FACTORY AND SITE-BUILT HOUSING
A COMPARISON FOR THE 21ST CENTURY

Prepared for:

U.S. Department of Housing and Urban Development
Office of Policy Development and Research
451 Seventh Street, S.W.
Washington, D.C. 20410

by:

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NOTICE

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New homes in the United States are produced in a variety of different ways. Conventional site-built construction has historically predominated, but factory built homes, especially "manufactured homes" built under the preemptive Federal "HUD code," also play a very important role. This report, for the first time, provides a comprehensive comparison of HUD-code manufactured housing, conventional site-built homes and factory-built modular homes along several important dimensions. The comparisons address industry structure, production cost, characteristics of occupants and purchasers, unit designs and construction materials, regulatory processes, code requirements, and buyer costs.

Many of the historical distinctions between manufactured homes and conventional homes have been disappearing. During the 1990's, as HUD-code homes have become larger, multi-section units have become more common than single-section units, and placements on private land have outpaced placements on rented land. At the same time, site builders have slowly been shifting away from construction of compact, relatively inexpensive entry-level homes in favor of larger homes aimed at move-up buyers. However, very important differences still remain. For example, conventional site builders continue to play a much greater role in land and site development than HUD-code producers, and the two groups market their homes to purchasers in entirely different ways.

Based on the success and significant recent growth in the HUD-code sector, the report also recommends strategies by which home builders can improve efficiency, reduce production costs and play a larger role in delivering affordable homes to buyers of modest means. The future may ultimately see a more creative blending of factory production technology with conventional home building activities. Drawing on strengths and talents of both sectors offers a very potent approach to improving affordability while meeting the needs of home buyers and the communities where they live.

Xavier de Souza Briggs
Deputy Assistant Secretary for
Research, Evaluation, and
Monitoring

Executive Summary

The dramatic growth in the production of factory-built manufactured homes will have both short- and long-term implications for the housing industry as a whole. This comparative study of three main housing sectors—site-built housing, manufactured housing, and modular housing—details the recent growth in the manufactured home market and identifies efficiencies in the manufactured housing sector that can be applied to conventional site-built or modular home construction.

The study begins with an overview of housing industry trends in production, market share, and price. The characteristics of conventional, modular, and manufactured homes are described, comparing the similarities and differences between them, including location and land tenure, occupant characteristics, and design and material characteristics.

Historically, manufactured housing—often referred to as "HUD-Code" homes—have not competed with site-built homes because of the substantial differences between the two types of homes. Recent trends in the HUD-Code sector suggest increasing market overlap, particularly in the entry-level affordable home market. Not only has the demand for manufactured homes more than doubled from 1991 to 1996, but the units are larger, better equipped, and often look very similar to conventional ranch style houses. Two-story HUD-Code homes are now being developed and most new manufactured units are now being placed on privately owned land rather than on rented sites. Additionally, HUD-Code and site-built producers are forming partnerships that suggest industrywide changes may be underway.

While most producers of manufactured and modular housing focus on the construction of the housing, site-built producers often address a multitude of other issues, including land development, zoning, subdivision planning, provision of utilities and other infrastructure, arrangement of financing, and marketing to consumers. These different approaches to business are important to understand how the sectors will relate to one another in the future.

Regulatory systems among manufactured, modular, and site-built housing differ based on the jurisdiction that oversees production. The report assesses the potential impact of code differentiation on the costs of producing industrialized versus conventional housing. Site-built and modular homes must conform to state and/or local Standards (HUD-Code). The HUD-Code pre-empts all state and local codes that might otherwise apply to design and construction of manufactured homes. The federal system for regulating manufactured housing appears to be more efficient and less costly to administer than state and local systems for regulating site-built and modular construction. The study details the regulations of unit construction for three housing sectors: approval, design review, and inspection; land development, site-work, and installation; building requirements; electrical requirements; plumbing requirements; and energy requirement.

Using three approaches, the study analyzes and compares the relative costs of site-built, modular, and manufactured homes. A detailed analysis contracts the selling prices and production costs between site-built homes and HUD-Code homes. Contributing factors to variances in selling price and production cost include:

- Factory production economies of scale and purchasing power of producers.

- Presence or absence of land in the transaction.
- Type of foundation systems.
- Inclusion of design amenities such as garages and fireplaces.
- Building materials used for floor, roof, and wall construction.
- Regulatory systems and technical requirements for design and construction.

A cost comparison of the three types of housing finds that manufactured homes are less expensive than the site-built or modular homes due to their lower square-foot production costs, even after correction for major contributing factors including land, square footage, and differences in foundation costs. Up-front costs and monthly payment estimates form the buyer's perspective under several alternative scenarios are also used in the analysis.

The report concludes with a series of regulatory and technical recommendations and a separate set of recommendations for site builders and production builders. The recommendations show how conventional home builders can improve their operations, take advantage of new opportunities, and learn from the experience of the manufactured homes sector as strategic alliances and interactions between large site builders and large HUD-Code producers increase.

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CHAPTER 1

INTRODUCTION

During the decade of the 1990's, the United States has seen dramatic changes in the production of single family homes. The decade began with the housing industry approaching a cyclical trough that was reached in 1991 when single-family starts fell to a low of 840,000. As of 1996 starts had risen to 1,160,000 in a sustained period of recovery for the industry and strong growth throughout the economy.

But conventional site-built housing is only part of the story. An even more dramatic development over the same period of time has been the growing production of industrialized housing, most notably factory-built "manufactured homes" that are produced under a federal regulatory system and shipped throughout the U.S. Evolution in the manufactured housing or "HUD-Code" sector has been particularly rapid. There are many signs of this:

- Shipments of HUD-Code homes more than doubled from 171,000 units in 1991 to over 363,000 units in 1996. Output per firm and per plant are at historical highs.
- When HUD-Code and conventional homes are considered together, HUD-Code homes constituted over 24 percent of U.S. total housing starts and almost 32 percent of all new homes sold in the U.S. in 1996.
- Prices of HUD-Code homes have risen but remain well below prices of new site-built homes even after adjusting for house size, foundation and lot costs.
- HUD-Code homes are growing in floor area, double-section units are now more common than single-section units, and the share of new units placed in rental communities is declining.
- HUD-Code homes are increasingly being placed on permanent foundations and financed with 30-year mortgages rather than personal property loans.
- Technological innovations have made it possible to integrate the chassis with the floor system, and 2-story HUD-Code homes are now being built.
- Large conventional home building firms are becoming active in the HUD-Code sector through acquisitions or joint ventures.

These developments naturally raise questions about the underlying reasons for such strong performance in the manufactured home sector. Those questions lead to others, such as the potential for continuation of this trend, the longer-term significance of industrialization in new home production and its relationship to the "affordable housing" market, and the future role of conventional site-built construction and other types of factory-built housing within the overall new home market. This comparative study of industrialized housing and conventional home building was undertaken to improve understanding of recent developments in the manufactured home market and to identify efficiencies in that sector that may find application to more conventional forms of new home construction. Specifically, the study seeks to:

- Document and analyze the recent growth in industrialized housing,
- Assess technical, market and institutional factors contributing to the growth of industrialized housing, and
- Identify efficiencies that may be applicable to conventional site-built or modular housing.

This report draws on information gathered in a series of site visits and interviews with producers, regulators and others involved in production of manufactured and modular housing; information from a variety of site building firms; and review and analysis of existing published studies from numerous sources. It incorporates the most recent data on industrialized housing from the U.S. Bureau of the Census and the Manufactured Housing Institute (MHI) and presents extensive analysis of results from the 1995 *American Housing Survey*. Statistical data on housing characteristics and building product usage from the NAHB Research Center's annual survey of new home construction practices and data from a similar Research Center survey of manufactured housing producers are also used to document characteristics of site-built and HUD-Code homes.

The study is organized into seven chapters. Chapter 1 explains the purpose of the study. Chapters 2 and 3 provide detailed information about the products, producers and purchasers of each type of housing. Chapter 2 describes the overall structure of the site-built, HUD-Code and modular sectors of the industry and documents recent production and price trends in Chapter 2. Chapter 3 presents basic information about the stock of conventional and HUD-Code homes, the owners, occupants and purchasers of each type of home, and the design features, amenities, building products and materials that affect the cost and marketability of each type of home.

Manufactured housing is also regulated in a completely different way than site-built homes or modular construction, and this can affect design, construction and cost in each sector. Chapters 4 and 5 deal with these issues. Chapter 4 describes the regulatory processes governing unit construction, approvals and inspections, and land development, and Chapter 5 summarizes important substantive differences between the technical requirements of the HUD-Code and the prevailing model codes that apply to site-built and modular housing. Chapter 6 develops a comparative analysis of housing costs for different configurations of site-built, modular and HUD-Code homes, as well as comparisons of normalized costs of purchasing and monthly costs of home ownership under a variety of assumptions about land tenure, financing and other factors. Finally, Chapter 7 presents recommendations for all sectors of the industry intended to help improve efficiency and take advantage in other ways of experience in the manufactured housing sector. Appendix A and Appendix B present additional documentation to supplement the code comparison of Chapter 5 and the cost calculations of Chapter 6.

CHAPTER 2

OVERVIEW OF THE HOUSING INDUSTRY AND RECENT TRENDS

This Chapter begins with a description of the principal sectors of the U.S. housing industry as it has developed in recent years up to the present time, and presents basic information about trends in production, market share and price. Subsequent chapters of the report build on this information.

2.1 INDUSTRY STRUCTURE

For purposes of this report the home building industry is treated as multiple overlapping sectors of production, each with its own approach to building and selling new homes. The principal sectors include site-built housing, manufactured (HUD-Code) housing and modular housing. Statistical information is generally presented from a national perspective even though the competitive overlaps within and between these sectors occur in regional and local markets as well, and all the sectors face some degree of competition from sales of existing housing units. Each sector is discussed below.

Site-Built Housing Sector. The home building business has historically been dominated by the construction of new homes on site through sequential fabrication and assembly of products, materials and systems into finished homes by skilled tradesmen and general laborers. Activities are planned and coordinated by experts with regulatory oversight at the local or state level of government. The resulting "site-built" sector of the home building industry is large and very diffuse. It encompasses not only the construction of houses but ancillary activities including land development, infrastructure planning and sale of the finished product as a complete package. In 1996 the two largest conventional home builders, Pulte Home Corporation and Centex Corporation, each constructed more than 10,000 detached homes. For the same year the top 10 companies built almost 75,000 detached homes, which represented about 6.5 percent of national housing starts.[1] Firm sizes drop rapidly from there; for example, the 100 largest companies built an estimated 162,000 single-family homes in 1994.[2]

Tremendous diversity and an unconcentrated, highly competitive economic structure are apparent when the site-built sector is viewed as a whole. Capital requirements are low and there are few barriers to entry or exit. For example, recent National Association of Home Builders membership information indicates that the site-building segment consists of some 50,000 active home building firms with average production of around 20 housing units a year. Typical firms are very small, with the majority building less than 10 units per year, and about 80 percent building less than 25 units per year. The broadest picture of all appears in the 1992 *Census of*

[1] *Professional Builder*, April 1996 and April 1997.

[2] *Builder*, May 1996, "Builder 100", p.184.

Construction, which reported over 130,000 residential construction "establishments" with one or more employees, and another 210,000 residential construction establishments without employees.[3] While these residential construction establishments also include firms exclusively involved in remodeling, they do not include the hundreds of thousands of special trade contractors used extensively by home builders as subcontractors performing carpentry, plumbing, electrical, mechanical and other work. The number of residential construction establishments in 1992 was not much changed from the number reported in the 1977 *Census of Construction*.

The level of site construction activity is reported by the Bureau of the Census as housing "starts" (when ground is broken for construction) and housing "sales" (homes for which a sales contract has been signed). Both statistics customarily exclude HUD-Code housing units, which are reported separately. There are usually many more housing starts than housing sales because about one-quarter to one-third of new site-built homes are started but not "sold." Rather, they are built under contract between an owner and a builder serving as general contractor. This difference between "starts" and sales" can be seen in Figure 1 on page 8 below.

While there is always some level of demand for new homes as population grows, new households are formed and economic activity shifts from one area to another, the housing business has been characterized by powerful cyclical trends as well. As the economy moves into recession housing starts can drop abruptly, and as the economy recovers housing starts often rise very quickly. Since most houses are purchased with long-term loans, the demand for new homes is also very sensitive to interest rates and monetary policy. Site builders operating in this volatile environment have tended to protect themselves by minimizing fixed capital investment and making extensive use of subcontracting arrangements.

Manufactured Housing Sector. New homes can be and often are built partly or almost entirely in factories rather than on site. Factory construction offers many opportunities for economizing and increasing efficiency in the production process modeled after experience gained in other industrialized sectors of the economy. For many years the most common type of factory-built housing was the "mobile home," a narrow, lightweight technological descendant of the self-contained travel trailer that was designed to be towed from one location to another along public roads and hooked up for temporary use. This sector first achieved prominence in the 1960s and early 1970s. By 1976 mobile homes had come under regulation in the form of the pre-emptive federal "Manufactured Home Construction and Safety Standards" or "HUD-Code," and the era of modern "manufactured homes" began. Manufactured homes are required to be produced with

[3] An "establishment" is a relatively permanent office; one firm may have several establishments. Results of the 1992 Census of Construction are summarized in NAHB, *Housing Economics*, June 1996, p.5-8.

a permanent chassis designed for over-the-road transportation. They are usually placed at the site on non-permanent foundations (e.g., block piers) and are almost invariably one-story units.

The manufactured housing sector has a profoundly different economic structure and way of doing business than the site-built sector of the industry. Production is much more concentrated in fewer firms than site-built home construction, and is exhibiting a trend towards consolidation that has not been observed elsewhere in the industry. Producers of manufactured homes have historically been focused on the production process itself and left land development and retailing activities to others, but vertical integration into retailing and operation of manufactured home parks or rental communities is taking place.

The level of economic activity in this sector is generally reported as units shipped from the factory (based on comprehensive production monitoring performed on behalf of HUD), or units placed for residential use (based on survey data). Production of manufactured homes, like site-built homes, is subject to cyclical trends and a sensitivity to interest rates. Compared with the site-built sector, however, larger capital investment and the more concentrated industry structure of HUD-Code producers leads to less flexibility in responding to changes in the level of demand and more incentive to maintain production in slow markets.

The two largest HUD-Code producers in 1996, Fleetwood Enterprises and Champion Enterprises, each built about 60,000 homes and together accounted for about 35 percent of total HUD-Code shipments for the year. The top four firms accounted for over 50 percent of 1996 shipments, and the top ten firms accounted for over 70 percent. On a broader scale, numbers of firms and plants dropped steadily from 1977 to 1992, while output per plant and output per firm both rose by large amounts over the period. Some key statistics are summarized in Table 1.

Table 1: Manufactured Housing Sector Statistics for 1977, 1982, 1987 and 1992

Manufactured Housing	1977	1982	1987	1992
Firms	306	261	207	155
Plants	597	516	395	286
Units Produced (Shipped)	267,289	238,820	232,823	210,453
Average Units per Firm	873	915	1,125	1,357
Average Plants per Firm	1.95	1.97	1.91	1.84
Average Units per Plant	447	462	590	736

Sources: Firm and Plant data from U.S. Department of Commerce, Bureau of the Census, 1992 *Census of Manufactures*, MC92-I-24D, "Wood Buildings and Mobile Homes – Industries 2451 and 2452." Shipments as reported by NCSBCS or MHI. Counts of firms and plants published by MHI differ somewhat from those based on the *Census of Manufactures*, but display similar trends.

Modular Housing Sector. Modular housing is the largest of the other segments of the housing industry, each of which are for the most part very small compared to the site-built and HUD-Code sectors. Modular housing includes factory-built homes that are delivered to the building site in largely complete form as multiple modules and placed by crane on conventional basement or crawl space foundations. Unlike HUD-Code homes, however, the design and construction of modular homes is regulated entirely by state and local building codes similar or identical to those that apply to site-built homes. Many modulars are two-story houses, and modular producers often report that they compete directly with site-built homes in terms of design and amenities. Modular homes are usually sold through small builders responsible for preparing the site and foundation as well as required finish work. These builders often construct modulars on land owned by the purchaser. The modular sector represents an intermediate form of new home production and distribution that is of significant interest for the present study.

Definitive information about the structure of production in the modular sector is lacking, but it is very clear that modular houses have never achieved the popularity of HUD-Code homes. A 1987 report estimated that about 152 firms produced modular homes, some operating multiple plants.[4] Average production was estimated at between 300 and 400 units per firm, with the largest 25 percent of modular producers accounting for two-thirds of output. Most firms shipped to five or more states. To some degree modular production was found to be a regional phenomenon concentrated at that time in the northeastern and mid-Atlantic states, and to a lesser degree in the midwestern and southeastern states. More recent estimates of annual modular production vary widely, from around 25,000 to 100,000 homes depending on the source. The Bureau of the Census has only published estimates of modular production since 1992, and reports that from 1992 through 1996 modular production has ranged from 32,000 to 37,000 homes per year.[5] The largest modular producer in 1997 was All American Homes of Elkhart, Indiana (2,300 homes), and the second largest producer was Champion Enterprises (1,631 homes), a firm that is much better known as a producer of HUD-Code homes.[6]

A recent analysis of 1995-96 Census data on modular homes provides more information about how modulars compare to stick-built homes.[7] For example, 26 percent of modulars were 2-story, compared to 48 percent of conventional stick-built homes; the median modular square footage was 1,560 compared to 1,950 for conventional homes. The modulars were more likely to have vinyl siding and less likely to have a fireplace or a garage than the conventional homes. Modular

[4] *Modular Housing Industry: Structure and Regulation*. NAHB Research Center, Upper Marlboro, MD. 1987.

[5] By contrast, *Automated Builder* for January 1998 estimated modular production for 1997 at 124,000 homes, vs. 84,000 homes in 1991.

[6] *Manufactured Home Merchandiser*, June 1998, p.30.

[7] A. Kochera, "Modular, Panelized and Precut Homes," *Housing Economics*, May 1998, p.10.

houses are disproportionately sited in the Midwest (45 percent of all modulars vs. 21 percent of stick-built) and uncommon in the West (6 percent of modulars vs. 25 percent of stick-built). Modulars were also more likely to be located outside of metropolitan areas (51 percent vs. 18 percent for stick-built homes). The report concluded that modular homes are geared more towards first-time and non-metropolitan purchasers than conventional homes.

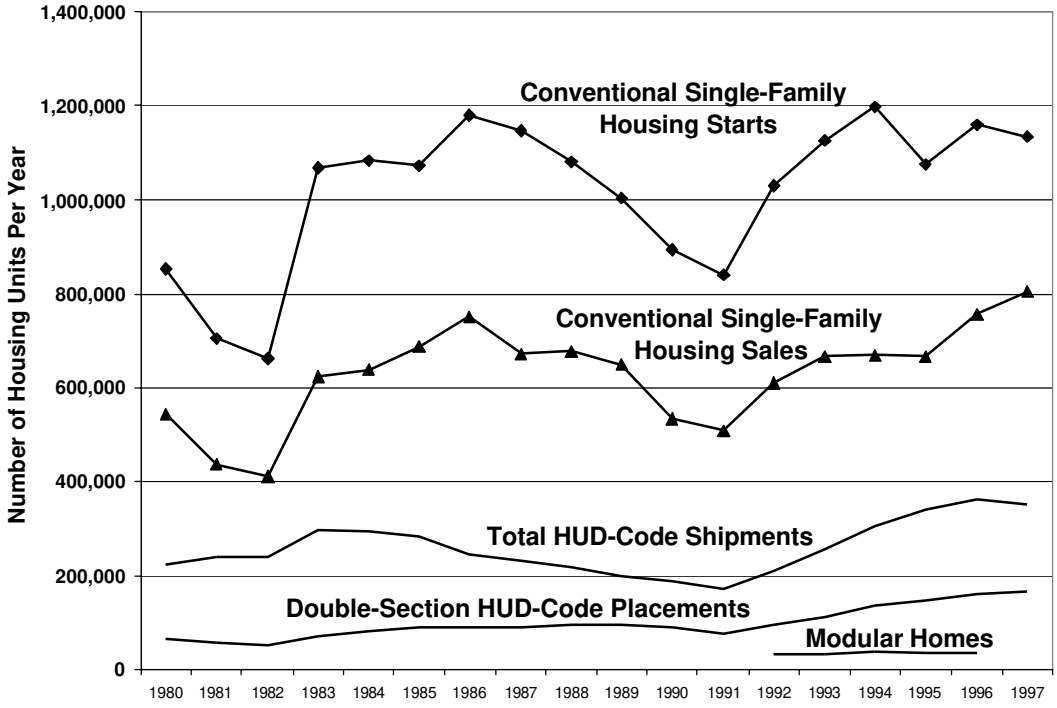
Other Industry Sectors. There are several other, smaller sectors that constitute the remainder of the housing industry, though they are not focused on in the present study. These include log homes, pre-cut package homes and various types of panelized construction. Total production of all these types is currently estimated by the Bureau of the Census at less than 30,000 units per year. Producers are small and geographically dispersed.

2.2 TRENDS IN HOUSING PRODUCTION

Figure 1 below shows how the overall production of single-family housing has been divided among the conventional (site-built), HUD-Code and modular segments of the industry for the period 1980 to 1997.[8] The Figure gives a good sense of the volatility in housing starts and housing sales, the relative shares of the new home market occupied by each industry sector, and the recent growth in manufactured housing. The data clearly shows the recession in the housing industry that reached bottom for conventional homes and HUD-Code homes alike in 1991. Since then both sectors have displayed strong recoveries. Yet although conventional housing starts and sales have grown in number, they have also dropped as a share of all new housing units. Manufactured housing shipments reached a peak in 1996 at 363,000 units. Modular production has fluctuated between 30,000 and 40,000 units per year since 1992, and has not evidenced the degree of growth of HUD-Code homes.

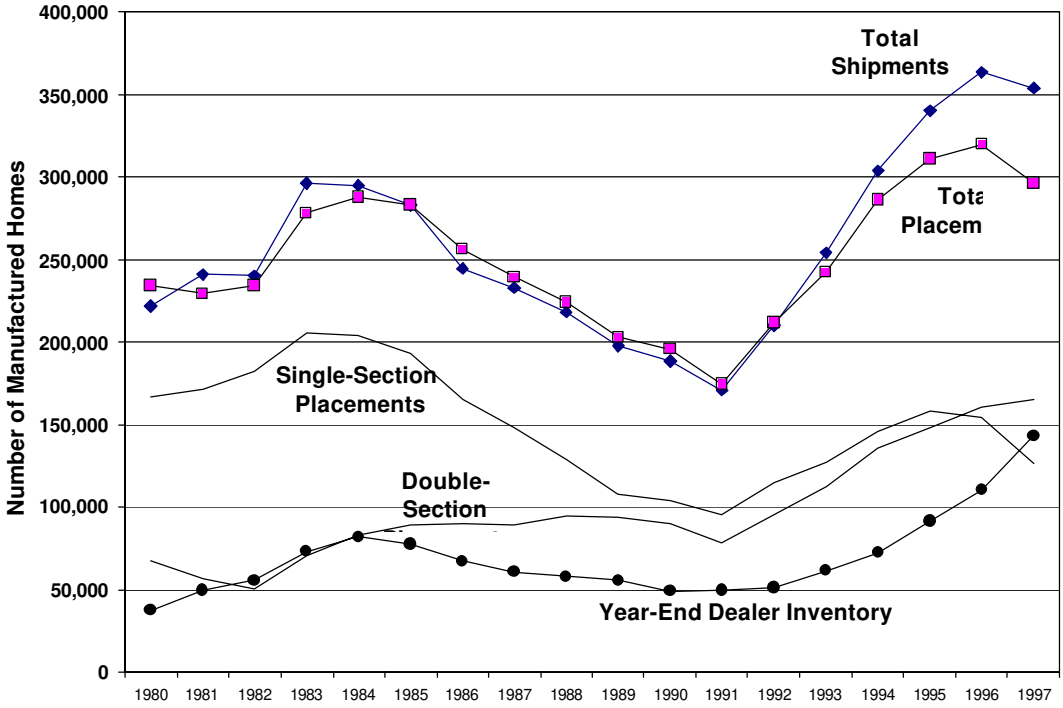
[8] Note that while modular homes are shown separately in the Figure for 1992-96, modulars are also included in the conventional single-family starts and sales shown for the entire 1980-1997 period.

Figure 1: Conventional Single-Family Housing Starts, Housing Sales, Manufactured Home Shipments and Modular Home Production, 1980-1997



Production of manufactured homes is of particular interest for this study, and is documented in greater detail in Figure 2. The curves show substantial growth in shipments and placements during the overall period of recovery for the housing industry that started from the low point in 1991. Figure 2 also divides placements into single-section and double-section units, and shows that double-sections grew from less than 25 percent of all placements in the 1980's to more than 50 percent by 1997. Finally, Figure 2 tracks dealer inventories (the cumulative difference between shipments and placements) over the period, showing significant accumulation since 1991. The inventory data is further discussed in a later section.

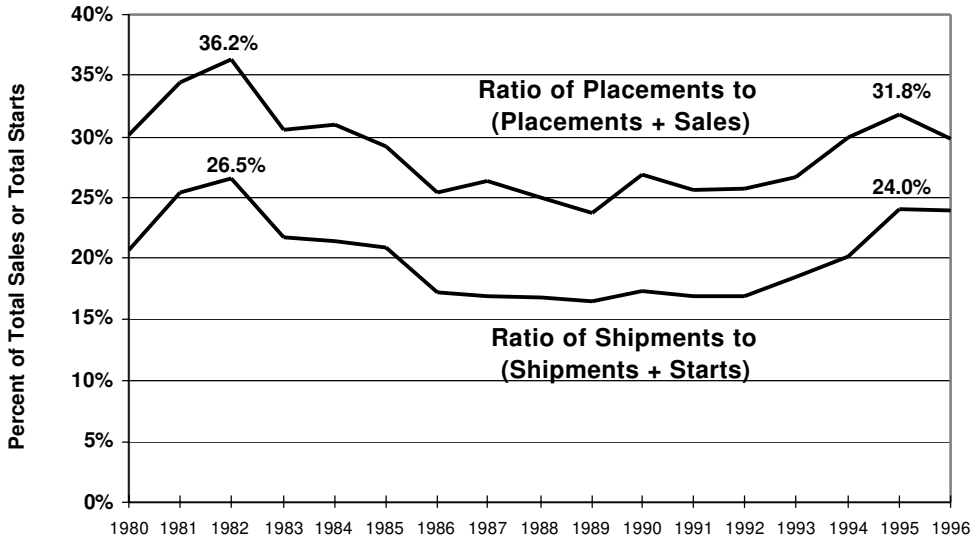
Figure 2: Manufactured Home Shipments, Placements and Year-End Dealer Inventory, 1980-1997



Source: Bureau of the Census, *Current Construction Reports*, Series C20, "Housing Starts", various years.

Trends in Market Shares. The market share of manufactured housing relative to conventional housing can be measured in two distinct ways, depending on the source and the purpose of the comparison. One way is to compute manufactured home *placements* as a fraction of total new housing *sales* (with sales also including placements), while the other is to compute manufactured home *shipments* as a fraction of total housing *starts* (with starts also including shipments). The form of measurement makes a significant difference because even though manufactured housing placements and shipments tend to come into balance over time, new housing sales (as previously noted) are consistently less than housing starts. Thus, for example, manufactured housing had a 30 percent market share in 1996 based on placements and new housing sales, compared to a 24 percent share based on shipments and housing starts. Figure 3 gives data since 1980 expressed in both ways.

Figure 3: Manufactured Housing Market Share Based on Total New Housing Sales and on Total Housing Starts, 1980-1996



Source: Bureau of the Census, *Current Construction Reports*, Series C20 and C25, various years.

Figure 3 also shows that while manufactured housing has grown considerably in market share since the start of the 1990's, it remains below a peak that was reached in 1982.[9] Of course, the 1982 market was totally unlike the situation in the mid-1990s. The 1982 peak did not reflect high production of manufactured homes (1982 shipments were 240,000) so much as abnormally depressed sales of site-built homes in a very weak economy with high interest rates. Furthermore, placements in 1982 were overwhelmingly single-wide units, so the degree of competitive overlap between manufactured and site-built housing was considerably less than in today's environment where the majority of units are double-wide.

Trends in Manufactured Housing Inventories. The balance over time between manufactured housing shipments to retailers and placements from retailer lots determines the number of homes in dealer inventories. In this market and elsewhere in the economy, inventories are frequently studied as indicators of future economic activity in an industry. The shipments and placements curves in Figure 2 show that every year since 1992 there has been an excess of shipments over placements, with the difference growing every year. By 1997, placements were just 80 percent

[9] The overall market share peak actually occurred in 1973, prior to adoption of the HUD-Code, a year when almost 580,000 mobile homes were shipped compared to about 1,130,000 single-family home starts and 634,000 single-family home sales. For that year the ratio of shipments to (shipments + starts) was nearly 34 percent, and the ratio of shipments to (shipments + sales) was over 47 percent.

of shipments. The result has been a large jump in estimated dealer year-end inventories, which rose to more than 50 percent of annual placements by 1997.

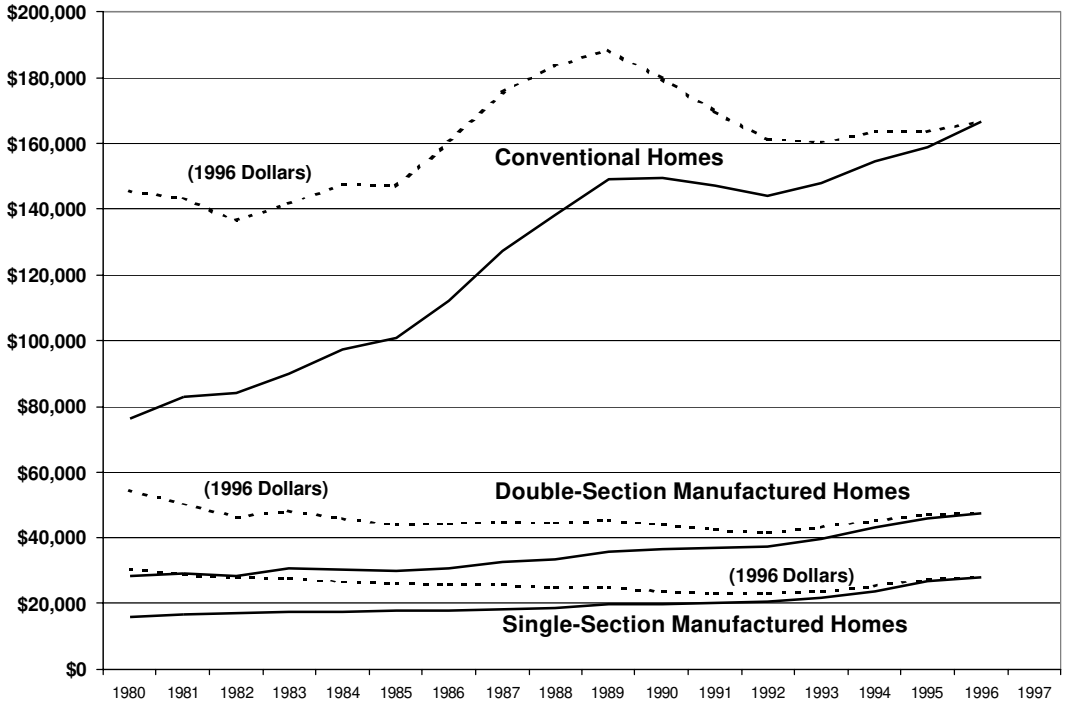
Some growth in inventories is to be expected as the HUD-Code sector grows and more retail outlets come on line, which has been the case in most recent years. But some of it may simply represent the accumulation of unsold homes on dealer lots, which would ultimately dampen orders for new homes from the factory. Indeed, in 1997 there were reports of some consolidation in retailers at the same time as the industry experienced its first production decline in six years. It is not at all surprising that shipments would stabilize or even decline once dealer inventories reach unusually high levels. And it is too soon to tell whether this decline is temporary, until the manufactured home industry works off its unsold inventory, or represents the end of the rapid growth period of the 1990s. Finally, the estimates of placements and inventory should be viewed cautiously, since the Census sampling methodology does not survey dealer inventory directly. Rather, a sample of HUD-Code homes shipped to dealers is tracked over time to simultaneously estimate placements and inventory. If a given home in the sample cannot be confirmed to have been placed for use, it is assumed to remain in inventory.[10] This means that any problems in tracking the sample over time may tend to raise the estimated level of inventory and depress reported placements.

[10] A description of the methodology used by the Bureau of the Census to estimate manufactured housing placements and dealer inventories appears in a Supplement to each issue of *Current Construction Reports*, Series C20, "Housing Starts."

2.3 TRENDS IN SALES PRICES OF NEW HOMES

One of the most obvious and potentially important factors distinguishing conventional and manufactured housing is selling price. Average selling prices for new conventional homes and for single-wide and double-wide HUD-Code homes as tabulated by the U.S. Bureau of the Census are shown below in Figure 4.

Figure 4: Average Selling Prices of New Homes by Type of Home in Nominal Dollars and 1996 Constant Dollars, 1980-1996

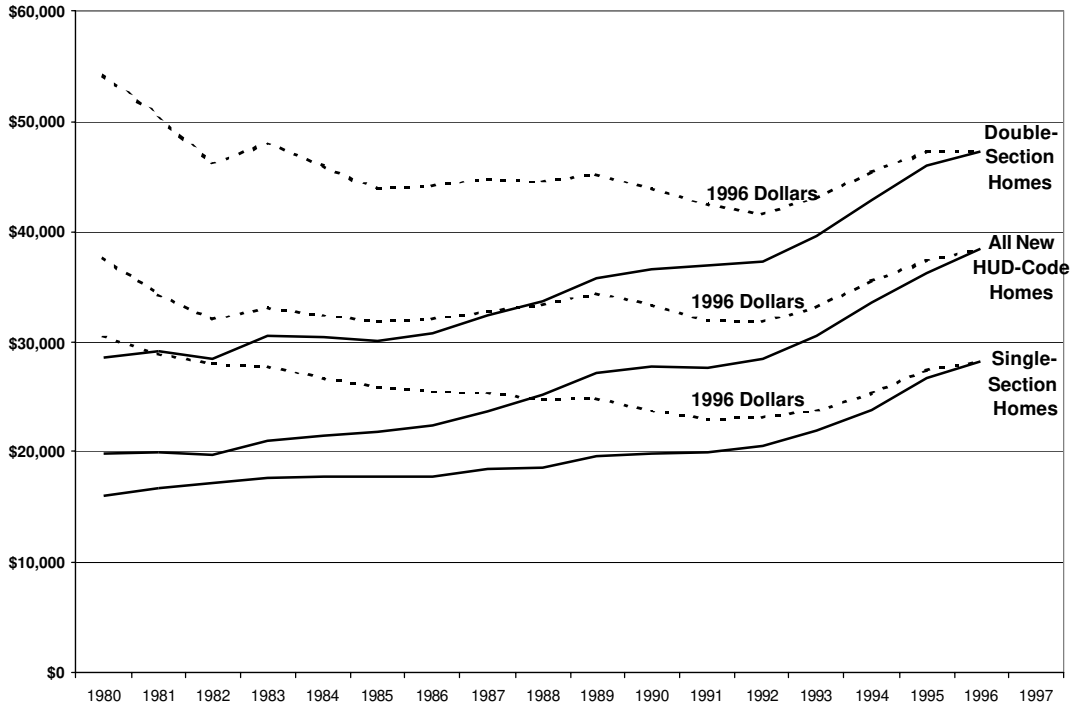


Source: Bureau of the Census, Current Construction Reports C25, *Characteristics of New Housing*, various years.

The raw Census price data (shown as solid lines in the figure) obviously reflects substantial inflation for all types of housing over the 17-year period, while the 1996 constant-dollar prices (the dashed lines, adjusted for inflation by using the overall Consumer Price Index) show much less overall change. In addition, the conventional new home prices include land and site improvements, while the manufactured home prices do not include land or site improvements. No attempt has been made to adjust for differences or changes over time in new home size, quality or amenities. Nevertheless, the figure makes it clear that site-built homes have been and still remain significantly more expensive to purchase than manufactured homes. Much of this report focuses on identifying and analyzing the reasons for this difference, which clearly has been an important factor underlying growth in the HUD-Code sector.

Figure 5 gives more details about the price trends for HUD-Code homes. It shows the average prices for single-section, double-section and all HUD-Code homes, in both nominal dollars (solid lines) and adjusted for inflation to constant 1996 dollars.

Figure 5: Average Selling Prices of New HUD-Code Homes in Nominal Dollars and 1996 Constant Dollars, 1980-1996



Source: Bureau of the Census, *Characteristics of New Housing,* Current Construction Reports C25, various years.

Several important trends are apparent from Figure 5. The real prices of single-section and double-section manufactured homes both declined slightly on balance from 1980 to 1996, but at the same time the real price of the average HUD-Code home rose by a small amount. This increase reflects a shift in the output mix towards double-section homes. Furthermore, real prices of both single-section and double-section homes have been increasing significantly since 1992. This is believed to reflect enhancements to new manufactured homes, both single-section and double-section, that have added cost but also expanded market appeal. Analysis of median prices as opposed to average prices points to similar trends and conclusions.

2.4 GENERAL ANALYSIS

The data on industry structure, production trends and sales prices presents a very basic picture of the market for new housing and highlights issues discussed throughout this report. Manufactured

housing and conventional homes are produced in fundamentally different ways by very different types of organizations, and sell for considerably different prices. Yet the finished products can be remarkably similar, and there is some degree of overlap in the pool of interested buyers. The situation is also highly dynamic because manufactured homes themselves have evolved in design and production technology to add buyer appeal at the same time as output has grown.

A major purpose of this report is to identify efficiencies in manufactured housing that may be applicable to more conventionally produced homes. Since opportunities to realize cost savings are obviously important to any producer of housing, one of the major questions considered throughout this report is the degree to which manufactured homes actually cost less to produce than comparable site-built homes and the reasons for such a difference. There are clearly differences in production cost, though the actual picture is far more complicated than indicated by the highly simplified price statistics discussed so far. There are also differences in the finished product and other reasons for real or apparent cost differences considered throughout the report.

One very basic reason is quite straightforward. It is logical to expect manufactured housing to enjoy some inherent cost savings over conventional homes due to fundamental differences in the production process. Production of new homes in a factory differs in many important ways from construction of homes on site, and general opportunities for efficiency exist in this centralized, controlled environment compared to construction on scattered sites. For example, factories built in low-cost areas where prevailing wage rates are lower can achieve a competitive advantage by selling finished products into markets where the wage rates for similar work performed on site would be much higher. These savings are attractive to the extent they outweigh the costs of transportation and installation that are unique to factory-built housing. In addition, capital investment for plant and specialized equipment used in assembly-line operations shifts the mix of labor and capital inputs and raises labor productivity. Unskilled, less expensive labor can be used more effectively when production takes place on an assembly line and can be organized into simple, repetitive operations. Workers in the plant are generally employees of the firm, not subcontractors, and as such can be scheduled, managed, trained and deployed by a single authority in the interests of productivity and efficiency. These factors, which characterize both HUD-Code and modular home production, differ greatly from the institutional contracting and subcontracting arrangements that characterize conventional site-built homes and home building firms. Industry sources report that the labor content of HUD-Code homes typically ranges from 8 to 12 percent of total cost, compared to total labor costs for site-built homes which have been estimated to constitute 40 percent or more of total cost. Of course, to some degree a smaller labor share will be offset by higher costs of capital for any firm with investment in fixed production facilities, but the successes of industrialization throughout the economy are powerful evidence of the opportunities to reduce production cost by substituting capital for labor.

The factory setting offers other advantages that can help control cost. It minimizes delays due to poor weather, exposure to theft and vandalism, and damage to building products and materials stored for use in construction. It also affords opportunities to realize economies of scale or lower unit cost of production through expansion of highly centralized facilities, a result that has proven extremely difficult to achieve in the decentralized site-built environment. The dramatic differences in competitive structure between the site-built and manufactured sectors of the industry emphasize this point. As a related point, the large size and purchasing power of firms that produce most manufactured homes undoubtedly gives them the pure economic leverage needed to negotiate the lowest possible prices for all commodity-type building products. HUD-Code producers indicate that they can save up to 30 percent of cost on standard building materials, although a ten percent savings is reportedly more common. Producers achieve savings through large-scale purchases direct from manufacturers instead of distributors or wholesalers, and by taking delivery at centralized production facilities rather than at multiple building sites. Such a difference in the cost of inputs alone goes far to explaining differences in selling prices, even where products or materials are identical in conventional and manufactured homes. It is significant that modular producers have failed to grow to the point where they can realize this benefit of size.

A more detailed look at other factors contributing to differences in production cost will be found in subsequent chapters. Conventional and manufactured homes are similar, but they are hardly identical. Chapter 3 looks at differences in design features, amenities and various building products found in conventional and manufactured homes that undoubtedly contribute to differences in production cost and selling price. Chapters 4 and 5 compare the regulatory systems and code requirements applicable in each sector of the industry. Substantive differences in codes, regulatory procedures and compliance costs also contribute to differences in production cost. Itemized cost comparisons in Chapter 6 control for various factors and give the most complete picture of where costs differ, where they are similar, and how they relate to the overall cost of purchasing a completed home or financing purchase through a mortgage.

CHAPTER 3

CHARACTERISTICS OF CONVENTIONAL AND MANUFACTURED HOMES

3.1 INTRODUCTION

This chapter presents statistical data documenting several types of similarities and differences between conventional and manufactured homes, including location and land tenure, occupant characteristics, and design and material characteristics. Some of the comparisons indicate underlying differences in cost of production that contribute to differences in selling prices between the two categories of housing as documented in Chapter 2. Other information provides insights concerning the degree of market overlap, i.e. the similarities and differences between actual or potential buyers of either type of home. Where possible the data is based specifically on newly constructed units but in some cases the statistics reflect all units in the housing stock.

