Prepared for
The American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
Technical Committee 4.4, Building Materials and Building Envelope Performance

CHARACTERIZATION OF FRAMING FACTORS FOR NEW LOW-RISE RESIDENTIAL BUILDING ENVELOPES (904-RP)

FINAL REPORT

August 2001

Prepared by
Enermodal Engineering Limited, Kitchener, ON

In association with
Enermodal Engineering, Inc., Denver, CO
Energy Rated Homes of Iowa, Des Moines IA
Tait Solar, Phoenix, AZ
Conservation Services Group, Westborough, MA
University of Tennessee, Knoxville, TN
Chitwood Energy Management, Mount Shasta, CA

EXECUTIVE SUMMARY

Residential building energy codes (such as ASHRAE Standard 90.2, MEC – Model Energy Code, HERS – Home Energy Rating System and ICC – International Energy Conservation Code) require building assemblies to meet or exceed a specific R-value. Designers typically show compliance by adding up the thermal resistances of each layer in the assembly (i.e. parallel-path method). When there is more than one "path" through the assembly, for example through the insulation and through the wood framing in the case of a wood-framed wall, the thermal resistance through each path is calculated and area weighted.

The area represented by framing is not well substantiated. It is not a simple case of knowing the on-center stud spacing. Residential construction includes much more framing or corners, around windows and doors, between floors and for blocking and bracing. The ASHRAE Handbook of Fundamentals has offered some guidance as to what typical framing percentages are, but values range between 15 and 25%.

Component	1985 & 89 ASHRAE Handbook		1993 & 97 ASHRAE Handbook	
	16" Studs	24" Studs	16" Studs	24" Studs
Studs & Sills	N/A	N/A	21%	18%
Headers	N/A	N/A	4%	4%
Total	15%	12%	25%	22%

One hundred and twenty dwellings were audited during construction to assess the amount of framing. The dwellings were distributed in four regions of the United States (North-east, South-east, Mid-west and West) and three dwelling types (single detached, attached and multi-family) so as to obtain statistically significant samples for each dwellings type and region. The size and style of dwelling within each group were selected to represent the range in that region.

This study excluded two types of dwellings to minimize the number of variables: cold-formed (light gauge) steel-framed dwellings and dwellings located in high wind or high seismic load regions.

The amount of framing is expressed in two ways: gross and net. The gross values are the amount of framing in an envelope component (wall, floor, or ceiling) divided by the gross component area (including the area of any openings). The net values are the

amount of framing in the component divided by the framed area (excluding the area of any openings). The framing factors based on the net area should be used whenever the net area is known.

Approximately 17% of the gross wall area is taken up by openings for windows and doors. Windows account for 12% of the wall area and doors account for 5% of the wall area. The door area includes swinging and sliding glass doors. The amount of openings in floors and ceilings is negligible (less than 2% of the gross area).

There is very little regional variation in house framing factors. Dwellings in the western U.S. appear to have lower overall framing factors because they have a large ceiling component (they are predominantly large single-story dwellings). Framing factors do not appear to be dependent on house size or size of wall studs (2X4 vs. 2X6). For the dwellings audited, 2X6 framing was used to accommodate taller walls or buildings rather than wider stud spacing. During the audits it was noted that few dwellings were framed with 24" stud spacing. Multi-story dwellings appear to have slightly higher overall framing factors because of the smaller ceiling area and additional framing for support.

The framing factors for attached, detached and multi-family dwellings are very similar. The values are summarized in the table below. This table is recommended for inclusion in the ASHRAE Handbook of Fundamentals.

Component	All Dwellings (Detached, Attached, and Multi-Family)
Window Area to Gross Wall Area	**12 %**
Door Area to Gross Wall Area	**5 %**
Rim Joist Area to Gross Wall Area	**4 %**
Framing Factors	% of Net Framed Area
Ceiling	**7 %**
Wall	**25 %**
Floor	**12 %**
Overall	**16 %**

A review of the 2000 International Residential Code indicates that the design requirements for high wind and high seismic loads can be met without increasing the framing factors. A similar study on dwellings in California, a region with high seismic loads, showed similar framing factors as this study [Enermodal, 2001].

ACKNOWLEDGEMENTS

This report was prepared by Stephen Carpenter and Chris Schumacher of Enermodal Engineering Limited for ASHRAE Technical Committee 4.4. The support of regional auditors in collecting the housing data is appreciated:

Lois Arena & Sue Reilly, Enermodal Engineering, Inc., Denver, CO

Claude Papesh, Energy Rated Homes of Iowa, Des Moines IA

David Tait, Tait Solar, Phoenix, AZ

Bruce Harley, Conservation Services Group, Westborough, MA

Dick Bennett, University of Tennessee, Knoxville, TN

Rick Chitwood, Chitwood Energy Management, CA

The authors would like to acknowledge the financial support of ASHRAE and the guidance provided by the Project Monitoring Subcommittee of Jonathan Humble, Dick Ray, Bill Brown, Jeff Christian, and Mikael Salonvaara. We would also like to thank Jonathan Leber and Don Aumann of CEC for their review and comments.

Table of Contents

List of Figures

List of Tables

1. INTRODUCTION

Residential building energy codes (such as ASHRAE Standard 90.2, International Energy Conservation Code, etc.) require building assemblies to meet or exceed a specific R-value. The requirements are usually a function of assembly type (e.g., wall, ceiling), climatic region and in some cases fuel type. Designers typically show compliance with these requirements by performing a set of calculations that add up the thermal resistances of each layer in the assembly (i.e. parallel-path method). When there is more than one "path" through the assembly, for example through the insulation and through the wood framing in the case of a wood-framed wall, the thermal resistance through each path is calculated and area weighted.

Performing the area weighting requires knowledge of the relative amounts of each path in the assembly. The ratio of the area of wood framing to the area of the wall is called the framing factor. For wood-frame dwellings, calculation of framing factors would seem to be a simple task since the studs are installed at equal spacings (e.g., 16 or 24" on center). The reality is that residential construction is much more complicated because of the additional framing that must be added in corners, around windows and doors, between floors and for blocking and bracing.

The original framing factor values used in the ASHRAE Handbook during the 1970's were derived from a limited number of dwellings constructed in the field and from calculations of design models of dwellings. Since that time, various field studies were presented to ASHRAE for consideration for inclusion in the Handbook of Fundamentals. These led to the changes in the framing factor sections of the Handbook. ASHRAE Technical Committee 4.4, Building Materials and Building Envelope Performance, realized that the housing stock types in the United States have changed since the 1970's and determined in 1998 that a comprehensive study was necessary to determine the validity of the framing factors section of the Handbook of Fundamentals, thus initiating this project.

Having more accurate and representative framing percentages offers four benefits. First, more accurate data can have a significant effect on total-assembly R-value because heat transfer is much higher through the studs than through the insulation. For example, an eight-point increase in percentage framing (from 11 to 19%) reduces total-wall R-value by 12%. Second, using a more representative framing percentage may alter the relative cost-effectiveness between building assemblies (e.g., 2X6 vs. 2X4 with insulated sheathing vs. concrete block). Third, building assemblies that currently qualify in energy codes may no longer qualify if more representative framing factors are used (and vice versa). Fourth, the energy benefit of more efficient framing techniques (e.g., 2-stud corners) could be calculated (and accounted for in codes).

This report outlines the work undertaken to develop a representative set of framing factors for new low-rise residential dwellings. The objectives of this work were

- to develop a statistically representative set of framing factors
- to identify regional and dwellings-type differences in framing factors
- to quantify the distribution of framing within dwellings (e.g., walls, windows, ceilings)
- to present the information in a form that can be used in the ASHRAE Handbook by designers, code officials and the building community.

One hundred and twenty dwellings were audited during construction to assess the amount of framing. The dwellings were distributed in four regions of the United States (North-east, South-east, Mid-west and West) and three dwelling types (single family detached, single family attached and low-rise multi-family) so as to obtain statistically significant samples for each dwellings type and region. The size and style of dwellings within each group were selected to represent the range in that region. The data was analyzed in a database program to determine the amount and type of framing.

For the purpose of this research report, the following terms shall have the meanings indicated:

Attached Single-Family Dwelling: A single-family dwelling unit constructed in a row of attached units separated by property lines and with open space on at least two sides.

Detached Single-Family Dwelling: Any building which contains one dwelling, used, intended or designed to be built, and is occupied for living purposes.

Dwelling: A single unit providing complete independent living facilities for one or more persons, which includes permanent provisions for living, sleeping, eating, cooking, and sanitation [ICC-2000].

Multi-family Low-Rise Dwellings: A group of single-family units contained in a two- or three-story building where the occupants are non-transient in nature (e.g. apartment house).

This study excluded two types of building construction. Cold-formed (Light Gauge) steel-framed residential construction was not included so as to minimize the number of variables. Similarly, dwellings located in high wind load or seismic regions were excluded. It is likely that dwellings in these regions would have additional framing to withstand these natural forces. If they were included in the database, they may tend to skew the data. However, the amount of extra framing that would likely be added is studied by reviewing the structural requirements of buildings in these regions.

2. BACKGROUND INFORMATION

2.1 Published Values of Framing Factors

Several sources have published data on the percentage framing in wood frame dwellings. Table 2.1 lists "typical" values of percent framing from previous versions of the ASHRAE Handbook of Fundamentals. Table 2.2 lists the values given in the Canadian Model National Energy for Dwellings [NRCC, 1997]. These sources represent a large variation in the amount of framing: from 15% to 25% for 16" stud spacing and from 12% to 22% for 24" stud spacing. The value of this data is limited in three ways. First, the source and representativeness of this data is not known. It does not appear to be based on a statistically valid sampling procedure. Second, given the wide range in house types (e.g., detached, attached, multi-unit), regional construction practices and house designs, it is likely that a single value is not representative of all cases. Third, in many cases, it is important to know where the framing is to evaluate its impact on the assembly R-value. Framing in attics may have a lower effect on assembly R-value than for walls because ceiling joists are often covered by the insulation.

Table 2.1: Framing Factors from the ASHRAE Handbook of Fundamentals

Component	1985 & 89 ASHRAE Handbook		1993 & 97 ASHRAE Handbook	
	16" Studs	24" Studs	16" Studs	24" Studs
Studs & Sills	N/A	N/A	21%	18%
Headers	N/A	N/A	4%	4%
Total	15%	12%	25%	22%

Table 2.2: Framing Factors from the Canadian Model National Energy Code for Dwellings

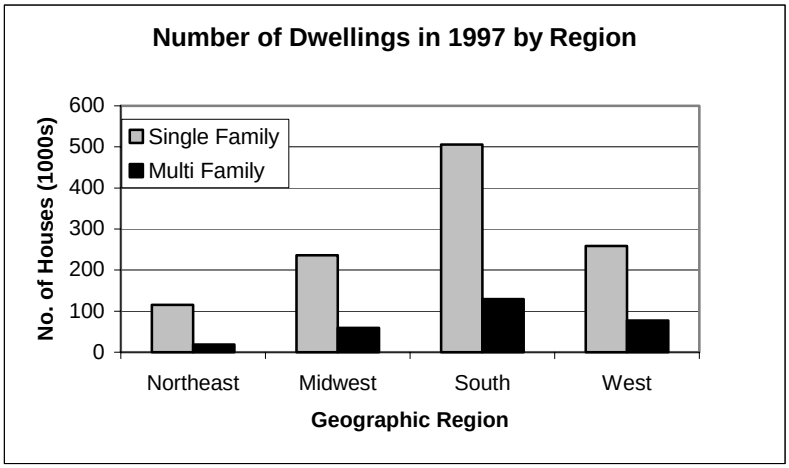
Component	16" Stud Spacing	24" Stud Spacing
Roofs, Ceilings, Floors	10%	7%
Above-Grade Walls	19%	11%
Below-Grade Walls	17%	10%
Overall[1]	*15%*	*9%*

[1] – Overall values are estimated assuming equal area of floor/ceiling and above-grade walls

2.2 Distribution of Dwellings Starts

The US Census Bureau reported approximately 1.5 million dwellings starts in both 1996 and 1997. In 1998, starts rose to over 1.6 million. Figure 2.1 illustrates the distribution of single and multi-family dwellings constructed in 1997 by geographic region. Approximately 650,000 dwellings (almost half of the dwellings built in 1997) were constructed in the south. Over 300,000 dwellings were constructed in each of the Midwest and West regions, while only 120,000 dwellings were constructed in the Northeast. Figure 2.1 also indicates that roughly 80% of the dwellings constructed are single-family dwellings. For this study, 30 buildings in each geographic region were sampled: 10 detached single-family dwellings, 10 attached single-family dwellings and 10 multi-family dwellings. Although this distribution does not reflect current residential construction trends, it is necessary to ensure statistical validity of the data.

Figure 2.1: Number of Dwellings Constructed in the US in 1997 by Geographical Region (US Census Bureau)



The majority of the single-family dwellings constructed in the United States are wood frame or "stick-built". Dwellings built using modular framing systems and other methods only account for 6% of the single-family dwellings constructed in 1997. This study only includes stick-built dwellings.

In the Northeast and Midwest, most single-family dwellings are constructed on full basements, while in the South and West; the majority are constructed on slab-on-grade floors.

Almost 80% of the single-family dwellings constructed in the Northeast region are two or more stories in height while the remainder are all 1 story high. In contrast, the single-family dwellings constructed in the other three regions are evenly divided between one story and two or more stories in height. There are very few split-level homes in any region.

Figure 2.2 illustrates the distribution of single-family dwellings by house size and geographic region. In all four regions, the majority of single-family dwellings are between 1,200 and 3,000 square feet in size (gross floor area). The distribution of size of units in multi-family dwellings is illustrated Figure 2.3. Most units in multi-family dwellings are greater than 800 square feet in size.

