or renovations if changes to the home require a building permit.

The 1976 HUD Code set thermal standards for new mobile homes, depending on their location. The HUD Code divided the country into three climate zones and established average R-value requirements for mobile homes. The table on this page gives examples of the R-values and window types that could be used to meet these 1976 thermal standards and also the revised 1994 standards discussed below.

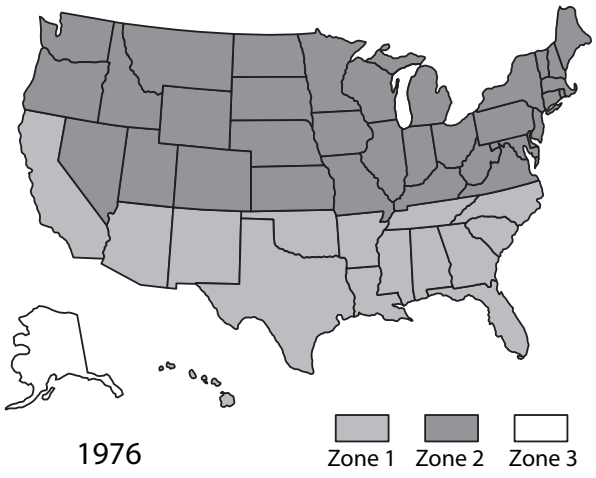
In 1985, sections were added to the HUD Code that set maximum formaldehyde emissions by building products. HUD also required manufacturers to provide whole-house ventilation systems as options in new manufactured homes in the same year.

HUD Code changes, which took effect in the fall of 1994, raised minimum insulation requirements for manufactured homes. HUD also changed its thermal zone map in 1994. Although some temporary confusion may arise, these changes will ultimately provide for more site-appropriate construction.

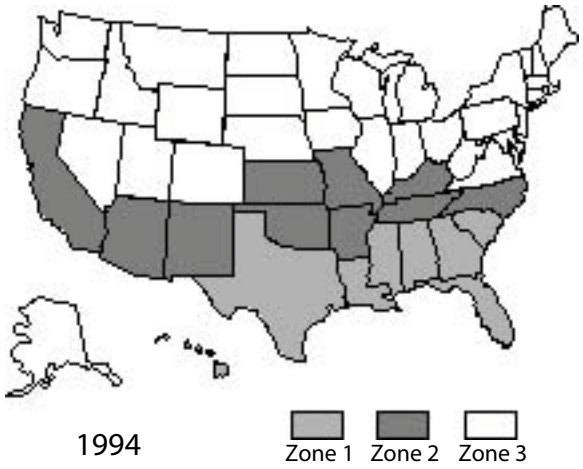
In short, a home built after October 1994 may be certified for a different numbered zone than a similar home built before the 1994 code change. The reason for this map change was to more accurately reflect the climatic differences between different sections of the country. Check the two maps included here for a comparison.

The 1994 revisions also mandated whole-house ventilation and attic ventilation (*See "Ventilating the Indoors" on page 64*).

Figure 1-11 HUD Climate Zone Maps



In this original zone map from 1976, most of the middle and northern U.S. was in Zone 2. Alaska was the only Zone-3 state until the 1994 changes.



1994 revisions to the HUD Code redrew zones to provide more accurate differentiation than the 1976 map. The entire northern U.S. is now in Zone 3, the middle states are in Zone 2, and the southern states are in Zone 1.

HUD Code: Then and Now — Mobile homes built before the 1976 HUD Code are generally less energy-efficient than those built after 1976. These older mobile homes may have some or all of the following characteristics:

- Little or no insulation;
- No vapor barrier in the ceiling;

- 1-to-2 inches of fiberglass insulation wrapped around the outside of wall, floor, and roof framing;
- 2-by-2 or 2-by-3 wall studs;
- Un-insulated supply and return air ducts in the floor or ceiling; and
- Jalousie windows.
- Mobile homes that conform to the 1976 HUD Code must have:
- Insulation in walls, floor, and ceiling;
- A vapor barrier in the ceiling;
- An underbelly of rigid or flexible material to prevent the entry of rodents, water, and road dirt;
- At least 2-by-4 exterior wall studs;
- Supply and return ducts for heating systems that are enclosed in the heated envelope. Or, if not enclosed within the heated envelope, they must be insulated to R-4; and
- Single-hung or slider windows with storm windows in the northern U.S.