3.2 COMPOSITION AND LOCATION OF THE U.S. HOUSING STOCK

The American Housing Survey (AHS) is a comprehensive national compilation of information about all types of housing units, and is performed jointly at regular intervals by the U.S. Department of Commerce, Bureau of the Census, on behalf of the U.S. Department of Housing and Urban Development. The most recent AHS estimated that as of 1995 the U.S. housing stock consisted of more than 109 million housing units.[11] This total included 66 million detached houses and 7.6 million other units classified as "mobile home or trailer."[12] After eliminating seasonal and vacant properties the year-round occupied housing stock was estimated at 98 million units, including almost 61 million detached houses (86 percent owner-occupied) and 6.1 million manufactured houses (78 percent owner-occupied). A comparison to earlier data shows that manufactured housing rose from 3.3 percent of the occupied housing stock in 1970 to 6.3 percent by 1995.

3.2.1 Age of Housing

As might be expected, manufactured homes are considerably newer than other units in the housing stock. In 1995 the median manufactured home was 15 years of age, compared to 30 years for all other housing units. Table 2 shows the distribution of year of production for manufactured homes and all other housing units as of 1995. The Table clearly shows that large

[11] Comprehensive 1995 AHS tabulations are in U.S. Department of Commerce and U.S. Department of Housing and Urban Development, *American Housing Survey for the United States in 1995*, Current Housing Reports H150/95, April 1997.

[12] The AHS uses the generic term "mobile home" to include not just transportable housing units produced prior to the HUD-Code, but also newer manufactured housing subject to the HUD-Code. This chapter generally refers to all such housing units as "manufactured homes" or "manufactured housing."

numbers of mobile homes were first introduced in the 1960s; only 2 percent were built earlier than 1960. About 35 percent of the existing manufactured housing units were built prior to 1975, the year the HUD-Code went into effect. More than 19 percent of the stock of manufactured homes were built in the 1970-74 period, the highest number of manufactured homes produced in a five-year period since large-scale production began in the early 1960s. Much of the perception of manufactured homes is based on the majority of units that predated the early 1980's.

Table 2: Year of Construction of Year-Round Occupied Housing Units by Type, 1995

Year of Construction	Manufactured Homes		All Other Housing Units	
	Number	Percent of Total	Number	Percent ofTotal
1995 (part year)	136,000	2.2%	674,000	0.7%
1990-94	1,183,000	19.2%	5,795,000	6.3%
1985-89	852,000	13.8%	7,266,000	7.9%
1980-84	811,000	13.2%	6,484,000	7.1%
1975-79	1,054,000	17.1%	10,054,000	11.0%
1970-74	1,184,000	19.1%	8,741,000	9.5%
1960-69	809,000	13.1%	13,458,000	14.7%
pre-1960	134,000	2.1%	39,059,000	42.7%
Total Units	6,164,000	100%	91,531,000	100%
Median Year	1980		1965	

Source: *American Housing Survey*, 1995.

3.2.2 Regional Distribution of Housing and Market Shares

The regional distribution of the overall housing stock and the newly constructed stock, as well as the corresponding distributions for manufactured homes, appear in Table 3.

Table 3: Regional Distribution of Total Housing Stock and Newly Constructed Housing Units by Housing Type, 1995

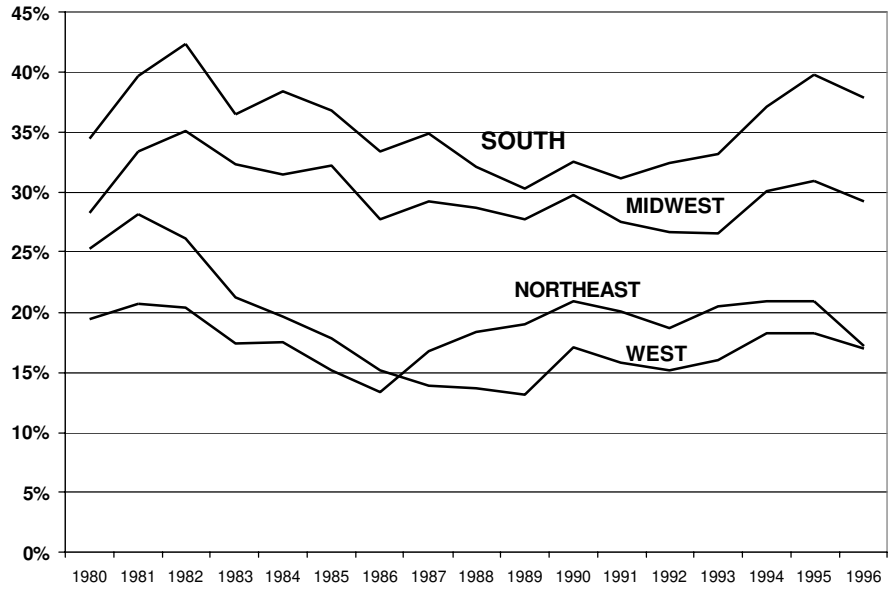
Region	Total Housing Stock, 1995		New Construction, 1995	
	All Types	Manufactured	All Types	Manufactured
Northeast	19.6%	8.5%	8.7%	4.7%
Midwest	23.8%	18.0%	21.4%	18.0%
South	35.8%	53.6%	45.4%	63.8%
West	20.8%	20.0%	24.5%	13.5%
Total	100%	100%	100%	100%
Total Housing Units	109,457,000	7,647,000	1,354,100	310,700

Sources: Total housing stock data from *American Housing Survey*, 1995. New construction data for 1995 from Bureau of the Census, *Current Construction Reports,* Series C20, "Housing Starts."

The Table shows that while the South has just over one-third of all existing housing units, it contains over half of the nation's manufactured housing. New construction data shows an even stronger trend: in 1995 over 45 percent of all housing starts and almost two-thirds of all HUD-Code placements were in the South. This suggests that some of the growth in manufactured housing production during the 1990s can be explained simply by the general regional shift in housing production towards its historically strongest region.

There is, however, more at work than just an overall regional shift in new home location. This can be seen by examining trends in the composition of housing sales by region, as shown in Figure 6. In 1996, manufactured home placements had a market share of nearly 38 percent of all single-family homes sold or placed in the South, compared with a 30 percent share in the Midwest and 17 percent shares in both the West and Northeast. This represents an increase of 8 percentage points in market share for manufactured homes in the South from its low of 30 percent of the single-family home market in 1989. Shares for the other regions have fluctuated within ranges of about five percentage points over the last 10 years, with a slight increase suggested in the West that has yet to make up for a substantial decline in that region since 1980.

Figure 6: Placements of Manufactured Homes by Region as a Percent of Regional Single-Family Home Sales, 1980-1996



Source: U.S. Department of Commerce, Bureau of the Census, *Current Construction Reports*, C20 and C25, various years.

The resulting picture is a complex one. While Figure 3 shows manufactured homes with an overall market share that has been rising since the late 1980s, Table 3 documents a general shift in housing production towards the South that would in itself be expected to increase overall

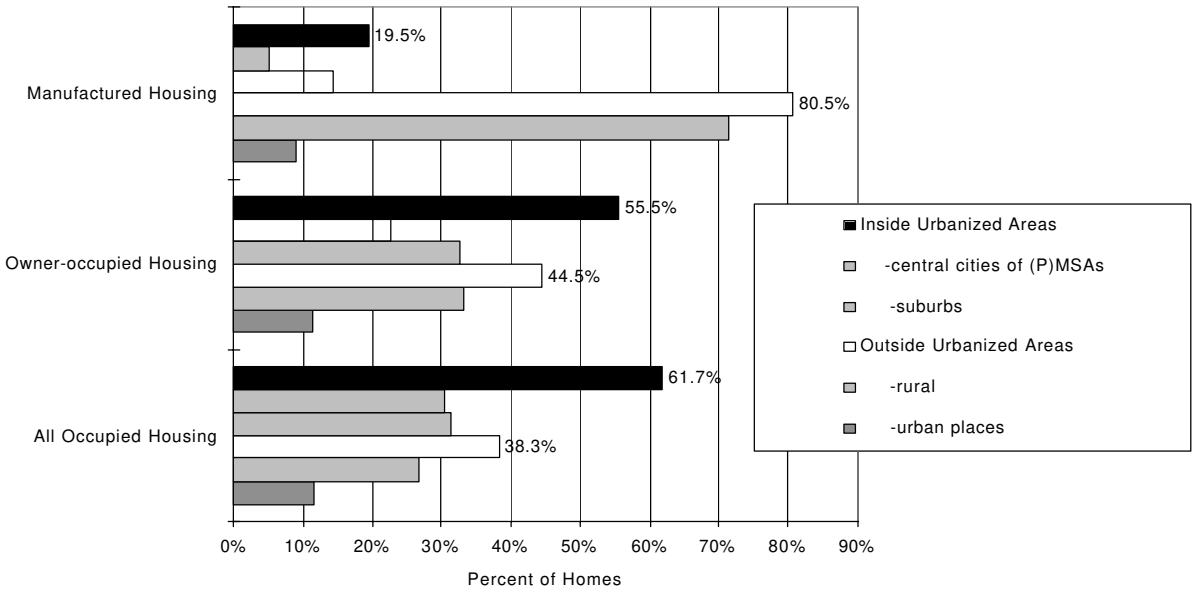
market share of manufactured homes based on the historical mixture of conventional and manufactured homes by region. Finally, Figure 6 gives a regionally disaggregated picture of the market share of manufactured homes, showing a growing market share in the South and possibly the West but no clear trend in the Midwest or the Northeast. In conclusion, the statistics indicate that recent growth in the market share of manufactured housing appears to be more a regional than a nationwide phenomenon, concentrated in the Southern and possibly the Western states.

3.2.3 Community Characteristics and Land Tenure

Manufactured homes are disproportionately sited in non-metropolitan areas, and in the less-densely populated suburban fringes of metropolitan areas (see Figure 7). More than eighty percent of manufactured homes are placed outside urbanized areas, with 89 percent of those in rural settings. Of the 20 percent inside urbanized areas, three-fourths are in suburban areas and only 25 percent are in central cities. Conversely, over 55 percent of all owner-occupied homes are located in urbanized areas and more than 40 percent of that group is located in central cities. Thus, only about 5 percent of all manufactured homes are in central cities, compared to about 22 percent of all owner-occupied homes.[13] The overall pattern most likely reflects a combination of market forces and historical zoning restrictions on the placement of manufactured homes.

[13] The Manufactured Housing Institute initiated an "Urban Design Demonstration Project" during 1997 to place infill units in urban neighborhoods in six cities including Birmingham, Washington D.C., Louisville and Denver. The project is described in *Automated Builder*, July 1997, p.31.

Figure 7: Location of Manufactured Housing, Owner-Occupied Housing and All Occupied Housing Inside and Outside Urbanized Areas, 1995



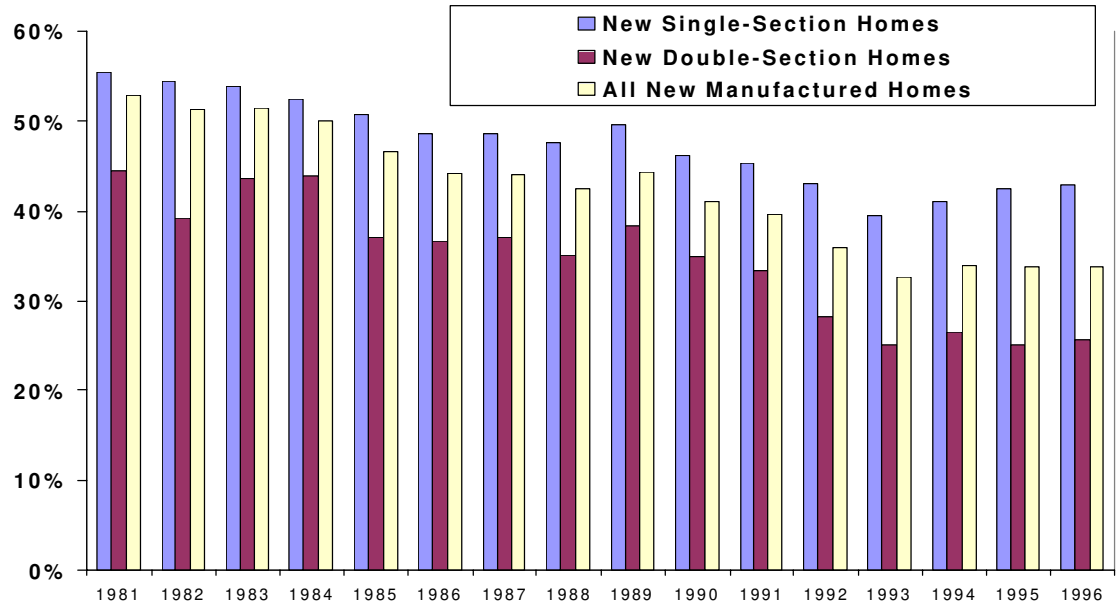
Source: *American Housing Survey*, 1995

Land Tenure. While conventional single-family homes are built almost exclusively on private land, manufactured homes can be placed either in rental communities or on private land. Rental communities are referred to by various terms including "mobile home parks," "manufactured home communities," and "land-lease communities." Placing a manufactured home on a rented house site allows the buyer to avoid the cost of land and related infrastructure when purchasing a home. This minimizes the required down payment and closing costs, but adds monthly land rent or "pad rent" fees to housing costs. In many rental communities the leases are relatively short-term, but longer leases also can be found.

About 50,000 to 55,000 manufactured home communities currently exist in the U.S, ranging in size from three to 1,000 homes. About 80 to 85 percent of these communities have 100 or fewer sites. The largest 15 to 20 percent of parks, sometimes referred to as "institutional investment-grade" parks, each have more than 100 sites. One source estimates that 500 major owner/operators, each with a minimum portfolio of five manufactured home communities (500 home sites), control about 15 percent of the inventory of community parks. The annual turnover of manufactured home residents in these communities is estimated to be just five percent, compared with 10 and 60 percent for conventional owner/rental and apartment rentals respectively. The 1995 AHS reported that almost two-thirds of manufactured homes were in groups of one to six units, while nearly 32 percent were in groups of more than 20 units. Most of the units in every size group were owner-occupied. The highest proportion of rental units was 36 percent, found in the 7- to 20-unit group size.

Development of new parks is seen as a significant problem by the manufactured home industry. This may reflect negative perceptions of existing park communities, some of which are poorly maintained and permitted only as pre-existing non-conforming uses. From 1989 to 1996 the number of manufactured homes placed outside parks each year increased more than 80 percent, four times as much as the number of homes placed inside parks. Single-section placements in parks grew more than double-section placements.[14] Trends in the proportions of single-section and double-section placements in parks for 1980 through 1996 are shown in Figure 8. The Figure shows that single-section park placements dropped from over 50 percent to just over 40 percent during this period, and double-section park placements dropped from over 40 percent to slightly over 25 percent. Overall park placements dropped from over 50 percent to about 33 percent. Even though the absolute number of homes placed in parks actually grew by 20 percent from 1989 to 1996, reflecting overall growth in sales and development of new communities, Figure 8 shows that a clear shift away from park placement has been taking place since 1980, and has been pronounced in recent years. The trend towards locating manufactured homes on private lots rather than in rented park spaces is quite important because it bridges some of the differences historically associated with location of manufactured homes and conventional homes.

Figure 8: Park Placement for New Manufactured Homes, 1980-1996



Source: U.S. Department of Commerce, Bureau of the Census, *Characteristics of New Housing*, various years.

Lot Size. According to the 1995 AHS, the average lot size for manufactured homes is 0.88 acres, compared with a 0.43 acre average for both all detached houses and detached owner-

[14] O. George Allen, "Community Types," *Allen Report*, February 1998.

occupied houses, and a 0.48 acre average for new housing. Thus, manufactured homes appear to be concentrated at both ends of the density spectrum. Compared with other housing, not only is the stock of manufactured homes concentrated in high densities of eight units or more per acre (14 percent vs. 6 percent), but it is also concentrated at low densities exceeding one acre per unit (32 percent vs. 15 percent). This may reflect location of many older mobile homes in rental parks at very high densities. In more recent years, changing standards in land development and zoning have decreased density for all housing. The larger lot size for new manufactured homes compared with other homes results from the tendency to place manufactured homes in less populated areas where lots are larger, land is less expensive, and zoning is less restrictive.

Summary. Locations of both new and existing manufactured homes differ considerably from other types of housing. The overall stock of manufactured homes is disproportionately located in rural areas, and the majority of new manufactured homes are being placed on parcels of land owned by individuals outside of urbanized areas, particularly in rural areas. Notwithstanding the trend to place owned manufactured homes on their own parcels of land, over 40 percent of new single-section units and about 25 percent of new double-section units are still being placed on rental sites in manufactured home communities.

3.3 HOUSEHOLD CHARACTERISTICS FOR CONVENTIONAL AND MANUFACTURED HOUSING

This section compares the households that occupy conventional and manufactured homes with respect to age, education, household income and housing expenditures. It also compares reasons given by recent movers to owner-occupied manufactured and conventional homes for leaving their previous home and for choosing their present home.

3.3.1 Age Composition

According to AHS data the three major age groups, defined as the young (under 35), middle-age (35-64) and elderly (65 and above), are relatively evenly distributed in manufactured housing. The highest proportion of residents is in the middle-age group. Manufactured homes have been increasingly attractive to households in the young age group and to a lesser extent to the middle-age group. Counterbalancing trends among age groups in manufactured housing have resulted in little change in the median age of heads of households of manufactured homes from 1987 to 1995. Heads of households living in manufactured homes have a median age of 44 years, compared with 46 years for all households, 38 years for renters, and 51 years for households in owner-occupied units.

The following trends were observed in the age of heads of households residing in manufactured housing compared to all households and all owner-occupied households (see Table 4):

- **Under age 35.** In 1995, 29 percent of heads of households in manufactured housing were under age 35, a larger share than in all households or owner-occupied households. This represented a decrease from 1987 when this age group had a 35 percent share.

- **Age 35 to 54.** In 1995, 37 percent of heads of households in manufactured housing were age 35 to 54. This was a lower share than in other types of housing. However, since 1987 this group has been increasing more rapidly in manufactured housing than in owner-occupied homes or all housing.

- **Age 55 and above.** The 34 percent share of households over age 55 in manufactured homes is nearly the same as the share of such households in all occupied units, but significantly less than the 40 percent share of such households in owner-occupied housing units. The share of this age group in manufactured homes has declined less since 1987 than in owner-occupied households or all households.[15]

Table 4: Ages of Heads of Households by Type of Housing, 1987 and 1995

Age Group (years)	1987					1995				
	All Units	Manufactured Housing		Owner-Occupied Units		All Units	Manufactured Housing		Owner Occupied Units	
	Percent of Total	No. (000)	Percent of Total	No. (000)	Percent of Total	Percent of Total	No. (000)	Percent of Total	No. (000)	Percent of Total
< 25	5.9%	462	8.8%	901	1.5%	5.2%	371	6.0%	724	1.2%
25-29	10.3%	721	13.7%	3,499	6.0%	8.4%	642	10.4%	2,847	4.5%
30-34	11.7%	671	12.7%	5,585	9.6%	11.5%	799	12.9%	5,990	9.4%
35-44	21.2%	886	16.8%	12,851	22.1%	23.1%	1,367	22.2%	14,746	23.2%
45-54	14.8%	651	12.4%	10,172	17.5%	18.0%	900	14.6%	13,446	21.2%
55-64	14.3%	725	13.8%	10,365	17.8%	12.2%	764	12.4%	9,492	14.9%
65-74	12.9%	718	13.6%	9,246	15.9%	11.7%	741	12.0%	9,301	14.6%
75 +	8.9%	433	8.2%	5,544	9.5%	9.4%	579	9.4%	6,998	11.0%
Total	100%	5,267	100%	58,164	100%	100%	6,164	100%	63,544	100%
Median	46 years	44 years		50 years		46 years	44 years		51 years	

Source: *American Housing Survey*, 1987 and 1995.

[15] A separate sample survey undertaken by the Foremost Insurance Group of Companies, in which over 14,000 households living in manufactured homes returned completed questionnaires, has indicated results contrary to those obtained from the AHS, which sampled only 6,164 households from manufactured homes. The larger Foremost survey may have been affected by using a consumer research panel rather than a random sample. According to the Foremost survey, the proportion of households in the youngest age group declined from 20 percent in 1987 to eight percent in 1993, while the share of older households over age 60 increased from 30 percent in 1987 to 35 percent in 1993. The reported median age of households in manufactured homes was found to have increased from 47 years in 1987 to 51 years in 1993.

A special tabulation of 1993 AHS data revealed the following with regard to the age composition of recent purchasers of owner-occupied manufactured housing compared to all other housing:[16]

- A much greater share of the purchasers of manufactured housing were in the age group under 25, compared with all other housing (13 percent vs. 5 percent). This suggests that young, first-time buyers with lower incomes may find manufactured housing a more attractive vehicle for achieving home ownership than other types of housing.

- The proportion of manufactured housing purchasers aged 65 and older was 15 percent, much more than the 6.4 percent rate for all other housing. This suggests that ownership of manufactured housing may be an affordable and favorable alternative for retirees living on fixed incomes.

The strong growth in the proportion of manufactured housing heads of households between 35 and 54 years of age also suggests a reservoir of demand in that group. The age data alone is inconclusive, but this trend would be consistent with purchases by families of modest income that deferred home ownership during the price increases of the 1980's and continue to find new conventional homes unaffordable.

3.3.2 Level of Education

The level of education of manufactured home occupants is lower than that for the general housing population. According to the 1995 AHS, 81 percent of all heads of households had attained a high school degree or higher, compared to 71 percent of heads of household in manufactured homes. Similarly, nearly 24 percent of all heads of households had attained at least a college bachelor's degree, while only 6 percent of manufactured home heads of households had attained that level.

3.3.3 Household Income and Housing Expenditures

Household Income. The incomes of owner-occupant households in manufactured housing are higher than incomes of all renters, but considerably lower than incomes of all households in owner-occupied conventional housing. The AHS reported median income for all owner-occupied households of almost $40,000, compared to median income of $24,000 for manufactured home owner-occupants and $22,000 for all renter households. Other income distribution statistics by housing type are also consistent with the ranking of median incomes, e.g., 16 percent of owner-occupants living in manufactured housing were below the poverty

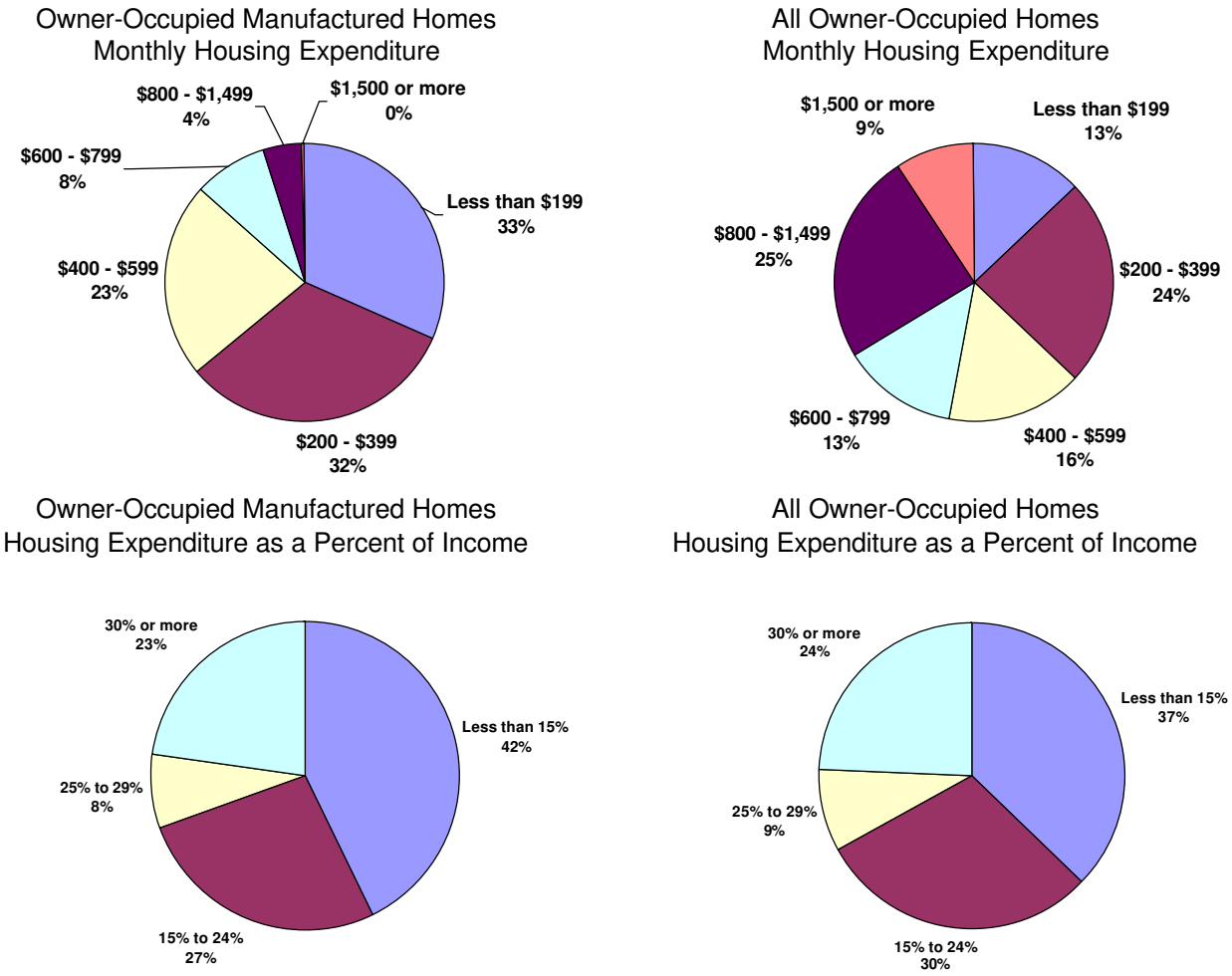
[16] Appendix A-1 in K. Vermeer and J. Louie, *The Future of Manufactured Housing*, Joint Center for Housing Studies of Harvard University, January 1997.

level, compared with less than 10 percent of all owner-occupants and 50 percent of all renters. Finally, about 54 percent of owner-occupants in manufactured homes had incomes at least twice the poverty level, compared to 74 percent of all owner-occupants. One significant development is that the incomes of households living in manufactured homes grew by 32 percent from 1987 to 1995, more than the growth experienced by all owner-occupants, all households or rental households.

Housing Expenditures. Owner-occupants of manufactured homes spend considerably less on housing than all owner-occupant households, but the proportion of income spent on housing is about the same for both groups. This can be seen in Figure 9, which gives the distribution of monthly dollar housing expenditures and the distribution of housing expenditures as a percent of income for each group. Charts in the upper half of the Figure shows that 86 percent of all households in owner-occupied manufactured homes spend under $600 a month for housing, compared to just 53 percent of all owner-occupants. Expenditures of less than $200 per month are far more common among manufactured housing owner-occupants than all owner-occupants (33 percent vs. 13 percent). Median and average expenditures show similar differences between the two groups.

These differences virtually disappear when housing expenditures are expressed as a percentage of income, as shown in the two charts in the lower half of Figure 9. Owner-occupied manufactured households had a median housing expenditure of 17 percent of income, compared to 18 percent for all owner-occupants. By contrast, although not shown in the Figure, the median housing expenditure for all renters was 28 percent of income and the median for all households was 21 percent of income. The high cost of renting and lower incomes of renters suggest that they are most likely to find manufactured housing attractive from a cost standpoint. However, this opportunity is undermined by the fact that rental housing is most common in urban areas, not in the rural areas where manufactured homes are most common.

Figure 9: Distribution of Housing Expenditure by Type of Housing, 1996



Source: *American Housing Survey, 1995*, Table 3-12.

3.3.4 Recent Movers, Choice of New Housing and Reasons for Moving

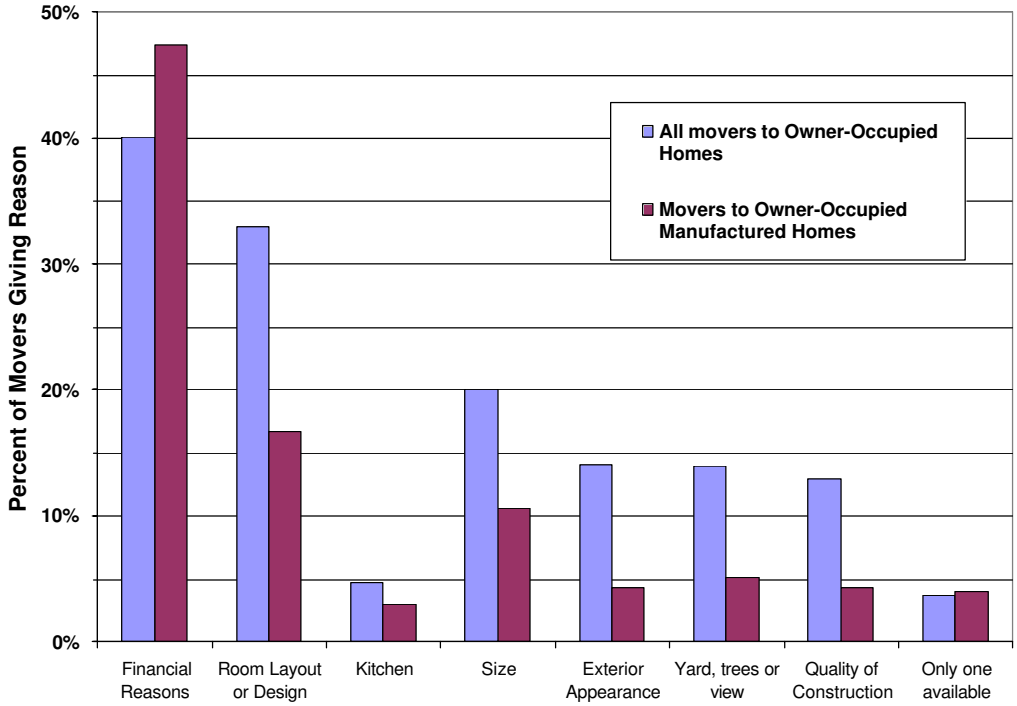
The AHS includes several special questions for recent movers. About 18 percent of all households moved in the previous year, according to the 1995 survey. The greatest proportion of these movers, about 71 percent, moved out of rental housing. This was more than twice the 35 percent share of rental units in the total housing stock, and owner-occupants were correspondingly underrepresented among movers. The 6.6 percent of movers who came from manufactured homes was in line with the proportion of manufactured homes in the overall housing stock. About half of the owners and three-quarters of the renters who moved remained owners and renters respectively. Over 55 percent of those who moved into manufactured homes had previously been renters.

The published AHS survey tabulations do not separately analyze recent purchasers of new manufactured homes, but they do present information about an estimated 603,000 households that moved into manufactured homes as owner-occupants within the previous year (i.e., in the general period 1994 to 1995). Since an average of almost 300,000 new manufactured homes were placed in 1994 and 1995, it appears that between one-third and one-half of all the movers that became owner-occupants were moving into new manufactured homes.[17] Therefore, some of the AHS data is quite relevant to reasons for purchasing new manufactured homes, even though manufactured units of all ages are pooled in the tabulations.

Reasons for Choice of New Housing. All types of households that moved in the last twelve months cited financial reasons as the most important factor in their choice of new housing. Room layout or design and size of home were also important in their decisions. But while the rank order of these factors was similar for all types of housing, it is clear that movers into manufactured homes were less likely than movers in general to identify factors other than financial reasons for their choice of new home. The distributions of reasons given by movers to owner-occupied manufactured homes and to all owner-occupied units are summarized below in Figure 10. Financial reasons were more commonly cited by those who moved to manufactured homes, while room layout, kitchen, size, appearance, etc. were less commonly cited. The relative distribution of responses for all movers (not just owner-occupants) showed the same general pattern.

[17] Not all of the 300,000 new manufactured homes placed in the 1994-95 period would be included in this group, since some were undoubtedly rental units and others were seasonal or vacant. Other data in the AHS provides more insights into this: about 82 percent of the HUD-Code homes in the 1995 housing stock that were produced in the previous 4 years were owner-occupied, about 12 percent were rental units, and the remainder were vacant or seasonal properties. These proportions indicate that between 82 and 88 percent of new HUD-Code homes are owner-occupied (full time or seasonally), corresponding to about 250,000 homes out of the 300,000 in question. In other words, out of the overall pool of 603,000 recent movers to owner-occupied HUD-Code homes reported on in the 1995 AHS, between 40 and 45 percent purchased new homes rather than resale units.

Figure 10: Reasons Given by Recent Movers to Owner-Occupied Units for Choice of Present Home, by Type of Unit, 1995

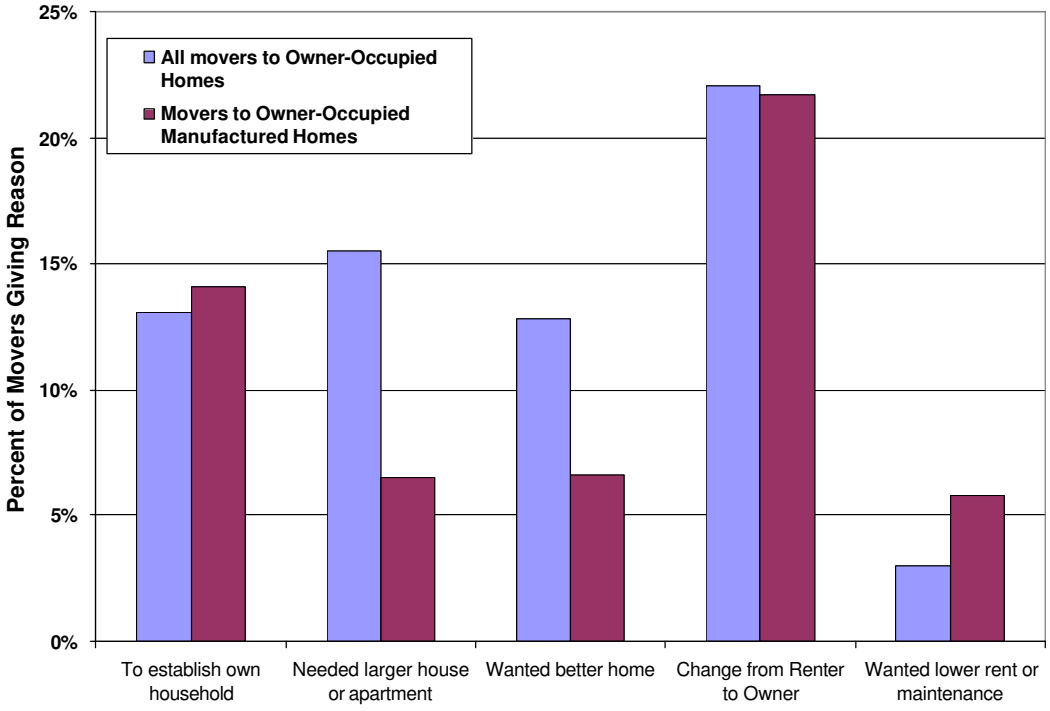


Source: 1995 *American Housing Survey*, Table 3-11.

Reasons for Moving. The survey also reported on reasons given for leaving the previous housing unit. Responses varied according to which movers were involved. Movers as a whole stated that the desire to establish a new or separate household, the need for more space or a better home, and job-related factors were the important reasons for leaving their previous housing unit. Those households moving into owner-occupied housing also mentioned a change from renter to owner and desire for a larger or better house as important reasons, while households moving into rental housing tended to cite the need to be near a new job or school more than other groups.

Households moving into owner-occupied manufactured homes again showed important similarities and differences compared to all households moving into owner-occupied housing units. Selected responses appear in Figure 11. The most commonly reported reason for moving to a manufactured home as an owner-occupant was to "change from renter to owner," which was cited by about 22 percent of both groups. The desire to "establish own household" was the next most frequently cited by each group, again in approximately equal numbers. However, those who moved to manufactured housing as owner-occupants were less likely to cite the desire for a larger home or a better home, and more likely to cite the desire for lower rent or maintenance, than all movers to owner-occupied housing. Similar trends can be seen in comparisons of all movers rather than just movers to owner-occupied units.

Figure 11: Reasons Given by Recent Movers to Owner-Occupied Units for Leaving Previous Unit, by Type of Unit, 1995



Source: 1995 *American Housing Survey*, Table 3-11.

Implications. Generally speaking, the data on movers suggests that manufactured homes are attractive to former renters and other first-time buyers of limited means, and that purchasers of manufactured homes are motivated more by the desire to become home owners than by positive perceptions about design features or construction quality, or perceived physical advantages relative to their previous residence. First-time buyers today have fewer and fewer choices in new conventional construction. Many ultimately are achieving home ownership by purchasing small, older "starter" homes that may require basic repairs, major system or appliance replacements, or other work. Others either find themselves unable to buy any conventional home at all, or unwilling to risk the potential problems associated with an older one.

Once a first-time buyer focuses attention on purchasing a new home rather than an existing home, they may seriously consider buying a manufactured home where a viable local market exists. As discussed throughout this chapter, there are many differences in housing characteristics between manufactured and conventional homes, but it is not surprising that the most important difference for first-time buyers of modest means may be the difference in price. The survey data suggests that recent purchasers of manufactured housing are deciding that the opportunity to economize with a new manufactured home outweighs the style, layout, design

appeal and amenities available at higher cost in today's new site-built homes. This trend may continue as manufactured homes become more similar in size and appearance to site-built homes, and as their financing becomes less burdensome than in the past. While other groups including the elderly may be drawn towards manufactured housing for an entirely different set of reasons, the first-time home buyer is a large and important part of the overall market for housing that appears to be playing a significant role in growth of the manufactured housing sector.

3.4 DESIGN AND MATERIAL CHARACTERISTICS OF NEW CONVENTIONAL AND HUD-CODE HOMES

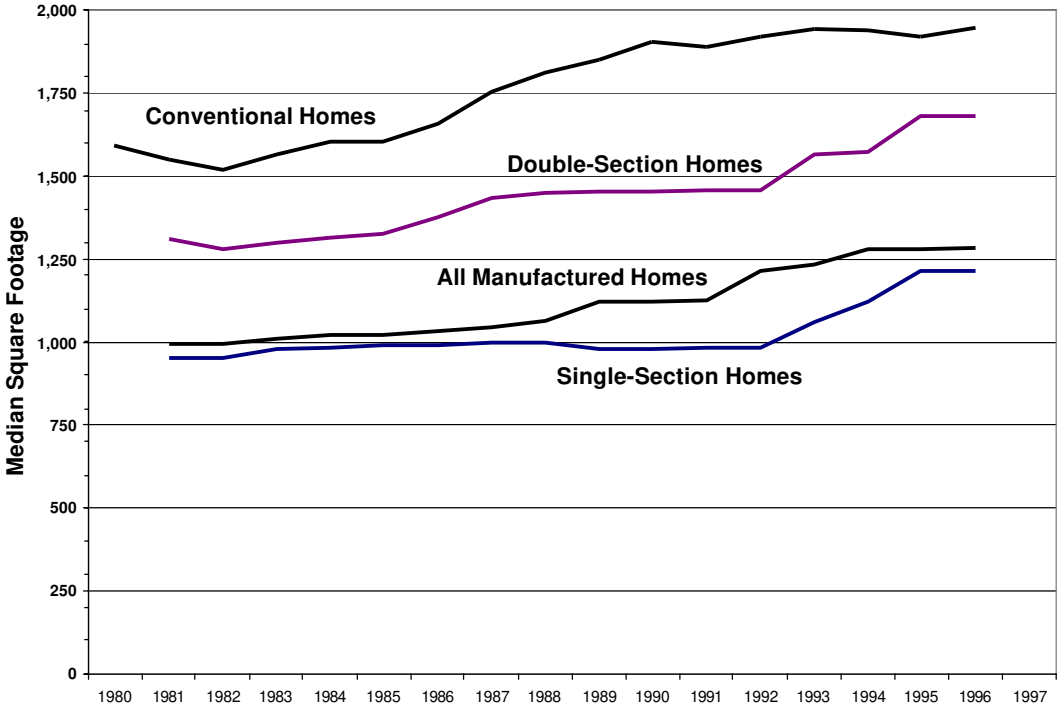
Chapter 2 documents the significant difference in selling prices of conventional housing and manufactured housing, both historical and at the present time. This section reviews a series of contributing factors that help to explain the difference: the physical characteristics of each type of housing unit. Comparisons are drawn between conventional and manufactured homes, where "conventional" is generally intended to include site-built as well as modular units. Inasmuch as site-built and modular homes have similar characteristics, where "site-built" and manufactured homes are compared the site-built category frequently will encompass modular homes.

3.4.1 Sizes of Housing Units and Price per Square Foot

Sizes of Housing Units. The sizes of new conventional homes and new manufactured homes have both increased since 1981. Median sizes are plotted below in Figure 12. Conventional home sizes have increased little since 1991. By contrast, manufactured home sizes were relatively constant from around 1988 to 1992, but since then have grown strongly every year. More importantly, both single-wide and double-wide units are becoming larger. The overall median size has also grown, though not by as much as single-wides or double-wides taken separately.[18] Indeed, single-wide homes at just over 1,200 square feet have reached the point where they are comparable in floor area to site-built postwar starter homes, and the median double-wide home in 1996 was 1,680 square feet, more than 85 percent of the median conventional home size in 1996.