Figure 2.2: Distribution of Single-Family Dwelling Sizes in 1997 by Geographic Region (US Census Bureau)

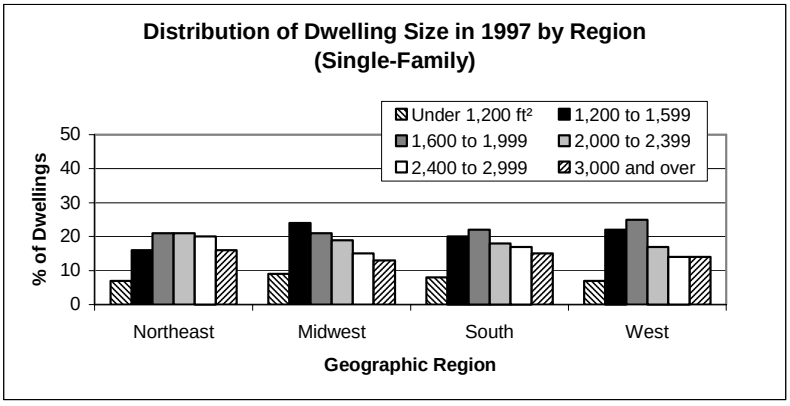
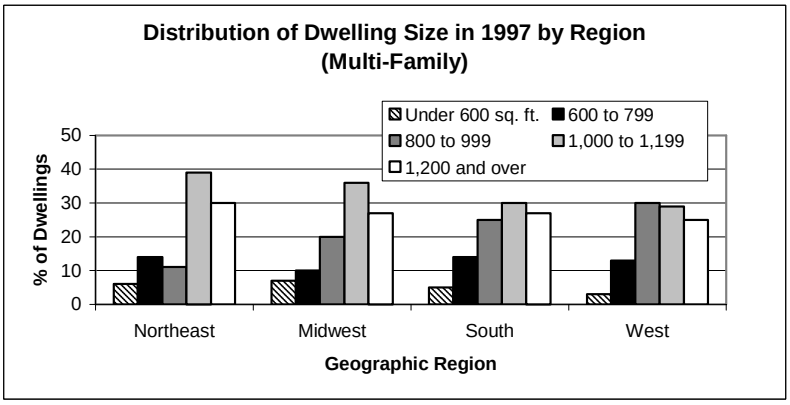


Figure 2.3: Distribution of Multi-Family Dwelling Sizes in 1997 by Geographic Region (US Census Bureau)



3. METHODOLOGY FOR DETERMINING FRAMING FACTORS

3.1 Overview

The method for determining framing factors consists of five steps as follows.

Step 1 - Locate Suitable Dwellings: The dwellings data must cover all regions of the U.S. and be representative of the type of dwellings built in each region.

Step 2 – Audit Dwellings: For each selected dwelling, regional auditors collected information on the amount of framing used in the ceiling, walls and floor. The audits were performed when the dwellings were framed but before insulation or drywall was added.

Step 3 – Enter Data into Database: An ACCESS database program was developed to assist regional auditors in the collection and storage of the dwellings data

Step 4 – Analyze Dwellings Data: The project manager reviewed all regional data for consistency and suitability. The regional data was analyzed using the database program and conclusions drawn about the amount and type of framing.

Step 5 – Adjust Data for High Wind Load and Seismic Regions: The final step was to determine how the amount of framing would change in these regions by examining requirements in the building codes.

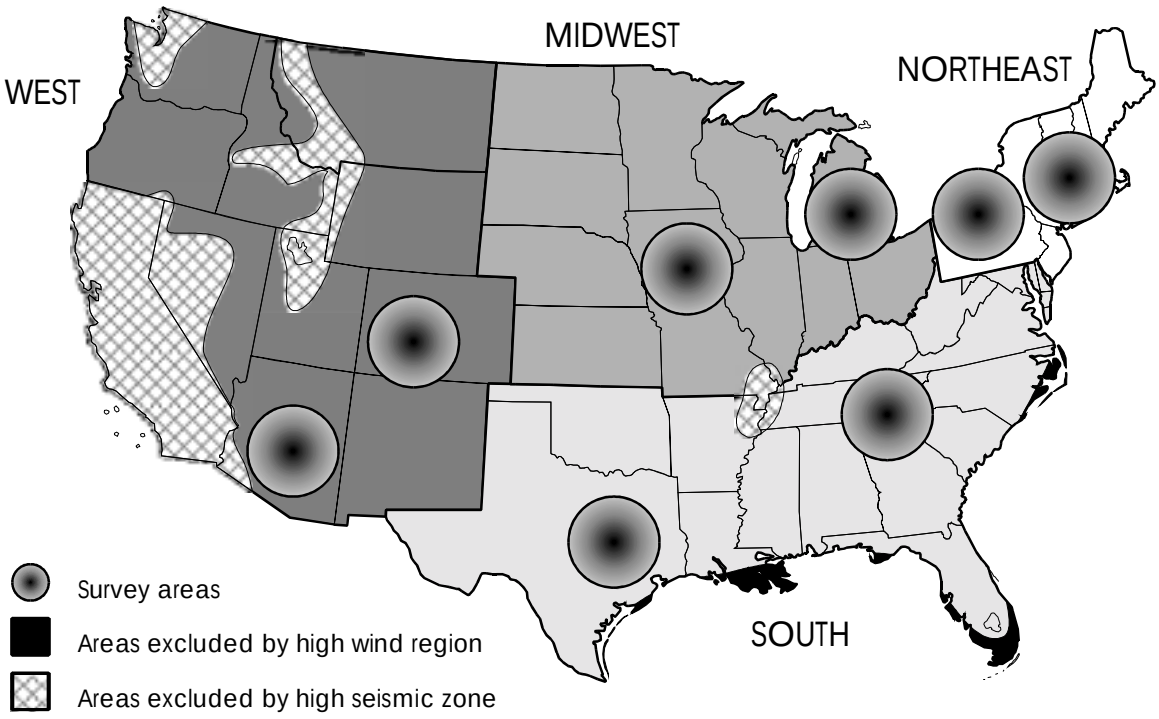
3.2 Geographic Distribution of Data

120 dwellings units were studied covering single-family detached, single-family attached and low-rise multi-family housing. These were proportionately located in the northeast, south, mid-west and west. These regions are shown in Figure 3.1. Regions with high-seismic or high-wind loads were excluded from the study. These regions are also shown on Figure 3.1 (Alaska and Hawaii are not shown because for the most part they are both high-seismic and high-wind regions).

Regional auditors were selected for their expertise in the fields of framing, insulation and residential energy efficiency. The dwellings were taken from two survey areas within each region as shown by the circles on Figure 3.1. Auditors traveled throughout these areas in order to find suitable dwellings at the appropriate point in the construction

process. The survey results in Appendix B indicate the geographic location of each site by city and state.

Figure 3.1: Regions for Dwelling Data Collection



3.3 Representative Data

To ensure framing factors are meaningful, the dwellings surveyed must be representative of the dwellings in the region. Guidelines were given to each of the regional auditors on the size and type of dwellings to be selected (see Table 3.1 and Table 3.2). These guidelines reflect the U.S. Census Bureau data for housing trends in each region.

Table 3.1 sets out criteria for selecting the 10 detached and attached single-family dwellings. The numbers in the table represent the number of dwellings that should meet each criterion (+/-1). For example, 2 to 4 of the detached and attached dwellings in the Northeast should be 1 story high, 6 to 8 dwellings should be 2 or more stories in height and no more than 1 dwelling should be split-level.

Table 3.1: Desired Single Detached and Attached Distribution

		Number of Dwellings by Region (+/-2)			
		Northeast	**Midwest**	**South**	**West**
Area	**Under 2400 sq. ft.**	10	12	10	12
	Over 2400 sq. ft.	10	8	10	8
Stories	**1 Story**	6	8	10	10
	2 or more	14	10	8	10
	Split	0	2	2	0
Basement	**Full**	16	16	4	4
	Slab-on-grade	2	2	12	12
	Crawlspace	2	2	4	4

Table 3.2 sets out criteria for selecting the 5 multi-family buildings. Since there is less variety in multi-family dwellings than there is in detached and attached dwellings, the only selection criterion for multi-family dwellings is area/unit. In the Midwestern region, 1 to 3 of the multi-family dwellings selected should have an area of less than 1000 sq. ft. per unit and 2 to 4 of the dwellings should have an area of more than 1000 sq. ft. unit.

Table 3.2: Desired Multi-Family Distribution

		Number of Buildings by Region (+/-1)			
		Northeast	**Midwest**	**South**	**West**
Area	**< 1000 sq. ft./unit**	1	2	2	2
	> 1000 sq. ft./unit	4	3	3	3

Auditors were also required to meet the following additional requirements.

- detached and attached dwellings to be between 1,500 and 3,500 square feet of finished floor area
- multi-unit dwellings to have at least 8 units
- no house plan is used more than once
- no more than two dwellings from the same builder
- no unique custom-built homes or exotic styles (e.g., Spanish style in the northeast)

3.4 Data Collection Procedure

The audits were performed during construction after the framing was up but before it was enclosed with insulation and drywall. At this stage, the amount of framing can be visually verified, including additional framing not shown on the drawings. The data collection process was

- identify survey sites
- arrange access with the builder
- get dimensioned drawings (if available)
- visit the site at the appropriate construction phase
- photograph typical and unique construction details
- count/measure all framing members and record this information in the ACCESS-based computer program
- return the data tables to project manager for statistical analysis

3.5 Data Analysis Procedure

This project involves the collection and analysis of a large amount of data – a job well suited to a database program. An ACCESS-based computer program was developed to facilitate data collection and analysis. In essence, the ACCESS program serves as a series of electronic data collection forms and a standardized method for calculating framing factors. Appendix A shows the software screens and user manual. The auditor would take the program (on a laptop computer) to the site and collect and enter the data at one time.

The ACCESS computer program offered several advantages over manual data collection. First, the data collection and data entry was done on site, thereby reducing time and potential for errors in recording the data and transferring it from field notes. Second, some data analysis can be done on site for the dwelling being inspected. Thus, the auditor gets immediate feedback on the results for the dwelling. If one or more of the calculated quantities looks unreasonable, the auditor can re-check the data on site. Third, a set of standardized input forms helped to reduce differences in data collection procedures among the regional representatives.

The regional auditors entered data for individual dwellings. Their audit results were sent to the project manager for review, amalgamation and computation of the important

framing characteristics. The program is able to aggregate and disaggregate the information as needed.

3.6 Framing Factor Definitions

The ACCESS computer program calculates a range of dwelling framing characteristics. The definitions of these framing factors are given below.

Ceiling Framing Factor: ratio of framing area in insulated ceilings to the ceiling area (either gross or net). Framing includes joists, trusses, blocking and framing around skylights and attic hatches that partially or fully penetrate the insulation. Rim joists are not included.

Ceiling Opening to Ceiling Area: ratio of the opening areas in the ceiling to the gross ceiling area (including skylights and access hatches).

Corner Height to Wall Area: ratio of the total height of all corners in insulated walls to the wall area in units of inches per square foot.

Door Area to Wall Area: ratio of the rough door opening area to the gross wall area (including window and door areas). Swinging and sliding glass doors are considered doors. The reader should note that the door area may include transom or sidelight windows.

Floor Framing Factor: ratio of framing area in insulated floors to the floor area (either gross or net). Framing includes joists, blocking and framing around access hatches that penetrate the insulation. Rim joists are not included.

Floor Opening to Floor Area: ratio of the opening areas in the floor to the gross floor area (including access hatches).

Gross Insulated Ceiling Area: surface area (in the direction perpendicular to heat flow) of all insulated ceilings between heated areas and the outside or unheated areas (such as attics). The ceiling area is based on exterior or outside ceiling dimensions. The ceiling dimensions are to the outside of the framing and include the area of any skylights or attic hatches.

Gross Insulated Floor Area: surface area (in the direction perpendicular to heat flow) of all insulated floors between conditioned spaces and the outside or unconditioned spaces (such as crawlspaces and unheated basements). Non-framed floors such as concrete (e.g. slab on grade) floors are excluded. The floor area is based on exterior or outside floor dimensions. The floor dimensions are to the outside of the framing.

Gross Insulated Wall Area: surface area (in the direction perpendicular to heat flow) of all insulated walls between conditioned spaces and the outside or unconditioned spaces (such as garages and porches). The wall area is based on exterior or outside wall dimensions. The wall width is to the outside of the framing. The wall height is from the bottom of the main floor to the inside of the ceiling framing, including the height of any wall/interior floors junctions (i.e. including rim joists). The area of any windows or doors is included.

Net Insulated Ceiling Area: is the gross ceiling area less the area of any skylights or attic hatches.

Net Insulated Floor Area: is the gross floor area less the area of any floor hatches.

Net Insulated Wall Area: is the gross wall area less the area of windows, doors. The net insulated wall area includes the area of rim joists.

Overall Framing Factor: ratio of all framing areas in the insulated floors, ceilings and walls to the total area of insulated floors, ceilings and walls (either gross or net). Non-framed floors, ceilings and walls (e.g. concrete or solid masonry) are not included in the calculation.

Rim Joist Area to Wall Area: ratio of the rim joist area to the gross wall area

Total Floor Area: total area of all floors (above conditioned & unconditioned spaces). This area used by builders, realtors and homeowners to describe the size of the dwelling.

Window Area to Wall Area: ratio of the rough window opening area to the gross wall area (including window and door areas). Swinging and sliding glass doors are considered doors.

Wall Framing Factor: ratio of the framing area in the insulated walls to the wall area (either gross or net). Framing includes headers, sill plates, studs, framing around doors and windows, corners, blocking and where floor joists penetrate the wall insulation layer. Framing that does not bridge the insulation (e.g., exterior or interior strapping, let-in bracing, rim joist) is excluded.

4. RESULTS OF DWELLINGS AUDITS

4.1 Dwellings Characteristics

The audits were performed over the period from Fall 1999 to Spring 2001. The results are summarized by region and dwelling type in Table 4.1. Tables 4.2 and 4.3 show the distribution of the dwellings characteristics. The auditors had to work with the dwellings available in the field and, as a result, it was not always possible to meet the exact targets set out in Tables 3.1 and 3.2. However the actual distribution is very close to the desired distribution. The data from these dwellings has been analyzed and is presented in the remainder of this section.

Table 4.1: Number of Completed Audits by Region and Dwelling Type

Dwelling Type	Northeast	Midwest	South	West	Total
Detached	10	10	10	14	44
Attached	8	10	10	10	38
Multi-unit	10	8	10	10	38
Total	28	28	30	34	120

Table 4.2: Single Detached and Attached Audit Distribution

		Number of Dwellings by Region			
		Northeast	Midwest	South	West
Area	**Under 2400 sq. ft.**	10	16	14	13
	Over 2400 sq. ft.	8	4	6	11
Stories	**1 Story**	2	7	8	10
	2 or more	16	13	12	14
	Split	0	0	0	0
Basement	**Full**	15	13	5	6
	Slab-on-grade	3	6	13	15
	Crawlspace	0	1	2	3

Table 4.3: Multi-Family Audit Distribution

		Number of Buildings by Region (+/-1)			
		Northeast	**Midwest**	**South**	**West**
Area	**< 1000 sq. ft./unit**	9	2	5	4
	> 1000 sq. ft./unit	1	6	5	6

The average characteristics of the audit are given in Table 4.4. The three types of dwellings have significantly different floor areas. Detached dwellings are more than twice the size of multi-family dwellings. Attached dwellings in the west appear to be larger than the other areas, although the regional differences in dwelling size do not have significant impact on the framing factors.