Manufactured homes built after October of 1994 must have:

- Higher insulation levels in walls, floors, and ceilings than the 1976 requirements;
- Vent fans in kitchens and bathrooms;
- Whole-house ventilation of 0.10 air changes per hour; and
- More ground anchors, if the home is located in a windy region.

Installation Standards for Manufactured Homes

The American National Standards Institute (ANSI) publishes standards for building foundations and installing mobile homes. And, the Manufactured Housing Institute (MHI) publishes the Model Manufactured Home Installation Manual which serves as a guide for the installation manuals written by manufacturers.

A few states have adopted their own standards for installing manufactured homes. Many more have adopted the ANSI Standard for installation: The 1994 revised edition of the ANSI 225.1 standard is available from NCS/BCS. Manufacturers and lenders consult HUD's Permanent Foundations Guide for Manufactured Housing for guidance on foundations.

Mobile homes must usually meet specific local code requirements for the connection of utilities like water, sewer, natural gas, and electricity. Some local building departments look to the HUD Code for guidance in regulating modifications to mobile homes. Other building officials look to local codes for guidance.

Local Codes

Local codes are enforced by local building departments as part of the process of issuing building permits. Local or state building officials and fire marshals interpret the building codes and are responsible for enforcing them. Cities, counties, and states—the building officials' employers—may adopt any of several common building codes covering construction practices, fire prevention, and safe installation of plumbing, wiring, and mechanical devices for site-built homes. If the city or county has not adopted building codes, then the building codes adopted by the state usually apply. These codes can be used to regulate utility connections, additions, and renovation of manufactured homes.

Most local building authorities lack knowledge or interest in mobile homes. Many state and local building departments simply exempt mobile homes from building codes. Even if local codes apply to mobile homes, most repairs and weatherization improvements aren't considered to be major changes and will usually not require a building permit or inspection.

Mobile Home Research

Research conducted during the past 10 years shows that energy savings of 25% to 45% are achievable through effective energy retrofit or building greater efficiency into new homes.

New-Home Research

In 1992, the Bonneville Power Administration (BPA) signed an agreement with all 18 home manufacturers in the Northwest to produce only homes that met the Model Conservation Standards. The BPA, a federal energy producer and broker, paid incentives of $2500 per home to purchase the energy savings from these manufacturers and their customers and to prevent price increases to customers.

Figure 1-12 Comparison of New Manufactured Homes

City	HUD space Heating kWh/yr.	MAP Space Heating kWh/yr.	Annual Savings kWh/yr.	Annual Savings $/yr. @ $0.08/kWh	Percentage Savings
Portland, OR	8,364	4,737	3,627	$290	43%
Spokane, WA	13,888	8,574	5,314	$425	38%
Missoula, MT	16,299	10,129	6,170	$493	38%

MAP Homes with energy saving features, costing about $1915 per home, use about 40% less energy for heating than standard HUD homes. Portland has a mild winter climate; Spokane is moderate; Missoula has a more severe winter climate.

This BPA program, called the Manufactured Homes Acquisition Program (MAP), paid incentives on 50,000 MAP homes between 1992 and 1995. These homes contained many improvements over homes built to HUD Code including the following.

1. Vinyl double-pane windows with low-e glass instead of aluminum single-pane windows with aluminum storm windows
2. Wall insulation of R-19 or R-21 instead of R-11
3. Floor insulation of R-33 instead of R-22
4. Attic insulation of R-30 to R-49 instead of R-19
5. Doors having R-5.3 instead of R-2.6
6. Measures to reduce duct air leakage
7. Measures to produce a more airtight shell
8. Intermittent or continuous mechanical ventilation

In 1995, Ecotope, Inc. of Seattle published a report documenting the savings produced by building homes to MAP energy standards versus HUD energy standards. Energy savings for these measures were estimated by utility bill analysis, on-site testing, and computer modeling. The energy savings of MAP homes compared to standard HUD homes was approximately 40% with annual kilowatt-hour savings ranging from 3900 kWh to 6600 kWh, depending on climate.

Existing-Home Research

From 1988 to 1991, the National Renewable Energy Laboratory (NREL) conducted mobile-home energy-conservation experiments. These experiments, funded by the U.S. Department of Energy, tested the effectiveness of weatherization and energy conservation measures in cold climates. Many of the conservation methods tested by NREL are described in this book.