[18] It is noteworthy that the median manufactured home size rose by only 6 percent over the 1992-96 period when the median single-wide grew by 23 percent, the median double-wide grew by 15 percent, and the mix of production shifted towards the larger double-wide units. By contrast, over the same time period the *average* square footage for all manufactured homes rose by 10 percent (from 1,255 to 1,380 square feet), the average single-wide grew by 8 percent (from 1,035 to 1,120 square feet) and the average double-wide grew by 7 percent (from 1,495 to 1,600 square feet). The average manufactured home built in 1996 was 7.4 percent larger than the median manufactured home built that year, even though the average single-wide was 8 percent *smaller* than the median single-wide and the average double-wide was 5 percent *smaller* than the median double-wide.

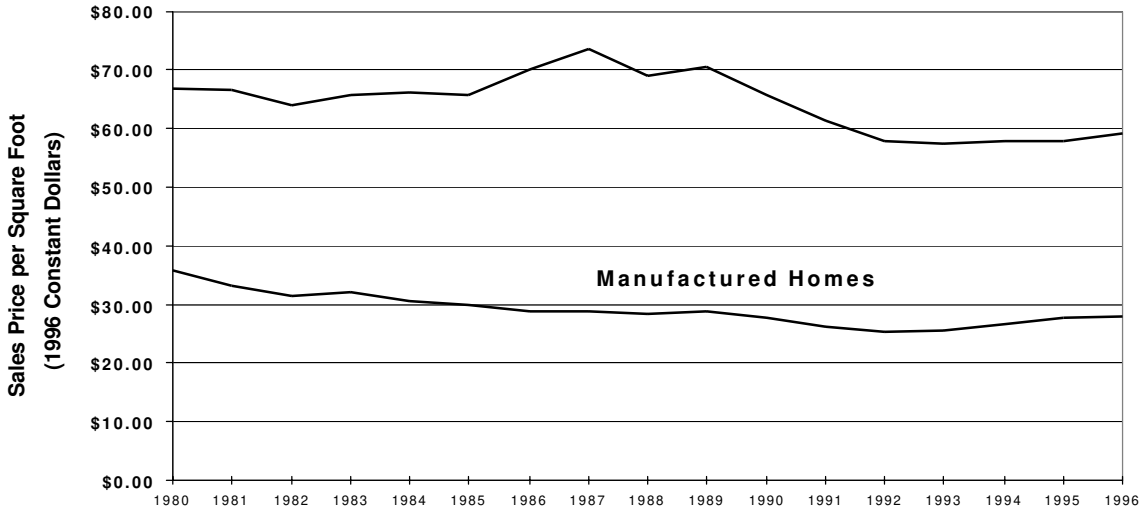
Figure 12: Median Square Footage of New Conventional and Manufactured Homes, 1980-1996



Source: Bureau of the Census, *Current Construction Reports*, Series C25, "Characteristics of New Housing", various years.

Price per square foot. Several significant cost elements such as raw land and site preparation are not included in the most widely cited prices of manufactured homes; furthermore, square footage differs between conventional and manufactured homes. Therefore, a simple first step in explaining the differences in prices between manufactured and conventional homes is to compare selling price of the structure alone, measured per square foot of floor area. This provides a first-order adjustment for differences in unit size and excludes the cost of land and site improvement for conventional homes to facilitate a meaningful comparison. In 1996 the average price per square foot of manufactured homes was $27.83, about 47 percent of the $59.25 price per square foot of conventional single-family homes. Figure 13 tracks average sales price per square foot of both types over the period 1980-1996 in constant 1996 dollars. The inflation-adjusted prices per square foot for both types have dropped, but the ratio of prices between the two types has increased marginally since 1985 when manufactured housing prices were less than 46 percent of site-built housing prices.

Figure 13: Average Sales Price per Square Foot for New Conventional Homes and Manufactured Homes in 1996 Constant Dollars, 1980-1996



The square-foot price spread between HUD-Code and conventional homes is large enough to strongly suggest that factors other than unit size and lot cost are contributing to the difference. Important variations in design features and construction materials are further discussed in this chapter, and the cost differences are analyzed in greater detail in Chapter 6.

3.4.2 Design Features in New Manufactured and Conventional Homes

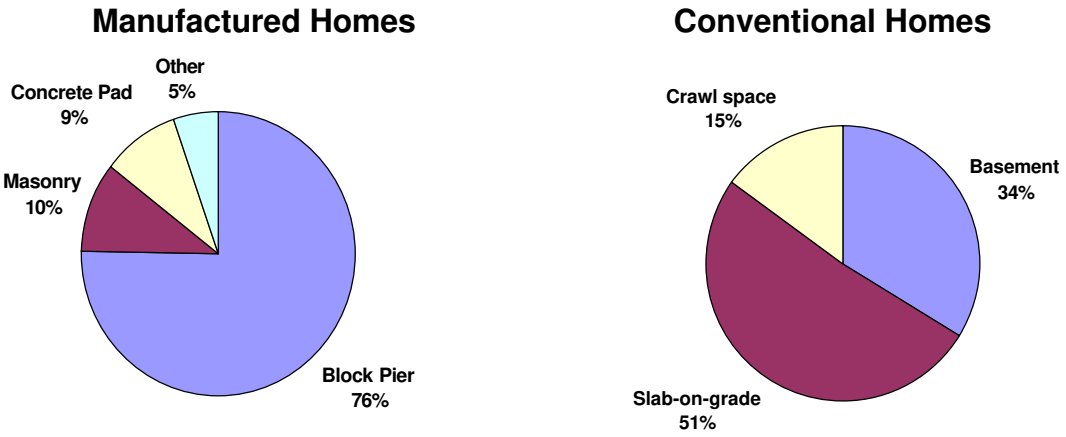
In addition to differing unit sizes the price disparity between manufactured homes and conventional single-family homes also reflects many differences in basic housing designs and features. These include different types of foundations and differences in exterior finishes, roof pitch, numbers of window and door openings, wall height and appliances. They not only influence the cost and sales price of the home, but also reflect the market orientations of the two types of housing. Homes with basic features are most often targeted at the starter home buyer, while homes with more dramatic features and complex designs are sold to move-up and luxury home buyers. Manufactured homes have typically catered to those in the market seeking entry-level homes, while site-builders and modular producers have been shifting emphasis towards the move-up market.

Limits on unit heights, lengths and widths imposed by regulation of the transport of goods on public highways, as well as the practical obstacles to production of 2-story HUD-code homes, have significantly constrained the variety and design of floor plans in manufactured housing. The result is not only that site-built homes are larger overall, they also tend to have larger living rooms, kitchens and family rooms, and more and larger bedrooms and bathrooms. Prevailing differences in other design features are discussed in the following sections, including number of

rooms, exterior finish materials, roof design and shape, wall and ceiling heights, and number of window and door openings. Extensive use is made of data on conventionally constructed homes built in 1996 developed through the NAHB Research Center's Annual Builder Practices Survey, as well as data from a companion survey of manufactured home producers covering 1996 production.

Type of Foundation. The type of foundation represents an important difference between manufactured homes and conventional homes with significant cost implications. Data on foundation types for new housing units appear in Figure 14. Manufactured homes were designed to be capable of moving from site to site, so they are required by regulation to have a structural chassis to provide stability in transport. They have historically been placed at the site on non-permanent foundations such as concrete block piers. At present about three-fourths of new manufactured homes are placed on blocks that support the home beneath the integral steel chassis. By contrast, conventional single-family homes are invariably built on permanent foundations, predominately basements, crawl spaces or concrete slabs on grade. Concrete slabs constitute 51 percent of foundations in new site-built homes, while basements and crawl spaces account for 34 and 15 percent respectively. Type of foundation, however, shows strong regional variation for conventional homes. Basements are the most common foundation types used in the Northeast (85 percent) and Midwest (76 percent), while slab-on-grade foundations are most common in the South (62 percent) and West (54 percent). The effects of differences in foundation on the cost of housing are further explored in Chapter 6.

Figure 14: Foundation Types for New Manufactured and Conventional Homes, 1996



"Other" may include basements, crawl spaces, etc.

Source: Bureau of the Census C25/96A

Number of Rooms. New conventional and manufactured homes differ significantly not just in house sizes but also in numbers of different types of rooms, as shown below in Table 5. Conventional homes have more bedrooms, bathrooms, closets and total rooms than any of the manufactured house categories, though the differences are less than proportional to average square footage for single-sections and more than proportionate for multi-sections. In other words, individual rooms are smaller in single-section manufactured homes than in conventional homes, while the room sizes in multi-sections are similar to or perhaps even slightly larger than those in conventional homes. These differences do little to account for differences in square foot prices between conventional and HUD-Code homes as discussed above.

Table 5: Average Numbers of Rooms in New Conventional and Manufactured Homes, 1996

Room Feature	Conventional Single-Family Homes	Manufactured Homes		
		Single-section	Double-section	Multi-section
Number of Bedrooms	3.48	2.95	3.03	3.01
Number of Bathrooms	2.58	1.99	2.08	2.30
Total Rooms (excluding bathrooms)	7.74	5.40	6.66	7.09
Number of Closets	6.55	3.68	4.60	5.63
Average Square Footage	2,048	1,056	1,629	1,955
Share of Total Output	100%	46.2%	51.2%	2.6%

Sources: NAHB Research Center, *Lumber and Plywood Usage in New Home Construction*, 1996, and NAHB Research Center, *Lumber and Plywood Usage in HUD-Code Manufactured Housing*, 1997.

Exterior Finish Materials. Finish materials used on the exterior walls of new conventional homes and manufactured homes differ significantly. As Table 6 shows, conventional homes primarily use brick (22 percent), vinyl siding (22 percent) and stucco (17 percent) for exterior wall coverings, while manufactured homes use far more vinyl siding (61 percent) and steel siding (21 percent). Masonry-type materials are not ordinarily used in manufactured homes due to weight and the risk of damage in transportation. However, with the rise of foam-applied stuccos, manufactured homes with stucco walls are beginning to be produced in the West. Otherwise if masonry is desired, it must be applied on site.

Table 6: Exterior Finish Materials on New Conventional and Manufactured Homes, Percent of Total, 1996

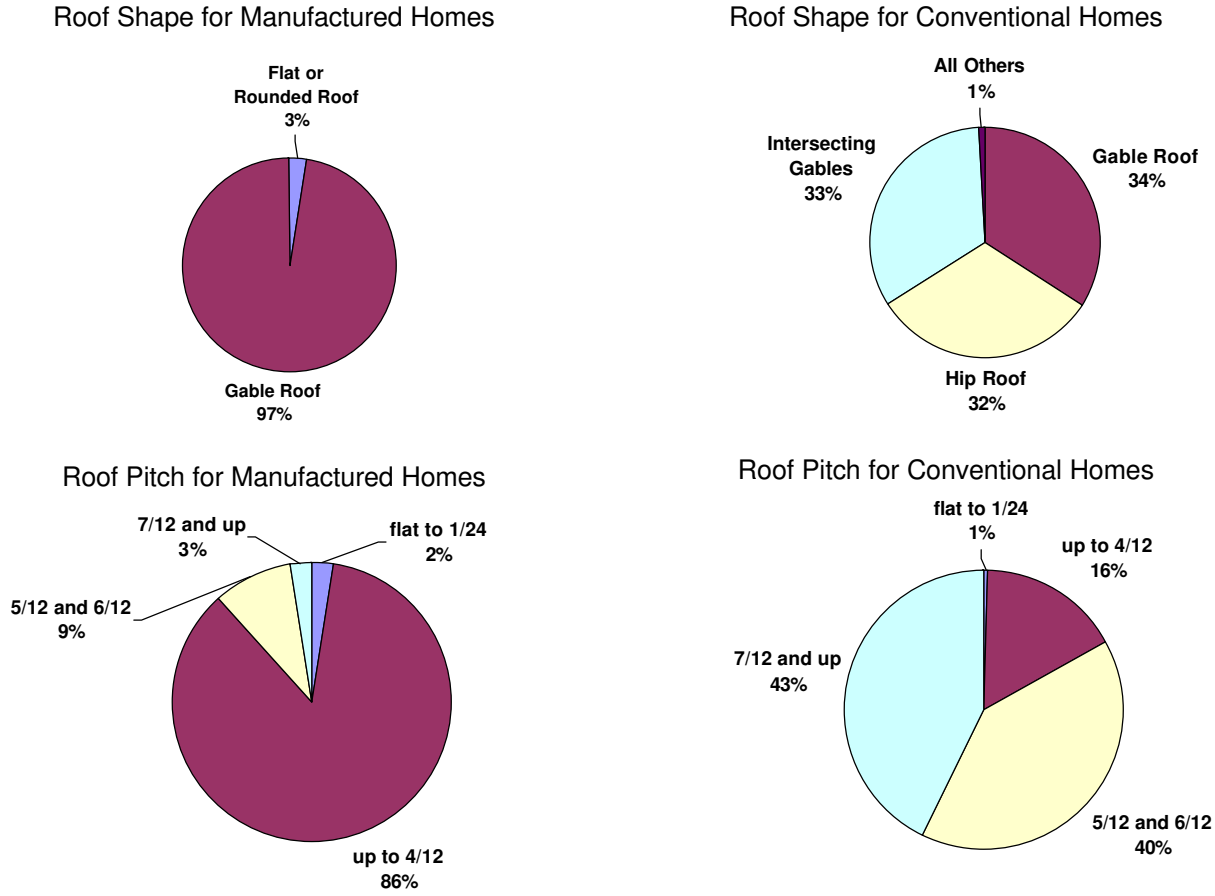
Exterior Finish Material	Conventional Homes	Manufactured Homes
Plywood panel siding	3.7%	--
Hardboard siding	6.3%	14.9%
Lumber siding	6.2%	0.7%
Cedar shingles	0.6%	0.1%
OSB, panels or lap	5.2%	0.9%
Other wood siding	0.7%	0.8%
Vinyl siding	22.4%	60.8%
Aluminum siding	7.1%	0.6%
Steel siding	0.9%	20.9%
Masonry (total)	46.9%	--
-- brick	22.4%	--
-- stucco	16.6%	--
-- cement-based siding	2.0%	--
Other finish material	--	0.2%
TOTAL	100%	100%

Sources: NAHB Research Center, *Lumber and Plywood Usage in New Home Construction*, 1996, and NAHB Research Center, *Lumber and Plywood Usage in HUD-Code Manufactured Housing*, 1997.

Usage of exterior finish materials show strong regional variations, but the overall picture remains the same. For example, vinyl usage on site-built housing in the West has traditionally been low relative to the nation as a whole, at 2 percent vs. 22 percent. By contrast, over 20 percent of manufactured homes in the West use vinyl siding, compared to 58 percent in the South and 93 percent in the North. Thus, vinyl siding is far more common on manufactured homes than on site built homes, yet in both sectors the vinyl is still disfavored in the West compared to other regions. As another example, hardboard siding on conventional new homes is relatively low at 6 to 7 percent nationwide. Hardboard siding use in manufactured housing on the other hand, is more than double (15 percent) that of conventional housing. It is also concentrated to some degree in the West at 55 percent of exterior finish material. In this case, hardboard usage on manufactured homes apparently represents an inexpensive alternative to other wood sidings without the negative connotation of vinyl that characterizes the region. In summary, the product usage data strongly indicates that exterior finishes used on manufactured homes are considerably less expensive than those found on site-built homes, both on a national and a regional level, illustrating what appears to be a decision by manufactured housing producers to focus on the affordable housing market.

Roof Design and Shape. As Figure 15 shows, roof design and shape for new manufactured homes is typically much simpler and lower-pitched than for new site-built homes. Roof designs for site-built homes are nearly equally divided among gables, intersecting gables and hip roofs, while manufactured homes are almost exclusively built with gable roofs. More than 88 percent of all manufactured homes have roof pitches of 4/12 or less, while 83 percent of site-built homes have roof pitches of 5/12 or greater.

Figure 15: Roof Shape and Roof Pitch for New Manufactured and Conventional Homes, 1996



Sources: NAHB Research Center, *Lumber and Plywood Usage in New Home Construction*, 1996, and NAHB Research Center, *Lumber and Plywood Usage in HUD-Code Manufactured Housing*, 1997.

Wall and Ceiling Heights. More than 85 percent of new manufactured homes in 1996 were built with wall heights of 7-1/2 feet or less, compared to less than 2 percent of first-floor wall heights for conventional homes. Table 7 gives a breakdown of wall height by type of home. It shows that eight-foot high walls are most common in new conventional homes, and that while

almost 40 percent of such homes have first-floor wall heights of nine feet or more, less than 8 percent of manufactured homes have 9-foot walls.

Table 7: Wall Height in New Conventional and Manufactured Homes, 1996

Wall Height	Conventional Homes (First Floor), Percent of Total	Manufactured Homes, Percent of Total
7 feet or less	0.1%	48.2%
7-1/2 feet	1.6%	37.4%
8 feet	57.8%	5.1%
8-1/2 feet	0.8%	1.5%
9 feet	24.2%	7.7%
More than 9 feet	15.5%	---

Sources: NAHB Research Center, *Lumber and Plywood Usage in New Home Construction*, 1996, and NAHB Research Center, *Lumber and Plywood Usage in HUD-Code Manufactured Housing*, 1997.

Differences in code requirements as discussed in Chapter 5 may be contributing to these differences, but other factors are also believed to be at work. Wall and ceiling height are important for both economic and aesthetic reasons. From an economic standpoint, the height of a wall affects material and labor costs, cycle time, and heating and cooling expenses. Shorter walls require less sheathing, drywall and siding materials, and take less time for fastening and finishing. This opportunity to economize is most advantageous in the high-volume factory setting where panel materials can readily be ordered to exact specifications for any desired size of wall. By contrast, the lower-volume site builder may actually find it more expensive to build with 7-1/2 foot or shorter walls than with 8-foot walls whenever the shorter walls must be built by starting with standard eight-foot products. Nine-foot walls can be much more expensive than 8-foot walls to build for similar reasons.

Wall height is also important from an energy standpoint. Shorter walls with lower ceilings mean less surface area to lose or gain heat, and less volume of interior air to condition. Both factors reduce design heating and cooling loads and may allow the use of smaller mechanical equipment. Both also generally reduce annual energy consumption for heating and cooling.

Finally, wall and ceiling height can have a powerful aesthetic impact on the interior appearance of a home. Nine-foot first-floor ceilings have become more popular in recent years, notwithstanding the various added costs, because they provide a very spacious, open feel that is valued by many buyers and helps differentiate move-up and luxury homes from more economical starter homes.

Window and Door Openings. New site-built homes tend to have more openings for windows and doors than most new manufactured homes. This undoubtedly reflects their larger average

size but may also constitute a design amenity. Table 8 compares window and door openings in new site-built homes with new single-section, double-section and multi-section manufactured homes.

Table 8: Average Number of Window and Door Openings per Dwelling in New Conventional and Manufactured Homes, 1996

Type of Opening	Conventional Homes	Manufactured Homes		
		Single-section	Double-section	Multi-section
Window	14.5	8.4	10.0	14.5
Patio door	1.2	0.5	0.7	1.0
Exterior door	2.3	2.1	2.0	2.6

Sources: NAHB Research Center, *Lumber and Plywood Usage in New Home Construction*, 1996, and NAHB Research Center, *Lumber and Plywood Usage in HUD-Code Manufactured Housing*, 1997.

Single-section manufactured homes have 40 percent fewer window openings and double-section manufactured homes have just over 30 percent fewer window openings than conventional single-family homes. However, multi-section homes and conventional homes have the same number of window openings. Conventional homes have more patio doors than any size of manufactured homes, ranging from 58 percent more than single-section manufactured homes to 17 percent more than multi-section homes. Finally, conventional homes have slightly more exterior doors than single and double-section manufactured homes, but fewer such doors than multi-section homes.

Summary. New manufactured homes show many differences in basic design and visible construction features compared to new conventional homes. Manufactured homes are most commonly placed on inexpensive non-permanent foundations rather than basements, crawl spaces or slabs-on-grade. They have fewer bedrooms, bathrooms and other rooms, and although this is partly a reflection of smaller size the data suggests that individual rooms are smaller as well, at least in single-wide manufactured homes. Conventional and manufactured homes have comparable numbers of exterior doors, and the largest manufactured homes have similar numbers of window openings compared to conventional homes. Manufactured homes use a much higher percentage of low-cost exterior finish materials than site-built homes, particularly vinyl, steel and hardboard siding. Roof design and shape is also simpler and considerably flatter than in other single-family homes, and walls tend to be shorter with lower ceilings. Both factors tend to reduce construction cost for manufactured homes compared to conventional homes.

3.4.3 Design Features in Existing Manufactured and Conventional Homes

Data on some types of design features is readily available only for the entire stock of manufactured homes versus all other detached single-family homes, rather than just for newly constructed units. This includes data on the types of glazing in windows and sliding glass doors, the types of appliances and equipment found in the home, and the presence or absence of numerous amenities. These comparisons are more difficult to interpret than comparisons based only on recent production because they do not necessarily reflect the latest trends. They may therefore be skewed to some degree by differences such as the fact that manufactured homes tend to be newer than detached homes in general. Nevertheless, the comparisons are indicative of historical differences and suggestive as to ongoing differences in the two types of housing.

Type of Glass in Windows and Sliding Glass Doors. The type of glass used in windows and sliding glass doors has historically differed significantly between manufactured homes and other single-family detached homes, as summarized in Table 9. While single-pane glass predominated for windows in both types of homes as of 1993, it was more common in manufactured homes than in other detached homes. Correspondingly, double-pane and triple-pane windows were more common in conventional homes than manufactured homes. Finally, low-emissivity ("low-E") coating was more common in double-pane windows of conventional detached homes than in double-pane windows of manufactured homes. Note that the table does not capture the impact of current energy code requirements for conventional homes or manufactured homes.

Table 9: Type of Glass in Windows and Sliding Glass Doors of Existing Conventional and Manufactured Homes, Percent of Total, 1993

Type of Glass	Windows		Sliding Glass Doors	
	Conventional Homes	Manufactured Homes	Conventional Homes	Manufactured Homes
Single pane	62.2%	76.8%	12.4%	7.0%
Double pane	36.7%	22.2%	21.2%	6.3%
-- untreated	34.3%	22.0%	20.2%	6.3%
-- low-E coating	2.4%	0.2%	1.0%	--
Triple pane	1.1%	--	0.4%	--
No sliding doors	n/a	n/a	65.9%	86.7%
TOTAL	100%	100%	100%	100%

Source: *Housing Characteristics 1993*. Energy Information Administration, U.S. Department of Energy, 1995.

The Table also shows that sliding glass doors were less common in manufactured homes than in site-built homes (about 13 percent vs. 34 percent). In addition, more than half of the sliding doors in manufactured homes contained single-pane glass, while site-built homes were nearly

twice as likely to have double-pane glass than single-pane glass in sliding doors. As with windows, low-E coating was more common on sliding glass doors of site-built homes than manufactured homes, although its penetration was not high in either type of home.

Overall differences in window and door characteristics may be attributed in part to the fact that manufactured homes are disproportionately located in the Southern U.S. where the climate tends to be mild. On the other hand, the greater prevalence of thermally-efficient windows and doors in existing site-built homes compared to existing manufactured homes may be even more significant inasmuch as site-built homes tend to be much older than manufactured homes.

Appliances and Equipment. The appliances and equipment contained in homes reflect several factors, including occupant income and standard of living, geographic location of the house, family characteristics and amenities built-in at the time of construction. Conventional single-family homes have a significantly higher overall frequency of some major appliances, but others are more common in manufactured homes. Table 10 summarizes the data on appliance and equipment penetration in existing homes.

Table 10: Appliances and Equipment in Existing Single-Family and Manufactured Homes, Percent of Homes, 1993

Type of Appliance or Equipment	All Single-Family Homes	All Manufactured Homes
Air Conditioner (central or room)	69.6%	69.9%
-- central	46.6%	42.8%
-- room unit	46.5%	28.8%
Refrigerator	99.9%	100.0%
Dishwasher	52.4%	18.0%
Microwave Oven	89.0%	85.9%
Clothes Washer	93.4%	83.9%
Clothes Dryer	87.8%	74.8%
Water Heater (all)	98.5%	99.3%
-- small capacity	16.4%	42.7%
-- medium capacity	52.9%	41.0%
-- large capacity	24.0%	9.7%

Sources: *Housing Characteristics 1993*, Energy Information Administration, U.S. Department of Energy, 1995.

Table 10 shows some interesting similarities and differences. For example, manufactured homes are equally likely to have some form of air conditioning as single-family homes in general; about 70 percent in each case. Essentially all of both types of home contain refrigerators, and microwave ovens are also about equally common.

Manufactured homes are somewhat less likely to have a clothes washer and dryer than single-family homes in general. They are substantially less likely than other single-family homes to have a dishwasher, at 52 percent vs. 18 percent.

Almost all homes of each type have water heaters, but the water heaters tend to be smaller sizes in manufactured homes. Over three-fourths of conventional homes have medium- to large-capacity water heaters compared with only about half of manufactured homes; small water heaters are far more common in manufactured homes than in other single-family homes. This may be largely or entirely a reflection of differences in dwelling unit size.

Selected Design Amenities. There are several other design features commonly viewed as housing amenities that are present in differing amounts in site-built and manufactured homes. These generally add functional or recreational value to the dwelling unit; several examples are listed in Table 11. One of the clearest examples is garages. The Table shows that site-built homes are far more likely to have a garage than manufactured homes. Over 60 percent of existing conventional single-family homes have garages; just over one-third are 1-car garages and the remainder are two-car or larger garages. By contrast, less than 8 percent of manufactured homes have a garage. Carports are essentially equally common in manufactured homes and other single-family homes (10 percent vs. 8.6 percent). Although not indicated in the Table, the difference in frequency of garages holds equally true for new homes of both types. It is rare for manufactured homes to be provided with factory-built garages, while virtually all new site-built homes have garages.

Table 11: Selected Design Amenities, Existing Conventional and Manufactured Homes, Percent of Total

Design Amenity	All Conventional Homes	All Manufactured Homes
Garage	61.0%	7.8%
-- 1-car	21.3%	3.6%
-- 2-car	36.6%	4.2%
Carport	8.6%	10.0%
Porch, Deck, Balcony and/or Patio	77.4%	76.4%
Fireplace	32.5%	10.7%
Separate Dining Room	47.8%	26.7%
2+ Living Rooms/Recreation Rooms	29.6%	13.0%

Sources: *Housing Characteristics 1993*, Energy Information Administration, U.S. Department of Energy, 1995, and *American Housing Survey*, 1995.

One area where no significant difference is apparent is the percentage of homes with a porch, deck, balcony and/or patio. Lumping all four items together into a single category may simply mask any difference in total number or size of specific features between site-built and manufactured homes. Fireplaces show a strong difference: they are about three times as common in site-built homes as in manufactured homes.[19] Site-built homes are nearly twice as likely as manufactured homes to have a separate dining room, and more than twice as likely to have two or more living and/or recreation rooms.

Summary. On the whole, existing manufactured homes have less energy-efficient windows and glass doors than conventional homes. Several major appliance usage rates are similar between manufactured homes and other single-family homes, but clothes washers, clothes dryers and dishwashers are less common in manufactured homes than in other single-family homes.

Existing manufactured homes as a group are less likely to have various amenities that add functional or recreational value, such as garages, fireplaces, separate dining rooms, and more than one living or recreation room. Differences in room counts are at least partially a reflection of size constraints, but the absence of other amenities indicates a tendency to economize since adding site-built custom features such as garages and decks would add cost and materially diminish the affordability of manufactured homes.

There are other types of differences that could not specifically be examined in this section due to lack of relevant data, but merit further study as potential contributors to differences in cost between manufactured and conventional homes. Some examples are finish flooring, carpeting, interior drywall or wall finish, trim, kitchen and bath cabinetry, plumbing fixtures and locksets. To the degree that manufactured homes use less expensive products in these and similar applications than conventional homes there would be corresponding cost savings.

3.4.4 Construction Materials in New Manufactured and Conventional Homes

In addition to unit design and visible architectural features of a home, manufactured homes differ significantly from site-built homes in many of the underlying structural materials used for sheathing and framing of exterior walls, floors and roofs. These features are generally less visible to the home buyer but are a large part of the square-foot cost of building a structure.

Some of the differences in structural materials arise from the varying requirements and practices of state and local jurisdictions as they apply one or another of the model codes, compared with the preemptive national HUD-Code. Other differences may result from reliance on performance

[19] As defined for the EIA survey, fireplaces are wood-burning units built into a wall, with a permanent chimney. They do not include "heating stoves" burning solid fuel, or vented room heaters.

compliance options available under the HUD-Code, compared to the typical emphasis in site-construction on prescriptive requirements under the model codes. Still others reflect substantive differences in requirements of the HUD-Code compared to other model Codes. For example, deflection criteria are less stringent under the HUD-Code, which allows use of smaller structural members in some cases. These topics are discussed in Chapters 4 and 5.

Framing and sheathing material usage rates in conventional new home construction and manufactured home production during 1996 were derived from the NAHB Research Center's Annual Builder Practices Survey and a separate survey of manufactured home producers. Those surveys show significant overlap but also indicated that manufactured housing producers tend to use more oriented strand-board (OSB) and particleboard relative to plywood than conventional home builders, and that some panel products used on manufactured homes are less thick than comparable products on conventional homes. Manufactured housing producers also use a significant amount of 1/2-inch fiberboard wall sheathing. Many conventional homes regularly use OSB, but there is still more of a tendency to use plywood than in manufactured housing. Plywood has a longer record of usage and is more expensive than OSB, and there is debate as to their relative merits, but either is acceptable by code in most applications. Nevertheless, some builders and home buyers view plywood as a superior product, which may be a factor in the continuing usage of plywood as a material in site-built housing.

As a general observation, the mix of structural products used in manufactured housing is considerably less varied than in site-built housing. This may reflect differences in economic concentration of producers in these sectors, as well as the broader audience, wider market focus and more diverse output mix of site builders compared to manufactured housing producers with a sharp focus on the affordable housing market. The following sections contain more detailed comparisons of structural usage for framing and sheathing of exterior walls, floors and roofs of new site-built and manufactured homes.

Exterior Wall Framing and Wall Sheathing Materials. The most common type of wall studs in both types of homes are 2x4s, with estimated market penetration of about 73 percent in conventional construction and 65 percent in manufactured homes. Usage of 2x6 wall studs is comparable for single-family conventional and manufactured homes at 27 and 29 percent respectively. The usage of 24-inch on-center stud spacing rather than 16-inch spacing is just under 10 percent in conventional construction, compared to 3 percent in manufactured homes.

Exterior wall sheathing material usage in both sectors is listed in Table 12. Wall sheathing can serve several functions and a variety of products are in common usage. Structural sheathing provides resistance to racking from wind loads, foam sheathing improves thermal performance of walls, and other non-structural products provide a surface for attaching siding. It is possible to omit sheathing in some situations by using let-in corner bracing or attaching certain panel siding

products directly to the wall studs, but the survey data does not suggest that this practice is common in new manufactured homes, and it is very rare in site-built homes. However, not all sheathing that is reported in Table 12 can be considered structural in nature.

Site-built homes most commonly use OSB for wall sheathing (32 percent), followed in order by plastic foam board and plywood. By contrast, manufactured homes most often used 1/2-inch fiberboard sheathing (22 percent), with 3/8-inch plywood the second most-used sheathing type (20 percent), and OSB ranking third in usage (17 percent). More than 60 percent of OSB wall sheathing in both sectors was 7/16-inch thickness, but where other thicknesses were used the manufactured homes tended to use smaller thicknesses and conventional homes tended to use larger thicknesses. The differences in plywood thicknesses were even greater. Conventional houses used 1/2-inch (49 percent) or 3/4-inch (35 percent) plywood, compared with near-universal use of 3/8-inch plywood in manufactured homes. Foam plastic insulation board usage is nearly twice as high in conventional construction as in manufactured housing (29 percent vs. 16 percent). Finally, manufactured home producers are much more likely than site-builders to use wall sheathing materials other than OSB, plywood, and foam board (48 percent vs. 20 percent). The most notable example is 1/2-inch fiberboard, which is four times more common on manufactured homes than on site-built homes.

Table 12: Use of Wall Sheathing Materials in New Conventional Single-Family Housing and Manufactured Housing, 1996

Sheathing Material	Type or Thickness	Conventional Housing		Manufactured Housing	
		Percent Usage	Percent of Total	Percent Usage	Percent of Total
OSB	3/8”	7.4%	2.4%	36.6%	6.1%
	7/16”	69.0%	22.3%	62.6%	10.4%
	1/2"	19.3%	6.2%	0.8%	0.1%
	5/8”	2.6%	0.8%	--	--
	3/4"	1.8%	0.6%	--	--
	All OSB	100%	32.3%	100%	16.7%
Plywood	3/8”	13.3%	2.5%	99.9%	20.3%
	1/2"	49.0%	9.2%	0.1%	0.01%
	5/8”	2.4%	0.5%	--	--
	3/4"	35.2%	6.6%	--	--
	All Plywood	100%	18.8%	100%	20.4%
Foam	Extruded Poly			60.0%	9.3%
	Expanded Poly			0.1%	0.01%
	Polyisocyanurate			39.9%	6.2%
	All Foam		29.3%	100%	15.5%
Other	Fiberboard 1/2"		5.6%		21.9%
	Foil-Kraft 1/8”		2.8%		8.0%
	Gypsum		0.7%		0.5%
	Cementitious		0.1%		--
	Boards 1”		0.1%		--
	Other		1.2%		12.1%
	None-SIPS or Slab		7.7%		--
	No Answer		1.5%		5.1%
	All Other		19.7%		47.6%

Source: *Final Report, Data Tables: Wood Product Usage in New Home Construction,* NAHB Research Center, 1996, and *Final Report, Data Tables: Lumber and Plywood Usage in HUD-Code Manufactured Housing*, NAHB Research Center, 1997.

Floor Framing and Floor Sheathing Materials. Dimension lumber is the most commonly used framing material in both single-family site-built homes and manufactured home production. While site-builders also use engineered wood I-joists for about 10 percent of floor framing, such I-joists are very rare in manufactured housing. The steel chassis in the manufactured home serves to reduce floor spans and permits the use of less expensive floor framing. Almost 80 percent of lumber floor joists in manufactured homes are 2x6s, while site-built homes generally use 2x8 or larger members.

Floor sheathing generally can consist of a single structural layer, or a structural layer beneath a separate underlayment. Two-layer floor systems predominate in site-built homes but are far less common in manufactured homes. Underlayments found in site-built homes include 1/4-inch lauan (30 percent), plywood (28 percent), OSB (10 percent), cementitious board (7 percent), particleboard (7 percent), and other miscellaneous materials (37 percent). Manufactured housing producers, on the other hand, reported that underlayment usage was very small (less than 5 percent of floor area); the only products identified were particleboard (39 percent), OSB (33 percent), and plywood (28 percent). Where underlayment was identified it was exclusively material 5/8-inch or greater in thickness, suggesting that it may have actually been a single-layer floor system.

Structural floor sheathing material usage in both sectors is summarized in Table 13. Site-built homes use plywood (51 percent) and OSB (42 percent) almost exclusively for floor sheathing, with particleboard accounting for only 7 percent of use. Manufactured housing makes extensive use of less expensive particleboard floor sheathing (47 percent) with OSB and plywood accounting for the remainder (28 percent and 26 percent respectively). In terms of thickness, site-built homes primarily use 3/4-inch floor sheathing (72 percent), while manufactured housing uses 5/8-inch sheathing more often than 3/4-inch sheathing (59 percent vs. 40 percent).

Table 13: Use of Floor and Roof Sheathing Materials in New Conventional Single-Family Housing and Manufactured Housing, 1996

Sheathing Material	Type or Thickness	Floor Sheathing by Type of House				Roof Sheathing by Type of House			
		Conventional		Manufactured		Conventional		Manufactured	
		Percent Usage	Percent of Total	Percent Usage	Percent of Total	Percent Usage	Percent of Total	Percent Usage	Percent of Total
OSB	3/8"	--	--	--	--	4.0%	2.5%	8.6%	8.0%
	7/16"	2.4%	1.0%	--	--	56.7%	34.8%	86.8%	80.8%
	1/2"	0.7%	0.3%	--	--	26.8%	16.5%	4.1%	3.8%
	5/8"	24.7%	10.3%	58.5%	16.2%	3.4%	2.1%	0.5%	0.5%
	3/4"	70.1%	29.3%	39.3%	10.9%	9.0%	5.5%	--	--
	7/8"	1.4%	0.6%	2.2%	0.6%	--	--	--	--
	Other	0.7%	0.3%	--	--	--	--	--	--
	All OSB	100%	41.8%	100%	27.7%	100%	61.4%	100%	93.1%
Plywood	3/8"	-	--	--	--	5.8%	2.2%	--	--
	1/2"	3.3%	1.7%	--	--	51.3%	19.0%	83.6%	2.4%
	5/8"	13.5%	6.8%	51.5%	13.2%	42.7%	15.8%	16.4%	0.5%
	3/4"	83.2%	42.2%	48.5%	12.4%	0.3%	0.1%	--	--
	1-1/8"	1.3%	0.7%	--	--	--	--	--	--
	All Plywood	100%	51.4%	100%	25.6%	100%	37.1%	100%	2.9%
Particle-board	5/8"	--	--	63.6%	29.7%				
	3/4"	--	--	36.4%	17.0%				
	All Particle-board		6.8%	100%	46.7%				
Other	All		--		--		1.5%		4.0%

Sources: *Final Report, Data Tables: Wood Product Usage in New Home Construction*, NAHB Research Center, 1996, and *Final Report, Data Tables: Lumber and Plywood Usage in HUD-Code Manufactured Housing*, NAHB Research Center, 1997.

Roof Framing and Roof Sheathing Materials. The most common structural system used for roof framing in both single-family conventional construction and manufactured housing is prefabricated roof trusses. Trusses are more common in manufactured homes, however, at about 85 percent vs. 65 percent of roof area. This is believed to reflect the higher frequency of simple rectangular footprints in manufactured homes that are very conducive to roof trusses. Shorter spans, lower design loads and larger deflection limits also allow some manufactured homes to use roof trusses made with 2x3 chords or struts rather than 2x4 members. This is not an option in site-built homes.

Roof sheathing material usage is summarized above in Table 13. While the roof deck is most commonly built with OSB in conventional houses (61 percent), it is almost exclusively OSB in manufactured houses (93 percent). Plywood, the other material most often used in both types of homes, is much more common in site-built homes than in manufactured homes (37 percent penetration vs. 3 percent). Although the most common OSB thickness in both sectors is 7/16-inch, where other thicknesses are used site builders are more likely to use 1/2-inch to 3/4-inch material, and manufactured housing producers are more likely to use 3/8-inch material. Similar trends in product thickness are observed for plywood roof sheathing.

Summary. Manufactured homes use significantly different basic materials for framing and sheathing walls, floors and roofs than conventional homes. There are some overlaps, but differences are evident both in the mix of product types and in product thicknesses. In practically every case the usage of thinner panel products and/or less expensive product alternatives in manufactured homes is higher than in conventional homes. Wall studs are most commonly 2x4s in both types of homes, but a small proportion of manufactured homes are framed with 2x3s studs. Usage of economical roof trusses instead of rafters is also higher in manufactured homes than in conventional homes. Most of these products perform structural functions but are not readily visible to the occupant. The general result is lower square-foot costs of sheathing materials for walls, floors and roofs in manufactured homes than in conventional homes. The only offsetting factor is the structural chassis required in manufactured homes but not in conventional homes.

CHAPTER 4

COMPARISON OF THE REGULATORY PROCESSES FOR INDUSTRIALIZED AND SITE-BUILT HOUSING

4.1 INTRODUCTION

This chapter compares the significant procedural differences in regulatory systems and processes among manufactured, modular, and site-built housing in order to assess their potential impact on the economics of producing industrialized versus conventional housing. Section 4.2 reviews the process of setting regulations for actual dwelling unit construction, Section 4.3 discusses additional regulatory processes relating to regulatory approvals, design reviews and inspections, and Section 4.4 covers regulation of land development, site-work and installation.

As an overview, site-built housing is clearly subject to the widest variety of state and local codes relating to unit construction. Some of these are based on the *One and Two Family Dwelling Code* currently published by the International Code Council,[20] while others are based on model codes that cover all types of buildings in addition to houses. The three other model building codes in common use are the *National Building Code* published by Building Officials and Code Administrators International (BOCA), the *Standard Building Code* published by the Southern Building Code Congress International (SBCCI), and the *Uniform Building Code* published by the International Conference of Building Officials (ICBO). Amendments of these model codes at the state or local level are common. Producers of modular houses usually must comply with a pre-emptive statewide code that is typically based on a major model code, possibly with a variety of state (but not local) amendments. Finally, the federal Manufactured Home Construction and Safety Standards, developed and administered by the U.S. Department of Housing and Urban Development (HUD), are applicable to all manufactured houses regardless of where in the U.S. they are produced or placed. These federal requirements pre-empt all state and local codes that might otherwise apply to design and construction of manufactured homes. These fundamental differences in approach have implications that are considered throughout this chapter.

4.2 REGULATION OF UNIT CONSTRUCTION

4.2.1 Site-Built and Modular Housing

This section discusses the systems for regulating site-built homes and modular homes together. This is appropriate since modular housing, like site-built housing, must conform to state and/or local codes. Differences in the codes or the code change and adoption processes between modular housing and site-built housing are noted.

[20] The *One and Two Family Dwelling Code* was previously published by the Council of American Building Officials, and is generally referred to in this report as the "CABO OTFDC" or the "CABO code."

Authority and Scope. Where construction codes have been adopted, states and/or local governments act as governing authorities for site-built and modular housing under applicable state laws. Yet there are typically differences in the way the two types of housing are treated. For example, in many states site-built housing is regulated significantly or entirely at the local level. Localities may have the power to decide whether to adopt a code at all, can decide what code to adopt, or are permitted to make various types of amendments to a code adopted at the state level. By contrast, modular housing is most commonly subject to a statewide code that cannot be locally amended. As of the mid-1990's a total of 32 states administered uniform requirements for modular construction that could not be modified at the local level.