Table 4.4: Characteristics of Audit Dwellings (ft^2)

Component	Northeast	Midwest	South	West	Average
Detached Dwellings					
Total Floor Area	**2717** ± 540	**2339** ± 630	**2292** ± 972	**2489** ± 778	**2461** ± 730
Gross Insulated Wall Area	**2751** ± 528	**2234** ± 684	**2571** ± 1119	**2623** ± 68	**2550** ± 750
Attached Dwellings					
Total Floor Area	**1541** ± 226	**1550** ± 379	**1565** ± 506	**2155** ± 660	**1703** ± 443
Gross Insulated Wall Area	**1025** ± 406	**1804** ± 1396	**1247** ± 434	**1970** ± 772	**1556** ± 752
Multi-Family Dwellings					
Total Floor Area	**732** ± 181	**1087** ± 404	**1028** ± 213	**1019** ± 176	**972** ± 243
Gross Insulated Wall Area	**583** ± 168	**725** ± 431	**899** ± 193	**1097** ± 405	**826** ± 300

4.2 Detached Dwellings Framing Factors

The framing factors for detached dwellings are presented in Table 4.5. The individual values for each survey site are given in Appendix B. The table presents the framing factors in % and indicates the standard deviation for each average. For floor framing factors, dwellings with no framing (e.g., concrete slab-on-grade) were excluded from the average. Zero values for the area and length are included in the averages.

The area ratios are similar for the four regions. Windows and doors represent 17% of the gross wall area. Although the Mid-west window area is low, its door area is high. It is likely that some of these doors are sliding or swinging glass doors, so that the amount of glass is similar in all regions. The Northeast region has the highest combined window and door area. The rim joists represent 5% of the gross wall area.

The openings in the insulated floors and ceilings are minimal. Only ceilings in the south had a significant opening area; in this case, two dwellings with large skylights.

Table 4.5 lists the framing factors based on the gross and net ceiling, wall and floor area. Because of the small opening areas in the ceilings and floors, their gross and net framing factors are essentially the same. The ceiling has 7% framing and the floor has 11% framing.

Walls have the largest amount of framing because of the extra framing around doors and windows and at corners. The amount of framing in walls is 20% based on the gross wall area or 24% based on the net wall area.

The overall framing percentage is 13% (gross) or 15% (net). Western dwellings have a lower overall framing percentage because the dwellings tend be large and single-story buildings. Large single-story dwellings have a large ceiling area with a low framing percentage.

Table 4.5: Framing Factors for Detached Dwellings (%, unless noted)[1]

Component	Northeast	Midwest	South	West	Average
Area and Length Ratios					
Window Area to Wall Area	**12.9** ± 3.3	**10.1** ± 5.7	**11.8** ± 4.3	**11.4** ± 1.4	**11.5** ± 3.7
Door Area to Wall Area	**5.8** ± 2.2	**7.1** ± 3.2	**4.3** ± 2.3	**5.2** ± 2.1	**5.6** ± 2.4
Rim Joist Area to Wall Area	**5.4** ± 1.9	**4.6** ± 4.1	**3.5** ± 2.1	**5.0** ± 2.4	**4.7** ± 2.6
Corner Height to Wall Area (inches/ft^2)	**0.5** ± 0.2	**0.4** ± 0.1	**0.5** ± 0.1	**0.4** ± 0.2	**0.4** ± 0.1
Ceiling Opening to Ceiling Area	**2.9** ± 2.7	**0.3** ± 0.4	**5.8** ± 7.8	**0.4** ± 0.6	**2.2** ± 2.8
Exposed Perimeter to Floor Area (inches/ft^2)	**0.8** ± 0.3	**0.7** ± 0.4	**0.4** ± 0.4	**0.8** ± 0.4	**0.7** ± 0.4
Floor Opening to Floor Area	**0.5** ± 1.0	**0.1** ± 0.3	**0.0** ± 0.0	**0.0** ± 0.0	**0.1** ± 0.3
Framing Factors based on Gross Areas					
Ceiling	**8.4** ± 1.9	**6.0** ± 0.9	**6.7** ± 1.0	**6.5** ± 3.0	**6.9** ± 1.7
Wall	**20.1** ± 1.0	**21.1** ± 2.8	**19.6** ± 2.5	**19.4** ± 3.3	**20.0** ± 2.4
Floor	**11.2** ± 5.0	**14.5** ± 5.1	**10.9** ± 3.2	**9.3** ± 10.2	**11.3** ± 5.9
Overall	**14.1** ± 1.4	**14.5** ± 2.6	**14.0** ± 1.9	**11.9** ± 3.8	**13.5** ± 2.4
Framing Factors based on Net Areas					
Ceiling	**8.7** ± 1.9	**6.0** ± 0.9	**7.2** ± 1.1	**6.6** ± 3.0	**7.1** ± 1.8
Wall	**24.6** ± 2.3	**25.5** ± 3.9	**23.5** ± 3.3	**23.3** ± 4.2	**24.2** ± 3.4
Floor	**11.3** ± 5.0	**14.6** ± 7.4	**10.9** ± 6.1	**9.3** ± 4.4	**11.3** ± 5.9
Overall	**14.7** ± 2.1	**15.9** ± 3.2	**16.1** ± 3.0	**13.4** ± 4.4	**14.9** ± 3.2

[1] - ± values indicate one standard deviation

4.3 Attached Dwellings Framing Factors

The framing factors for attached dwellings are presented in Table 4.6. The individual values are given in Appendix B. The table presents the framing factors in % and indicates the standard deviation for each average. For floor framing factors, dwellings with no framing (e.g., concrete slab-on-grade) were excluded from the average. Zero values for the area and length are included in the averages.

The results for the attached dwellings are similar to the results for detached dwellings. The area ratios and framing factors are marginally higher primarily because of the

smaller livable floor area. The common wall in attached dwellings reduces the exterior wall area available for windows and doors. The result is a higher percentage of windows and doors in the insulated walls, 20% versus 17% for detached dwellings. As with detached dwellings, floor and ceiling openings are minimal.

The framing factors appear larger than for detached dwellings. The larger window and door area ratios increase the wall framing factor to 21% (gross) and 27% (net). The overall framing percentage is similar to detached dwellings at 15%. Although the wall framing percentage is higher, there is a smaller area of insulated walls (because one wall is common).

Table 4.6: Framing Factors for Attached Dwellings (% unless noted)[1]

Component	Northeast	Midwest	South	West	Average
Area and Length Ratios					
Window Area to Wall Area	**12.5** ± 5.4	**11.3** ± 4.5	**11.5** ± 4.6	**15.5** ± 6.2	**12.7** ± 5.2
Door Area to Wall Area	**6.3** ± 4.1	**7.2** ± 5.3	**6.7** ± 2.7	**8.3** ± 4.7	**7.1** ± 4.2
Rim Joist Area to Wall Area	**6.5** ± 3.1	**5.6** ± 2.5	**4.7** ± 2.8	**4.4** ± 3.5	**5.3** ± 3.0
Corner Height to Wall Area (inches/ft^2)	**0.7** ± 0.4	**0.5** ± 0.3	**0.7** ± 0.2	**0.7** ± 0.2	**0.7** ± 0.3
Ceiling Opening to Ceiling Area	**1.9** ± 1.8	**1.0** ± 1.1	**2.0** ± 2.7	**0.7** ± 1.0	**1.4** ± 1.7
Exposed Perimeter to Floor Area (inches/ft^2)	**0.3** ± 0.4	**0.2** ± 0.4	**0.2** ± 0.2	**0.6** ± 0.4	**0.3** ± 0.3
Floor Opening to Floor Area	**0.0** ± 0.0	**0.3** ± 0.6	**0.0** ± 0.0	**0.0** ± 0.0	**0.1** ± 0.2
Framing Factors based on Gross Areas					
Ceiling	**7.1** ± 2.4	**6.2** ± 2.1	**6.9** ± 1.5	**6.3** ± 1.1	**6.6** ± 1.8
Wall	**22.7** ± 2.4	**21.6** ± 4.1	**20.4** ± 1.7	**20.4** ± 4.0	**21.3** ± 3.0
Floor	**10.3** ± 3.6	**11.8** ± 0.0	**17.9** ± 5.0	**9.3** ± 4.5	**12.3** ± 3.3
Overall	**15.1** ± 2.3	**15.2** ± 2.3	**13.7** ± 2.7	**11.1** ± 2.9	**13.8** ± 2.5
Framing Factors based on Net Areas					
Ceiling	**7.2** ± 2.5	**6.3** ± 2.1	**7.0** ± 1.8	**6.4** ± 1.2	**6.7** ± 1.9
Wall	**28.0** ± 3.6	**26.8** ± 6.2	**25.0** ± 2.6	**27.2** ± 6.9	**26.8** ± 4.8
Floor	**10.3** ± 3.6	**11.8** ± 0.0	**17.9** ± 5.0	**9.3** ± 4.5	**12.3** ± 3.3
Overall	**16.7** ± 2.9	**16.7** ± 3.0	**15.2** ± 3.5	**12.8** ± 3.1	**15.4** ± 3.1

[1] - ± values indicate one standard deviation

4.4 Multi-Family Dwellings Framing Factors

The framing factors for multi-family dwellings are presented in Table 4.7. The individual dwellings values are given in Appendix B. The table presents the framing factors in % and indicates the standard deviation for each average. For floor framing factors, dwellings with no framing (e.g., concrete slab-on-grade) were excluded from the average. Zero values for the area and length are included in the averages.

Some of the results for multi-family dwellings are significantly different from detached and attached dwellings. Windows and doors represent a smaller percentage of the gross wall area at 13% down from 17% and 20% for detached and attached dwellings. Again, the dwellings in the Northeast appear to have a larger area of windows and doors. For multi-family dwellings, ceiling and floor opening ratios are essentially zero.

The smaller size of multi-family units means that there is slightly more framing than for the larger detached dwellings. The wall framing factor is 21% (gross) or 24% (net). The overall framing percentage is also slightly higher at 16%. However, all these differences are within one standard deviation of one another and may not be statistically significant.

Table 4.7: Framing Factors for Multi-Family Dwellings (in % unless noted)[1]

Component	Northeast	Midwest	South	West	Average
Area and Length Ratios					
Window Area to Wall Area	**13.1** ± 5.7	**9.6** ± 4.7	**10.2** ± 3.7	**7.5** ± 4.0	**9.9** ± 4.5
Door Area to Wall Area	**1.4** ± 0.9	**2.4** ± 1.6	**3.8** ± 3.3	**3.9** ± 4.8	**3.0** ± 2.6
Rim Joist Area to Wall Area	**5.1** ± 2.2	**2.2** ± 3.0	**7.1** ± 4.4	**0.2** ± 0.7	**3.8** ± 2.6
Corner Height to Wall Area (inches/ft^2)	**0.1** ± 0.1	**0.2** ± 0.1	**0.3** ± 0.2	**0.2** ± 0.1	**0.2** ± 0.1
Ceiling Opening to Ceiling Area	**0.1** ± 0.2	**0.2** ± 0.3	**0.0** ± 0.0	**0.0** ± 0.0	**0.1** ± 0.1
Exposed Perimeter to Floor Area (inches/ft^2)	**0.1** ± 0.3	**0.3** ± 0.4	**0.4** ± 0.6	**0.6** ± 0.6	**0.4** ± 0.4
Floor Opening to Floor Area	**0.0** ± 0.0	**0.0** ± 0.0	**0.0** ± 0.0	**0.0** ± 0.0	**0.0** ± 0.0
Framing Factors based on Gross Areas					
Ceiling	**5.8** ± 2.2	**6.2** ± 1.1	**6.5** ± 0.8	**6.3** ± 2.1	**6.3** ± 1.5
Wall	**22.0** ± 2.6	**21.0** ± 2.4	**21.3** ± 5.4	**20.1** ± 2.8	**21.0** ± 3.3
Floor	**10.7** ± 3.4	**11.0** ± 6.2	**0.0** ± 0.0	**0.0** ± 0.0	**10.8** ± 1.0
Overall	**16.6** ± 2.5	**15.5** ± 3.3	**16.0** ± 3.7	**13.4** ± 3.9	**15.3** ± 3.4
Framing Factors based on Net Areas					
Ceiling	**5.8** ± 2.2	**6.2** ± 1.1	**6.5** ± 0.8	**6.3** ± 2.1	**6.3** ± 1.5
Wall	**25.8** ± 3.1	**24.0** ± 3.5	**24.8** ± 6.5	**22.7** ± 3.5	**24.3** ± 3.3
Floor	**10.7** ± 3.4	**11.0** ± 6.2	**0.0** ± 0.0	**0.0** ± 0.0	**10.8** ± 2.4
Overall	**18.3** ± 2.7	**16.7** ± 4.0	**16.1** ± 5.0	**13.9** ± 5.0	**16.1** ± 3.4

[1] - ± values indicate one standard deviation

4.5 Analysis of Framing Factors

Sections 4.2 to 4.4 presented the framing factors as a function of dwellings type and region. In this section, the effect of other dwelling characteristics on framing factors is studied, specifically floor area, number of stories, and type of wall framing (2X4 or 2X6).

Figures 4.1 and 4.2 show the overall net framing factor as a function of total floor area. The values for detached and attached dwellings are included on the same graph because the values are so similar. The overall framing percentage varies from 6 to 22%

for individual dwellings, however, there appears to be no correlation between dwelling size and the amount of framing. The same result seems to apply for multi-family dwellings. Overall framing factors range from 8 to 24% with no discernable trend.