During the experiments, seven mobile homes were tested before and after the following conservation measures were installed:

1. Interior storm windows
2. General repairs including air sealing and duct repair
3. Blown underbelly insulation

4. Wall insulation
5. Blown roof-cavity insulation
6. Rooftop insulation
7. Insulated skirting

NREL scientists used a procedure called coheating to monitor changes in heat loss after conservation measures were installed in the mobile homes. This procedure used 100%-efficient electric space heaters to heat the homes. The electrical energy used by the space heaters was easily measured, so it was relatively simple for scientists to accurately determine hourly heat-loss.

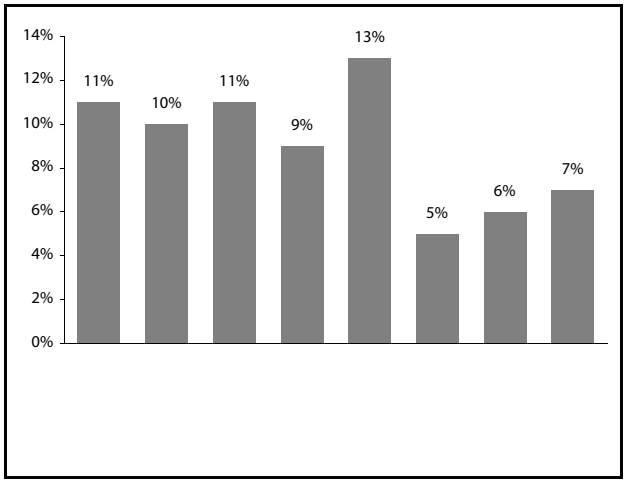
Figure 1-13 NREL Testing Site

NREL scientists used a warehouse as an environmental chamber to accurately measure retrofit energy savings in older mobile homes.

Knowing existing heat-loss, scientists could measure the heat-loss reduction after installation of each conservation improvement. They also measured heating efficiency and how it changed as a result of weatherization and tune-up procedures. NREL scientists also accurately measured air leakage by using a tracer gas. They employed 28 fans to simulate wind to measure the effect of wind on heat loss before and after conservation measures were installed.

The heat loss percentage reductions for individual conservation measures is shown in the bar graph. The average overall heating energy-use reduction was 43%. Follow-up field tests by NREL and the Colorado Department of Housing indicate that actual savings in real, lived-in homes varies from 25% to 35% from the package of retrofits described here.

Figure 1-14 Heat Loss Percentage Reduction for Conservation Projects



This bar graph show the average reduction in heat loss for the energy conservation projects tested by NREL.

The most important findings from this study on weatherization measures for cold climates are summarized below:

1. The most cost-effective measures for colder climates appear to be: air sealing and duct repair, furnace tune-up, blown roof insulation, interior storm windows, and blown floor insulation.
2. Furnace tune-ups, sealing duct leaks, and underbelly insulation directly increase the overall heating efficiency of a mobile home. The average increase in efficiency from these experiments was 15%.
3. Wall insulation can be a practical and cost-effective energy conservation measure on mobile homes.
4. Blown-in floor insulation slightly outperforms insulated skirting in still-air conditions.
5. Blown-in floor insulation significantly outperforms skirting in windy conditions, providing 42% greater savings than skirting with a 3.5 m.p.h. wind.

6. Fastening insulation to the top of the roof or the bottom of the floor is not as effective as filling the roof and floor cavities with blown-in insulation.
7. The conservation measures listed above are more cost-effective in a 3.5 m.p.h. wind than in calm wind conditions.

NREL scientists also found that average newer manufactured homes are at least as airtight as average site-built homes. The average natural ventilation rate for new manufactured homes was found to be around 0.25 air change per hour. HUD used this figure to estimate the natural ventilation rate for its new whole-house ventilation code that took effect in 1994.

The above NREL studies focused primarily on how mobile homes respond to cold climates. For mobile homes in very warm climates, adding wall and floor insulation may not be cost-effective, especially if the walls and floor already contain some insulation. However, roof insulation is doubly cost-effective in warm climates.

Figure 1-15 Filling Roof Cavities with Blown Insulation

This retrofit produced the best and most predictable energy savings of all the retrofits tested by NREL.