A few states and localities continue to write their own codes, but one or more of the model codes published by BOCA, SBCCI, or ICBO typically form the basis of codes for both site-built and modular housing. Each of these organizations publishes a family of codes including a building code, a plumbing code, a mechanical code and various others. Specific model codes have traditionally tended to be adopted in particular regions of the nation, (i.e., ICBO codes in the West, BOCA codes in the Northeast and Midwest, and SBCCI codes in the South). All of those model codes recognize the CABO *One and Two Family Dwelling Code* (OTFDC) as an acceptable alternate for construction of certain residential buildings.

While model codes generally include both technical and administrative provisions, most jurisdictions amend the administrative sections heavily to conform to their own established procedures. Technical provisions in the model codes may also be amended in various ways as part of the adoption process. For site-built construction the amendments can be made at the state or local level, although some states prohibit local amendment and others permit it only if the code is not less stringent than the model code as adopted at the state level. For modular construction the amendments are primarily at the state level and, in the interest of efficiency in commerce within the state, most states do not permit local amendments for modular construction, even if they permit it for site-built homes. As with manufactured housing, other state and especially local codes or regulations may also govern topics such as zoning and environmental considerations for site-built or modular housing. The model codes do not address consumer complaint handling, manufacturer recordkeeping or consumer warranties.

The CABO OTFDC is a particularly significant point of reference with respect to construction of new houses. It is a product of the three model code organizations originally envisioned as a national model code that is basically consistent with the three major other model codes, but different in several ways. First, the scope of the OTFDC is limited to detached homes (single-family or duplex) and fee-simple townhouses (i.e., townhouses separated by property lines). Second, the OTFDC includes all building, mechanical, plumbing and electrical requirements for new homes in a single volume. Third, the OTFDC is intended to be prescriptive and “cookbook”

for ease of understanding and enforcement. The HUD-Code, as well as the BOCA, ICBO, and SBCCI model codes, are more "performance-oriented" than the OTFDC in that they tend to make greater use of or reference to engineering-type criteria or analysis intended for use by engineers or architects. However, the difference is one of degree since all the codes, including the HUD-Code, contain some specification-type requirements and even the OTFDC specifically recognizes alternative compliance with applicable performance-based requirements in the major model codes. Note that all these codes (except the HUD-Code) presently reference the CABO *Model Energy Code* (MEC) for energy efficiency requirements.

The three model code organizations have recently joined forces under an umbrella organization, the "International Code Council" (ICC), to draft a single family of codes envisioned as a replacement for the separate sets of code books published by BOCA, SBCCI and ICBO. These include the *International Building Code* (IBC), currently in draft form but scheduled to be published in the year 2000, as well as the *International Plumbing Code* (IPC) and the *International Mechanical Code* (IMC), both already published. The ICC is also drafting an *International Residential Code* (IRC) for publication in the year 2000. The IRC will be technically comprehensive but limited in scope to one and two-family homes and townhouses, and therefore can be viewed as a successor to the current CABO OTFDC. The ICC code-drafting activities require reconciling technical differences among the three model code families. But since the ICC has no greater legal authority or standing than the other major model code organizations, it cannot address the variations introduced when model codes are amended at the state or local level during the process of adoption, nor can it reconcile differences resulting from non-uniform interpretation or enforcement.

Method of Adoption. Building codes for site-built and modular construction are adopted through legal action at the state level or, when required by the state constitution or delegated by statute, at the local jurisdictional level (city, county, township, municipality or other governmental authority). Many different systems can be found in practice around the United States. Some states retain all authority in a central department that establishes and oversees a uniform statewide code. Other states have no statewide code at all and leave regulation to local government. Others have hybrid systems that specify what code localities must adopt if they adopt any code at all, or specify "minimum" requirements that localities can meet or exceed in their own codes. Within this framework, the regulation of modular construction tends to be more centralized than regulation of site-built construction. There is also variation in how comprehensive the adopted codes are; for example, states and localities often make separate decisions about adoption of a building code, mechanical code, plumbing code, electrical code, energy code and possibly other codes. As a result, it is entirely possible to have one type of code in force but not another.

Most of the adopted codes are based on one of the major model codes and/or the CABO OTFDC. However, these source documents have historically been revised and republished at three-year intervals, so jurisdictions planning to adopt a new code must not only choose a model code, they must also select a specific edition and develop the necessary adopting legislation as well as the necessary state or local amendments. There are ordinarily time lags, sometimes significant, between publication of a new edition of a model code and its legal adoption in any particular jurisdiction. This process typically takes at least a year and sometimes much longer, so even states or localities that use the same model code frequently use different editions for periods of time. Most of the code groups keep earlier editions of their codes in print for three to six years and sometimes more following publication of a new edition, for use in jurisdictions that have not adopted the latest edition. Finally, while model code amendments are often published each year as they are approved between new editions of the codes, interim amendments are ordinarily not adopted.

Uniformity. The significant differences in technical content of codes applicable to site-built and modular housing around the country result to some degree from differences in the underlying intra-state systems of code adoption and administration. These are summarized in Table 14, which shows that as of the mid 1990's, 18 states had no state-level code requirements for site-built homes, 11 states had codes that pre-empted local regulation, and 16 states set minimum standards but allowed localities to make modifications as long as they were not less stringent than the state-adopted code. A tabulation of 1996 single-family housing starts by type of state code shows that the 18 states without any statewide requirements (Type 0) had 32 percent of 1996 starts, the 16 states with minimum codes that permitted more stringent local amendments (Type 3) had 42 percent of starts, and the 11 states with mandatory uniform statewide codes and no local amendments (Type 4) had only 15 percent of starts. In total, over 80 percent of single-family homes built in 1996 were in states where there was a clear legal potential for code variations from one jurisdiction to the next (Types 0, 1 and 3).

Greater uniformity is evident for modular housing based on Table 14. Only 8 states had no state-level code requirements for modulars, 32 states had statewide codes for modulars that preempted local amendments, and ten states set minimum standards for modulars but permitted stricter local amendments. While modular starts by state are not available, the 32 states with mandatory uniform statewide codes (Type 4) had 80 percent of all 1996 single-family starts, the 8 states with no statewide requirements for modulars (Type 0) had only 3 percent of 1996 single-family starts, and the 10 states that set minimum codes for modulars but permit more stringent local amendments (Type 3) had 15 percent of 1996 single-family starts. Therefore it appears the vast majority of modulars are placed in states that have enacted uniform codes for modular construction and do not permit local amendments relating to modulars.

Table 14: State Requirements for Construction of Site-Built Homes, Construction of Modular Homes, and Installation of Manufactured Homes

State-Level Requirement	Site-Built Homes: Number of States	Modular Homes: Number of States	Manufactured Home Installation: Number of States
Type 0	18	8	27
Type 1	5	2	0
Type 2	2	0	0
Type 3	16	10	3
Type 4	11	32	22

Key to State-Level Requirements:

Type 0: No state-wide requirements.

Type 1: No mandatory state-wide code, but if localities adopt a code it must meet minimum requirements.

Type 2: No mandatory state-wide code, but if localities adopt a code it must be the state code without modification.

Type 3: Mandatory minimum state-wide (localities can make more stringent).

Type 4: Mandatory state-wide (local modification not allowed).

Source: *Directory of Building Codes and Regulations – State Directory*, National Conference of States on Building Codes and Standards, Inc. (NCSBCS), various dates. The District of Columbia and the Commonwealth of Puerto Rico are tabulated as states in all three columns. State-level requirements change periodically; more recent information may be available from NCSBCS.

The issue of uniformity in codes for site-built and modular homes is further complicated by problems of code interpretation. Even identical code language can potentially mean different things to different people, especially where provisions are complex, highly technical, or ambiguous. Staff members of the model code organizations will provide informal interpretations of their code texts as a service to local code officials, and formal interpretations are available as well, but all such interpretations are presented as advisory inasmuch as the ultimate responsibility for interpretation rests with the authority having legal jurisdiction. As usual, depending on the state, this authority may be the local inspector or a centralized state department responsible for administration of a uniform statewide code. The interpretation problem is most significant for site-built construction where the inspection and enforcement process is highly decentralized. It adds uncertainty and variability to the application of building codes in practice.

Uniformity of requirements for modular housing has been achieved legislatively and administratively in many states, but problems of inconsistent requirements between states and within other states remain. Attempts to address the interstate situation through "reciprocity agreements" between or among states, as well as through the recently-created "Industrialized Buildings Commission," have generally focused on interstate acceptance of code administration

and enforcement processes rather than substantive uniformity in technical code requirements. These developments are further discussed in a subsequent section.

Code Change Process. Each model code organization has its own procedures for revision of its family of codes. In general, each of the codes has an annual cycle that begins with an opportunity for any interested party to submit written code change proposals along with supporting documentation. The proposals are published and an initial public hearing is held where a code change committee receives testimony for and against the proposals. The committee makes an initial determination of whether or not to accept each change, either as proposed or with modifications. These determinations are published and there is an opportunity to formally challenge each decision. Unchallenged decisions are automatically upheld, but if a challenge or "negative ballot" is submitted on a specific item then the first hearing result is reviewed at a second public hearing when a final decision is made by the state and local code officials holding voting membership in the model code organization. Thus, while any person can submit a proposal or testify for or against any proposal, the ultimate decision on whether or not to adopt a code change rests with participating code officials.

The CABO OTFDC (and CABO MEC) amendment process is similar, as is the process for the CABO MEC, except that CABO has no general membership so all decisions have historically been made by a small code change committee consisting of members appointed by the three model code groups. The committee members primarily include code officials, but sometimes one or more voting members from industry or other government agencies are permitted to serve.[21]

The process for amending the NFPA *National Electrical Code* (NEC) differs considerably from the other model code procedures. The NEC is maintained through an ANSI-approved consensus process operated by the National Fire Protection Association, under a 3-year cycle rather than an annual cycle. Participation and voting rights are open to all interested parties, subject to general requirements for committee balance and due process.

4.2.2 Manufactured Housing

Authority and Scope. HUD is the federal agency with ultimate authority over the design and construction of every manufactured home made in the United States. The Manufactured Home Construction and Safety Standards or "HUD-Code," compiled at 24 CFR Section 3280, and the companion Manufactured Home Procedural and Enforcement Regulations, compiled at 24 CFR Section 3282, are the requirements that govern the construction of manufactured homes and

[21] Historical code change procedures are evolving with the emergence of the ICC family of codes as well as with the recent transfer of responsibility for maintaining the OTFDC and the MEC from CABO to ICC.

operation of the regulatory process. Prior to promulgation of the HUD-Code in 1975, a voluntary standard regulating design and construction of mobile homes was available for adoption by states and localities.[22] Since that time, the HUD-Code has contained all the technical requirements for construction, including unit planning, structural, fire protection, energy efficiency, plumbing, electrical and mechanical systems. HUD regulations govern inspection and oversight of manufactured home construction, and provide for rulemaking, recordkeeping, complaint handling and related functions.

Uniformity. All manufactured houses designed to be used as dwelling units must comply with provisions of the HUD-Code. Some specific requirements may vary depending on environmental conditions where the home is sited, such as wind speeds, snow loads and climate, but these variations must be set forth in the HUD-Code itself. Furthermore, the HUD-Code is preemptive, meaning that it nullifies or supersedes any and all other state and local requirements that might otherwise apply to design and construction of manufactured housing.

The HUD-Code only tangentially addresses ancillary issues related to site installation, utility connections, add-ons or modifications to manufactured houses, warranties, transportation, or siting approval. State or local regulations and codes, often based on the model codes for site-built housing, can address these issues. The result is a high degree of variation around the country in regulation of these activities, ranging from little or no regulation or enforcement to comprehensive state-wide systems.

The HUD-Code is not specifically based on any other model code, except for its electrical provisions which are based on the 1993 *National Electrical Code*. The HUD-Code places greater emphasis on performance standards than any of the other U.S. model codes. This gives manufactured housing maximum flexibility in compliance so long as producers can show by engineering analysis or physical tests that an assembly (wall, roof, etc.) meets the general performance standard. For example, under the performance method a manufacturer may use any combination of materials and fasteners to construct exterior wall assemblies that withstand design dead and live loads (e.g., wind loads) and may demonstrate compliance by full-scale tests in lieu of engineering calculations. Prescriptive standards such as found in the CABO code, on the other hand, might simply require 2x4 wall studs spaced not more than 16 inches on-center and specified amounts of structural sheathing on the first floor walls of a two-story house in a given wind zone and seismic zone. There is no testing and therefore no opportunity to consider workmanship or the interaction of all parts of an assembly in resisting wind loads.

HUD also issues formal Interpretative Bulletins as necessary to clarify the meaning of specific parts of the standards or assist in enforcement. These can be issued without rulemaking

[22] ANSI 119.1/NFPA 501, "Standard for Mobile Homes."

proceedings or public comment. This uniform system of binding interpretations applicable nationwide is an important tool for achieving consistent application of the HUD-Code.

Code Change Process. HUD is legally responsible for maintaining and revising the HUD-Code, but substantive amendments have been quite infrequent since the regulations were first published in 1975. Two private sector committees have suggested revisions to the HUD-Code at various times in recent years, but few if any changes have resulted. For that matter, any interested party is free to submit proposed changes to HUD, even though the agency has no obligation to act on them. In addition, Congress may enact legislation requiring the agency to revise its rules. Perhaps the most significant changes to the HUD-Code were provisions concerning formaldehyde emissions adopted in 1984, and updated high wind and thermal protection standards that became effective in 1994.

If HUD decides to initiate a revision to the standards, a draft of the proposed new language and a supporting rationale is prepared by the HUD Office of Manufactured Housing and reviewed by the Office of Management and Budget (OMB). After OMB clears issuance of the proposal, the proposed changes are published in the *Federal Register* with a request for public comment. HUD must review all public comments and then may (1) revise the proposed rule (if revisions are deemed necessary) and publish it as a final rule with a specified effective date, (2) re-submit a revised proposal for OMB clearance and repeat the entire notice and comment rulemaking process, or (3) decide not to proceed with any change to the existing standards. This overall rulemaking process typically takes two to three years, and legal challenges may follow.

4.2.3 Findings and Implications

Centralization and Uniformity. It is inherently less time-consuming and expensive in terms of administration and compliance to follow direction under a single system of governance, as found in manufactured housing, than to be subject to the authority of multiple jurisdictions, as found in site-built and modular construction. The manufactured housing industry realizes significant efficiencies by operating in an environment where a relatively small number of large producers all are working under a uniform set of rules that are written, interpreted and enforced by one national authority. In contrast, the tendency for the vast majority of individual site-builders each to produce a small number of homes under inconsistent requirements that are adopted, interpreted and enforced by thousands of state and local code authorities complicates compliance and decreases efficiency.

Modular housing producers fall in the middle. They benefit from statewide code uniformity, centralized regulation and pre-emption in most states, but only on a state-by-state basis. In other states they remain subject to locally varying requirements, and in general they experience more and more variations as they attempt to expand into interstate shipments and sales. More uniform

governance might not be a great advantage for smaller modular producers that confine placement of their housing units within one or two states or a single local area, but at least on an interstate level it could potentially provide some advantage for larger modular builders that operate over wider geographic areas. In cases where many jurisdictions exist within a few hundred miles of a single modular housing factory interstate uniformity could be an advantage, whereas state-to-state or local variations could be a significant barrier to growth and maximum production efficiency. Under such circumstances, national legislation or widespread voluntary adoption of uniform technical requirements and enforcement procedures for modular builders could create efficiencies for the modular sector. At this point there is little reason to expect such a development.

The actual extent of non-uniformity is a complex and constantly changing topic. It is true that most states and localities around the U.S. adopt modified versions of recent editions of a small number of model codes. Totally unique state and local codes have become less common today than in previous decades. The goal of uniformity could be advanced with the ongoing consolidation of the major model codes into one building code (the IBC) and its publication in the year 2000, but any real improvement will depend on the speed with which a single model code is adopted and the degree to which it is amended at the state and local level. The parallel development and publication of the IRC may do little to increase uniformity since, as seen by the example of the CABO OTFDC, mere availability of a single, largely complete code that addresses much of home building does not guarantee uniform adoption. It is not clear that the IBC or the IRC will be any different. And finally, achieving uniform technical requirements only addresses part of the problem because the ultimate impact of an adopted code can easily be changed through varying interpretations by local building inspectors. This process of local interpretation has been said to result in several thousand major and minor variations of current codes.[23]

Comprehensiveness. Presentation of comprehensive requirements for all aspects of home building in a single document, as has been done with the HUD-Code and CABO OTFDC, makes it easier for users to understand the rules and regulators to enforce them. This has benefitted manufactured housing, but can do little to improve efficiency for site-built and modular construction as long as state and local jurisdictions have the authority to selectively adopt or overrule provisions of the code. For example, many states or localities have only adopted portions of the CABO OTFDC (such as the building chapters) and excluded other provisions (such as the plumbing section).

[23] U.S. Congress, Office of Technology Assessment, *Technology, Trade, and the U.S. Residential Construction Industries – Special Report*, OTA-TET-315, Washington, D.C., U.S. GPO, September 1986, p.70.

Performance vs. Prescriptive Requirements. Some of the efficiency in producing HUD-Code housing may be the result of the greater use of more flexible performance standards for regulation, because many of the requirements in the HUD-Code are framed in terms of performance standards. The fact that producers of manufactured housing engage in large-scale production of more standardized housing units with a large investment in equipment, centralized factories and professional engineering staff makes performance compliance attractive. Manufactured housing producers can use in-house expertise to do the required engineering analysis or testing for standard designs, and minimize the cost impact by spreading it over the large number of similar units produced.

Of course, performance standards are not unique to the HUD-Code. The BOCA, ICBO, and SBCCI model codes also have provisions for the use of performance standards, and CABO allows builders to use the performance standards cited in these model codes as an alternative to prescriptive requirements in the OTFDC. Yet about 80 percent of conventional home building companies are small in size, building less than 25 units a year, each one often significantly different from the others. Consequently, most builders have little to gain from using performance standards because the cost of engineering and testing to meet those requirements is too burdensome when spread over production of such a small number of varied units in a year. Performance standards also are inherently complex and technical to apply. Even when performance criteria are incorporated or referenced in the code text, it is not clear whether local building officials will find such procedures acceptable. Ultimately, inspectors have wide discretion in reviewing a builder's plans. If they have no common understanding of the criteria by which they can judge that an assembly is meeting performance standards, they will have difficulty in interpreting and accepting the computations and tests required to prove performance and may demand extensive verification by design professionals. Some inspectors set the burden of proof so high that builders do not find it cost-effective to use innovative techniques not specifically permitted in the code.[24] Overall, the potential advantages of performance compliance are smaller and more difficult to realize for small site builders in a decentralized regulatory environment than for manufactured housing producers operating under the HUD-Code.

Amendments. The model codes have historically proven more responsive to change than the HUD-Code; each model code has a regular, institutionalized code change processes with periodic formal consideration of large numbers of proposals submitted by many interested parties. While this process may help speed the legal recognition of new materials and techniques, state and local authorities can nullify this advantage by taking long periods of time to enact new editions of the model codes into law. And there is little evidence that this difference

[24] Richard Duke, *Local Building Codes and The Use of Cost Saving Methods*, A Staff Report of the Bureau of Economics to the Federal Trade Commission. December 1988, p.8.

has significantly limited innovation in HUD-Code homes. It may be that the performance nature of the HUD-Code reduces the need for constant revision compared to the model codes, which include many more material-specific or quasi-prescriptive provisions.

A uniform, complete model code for all site-built and modular housing will not be advantageous unless the current variations in practice at the state and local level are also addressed. Some element of national preemption or widespread voluntary interstate adoption without amendment would have to occur for significant progress to result. Widespread implementation of a single code devoted to low-rise site-built housing and encompassing all the specialized building systems could facilitate innovation in technology and materials and might lead to reductions in compliance cost. Nevertheless, it is unlikely that any resulting savings would allow site-built housing in its present form to compete effectively with manufactured housing in the same affordable housing market.

Summary. The differences in regulatory practice between site-built or conventional housing and manufactured housing arise from the different economic and structural characteristics of the two industry sectors and the differences in the basic production processes. Decentralized regulatory practices have been considered appropriate in a sector where 80 percent of the producers each build less than twenty-five units a year, often in scattered locations, through a process requiring coordination on a site-by-site basis of the largely sequential work of numerous special trade contractors over a protracted period of time. This approach to regulation has not necessarily proven to be very efficient, but it appears to have served the underlying purposes of protecting public health and safety. Prior to the HUD-Code it was the universally accepted approach to regulating building construction.

In contrast, manufactured housing is a concentrated industry in which the largest ten firms have a 65 percent market share. Large numbers of HUD-Code homes are produced at centralized production facilities under controlled conditions where relatively unskilled labor performs simplified, specialized, predictable tasks that can easily be regulated and inspected by one authority and system of governance. Yet these considerations were not what led to the HUD-Code. Rather, attempts to apply traditional decentralized regulatory approaches to the centralized processes of mobile home design and construction were inherently questionable, and there were long-standing concerns about the safety, quality and durability of the resulting product that outweighed any possible benefits of state-level autonomy or local enforcement. The existing system was not working and arguably constituted an impediment to progress and a burden on interstate commerce. The potential benefits of a pre-emptive federal regulatory presence were recognized, and the HUD-Code was the result.

Modular housing is in an intermediate position between HUD-Code housing and site-built housing in regard to regulation. Modular producers benefit from some of the efficiency and

process control inherent in factory production, but in practice have not realized similar economies of scale as HUD-Code producers. One reason is that modular companies are smaller and less well capitalized. Another is that they must deal with multiple regulatory authorities and a variety of codes in order to sell in a large geographic area. Modular production also includes many two-story units that automatically require assembly and finish work at the site, limiting the potential advantages of factory production and subjecting these units to more on-site regulation than HUD-Code homes. Finally, the greater extent of customization in the modular industry is believed to reflect conscious attempts by the industry to appeal to a higher-end market than manufactured housing. As a result, it is difficult to discern the degree to which variable local regulation as opposed to market forces leads to more costly customization. Nevertheless, greater standardization of the underlying construction requirements that apply to the modular industry, whether by legislation or on a voluntary basis, could reduce modular production costs, expand access to larger markets, and make modular producers more competitive with HUD-Code producers.

4.3 APPROVAL, DESIGN REVIEW AND INSPECTION

4.3.1 Site-Built Housing

Approvals and Design Review. Site-builders need to obtain a variety of permits in order to construct a new house. In many jurisdictions, detailed building plans must be reviewed and approved by the local code enforcement department before a permit allowing construction is issued. Waiver of design review is permitted under CABO at the discretion of the building department, but when a house plan is required it must "show in detail that [construction] will conform to the provisions of this code and all relevant laws, ordinances, rules, and regulations."[25] CABO also mentions that a plot plan is required, showing the location of all easements, drainage facilities, adjacent grades, property lines, the proposed building, and any existing buildings on the property.

Design review would ordinarily involve review of site/foundation conditions, major structural systems, energy use, and electrical and mechanical plans. When the quality of materials used in construction is critical to code compliance, specific information is required to verify the quality of the materials. Depending on the jurisdiction and applicable code, specific engineering details may also be required for structural, mechanical, and electrical work, including computations, diagrams and other supporting technical data bearing the seal of a registered design professional.

Design details including three to four elevations, floor plans of each level, and one basic section showing structural details are typically required on the plans. Joist sizing, spacing, and beam

[25] 1995 CABO *One and Two-Family Dwelling Code*, Section 112.

sizes are usually specified, as are basic wall framing specifications (e.g., 2x4 studs at 16 inches on-center). Very basic electrical, mechanical and plumbing layouts are also typically required. Specifications for insulation and calculations showing conformance to the CABO *Model Energy Code* or other applicable energy code may also be required.

Inspection. Numerous field inspections are typically required for site-built housing. The CABO code specifies inspections for foundation; rough mechanical, electrical, and plumbing; framing; and the completed house. In practice additional inspections are common, such as after installation of insulation, as well as multiple final inspections for mechanical, electrical, and plumbing systems. Building officials have authority to stop work until any required corrections are made. Inspections are most commonly made by employees of the jurisdiction.

In addition to passing required inspections builders may need to obtain other certifications to secure a final occupancy permit, such as certification by the HVAC contractor that the installed heating and cooling equipment meets the design heat loss and gain of the house.

In reality many inspections are very cursory and may not find all defects due to the wide variety of possible deficiencies and large number of inspections required of any given inspector. As a practical matter, most inspectors tend to focus on the most critical elements of construction such as the sizing and proper installation of beams, load-bearing walls, floors and structural sheathing. They may be less concerned with other details that have limited impact on safety or performance of the building.

The costs of administering this process of permit issuance, plan review, inspections and approval are generally recovered in whole or in part through fees charged to a permit applicant. Fees are usually based on the value of work performed, and separate fees may be charged for building, plumbing, mechanical and electrical permits. These fees vary widely across jurisdictions depending on specific enforcement practices and revenue goals, but permit fee schedules appearing in the model codes can give some idea of their size. For example, Table 1-A of the 1997 *Uniform Building Code* calls for a baseline building permit fee of $993.75 for construction valued at $100,000, plus an additional $5.60 per $1,000 of value above $100,000. Recommended fees in Appendix B of the 1997 *Standard Building Code* are only about half this amount: a fee of $460.00 for construction valued at $100,000 plus $3.00 per $1,000 of value above $100,000. These fees do not include plan review. Where plan review is required, the UBC recommends an additional fee equal to 65 percent of the baseline fee and the SBC recommends an additional 50 percent fee. Separate fees assessed for mechanical, plumbing and electrical permits are usually much smaller but can easily add hundreds of dollars to the total. Based on these fee schedules, the total cost of permits for typical site-built houses would be anywhere from $500 to more than $2,000. Fees may be lower in jurisdictions with streamlined regulatory systems or where some of the costs of code enforcement are borne from general

revenues, but the point is that the unit costs of administering the regulatory system applied to new site-built homes can be very substantial.

4.3.2 Manufactured Housing

The system for regulating construction of manufactured homes is radically different from the system for site-built homes. The HUD-Code approach relies heavily on engineering design and approval of every unit, rather than application of the conventional construction methods used for most site-built homes. HUD has created an elaborate system to provide oversight and assurance that each unit is properly designed, each design is formally reviewed and approved, and every finished product is built in accordance with its approved design. While the system appears complicated, it also makes extensive use of third parties and quality control approaches that minimize the burden of compliance. Experience has shown that the system can function smoothly and efficiently, particularly in the context of factory-built housing.

The following definitions, found in section 3282.7 of the Manufactured Home Procedural and Enforcement Regulations, are useful in understanding the procedural framework for approval, design review and inspection of manufactured housing:

> A *Design Approval Primary Inspection Agency* (DAPIA) is a state or private organization which evaluates and approves or disapproves manufactured home designs and quality control procedures. DAPIAs must be recognized and approved by HUD.
>
> A *Production Inspection Primary Inspection Agency* (IPIA) is a state or private organization which evaluates the ability of manufactured home manufacturing plants to follow approved quality control procedures and provides ongoing surveillance of the manufacturing process. IPIAs must be approved by HUD. Organizations may act as either IPIAs, DAPIAs or both.
>
> A *Quality Assurance Manual* is a manual, prepared by each manufacturer for each of its manufacturing plants and approved by a DAPIA, which contains:
>
> - a statement of the manufacturer's quality assurance program,
> - a chart of the organization showing, by position, all personnel accountable for quality assurance,
> - a list of tests and test equipment required,
> - a station-by-station description of the manufacturing process
> - a list of inspections required at each station, and
> - a list by title of personnel in the manufacturer's organization to be held responsible for each inspection.
>
> A *State Administrative Agency* (SAA) is an agency of a State which has been approved or conditionally approved by HUD to carry out the State plan for enforcement of the manufactured housing standards in the HUD-Code.
>
> A *Certification Report* is prepared by an IPIA for each manufactured home manufacturing plant, which includes a complete description of the initial comprehensive inspection of the plant, an evaluation of the quality assurance program under the approved quality assurance manual, and the identify of the DAPIA which approved the designs and quality assurance manual used in the plant. Where appropriate, the certification report may be made by a DAPIA.

Approval Process. Enforcement of the HUD-Code standards involves several parties. Unit designs and quality assurance manuals prepared by the manufacturer are reviewed and must be approved by a DAPIA. An IPIA is generally responsible for in-plant monitoring, including verification that the quality assurance manual is followed, and production inspection of manufactured homes until a Certification Report is issued for the facility. After a facility is certified, the IPIA performs ongoing surveillance of the manufacturing process, including representative unit inspections to assure that the manufacturer produces units that comply with the approved designs, in accordance with the quality assurance manual. IPIAs have the power to withhold certification of any particular non-conforming unit and to withhold the issuance of HUD certification labels. Fees for DAPIA and IPIA services are negotiated between the manufacturer and the service provider.

Manufacturers are free to choose service providers recognized by HUD to act as their DAPIA(s) and IPIA(s). IPIAs may be private or state organizations, except in states which have HUD approval to act as exclusive IPIAs. Regulations require states to participate to the maximum extent possible. States acting as exclusive IPIAs must have SAA status but may provide non-exclusive IPIA services if not an approved SAA. States may also provide DAPIA services. A "fully approved" SAA (in contrast to a "conditionally approved" SAA) has the same enforcement authority as HUD. In order to become a fully approved SAA, the state authority must be empowered by state law to enter and inspect plants, impose penalties, require manufacturers to provide consumer notification of defects and make corrections, and review plans and provide information. As of 1994, 21 states were fully approved and 15 were conditionally approved to act as SAAs, eleven states were acting as exclusive IPIAs, and three other states were acting as non-exclusive IPIAs. The devolution of IPIA inspection responsibility to the states relieves HUD of some of the burden of oversight, but HUD still has overall monitoring responsibility.

The National Conference of States on Building Codes and Standards, Inc. (NCSBCS) currently works under contract to HUD to monitor and evaluate the performance of IPIAs, DAPIAs, and SAAs. NCSBCS staff conduct reviews of selected DAPIA design approvals and IPIA plant and construction inspections, and perform periodic plant visits. The purpose is to recommend approval or disapproval of entities to provide IPIA and DAPIA services. NCSBCS also provides SAA services on behalf of HUD in those states that do not have an approved or conditionally approved plan.

NCSBCS reviews performance of IPIAs and rates them on an annual basis. It also reviews manufacturer quality assurance programs and certifies part of the design review performed by DAPIAs; registers all design reviews and maintains them in a computerized format; and conducts regional training programs and annual workshops in cooperation with the Council of State Administrative Agencies (composed of representatives of authorized SAAs). Since

DAIPAs also play a role in performance-based approval of assemblies, NCSBCS samples and reviews ten percent of such assemblies in order to monitor DAIPA performance and in-house testing by producers and determine whether or not the assemblies actually conform to the underlying standards.

Fully qualified SAAs also monitor and enforce the consumer notification, defect correction, and consumer complaint-handling requirements of the regulations. Where SAAs do not exist, HUD (or NCSBCS operating as its agent) performs this role. The regulations also allow SAAs to provide additional consumer protection, including oversight of retailers/dealers, installations, resale and transportation, and to include specific requirements such as licensing and warranty provisions.

Manufacturers must keep records of all units sold, submit periodic reports to SAAs, IPIAs, and/or HUD, provide Consumer Manuals, and provide "registration" cards for home buyers to return to the manufacturer. This allows buyers to be matched up with particular units and subsequently be notified of any defects found to exist in their homes. Manufacturers are also required to specify the dealers they ship to in their production reports. This provides NCSBCS with a record of dealers as well as authoritative data about volume of shipments of HUD-Code homes.

HUD does not itself perform, nor does it require states to perform, any of the following activities:

- monitor retailers or dealers,
- approve retailer/dealer "add-ons" made at the time of sale (HUD does require that add-ons not adversely affect compliance of the basic unit with the standards),
- specify or monitor installation,
- inspect units at time of resale, or
- regulate actual transportation of units.

HUD does, however, encourage states to perform these functions, and some states do so.

Design Review. All unit designs must be reviewed and ultimately approved by the manufacturer's DAPIA. Design submissions may include drawings, specifications, sketches and related engineering calculations, tests and data in support of particular structural, electrical and mechanical systems in each manufactured home design or variation being reviewed. Changes in approved designs also require DAPIA approval. Specific design information required to be submitted to the DAPIA by the manufacturer includes the following, unless demonstrated to the DAPIA that it is not necessary:

1. Construction drawings and/or specifications showing structural details and layouts of frames, floors, walls, roofs, and chassis; material specifications, framing details, door locations, etc., for each floor plan proposed to be manufactured,

2. Structural analysis and calculations, test data and/or other accepted engineering practices used by the manufacturer to validate the design,
3. Complete heat loss calculations for each significant variation of home design,
4. Floor plans showing room arrangement and sizes, window sizes, emergency exits and locations, locations of smoke detectors, fixed appliance range hoods, and other standards related aspects of the manufactured home that can be shown on the floor plans,
5. Diagrams of the fuel supply system, potable water system and drain, waste and vent systems. The diagrams shall specify the types of materials used, types of fittings and methods of installing required safety equipment,
6. Wiring diagrams, including circuit allocation of electrical load and branch circuit calculations, a table of the branch circuit protection provided, the type of wiring used, and wiring methods,
7. Details showing the design of air supply and return systems,
8. Details of chassis construction, components, connections and running gear including rating capacities of tires,
9. A list of fixed and portable appliances furnished with the manufactured home, including type of appliance, rating of appliance, and applicable minimum and maximum performance ratings and/or energy requirements,
10. Detailed manufacturer installation instructions including specifications and procedures for the erection and hook-up of the home at its permanent location, and
11. Reports of all tests that were run to validate the conformance of the design to the standards.

The DAPIA also inspects and approves the manufacturer's Quality Assurance Manual. Such a manual is prepared by or on behalf of the manufacturer for each of its manufacturing plants. The manual includes the manufacturer's quality assurance program, a chart of the organization showing all personnel accountable for quality assurance, a list of tests and test equipment required, a station-by-station description of the manufacturing process, a list of inspections required at each station, and a list of manufacturer personnel by job title responsible for each inspection. Changes in an approved quality assurance manual require DAPIA approval.

Production Inspection. IPIAs first conduct an initial inspection of each plant and evaluate compliance with the manufacturer's quality assurance program. At least one unit must also be inspected during all phases of construction and found to comply with the approved design and the underlying standards before a Certification Report can be issued, attesting to the manufacturer's ability to perform in compliance with its Quality Assurance Manual and produce units conforming to the HUD standards. Once a Certification Report has been issued, full-scale production is approved and the manufacturer can be provided with a supply of certification labels for use on completed units. At that time the IPIA is responsible for performing ongoing surveillance of the production process by conducting representative inspections. If units inspected by the IPIA are found not to comply with their approved designs or the underlying standards, the IPIA can "red-tag" them, require corrective action, and withhold the required certification labels from other units in production until their compliance has been verified.

Notwithstanding the streamlined inspection procedure, some units may not be inspected at all during production, due to an insufficient number of inspectors, and may only be inspected after

completion. This creates the potential for overlooking some violations that are not visible in the final stages of production. The requirements for manufacturer adherence to in-process quality control procedures are intended to minimize this possibility.

The costs of administering the HUD-Code process of design review, approval and inspection are covered by per-floor fees administratively set by HUD, plus other fees negotiated between the manufacturer and the selected DAPIA and IPIA. The HUD fees are presently set at $24 per section, i.e. $24 for a single-wide unit and $48 for a double-wide unit. There are no set fees for IPIA and DAPIA services, but since eligible third-party organizations compete with one another for business with producers there is a natural tendency to keep costs under control. Anecdotal information from manufacturers suggests that combined fees for IPIA and DAPIA services paid by HUD-Code producers could be up to about $60 for a single-section unit and average less than $100 for a double-section unit. This corresponds to a cost for administration of the HUD-Code regulatory system on the order of $150 per double-section HUD-Code home, and closer to $100 for a single-section home, not including the cost of any manufactured home "installation permit" required at the state or local level.

4.3.3 Modular Housing

Approvals. The CABO code requires prefabricated construction to have a certificate of approval by an approved agency, except when all portions of any prefabricated assembly are accessible for on-site inspection. Placements of prefabricated assemblies at the site are to be inspected by local building officials for compliance with the CABO code.[26]

Zoning approval and a building permit allowing construction on a given site would still be required in most locations. In such cases, local building officials would be involved in design approval and inspections for the foundation, the joining of modular units, any final installation of siding or roofing, rough mechanical work including site utility connections, and all other work not specifically exempt from permit. Like site-built housing, interim and final inspections could also be required for modular housing, although interim inspections are relatively unlikely because modular units are largely complete when delivered to the site and most have been pre-inspected at the plant.

Design Review. Most states have a design approval and inspection system for modular housing similar to that used for manufactured housing, including requirements for quality control procedures and manuals, design review of all units produced, and in-plant inspections by state-approved third-party agencies and/or the state itself. In such cases, a preemptive state code based on one of the model codes is most often used. Nevertheless, a major impediment faced by

[26] 1995 CABO *One and Two-Family Dwelling Code*, Section 114.

manufacturers who ship to multiple states is the potential need for separate procedural and design reviews and in-plant inspections of the same designs by representatives of the destination state in order to satisfy each state.

Simplification of the process has sometimes been attempted through interstate reciprocity agreements, under which two or more states agree to accept design reviews and approvals from one another. Generally these agreements still require units to conform to code requirements of the destination state. The Housing and Community Development Act of 1987 called for a study of the inefficiencies faced by modular homes in interstate commerce and identification of potential solutions. One outgrowth of the resulting study was creation of the "Industrialized Buildings Commission" which developed, adopted and published a set of model rules and regulations for modular buildings and a companion set of administrative procedures.[27] The Commission, which is administered by NCSBCS, promotes interstate reciprocity for modular units through adoption of the model rules and procedures, in conjunction with a formal "Interstate Compact on Industrialized/Modular Buildings." The regulations and the administrative procedures are very similar to those for manufactured housing, and are designed to replace state-level modular certification programs with certification and label sales carried out by the Industrialized Building Commission. As of 1997, New Jersey, Minnesota and Rhode Island have entered into the Interstate Compact. According to NCSBCS, over 8,100 modules with IBC labels were shipped from more than 25 states between August 1993 and December 1994, and over 20,000 modules with such labels had been shipped by June 1997. This apparently represents most or all of the modular units shipped into the three member states, and obviously includes many units other than modular homes. However, there is concern in the industry that manufacturers have not realized significant cost savings through this program.

The Industrialized Building Commission approach goes beyond earlier reciprocity agreements by eliminating separate labels issued by individual member states. Thus, its impact is not limited solely to commerce between member states. However it remains similar to earlier reciprocity agreements in that it is essentially procedural and does not purport to address inconsistencies in state level code requirements. In other words, labeled units are still required to meet the code of the specific state where the structure is to be sited. The Uniform Administrative Procedures are also more flexible than the HUD-Code in regard to changes in design; they provide an optional "Manufacturer's Design Program" allowing modification of previously approved plans or systems without prior approval of the evaluation agency, for manufacturers with certified plans examiners on staff. Detailed plans and records must be kept of all such modifications. They must be sent to the evaluation agency and kept available in the factory for review by in-plant

[27] Industrialized Buildings Commission, "Model Rules and Regulations for Industrialized/Modular Buildings" and "Uniform Administrative Procedures", both adopted July 9, 1993. Available from the Commission Secretariat, NCSBCS, located in Herndon, VA.

inspection agency and compliance assurance personnel. Any violations of codes or regulations that are subsequently found must be corrected by the manufacturer.

In the interests of production efficiency, modular producers will often choose to design and build to a set of code requirements well above the minimum, conforming to the most stringent requirements of the states within their market area. In this way, the lack of uniformity of code requirements among state jurisdictions can indirectly lead modular producers to build beyond the minimum standards. This is one reason given by modular producers for targeting a higher end of the market than HUD-Code homes.

Inspection. The CABO code requires the placement of prefabricated assemblies at the site to be inspected by local building officials for compliance with the CABO code. When a pre-emptive state code is in effect, local officials do not have authority to reject modular units certified under state procedures as complying with the code.

Frequently modular units produced in one state for shipment to another state must be inspected by representatives of the destination state, who may need to make special trips to the production facility for this purpose. The requirement for the number of in-plant inspections varies from state to state. Some states require at least one inspection of all units, while others may require that only a relatively small percentage of units have any inspections at all, based on the assumption that quality assurance plans and repetitive manufacturing processes will prevent problems.

The Uniform Administrative Procedures for Industrialized/Modular Buildings, like the HUD-Code, generally require at least one inspection during production. However, inspections may be performed at an unspecified reduced frequency if manufacturers provide an insurance-backed warranty or if they have Certified Compliance Assurance Personnel on staff.

4.3.4 Findings and Implications

Site-built housing is usually not subject to nearly the same degree of design review as manufactured or modular housing, nor do site-builders have to adhere to formal programs that demonstrate that the construction process incorporates accepted quality improvement and control procedures. Yet the systems for HUD-Code and modular housing are not particularly burdensome in practice. Once designs of manufactured and modular housing are approved, the same or similar designs can be replicated many times in the controlled factory environment where producers can closely monitor labor and schedule the work, and a limited regime of inspection is permitted. Efficiency of the system of regulation is evidenced by the fact that total costs for fees paid to HUD and for IPIA and DAPIA services are on the order of $150 for a double-section home.

In many cases the inspection of modular units is equally streamlined. Yet even after years of working for effective reciprocity agreements, the process of design approval and in-plant inspection of modular homes destined for interstate shipment remain a duplicative and inefficient process due to limited coordination across state lines. The procedural focus and limited success of current interstate programs leaves open the possibility that some kind of pre-emptive federal regulatory system addressing standards and procedures, perhaps a system that remains voluntary at the state level, would benefit the modular sector.