Figure 4.1: Overall Net Framing Factors for Attached and Detached Dwellings

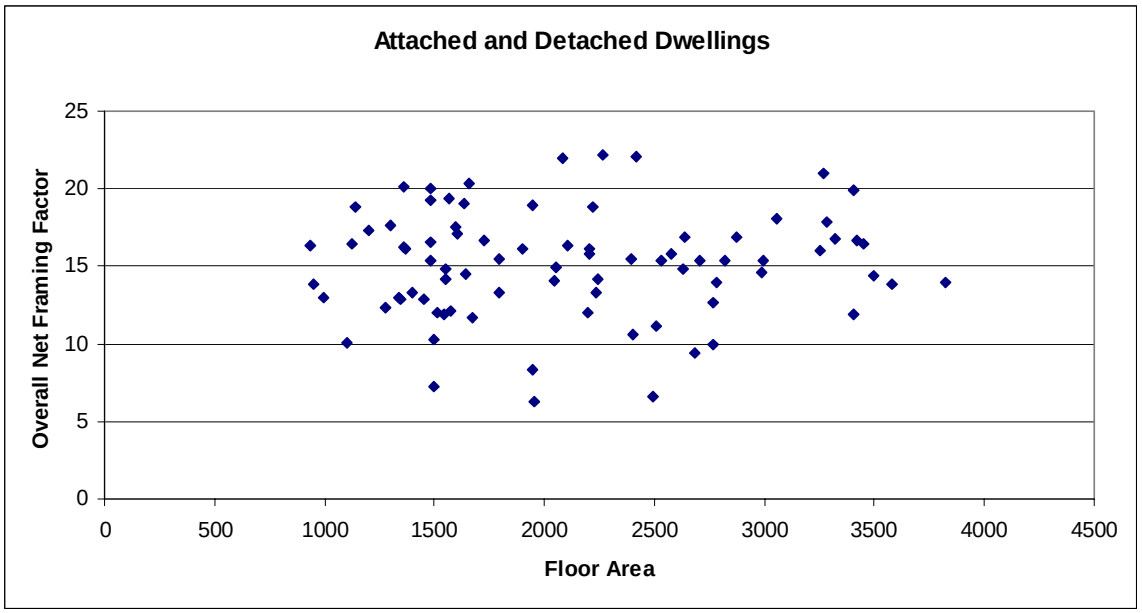


Figure 4.2: Overall Net Framing Factors for Multi-Family Dwellings

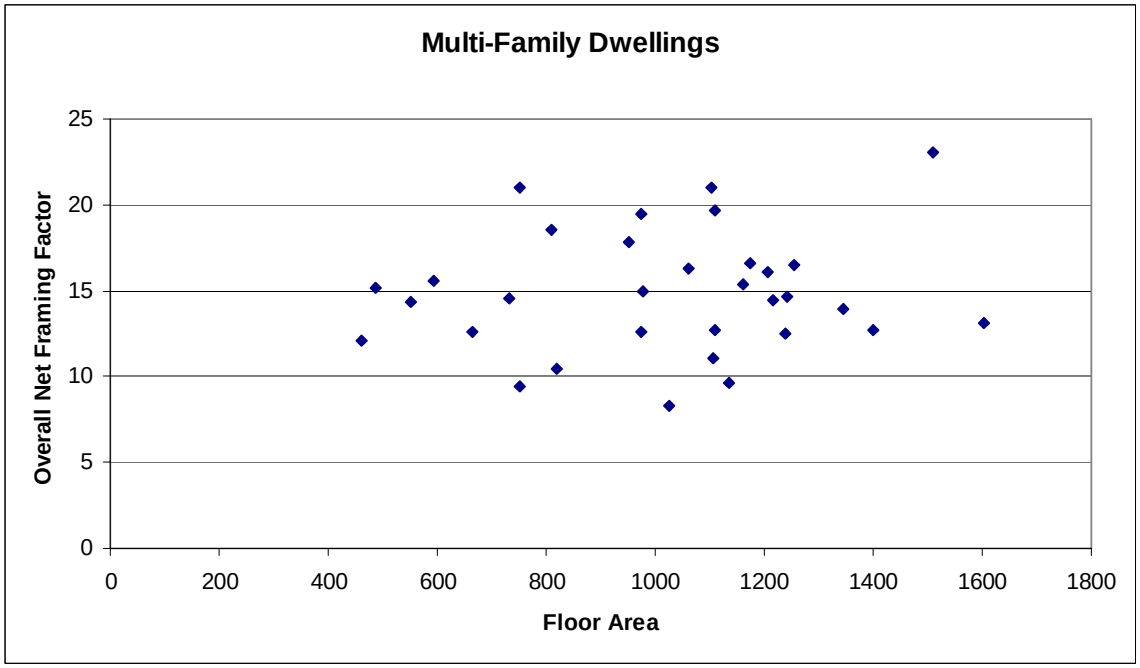
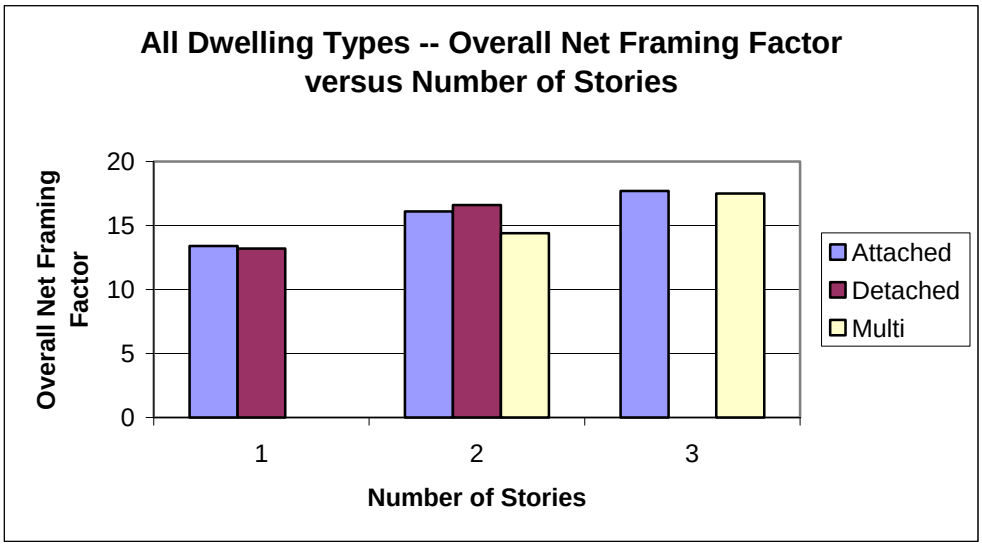


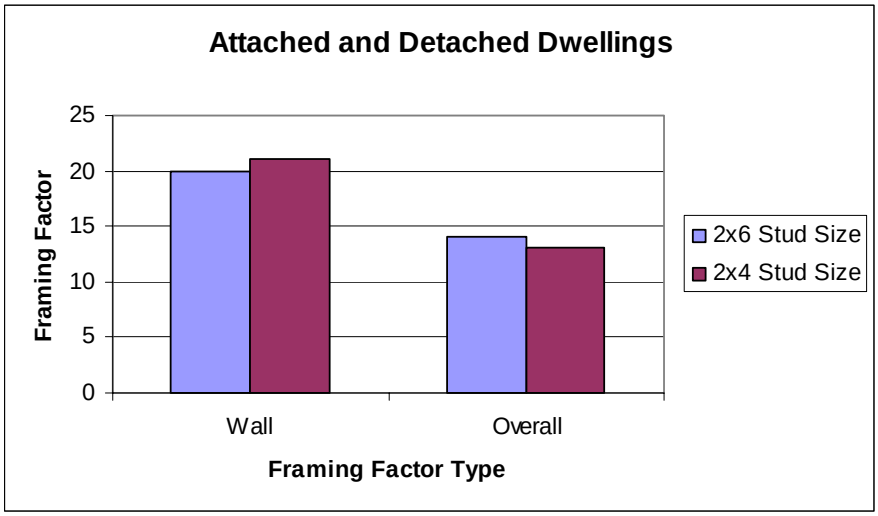
Figure 4.3 shows the effect of the number of stories on overall net framing factor. The framing factor increases with the number of stories with an average of 14, 15 and 17% for 1, 2 and 3 story dwellings. There are two reasons for this increase. First, single story dwellings have a larger ceiling area than multi-story buildings. Because ceilings have a low framing factor, increasing the ceiling area decreases the overall framing factor. Second, for multi-story dwellings, the amount of wall framing in lower floors is increased in order to carry the weight of the floors above. For example, some dwellings had studs spaced on 12-inch centers for the first floor and on 16-inch centers for the upper floors.

Figure 4.3: Effect of Number of Stories on Overall Framing Factor



Most of the dwellings surveyed used 2X4 studs for the wall framing, with the remainder using 2X6 studs. In many cases, a combination of the two stud sizes was used to deal with unique or difficult framing details. For the purposes of comparison, dwellings where divided into two groups: predominantly 2X4 framing and predominantly 2X6 framing. Figure 4.4 shows the effect of wall stud size on the framing factor. Somewhat surprisingly, there is very little difference between the two types. The wall and overall framing factor are less than 1% higher for 2X4 framing. Auditors were asked to record the predominant stud spacing in the notes section on the site survey forms. A review of the individual files showed that 2X6 studs were used more for structural reasons (high ceiling, multi-floors) than to take advantage of potentially wider stud spacing (e.g., 24 inch centers). No conclusions can be drawn about framing factors for 24-inch stud spacing because of the lack of data for this construction type.

Figure 4.4: Effect of Wall Stud Size on Framing Factor



Based on the analysis that accompanies Figures 4.1 to 4.4 and a review of the individual survey files, it would appear that there is not a single dominant characteristic that defines the framing factor. Site observations indicate that there are many characteristics that affect the framing factor including

- number of stories
- building type,
- floor area,
- type of wall framing (2X4 or 2X6)
- number and size of openings (e.g., windows and doors)
- architectural complexity
- builder practices (e.g., 2-stud vs. 3-stud corners)

It is the combination of all the characteristics listed above which results in the wide variation in framing factors. Although not discussed in this report, architectural complexity and builder practices may have the largest impact on framing factor. There is a wide range in framing factors for the different builders, however, the framing factors for two different, but architecturally similar, dwelling plans from the same builder showed little variation. Five of the eight pairs of dwellings framed by the same builder have wall framing factors within 1%. Framers tend to learn on the job in small groups and there is

no standardized method for framing. In addition, small architectural details (e.g., framing around a bay window) can greatly increase the amount of framing.

Table 4.8 summarizes the framing factors for the three dwelling types. Because of the similarity in the values for the three dwelling types, it is recommended that the "all dwellings" column be included in the ASHRAE Handbook of Fundamentals (without decimal places and standard deviation) to allow designers to estimate the amount of framing required. The overall framing factor has been provided for comparison to other published framing factors, however designers are advised to calculate net exposed wall, ceiling and floor areas and apply the respective framing factors.

Table 4.8: Recommended Table of Framing Factors (all values in %)[1]

Component	Detached	Attached	Multi-Family	All Dwellings
Window Area to Gross Wall Area	**11.5** ± 3.7	**12.7** ± 5.2	**10.1** ± 4.8	**11.5** ± 4.7
Door Area to Gross Wall Area	**5.6** ± 2.4	**7.1** ± 4.2	**3.1** ± 3.2	**5.2** ± 3.7
Rim Joist Area to Gross Wall Area	**4.7** ± 2.6	**5.3** ± 3.0	**3.7** ± 3.9	**4.3** ± 3.3
Framing Factors	Net	Net	Net	Net
Ceiling	**7.1** ± 1.8	**6.7** ± 1.9	**6.2** ± 1.6	**6.9** ± 2.1
Wall	**24.2** ± 3.4	**26.8** ± 4.8	**24.4** ± 4.4	**25.4** ± 4.5
Floor	**11.3** ± 5.7	**12.3** ± 6.7	**10.9** ± 3.8	**11.9** ± 5.1
Overall	**14.9** ± 3.2	**15.4** ± 3.1	**16.3** ± 4.4	**15.5** ± 3.8

[1] - ± values indicate one standard deviation

The values in Table 4.8 are consistent with the wall framing factors in the 1997 ASHRAE Handbook of Fundamentals and the floor, ceiling and overall values given in the Canadian Energy Code for 16-inch stud spacing (see Section 2).

5. ADJUSTMENTS FOR HIGH WIND LOAD AND HIGH SEISMIC REGIONS

The framing factors presented in Section 4 are based on dwellings that are not subject to the design requirements of high wind and high seismic loads. This section examines the framing adjustments that may be necessary to handle these loads and how they affect the framing factors.

The International Code Council produced the International Residential Code-2000 (IRC-2000) as a successor to the International One and Two Family Dwelling Code-1998 and the CABO Model Energy Codes (Various editions). Section R301 of the IRC-2000 sets out the design criteria for residential buildings. Design wind loads are determined using the Basic Wind Speed, which is defined as the 3-second gust speed at 33 ft above ground in Exposure Category C (i.e. an area of open terrain with scatter obstructions and surface undulations less than 30 ft in height). The basic wind speed for any location in the United States can be determined using the maps provided in Figure R301.2(4) of the IRC-2000. These basic wind speeds range from 80 mph to over 150 mph and must be adjusted for different Exposure Categories.

Seismic design is based on Seismic Design Category. This is a classification assigned to a structure based on its Seismic Group (i.e. type of building) and the severity of the design earthquake ground motion at the site. The seismic design category is determined on the basis of the calculated Short Period Spectral Response Acceleration, S_{DS}. The relationship between S_{DS} and seismic design category is summarized in Table 5.1.

Table 5.1: Relationship between S_{DS} & Seismic Design Category

Calculated S_{DS}	Seismic Design Category
$S_{DS} \leq 0.17g$	A
$0.17g < S_{DS} \leq 0.33g$	B
$0.33g < S_{DS} \leq 0.50g$	C
$0.50g < S_{DS} \leq 0.83g$	D_1
$0.83g < S_{DS} \leq 1.17g$	D_2
$1.17g < S_{DS}$	E

Figure R301.2(4) of the IRC-2000 provides maps to determine the seismic design category for any location within the United States. The seismic provisions of the

IRC-2000 apply to buildings constructed in seismic design categories C, D_1 & D_2. Buildings that fall under category E are to be designed in accordance with the International Building Code. The IRC-2000 contains provisions for the construction of concrete, masonry and wood & cold-formed steel framed buildings in higher seismic design categories.

The code requires the use of wall bracing to accommodate lateral loads (i.e. wind & seismic) in framed buildings. Section R602.10.3 of the IRC-2000 describes 8 methods for constructing braced wall panels:

1. Diagonal let in bracing
2. Diagonal boards applied at max. 24" O/C to side of studs wall
3. Wood structural panel sheathing
4. Structural fiberboard sheathing
5. Gypsum board sheathing
6. Particle board sheathing
7. Lath & portland cement plaster on studs at max. 16" O/C
8. Hardboard panel siding

The permitted method of bracing and the amount of bracing required are determined from Table R602.10.1 of the IRC-2000. As the seismic design category or the basic wind speed increases, the type of bracing permitted changes and the length of bracing required increases. For example, a one-story dwelling in category B, or less than 120 mph wind, would be permitted to use any of the 8 bracing methods. If the length of a braced wall in the dwelling is 50 ft, the braced panel length would be a minimum of 8 ft long. If this same dwelling was built in Category D2, or less than 130 mph wind, bracing method 1 could not be used. The braced panel length would be increased to 12 ft 6 in. for method 3 and 20 ft for all other methods.

The increase in braced panel length does not necessarily mean an increase in framing factor. Bracing methods 1, 2 and 8 are independent of the stud spacing and do not introduce any new framing that penetrates the insulation. Similarly, bracing methods 3-6 all use sheathings that are attached to the outside of the studs. Bracing method 7 will only increase the framing factor if it is employed in a wall that uses a stud spacing greater than 16". Section R602.10.7 of the IRC-2000 requires that the vertical joints in sheathing panels occur over studs and horizontal joints occur over blocking with a minimum thickness of 1½". The studs can be easily arranged to comply with this requirement so that no additional framing is necessary. Thus, it would appear that the

IRC-2000 seismic and wind load requirements can be met without increasing the framing factors.