Since almost all construction details of manufactured housing are subject to internal quality inspections and the units are required to be essentially complete prior to shipment, little remains to be inspected on site. While manufactured units are theoretically subject to on-site inspections by state and local agencies for installation and utility connections, some building departments are reluctant to become involved with HUD-Code units. Yet more than half of current manufactured housing unit placements involve multi-section homes that must be joined on-site, and the installation of other amenities on site such as porches and decks is also becoming more common. The degree to which this work is actually regulated is not clear. Modular units probably encounter more site inspection since they are not regulated under the HUD-Code, involve more on-site customization, and are usually placed on conventional foundations that are clearly subject to local regulation and inspection.

Site-built housing, with the greatest variety and customization of features, is subject to a comparatively inefficient series of field inspections extending throughout the construction process to ensure code compliance. These inspections are more time consuming and difficult to schedule than any factory inspections, since they are dependent on a sequential construction schedule which is subject to unpredictable delays including bad weather, conflicting schedules of subcontractors, and variable site conditions. Inspectors are usually government employees rather than independent professionals retained by the builder, so they have less incentive to work effectively with the builder than the third-party inspectors relied upon in HUD-Code and modular factories. The overall cost of administering this system clearly varies, but based on the suggested permit fee schedules in the model codes, average cost of a comprehensive system can range anywhere from $500 to over $2,000 for a typical new home, or three to 15 times the code-related fees for a double-wide HUD-Code home.[28]

The design review and inspection efficiencies available to manufactured and modular housing would be difficult but not impossible to realize in site-built housing. For example, some

[28] The cost of any state or local permit fees for installation of a manufactured home is not included. However, any such fee would generally be based on the cost of installation and site-built improvements alone, not the value of the underlying home, and would be unlikely to significantly alter the comparison.

elements of cycle-time and quality improvement are applicable to site-built housing under particular circumstances. Reducing construction cycle-time by performing the specialized aspects of construction activity concurrently rather than sequentially through better coordination and education of subcontractors would help reduce the site-builder's carrying charges as well as improving margins and quality of the finished product, since accelerated cycle-time compels builders and subcontractors to solve problems as they occur rather than after-the-fact. The use of multidisciplinary inspectors to inspect mechanical, electrical, and plumbing systems in one visit could shorten cycle-time by reducing the number of sequential inspections scheduled. Options for privatizing aspects of the design review and/or inspection functions should be explored. These would reduce delays and enhance service, and experience in the HUD sector shows they are not inconsistent with achieving code compliance.

Application of improved quality control systems by the builder is another opportunity. The possibility of applying quality control is complicated by the use of subcontractors and the attendant constant change of skill levels of workers, the variety of home designs and options offered, and the often small number of houses built by particular builders. If a builder could submit more complete documentation of the construction process and plans, exercise more control over the personnel, expertise and responsibilities of subcontractors, and provide a reliable method of self-inspection and recordkeeping throughout the construction process, then fewer after-the-fact inspections by local government would be needed. Standard methods of the traditional quality improvement program are more likely to be implemented by large builders constructing many similar houses, particularly those with an in-house work force. The up-front work required to provide the detailed metrics and plans necessary to achieve fewer inspections would probably be beyond the capability and means of the typical small custom builder, but by no means impossible for some, and even smaller firms could use boilerplate plans developed by consultants to move in this direction.

4.4 LAND DEVELOPMENT, SITE-WORK AND INSTALLATION

4.4.1 Site-Built Housing

Land Development. Site-builders are frequently involved with land development, but the relationship can be complex and indirect. Yet land development is critical to the overall new home production process, because without a steady stream of finished building lots coming on line, new construction activity would essentially come to a standstill. The land development process is steadily becoming more complex as well, encompassing zoning requirements; federal, state and local environmental issues; and problems of community planning. For typical site-built residential construction, three basic options exist: developer-only, developer/builder, and builder-only.

Developers-only are entrepreneurs who only develop land. They may buy raw land and then develop it by subdividing it into lots, installing the necessary utilities and infrastructure, and eventually selling the developed lots to builders or would-be home owners who contract with their own builders. In this option, the developer would be responsible for obtaining any required environmental, zoning, or other permits for grading the land, constructing roads, installing water, sewer, gas, electricity and storm water systems, etc. A pure land developer does not become involved in house construction. In extreme cases the process of obtaining necessary approvals may take years, during which the land developer bears the carrying costs on the land for interest and taxes as well as the cost of engineering, planning and execution of the development activities.

Developer/builders perform all of the development-related activities described above and then, based on market demand, build houses on some of the lots. Other lots may be sold to other builders or prospective homeowners who are responsible for arranging their own construction.

Builders-only purchase finished lots from land developers or developer/builders. They secure permits and construct houses on individual lots, either pre-sold or for eventual sale. Under this arrangement the builder carries the cost of the developed land from the time the lot is purchased until the completed home is sold.

Builders who construct homes on land they own with an expectation of eventual sale are termed "merchant" or "speculative" builders. Builders who build on land owned by a home buyer to the buyer's specifications are often called "custom" builders. They deal less often with purchase of land, but depending on circumstances, may become involved with developing land. They typically have experience in buying and developing land, but do not engage in such activity as often as merchant builders.

With respect to land development, the primary difference between modular and HUD-Code housing manufacturers on the one hand, and site-builders on the other hand, is that merchant site-builders carry some costs related to the land for a period of time. In 1992, the latest year for which data is available, the U.S. Bureau of the Census reported that merchant builders (constructing homes on land they own and selling the land and structure as a package) accounted for two-thirds of all new, single-family units built.[29] Although developing and selling raw land can potentially be time consuming and costly, margins from the sale of land bought inexpensively and subdivided into lots for residential use can sometimes be higher than margins derived from construction and sale of homes per se. In such cases, residential development can be viewed as a process that creates value and greater margins from the eventual sale and development of land.

[29] Mark A. Calabria, "A Picture of the Construction Industry," *Housing Economics*, April 1997, p.5.

In recent years, some large production site-builders have acquired or developed partnerships with producers of HUD-Code homes. These high volume builders have a great deal of experience with land development and may view manufactured housing as a relatively inexpensive way to create value and ultimately improve the margins that can be derived from land. The cost and availability of raw land, however, is a limiting factor. Such a strategy makes little sense for expensive land in suburbs or central cities, which may require more expensive, often high-density residential or commercial uses to net significant margins. Developers of vacant land in these situations seem less likely to find HUD-Code homes a viable strategy.

Site-Work and Foundation. Even developed lots need excavation for footings and foundations in order to build a home. Site-builders who buy a developed lot are responsible for obtaining any required permits from the appropriate local officials for final grading, excavation for the footings and foundation, bringing utilities to the house, and all other construction activities. While there is no "installation" as such in site-built construction, the analogous activities (construction of the foundation and anchorage of the superstructure) are integral components of the construction of the house and the responsibility of the builder or general contractor.

4.4.2 Manufactured Housing

Land Development. Companies that produce manufactured homes have historically not dealt with land development or retailing and, therefore, have not borne any of the costs or captured the profits associated with land development. The ability of manufacturers to concentrate on production of homes unencumbered by dealings in land allowed producers to focus on what they knew best, but also resulted in lack of control over the disposition of the final product. HUD-Code homes also have historically been subject to zoning-based restrictions in many communities that tend to reduce the supply of suitable home sites.

Obviously every home needs to be placed in some suitable location, so the HUD-Code sector has dealt with this requirement in other ways. Full-service or turnkey retailers of HUD-Code homes buy, develop and sell land, and can package the ownership or rent of lots in scattered locations or in community parks as part of the home sale. They can also sell to customers that own their own land. Retail dealers can accomplish this since they arrange for most of the consumer financing of manufactured homes through individual banks and financing companies. According to an MHI Survey, in 1996 about 78 percent of loans and 80 percent of the dollars for manufactured housing loans were placed through dealers.[30] Other retail dealers either sell manufactured homes to customers that already own land, or can direct customers to owners of lots developed and zoned for manufactured homes, either scattered or located in community parks.

[30] Manufactured Housing Institute, "Manufactured Home Financing in 1996," p.5, based on a survey of 282 financial institutions.

There is reason to believe that producers of manufactured housing are expanding their role. Large manufactured home producers including Clayton Homes and Oakwood have already integrated to the retail level. Clayton, for example, engages in retailing and financing manufactured homes through 63 retail centers and is involved in land development through the operation of 67 manufactured home communities. Related industry developments involve the formation of alliances between large site builders and large manufactured housing producers that extend to the retail level. For example, Zaring and Champion Enterprises have formed a partnership to provide an exclusive branded product line of manufactured homes to Zaring Home Max super retail distributors. If large manufactured housing producers continue to vertically integrate with dealers and enter into ventures with single-family production builders who are also land developers, producers of manufactured housing may directly or indirectly gain more control over the land development process.

Site-Work and Installation. It is generally acknowledged that most consumer complaints regarding manufactured housing are ultimately related to installation and handling at the site.[31] Producers of manufactured housing are only rarely involved with installation at the site and the HUD-Code does not require monitoring or regulation of installation. Rather, HUD-Code producers deliver units directly to independent retail dealers or to dealer-developers that own parks or scattered individual lots. The dealer-developer will usually include the cost of installation as part of a unit's total cost package, and banks include an allowance in the consumer loan to cover installation. Independent retail dealers can contract for installation and related site services as part of the financial package or let the buyer contract for these site development services. The latter may be more likely if the buyer already owns land for placement of the unit. Full-service or turnkey dealers will not only install the unit by providing for anchoring and support, but may also perform site work such as grading, utility connections and landscaping. They can also add ancillary facilities such as garages, porches, and decks. Many dealer-developers or independent developer/owners who have parks for rent, lease, or ownership already have developed lots for rent or sale that only require connection of utilities once the unit is installed.

Section 305 of the HUD-Code requires each manufactured home to be capable of transmitting the design loads of the home to stabilizing devices. Section 306 requires that each home have provisions for support/anchoring or foundation systems that, when properly designed and installed, will resist overturning and sliding due to imposed design loads. Support and anchoring systems are required to be designed by a professional engineer or architect. Manufacturers are

[31] Ashok K. Goswami, "Installation of Manufactured Homes," National Conference of States on Building Codes and Standards, Inc., unpublished paper, 1997, p.1. Also see National Commission on Manufactured Housing, *Final Report*, 1994, p.55.

not required to provide or install the anchoring equipment or stabilizing devices, but must provide approved installation instructions specifying the location and required capacity of stabilizing devices as well as drawings and specifications for at least one acceptable anchoring method. Yet a report by the National Commission on Manufactured Housing indicates that the installation manuals prepared by engineers and provided by manufacturers may be too generic and difficult for some installers to understand.[32]

The HUD-Code does not require any field inspections of installed homes but leaves this up to state and local governments. State-level requirements for manufactured home installation are summarized in the right-hand column of Table 14 on page 55 above. Although not shown in the Table, the 27 states without statewide installation requirements accounted for about 39 percent of HUD-Code placements in 1995, while the 22 states with mandatory state-wide installation standards had about 58 percent of 1995 placements. This suggests that most HUD-Code homes are placed in states that have statewide installation standards. However, there are indications that even where HUD-Code home installations are regulated, inspections frequently are not performed.

Installation standards can come from various sources. For example, the CABO OTFDC has an optional appendix covering the installation of manufactured houses that are bought and owned with land and are therefore considered real property. Where adopted, this Appendix regulates locating, anchoring, utility connections and additions, and includes provisions for inspection. The extent of its adoption and enforcement is unknown. NCSBCS and MHI have also created a model "Manufactured Home Installation Program" for state use. The model program addresses installation, support and anchorage for the appropriate wind zone, and connections for electrical, plumbing, mechanical equipment and duct work. It requires installers to be licensed and requires a tracking system to assist in monitoring and regulating installations. The program also includes periodic inspections, an ongoing educational system for dealers, and financial protection for consumers in the form of a recovery fund. Although the model installation program appears to be targeted primarily for state use in an effort to preempt local regulation, nothing prevents local jurisdictions from having the authority to develop their own regulations for installation except in those states that have preemptive state regulation.

4.4.3 Modular Housing

Land Development. Modular manufacturers, like manufactured housing producers, have typically had little if any involvement in the land development process. Instead, the factories sell to independent or franchised builders, or to home buyers working with a general contractor or builder. In either case the purchaser is responsible for the land development function.

[32] National Commission on Manufactured Housing, *Final Report*, 1994, p.56.

Site-Work and Installation. Modular units are usually placed on conventional foundations, either crawlspaces or full basements, and are most commonly sold to builders representing customers with land or to third-party builders who own scattered lots. The builders are typically responsible for excavation, final grading, construction of a suitable foundation, and connection of utilities. Consequently, modular builders are subject to the same local regulation in these areas as site-builders.

Although modular producers do as much customization as they can in the plant, there is no requirement for modular units to be substantially complete when shipped to the site. Modular homes, moreover, are shipped in at least two sections and as many as four sections for a typical two-story house, all of which must be joined at the site. As a rule, therefore, siding on the gable ends and many other finishing details related to joining are installed at the site. Also, since modular units are sometimes regulated by different local codes and are designed to appeal to a higher-end market than manufactured homes, they are likely to have more customization in details and finishes, some of which may be performed at the site. The amount of such finish work, however, can vary markedly by producer.

Modular producers either provide a full line of services at the site as a so-called "turnkey operation," or only provide a "rough-set" of site services. In the rough-set, the modular producer provides a crane and its rough-set crew removes the units or boxes from the trailer, places them on the foundation, and seals the home so that it is weather-tight, while a builder does the finishing and the remaining site work (e.g., porch, deck, garage and landscaping). The turnkey producer, on the other hand, not only sets the unit but also does the finishing activities at the site including covering the marriage walls and installing such items as casement, tile work, siding on the gable ends and shutters.

Modular buildings that have already been inspected in-plant and certified according to state regulations and procedures are usually issued permits for site work by local enforcement agencies after local review of floor plans, elevations, plans for site-built construction and installation, and installation instructions. Local or state code officials defer to in-plant inspections and approvals but are responsible for inspecting work performed on site to determine whether it is in compliance with the applicable regulations.

4.4.4 Findings and Implications

Responsibility for land development is a major distinction between conventional home builders on the one hand and HUD-Code and modular producers on the other. Many site builders have expertise in dealing with complex land development issues, while factory producers specialize in unit construction and must rely on retailers or local builders to arrange for suitable sites. For

modulars this means private land suitable for placing the home, while for HUD-Code homes it means either a private lot where the home can be sited or an available rental spot in a manufactured home park. The separation of roles between producers and retailers that characterizes the HUD-Code and modular sectors may have helped to improve production efficiency, but problems relating to land can limit growth in both sectors. The land development process is also becoming much more complex, costly and time-consuming for all types of housing as a result of limited supply, environmental concerns, restrictive zoning and anti-growth sentiment. Yet the process of land development and creation of new subdivisions may offer the clearest opportunities for conventional builders and manufactured housing producers to work together efficiently.

CHAPTER 5

COMPARISON OF CODE REQUIREMENTS

5.1 INTRODUCTION

This chapter compares the technical requirements for building manufactured housing according to the HUD-Code, as revised through October 25, 1994, with comparable requirements typically applied to conventional site-built or modular homes. These include the building and electrical requirements for conventional single-family housing found in the 1995 CABO *One and Two Family Dwelling Code* (OTFDC), the plumbing requirements in the 1997 ICC *International Plumbing Code* (IPC), and the energy requirements in the 1995 CABO *Model Energy Code* (MEC). Other model codes that might sometimes be applied to site-built or modular homes are beyond the scope of this comparison.

There are various differences in coverage between the HUD-Code and the others reflecting the nature of the units produced. For example, the HUD-Code addresses structural features required for transportation while the other codes do not. However, the focus of this discussion is on technical differences in analogous building, plumbing, electrical and energy requirements. The goal is to identify provisions that are clearly different, summarize the differences, and assess the general extent to which they may be contributing to differences in production costs between HUD-Code homes and conventional single-family housing.

The HUD-Code is intended to present performance requirements wherever possible, while the CABO OTFDC is intended to contain prescriptive solutions. This complicates the comparison of HUD-Code provisions with CABO provisions in some cases. For example, CABO specifies that 2x4 studs in exterior walls supporting a roof shall not be spaced more than 24 inches on-center, whereas the HUD-Code specifies the various types of loads that a wall must withstand and the maximum deflections under those loads. HUD-Code manufacturers need not adhere to specific prescriptive values. They can perform load tests on complete wall assemblies to document compliance, and many alternative configurations could comply.

The four sections that follow compare building, electrical, plumbing and energy requirements. The first three sections review selected provisions in the HUD-Code that are more or less restrictive than those in CABO (or, for plumbing, the IPC). For the building requirements, general areas covered by one of the codes but not the other are also summarized. The final section compares energy requirements in the HUD-Code and the CABO MEC on an overall basis. More detailed comparative information is in Appendix A.

5.2 BUILDING REQUIREMENTS

5.2.1 General Findings

It is clear that there are many differences in building requirements between the HUD-Code and the CABO OTFDC that contribute to differences in the cost of construction of manufactured and conventional housing. On balance, while CABO is more stringent in more areas than the HUD-Code, the net cumulative effect of the differences between the two codes is more likely on the order of hundreds of dollars rather than thousands of dollars per unit. This generalization is limited to areas where the codes can readily be compared. In reality, the overall impact of switching codes on any given house or manufactured home depends on factors such as underlying design and the degree to which it is actually built to code minimums before the change or would be built to revised minimums after the change. For example, while it is clearly possible to build manufactured homes with 2x3 exterior walls, survey data indicates it is much more common for them to have 2x4 or even 2x6 walls.

One key difference between the technical requirements of the two codes is that the HUD-Code tends to rely more heavily on performance requirements and engineering analysis while the CABO code tends to present prescriptive solutions. The performance approach potentially allows HUD-Code housing producers more flexibility in compliance. Opportunities to make tradeoffs among different components of a structure and document compliance to general performance standards on an overall basis can permit HUD-Code producers to achieve cost savings greater than indicated by direct comparison of the code requirements. While CABO allows the builder the option to use performance standards contained in one of the other model codes, most site-builders lack the technical resources or volume of production to make this option attractive.

The HUD-Code is applied throughout the U.S., without local modification except for some loading conditions based on local conditions such as snow loads. The CABO OTFDC, on the other hand, is a model code adopted on a state or local basis, usually with amendments. Such amendments could affect the comparison and cost impact of differences.

5.2.2 Significant Differences in Building Requirements

Differences in stringency between the CABO and HUD-Code building-related sections that have the greatest potential impact on construction cost are listed below in Table 15 and further discussed in Appendix A, with highlights in this section. Many other differences exist in these two codes that may affect construction cost, but they are not listed or discussed since it was judged that their individual or collective impact would likely be minimal. Such differences include small variations that might apply to the majority of houses as well as larger differences

that would likely occur in relatively few houses. In some cases the impact that might arise is difficult to determine given the largely prescriptive nature of the CABO code and the performance nature of the HUD-Code. In such cases a manufacturer's actual construction practice to meet minimum requirements would have to be known to assess the cost impact in a given case.

Table 15: Differences in Stringency of Selected Building Requirements

HUD-Code More Stringent than CABO	CABO More Stringent than HUD-Code
Ventilation of kitchens, bathrooms and whole house	Artificial Light
Flame Spread of Kitchen Cabinets and Bathroom Fixtures	Minimum Room Sizes
Fire Protection of Kitchen Cabinets	Minimum Ceiling Height
Formaldehyde Emissions from Wood Products	Minimum Hallway Width
Separation of Combustion Systems from the Interior Atmosphere	Flame Spread and Smoke Developed Ratings of Insulation other than Foam Plastic
Deflection Criteria for Eaves and Cornices	Fire Detection Equipment
Floor Loads for Sleeping Rooms	Fire Protection of Roofs
Minimum Number of Egress Doors	Thickness of Gypsum Drywall
	Deflection Criteria for Floors, Exterior Walls, Headers, Beams, Girders and Ceilings
	Live Loads for Attics
	Exit Facilities: Required Door Size
	Seismic Loads and Seismic Construction Provisions

Selected Areas Where the HUD-Code is More Stringent than CABO. The most significant areas where the HUD-Code is more stringent than the CABO code are ventilation requirements, flame spread requirements, and the requirement to separate certain combustion systems from the interior atmosphere. The HUD-Code ventilation requirements call for mechanical ventilation in kitchens and bathrooms, as well as balanced whole-house mechanical ventilation. Compliance can generally be achieved with exhaust fans and passive components. The CABO ventilation requirements can be met with openable windows. The flame spread requirements in the HUD-Code explicitly limit the flame spread rating of certain interior finishes, particularly in kitchens and near water heaters. These requirements compelled greater use of gypsum drywall in manufactured homes, where paneling had previously been in widespread use. While the HUD-Code requirement is stricter, it would have little effect if applied to conventional homes where drywall finishes are standard practice. Finally, the HUD-Code requires certain combustion appliances (i.e., furnaces and water heaters) to be separated from the indoor atmosphere of the

dwelling unit. CABO permits atmospherically vented appliances except in unusually tight homes or confined spaces.

Selected Areas Where CABO is More Stringent than the HUD-Code. The most significant areas where CABO is more stringent than the HUD-Code include space planning, smoke detectors, deflection criteria for most structural members, seismic design requirements and minimum thickness of gypsum drywall. With respect to space planning, CABO generally requires larger room areas and dimensions, higher ceilings and wider halls than the HUD-Code. Imposing similar requirements on HUD-Code homes could have major adverse impacts on small units, especially single-sections. CABO also goes beyond the HUD-Code by requiring all smoke detectors to be interconnected with battery backup, and by calling for smoke detectors in every bedroom, with a clear impact on cost of conventional homes. The basic deflection criteria permitted for load-bearing structural members under CABO are more stringent than those in the HUD-Code. This makes the pre-calculated span tables in CABO for floor joists, ceiling joists, rafters, headers and beams more conservative than would be permitted under the HUD-Code. Because the underlying criteria are different it also means an engineered design in a HUD-Code home could be more economical to build than an engineered design meeting the CABO requirements. CABO includes provisions requiring homes in areas of high seismic risk to have increased amounts of structural bracing on exterior walls. The HUD-Code does not specifically address seismic risk. Finally, CABO requires 3/8-inch to 5/8-inch drywall throughout the building while the HUD-Code permits 5/16-inch drywall in all applications.

5.2.3 Differences in Coverage of Building Requirements

There are significant differences in topical coverage of the HUD-Code and the CABO building chapters as well. Each code has provisions for items that are not addressed in the other. Table 16 lists selected items of this type. The differences relate in some ways to production cost of both types of housing, but are unlike those listed in Table 15 because they do not really represent alternative requirements so much as they reflect differences in the nature of the units themselves. A notable example is the requirement of a structural chassis in manufactured homes. A chassis is essential to units that are designed to be towed for transport, but would be irrelevant for conventional construction. However, CABO does have requirements for many features that could be and often are built on site in manufactured homes, such as stairs, railings and decks or even foundations. In principle, local codes (e.g., CABO) would apply when such items are added to a manufactured home at the time it is sited or afterwards, but some code officials express concern about any assertion of jurisdiction over HUD-Code housing and the resulting degree of enforcement in practice is uncertain.

Table 16: Differences in Coverage between HUD-Code and CABO Building Requirements

Covered in HUD-Code but Not in CABO	Covered in CABO but Not in HUD-Code
Hitches	Foundations
Chassis or Permanent Mainframe	Stairways
Bottom boards	Ramps
	Handrails and Guardrails
	Dwelling Unit Separation
	Concrete Floors
	Masonry Construction
	Details for Various Exterior Wall and Roof Coverings and Fireplaces
	Radon
	Decay
	Termites
	Garages

Selected Areas Covered by CABO but not by the HUD-Code. Some of the items covered by CABO but not by the HUD-Code do not apply to manufactured housing as built in the plant (e.g., concrete floors, garages, and dwelling unit separation), so no comparison is possible. Local codes may address these or other items when, for instance, stairs, handrails, guardrails or garages are added on-site. The CABO foundation requirements could also be applied to manufactured houses installed on permanent foundations. On the other hand, no site-built or modular house would ever be permitted to be installed on-site in the same manner as most manufactured houses. If installation requirements for all manufactured houses were similar to the foundation requirements of CABO, thousands of dollars of cost would be added to manufactured houses. The cost impacts of permanent foundations for manufactured homes are further discussed in Chapter 6.

Selected Areas Covered by the HUD-Code but not by CABO. Requirements that are unique to the HUD-Code add cost to manufactured housing compared with site-built housing. The chassis and bottom boards are necessary for transportation and must be permanently affixed to a home. The "permanent chassis" requirement distinguishes manufactured housing from modular housing. Nevertheless, some modular units are produced on the same production lines as HUD-Code homes, and in the interest of economy also are produced with some form of chassis that is technically permitted to be removed on site. This difference between “modular” and “HUD-Code” in such cases becomes less a matter of physical construction and more one of the manufacturer’s choice between certification under the HUD-Code or the applicable code for modular buildings.

A permanent chassis was originally deemed a necessary requirement under the HUD-Code to permit the manufactured home to be mobile (i.e., capable of being moved to and removed from any location). The chassis is a permanent main frame typically consisting of two steel I-beams running lengthwise along the unit, to which the axles and wheels are attached. While the steel I-beam chassis is most common, the chassis can be made of wood, steel or other materials so long as it serves the intended purpose of supporting the home during transport and final installation. When the manufactured unit is placed at the site the wheels and axles are removed but the integral chassis remains permanently on the unit. The chassis then is typically supported on piers which, in turn, rest on pads or footings. Since the vast majority of manufactured homes remain where they are first placed, the manufactured home industry has argued that the added cost of a permanent (i.e., non-removable) chassis is no longer necessary. The size, shape and structure of the chassis can limit design flexibility for manufactured homes by not allowing (or significantly complicating) placement in a multi-story unit or on a full-basement foundation. On the other hand, steel chassis I-beams permit the use of smaller floor joists in manufactured homes, a potentially significant offset to the cost of the chassis.

5.3 ELECTRICAL REQUIREMENTS

5.3.1 General Findings

The Electrical Systems provisions in Subpart I of the HUD-Code were compared with the CABO OTFDC requirements as amended in 1996 to reflect the 1996 *National Electrical Code* (NEC) requirements. Electrical requirements of the CABO code and the HUD-Code are generally similar since both are largely based on the NEC, but the HUD-Code continues to reference an earlier edition of the NEC (1993). Most of the differences that were identified would tend to increase cost for units built under CABO compared to units built under the HUD-Code. As with other aspects of this code comparison, some of the differences in the code are a reflection of differences in the basic structure of the house types. For example, the HUD-Code allows for non-permanent cord-cap connections for homes with a calculated load not exceeding 40 amps. Such a low calculated load would rarely if ever be encountered for site-built housing but might be achieved in the smallest HUD-Code homes. Similarly, there is no point in a non-permanent electrical service connection except in a structure that is designed to be transported.

The electrical provisions in the CABO code are essentially a compilation of those NEC provisions that apply to one- and two-family dwellings. Use of identical language minimizes any ambiguity in the relationship between CABO and the NEC. CABO also states that omission of any material or method from the CABO code provided for in the NEC must not be construed as prohibiting the use of such material or equipment, and that items not specifically covered by the CABO code shall comply with the NEC.

Section 3280.801 of the HUD-Code incorporates the 1993 NEC with the following language:

> "Subpart I of this standard and Part A of Article 550 of the National Electrical Code (NFPA No. 70-1993) cover the electrical conductors and equipment installed within or on manufactured homes and the conductors that connect manufactured homes to a supply of electricity.
>
> "In addition to the requirements of this standard and Article 550 of the National Electrical Code (NFPA No. 70-1993), the applicable portions of other Articles of the National Electrical Code shall be followed covering electrical installations in manufactured homes. Wherever the requirements of this standard differ from the National Electrical Code this standard shall apply."

In other words, the HUD-Code takes priority over the NEC in the event of any conflict, but Part A of NEC Article 550 is specifically incorporated and the other applicable sections of the NEC must also be followed. The term "applicable portions" presumably is intended to exclude specific requirements that might govern special installations, such as for health care facilities.

This particular approach requires some interpretation in cases where the HUD-Code is silent on an issue addressed by the NEC. The question is whether silence on an issue in the HUD-Code means that the NEC requirement is to be excluded or in fact required. Several things must generally be considered to determine which requirements apply. The HUD-Code takes precedence if it speaks directly to an item. If not, then Article 550 of the NEC takes precedence. If Article 550 is silent, then reference is made to the complete NEC. For example, the HUD-Code provides a list of required locations for receptacle outlets in section 3280.806(d) that permits a bathroom receptacle to be integral with the light fixture over the bathroom basin. Even though this practice is not permitted in the NEC, it is clearly allowable for HUD-Code homes. By contrast, since the HUD-Code does not address the issue of required light fixtures or switched receptacles at all, the NEC provisions on that subject are presumed to apply.

5.3.2 Significant Differences in Electrical Requirements

This section lists differences between the CABO and HUD-Code electrical requirements that have the greatest potential impact on construction cost, and summarizes the differences judged most significant. A list of differences appears below in Table 17. Highlights from the Table are summarized in this section, and the table entries are discussed in more detail in Appendix A. Various other differences between electrical requirements of the two codes that may affect construction cost are not listed or discussed since their individual or collective impact was judged likely to be minimal.

Table 17: Differences in Stringency of Selected Electrical Requirements

HUD-Code More Stringent than CABO	CABO More Stringent than HUD-Code
Placement of Electrical Receptacle near Bath or Shower	Required Electrical Receptacle Locations
Type of Wire/Conductor Allowed	Required GFI Locations
Wire Protection	Required Electrical Service Connection
Electrical System Testing	Required Electrical Service Size
	Panelboard Location
	Weatherproof Fixtures

The most significant difference where the HUD-Code is more stringent is the requirement for metal conduit on under-chassis line voltage wiring. This provision may reflect special concern about potential damage during transportation. The most significant differences where CABO is more stringent are the added locations where electrical receptacles are required, the broader requirements for ground-fault circuit interrupters in kitchens under CABO and the smaller minimum electrical service size potentially achievable under the HUD-Code.

5.4 PLUMBING REQUIREMENTS

5.4.1 General Findings

Differences in plumbing code requirements between manufactured housing and site-built housing were identified by comparing the requirements and provisions of Subpart G of the HUD-Code with those of the 1997 ICC *International Plumbing Code* (IPC). The comparison focuses on the technical requirements for plumbing design and installation in single-family homes, including piping materials, sizes and configurations, fixtures and fittings, and plumbing appliances. The IPC is a relatively new code promulgated by the three U.S. model code organizations as part of an effort to integrate the model codes. Although not yet widely used, the IPC was selected for this comparison because it resolves differences between the three major plumbing codes and offers the broadest base for future acceptance across the U.S.[33]

[33]The plumbing provisions in Chapters 29-38 of the CABO OTFDC were also considered as a basis for comparison, as well as those in the IAPMO *Uniform Plumbing Code*. Even though CABO is specific to housing, the plumbing section of the CABO code was not used because it has not been widely adopted. The CABO plumbing provisions as amended through 1998 are generally quite consistent with those in the IPC, so the impact of using the most recent CABO would be limited. By contrast, use of the *Uniform Plumbing Code* as the baseline for comparison would be relevant in many areas, particularly in the western states, and such a comparison would clearly identify many other plumbing requirements for site-built construction that exceed those in the HUD-Code.

Plumbing requirements in the HUD-Code are more narrowly focused than those in the IPC, since the HUD-Code is specific to manufactured homes while the IPC applies to all building types and occupancies. The IPC therefore addresses many highly specialized plumbing installations as well as site installations such as sewers, water service and storm drainage. This comparison is therefore limited to specific requirements found in the HUD-Code and comparable requirements of the IPC.

The requirements of the two codes for single-family homes are generally similar. Differences that were identified more often tend to increase costs for houses built under the IPC relative to houses built under the HUD-Code, but as with other parts of the code the incremental cost impact would more likely be hundreds of dollars than thousands of dollars per new home. And while the HUD-Code provisions are for the most part less restrictive than those in the IPC, the wider choice of alternatives in the IPC for venting systems in particular provides options not explicitly available in the HUD-Code. Referenced standards in the IPC are also more complete and up-to-date than standards referenced in the HUD-Code.

5.4.2 Significant Differences in Plumbing Requirements

This section summarizes differences between the HUD-Code and the IPC that were judged most likely to have an impact on construction cost and most relevant for this comparison. A list of the significant differences identified during this review appears below in Table 18. The more important differences are highlighted in this section. More detailed comparisons appear in Appendix A.

Table 18: Differences in Stringency of Selected Plumbing Requirements

HUD-Code More Stringent than IPC	IPC More Stringent than HUD-Code
Water Supply System Test	Shower Size Requirements
Venting: Vent Terminals	Clothes Washer Connection
Venting: Anti-siphon Trap Vents	Pressure Balancing/Thermostatic Mixing Valves
Venting: Wet Vents	Water Distribution Pipe Sizing
Venting: Engineered Vent Systems	Water Heater Specifications
Trap Arm Length for 1-1/2 inch and Larger Drains	Pipe Support
	Water Shut-off Valves
	Drainage Pipe Sizing
	DWV System Test
	Trap Arm Length for 1-1/4 inch Drains

HUD-Code More Stringent than the IPC. The most important areas where the HUD-Code is more stringent than the IPC relate to venting of plumbing fixtures. The IPC permits greater use of anti-siphon valves for venting. The IPC also has less restrictive criteria for wet venting and specifically covers waste stack vents, common vents and other configurations not described in the HUD-Code (although these variations may be generally more relevant to multi-story homes than to HUD-Code homes). Finally, the IPC contains criteria for engineering vent systems that have the potential to considerably reduce vent sizes. While engineered venting would ordinarily not be economical to use in conventional homes, it could find application in mass-produced HUD-Code homes. However, this difference may be more apparent than real since it is possible that engineered venting would also be permitted in HUD-Code homes under the general performance provision of section 3280.10, "Use of alternative construction."

IPC More Stringent than the HUD-Code. Requirements in the IPC that are more stringent than those in the HUD-Code and were judged most significant include the requirement for a master pressure balancing valve in each home (this is not addressed in the HUD-Code), the sizing criteria for water distribution pipes (larger supply pipes are required under the IPC than the HUD-Code), water heater installation requirements including drain pans and extensive criteria for relief valve termination not found in the HUD-Code, additional water shut-off valves required under the IPC, and more conservative drainage pipe sizing criteria.

5.5 THERMAL REQUIREMENTS

5.5.1 Comparison Methodology

The HUD-Code has its own unique set of thermal requirements that were revised in 1994. They are expressed as a maximum overall U-value (U_o) for the entire building envelope (ceiling, walls, windows and floors but not including air infiltration) for each of three climate zones. The HUD climate zones are divided along state boundaries. The maximum allowable U_o drops from 0.116 Btu/hr·ft2·°F in Zone 1 (Alabama, Florida, Georgia, Hawaii, Louisiana, Mississippi, South Carolina and Texas) to 0.096 Btu/hr·ft2·°F in Zone 2 (Arizona, Arkansas, California, Kansas, Kentucky, Missouri, New Mexico, North Carolina, Oklahoma, and Tennessee) and 0.079 Btu/hr·ft2·°F in Zone 3 (all remaining states).

Appendix E of the CABO OTFDC references the 1995 CABO *Model Energy Code* (MEC) for energy conservation requirements. Therefore, the 1995 MEC is used as the reference point for conventional single-family homes in this comparison. CABO MEC requirements are presented in a U_o format that varies with location, based on heating degree-days (HDD) base 65° Fahrenheit. However, under the MEC the U_o requirements vary from one building envelope component to another rather than being specified for an entire building shell, so in effect the permitted U_o depends on the geometry of the building envelope (i.e., the relative areas of walls,

ceilings and floors or foundation assemblies) as well as the location. Also, unlike the HUD-Code, the MEC requirements vary continuously with HDD rather than changing abruptly at state lines or zone boundaries.

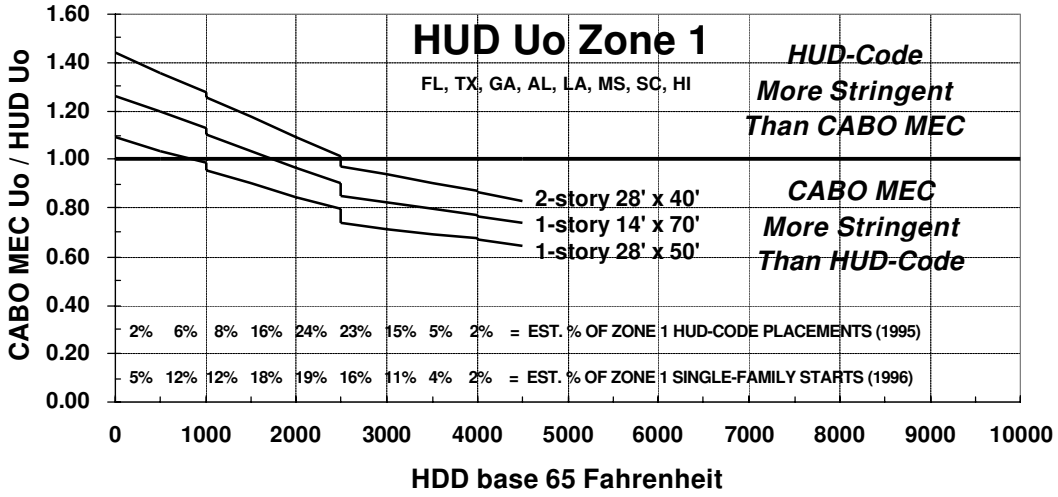
A simplified overall comparison of the thermal envelope standards in the HUD-Code and the 1995 CABO MEC was developed for this report. The HUD-Code thermal Zones tend to represent increasing numbers of degree days, but there is considerable overlap due to the wide HDD variations within states included in each Zone. Therefore, the results depend to some extent on the specific heating degree day value chosen within any zone. The comparison was developed for three prototype house geometries:

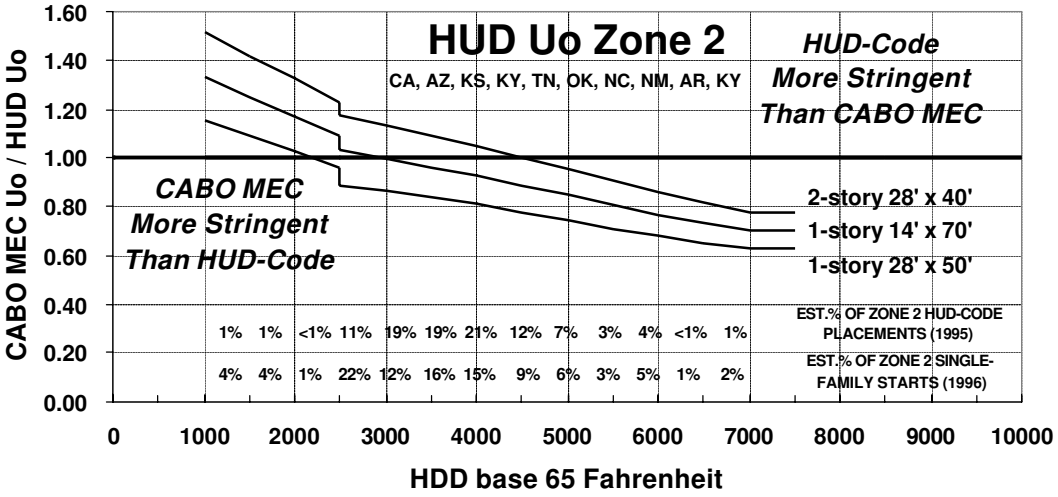
- *Double-wide/ranch house prototype:* a one-story home measuring 28 x 50 ft., representing either a double-wide HUD-Code home or a site-built ranch house,
- *Single-wide prototype:* a one-story home measuring 14 x 70 ft, representing a single-wide HUD-Code home without any corresponding site-built model, and
- *Two-story prototype:* a two-story home measuring 28 x 40 ft., representing a site-built home without any real counterpart among HUD-Code homes.

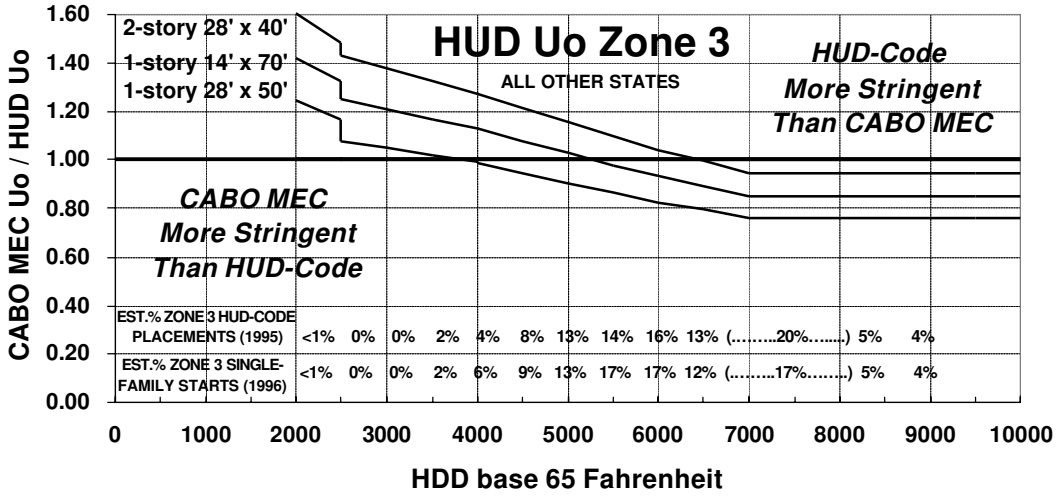
These prototypes were chosen in part to show the sensitivity of the comparison to the geometry of the home under consideration, and in part to allow the comparison to be done symmetrically. That is, using these prototypes allow the impact of building typical HUD-Code homes to the CABO MEC envelope requirements to be assessed as well as the impact of building typical site-built or modular homes to the HUD-Code energy standards. Small changes in the dimensions of any prototype would have very little effect on the comparison.