A similar framing factors study has been performed in California, a region of high seismic loading [Enermodal, 2001]. The dwellings involved in that study are constructed under the Uniform Building Code, which has similar requirements for braced panels. The wall, and ceiling framing factors in the California study are less than 1% higher than the values presented in this study. One anecdotal difference noted in dwellings surveyed in the San Francisco Bay area for the California study has been in the treatment of framing at sheathing joints. In this area, the sheathing joints are usually located over studs that are nominal 4" wide (e.g. 4X4 or 4X6) rather than nominal 2" wide (e.g. 2X4 or 2X6). Approximately every 3rd stud in a braced wall line is therefore 3½" wide, increasing the amount of framing in the walls. Although this approach was observed in the Bay area, it is not strictly required by the IRC 2000 and may not be typical of other parts of California. Nevertheless, the differences in framing factors between the two studies are well within one standard deviation and are not considered significant. The values presented in this report appear to be reasonable for regions of high seismic loading.

6. APPLICATION OF THE FRAMING FACTORS

This section describes how the framing factors presented in Section 4 can be used to determine the total dwelling heat loss coefficient or UA (excluding infiltration/ventilation and below grade losses).

For wood-frame dwellings the parallel-path method for calculating conductive heat losses is reasonably accurate. In this method, the thermal resistances of each layer in the assembly are added together. When there is more than one "path" through the assembly, for example through the insulation and through the wood framing in the case of a wood-framed wall, the thermal resistance through each path is calculated. The total dwelling UA is the sum of the area of each path multiplied by the U-value of each path (U-value is 1/R-value).

Using the parallel path method, the building UA can be written as

$$UA_{dwelling} = [U_{wall}*(1-F_{wall})+U_{wall\ framing}*F_{wall}]A_{wall} + [U_{ceiling}*(1-F_{ceiling})+U_{ceiling\ framing}*F_{ceiling}]A_{ceiling}$$

$$+ [U_{floor}*(1-F_{floor})+U_{floor\ framing}*F_{floor}] A_{floor} + [U_{rim}*(1-F_{wall})+U_{rim\ framing}*F_{wall}]A_{rim} + UA_{windows} + UA_{doors}$$

If more than one type of construction is used for a building component, then the UA of that component can be added to the equation. The area taken up by the rim joists at interior floors is treated separately from the walls because this area is usually not as well insulated as the wall. The areas are defined in Section 3.5 and are based on the outside dimensions of the framed components. The framing factors are in Table 4.8 and should be entered as a fraction in the above equation.

For generic studies where the dwelling design is not known, the dwellings component areas in Table 4.8 can be used in the above equation.

7. CONCLUSIONS

Audits of 120 dwellings were conducted in four regions for three dwelling types. The following conclusions can be drawn about framing in housing.

Approximately 17% of the gross wall area is taken up by openings for windows and doors. Rim joists account for about 4% of the gross wall area. The amount of openings in floors and ceilings is negligible (less than 2% of the gross area).

There is very little regional variation in the framing factors. Buildings in the western U.S. appear to have lower overall framing factors because they have a large ceiling component (they are predominantly large single-story dwellings). Framing factor does not appear to be dependent on dwelling size or size of wall studs (2X4 vs. 2X6). Almost all of the houses surveyed were constructed with 16-inch wall stud spacing, and as such, no conclusions can be made about framing factors for 24-inch stud spacing. Low-rise multi-story dwellings appear to have higher overall framing factors because of the smaller ceiling area and additional framing for support.

The average framing factors for attached, detached and multi-family dwellings are very similar. The framing factors recommended for inclusion in the ASHRAE Handbook of Fundamentals are summarized in the table below.

Table 7.1: Recommended Table of Framing Factors (all values in %)

Component	All Dwellings (Detached, Attached, and Multi-Family)
Window Area to Gross Wall Area	**12**
Door Area to Gross Wall Area	**5**
Rim Joist Area to Gross Wall Area	**4**
Framing Factors	% of Net Framed Area
Ceiling	**7**
Wall	**25**
Floor	**12**
Overall	**16**

A review of the 2000 International Residential Code indicates that the design requirements for high wind and high seismic loads can be met without increasing the framing factors. A study on framing factors in dwellings in California substantiated this assessment.

8. REFERENCES

ASHRAE, Handbook of Fundamentals, 1997 edition, American Society of Heating Refrigerating and Air-Conditioning Engineers, Atlanta, GA (USA)

Enermodal, 2001. Characterization of Framing Factors for Low-Rise Residential Building Envelopes in California. Draft Final Report prepared for the California Energy Commission, Sacramento, CA (USA)

IRC, International Residential Code, 2000 edition, International Code Council, Falls Church, VA (USA)

NRCC, 1997. Model National Energy Code for Dwellings, National Research Council of Canada, Ottawa, ON (Canada)

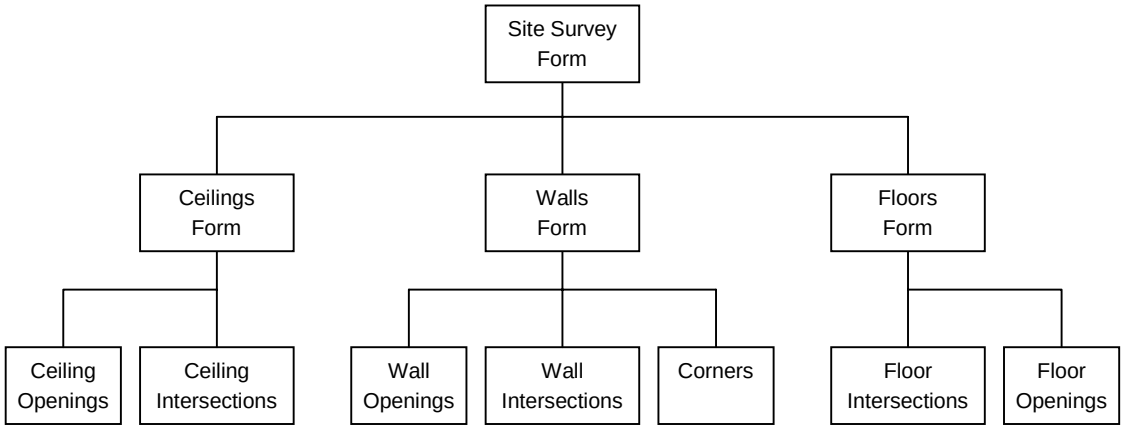
US Bureau of Census, Washington, DC (USA)

Appendix A. Procedure for Dwellings Data Collection

A large amount of data must be collected to establish statistically valid framing factors for wood-framed dwellings. A database program was developed as the basis of the framing survey. Each dwellings auditor used a copy of the program to enter, store and process survey data. This section explains the format of the data entry forms and outlines the type of data collected.

The flowchart in Figure 8.1 illustrates the relationship between the 11 entry forms that make up the database program. General information about the site is entered in the ***Site Survey*** form; the ***Ceilings***, ***Walls*** and ***Floors*** forms are used to describe the general framing elements that make up the dwelling; and framing details are entered in the ***Openings***, ***Intersections*** and ***Corners*** forms.

Figure 8.1: Database Structure

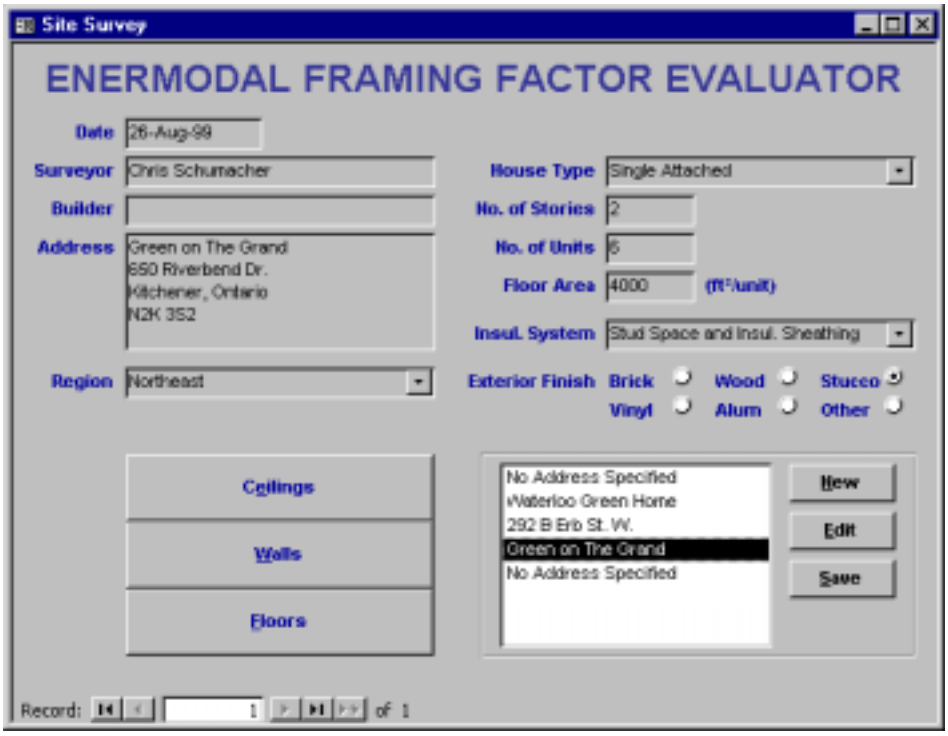


The forms that are lower in the database structure shown in Figure 8.1 contain more detail and are accessed from the less detailed forms higher up in the flowchart. Surveyors will work from general to specific (i.e., down the flowchart) when entering data. The program will work from specific to general (i.e., up the flowchart) when processing data. Sections 2.1 through 2.4 describe the type of data entered into the database. Section 3 describes how these data are processed to determine the framing factors.

Site Survey Form

The ***Site Survey*** (Figure 8.2) form has three functions: to navigate through the database of survey sites, to summarize general information about each site, and to access the site details in the ***Ceiling***, ***Wall*** and ***Floor*** forms.

Figure 8.2: Site Survey Form



The program allows the surveyor to navigate through the survey site database using the "Site" list box. The surveyor can add a site by pressing the ***New*** button. When a new site is added, the surveyor is immediately asked to enter the general information for that site:

Date	Enter the date on which the survey was conducted
Surveyor	Enter the name of the surveyor
Builder	Enter the name of the builder
Address	Enter the address of the survey site
Region	Select the census region of the survey site: *West, Midwest, Northeast, South*

Dwelling Type Select the type of dwelling:
Single Detached, Single Attached, Multi-Family
If the building is Multi-Family, the surveyor should enter each unit type as a separate site. The sites are related using a similar address. Given a building with, for example, 8 units of one type of layout and 4 units of another, the surveyor would create two sites (e.g., Water St. A and Water St. B). One site would have 8 units and the other would have 4.

No. of Stories Enter the number of stories

No. of Units Enter the number of units if Multi-Family

Floor Area Enter the gross floor area in ft^2/unit

Insul. System Select the insulation placement used:
Cavity insulation, Insulating sheathing, Cavity & Insul. Sheathing

Exterior Finish Select the exterior wall finish(es) as applicable:
Brick, Wood, Stucco, Vinyl, Aluminum, Other
If exterior finishes have not yet been applied, refer to the builder or realtor.

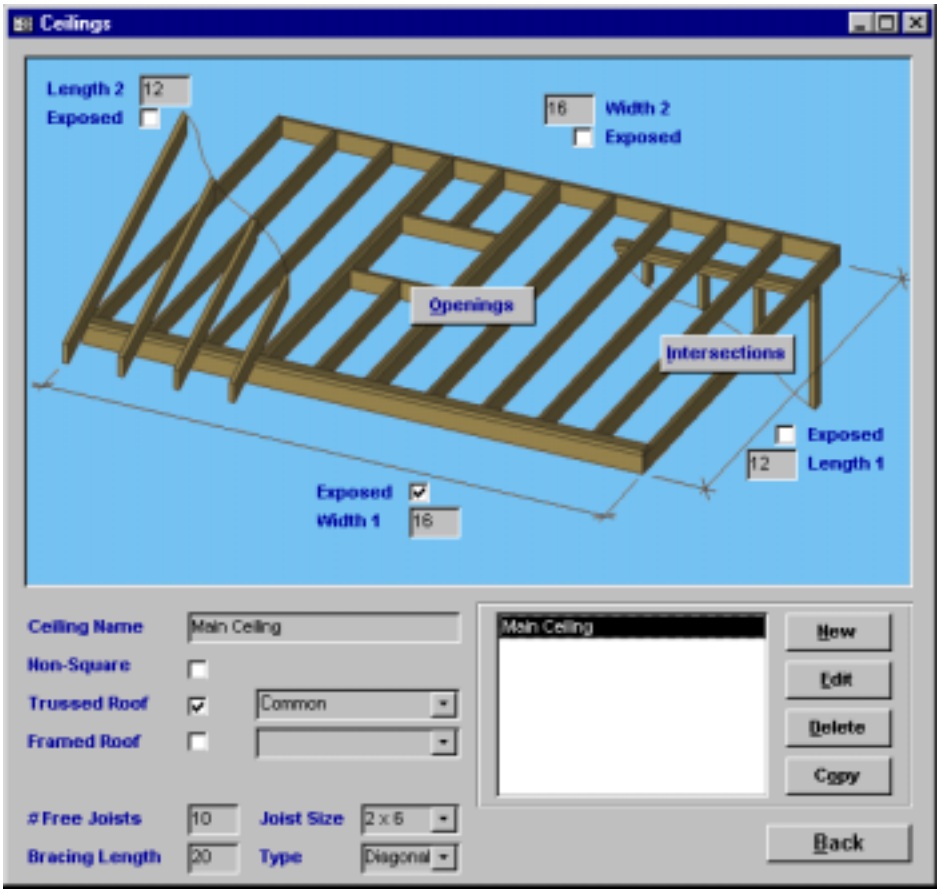
Once the general information has been entered, the database is updated by pressing the ***Save*** button. The surveyor can make corrections to the general information by selecting a site from the "Site" list box and pressing the ***Edit*** button. If necessary, the surveyor can remove a site from the database by selecting it from the "Site" list box and pressing the ***Delete*** button. All of the forms use similar list boxes to manage the database records.

The surveyor can enter or modify detailed site information by selecting a site from the "Site" list box and pressing one of the ***Ceilings***, ***Walls*** or ***Floors*** buttons. The detailed information forms are explained in the following sections.

Ceiling Form

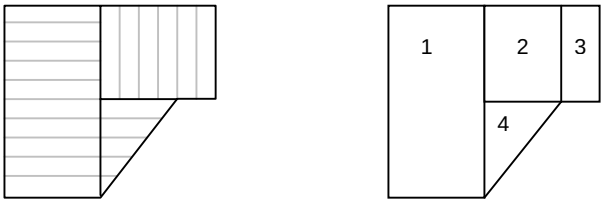
The ***Ceiling*** form (Figure 8.3) allows the surveyor to enter detailed information about ceiling framing for each site. The information contained on the ***Ceiling*** form describes a ceiling element (i.e., a grouping of similar ceiling joists). A "Ceiling" list box allows the user to navigate through and edit ceiling elements.

Figure 8.3: Ceiling Form



If the dwelling has more than a simple rectangular ceiling, the surveyor must enter the ceiling as several ceiling elements. A complex ceiling shape is illustrated on the left in Figure 8.4. This ceiling can be entered as four ceiling elements as illustrated on the right in Figure 8.4. Each element has 3 or 4 sides. A 3-sided element must have one right angle corner and a 4-sided element must have 2 right angle corners. The side of an element can be completely exposed to the exterior (e.g., a ring joist) or can be completely sheltered by another ceiling element. A side cannot be partially exposed and partially sheltered. In the example, ceiling element 2 has one exposed side while ceiling element 3 has three exposed sides. Ceiling elements 2 and 3 could not be combined into one element because one of the sides would be partially exposed and partially sheltered.

Figure 8.4: Dividing a Ceiling Into Ceiling Elements



The surveyor can add a ceiling element by pressing the ***New*** button. When a new ceiling element is added, the surveyor is immediately asked to enter the details for that ceiling element.

Name	Enter a name for the ceiling element
Non-square	Check this box if the ceiling element is not rectangular
Length	Enter the length of the ceiling element. The length is measured parallel to the span of the joists.
Width	Enter the width of the ceiling element. The width is measured perpendicular to the span of the joists.
Exposed	Check the exposed box on each side of the ceiling that is exposed to the exterior (i.e. a ring joist).
Trussed Roof	Check this box if the ceiling is beneath a trussed roof, and select the type of truss used: *Common, Scissor, Raised Heel, Parallel, Cantilever, Dropped Chord*
Framed Roof	Check this box if the ceiling is beneath a framed roof, and select the type of bearing for the rafters & ceiling joists: *Vaulted, Top Plate, Rafter Plate*
# Free Joists	Enter the number of free joists in the ceiling element. Free joists are joists that are NOT part of the framing around an opening and are NOT ring joists.
Joist Size	Select the size of the joists used: *2 x 6, 2 x 8, 2 x 10, 2 x 12, 12 Wood-I, 14 Wood-I, 16 Wood-I*
Bracing Length	Enter the total length of the bracing. If there is more than one row of bracing, enter the sum of the lengths of the individual rows.
Bracing	Select the type of bracing used: *Blocking, Cross Bracing, Let-In, Diagonal Bracing, Strapping*

Once this information has been entered, the database is updated by pressing the ***Save*** button. The surveyor can make corrections to the information in a ceiling element by selecting it from the “Ceiling” list box and pressing the ***Edit*** button. If necessary, the

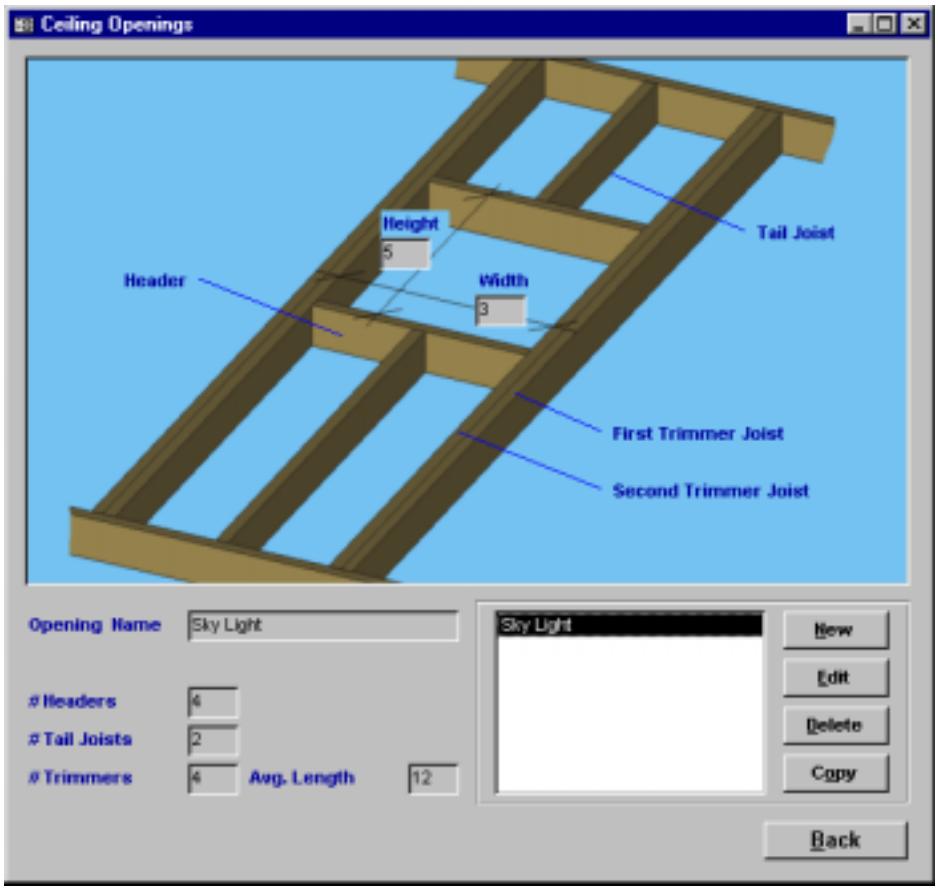
surveyor can remove a ceiling element from the database by selecting it from the "Ceiling" list box and pressing the ***Delete*** button.

The surveyor must enter details about the ceiling openings and intersections. This is done in the forms accessed by the ***Openings*** and ***Intersections*** buttons.

Ceiling Openings Form

The ***Ceiling Openings*** (Figure 8.5) form is used to describe the framing around openings such as attic accesses and skylights. A "Ceiling Openings" list box is used to manage ceiling opening elements.

Figure 8.5: Ceiling Openings Form



Several details are necessary to describe each ceiling opening:

Name Enter a name for the ceiling opening.

Height Enter the height of the rough ceiling opening.

Width Enter the width of the rough ceiling opening.

 # Headers Enter the total number of headers included in the ceiling opening. Count all headers above and below the opening.

 # Tail Joists Enter the total number of tail joists included in the ceiling opening. Count all tail joists above and below the opening.

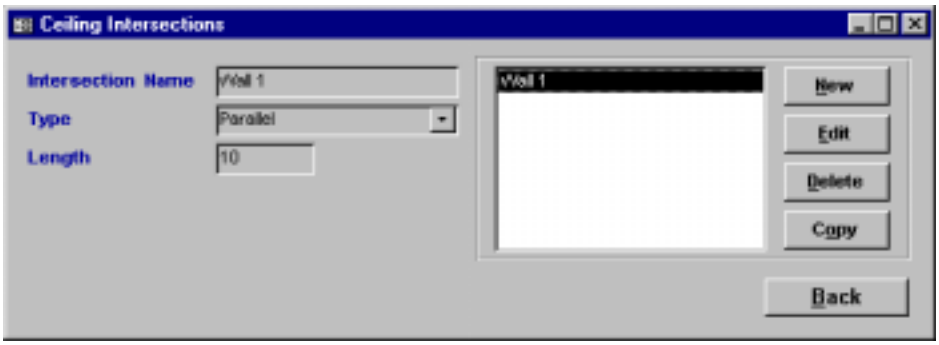
 # Trimmers Enter the total number of trimmer joists included in the ceiling opening. Count all trimmer joists on both sides of the opening.

Avg. Length Enter the average length of the trimmers.

Ceiling Intersections Form

The ***Ceiling Intersections*** (Figure 8.6) form is used to describe the framing at intersections between the ceiling elements and interior walls. The surveyor can manage the ceiling intersection elements using the "Ceiling Intersections" list box.

Figure 8.6: Ceiling Intersections Form



Few details are needed to describe a ceiling intersection:

Name Enter a name for the ceiling intersection.

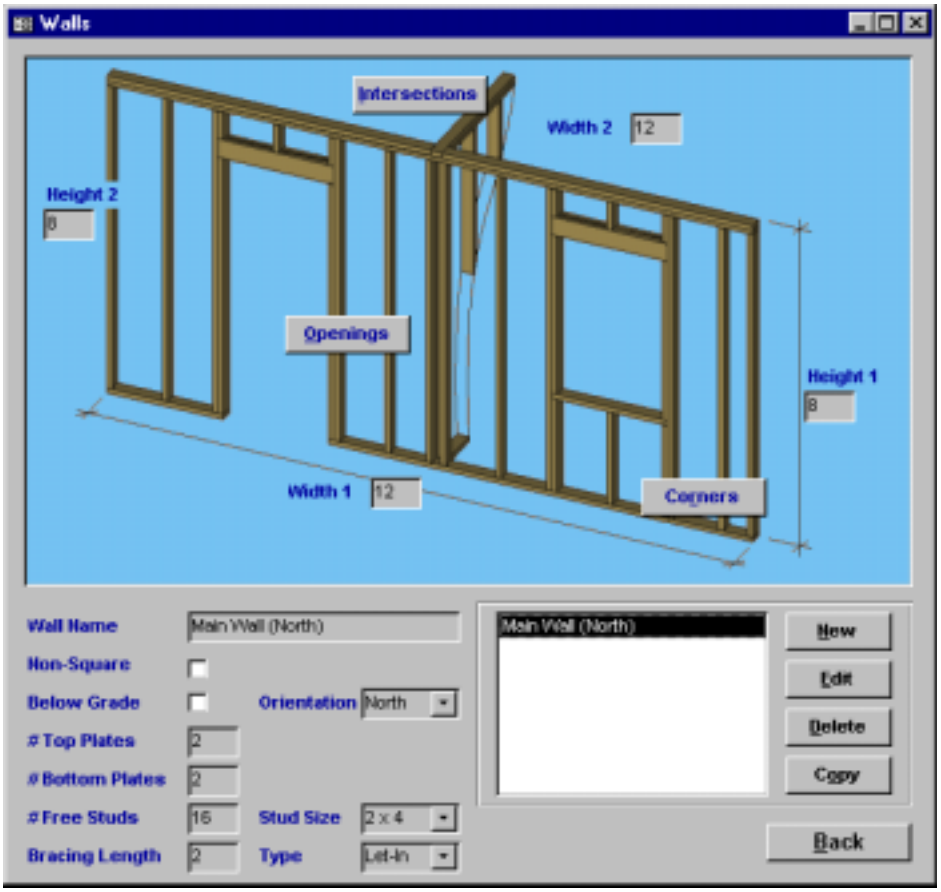
Type Select the type of intersection:
Parallel (i.e., in the direction of the joists), Perpendicular

Length Enter the length of the intersection.

Wall Form

The ***Wall*** form (Figure 8.7) allows the surveyor to enter detailed information about wall framing for each site. The information contained on the ***Wall*** form describes a wall element (a grouping of similar wall studs). A "Wall" list box allows the user to navigate through and edit wall elements.

Figure 8.7: Wall Form



Like ceiling elements, wall elements can be 3- or 4-sided. However, since walls are more complicated than ceilings, more details are required to describe a wall element:

Name	Enter a name for the wall element
Non-square	Check this box if the wall element is not rectangular
Height	Enter the height of the wall element. The height is measured parallel to the direction of the studs.
Width	Enter the width of the wall element. The width is measured perpendicular to the direction of the studs.

Below Grade	Check this box if the wall is below grade (i.e., a basement wall).
Orientation	Select the orientation of the wall element: *N, NE, E, SE, S, SW, W, NW.*
# Top Plates	Enter the number of top plates in the wall element.
# Bottom Plates	Enter the number of bottom plates in the wall element.
# Free Studs	Enter the number of free studs in the wall element. Free studs are studs that are NOT part of the framing around an opening or part of the framing at a corner.
Stud Size	Select the size of the joists used: *2 x 4, 2 x 6*
Bracing Length	Enter the total length of the bracing in the wall element. If there is more than one row of bracing, enter the sum of the lengths of the individual rows.
Type	Select the type of bracing used: *Blocking, Cross Bracing, Let-In, Diagonal Bracing, Strapping*

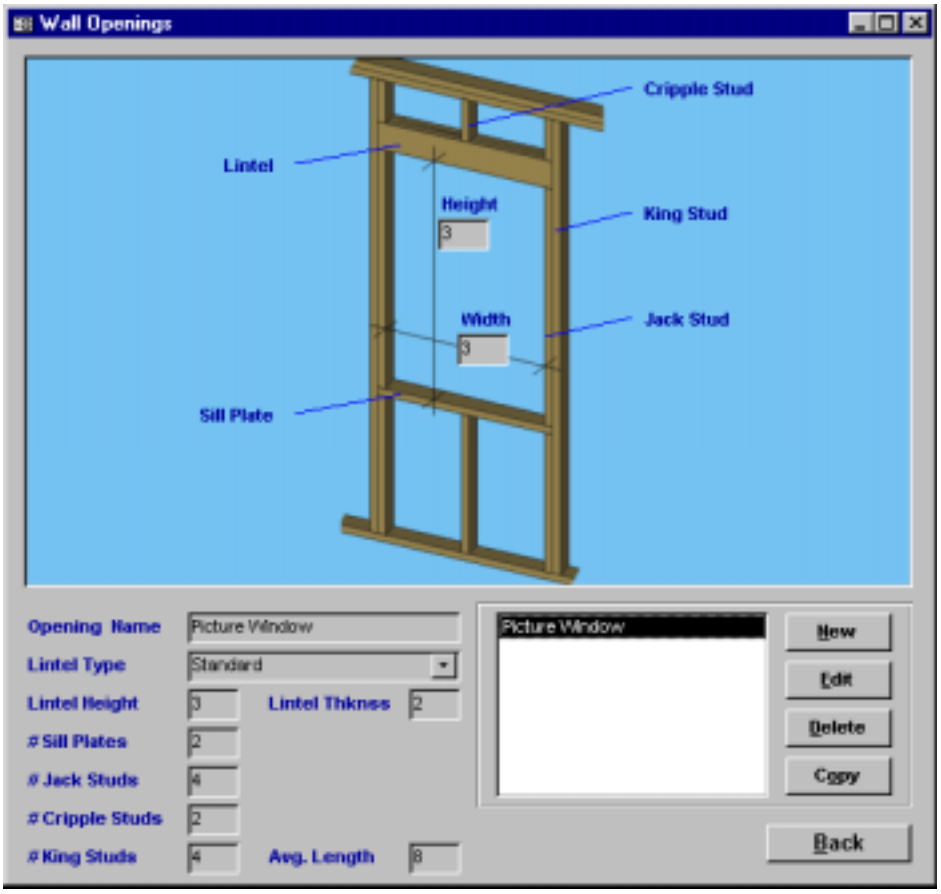
The database is updated by pressing the ***Save*** button. The surveyor can make corrections to the information in a wall element by selecting it from the "Wall" list box and pressing the ***Edit*** button. If necessary, the surveyor can remove a wall element from the database by selecting it from the "Wall" list box and pressing the ***Delete*** button.