Each prototype was assumed to have an insulated floor as would be typical for HUD-Code homes and site-built homes on crawl spaces or unconditioned basements. All prototypes had 8-foot walls for each story. Duct insulation was not considered. The MEC U_o requirement for these homes in any HDD location can be computed based on measured envelope areas, and then compared to the HUD-Code requirements over the range of HDD values in each of the HUD-Code U_o zones. The variable of interest for each prototype and HDD value is the ratio of the maximum U_o permitted under the CABO MEC to that permitted under the HUD-Code. The higher the maximum U_o value permitted, the lower the insulation requirements. When the U_o ratio is greater than 1.00 it indicates that the HUD-Code is more stringent than the CABO MEC. When the U_o ratio is less than 1.00 it indicates that the CABO MEC is more stringent than the HUD-Code. The U_o ratio is plotted for each of the three prototypes in each Zone as a function of HDD. Results of the comparison are presented on separate graphs for HUD U_o Zones 1, 2 and 3 in Figure 16 below.

Figure 16: Comparison of HUD-Code and 1995 CABO MEC Thermal Requirements







The heavy horizontal line near the middle of each graph in Figure 16 represents cases where the HUD-Code and CABO MEC have the same U_o requirements (i.e., the U_o ratio is exactly 1.00, so the requirements are considered equivalent). At the bottom of each graph, estimated percentages of HUD-Code placements and single-family housing starts for the Zone are listed by degree-day band.[34] These percentages are included to give some idea which parts of each graph (i.e., which ranges of degree-day values) are most relevant in actual practice for the different prototypes and zones.

5.5.2 General Findings

As revealed by the three graphs in Figure 16, results of the comparison vary significantly by HUD-Code Zone and prototype geometry. At one extreme, the ratio exceeds 1.60 for the two-story prototype in the mildest part of the most northern Zone 3 (HUD-Code substantially more stringent), while at the other extreme the ratio falls to just over 0.60 for the double-wide/ranch house prototype in the coldest part of the intermediate Zone 2 (CABO MEC substantially more stringent). For each prototype and each Zone, the HUD-Code requirements are more stringent than the CABO MEC requirements in the mildest part of the Zone, the CABO MEC requirements are more stringent than the HUD-Code requirements in the coldest part of the Zone, and the two are equivalent at some point in between. A more detailed summary by Zone and prototype is below.

Results for Zone 1. This Zone includes 8 states and extends from 0 HDD to over 4000 HDD. About 38 percent of all 1995 HUD-Code placements and 28 percent of all 1996 single-family starts were in Zone 1.

- *Double-wide/ranch house prototype:* The HUD-Code is more stringent than CABO MEC only up to 1000 HDD (about 8 percent of Zone 1 HUD-Code placements and 17 percent of Zone 1 single-family starts) and less stringent elsewhere.
- *Single-wide prototype:* The HUD-Code is more stringent than CABO MEC up to almost 2000 HDD (about 32 percent of Zone 1 HUD-Code placements) and less stringent elsewhere.
- *Two-story prototype:* The HUD-Code is more stringent than CABO MEC up to about 2500 HDD (about 66 percent of Zone 1 single-family starts) and less stringent elsewhere.

[34] The estimated percentages of placements and single-family starts by Zone were derived using 1995 Bureau of the Census "Annual Mobile Home Supplement" data on placements by state, Census data for site-built housing starts by state, and the proportions of counties in each state assigned to specific HDD bands in materials developed by the DOE Pacific Northwest National Laboratory for use with the CABO MEC "MECCheck" compliance materials. For each Zone, the single-family starts and HUD-Code placements within each state in the Zone were apportioned equally across all counties in the state, then tabulated by HDD-band.

Results for Zone 2. This Zone includes 10 states and extends from below 1500 HDD to over 7000 HDD. About 30 percent of all 1995 HUD-Code placements and 25 percent of all 1996 single-family starts were in Zone 2.

- *Double-wide/ranch house prototype:* The HUD-Code is more stringent than CABO MEC only up to about 2250 HDD (about 2 percent of Zone 2 HUD-Code placements and 9 percent of Zone 2 single-family starts) and less stringent elsewhere.
- *Single-wide prototype:* The HUD-Code is more stringent than CABO MEC only up to about 3000 HDD (about 13 percent of Zone 2 HUD-Code placements) and less stringent elsewhere.
- *Two-story prototype:* The HUD-Code is more stringent than CABO MEC up to about 4500 HDD (about 74 percent of Zone 2 single-family starts) and less stringent elsewhere.

Results for Zone 3. This Zone includes 32 states and extends from below 2500 HDD to over 10,000 HDD. About 32 percent of all 1995 HUD-Code placements and 47 percent of all 1996 single-family starts were in Zone 3.

- *Double-wide/ranch house prototype:* The HUD-Code is more stringent than CABO MEC only up to about 4000 HDD (about 3 percent of Zone 3 HUD-Code placements and 3 percent of Zone 3 single-family starts) and less stringent elsewhere.
- *Single-wide prototype:* The HUD-Code is more stringent than CABO MEC up to almost 5500 HDD (about 28 percent of Zone 3 HUD-Code placements) and less stringent elsewhere.
- *Two-story prototype:* The HUD-Code is more stringent than CABO MEC up to about 6500 HDD (about 68 percent of Zone 3 single-family starts) and less stringent elsewhere.

Overall Results. General conclusions based on results for all three Zones are as follows:

- *Double-wide/ranch house prototype:* CABO MEC is more stringent than the HUD-Code about 80 to 95 percent of the time, based on HUD-Code placements and single-family housing starts.
- *Single-wide prototype:* CABO MEC is more stringent than the HUD-Code about 65 to 85 percent of the time, based on HUD-Code placements.
- *Two-story prototype:* The HUD-Code is more stringent than CABO MEC about 65 to 75 percent of the time, based on single-family housing starts.

These conclusions hold true regardless of the Zone, although the magnitude of the differences vary by Zone. On balance this indicates that applying CABO MEC to HUD-Code homes would represent an increase in stringency, particularly for double-wides, while applying the HUD-Code to conventional single-family homes would increase stringency compared to CABO MEC for two-story homes and decrease it for one-story homes.

Differences in results for the three prototypes are driven primarily by the differing ratios of wall area to floor and ceiling area. Under CABO MEC, the allowable overall wall U-value is higher than the allowable value for other components, because window area and performance are included as part of the evaluation of overall wall thermal performance. Therefore, prototypes with larger ratios of wall area to ceiling and floor area (such as 2-story homes) tend to have higher allowable overall envelope U_o requirements under CABO MEC than other prototypes. By contrast, under the HUD-Code the permitted U_o for the whole building envelope is fixed within each zone and independent of the relative areas of wall and floor or ceiling. If window area tends to be a constant proportion of overall wall area, then the HUD-Code is least stringent for homes with smaller ratios of overall wall area to ceiling and floor area, such as the 28' x 50' single-story home (the double-wide/ranch house prototype). In this respect, CABO MEC is more flexible than the HUD-Code for houses with widely different designs. This is probably appropriate since in reality CABO MEC is more likely to be applied across a broader range of building geometries than the HUD-Code.

5.5.3 Other Differences between the HUD-Code and CABO MEC

Some other differences should be noted in this comparison, each of which tends to make the HUD-Code requirements less stringent or less costly to comply with than the CABO MEC requirements. The first is that the HUD-Code references the 1989 edition of the ASHRAE *Handbook of Fundamentals* for thermal calculations, while the 1995 MEC references the 1993 edition of the ASHRAE Handbook. One difference between the two Handbook editions is that the 1989 version specifies use of a 15 percent "framing factor" for wood frame walls with studs at 16 inches on center, while the 1993 edition raises this framing factor to 25 percent for 16-inch stud spacing.[35] The impact of this revision is that a given level of wall cavity insulation (say, R-13) corresponds to a lower U-value for the opaque wall assembly under the HUD-Code than under the 1995 MEC. In other words, even if the HUD-Code and CABO MEC were "equivalent" in that they required exactly the same U-value for walls, compliance can potentially be achieved with less insulation R-value under the HUD-Code than under the CABO MEC.

A related difference is that the CABO MEC requires fenestration products (windows, glazed doors and skylights) to have U-value ratings either certified on the basis of a standard developed by the National Fenestration Rating Council or taken from a default table limited to a small number of "site-verifiable" product variations representing near worst-case performance, while the HUD-Code permits assignment of U-values to glazed products based on more comprehensive listings in the 1989 ASHRAE *Handbook of Fundamentals*. The effect is to essentially require use of NFRC-rated products in cold climates under the CABO MEC, while providing

[35] The "framing factor" is the proportion of wall area assumed to be occupied by studs, plates, headers and blocking, and therefore not available for wall cavity insulation.

considerable additional flexibility to manufactured housing producers in all climates under the HUD-Code.

A final feature of the HUD-Code that is important for this comparison is that 24 CFR 3280.508(d) provides a very simple, easy-to-use method to "trade off" high-efficiency heating and air conditioning equipment for reduced levels of envelope insulation. This innovative provision increases opportunities to minimize the cost of compliance compared to the baseline HUD requirements or CABO MEC. While chapter 4 of the CABO MEC theoretically permits such tradeoffs, in practice the code provides no simple way to use equipment efficiency tradeoffs for compliance. This makes the opportunity of little use to site builders without specialized and costly house-by-house analysis that makes the procedure impractical.

CHAPTER 6

COMPARATIVE COST ANALYSIS

6.1 INTRODUCTION

This chapter analyzes and compares the relative in-place costs of site-built, modular and manufactured homes as they are or might be experienced by purchasers and the various actors involved in the construction of new housing. Three basic approaches are used. Under the first approach, costs and sales prices of typical homes in each category of housing are reduced to a common format that simplifies comparison. Total sales price for each type of unit is derived based on construction costs for the structure and foundation; land costs based on density, improved lot costs and site preparation; overhead and administration costs including marketing and sales, profit, construction financing and inventory financing; and delivery and set-up costs for industrialized housing. Under the second comparison, several adjustments are made to the average numbers in order to make the house/land "products" more closely comparable. This is done by normalizing construction costs to a per-square-foot basis by housing type, applying them to identical house sizes, and imputing similar land and foundation costs. The first two comparisons are presented and discussed together in sections 6.2 and 6.3.

The third comparison is an extension of the second comparison that specifically addresses financing effects, and appears in section 6.4. Adjusted sales prices are used to estimate the total monthly payments required of consumers for each type of housing using different assumptions as to tenure, loan type and loan terms. The corresponding initial cash outlays for down payment, closing costs, taxes and security deposit are also presented. Finally, section 6.5 uses the comparisons to summarize the incidence of cost on various actors and develop implications for the competitive position of each type of housing. Appendix B of the report gives more details about how costs in the principal tables of this chapter were calculated.

Many specifics appearing in the comparisons of this chapter reflect basic differences in the way each type of home is produced and sold, as discussed throughout the report. Manufactured homes, for example, are required by the HUD-Code to be substantially complete when shipped from the factory. They are often delivered to a retailer for inspection or temporary storage during site preparation, although they may be delivered directly from the factory to the site. Once the home has been towed to the site and rolled into place, the foundation is installed. Utility hook-up and exterior and interior finishes for marriage walls of double-section units are performed after placement.

Modular homes are ordinarily 85 to 95 percent complete when they leave the factory. Required site work for modular houses typically includes installation of HVAC equipment, interior and exterior finishes for marriage walls and floors, utility hook-up and additional elements such as roofs, garages, and decks. The modular producer may offer the homes as a turnkey operation,

installing and completing the finishes at the site while builders excavate and prepare the foundation, or may simply deliver and join the factory modules at the site and leave the necessary finish materials for the builder to install. In either case, modular homes usually do not pass through dealer lots. They are most commonly shipped directly to the home site on a truck bed and installed with a crane upon arrival. Direct shipment of modular homes from the factory to the site minimizes the truck and crane use/rental period and allows builders to take advantage of the storage space at the plant.

Builders of site-built homes, whether building speculatively or for a home buyer, will acquire a building permit and manage the construction of a home from excavation and foundation to the sale and final walk-through with the home buyer. Builders typically coordinate the permits, code inspections, trade contractors, and building materials delivery during construction of a house.

6.2 HOUSING COST ANALYSIS

Table 19 and Table 20 present comparisons of costs and prices for three housing types: site-built, modular and manufactured. Manufactured homes are further differentiated according to whether they are placed on private land or in land-lease rental communities. Two types of private land options are presented. Manufactured double-section homes can be placed on individually-owned private land located in scattered parcels or, less commonly, on lots in fee-simple subdivisions. Alternatively, they can be placed in land-lease communities or parks owned by one party and subdivided into rental spaces or lots for placement of homes. Land-lease options are further differentiated according to whether such placements involve single- or double-sections. A total of six housing/land types are included in each Table.

Table 19 gives the comparison of "average" or typical homes across a range of scenarios, to serve as a starting point. The six cases presented include site-built, modular, and manufactured homes as commonly built today with standard land placement options. Financing arrangements for each home as used in a subsequent section of this chapter are also noted. The cases presented are:

1. *Site-built Single-Family Detached Home*: A typical 2 story design with 1,990 square feet on a slab foundation, built on a 1/4-acre private lot.[36] The home is assumed to be financed with a 30-year conventional mortgage at an 8 percent interest rate.
2. *Modular Home:* The size, height, land characteristics and financing of the modular are assumed to be the same as for the site-built home.
3. *Manufactured Double-Section on an Individual Lot:* A 1,680 square foot home installed on a masonry pier foundation, sited on a 1/2-acre private lot. The lot is larger because it is assumed to be located on inexpensive land outside urban areas, but its cost is assumed to be the same as for the site-built and

[36] The costs and features for site-built homes are derived from 1996 Bureau of the Census, *Current Construction Reports* and a 1995 National Association of Home Builders survey of builders' construction costs.

modular home. This home is assumed to be financed with land-in-lieu of a down payment and a 20 year loan at 8 percent interest.

4. *Manufactured Double-Section in a Fee-Simple Subdivision:* The same size double-section home is placed on a fee simple subdivision lot with a permanent foundation. Land is included in the sales price. The house is assumed to be financed by a real property loan with terms the same as for the site-built and modular homes.
5. *Manufactured Double-Section in a Land-lease Community:* The same size double-section home placed in an upscale landlease community, requiring a permanent foundation. The occupants pay rent for the site under a long term lease. The home is assumed to be financed as personal property with a 10 percent interest rate and a 15 year term.
6. *Manufactured Single-Section in a Land-lease Community:* A 1,215 square foot single-section home on a block pier foundation in a landlease community, financed with a personal property loan similar to that used for the double-section home in a landlease community.

The four manufactured home cases in Table 19 are intended to capture a range of real-world alternatives. Over one-half of new manufactured homes in 1996 were double-section homes, the median size was 1,680 square feet, and most were placed on block piers. The environment in which a home is placed, however, influences whether the home will be single- or double-section and the type of foundation. Homes placed on private land (individual lots) are more likely to be double-section while homes placed in land-lease communities may be either single-section or double-section.[37] Double-section homes placed in fee-simple subdivisions or modern, upscale land-lease communities are more likely to be installed on engineered permanent foundations that are more expensive than a typical masonry pier installation. They are costed in Table 19 at about $3,000, still only about one-half of the cost of a permanent foundation for the modular home and site-built home in that Table. Double-sections on individual lots and single-sections in land-lease communities are usually placed on less expensive block pier foundations. Land costs are included for manufactured homes on private land (cases 3 and 4) to simplify the comparison.[38]

Table 20 is an adjusted version of the comparison of average homes in Table 19. The costing has been modified in cases 1 through 5 (i.e., all but the single-section manufactured home) to standardize floor area at 2,000 square feet per home and to correct for differences in foundation and land costs. These adjustments have little impact on the site-built and modular home costs, but reduce the cost differences between the conventional homes and the manufactured housing options. Results from Table 19 and Table 20 are discussed in detail in the next section, and more information about the cost numbers in each table appears in Appendix B.

[37] The costs and features of manufactured homes are also derived from 1996 Bureau of the Census, *Current Construction Reports*. Overhead, administration, and financing costs are derived from George Allen, David Alley and Edward Hicks, *Development, Marketing, and Operation of Manufactured Home Communities*. Foundation and site preparation costs for manufactured homes were estimated using R.S. Means cost estimating guides.

[38] These land costs would be highly variable. One reviewer indicated these particular costs in Table 19 were too high, and suggested that more typical land costs for manufactured homes on private land would be $15,000 for an individual lot and $20,000 for a subdivision lot. Those values assume the owner performs much of the site preparation work and that the site is finished to lower standards than a builder would use.

Table 19: Comparison of "Average" Homes

Description:	Site-Built	Modular	Manufactured Homes			
	Two-Story	Two-Story	Double-Section	Double-Section	Double-Section	Single-Section
Square Feet:	1,990	1,990	1,680	1,680	1,680	1,215
Foundation:			Blocks	Permanent	Permanent	Blocks
	Private Land		Private Land		Landlease Community	
			Individual Lot	Subdivision		
Construction Costs	**$76,752**	**$65,239**	**$36,150**	**$37,650**	**$37,650**	**$21,650**
structure	$70,765	$59,253	$34,650	$34,650	$34,650	$20,850
foundation	$5,987	$5,987	$1,500	$3,000	$3,000	$800
cost per square foot	$38.57	$32.78	$21.52	$22.41	$22.41	$17.82
Land Costs	**$35,136**	**$35,136**	**$34,425**	**$34,881**	**$1,167**	**$711**
lot density	4 per acre	4 per acre	2 per acre	4-6 per acre	4-6 per acre	6-8 per acre
improved lot	$33,941	$33,941	$33,714	$33,714	--	--
site preparation	$1,195	$1,195	$711	$1,167	$1,167	$711
monthly land rent	--	--	--	--	$250	$200
Overhead/Administration	**$29,232**	**$27,517**	**$11,448**	**$20,179**	**$12,088**	**$7,035**
overhead & gen. exp.	$8,352	$6,459	$1,908	$3,363	$2,015	$1,172
marketing	$3,024	$2,584	$954	$1,682	$1,007	$586
sales commission	$4,752	$4,263	$1,431	$2,522	$1,511	$879
profit	$13,104	$14,211	$7,155	$12,612	$7,555	$4,397
Financing Costs	**$2,880**	**$1,292**	**$477**	**$841**	**$504**	**$293**
construction financing	$2,880	$1,292	--	--	--	--
inventory financing	--	--	$477	$841	$504	$293
TOTAL SALES PRICE	**$144,000**	**$129,187**	**$82,500**	**$93,551**	**$51,409**	**$29,689**

Table 20: Comparison of "Identical" Homes (same square footage and foundation cost)

COST CATEGORY	Site-Built	Modular	Manufactured Homes			
	Private Land		Private Land		Landlease Community	
			Individual Lot	Subdivision	Double-Section	Single-Section*
Construction Costs	**$77,140**	**$65,560**	**$47,277**	**$47,277**	**$47,277**	**$26,350**
structure	$71,123	$59,543	$41,260	$41,260	$41,260	$20,850
foundation	$6,017	$6,017	$6,017	$6,017	$6,017	$5,550
cost per square foot	$38.57	$32.78	$23.64	$23.64	$23.64	$21.69
Land Costs	**$35,314**	**$35,314**	**$35,314**	**$35,314**	**$1,201**	**$1,000**
improved lot	$34,113	$34,113	$34,113	$34,113	--	--
site preparation	$1,201	$1,201	$1,201	$1,201	$1,201	$1,000
monthly land rent	--	--	--	--	$250	$200
Overhead/Administration	**$29,380**	**$27,652**	**$14,644**	**$23,119**	**$14,932**	**$8,232**
overhead & gen. exp.	$8,394	$6,491	$2,441	$3,853	$2,489	$1,372
marketing	$3,039	$2,596	$1,220	$1,927	$1,244	$686
sales commission	$4,776	$4,284	$1,831	$2,890	$1,867	$1,029
profit	$13,170	$14,280	$9,153	$14,450	$9,333	$5,145
Financing Costs	**$2,895**	**$1,298**	**$610**	**$963**	**$622**	**$343**
construction financing	$2,895	$1,298	--	--	--	--
inventory financing	--	--	$610	$963	$622	$343
TOTAL SALES PRICE	**$144,728**	**$129,822**	**$97,845**	**$106,673**	**$64,032**	**$35,925**

* Square footage is 2,000 for all cases except the single-section home in a land-lease community (1,215 square feet)

6.3 GENERAL RESULTS AND COMPARISON BY COST CATEGORY

Of the six options presented in Table 19, the four manufactured homes have the lowest typical or unadjusted prices. The differences in sales prices reflect the size difference, the difference in construction or structure costs, the foundation type, and the land costs. The manufactured homes range from 21 to 65 percent of the cost of the new site-built home and from 23 to 72 percent of the cost of the modular home. The lower costs of manufactured homes are due to their lower construction costs and minimal land costs for the land-lease community homes. The calculated sales price of the modular home is approximately 90 percent of that for the site-built home, primarily due to lower structure costs from prefabrication.[39] The efficiencies of factory production are counterbalanced by the desire for modular producers to do more customizations to compete in a more upscale market, and the necessity to meet the requirements of varied local codes.

Even after standardizing the house area, land cost and foundation cost in Table 20, the manufactured home options continue to have lower adjusted prices. However, the differences between options are considerably reduced compared to the unadjusted comparison of Table 19. The following sections discuss relative costs by cost category as listed in the Tables.

6.3.1 Construction Costs

Construction costs include labor and materials for both the structure and the foundation. For site-built homes, all labor and materials are consumed on site. For factory-built homes, most labor and materials are consumed in the factory. Modular homes are 85 to 95 percent complete when they leave the factory while manufactured homes are approximately 98 percent complete. Factory-incurred overhead costs are embedded in the structure costs or invoice price that the modular builder or manufactured home retailer pays to the producer. The cost of additional construction of site finishes such as siding and roofing completion, interior finish of marriage walls and flooring, and site-built garages, however, is also included in the structure cost. Delivery and site setup are included in the sale prices of modular homes but are additional charges for the buyers of manufactured homes.

Foundation Costs. Foundation costs are shown as a separate line item for each house-land combination in Table 19 and Table 20. These costs include excavation, pouring of footers and erecting the foundation systems, but exclude the cost of land clearing. In reality they are included as part of the total sales price of site-built and modular homes but are a separate cost for

[39] Whether or not the price a modular home could be sold for would ultimately be lower than the price of a comparable site-built home is a function of market conditions and consumer perceptions of the relative desirabilities of stick-built versus modular construction.

buyers of manufactured homes. Site-built homes are most commonly built over slab foundations in milder climates and on basements in colder areas, with crawl spaces representing the third common option. Modulars typically must be placed on basements or crawl spaces.

In 1996 blocks were the most common type of foundation for both single-section and double-section manufactured homes, at 87 percent and 65 percent respectively.[40] This system consists of concrete block piers placed underneath the chassis and the marriage walls (for multi-section homes) as load-bearing supports. Depending on the soil conditions, the blocks may rest on footers of precast concrete, poured-in-place concrete, pressure-treated wood or other engineered systems. A vinyl or metal "skirt" usually surrounds the perimeter of the home to conceal the support system and simulate a foundation wall. Permanent foundations for manufactured homes are typically continuous concrete block or brick perimeter walls with concrete block or steel supports beneath the chassis and the marriage walls. Manufactured homes can also be placed on slabs, crawlspaces, or basements, although relatively few use these foundations because the steel chassis makes such placement difficult. Another option found in upscale subdivisions is an excavated foundation which allows the home to be set at grade level rather than several feet above. The manufactured home examples in Table 19 are placed on either block or permanent perimeter foundations.

The type of foundation used for a home is an important determinant of cost and selling price. Block pier foundations can cost about $800 for a single-section manufactured home, whereas a slab foundation, the least expensive and most common foundation for site built homes, costs nearly $6,000 for a 1,990 square-foot home. In the case of a double-section manufactured home, the foundation can cost 25 to 50 percent as much as a conventional home foundation, depending on whether the manufactured home is on a block foundation or on continuous perimeter walls. The cost of a foundation is not only affected by the square footage of the home, but also by the footprint, i.e., the foundation for a 2,000 square-foot two-story home is less expensive than that for a single-story home with the same floor area because the footprint is smaller. Illustrative costs of typical foundation options appear in Table 21.

[40] Bureau of the Census, *Current Construction Reports* Series C25, "Characteristics of New Housing: 1996".

Table 21: Foundation Cost for a 2,000 Square Foot Home

Type of Foundation	One-Story Home	Two-Story Home
Blocks (HUD-Code)	$2,000	N/A
Perimeter Foundation (HUD-Code)	$4,500	N/A
Slab-on-grade	$10,990	$7,014 *
Crawl space (concrete floor)	$12,704	$8,200
Basement (unfinished)	$18,362	$12,277

* This number differs from the value in Table 19 because it is derived from information in R.S. Means, whereas the cost in Table 19 is based on averages reported by builders.

Source: R.S. Means *Residential Cost Data 1997*.

Per-Square-Foot Cost. Differences in square footage clearly account for some of the overall construction cost differential between site-built, modular, and manufactured homes as shown in Table 19. Double-section manufactured homes average about 85 percent of the size of site-built and modular homes, and the average single-section is only about 60 percent of the size of site-built and modular homes. But there is much more at work than just unit size. The manufactured home costs in Table 19 range from $17.82 to $22.41 per square foot, compared with $32.78 per square foot for the modular and $38.57 per square foot for the site-built home. Even the square-foot costs are only averages based on real-world experience and do not necessarily represent homes built to identical specifications.

After adjusting foundation costs and square footage to reflect identically sized 2,000 square-foot units and eliminate the effect of differences in average size, the construction costs for a double-section manufactured home as shown in Table 20 are still 32 percent less than that of the modular home and 42 percent less than that of the site-built home. In this comparison, the structure costs for a modular home are about 15 percent less than that of a site-built home. These persistent differences essentially result from underlying differences in the per-square-foot cost of construction across the housing types.

There are several factors that likely contribute to these differences in square-foot production cost, as noted and discussed elsewhere in this report. Factory producers can take advantage of less skilled labor in areas with generally lower wage rates, and thereby can simultaneously reduce labor input and increase labor productivity. The cost of building materials is a large share of the cost of building any home, and large HUD-Code producers can negotiate lower prices for identical building materials than practically any site builder by purchasing in large quantities for delivery to centralized facilities. Factory producers are insulated from poor weather, vandalism and other variables that add cost to on-site production, and financing costs or carrying costs for homes that are rapidly made to order in a factory are less than those for site-built homes. These

points are discussed in Chapter 2. Furthermore, Chapter 3 documents the degree to which HUD-Code homes make more use of various lower-cost building products and materials than site-built or modular homes, as well as other differences in the level of amenities between conventional and HUD-Code homes that raise the per-square-foot cost of the former. Finally, the uniform, pre-emptive regulatory process applied to the HUD-Code sector appears to operate efficiently and at lower cost to the manufacturer than the regulatory system applied to site-built and modular homes, as described in Chapter 4, and the underlying HUD-Code requirements on balance tend to permit less costly designs than the prevailing codes for conventional homes, as summarized in Chapter 5. All of these differences enter into the per-square-foot cost of construction, and none of them are eliminated simply by standardizing new home size.

6.3.2 Land Costs

The sales price of a home is greatly influenced by the land upon which it home is built or placed and by whether the land is purchased or rented. Site-built and modular homes are almost always built on private land or in fee-simple subdivisions, but manufactured homes have more flexible placement options: private land, fee-simple subdivisions, or land-lease communities. These options are defined below:

> *Private land*: an individually owned lot upon which one home is placed or built.
>
> *Fee-simple subdivision*: a housing development in which homes and the underlying lots are sold as a combined unit (e.g., a subdivision of site-built homes).
>
> *Land-lease community*: a system of property development in which a relatively large parcel of land under one ownership is separated into lots for lease and placement of homes. Lease agreements can be short or long term (e.g., 1 year, or 40 to 100 years). Long-term leases usually involve a recorded leasehold ownership interest in the lot where the home is placed.[41]

The contribution of land cost to selling price of a new home varies with location and housing density or lot size. Table 19 lists average lot densities for the different home-land combinations. The lowest density occurs with manufactured homes placed on individual lots, because manufactured homes are often placed in rural areas where land is plentiful and relatively inexpensive. Site-built and modular homes are typically placed on quarter-acre lots while subdivisions of manufactured homes usually involve higher densities with lots ranging from one-quarter to one-sixth acre.[42] Land-lease communities also have high densities, ranging from one-quarter to one-eighth acre lots depending on the size of the homes. In California, where land is exceptionally expensive, some manufactured home communities have had densities as high as 17 lots per acre, although that is rare.

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[41] There is a great deal of variation in the use and meaning of "land-lease community." Some sources use this to apply to any rental community park while others tend to restrict the term to parks with long-term leases and an implied ownership interest.

[42] *American Housing Survey*, 1995

The land costs in Table 19 reflect *developed* land costs, i.e., land costs including the cost of improvements resulting from subdivision of property into individual lots, construction of roads and sidewalks, installation and connection of utilities, and other improvements that may be required by local regulations. Clearing and grading are itemized as "site preparation." For the homes placed on rental property in land-lease communities, the monthly land rent fee can be considered a surrogate for land cost. Rent, however, also includes property taxes and may also include sewer and water service, lawn care, snow removal, or access to community facilities.

The two homes placed in land-lease communities have the lowest land costs in both Table 19 and Table 20. Except for the site preparation for the foundation, these options do not require a large up-front payment from the home buyer for land that is normally required under other options, whether site-built, modular, and manufactured homes on privately-owned land. The monthly rental/lease fee for the lot is noted in each table but is not included in land costs.

The land cost for individually-owned lots or fee-simple purchases depends on the value of land and the size of the lot.[43] The examples in Table 19 and Table 20 reflect minimal differences in land costs for the various house types, but land costs do vary by region and have a large impact on the price of new homes. Land zoned for site-built homes is usually more expensive per acre than that zoned for manufactured homes, largely because site-built homes are zoned into more desirable locations. Zoning may also control the possible lot size: land zoned for manufactured homes is typically authorized for higher densities (4 units to as high as 17 units per acre) than land zoned for single-family homes (0.5 units to 5 units per acre). Housing density affects the ultimate cost of individual lots.

Differences in site preparation costs result from the type of foundation used. Block foundations have lower site preparation costs because they do not require continuous footers but simply a graded lot or pad. In the "average" examples in Table 19, site preparation for the block foundations is about 60 percent of the cost of permanent foundations for site-built homes. These differences are adjusted out in the "identical homes" comparison of Table 20.

6.3.3 Overhead, Administration and Financing Costs

In addition to the costs associated with the structure and the land on which a home is built or placed, the price of a home also includes builder or retailer costs of doing business. Breakdowns of typical percentage costs for overhead, administration, financing and related categories by type

[43] Land costs for site-built and modular homes are based on a percentage of sales price of the home with the land as derived from NAHB's Builder Survey of Construction Costs. Manufactured housing leased land costs were derived from the U.S. Bureau of the Census, *Characteristics of New Housing*.

of construction appear in Table 22, and are discussed in this section. They are the basis of several of the detailed costs included in Table 19 and Table 20.[44]

Table 22: Overhead, Administration, Financing and Related Costs as a Percent of Sales Price, by Type of Home

Type of Cost	Site-Built Home *Percentage of Sales Price Including Land*	Modular Home *Percentage of Sales Price Including Land*	Manufactured Home *Percentage of Sales Price Not Including Land*
Overhead and general expenses	5.8%	5%	4%
Marketing expenses	2.1%	2%	2%
Sales commission	3.3%	3.3%	3%
Profit	9.1%	11%	15%
Construction financing	2%	1%	--
Inventory financing	--	--	1%
TOTAL	**22.3%**	**22.3%**	**25%**

Source: George Allen, David Alley and Edward Hicks, *Development, Marketing, and Operation of Manufactured Home Communities*, 1994.

Overhead and General Expenses. Overhead and general expenses include items such as office space, office supplies, administrative and management staff, and company vehicles. The statistics in Table 22 shows that overhead and general expenses as a percentage of sales price are lower for modular and manufactured homes than for site-built homes. Much of the overhead cost incurred by site-builders is due to their reliance on specialized trade contractors for much of construction. On average more than 20 different subcontractors are required to build one home, and the extent of subcontracting has been increasing.[45] Almost two-thirds (63 percent) of builders subcontracted more than 75 percent of their construction in 1994, compared with 55 percent in 1987.[46] Subcontractors include their own overhead rates in their prices which may be higher because that they do not always have steady work. The site builder or general contractor spends a great deal of overhead time in coordinating trade contractors. They often hire a site supervisor to facilitate coordination among specialized crafts that do not normally communicate with each other and that defend their prerogatives in regard to the type and extent of work that they do. Hierarchical communication to workers on scattered sites is also sometimes difficult.

[44] The cost percentages were derived from a 1995 survey of builders performed by NAHB (for site-built homes) and from by George Allen, David Alley and Edward Hicks, *Development, Marketing, and Operation of Manufactured Home Communities* (for manufactured housing costs). Costs for modular builders were modeled on the site-built costs with adjustments for differences in construction and overhead costs.

[45] NAHB Builders Economic Council Survey, 1994.

[46] NAHB Building Industry Survey, 1994.

Top management must deal with a site supervisor, who in turn must communicate with subcontractor foremen rather than individual craftsmen on the job. This makes it difficult to manage and focus the work.[47]

Marketing Expenses and Sales Commissions. Marketing costs and sales commissions are also part of the builder's cost structure. The amount of money allocated for marketing and advertising homes in Table 22 is virtually the same for all three types of home, but can vary by builder, retailer, type of home, and the local housing market. Larger producers and retailers may spend more on advertising and marketing than smaller firms. For example, large modular producers may rely on an "exclusive" site builder as a sales representative that markets their homes. In cases where some vertical integration, licensing or franchising arrangement exists between the producer and a builder or retailer, the producer may allocate a portion of his overhead costs to advertising in support of the site builder or retailer.

The amount of commission paid on the sale of a home varies by type of home and the method of sale. An in-house sales representative will typically receive a lower commission than an out-of-house broker or independent real estate agent. Commissions can be as low as 1.5 percent or as high as 6 to 8 percent of a home's sales price. Average commissions were estimated to be just over 3 percent.

Profit. The largest single non-construction or land expense item is profit. Strictly speaking, of course, profit is not a cost or an expense. Rather it is the difference between total revenues and total costs, and represents a return on invested capital. For site-built and modular homes, profit accrues to the builder. For manufactured homes, some profit accrues to the producer as part of the cost of production, while additional profit goes to the home retailer. The separate profit for the factory producer of homes is included in the structure cost charged by the factory as part of the invoice or wholesale price to the retailer.

Note that profitability as represented in Table 22 reflects typical margins under average conditions. In reality profitability can and does vary dramatically from one home, firm or location to another depending on market supply and demand conditions. The higher profit rate for manufactured homes applies to a lower base sales price, so per-unit profits are lowest. Profitability for modulars is slightly above the rate for site-built homes, consistent with the idea that only some of the lower production cost will flow through into selling prices. To some degree modular producers may set prices to "meet the competition" and translate lower production cost into higher margins. Finally, inasmuch as profit represents economic return on invested capital, persistent differences in profitability across sectors of the industry can be

[47] NAHB Research Center, *Diffusion of Innovation in the Housing Industry*, November 1989, pp. 18-26.

expected to the degree that capitalization requirements and capital/output ratios vary between sectors.

Construction or Inventory Financing. All builders incur financing costs, but they are lower for modular and manufactured homes compared with site-built homes. Site-built homes can take three months or more to build and the builder's carrying costs during this period can be substantial. Manufactured home producers, on the other hand, typically build units on direct order from the retailer in about five days. As a result, the financing cost of operation and inventory is minimal for the producer, and much of the cost of inventory is shifted to the retailer. The cost of the retailer inventory of models used to sell homes is financed by banks through "floor financing," typically at 2 percent above prime, which is less expensive than construction loan financing for site builders.

Modular manufacturers are in a similar position to that of manufactured home producers, but their period of construction is slightly longer and more complex due to the amount of customization and possible variation in local codes. Modular builders need fewer draws from the bank than site builders and are able to build a home over a shorter finance period, making it less expensive to borrow money for financing construction.

Marketing and sales commissions are about the same for all three types of housing, but profits are noticeably higher for modular and manufactured homes compared with site-built homes. The profits for modular builders and manufactured home retailers as a share of total sales price are higher as a result of a combination of lower construction costs and overhead and financing expenses. Site-builders are known to have a relatively low ratio of profit to sales due to structural characteristics of the industry explained above in regard to overhead costs.[48]

6.4 CONSUMER FINANCING

6.4.1 Financing Options and Analysis

The comparisons of the previous section have focused on total price for a single new home as if the home was being purchased in an all-cash transaction. They have not reflected any other complications introduced by the fact that homes are generally financed with long-term loans. As viewed by most owners or potential buyers, housing costs consist of an up-front charge for down payment and settlement, followed by a stream of future expenses for debt service. This section takes the "identical home" comparison of Table 20 one step further, to encompass transaction financing as experienced by typical buyers.

[48] NAHB Research Center, *Diffusion of Innovation in the Housing Industry*, November 1989, p.26.

Manufactured homes have historically been financed as personal property, unlike site-built and modular homes which are financed as real property. This occurred because the mobile homes that were the precursor to today's HUD-Code were used as temporary housing that was not fixed to the ground and was designed to be movable. The tradition of ownership of mobile homes not being tied to the land upon which the home was placed has carried over to modern manufactured homes, even though they are only rarely moved once placed on a site. The personal property or chattel loans still often used for manufactured homes are for shorter terms, have higher percentage down payments, and carry interest rates two to three percentage points higher than mortgages on conventional homes financed as real property. Yet despite these less favorable loan terms, it can be faster, easier and less costly to qualify a prospective buyer for a personal property loan than a real property mortgage. Since retailers assist in arranging financing for new manufactured homes, they have an interest in closing the sale rapidly that may lead them naturally to arrange a quick personal property loan.

Over time, as manufactured homes have become less mobile and more permanent, loan characteristics have been changing. As of 1996, loan terms averaged 13 years for new single-section homes and 16 years for new multi-section homes, compared to five years in 1964 and ten years in 1969.[49] Down payments have fallen to levels comparable to those required for site-built homes, averaging ten percent of the sales price. Since the early 1970s, Federal Housing Administration (FHA) and Veteran's Administration (VA) loans have also been available for manufactured homes. However, they are not widely used because of the red tape and because they require homes to be placed on a permanent foundation on land that the home buyer owns.

Four basic financing options are available to manufactured home buyers:

- *Federal Housing Administration Guaranteed Loans*: Title I loans are flexible, offering options including land and home purchase, or land purchase only. They require a 5 to 10 percent down payment, have terms ranging from 15 to 25 years, base interest rates on market rates, and have maximum loan amounts which vary with the item(s) being financed. Title II loans are available for homes that are placed on permanent foundations and require the home and land to be financed under one loan. This includes manufactured homes permanently sited on private property or on land in which the home buyer has a qualifying leasehold interest. Loan terms can be as long as 30 years and maximum loan amounts are higher and interest rates lower (2 percent) than for Title I loans.
- *Veterans Administration Guaranteed Loans*: VA personal property loans are available to members of the armed forces or eligible veterans, and guarantee the lesser of 40 percent of the total loan amount or $20,000. Essentially no down payment is required and loan terms range from 15 to 25 years. As of 1985, VA also guaranteed mortgage loans on permanently sited manufactured homes.
- *Conventional Mortgages*: Conventional mortgages requires that a home is permanently built or placed on private property. Loans of this type qualify for sale in the secondary loan market because of the permanently-fixed characteristic of the home placement and the comparability to neighboring site-built homes. Loan rates are based on market rates and terms can be as long as 30 years.

[49] Manufactured Housing Institute, *Manufactured Home Financing in 1996*, 1997, p.15.

- *Personal Property Loan*: Personal property loans are typical of high cost, limited lifetime material items. Loan terms are usually shorter than for conventional mortgages, ranging from 5 to 15 years. Interest rates are usually about 2 points higher than home mortgages since the land is not part of the collateral. Qualification for personal property loans is relatively quick and also less costly than the application process for a mortgage. In addition the personal property loan typically has no closing costs, escrow, title search or similar legal fees, and is available regardless of where the home is placed.

Table 23 presents the financing implications of purchasing site-built and factory-built homes with various land/placement and loan options. House size is assumed to be identical at 2,000 square feet (except that the single-section home is 1,215 square feet) to remove the effect of size difference on financing cost. Options summarized in the Table assume that the homes are placed on foundations of average cost (except that the single-section manufactured home is on a standard block pier foundation). All land is assumed to be a 1/5-acre private or rental lot. The two types of loans included are conventional real property mortgages and personal property loans.[50] The basic financing terms for each scenario were listed with the house descriptions in section 6.2 above.

The two key components of housing costs driven by the financing are the initial cash outlay and the total monthly payment. Both components are estimated for each of the six house-land combinations and listed in Table 23. Initial cash outlay will include down payment, closing costs and other taxes and fees. The down payment is assumed to be 10 percent of the purchase price. Closing costs for personal property loans include homeowner's insurance, loan processing, appraisal and the title/recording charge, and are based on flat fees. Closing costs for real property mortgages include the same fees plus additional charges for points, origination fee, private mortgage insurance, title insurance policy, prepaid interest, escrow, application fee and a property survey.[51] Manufactured homes sold for placement on rented land are considered personal property and subject to sales tax. A security deposit is also included for the homes placed in rental communities.[52]

[50] Federally guaranteed loans (FHA, VA) are not included in the Table 23 comparison because they represent a small percentage of loans for manufactured homes. For example, FHA Title I guaranteed loans are reported to have declined from almost 50,000 in 1983 to 2,400 in 1996. See Manufactured Housing Institute, *Manufactured Home Financing in 1996*, 1997, p.32.