The surveyor must also enter details about the wall openings, intersections and corners. This is done in the forms accessed by the ***Openings, Intersections*** and ***Corners*** buttons.

Wall Openings Form

The ***Wall Openings*** (Figure 8.8) form is used to describe the framing around openings such as windows and doors. A "Wall Openings" list box is used to manage wall opening elements.

Figure 8.8: Wall Openings Form



Several details are necessary to describe each wall opening:

Name Enter a name for the wall opening.

Height Enter the height of the rough wall opening.

Width Enter the width of the rough wall opening.

Lintel Type Select the type of lintel used above the wall opening:
Single, Built-Up, Glu-Lam, Double, Double Insulated

Lintel Height Enter the total height of the lintel.

Lintel Thknss Enter the total thickness of the lintel (measured from inside to outside).

 # Sill Plates Enter the total number of sill plates at the bottom of the wall opening. If there are no sill plates, the opening is assumed to be a door, otherwise it is assumed to be a window.

 # Jack Studs Enter the total number of jack studs included in the wall opening. Count the jack studs on both sides of the opening.

 # Cripple Studs Enter the total number of cripple studs in the wall opening. Count all cripple studs above and below the opening.

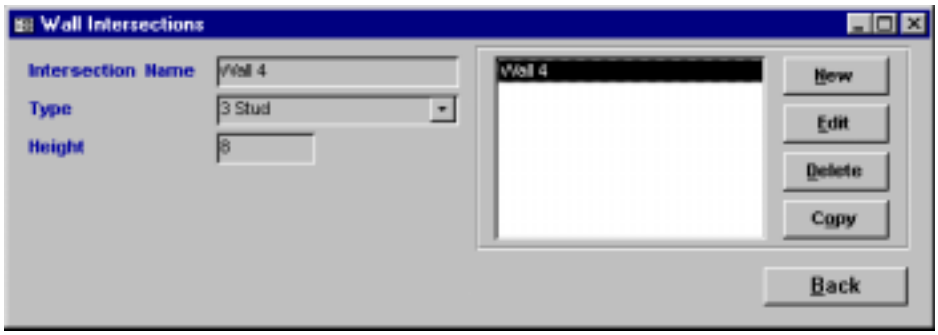
 # King Studs Enter the total number of king studs included in the wall opening. Count the king studs on both sides of the opening.

Avg. Length Enter the average length of the king studs.

Wall Intersections Form

The ***Wall Intersections*** (Figure 8.9) form is used to describe the framing at intersections between the wall elements and interior walls. The surveyor can manage the wall intersection elements using the "Wall Intersections" list box.

Figure 8.9: Wall Intersections Form



Few details are needed to describe a wall intersection:

Name Enter a name for the wall intersection.

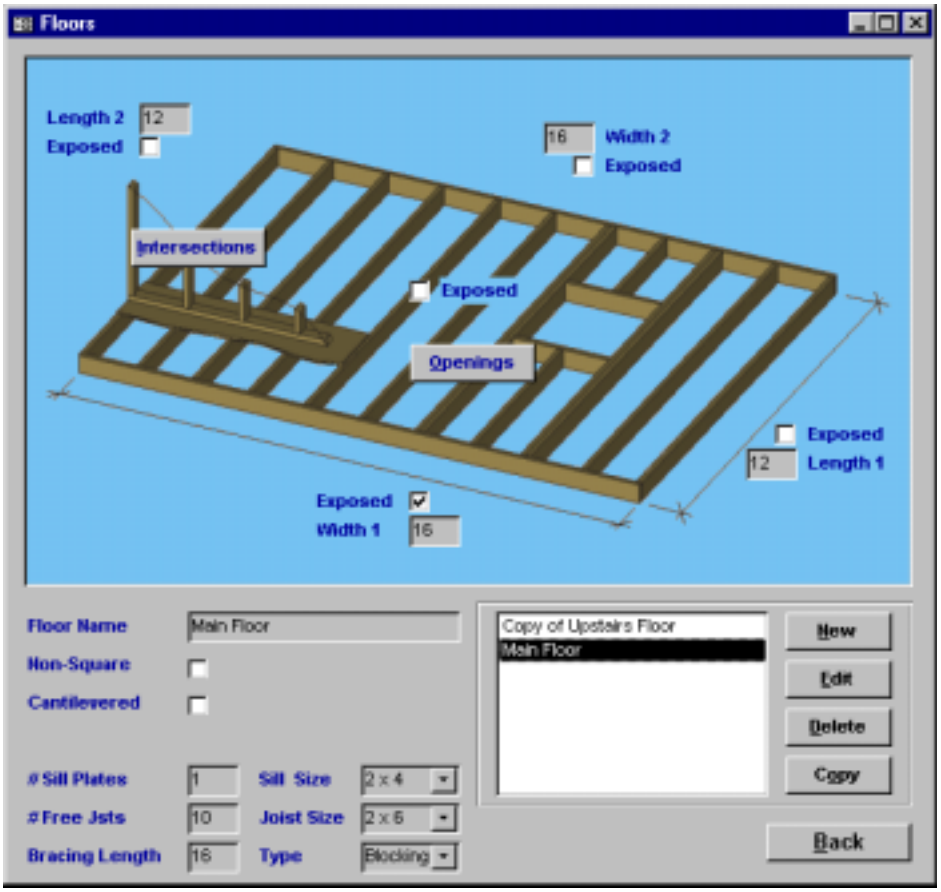
Type Select the type of intersection:
3 Stud, 2 Stud, 1 Stud w/ blocking, 1 Stud w/ clips

Length Enter the length of the intersection.

Floor Form

The ***Floor*** form (Figure 8.10) allows the surveyor to enter detailed information about floor framing for each site. The information contained on the ***Floor*** form describes a floor element (a grouping of similar floor joists). A "Floor" list box allows the user to navigate through and edit floor elements.

Figure 8.10: Floor Form



Like ceiling elements and wall elements, floor elements can be 3- or 4-sided. Different information is required to describe a floor element:

Name Enter a name for the floor element.

Non-square Check this box if the floor element is not rectangular.

Cantilevered Check this box if the floor element is cantilevered past the edge of the element that supports it.

Length	Enter the length of the wall element. The length is measured parallel to the direction of the joists.
Width	Enter the width of the floor element. The width is measured perpendicular to the direction of the joists.
# Sill Plates	Enter the number of sill plates if the floor is supported by a foundation wall.
Sill Size	Select the size of the sill plate used: *2 x 4, 2 x 6, 2 x 8*
# Free Joists	Enter the number of free joists in the ceiling element. Free joists are joists that are NOT ring joists or part of the framing around an opening.
Joist Size	Select the size of the joists used: *2 x 6, 2 x 8, 2 x 10, 2 x 12, 12 Wood-I, 14 Wood-I, 16 Wood-I*
Bracing Length	Enter the total length of the bracing in the floor element. If there is more than one row of bracing, enter the sum of the lengths of the individual rows.
Type	Select the type of bracing used: *Blocking, Cross Bracing, Let-In, Diagonal Bracing, Strapping*

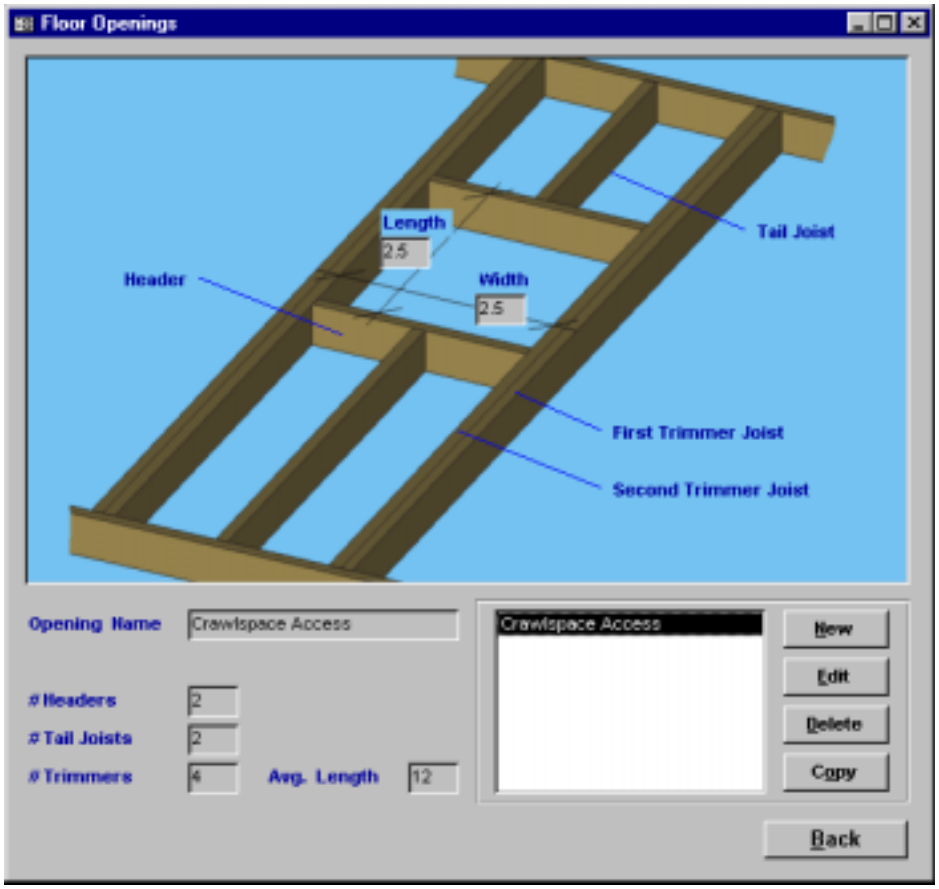
The database is updated by pressing the ***Save*** button. The surveyor can make corrections to the information in a floor element by selecting it from the "Floor" list box and pressing the ***Edit*** button. If necessary, the surveyor can remove a floor element from the database by selecting it from the "Floor" list box and pressing the ***Delete*** button.

The surveyor must also enter details about the floor openings and intersections. This is done in the forms accessed by the ***Openings*** and ***Intersections*** buttons.

Floor Openings Form

The ***Floor Openings*** (Figure 8.11) form is used to describe the framing around openings such as crawlspace accesses. A "Floor Openings" list box is used to manage floor opening elements.

Figure 8.11: Floor Openings Form



Several details are necessary to describe each floor opening:

Name	Enter a name for the floor opening.
Length	Enter the length of the rough floor opening.
Width	Enter the width of the rough floor opening.
# Headers	Enter the total number of headers included in the floor opening. Count all headers on both ends of the opening.

 # Tail Joists Enter the total number of tail joists included in the floor opening. Count all tail joists on both ends of the opening.

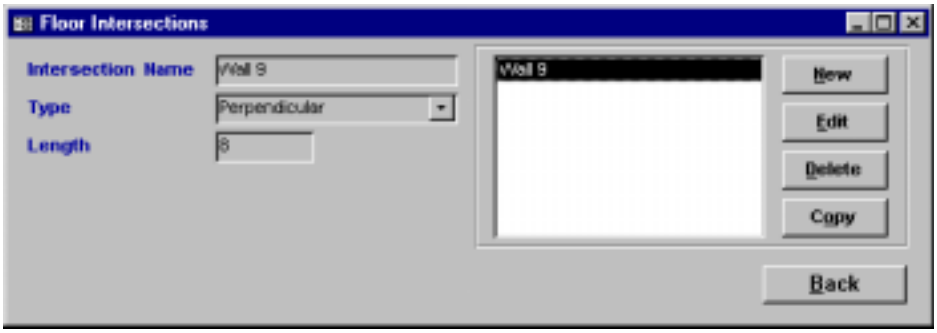
 # Trimmers Enter the total number of trimmer joists included in the floor opening. Count all trimmer joists on both sides of the opening.

Avg. Length Enter the average length of the trimmers.

Floor Intersections Form

The ***Floor Intersections*** (Figure 8.12) form is used to describe the framing at intersections between the floor elements and interior walls. The surveyor can manage the floor intersection elements using the "Floor Intersections" list box.

Figure 8.12: Floor Intersections Form



Few details are needed to describe a floor intersection:

Name Enter a name for the floor intersection.

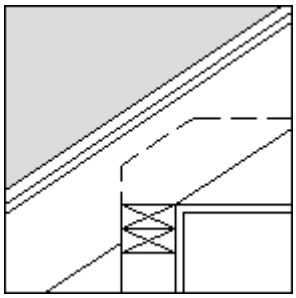
Type Select the type of intersection:
Parallel (i.e., in the direction of the joists), Perpendicular

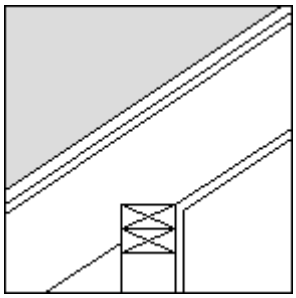
Length Enter the length of the intersection.

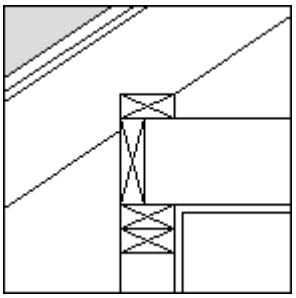
Typical Framing Details

This section contains illustrations of the choices available for the Framed Roof (Section 0), Corners (Section 0), Ceiling Intersections (Section 0) and Wall Intersections (Section 0) list boxes.