[51] Robert Johnson and Jeff Scheuer, *Manufactured Housing Costs and Finance*, Manufactured Housing Research Project, University of Michigan, January 1993.

[52] Property taxes, homeowners insurance and potential income tax benefits are not reflected in the total monthly payments shown in Table 23, nor is depreciation or appreciation of the underlying asset.

Table 23: Comparison of Financing of "Identical" Homes (2,000 square feet)

	Site-Built	Modular	Manufactured Homes			
	Private Land		Private Land		Landlease Community	
			Individual Lot	Subdivision	Double-Section	Single-Section*
Construction Costs	$77,140	$65,560	$47,277	$47,277	$47,277	$26,350
Overhead and Financing	$32,274	$28,950	$15,254	$24,083	$15,554	$8,575
Land Costs	$35,314	$35,314	pre-owned	$35,314	$1,201	$1,000
Delivery and Set Up	--	included	$1,500	$1,500	$1,500	$750
Total Sales Price	**$144,728**	**$129,824**	**$64,031**	**$108,173**	**$65,532**	**$36,675**
Type of Loan	real property	real property	real property	real property	personal property	personal property
Interest Rate	8%	8%	8%	8%	10%	10%
Term	30 years	30 years	20 years	30 years	15 years	15 years
Percent Down Payment	10%	10%	land in lieu	10%	10%	10%
Initial Cash Outlays	**$21,709**	**$19,474**	**$4,364**	**$17,389**	**$11,283**	**$6,389**
Down Payment Price	$14,473	$12,982	--	$10,817	$6,553	$3,668
Closing Costs	$7,236	$6,491	$3,127	$5,334	$3,142	$1,746
Sales Tax (3%)	--	--	$1,238	$1,238	$1,238	$626
Security Deposit	--	--	--	--	$350	$350
Loan Amount	**$130,255**	**$116,841**	**$64,031**	**$97,356**	**$58,979**	**$33,008**
Monthly Loan Payment	**$956**	**$858**	**$535**	**$715**	**$634**	**$355**
Monthly Land Rent	**--**	**--**	**--**	**--**	$250	$200
Total Monthly Payments	**$956**	**$858**	**$535**	**$715**	**$884**	**$555**

* Square footage is 2,000 in all cases except that the single-section home in a land-lease community is 1,215 square feet.

6.4.2 Results of Financing Comparison

Despite the fact that the down payment is a similar percentage of sales price for all options (except the land-in-lieu case), down payments remain higher for site-built and modular homes because they have higher sales prices than manufactured homes. Even based on a comparison of identically-sized units on similar foundations, the estimated price of a double-section home placed in a fee-simple subdivision is 25 percent less than a site-built home.

Because of the higher sales prices of site-built and modular homes, the initial cash outlay for buyers of manufactured homes in land-lease communities and for buyers placing units on previously-owned land is significantly lower, ranging from 48 percent less than site-built homes for the double-section in a land-lease community to 80 percent less for the double-section on previously-owned land. This is an important difference in an environment where inability to accumulate the initial cash outlay required for purchase represents a widespread barrier to home ownership.

Higher sales prices for site-built and modular homes are due to the inclusion of land as part of the sales transaction, as well as higher square-foot construction costs. Nevertheless, the initial outlay as a percent of sales price is around 15 to 17 percent for all options (except land-in-lieu), since the major components of the initial outlay (down payment, closing costs and sales tax) are for the most part computed as a standard percentage of sales price.

Closing costs as a percentage of sales price varies from 4.8 percent for manufactured homes on rented land to 5 percent for units placed on privately-owned land. Closing costs are slightly lower for rental homes since fees for land surveys and title insurance that are normally included in closing costs of units on privately-owned land are implicitly bundled into the monthly rent fee in land-lease communities. The additional sales tax on personal property for units in land-lease communities compensates in part for their lower closing costs in the initial down payment.

The monthly loan payments for single-section and double-section manufactured homes in land-lease communities are significantly lower than for the other housing types; 63 and 34 percent less than site-built homes and 59 and 26 percent less than modular homes respectively. Higher interest rates and shorter loan terms for units in land-lease communities are more than compensated for by their significantly lower sales price, reflecting the exclusion of land costs and lower square-foot construction costs. Double-section manufactured homes on privately-owned land or in a fee-simple subdivison also have lower monthly loan payments than the site-built and modular homes. These values in Table 23 are 44 and 25 percent less than site-built homes and 38 and 17 percent less than modular homes respectively.

The double-section home placed on previously-owned private land has the lowest monthly payments for the buyer, since the cost of land is not included in the sales price and the land is pledged as collateral in lieu of a down payment. Although the interest rate on the loan is comparable to that of site-built and modular homes, the 20-year loan term is shorter. The smaller monthly loan payment is primarily the result of a lower sales price as well as lower square-foot construction costs, which outweigh the impact of the slightly less favorable loan terms. No opportunity cost for the pre-owned land is reflected in this comparison. Parallel comparisons could be developed for modular or site-built homes on previously-owned private land. In either case the monthly payments would be considerably lower than the corresponding home purchased together with a lot, but higher than for the HUD-Code home.

Purchase of a double-section home in a fee-simple subdivision is more closely comparable to the site-built and modular home transactions because land is included in the sales price and the loan terms are the same. Despite these similarities, the sales price is substantially lower due to lower construction costs, and the monthly loan payment is also significantly lower. The differential, however, is less than for the double-section in a land-lease community which does not include land in the sales price.

When land rent is included and monthly costs are compared, the total monthly payment for the double-section home on pre-owned land is lowest ($535), followed in order by the single-section home in a land-lease community ($555), the double-section home in a fee-simple subdivision ($715), the modular home on private land ($858), the double-section home in a land-lease community ($884), and finally the site-built home on private land ($956).

6.5 CONCLUSIONS

The discussion in this chapter presents a comparative cost analysis for site-built, modular and manufactured homes. Both modular and manufactured homes are primarily built in a factory environment, unlike site-built homes which may use factory built components but are primarily constructed on the home site. This difference in form of production and other factors leads to a difference in the construction cost of the homes. Additional costs for land, builder overhead/administration and financing also affect the ultimate cost paid by the home buyer. Comparisons presented in this chapter are illustrative and many of the costs used are broad-based averages or estimated values, so they could easily be extended or tailored to more specific circumstances and should not be taken as applicable to any particular case. Only the most straightforward adjustments for differences in characteristics of HUD-Code and conventional homes have been included. However, the broad picture and general results would not likely be affected by small changes in the various details or assumptions embedded in the calculations.

The lower square-foot construction costs for factory-built homes reflect various factors including lower labor costs, economies of scale in production, and volume purchasing power. Manufactured homes also save on construction costs by using less expensive foundation systems and other building products than either modular or site-built homes. Modular homes have higher construction costs than HUD-Code homes, despite the common factory production environment, because modular homes tend to involve greater customization in the factory and on site and because modular factories are typically smaller and cannot achieve economies of scale comparable to those enjoyed by HUD-Code producers. Modular costs used in this analysis do reflect some economies compared to site-built production. The extent to which this difference is passed through to consumers as lower prices or retained by producers as higher profits is highly variable.

The cost of land or land rent represents a significant consideration in the calculation of the monthly cost of owning a new home. When purchasing a manufactured home with the land, the cost of an improved lot can increase the cost of a new manufactured home substantially. Even though the land rent paid by manufactured home purchasers moving into land-lease communities can add more than 50 percent to monthly housing costs, availability of a rental option clearly allows the buyer to minimize initial cash outlay. This may be a critical factor in completing a particular sale. Producers of manufactured and modular homes have the cost advantage of not being involved in the development and sale of land, though site-builders that buy raw land inexpensively and develop it often make a significant profit on the land with the sale of a house.

When comparing construction costs of the site-built home with the cost of manufactured homes, even after adjusting for size and foundation the absolute difference in these examples is over $29,000, while the difference in construction cost between the site-built and the modular home is over $11,000. After other cost elements and financing considerations are added and monthly loan payments are computed, a substantial difference is still apparent. Although lenders are beginning to offer more options to buyers of manufactured homes, many purchasers still must pay a premium in the form of a higher interest rate, a higher down payment and/or a shorter term compared with loans for site-built or modular homes. Yet the generally lower construction costs for manufactured homes and the flexibility regarding land purchase appear to outweigh increased costs of other elements such as financing, and give manufactured homes an overall cost advantage across the range of transaction scenarios reviewed in this Chapter.

CHAPTER 7

FINDINGS AND RECOMMENDATIONS

7.1 GENERAL FINDINGS

Basic differences in the economic structure and operation of the firms that produce manufactured, modular and site-built single-family homes contribute to different outcomes in the respective sectors of the housing industry, including differences in production technology, methods of distribution and sale to final purchasers, and selling prices. The recent and unprecedented emergence of strategic alliances between large site builders and large HUD-Code producers suggests the possibility of expanded future interaction between these historically distinct sectors of the industry.

Part of the lower square-foot construction cost of manufactured housing compared to modular and site-built homes reflects differences in focus regarding design features and amenities, choice of construction materials and degree of customization. Some of these differences are market-driven, and some reflect economies that are more readily achieved in a high-volume, centralized factory environment.

Production levels and selling prices are increasing more quickly for manufactured homes than for site-built homes because the sizes and designs of manufactured homes are evolving to more closely resemble the characteristics of site-built housing. As the market for manufactured housing has expanded and the output mix has shifted towards larger, double-section units located outside of rental parks, purchasers have become more similar to purchasers of site-built homes. These factors point to a substantial degree of competitive overlap in the entry-level or affordable segment of the new home market where price considerations are dominant. Increasingly flexible options regarding type of unit, land tenure and buyer financing have favorably impacted the cost, marketability and competitive position of manufactured housing.

Differences in the regulatory procedures that apply to manufactured homes and conventional housing contribute to differences in the cost of site-built housing compared to manufactured and modular housing. The federal system for regulating manufactured housing appears to be more efficient and less costly to administer than prevailing state and local systems for regulating site-built and modular construction. Differences in the applicable technical requirements for unit design and construction, while less extensive than the procedural differences, also contribute to the disparity in production costs between conventional housing and manufactured housing.

7.2 CURRENT TRENDS AND A LOOK TO THE FUTURE

A 1997 conference organized by the Manufactured Housing Institute included results of a HUD-sponsored investigation of a new type of chassis that would improve the versatility of

manufactured homes, allowing them to be more easily installed on permanent foundations and incorporated into two-story structures. Other presentations showed how two-story HUD-Code homes were built in California. A member of the audience, noting the added expense of such improvements, asserted that they were contrary to the traditional role of manufactured housing in providing affordable housing and were therefore not needed. The presenter responded that the manufactured housing industry already had the affordable housing market "locked up" and was now seeking to expand the market in other directions. This anecdote raises a number of issues for serious consideration by both site-builders and manufactured housing producers.

The inherent advantages of the manufactured housing industry are the economies of mass production along with a single-minded focus on the low-cost segment of the housing market. Along with economies of scale the factory provides a business environment that most effectively allows a focus on productivity, cost control and achievement of margins. Much of the economies are achieved with lower costs of relatively unskilled labor and through the use of inexpensive finishes and materials. The extremely large size of dominant HUD-Code producers also gives them ideal opportunities for savings in procurement of products and materials used in manufactured housing.

Some of the recent growth in manufactured housing is simply a by-product of a strong overall housing market that has seen rising sales of conventional housing as well. Some of the growth also appears to have resulted from a regional shift in overall housing market activity towards the South, an area where manufactured housing has historically been at its strongest. Some of the growth has simply taken the form of rising dealer inventories, as placements have lagged behind shipments. Yet even taken together, these factors seem insufficient to explain the bulk of the rising production and sales of HUD-Code homes in recent years. There appear to be other factors leading more buyers towards new manufactured homes today than in the past. These include design enhancements that bring manufactured homes closer in appearance to conventional housing, enhanced financing that reduces cost of ownership by bringing interest rates and loan terms closer to the mortgage financing available for conventional housing, and reduction of the zoning or land-use barriers that have historically hampered placements in some communities. The lessons for the remainder of the industry are limited to the extent that the manufactured housing sector has simply been "catching up" and becoming more like conventional housing. However, major differences in production technology, regulation, building features, market positioning, selling practices, financing arrangements and the final price are also at work.

Further Evolution in Manufactured Housing. Manufactured housing producers, in pursuing goals of growth in sales and market share, will continue exploring more product customization and innovation aimed at simulating the look and function of traditional single-family houses. Most potential customers considering purchase of a manufactured home still compare it with

their image of a free-standing single-family house in the suburbs. Consequently, manufactured home producers typically offer numerous optional variations of windows, glazing, and interior and exterior finishes that help to achieve the look and function of site-built single-family homes.

Despite the increase in size resulting from the joining of "floors," however, the basic profile of most manufactured homes retains a uniform, rectilinear appearance that reflects constraints imposed by standardized production and regulations governing transportation of homes on pubic highways. Garages, porches, and decks built on-site using traditional construction methods add variety to the exterior shape and help avoid a uniform look, but inevitably add cost and result in lower margins, higher selling prices or both. As a result, some producers are turning to basic but more expensive technological innovations to alter the uniformity of appearance and design. Examples are hinged roofs that achieve the steeper roof pitches characteristic of conventional housing, as well as new chassis designs that permit siting on permanent basements or construction of two-story manufactured homes.

Many of the obstacles to expanding the market for manufactured housing are related to the undesirable image of manufactured homes, a holdover from the days when such homes were very mobile, very small, and placed on very small plots of land in crowded parks. Problems related to lax regulation and the poor quality of site installations for homes that are sold and placed through retailers also have contributed to a negative perception of manufactured homes. Installation is an area in which manufacturers traditionally have had little direct involvement. Consequently, some producers are seeking to gain direct access to the market and control over installation and development through vertical integration to the retail level. At the same time, some of the largest production site-builders are seeking an expanded role in that portion of the affordable housing market now dominated by manufactured housing. They desire to apply their experience in large scale community planning and development to manufactured housing through acquisitions and partnerships with producers and retailers.

With such changes in direction, the question remains as to whether or not the manufactured housing industry will lose its focus and compromise its low-cost approach to housing by engaging in expensive customization and such activities as marketing and land development in which producers have little direct experience. The danger for manufactured housing producers is that, like modular home producers and some production site-builders, they will be "stuck in the middle," positioned somewhere above the low end of the market, but not quite firmly in the middle-income market.

Evolution of the Modular Sector. Modular home producers also have some of the advantages of factory production, but they consciously customize their product to compete in a more upscale market. Their sluggish growth may offer some useful lessons for the manufactured housing industry about the pitfalls of embarking on a program of customization. Although some of the

higher costs of modular housing are due to more stringent and more variable regulatory requirements in the factory and on-site, the potential economies of factory production also appear to be largely nullified either by indiscriminate customization or by lack of focus on the specific portion of the upscale market they wish to pursue. As a result, square-foot production costs of modular homes are much closer to site-built costs than to HUD-Code costs. Experience in the modular sector reinforces the point that the way in which HUD-Code producers go about increasing customization will be a key determinant of whether they can successfully expand market share by competing for more upscale purchasers.

The Declining Entry-Level Site-Built Housing Market. According to data from the Bureau of the Census and the analysis of costs in this study, typical modular and site-built homes appear to be competing in the sales price range under $150,000, with the competitive range possibly extending as high as $200,000. Competition with manufactured housing occurs most directly in the price range under $100,000. It is in these price ranges that most entry level site-built housing for first time buyers is being built. There is also no doubt that production of compact, low-cost site-built housing has been shrinking. Data supporting these conclusions are cited below:

- The market share for single-family, privately-owned housing completed in the price range under $200,000 shrank by six percentage points between 1992 and 1996, from 82 percent of all units to 76 percent of all units.
- The steepest market share declines within this range have occurred in the segment competitive with manufactured housing: those houses selling under $100,000. The share of new conventional homes priced below $100,000 has declined from 35 percent in 1992 to just 21 percent in 1996.
- The market share of housing in the intermediate price range between $100,000 - $150,000 has fluctuated and has actually increased slightly from 31 percent in 1992 to 34 percent in 1996, but only after declining from a peak of 37 percent in 1995.
- Medium (25-99 units/year) and large (100+ units/year) production site-builders are more active than small builders in price ranges under $200,000 and are far more active than small builders in the below-$100,000 price range.[53]
- First-time new home buyers as a share of all home buyers increased from below 25 percent in 1989 to 27 percent in the two years preceding 1995, but have actually suffered a substantial decline from their 37 percent share in the two years preceding 1985.[54]
- First time buyers are more likely to buy existing homes rather than new homes.[55]

[53] Gopal Ahluwalia, "Changing Industry Structure," *Housing Economics*, February 1994, p.5.

[54] Andrew Kochera, "Home Buyers and Home Search In 94 - 95," *Housing Economics*, May 1997, p.7.

[55] Ibid.

- Nearly all homes selling in the price ranges above $250,000 are bought by trade-up buyers, generally baby boomers in the 35 to 54 age bracket.[56] Production of these homes is dominated by small builders, whether building custom homes or homes for sale.
- A survey of NAHB members in 1995 indicated that only 40 percent of builders classified themselves as builders of entry level or affordable homes, with one-fourth building homes with a sales price less than $100,000 and the remaining three-fourths building homes priced between $100,000 and $200,000.[57]

Any recommendations for improving the efficiency of conventional site-built or modular housing based on the potential efficiencies of manufactured housing must take into account that conventional construction is far from a monolithic sector of the industry. Home building operations, and therefore recommendations, differ between custom builders and merchant or operative builders, and between small-volume and high-volume builders.

The proportion of all builders who are custom or operative rises and falls with the business cycle. The proportion of operative builders typically varies within a range of 55 to 65 percent of all builders, with custom builders constituting the remaining 35 to 45 percent. The proportion of operative builders constructing privately-owned single-family housing for sale has grown from 60 percent during the 1992 recession to 66 percent in 1996. Although some overlap exists between the markets served by the two types of builders, the operative or production builders tend to focus on turning over larger volumes of housing at the lower-priced end of the market, while custom builders concentrate on a smaller number of houses at the higher-priced end of the market.

Custom builders, as the name implies, expend a great deal of effort and money customizing the design and various features of a house to suit the tastes of an individual customer. There will always be a market for the higher income, middle-aged and older families that can afford expensive custom homes. Builders catering to this segment of the market are therefore far less likely to compete with manufactured housing or, for that matter, with production builders who serve the low-end of the market and are involved in land development on a larger scale.

One overarching lesson to be learned from the resurgence of the HUD-Code sector is that the entry-level "affordable housing" market need not consist entirely of older existing homes. The substantial numbers of consumers who buy today's manufactured homes are demonstrating a preference for new construction that is less spacious, has a simpler design with fewer amenities, and uses less expensive materials and finishes than what has come to be almost universally expected in site-built homes, so long as it is within their means and fulfills their goal of home

[56] Gopal Ahluwalia, "Upscale Housing," *Housing Economics*, August 1994, p.11.

[57] Gopal Ahluwalia, "Home Builders and Their Companies," *Housing Economics*, July 1995, p.12.

ownership. Any perception that consumers today would not be interested in new conventionally-built starter homes with very basic designs and fewer "extras" is mistaken. New homes of any type provide valuable conveniences and relative freedom from the burdens of maintenance and repairs or replacement of aging appliances and systems experienced with older homes. The challenge for site-builders who would compete directly in this arena is not overcoming a lack of buyer interest. The challenge is controlling costs while achieving large-scale production, and much can be learned about these issues by understanding the HUD-Code market. Indeed all builders, including custom builders, can benefit by drawing creatively upon what has been learned or can be inferred from experience in the manufactured housing sector.

7.3 REGULATORY AND TECHNOLOGY RECOMMENDATIONS

Some recommendations growing out of this study are not directed at building companies in particular, but relate to regulatory and technological issues that shape the overall system in which builders operate.

Building Code Administration and Enforcement. Opportunities for significantly improving the efficiency of the process of code administration and enforcement for site-built and modular homes need to be studied and tested. On balance the pre-emptive HUD-Code has been largely embraced by manufactured home producers, who can operate within a system that is more predictable, more consistent and relatively inexpensive compared to other approaches. The critical point is the high efficiency and low per-unit cost of administering and enforcing the HUD-Code. Total costs for building, mechanical, electrical and plumbing permits required to administer design review, perform construction inspections and operate the local building departments that regulate site-built construction may range up to an order of magnitude higher than the total per-unit fees paid to HUD plus the costs for third-party design review and in-plant inspection of manufactured homes.

This situation can be addressed without requiring a federal building code for modular or site-built homes, although that option lies at one extreme. Local building departments need to find ways to improve efficiency in provision of services to the public, including streamlining permit processes and instituting multidisciplinary inspections to reduce delays. The HUD-Code system shows that the regulatory process can be privatized in major ways. For example, there are competent professionals in any community who could perform third-party design reviews. Delays in design reviews can be a major problem in high growth areas, where rapidly developing markets make building departments fall behind to the point that building permits can take months to be issued. Similar opportunities exist for expanding use of third-party inspections or documented quality review or assurance systems rather than relying on after-the-fact inspections by government employees.

Reconciliation of Appropriate Minimum Code Requirements. Work should be performed to reconcile differences in minimum requirements found in the HUD-Code and the other model codes, as identified and discussed in Chapter 5 above. This is a complex area encompassing numerous details. While the differences do not consistently favor either sector and while most individual differences are relatively small, on balance they appear to limit the ability of site builders to produce a compact, streamlined product, and raise costs of site-built homes relative to HUD-Code homes in various ways. As a starting point, it seems clear that minimum code requirements to ensure health and safety should not vary significantly from one type of housing to another without a strong supporting rationale.

Evolution of Performance Technology Options. The integration of engineering and conventional construction will pose a major technical challenge for home building in the 21st century. Single engineered products are in significant use (e.g., I-joists) and engineered roof trusses are both commonplace and highly efficient in the right application. The important question is which home building products or systems will be the next to evolve in design and fabrication through "creeping engineering," and achieve broad market penetration. For example, exterior wall panels could be optimized for shear strength and load-bearing capacity at minimum cost through empirically-based engineering, factory quality-control systems and fastener detailing. Third-party quality assurance agencies could use full-scale testing to verify system performance and periodic inspection to verify consistent production in this enhanced approach to panelization. Similar opportunities undoubtedly exist in other applications.

Simplify Implementation of Performance Solutions. There is a major need for simplified tools to allow conventional home builders to take advantage of performance solutions to design problems. Some have argued that the development and referencing of more performance standards will naturally improve productivity and reduce cost, but many smaller builders have found this view unrealistic. From their standpoint, performance approaches too often are unworkable without the active involvement of engineers or architects, while the translation of abstract performance requirements into prescriptive solutions can lead to overly conservative results. Performance requirements or solutions are most likely to improve efficiency and be accepted by users and regulators if they are relatively easy to understand, or at least very straightforward to implement.

7.4 RECOMMENDATIONS FOR SITE BUILDERS

The following recommendations, based on the reduced cycle-time and economies characterizing the production of manufactured housing, could improve the efficiency and cost-effectiveness of all types of site-built housing. Depending on their scale of operations and their degree of involvement in the land development process, site builders may want to consider recommendations appearing in the next section as well.

Shift from On-site Towards Off-site Production. Increase the proportion of value added to the new home that is produced off-site by using prefabricated components and simplifying and reducing on-line activities directly involved with assembly of the house on-site. This can be accomplished by converting on-line activities at the site to support activities off-site as might be done with panelization, prefabricated trusses or pre-cast foundation systems.

Improve Coordination and Communication to Integrate the Production Process. Convert activities that are usually performed sequentially into parallel or simultaneous tasks through increased coordination among contractors and suppliers, acting as part of a team with the assistance of enhanced scheduling and modern communication techniques.

Take an Aggressive Approach to Identifying and Resolving Quality Problems. Reduce slack time and waste involved in sequential after-the fact inspections by leaving little margin for error and exposing quality problems as they occur. This approach encourages on-the-spot solutions of small problems early and avoids larger problems later.

Expand Usage of Sophisticated Design and Management Tools. Make design, processing and cost estimating more efficient through easy-to-use computer aided design (CAD) programs that link designs, design options, and design changes directly to cut-lists of materials, field drawings, cost estimating, invoicing and related activities. Use a pre-coded purchase order system that reduces the burden of home-office invoice identification, checking and approvals prior to payment by relying on information from underlying purchasing and subcontract arrangements with vendors. Integrate back office functions with the construction process to facilitate just-in-time operations and reduce unproductive delays or labor down time. These systems are widely used in large organizations and with improvements in information technology are becoming practical for use even in small building companies.

Incorporate Selected New Technologies. Investigate and experiment with innovative product and material technologies, and adopt the most promising candidates. Give special consideration to innovations that increase compatibility among components, reduce set-up and parts handled on-site through modularity (e.g., standard modules for plumbing fixtures), improve connectivity (e.g., plastic plumbing manifolds or stronger adhesives), combine functions previously performed separately by multiple contractors (e.g. insulated concrete forms or exterior insulation finish systems), or reduce sequential dependency of construction activity (e.g., surface electric raceways). Individual builders must make their own decisions about just which technologies make sense for them, but all builders need good information to make intelligent, well-informed decisions. Fortunately new channels of information flow between product manufacturers, builders and others are developing to simplify this process and help focus the development cycle by providing user feedback to manufacturers. Two recent developments in this direction are

availability of the "HomeBase Hotline," a toll-free telephone information service for the building industry operated by NAHB Research Center, and the Partnership for Advanced Technology in Housing ("PATH"), a public-private initiative to expand use of new technology in the home building industry through a comprehensive web site, new home demonstration programs, and other methods.

7.5 RECOMMENDATIONS FOR PRODUCTION BUILDERS

Higher-volume production home builders call for a different set of recommendations. Production builders differ from custom builders and are somewhat like manufactured housing producers because they are more likely to compete for similar markets and focus on volume. They are also very cost-conscious and already use various prefabricated components as well as some of the techniques recommended above for the rest of the industry. However, as a practical matter many of the efficiencies of factory production simply cannot be achieved on-site. Also, production site-builders differ from both manufactured housing producers and custom builders because they often are involved in land and subdivision development. Consequently, the recommendations below are directed to production site-builders either operating alone or, potentially, in cooperation with manufactured housing producers where each can focus on what they do best.

Basic House Plan Alternatives. There is a market for small, starter homes, but site builders are increasingly leaving it to producers of HUD-Code homes or the conventional home resale market. One way to address this is by developing ultra-low cost starter house plans similar in concept to the starter houses of past decades or today's upscale manufactured houses. Underutilized, inexpensive building products are available for siding, flooring, interior finishes and many other applications. Simple floor plans allow maximum use of roof trusses, and optimum value engineering practices reduce the need for framing lumber substantially. Frost-protected foundation technology can significantly reduce foundation costs in cold climates. Reducing house size and minimizing window area both cut costs. Ideally the plans would be pre-engineered to allow construction with few if any modifications in a wide range of locations. HUD has initiated work in this direction with an ongoing project to define, design and demonstrate construction of the "Marketable, Affordable, Durable House."

Partnering with HUD-Code Producers to Develop Subdivisions. Production builders may find opportunities to partner with HUD-Code producers in developing highly affordable subdivisions on land they hold in inventory. Under a simplified partnering arrangement the production builder can capitalize on its expertise in land acquisition, infrastructure planning and site development while the HUD-Code producer can concentrate on achieving economical unit construction through factory production. This kind of strategy would be most attractive in

communities where land availability and development approvals are not the limiting factor in new home construction.

Investigate Zoning Approvals Modeled after Manufactured Home Requirements. Production builders can consider seeking zoning approvals for entry-level site-built subdivisions that permit densities equivalent to that which would be permitted for HUD-Code homes, if that is greater than would otherwise be permitted for site-built homes. Higher density can substantially reduce per-unit cost of land, roads, drainage, utility infrastructure and shared site improvements. Differences in legally permitted density may potentially confer a significant competitive advantage on subdivisions of HUD-Code homes built on permanent foundations and detailed on site to appear similar to conventional site-built homes. It seems inappropriate to permit this for HUD-Code homes on leased land but prohibit it for site-built or modular homes.

Sale of Homes with Ground Rents. Production builders should explore options for selling conventional homes on leased land with a ground rent (e.g., a long-term renewable leasehold with specified rents), rather than as a complete fee-simple package. Eliminating land purchase and financing from the new home transaction would significantly reduce the required down payment and closing costs, and thereby help to address the single most substantial barrier to sale of entry level housing. This form of ownership and land tenure is standard in a few areas but would be very novel in others. An option to purchase the lot could be included in order to minimize buyer resistance. One important reason why HUD-Code homes are more affordable is that they are most commonly sold without land.

A significant drawback to the broader use of a ground rent approach is that it risks tying up builder capital in leased land rather than rolling it over in the form of a final sale. Production builders rely on being able to close out one deal and move on to another; they are not in business to operate as landlords. It might be possible to address this with a secondary market in ground rents or financing vehicles such as real estate investment trusts, either of which could provide capital and liquidity for the developer/builder in exchange for attractive returns to third-party investors.

Systematic Product Value Analysis and Negotiated Purchasing. Large-volume builders have a stake in developing the most efficient possible systems for selecting, specifying and purchasing building products and materials. They also have leverage with vendors that can justify price discounts or equivalent concessions, and should use this to maximum effect. There is no doubt that large producers of HUD-Code housing take a similar approach. Some very successful high-volume site building firms are known to have sophisticated in-house evaluation systems for reviewing all types of potential products and deciding which ones to incorporate into their new homes. These systems weigh factors such as number of alternative product sources, financial stability of the major suppliers, installation requirements and warranties, value-added

characteristics in the finished house, likelihood of call-backs or performance issues with unusual or alternative products, and availability of long-term supply commitments and volume discount arrangements. The result is a strategic product selection offering the best long-term potential for the company.

Explore a Mass Customization Approach to Production Home Building. In the coming years, production builders and HUD-Code producers should investigate and experiment with "mass customization" methods. Mass customization is a process of production that offers manufactured housing producers in combination with production site-builders an opportunity to customize and at the same time realize economies of scale. Maturing computer and communication technology has given birth to this new approach to production. Computers permit nearly instantaneous, real-time transfer of information, resulting in a just-in-time approach to manufacturing where the supply of production inputs is quickly accounted for and adjusted to meet near-term production needs. The emphasis is on time compression of the manufacturing process by accelerating the performance of existing activities, reducing or eliminating non-value-added activities, performing traditionally sequential activities concurrently, and improving the performance of support activities.

Time compression involves reducing waste in operation, processing modular units in smaller batches, reducing changeover times and solving problems as they arise. In order to reduce waste the firm focuses on those activities that change form and move the product closer to the customer. All other activities are classified as external and are sought to be eliminated, simplified or performed in parallel.

It could be argued that many of these techniques have already been adopted by the manufactured housing industry. To some degree, however, factory-built housing has done little more than transferring stick-built methods of production under a roof in order to minimize the use of expensive craft labor in a field environment. For example, one commentator has written:[58]

> "Industries such as prefabricated houses, specialized machinery, and retail legal and tax-preparation services all offer examples of 'custom' products that are actually quite standardized.
>
> "This not true of all firms. For example, modular housing companies in Japan and Scandinavia truly mass customize houses that bear no resemblance to 'prefab' houses common in the United States. The key is to standardize processes, not products. Properly designed low-cost processes can produce a highly varied flow of goods or services."

By designing and producing smaller component modules, processing smaller batches in short production runs, and making frequent changeovers, manufactured housing producers and

[58] B. Joseph Pine, "Customizing the Cookie Cutter", *Profit - Information Technology For Entrepreneurs, An IBM Magazine*, November/December 1992, p. 41.

production site-builders could increase the variety of their product and respond flexibly to individual customer demands. At the same time they could detect and correct small flaws early because the process leaves little margin for error and exposes quality problems as they occur. The process requires precise scheduling, changes in the layout of material and information flows, and adaptive skills in the labor force where one person operates multiple machines or equipment. This fosters decentralization of decision making authority and responsibility, teamwork to handle complex information flows and multifunctional tasks, and increased coordination of suppliers and subcontractors as part of the team. These labor and production requirements differ markedly from the situation in existing manufactured home plants, modular factories and large-scale production site building alike.

Mass customization, or the simultaneous realization of scale economies and product variety, has been successful in other industries and has the potential to change both conventional home building and manufactured housing. In adopting the mass customization approach, the following are the potential roles of production site-builders and manufactured housing producers:

- Production site-builders would rely on manufactured housing producers to manufacture a basic line of small modular units that they would combine on-site into one of perhaps 50 to 100 possible designs.
- Producers would also pre-fabricate pre-cast concrete foundations, garages, porches, and decks off-site for on-site assembly by site-builders.
- Production site-builders would acquire and develop the land and "master plan" the siting of housing units, including grading of land and supporting infrastructure such as roads and utilities.
- Production site-builders would focus on assembly of modular units, site preparation and installation.
- The marriage of many small modules on-site in different configurations has the potential to add variety to the profile and design of manufactured homes, but would also increase complexity and make the joining process more involved. Customization and joining at the site would therefore need to be handled more carefully and methodically than has historically been the case with large floors used in typical manufactured housing, and would become the specialty and focus of the large production site-builder.

Development of complementary relationships between production builders and manufactured housing producers as outlined above would allow each party to concentrate on what they do best. This scenario relies, however, on a considerable investment in experimentation, retooling and reorganization of processes by manufactured housing producers to engage in the still conceptual mass customization process. If manufactured housing producers customize homes without achieving significant economies they could end up in the same quandary currently facing production builders: the inability to economically and profitably satisfy the large potential

market for homes at affordable prices in the range below $100,000, or even $150,000. At the same time, production site-builders would have to relinquish much of the less efficient and less profitable construction by trades on-site, develop new skills in the assembly and installation of manufactured units on-site, and focus on the land development process that is critical to successful provision of all types of housing.

7.6 CONCLUDING REMARKS

This report has presented detailed information about the evolution and current competitive positions of the site-built, modular and HUD-Code segments of the new home industry. Recent developments point to a significant expansion in the role of HUD-Code manufactured housing in meeting new housing needs. Double-section HUD-Code homes on private lots, particularly in rural and suburban locations, have become a viable form of entry-level housing for purchasers with modest expectations at the same time as production of conventionally-built "starter homes" has fallen off. Manufactured housing producers have achieved lower production costs through many factors including factory mass production technology, economies of scale, use of various less expensive finishes and components, and savings in the costs of structural materials. They operate under a largely privatized, more uniform and efficient regulatory process together with somewhat less stringent code requirements. They also have succeeded in selling houses without land or finished lots at much lower cost than conventional house/land packages. These lower costs translate into less up-front costs for buyers and can reduce ongoing total housing costs as well.

For their part, conventional builders have important strengths and skills not found among HUD-Code producers, most notably in land and site development, zoning and environmental approvals, marketing and sales, as well as in building unique or complex designs with substantial buyer appeal. Analysis in the report leads naturally to various suggestions for improving efficiency in the conventional sector and taking advantage of opportunities made available through the maturing of HUD-Code unit designs and production technologies. Some suggestions are incremental, while others would involve more significant changes in the way homes are designed, built, sold, delivered and financed.

Conventional home builders have historically been considered slow to adopt new technical approaches to construction or use innovative products. This conclusion can easily be overstated. Today's site-built homes include many "industrialized" products and materials that were unknown a generation ago, and are responsible for considerable cost savings compared to traditional construction practices. Manufactured homes take this a step further by showing that a viable remains market for basic, compact, straightforward and inexpensive new home designs that can be mass produced, so long as suitable sites can be found.

The growth in manufactured housing and the convergence of many new HUD-Code homes with the functionality of site-built starter homes from a previous era are not speculation. They are facts that must be considered by all home building operations. They have implications that can ultimately affect the way housing is produced and sold, as well as the way new home construction is regulated, the nature of minimum code requirements, and the relationship of engineering to construction processes that have historically been based more on experience than on analysis. Some will choose to adapt with as little change as possible. Others will embrace new technologies and new ways of operating more aggressively as part of comprehensive business strategies. Experience strongly suggests that industrialization will continue in one form or another, and that production processes will continue to evolve in this direction. The recommendations in this report are intended to help home builders of all types to learn from and take advantage of industrialized housing as it exists today, and to play an active part through their own actions and decisions in shaping the future of the home building industry.

APPENDIX A

COMPARISON OF SPECIFIC CODE REQUIREMENTS

This Appendix includes a detailed description of specific differences between selected building code, electrical code and plumbing code requirements applicable to HUD-Code homes and conventional homes, as listed in Table 15, Table 17 and Table 18 and discussed in Chapter 5.[59]

A.1 BUILDING REQUIREMENTS

A.1.1 Areas Where the HUD-Code is More Stringent than CABO

Ventilation.

- *Kitchens.* The HUD-Code requires that kitchens have a mechanical ventilation system capable of exhausting 100 cubic feet per minute (cfm) to the outside of the home. CABO has no similar requirement. While in practice most site-built houses have at least a recirculating fan in a range hood, venting to the exterior is not required.
- *Bathrooms.* The HUD-Code requires mechanical ventilation in all bathrooms, while CABO permits operable windows in lieu of an exhaust fan.
- *Whole-house ventilation.* The HUD-Code requires active or passive whole house ventilation providing 0.10 air changes per hour as a supplement to natural ventilation. This can be accomplished in various ways including a mechanical system, a passive system using inlet and exhaust registers, or a combination system. Heat recovery is not required. There is little information about how manufacturers actually comply with this requirement, but complying designs tend to be simple and the incremental costs are relatively small. For example, a small duct carrying outdoor air to the return side of the furnace air handler combined with a small exhaust fan inside the home wired to run along with the air handler fan would readily achieve the required air flows and system balance. A passive vent that would open to relieve interior pressurization could even be substituted for the exhaust fan. Under CABO, whole-house ventilation requirements can be and generally are met by operable windows and natural envelope air leakage.

Flame Spread of Kitchen Cabinets and Bathroom Fixtures. The HUD-Code requires kitchen cabinet doors, countertops, backsplashes, exposed bottoms and end panels to have flame spread

[59] A January 1998 study of the HUD-Code and the OTFDC/MEC, entitled *Code Comparison: CABO One and Two Family Dwelling Code with Model Energy Code and Manufactured Home Construction and Safety Standards*, published by the School of Architecture, Building Research Council of the University of Illinois at Urbana-Champaign, includes a similar range of provisions as well as certain mechanical requirements not included in the present comparison.

ratings not greater than 200 as determined by ASTM E162-90. CABO has no similar provisions. The HUD-Code also requires that finish surfaces of plastic bathtubs, shower units, and tub or shower doors not exceed a flame spread rating of 200. CABO has no similar provisions. These and other similar special requirements were included based on concerns about the historically marginal performance of manufactured homes in fires.

Fire Protection of Kitchen Cabinets. The HUD-Code requires the cabinet area over the cooking range or cooktops to be protected by a metal hood that is at least as wide as the cooking range. Although CABO has no similar requirements, it is common for a range hood of some type to be installed over ranges or cooktops in site-built houses.

Formaldehyde Emissions from Wood Products. The HUD-Code limits formaldehyde emissions for plywood and particleboard installed in manufactured homes and requires third-party certification of such products. CABO has no provisions regarding formaldehyde.

Separation of the Combustion System from the Interior Atmosphere. The HUD-Code requires "complete separation" of combustion systems from the interior atmosphere of the manufactured home for all fuel-burning appliances. Fuel-burning warm air furnaces and water heaters would be covered, but there are exceptions for ranges, ovens, illuminating appliances, clothes dryers, solid fuel-burning fireplaces and solid fuel-burning fireplace stoves. The required separation may be obtained either by the installation of sealed combustion systems or by the installation of appliances within enclosures that separate them from the interior atmosphere of the manufactured home. In this case no door, removable access panel or other opening into the enclosure from the inside of the manufactured home is permitted, and openings for ducts, piping, wiring, etc., must be sealed. In addition, a forced air appliance and its return-air system must be designed and installed so that negative pressure created by the air-circulating fan cannot affect its or another appliance's combustion air supply or mix products of combustion with circulating air. CABO has no similar provisions. The cost impact for HUD-Code homes would reflect the added cost of sealed combustion appliances or construction of sealed enclosures for natural- or forced-draft appliances.

Deflection Criteria for Eaves and Cornices. The HUD-Code specifies a maximum deflection due to wind uplift for eaves and cornices of $(2 \times L_c)/180$, while CABO has no similar provisions. In some cases, this may translate to a need for stiffer (larger) rafters, roof trusses, or other associated parts of eaves and cornices in HUD-Code homes.

Floor Loads for Sleeping Rooms. The HUD-Code requires all floors to support a uniform 40 psf load. In addition, floors must support a 200 pound point load (not simultaneous with the uniform load) applied over a one-inch diameter circle at the weakest point in the floor, without deflecting more than 1/8-inch relative to the floor joists. CABO also has a general 40 psf load

requirement for floors, except that floors of sleeping rooms must support a uniform 30 psf load. There is no point loading requirement. Some homes are able to take advantage of the lower load requirement for sleeping rooms on the second floor, but many are designed to 40 psf throughout in order to simplify the site construction process, notwithstanding the lower requirement for sleeping rooms. The impact of this difference may also be negated by the less stringent deflection limit for floors under the HUD-Code, discussed below.

Number of Egress Doors. The HUD-Code requires manufactured homes to have at least two exterior doors, located remote from each other. Specific criteria for remoteness of the doors are included in the HUD-Code. CABO requires one exit door from each dwelling unit.

A.1.2 Areas Where CABO is More Stringent than the HUD-Code

Artificial Light. CABO provides that when artificial light is used in lieu of natural light for habitable rooms, the artificial light must be capable of producing an average illumination of 6 footcandles over the area of the room at a height of 30 inches above the floor level. The HUD-Code permits use of artificial light in certain rooms but does not have any provisions regarding quality of the light. This requirement might possibly add costs to site-built houses if more expensive fixtures are required compared with those typically used in manufactured houses, but most habitable rooms have natural light.

Minimum Room Sizes. Several of the provisions relating to minimum room size or dimensions are more stringent in CABO, including requirements for kitchens, bedrooms and other habitable rooms.

- *Kitchens*. CABO requires that kitchens have a floor area of not less than 50 square feet. The HUD-Code does not specify a minimum kitchen size.
- *Bedrooms for One Person*. CABO requires all bedrooms to have a floor area of not less than 70 square feet. The HUD-Code requires bedrooms designed for one person to have at least 50 square feet of floor area, and bedrooms designed for 2 or more persons to have at least 70 square feet plus 50 square feet for each person in excess of two.
- *Other Habitable Rooms*. CABO requires all habitable rooms other than kitchens and the required large room to have an area of not less than 70 square feet. The HUD-Code does not specify a minimum floor area for habitable rooms other than the required large room and sleeping rooms.
- *Least Horizontal Dimension*. CABO requires all habitable rooms except kitchens to be not less than 7 feet in any horizontal dimension. The only minimum horizontal dimension under the HUD-Code is for the required large room and rooms designed for sleeping purposes, which must have no clear horizontal dimension less than 5 feet.

All of these differences (and several others discussed in this section) appear designed to simplify the design and construction of small, space-efficient HUD-Code units, especially single-wide units. They may be less relevant to the increasingly common multi-section floorplans, but nearly 50 percent of HUD-Code homes shipped in 1996 were still single-wide.

Minimum Ceiling Height. The HUD-Code requires every habitable room and bathroom to have a minimum ceiling height of not less than 7 feet for at least half of its floor area, and 6 feet 4 inches under dropped ducts and beams. CABO requires all habitable rooms except kitchens to have a ceiling height of not less than 7 feet 6 inches for half of the required area, and 7 feet below beams and girders. Under CABO other rooms including kitchens, baths and hallways must have a ceiling height of at least 7 feet. There is no comparable requirement for non-habitable rooms in the HUD-Code.

Minimum Hallway Width. CABO requires the minimum width of a hallway to be at least 36 inches. The HUD-Code requires hallways to have a minimum horizontal dimension of 28 inches, with an exception for minor protrusions by doorknobs, smoke detectors, light fixtures and similar objects.

Flame Spread and Smoke Developed Ratings of Insulation other than Foam Plastic. In CABO, all exposed insulation materials, including facings, such as vapor barriers or breather papers installed within floor-ceiling assemblies, roof-ceiling assemblies, wall assemblies, crawlspaces and attics must have a flame-spread rating not to exceed 25 and a smoke-developed rating not to exceed 450. When such materials are installed in concealed spaces these requirements do not apply to the facings, provided that the facings are installed in substantial contact with the unexposed surface of the ceiling, floor, or wall finish. No comparable requirements for non-foam plastic insulation materials are in the HUD-Code.

Fire Detection Equipment. The CABO requirements for smoke detectors go beyond the HUD-Code requirements with respect to locations, interconnection and power source.

- *Locations*. CABO requires that smoke detectors be installed in each sleeping room, in addition to other required areas. The HUD-Code does not require smoke detectors in bedrooms. Otherwise, the location requirements are similar.
- *Interconnection*. CABO requires all smoke detectors to be interconnected (i.e., the actuation of one smoke detector will actuate all the detectors in a house). The HUD-Code permits "single-station" (non-interconnected) smoke detectors.
- *Power source*. CABO requires that all smoke detectors be hardwired with battery backup. The HUD-Code requires hardwiring but does not require battery backup.

The combined impact of these particular differences is that homes built to comply with CABO require more expensive smoke detectors, in more locations, with additional wiring interconnecting all the detectors, compared to homes built to comply with to the HUD-Code.

Fire Protection of Roofs. CABO requires that roofs be covered with specific materials as set forth in the code. Roofing classified for fire purposes under UL 790, "Tests for Fire Resistance of Roof Covering Materials," must be installed whenever the edge of the roof is less than three feet from a property line. Certain roofing materials set forth in the code, as well as concrete slabs, may be accepted as Class A roofing. The CABO requirement applies to townhouse dwellings as well as detached homes located with "zero-lot-line" on one side of the building. The HUD-Code has no similar requirements for fire protection of roofs. HUD-Code homes are not built in a townhouse arrangement, but the frequency with which individual units are located within three feet of lot lines is unknown.

Thickness of Gypsum Drywall. The minimum allowable thickness of drywall is 3/8-inch under CABO. CABO further requires drywall applied to ceilings to be 1/2-inch thick for 16-inch on-center framing and 5/8-inch thick for 24-inch on-center framing, when using water-based textured finishes or supporting insulation. This would be the case for at least one ceiling level in virtually all houses. The HUD-Code lists 5/16-inch drywall as the minimum thickness allowed for fire protection and would therefore permit use of thinner drywall throughout the building than the CABO code.

Deflection Criteria for Floors, Exterior Walls, Headers, Beams, Girders and Ceilings. Most aspects of structural design are required to meet limiting deflection criteria. These enter into sizing of lumber used throughout a building. The HUD-Code has less stringent limits than the CABO code for structural members throughout the building.

- *Floors*: CABO specifies a maximum deflection of L/360, while the HUD-Code specifies L/240. This may be offset to some degree by lower CABO floor live loads for sleeping rooms, as discussed above.
- *Exterior walls*: CABO specifies a maximum deflection of L/240, while the HUD-Code specifies L/180.
- *Headers, beams, and girders*: CABO specifies a maximum deflection of L/240, while the HUD-Code specifies L/180.
- *Ceilings*: CABO specifies a maximum deflection of L/240 for ceilings (except those with plaster finish, which must be L/360). The HUD-Code specifies L/180 for ceilings.

These differences in deflection limits are one of the most significant differences between the two codes. Deflection does not always govern in design (sometimes spans are limited by fiber stress

rather than deflection), but when deflection governs and other things are equal (e.g., span, species, grade, dead load, live load), the CABO deflection limits will translate into requirements for deeper floor joists, headers, beams, ceiling joists, truss chords, etc. than would be permitted under the HUD-Code.

Live Loads for Attics. HUD-Code live load criteria for low-slope roofs above attics without storage, and for attics with limited storage, are less stringent than the CABO criteria.

- *No storage, roof slope less than 3/12*. The HUD-Code does not address loads for attics, except that trusses would need to meet the L/180 deflection criteria. CABO requires such attics to withstand a 10 psf uniform load without exceeding the L/240 deflection criterion.
- *Limited storage*. The HUD-Code does not address loads for attics, except that trusses would need to meet L/180 deflection criteria. CABO requires attics with limited storage to withstand a 20 psf uniform load. This may require stronger trusses or ceiling joists than used in manufactured houses. However, the comparison is of little significance because the number of manufactured units with attics intended for even limited storage is likely very small.

Exit Facilities: Required Door Size. The HUD-Code requires all exterior swinging doors and exterior sliding glass doors to provide a minimum 28-inch wide by 74-inch high clear opening. CABO requires one exit door to be not less than 36 inches in width and 80 inches in height. The CABO provisions thus require an exit door to be larger and potentially more expensive than under the HUD-Code.

Seismic Loads and Seismic Construction Provisions. CABO contains a seismic map defining five seismic risk zones and a table with prescriptive minimum wall sheathing/bracing requirements by seismic zone and story of the building. The HUD-Code contains no references at all to seismic loads. State or local installation requirements may address seismic loads for installation or anchorage of HUD-Code homes.

A.2 ELECTRICAL REQUIREMENTS

A.2.1 Areas Where the HUD-Code is More Stringent than CABO

Placement of Electrical Receptacle near Bath or Shower. The HUD-Code prohibits locating receptacle outlets in or within reach (30 inches) of a shower or bathtub space. CABO prohibits installation of a receptacle outlet within a bathtub or shower space.

Type of Wire/Conductor Allowed. Aluminum conductors, aluminum alloy conductors, and aluminum core conductors, such as copper-clad aluminum, are not acceptable for use in branch-

circuit wiring in manufactured homes. CABO does not explicitly exclude aluminum conductors. A potential exists for some cost savings under the CABO Code to the extent that aluminum wiring is less expensive. The practical significance of this is doubtful because aluminum wire is not often used in branch circuit wiring even where it is permitted.

Wire Protection. The HUD-Code requires that outdoor or under-chassis line-voltage wiring, when exposed to moisture or physical damage, be protected by rigid metal conduit. Electrical metallic tubing may be used when closely routed against frames and equipment enclosures. Under a HUD Interpretative Bulletin, flexible metal conduit is also permitted for wiring protection in certain circumstances. CABO permits non-metallic tubing to be used in wet or damp locations. Some cost savings might be possible for manufactured houses if they could use non-metallic tubing in such locations. It is possible that this difference in requirements reflects concerns about transportation damage that are unique to HUD-Code homes.

Electrical System Testing. Manufactured houses are subjected to a one-minute, 900 to 1079 volt dielectric strength test or, alternatively, the test may be performed at 1080 to 1250 volts for one second. Each manufactured home is also subject to:

- A continuity test to assure that metallic parts are properly bonded;
- An operational test to demonstrate that all equipment, except water heaters, electric furnaces, dishwashers, clothes washers/dryers, and portable appliances, is connected and in working order; and
- Polarity checks to determine that connections have been properly made. Visual verification shall be an acceptable check.

Since no similar requirements exist in CABO, these requirements result in some increased costs for all manufactured houses compared with site-built houses.

A.2.2 Areas Where CABO is More Stringent than the HUD-Code

Required Electrical Receptacle Locations. CABO requires electrical receptacles in certain locations where the HUD-Code does not.

- *Hallways*. CABO requires a receptacle to be installed in hallways 10 feet or more in length, while the HUD-Code does not require receptacles in hallways. This difference could apply to multiple hallways in a single house under CABO.
- *Outdoors*. CABO requires outdoor receptacles at both the front and back of the dwelling; while the HUD-Code only requires one outdoor receptacle. One more outdoor receptacle would be required in each home under CABO than under the HUD-Code.

- *Bathrooms*. CABO specifically requires a "wall" receptacle in bathrooms, while the HUD-Code allows receptacles that are integral with the light fixture.

Required Ground-Fault Circuit Interrupter Locations. CABO requires ground-fault circuit interrupter (GFCI) protection at all kitchen countertop receptacles, whereas the HUD-Code only requires such protection on receptacles located within six feet of the sink. Thus, costs for GFCI protection in kitchens would typically be higher under CABO than under the HUD-Code.

Required Electrical Service Connection. A manufactured home that is factory-equipped with gas or oil-fired central heating equipment and cooking appliances is permitted to be provided with a listed manufactured home power-supply cord rated at 40 amp. CABO requires a permanent connection for electrical service; power supply cords are not an option. However this is of little significance since most homes built under CABO (and probably most HUD-Code homes as well) would require more than 40 amp service in the first place.

Required Electrical Service Size. The power supply to a manufactured home must be a feeder assembly consisting of not more than one listed 50 amp manufactured home power-supply cord, or a permanently installed service feeder, except that a manufactured home which is factory-equipped with gas or oil-fired central heating equipment and cooking appliances is permitted to be provided with a listed manufactured home power-supply cord (cap-cord) rated at 40 amp. Under CABO, Section 230-42 of the NEC requires, for initial computed loads greater than 10 kVA, a minimum service of 100 amps. The minimum service size is also 100 amps for dwellings with six or more two-wire circuits. Loads of 10 kVA can be met with service of just over 40 amp, and 60 amp panel boxes with at least six branch-circuit breaker spaces are available. A cost savings might result for some smaller site-built houses with computed loads less than 100 amps if the HUD-Code requirements were applied instead of the CABO requirements.

Panelboard Location. The HUD-Code allows the distribution panelboard to be installed in a closet, while CABO does not. While the HUD provisions clearly would add design flexibility compared to CABO, it is not clear when or to what extent this would translate into cost savings.

Weatherproof Fixture Exceptions. The HUD-Code defines "weatherproof" as:

> "[S]o constructed or protected that exposure to the weather will not interfere with successful operation. Rainproof, raintight, or watertight equipment can fulfill the requirements for weatherproof equipment where varying weather conditions other than wetness, such as snow, ice, dust, or temperature extremes, are not a factor."

The CABO code definition is similar but does not include the second sentence. Construction under the CABO code might therefore lead to some higher cost for outdoor electrical equipment located

in areas not directly exposed to weather, such as under porches or in crawlspaces. The cost per fixture and number of affected houses and fixtures/boxes per house is likely to be small.

A.3 PLUMBING REQUIREMENTS

A.3.1 Areas Where the HUD-Code is More Stringent than the IPC

Water Supply System Test. The HUD-Code requires a 100 psi pressure test with water or air for 15 minutes without loss of pressure. The IPC requires a somewhat less rigorous pressure test at "not less than the working pressure of the system" with water, or not less than 50 psi with air for systems other than plastic; no time interval is specified. In practice, site-built houses typically have a testing interval measured in hours because plumbers often set them up on one day in preparation for an inspection the next day. The issue of testing at the working pressure with water is a practical one: higher-than-street pressures could only be applied with the use of auxiliary devices. The higher test pressures required by the HUD-Code over a (typically) shorter time period compared with site-built houses allow factory production to continue sooner. This may offset the disadvantages of the more stringent pressure test.

Venting: Various Provisions. Many particulars of the venting requirements in the HUD-Code are more stringent than those in the IPC.

- *Vent terminals.* The HUD-Code requires vent terminals to extend vertically at least 2 inches above the roof. The IPC requires termination 6 inches above the roof for vents that extend through the roof, but also permits side-wall venting in some cases.
- *Engineered Vent Systems*. The prescriptive minimum vent sizes under the HUD-Code and the IPC are the same. However, Section 918 of the IPC provides for "engineered vent systems" with vents as small as 1/2-inch, based on calculations of vent air flow rate. The HUD-Code does not specifically mention engineered vent systems, although they might be permitted under section 3280.10, "Use of alternative construction."
- *Anti-Siphon Trap Vents.* The HUD-Code permits anti-siphon trap vents (air admittance valves) on individual fixtures protected by traps not larger than 1-1/2 inches. Other limitations on use and detailed materials specifications (most likely obsolete) for anti-siphon vents are also spelled out but no industry standard is cited. This HUD-Code provision effectively restricts other options that would achieve the same performance result by use of an outdated specification. The IPC references a recognized industry standard for such devices, ASCE 1051, and permits conforming air admittance valves to be used on individual fixture, branch and circuit vents. The only limitation on size is that the valve shall be rated for the size of the vent to which it is connected.
- *Wet Venting*. The HUD-Code is generally more restrictive than the IPC with respect to wet vented systems. HUD-Code provisions for wet venting may be summarized as requiring a

minimum two-inch pipe size that is at least one pipe size larger than the largest connected trap or fixture drain, and a limit of three fixtures connected to a two-inch wet vented system. Under the IPC wet vents are permitted on any combination of fixtures within two bathroom groups located on the same floor. The IPC contains other options for wet vented systems that are not in the HUD-Code.

- *Other Venting Systems*. The IPC contains several other provisions for special types of vents not specifically found in the HUD-Code, including stack vents and vent stacks, vents for stack offsets, relief vents, island sink vents, combination drain and vent systems, circuit venting, waste stack vents and common vents. Some of these would only be relevant for multi-story buildings but others could potentially be used in HUD-Code homes.

A.3.2 Areas Where the IPC is More Stringent than the HUD-Code

Shower Size Requirements. The IPC requires showers to have 900 square inches of interior cross-sectional area, not less than 30 inches in any horizontal dimension. The HUD-Code does not specify shower size. Smaller showers would be permitted under the HUD-Code than under the IPC.

Clothes Washer Connection. One connection for a washing machine is required by the IPC. The HUD-Code does not have a similar requirement.

Pressure Balancing/Thermostatic Mixing Valves. The IPC requires a minimum of a master thermostatic mixing valve in one- and two-family dwellings. The HUD-Code has no such provisions.

Water Distribution Pipe Sizing. In general, the IPC provisions for water pipe sizing are much more complex, and the resultant required piping sizes larger, than those allowed by the HUD-Code. The HUD-Code specifies only that "piping systems shall be sized to provide an adequate quantity of water to each plumbing fixture at a flow rate sufficient to keep the fixture in a clean and sanitary condition...based on a design condition of 80 psi." A simple table in the HUD-Code specifies minimum pipe size by the number of fixtures served as follows:

Table 24: HUD-Code Minimum Size Tubing and Pipe for Water Distribution Systems

Number of Fixtures	Tubing (Nominal)		Pipe Iron Pipe Size (Inches)
	Diameter (Inches)	Outer Diameter (Inches)	
1	1/4*	3/8	1/2
2	3/8	1/2	1/2
3	1/2	5/8	1/2
4	1/2	5/8	1/2
5 or more	3/4	7/8	3/4
*6 ft. maximum length.			

Only "water using" fixtures are counted (i.e., sinks, dishwashers, tubs, showers, lavatories, toilets, clothes washers and hose bibs). Fixtures are not "weighted" by volume or frequency of use in the fixture count. Dishwashers and clothes washers must be served by a minimum 3/8-inch tubing, but all other fixtures may be supplied with 1/4-inch tubing unless a larger size is required by the manufacturer. A 1/4-inch supply is limited to six feet maximum length while there is no limit on length for larger pipe sizes.

The IPC has a performance requirement calling for pipe sizing such that under peak demand, residual pressure and flow rate at the fixture supply pipe outlets shall not be less than specified values based on fixture type, as listed in Table 25. In addition, the IPC sets forth minimum sizes of supply pipes to selected individual fixtures, as summarized in Table 26. These sizes generally exceed those for water piping in the HUD-Code. Note that the same sizes also apply to individual distribution lines used in parallel water distribution systems, except as provided in the footnote to the table. Supply pipes must not terminate more than 30 inches from the point of connection to a fixture, compared to six feet for 1/4-inch supply tubing in the HUD-Code.

Table 25: IPC Water Distribution System Design Criteria

Fixture Supply Outlet Serving	Flow Rate (Gpm)	Flow Pressure (Psi)
Bathtub	4	8
Dishwasher, residential	2.75	8
Laundry tray	4	8
Lavatory	2	8
Shower	3	8
Shower, temperature controlled	3	20
Sillcock, hose bibb	5	8
Sink, residential	2.5	8
Water closet, tank, close coupled	3	8
Water closet, tank, one piece	6	20

Table 26: Minimum Sizes of Fixture Water Supply Pipes in the IPC

Fixture	Minimum Pipe Size (Inches)
Bathtubs (60" x 32" and smaller)*	1/2
Bathtubs (larger than 60" x 32")	1/2
Combination sink and tray	1/2
Dishwasher, domestic*	1/2
Hose bibbs	1/2
Kitchen sink*	1/2
Laundry, 1, 2 or 3 compartments*	1/2
Lavatory	3/8
Shower, single head*	1/2
Water closet, flush tank	3/8
Water closet, one piece*	1/2

* Where the developed length of the distribution line is 60 feet or less, and the available pressure at the meter is a minimum of 35 psi, the minimum size of an individual distribution line supplied from a manifold and installed as part of a parallel water distribution system shall be one nominal tube size smaller than the sizes indicated.

Water Heater Specifications: Various. IPC water heater provisions appear to be written with commercial applications in mind, rather than for use with simple residential systems. They contain several specific requirements that go beyond anything in the HUD-Code.

- *Water Supply Shut-Off*. The IPC requires that the cold water supply to the water heater have a shut-off valve which does not restrict cold water to the remainder of the cold water system. The HUD-Code has no such requirement.
- *Relief Valve Piping Drainage.* The IPC requires that the discharge from the temperature and pressure relief valve be piped separately to the outside of the building or to an indirect waste receptor located inside the building. Other requirements apply if the discharge pipe is in an area subject to freezing. Any discharge must also be readily observable. The HUD-Code has no such requirements.
- *Drainage Pans*. The IPC requires that a metal or plastic pan be installed under water heaters where their leakage could cause damage. The HUD-Code does not require drain pans but does require wood, wood fiber or plywood floors or subfloors in water heater compartments to be moisture-resistant or made moisture-resistant by sealing or by installing an overlay of nonabsorbent material applied with water-resistant adhesive. Additional costs for a pan, drain line, and labor would apply to many houses built under the IPC. Even houses with water heaters located in unfinished basements or garages could also be affected, depending on how the IPC provision is interpreted and enforced.
- *Manual Shutdown*. The IPC requires electric water heaters to have a separate switch allowing energy cut-off**,** whereas the HUD-Code does not. This would add cost for all houses with electric water heaters built under the IPC.

Pipe Support. According to the IPC, "where earthquake loads are applicable," piping supports must be designed and installed in accordance with the building code. The HUD-Code contains no specific seismic support requirements. Where this provision is triggered it would add cost, but it is ambiguous and its application is highly uncertain.

Water Shut-Off Valves.

Identification. The IPC requires that service and hose bib shut-off valves be identified. All other valves installed in locations that are not adjacent to the fixture or appliance must also be identified, indicating the fixture or appliance served. The HUD-Code requires only the main water supply connection to the house to be identified.

Required Shut-Off Valves. In the IPC, shut-off valves are required at the following locations:

-- connection to public water supply near the curb,
-- supply pipe at the entrance into the building,
-- on the discharge side of the water meter,
-- supply to each sillcock (hose bib), and
-- supply to each appliance or piece of mechanical equipment supplied with water.

The HUD-Code does not require installation of any shut-off valves. Manufacturers have the option to simply provide installation instructions indicating that a shut-off valve is to be installed in the water supply line adjacent to the home at the time the home is connected to a water supply. This suggests no difference in cost to the consumer for that particular valve, which will presumably be installed at some point before occupancy. Some cost savings would be realized in manufactured homes if the other shut-off valves that would be required under the IPC are not installed.

Drainage Pipe Sizing. The IPC has a more complex, somewhat more conservative procedure than the HUD-Code for specifying drainage pipe sizes. Under section 3280.610(e) of the HUD-Code, drainage pipe sizing is based on number of fixtures, as follows:

> "(i) A 1-1/2-inch minimum diameter piping shall be required for one and not more than three individually vented fixtures.
> "(ii) A 2-inch minimum diameter piping shall be required for four or more fixtures individually vented.
> "(iii) A 3-inch minimum diameter piping shall be required for water closets."

The minimum pipe size is further limited by the trap size for a fixture, which appears to be assumed based on fixture type. Accordingly, it should be noted that Section 3280.611 of the HUD-Code provides for a 1-1/4-inch individual fixture drain.

The IPC takes a more traditional two-step route to drainage pipe sizing. First, "drainage fixture unit" (dfu) values and minimum trap sizes are assigned to different fixture types based on the anticipated load (Table 27). Unlisted fixtures have a generic dfu assigned based on the drain or trap size (Table 28). Finally, the minimum diameters of horizontal branches and stacks that drain multiple fixtures are based on the sum of the dfu values for all fixtures or fixture groups served (Table 29).

Table 27: IPC Drainage Fixture Units for Selected Fixtures and Groups

Fixture Type	Drainage Fixture Units	Minimum Size of Trap (inches)
Automatic clothes washer	2	2
Bathroom group (water closet, lavatory, bidet and bathtub or shower)	6	--
Bathtub (with or without overhead shower or whirlpool attachments)	2	1-1/2
Kitchen sink with food waste grinder and/or dishwasher	2	1-1/2
Laundry tray (1 or 2 compartments)	1	1-1/2
Lavatory	1	1-1/4
Shower compartment	2	2
Water closet	4	*
* Trap size shall be consistent with the fixture outlet size.		

Table 28: IPC Drainage Fixture Units Based on Fixture Drain or Trap Size

Fixture Drain or Trap Size (inches)	Drainage Fixture Unit Value
1-1/4	1
1-1/2	2
2	3
2-1/2	4
3	5
4	6

Table 29: IPC Sizing of Horizontal Branches and Stacks

Diameter of Pipe (inches)	Maximum Number of Drainage Fixture Units (dfu)			
	Total for a horizontal branch	Stacks		
		Total discharge into one branch interval	Total for stack of three branch intervals or less	Total for stack greater than three branch intervals
1-1/2	3	2	4	8
2	6	6	10	24
2-1/2	12	9	20	42
3	20	20	48	72
4	160	90	240	500

Comparison of these tables with the simplified provisions of the HUD-Code, allowing up to three fixtures of any type (except water closets) on a 1-1/2-inch drain and four or more on a two-inch drain, shows that the IPC would frequently require larger drain sizes than the HUD-Code for the same set of fixtures.

DWV System Test. The HUD-Code specifies that the DWV system be tested by one of the three following methods for indication of leakage:

(1) **Water test**. Before plumbing fixtures are connected, all of the openings into the piping shall be plugged and the entire piping system subjected to a static water test for 15 minutes by filling it with water to the top of the highest vent opening. There shall be no evidence of leakage.

(2) **Air test**. After all fixtures have been installed, the traps filled with water, and the remaining openings securely plugged, the entire system shall be subjected to a two-inch (manometer) water column air pressure test. If the system loses pressure, leaks may be located with smoke pumped into the system, or with soap suds spread on the exterior of the piping (Bubble test).

(3) **Flood level test**. The manufactured home shall be in a level position, all fixtures shall be connected, and the entire system shall be filled with water to the rim of the water closet bowl. (Tub and shower drains shall be plugged). After all trapped air has been released, the test shall be sustained for not less than 15 minutes without evidence of leaks. Then the system shall be unplugged and emptied. The waste piping above the level of the water closet bowl shall then be tested and show no indication of leakage when the high fixtures are filled with water and emptied simultaneously to obtain the maximum possible flow in the drain piping.

The HUD-Code also specifies that plumbing fixtures and connections be subjected to a test by filling with water and checking for leaks or retarded flow while being emptied. Shower receptors must be tested by filling with water to the top of the dam for not less than 15 minutes without evidence of leakage.

The IPC provides for alternative tests of the DWV piping system using water or air. The water test is essentially the same as alternative test (1) under the HUD-Code. The air test under the IPC requires a test pressure of 5 psi for 15 minutes, while the HUD-Code test pressure is only two inches of water column (less than 0.1 psi) and no time interval is specified. The reason for the difference is that the IPC air test is applied to the DWV piping system before fixtures are set, whereas the HUD-Code air test is applied after fixtures are set and is therefore limited by the two-inch water seals in the traps. Finally, the IPC specifies a final test after fixtures are set. This is a subjective "visual" test by the inspector that may be replaced by a smoke test under a pressure of 1 inch water column for 15 minutes "where necessary for cause."

Trap Arm Length. A final provision with mixed impact concerns trap arm length (i.e., the maximum distance from a fixture trap to the vent for the fixture). The IPC has more restrictive criteria than the HUD-Code for 1-1/4" fixture drains, but less restrictive criteria for larger drains. This can affect design (location of the fixture relative to the drain line) or cost (requirement for

larger drain pipe size). Maximum lengths of trap arm as specified in the HUD-Code and the IPC are compared in Table 30.

Table 30: Maximum Distance of Fixture Trap from Vent

IPC			HUD-Code
Size of Trap (inches)	**Size of Fixture Drain (inches)**	**Distance from Trap (feet)**	**Distance from Trap (feet)**
1-1/4	1-1/4	3.5	4.5
1-1/4	1-1/2	5	4.5
1-1/2	1-1/2	5	4.5
1-1/2	2	8	5
2	2	6	5
3	3	10	6
4	4	12	--

APPENDIX B

COST COMPARISONS IN CHAPTER 6

This Appendix explains the sources of data and the methods used for deriving the numbers in the key tables of Chapter 6.

B.1 SITE-BUILT SINGLE-FAMILY HOUSES

The dollar values listed in the tables were derived from a 1995 survey of NAHB builder-members.[60] The survey asked builders to generate a profile of the cost of a standard house (see Table 31) including:

- construction
- finished lot cost (including financing cost)
- financing cost (construction)
- builder's overhead and general expenses
- marketing cost (including homebuyer financing)
- sales commission
- profit

Builders were also asked to complete a breakdown of construction and lot costs, although this detailed information was not as complete and was not used in the cost comparison tables.

Table 31: Characteristics of a Standard House

Interior Characteristic	Exterior Characteristic
• standard 8-foot ceiling • 2.5 baths • master bedroom bath with double vanity and skylight • fiberglass bathtub (no jacuzzi), standard toilets • 3 or 4 bedrooms • master bedroom with a walk-in closet • standard wall-to-wall carpeting in most living areas of home • standard appliances: refrigerator, range with oven, microwave, dishwasher, garbage disposal • standard grade wood cabinets and vanities • central A/C and gas furnace (or electric heat pump)	• roofing/asphalt shingles • double pane windows • insulated steel entry doors • 2-car attached garage • asphalt driveway
Optional Characteristics	
• Number of Stories: 1, 1-1/2, 2 or more • Basement: partial, full, crawl space, slab-on-grade • Exterior Wall Material – Front: brick, block, wood, vinyl, aluminum, stucco, other • Exterior Wall Material - 3 sides: brick, block, wood, vinyl, aluminum, stucco, other	
HOME: 2,000 square feet on a 1/4-acre lot in a subdivision of 30 or more homes in a suburban location within 15-20 miles of a major city or employment center.	

[60] *Builder's Survey of Construction Costs*, National Association of Home Builders, 1995.

The median sales price ($144,000) and the median square footage (1,990 square feet) of a new single-family detached home including land in 1996[61] were used in combination with the national cost averages from the NAHB survey to estimate the site-built home costs used in the initial cost comparison of Table 19. The cost percentages and values used in the Chapter 6 tables are summarized below in Table 32.

Table 32: Cost Percentages and Dollar Values for Site-Built Houses Used in the Chapter 6 Tables

Cost Component	NAHB survey cost estimate (%)	Table 19 value	Table 20 and Table 23 value
Construction Cost	53.3%	$76,752	$77,140
structure	49.14%	$70,765	$71,123
foundation	4.16%	$5,987	$6,017
Finished Lot Cost	24.4%	$35,136	$35,314
improved lot	23.57%	$33,941	$34,113
site preparation	0.83%	$1,195	$1,201
Financing Cost	2.0%	$2,880	$2,895
Overhead And General Expenses	5.8%	$8,352	$8,394
Marketing Cost	2.1%	$3,024	$3,039
Sales Commission	3.3%	$4,752	$4,776
Profit	9.1%	$13,104	$13,170
TOTAL SALES PRICE	100%	$144,000	$144,728

The comparisons assume that the distribution of the costs of a new house does not change; only the dollar values change because of the increased size of the home. The percentages from the NAHB survey were used to generate the dollar values after adjusting the construction cost (in dollars) for the increased size of the normalized home. The construction cost per square foot from Table 19 ($38.57) was used to calculate the new, normalized construction cost of $77,140 for the 2,000 square foot house. Because construction costs represent 53.3 percent of a house's price, the total sales price of the normalized house is calculated to be $144,728. The other cost elements were calculated from this total sales price.

B.2 MODULAR SINGLE-FAMILY HOUSES

The characteristics of modular houses were assumed to be comparable to the site-built houses. This comparability is assumed because modular homes are a direct competitor to site-built

[61] Bureau of the Census, *Characteristics of New Housing 1996*, C25/96-A, 1996.

houses. The distribution of costs among the seven basic cost components does, however, differ between modular and site-built houses in several ways:

1. Construction costs are 15 percent lower for modular houses.
2. Overhead and general expenses are slightly lower.
3. Marketing is marginally lower.
4. Profit is significantly higher.
5. Construction financing is lower.

Construction costs are lower because of the efficiency and economies of scale in the factory environment. The industry-accepted difference in construction cost between modular and site-built construction is 15 percent.[62] Using this relationship the construction cost for the modular house is 85 percent of the construction cost of the site-built house, or $65,239. Since the homes are assumed to have identical features, i.e., both are 2-story, 1,990 square foot homes, the foundation cost for the modular home is identical to that for the site-built home. The structure cost is calculated by subtracting foundation costs ($5,987) from total construction costs resulting in $59,253 for structure costs. Land costs ($35,136) are also assumed to be identical because lot size, location, and foundation are the same.

Total sales price was set at $129,817, calculated by summing the dollar costs for construction cost and land ($100,375), then dividing by their combined share of total costs (77.7 percent).

The overall percentage of total sales price allocated to overhead, marketing, commission, construction financing, and profit is the same for modular and site-built homes (22.3 percent, see Table 21). Overhead and general expenses for modular houses are 5 percent compared to 5.8 percent for site-built homes because modular builders do not have to manage as many subcontractors in the construction of the home and thus the cost of doing business is lower. Modular builders spend 2 percent on marketing, versus 2.1 percent for site builders. The lower percentage reflects the benefit that modular builders receive from advertising that the factory producer of homes may provide.

Modular builders earn 11 percent profit on the sales price of houses compared to an average 9.1 percent for site builders because of lower overhead and financing costs. Modular builders are able to earn higher profits for two main reasons. First, reduced costs of overhead and construction financing can be directly transferred to profits without inflating the price of the home. Second, lower square-foot construction costs allow for higher profit while the total sales price of the home remains competitive with the comparable site-built homes that dominate the market.

[62] See *Builder*, January 1996, and *Journal of Light Construction*, June 1996.

Construction financing is lower for modular builders (one percent versus two percent for site builders) because the construction cycle time is 50 percent or less of the time required to construct a site-built home. This shorter financing period results in lower financing costs.

These established cost percentages and the previously calculated total sales prices were used to calculate dollar values for the size-normalized modular house in Table 20. The average cost per square foot from Table 19 ($32.78) was used to calculate construction costs for the 2,000 square foot standard house ($65,560). As with Table 19, the foundation and land costs are identical for modular and site-built houses in Table 20, and the total sales price and overhead and financing costs were calculated in the same manner as for Table 19.

B.3 MANUFACTURED HOUSES

Manufactured homes are priced differently than site-built and modular homes in that their prices typically do not include the cost of land. The total sales price of manufactured homes was calculated by adding the sales price of the home and the price for land.[63] The median sales price of new manufactured homes was available for double-section homes (median 1,680 square feet) and single-section homes (median 1,215 square feet). Double-sections were most often placed outside of land-lease communities (74 percent), but this is also true for all manufactured houses. Blocks were the most common foundation (75 percent), but a double-section was the most likely size of home placed on a foundation other than blocks (35 percent).

These trends were used to select the four variations of manufactured house-land placement options presented in the various Chapter 6 tables. The double-section placed on an individual lot on a block foundation and the single-section placed in a land-lease community on blocks are the two most common real-world scenarios. The double-sections placed in a fee-simple subdivision and a land-lease community on permanent foundations are indicative of emerging trends. Permanent foundations are used in the examples for two reasons: financing with conventional loans require permanent foundations, and both fee simple and upscale land-lease communities typically require permanent foundations for aesthetic reasons.

The median sales price from the Bureau of the Census includes the structure cost of a house plus the retailer's profit and overhead costs, including general expenses, marketing, sales commission and inventory financing. The foundation and site preparation costs are separate charges that the home buyer must pay, either to the retailer or an independent contractor.

[63] U.S. Department of Commerce, Bureau of the Census, *Characteristics of New Housing 1996*, C25/96-A, and *Survey of Construction*, 1996.

Foundation costs were estimated based on telephone interviews with the Manufactured Housing Institute and various retailers in North Carolina, Maryland, and Virginia. For single-section homes, the range for block foundations was $750 to $1,000 and for permanent foundations was $1,500 to $2,000. For double-section homes, the price of block foundations ranged from $1,500 to $2,000 and for permanent foundations from $2,500 to $3,500.

Site preparation costs were estimated using R.S. Means cost estimating guides[64] and include the cost of clearing, excavating a footing (if necessary), grading, and backfilling (if necessary). Footing excavation was 4 feet deep and backfill included 4-inch lifts with no compression. The cost of footings is included in the foundation costs as a component of construction costs.

As stated previously, the median sales price from the Bureau of the Census includes the structure cost of a house plus the retailer's overhead costs and profit.[65] In the various Chapter 6 tables, the overhead cost and profit (25 percent) are also applied to the cost of the foundation and any land purchases. This assumption is made because retailers or subdivision developers incur costs and earn profit from the handling of foundation construction, site preparation, and sale of land.

Each of the four manufactured house examples includes different assumptions because of the different land purchase or size of home involved. Table 33 lists some of the assumptions for each home-land situation used in constructing the cost comparisons in Chapter 6. It is these assumptions that led to the calculation of overhead and profit to include or exclude land costs. For example, the retailer's profit on the double-section manufactured house placed on an individual lot is calculated by multiplying a 15 percent profit rate times the sum of the Census Bureau's median sales price ($46,200) and the foundation cost ($1,500). The site preparation and improved lot cost are not included in this calculation because the lot is pre-owned and the home buyer handles site preparation. The retailer's marketing expense on the double-section house placed in a fee simple subdivision is calculated by multiplying two percent times the sum of the Bureau of the Census median sales price ($46,200) plus the foundation cost ($3,000) and the land cost ($35,314), including the improved lot and site preparation. This is done because the retailer/developer incurs expenses from developing land and preparing lots for home placement.

[64] *Residential Cost Data*, R.S. Means, 1998.

[65] Overhead and profit were estimated from the explanation of retailer establishments in *Development, Marketing, and Operation of Manufactured Home Communities* by George Allen, David Alley and Edward Hicks. Table 21 provides an itemized list of the percent that overhead costs and profit represent of a home's sales price.

Table 33: Assumptions for Manufactured House-Land Examples in Chapter 6 Tables

Double-Section on an Individual Lot	Double-Section in a Fee Simple Subdivision	Double-Section in a Land-lease Community	Single-Section in a Land-lease Community
retailer arranges for foundation	retailer/developer arranges for foundation and site preparation	retailer arranges for foundation and site preparation	retailer arranges for foundation and site preparation
land is pre-owned and retailer is not involved in site preparation	retailer/developer offers home and land as a package purchase	permanent foundation required by community	block foundation is the most typical real-world situation
block foundation is the most typical real-world situation	permanent foundation required by community and for conventional mortgage		
	retailer/developer incurs costs and earns profit relating to land sale		

The land costs for manufactured homes differs for each of the four home-land options. The land costs for private land include the fixed improved lot cost ($33,714) plus the site preparation cost ($711 for the block foundation and $1,167 for the permanent foundation). The land costs for homes placed in land-lease communities is composed of only site preparation costs for the foundation type to be used under the home. Homes placed on individual lots are assumed to have 1/2-acre of space while homes placed in fee simple subdivisions are placed on 1/4- to 1/6 acre lots.[66] Land-lease communities offer 1/4-acre lot densities for double-section homes, but have higher lot densities (1/6-acre to 1/8 acre per unit) and thus smaller lots for the smaller, single-section homes.

Land-lease communities do not involve the purchase of a lot, but they do charge rent for the lot upon which the home is placed. Manufactured home owners will pay more for a double-section

[66] The one-half acre lot size was based on the 1995 *American Housing Survey* average lot size of 0.88 acres for all manufactured homes. This value is skewed higher than the typical new lot due to homes located on large lots (5 or more acres). The lot size for homes placed in fee simple subdivisions is based on case studies of developments of manufactured home communities published by the California Manufactured Housing Institute and in trade publication articles. It has been suggested that the land prices assumed for manufactured homes may be higher than average, as discussed above in footnote 38.

home lot ($250) than for a smaller, single-section home lot ($200).[67] The land rent is a monthly cost of owning a home but is not part of the purchase price of a home, so it does not appear in any land cost totals in the Chapter 6 tables.

B.4 Table 20: THE NORMALIZED COMPARISON

The comparison in Table 20 involved the normalization of the total price of the homes with regard to the following items:

- square footage of home
- foundation
- site preparation
- improved lot cost (for options involving private land)

The exception to the above list is the single-section manufactured house. It does not make sense, nor is it realistic to analyze a 2,000 square-foot single-section home. Thus, the single section home remains 1,215 square feet and the cost of the foundation and site preparation are reduced because of the significantly smaller size of the home. The cost of the foundation and site preparation were rounded down based on the lower materials expense for the foundation and smaller pad prepared for the home. The cost reduction is approximate and is not meant to be exact.

B.5 Table 23: THE FINANCING COMPARISON

The comparison of the consumer financing of the six home-land options uses the values from the normalized comparison. The total sales price of the homes are taken from Table 20, with two adjustments:

1. Sales price is reduced for the manufactured house placed on pre-owned land (i.e., land is deducted from the total sales price).
2. Delivery and set up costs are added to the cost of manufactured houses.

Down payment is equal to 10 percent of the total sales price of the home (including delivery and set up because lenders allow this charge to be added to the loan amount). The manufactured home placed on a pre-owned individual lot uses a lien on the land in lieu of a down payment. Closing costs are assumed to equal 5 percent of the total sales price of the homes. Sales tax is applied to the manufactured houses and is calculated based on the sales price of the home only. The cost of the foundation is not taxed. For example, the sales tax on the double-section homes

[67] Lot rental fees are based on the average rent paid as reported in *Manufactured Housing Research Project*, Kate Warner and Robert Johnson, University of Michigan, January 1993.

equals 3 percent of the retail sales price of the houses, or $1,650 (i.e., if structure cost equals $41,260 and structure represents 75 percent of the total sales price, then the total sales price is $55,000 and the tax would be $1,650). The security deposit is only applicable to houses placed in land-lease communities and is a fixed $350 per home based on an average for the industry.[68]

The loan amount is calculated by subtracting the down payment from the total sales price. For example, the loan amount for the modular home equals $129,824 minus 10 percent, or $116,841. The monthly loan payments were based on standard loan amortization tables for the specific loan term and interest rate applicable to each option. Total monthly payments were calculated by summing the monthly loan payment and land rent. In this comparison, land rent only applies to the houses placed in land-lease communities.

[68] Warner and Johnson, *Manufactured Housing Research Project*, University of Michigan, January 1993.

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