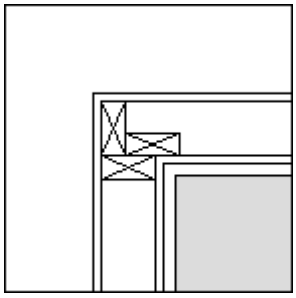
Framed Roofs @ Eave

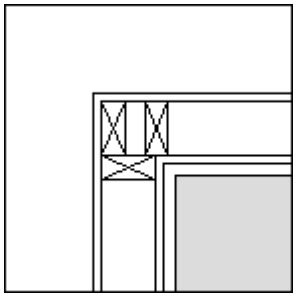

Double Top Plate

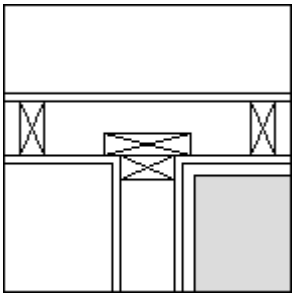

Vaulted


Rafter Plate

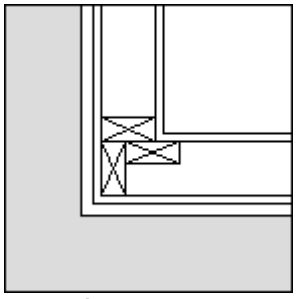
Inside Corners

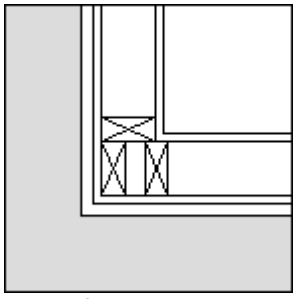

3-Stud A

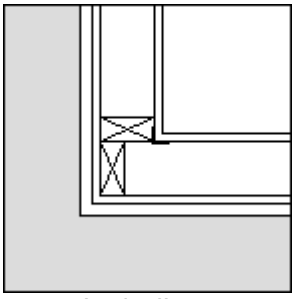

3-Stud B


2-Stud

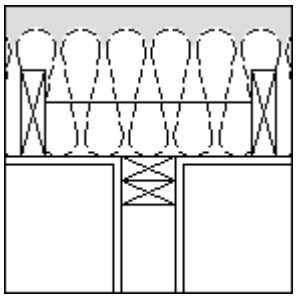
Outside Corners


3-Stud A

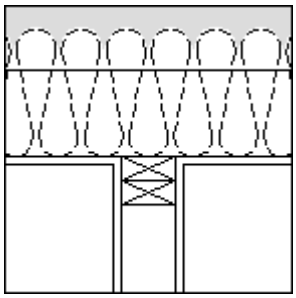

3-Stud B


2-Stud w/ Clips

Ceiling/Wall Intersections

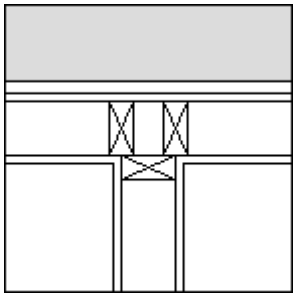


Parallel

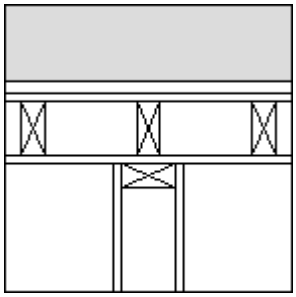


Perpendicular

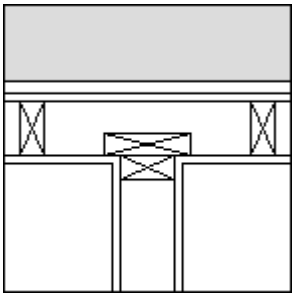
Wall/Wall Intersections



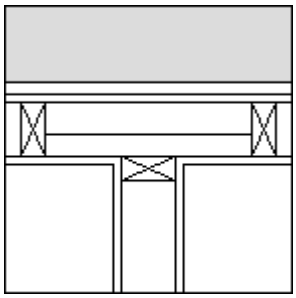
3-Stud



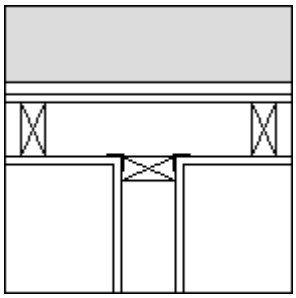
2-Stud A



2-Stud B



1-Stud w/ Blocking



1-Stud w/ Clips

Appendix B. Audit Results for Individual Dwellings

Appendix B – Individual Dwellings

Detached Dwellings

South - Detached										Ratios (Note 1)						
Site Code	Location	No. of Stry's	Total Floor Area Ft² /Unit	Gross Floor Area (Ft²)	Gross Ceiling Area (Ft²)	Gross Wall Area (Ft²)	Foundation	Walls -- Percent 2x4	Walls -- Percent 2x6	Window Area to Gross Insul. Wall Area	Door Area to Gross Insul. Wall Area	Rim Joist Area/Gross Wall Area	Corner Ht to Gross Insul. Wall Area (Note 3)	Ceiling Opening to Gross Insul. Clg Area	Exposed Perimeter to Floor (Note 3)	Floor Opening to Gross Insul. Floor Area
D-S1	Nashville, TN	1	938	0	935	1075	Slab-on-Grade	100.0	0.0	5.0	8.0		0.48	19.3	0.00	0.00
D-S2	Nashville, TN	2	3580	2880	3531	4507	Crawlspace	100.0	0.0	11.0	5.9	5.3	0.56		0.82	0.00
D-S3	Nashville, TN	1	1100	1100	1095	1287	Crawlspace	100.0	0.0	6.8	7.2	4.4	0.44		1.00	0.00
D-S4	Nashville, TN	2	1362	64	600	1793	Slab-on-Grade	100.0	0.0	7.2	5.0	1.8	0.37		0.43	0.00
D-S5	Nashville, TN	2	2817	1600	1380	3190	Full Basement	100.0	0.0	17.6	2.2	5.3	0.55		0.82	0.00
D-S6	Ft. Worth, TX	1	1900	0	1759	1828	Full Basement	100.0	0.0	13.2	3.4	0.0	0.26	19.5	0.00	0.00
D-S7	Arlington, TX	2	2420	0	168	3047	Slab-on-Grade	88.9	11.1	12.0	2.8	3.4	0.44	6.4	0.00	0.00
D-S8	Arlington, TX	2	3280	216	2129	3312	Slab-on-Grade	90.6	9.4	17.2	2.0	3.5	0.58	5.7	0.35	0.00
D-S9	Arlington, TX	2	3417	169	3603	3603	Full Basement	100.0	0.0	14.7	1.2	4.1	0.63	7.0	0.32	0.00
D-S10	Arlington, TX	1	2102	22	2167	2072	Slab-on-Grade	100.0	0.0	13.2	5.4	0.4	0.51		0.07	0.00
Averages:		**1.6**	**2292**	**605**	**1737**	**2571**		**98.0**	**2.0**	**11.8**	**4.3**	**3.5**	**0.5**	**11.6**	**0.4**	**0.0**
Standard Deviations:		**0.5**	**972**	**971**	**1154**	**1119**		**4.3**	**4.3**	**4.3**	**2.3**	**2.0**	**0.1**	**7.2**	**0.4**	**0.0**

	Framing Factors - Gross (Note 2)				Framing Factors - Net (Note 2)				Window Area (Ft²) by Orientation							
Site Code	Ceiling	Wall	Floor	Overall	Ceiling	Wall	Floor	Overall	N	NE	E	SE	S	SW	W	NW
D-S1	6.5	19.9		13.9	8.1	22.9		16.3	0	24	0	0	0	30	0	0
D-S2	8.6	19.6	7.9	13.1	8.6	23.6	7.9	13.9	128	0	90	0	194	0	52	0
D-S3	5.6	13.5	8.9	9.6	5.6	15.7	8.9	10.1	0	0	31	0	0	0	50	0
D-S4	5.8	18.4		14.9	5.8	20.9		16.3	0	0	71	0	15	0	39	0
D-S5	6.2	20.1	7.9	13.5	6.2	25.1	7.9	15.4	235	0	75	0	184	0	14	0
D-S6	6.1	20.0		13.2	7.6	24.0		16.1	87	1	35	0	47	0	71	0
D-S7	6.0	19.6		15.0	6.4	23.0		22.1	141	0	24	0	124	0	66	0
D-S8	6.7	21.3	12.9	15.7	7.1	26.4	12.9	17.9	178	0	77	0	192	0	103	0
D-S9	8.0	21.6	15.9	16.0	8.6	25.6	15.9	16.7	122	14	78	25	159	24	33	52
D-S10	7.6	22.5	12.0	14.9	7.6	27.6	12.0	16.3	32	0	1200	0	60	0	61	0
Averages:	**6.7**	**19.6**	**10.9**	**14.0**	**7.2**	**23.5**	**10.9**	**16.1**	**92**	**4**	**168**	**2**	**97**	**5**	**49**	**5**
Standard Deviations:	**1.0**	**2.5**	**3.2**	**1.9**	**1.1**	**3.3**	**3.2**	**3.0**	**82.6**	**8.3**	**363.7**	**7.8**	**81.7**	**11.6**	**29.5**	**16.4**

West - Detached										Ratios (Note 1)						
Site Code	Location	No. of Stry's	Floor Area Ft² /Unit	Gross Floor Area (Ft²)	Gross Ceiling Area (Ft²)	Gross Wall Area (Ft²)	Foundation	Walls -- Percent 2x4	Walls -- Percent 2x6	Window Area to Wall Area	Door Area to Wall Area	Rim Joist Area/Gross Wall Area	Corner Ht to Wall (Note 3)	Ceiling Opening to Ceiling	Exposed Perimeter to Floor (Note 3)	Floor Opening to Floor
D-W1	Pheonix, AZ	1	1500	1676	1776	2213	Slab-on-Grade	0.0	100.0	8.8	4.7	1.9	0.46	0.00	0.83	0.00
D-W2	Pheonix, AZ	2	3824	1535	1922	2887	Slab-on-Grade	72.7	27.3	11.9	4.6	4.3	0.22	0.00	0.35	0.00
D-W3	Pheonix, AZ	1	2511	2635	2351	2545	Slab-on-Grade	90.0	10.0	12.2	4.6	3.9	0.36	0.00	0.75	0.00
D-W4	Pheonix, AZ	1	2490	2491	2463	2389	Slab-on-Grade	90.0	10.0	9.5	11.1	8.4	0.47	1.62	0.96	0.00
D-W5	Pheonix, AZ	1	2986	0	2965	3523	Slab-on-Grade	100.0	0.0	11.3	7.5	7.8	0.41	0.00	0.97	0.00
D-W6	Pheonix, AZ	1	1500	1830	1535	1698	Slab-on-Grade	100.0	0.0	12.2	4.2	7.8	0.38	0.00	0.93	0.00
D-W7		1	1948	2144	0	2298	Slab-on-Grade	100.0	0.0	12.2	5.0	8.0	0.47	0.00	0.99	0.00
D-W8	Denver, CO	1	3056	0	1473	2208	Full Basement	78.6	21.4	13.5	6.8	3.5	0.41	1.02	0.41	0.00
D-W9	Denver, CO	2	1300	0	702	1873	Crawlspace	100.0	0.0	9.6	3.6	4.7	0.38	0.00	1.35	0.00
D-W10	Pheonix, AZ	2	3408	0	1203	2733	Slab-on-Grade	0.0	100.0	12.7	4.4	1.7	0.75	0.00	0.68	0.00
D-W11		2	3408	1899	1613	3726	Slab-on-Grade	78.6	21.4	12.0	3.3	4.3	0.00	0.00	0.49	0.00
D-W12	Denver, CO	2	2204	1169	966	3782	Full Basement	0.0	100.0	10.7	4.2	6.5	0.52	1.04	1.17	0.00
D-W13	Denver, CO	2	2217	103	815	2231	Full Basement	0.0	100.0	11.8	3.5	2.6	0.70	1.23	0.96	0.00
D-W14	Pheonix, AZ	1	2397	1781	1621	3161	Slab-on-Grade	75.0	25.0	13.6	5.3	6.6	0.37	0.00	0.01	0.00
Averages:		**1.5**	**2489**	**1191**	**1522**	**2623**		**62.3**	**37.7**	**11.4**	**5.2**	**5.0**	**0.4**	**0.4**	**0.8**	**0.0**
Standard Deviations:		**0.5**	**777.9**	**1004.9**	**774.6**	**667.9**		**42.5**	**42.5**	**1.4**	**2.1**	**2.4**	**0.2**	**0.6**	**0.4**	**0.0**

	Framing Factors - Gross (Note 2)				Framing Factors - Net (Note 2)				Window Area by Orientation							
Site Code	Ceiling	Wall	Floor	Overall	Ceiling	Wall	Floor	Overall	N	NE	E	SE	S	SW	W	NW
D-W1	6.6	19.6		13.8	6.6	22.7		10.3	60	36	10	0	45	0	44	0
D-W2	6.5	24.1		12.9	6.5	28.8		14.0	175	0	15	0	83	0	55	0
D-W3	14.1	18.2		10.6	14.1	21.9		11.2	78	0	11	0	45	0	58	0
D-W4	0.1	18.8		6.1	0.1	23.6		6.6	59	0	100	0	0	0	45	0
D-W5	6.4	18.8		8.9	6.4	23.2		14.7	33	0	1396	0	102	0	91	0
D-W6	6.1	15.1		6.9	6.1	18.0		7.3	75	0	36	0	40	0	40	0
D-W7	6.0	14.6		6.6	6.0	17.6		8.3	41	0	58	0	82	0	77	0
D-W8	5.0	23.1		15.9	5.1	28.9		18.1	64	0	175	0	32	0	11	0
D-W9	5.5	19.9		15.5	5.5	22.9		17.6	73	0	45	0	31	0	16	0
D-W10	5.8	22.7		17.5	5.8	27.4		19.9	50	0	87	0	81	0	103	0
D-W11	10.5	16.8		11.0	10.5	19.8		11.9	166	0	48	0	74	0	142	0
D-W12	6.4	20.1	2.1	12.7	6.4	23.6	2.1	15.8	96	0	55	0	42	0	52	0
D-W13	6.1	20.6	16.4	16.7	6.1	24.3	16.4	18.8	25	0	77	0	98	0	39	0
D-W14	6.4	25.9		14.1	6.4	32.0		15.5	0	0	0	0	0	0	0	0
Averages:	**6.5**	**19.4**	**9.3**	**11.9**	**6.6**	**23.3**	**9.3**	**13.4**	**76**	**3**	**151**	**0**	**58**	**0**	**59**	**0**
Standard Deviations:	**3.0**	**3.3**	**10.2**	**3.8**	**3.0**	**4.2**	**10.2**	**4.4**	**48.6**	**9.6**	**361.3**	**0.0**	**33.2**	**0.0**	**38.0**	**0.0**

Midwest - Detached								Ratios (Note 1)								
Site Code	Location	No. of Stry's	Floor Area Ft² /Unit	Gross Floor Area (Ft²)	Gross Ceiling Area (Ft²)	Gross Wall Area (Ft²)	Foundation	Walls -- Percent 2x4	Walls -- Percent 2x6	Window Area to Wall Area	Door Area to Wall Area	Rim_Joist Area/ Gross wall area	Corner Ht to Wall (Note 3)	Ceiling Opening to Ceiling	Exposed Perimeter to Floor (Note 3)	Floor Opening to Floor
D-MW1	Centennial Pk, MI	1	2703	0	2452	2720	Full Basement	96.9	3.1	13.5	5.7	7.1	0.53	0.00	0.75	0.0
D-MW2	Ann Arbor, MI	2	2081	0	1659	2427	Full Basement	93.8	6.3	13.1	5.3	9.9	0.33	0.00	1.00	0.0
D-MW3	Ann Arbor, MI	1	1550	0	1737	1986	Full Basement	100.0	0.0	6.1	5.9	7.0	0.37	0.00	0.94	0.0
D-MW4	Grand Blanc, MI	2	2871	0	1586	3005	Full Basement	95.0	5.0	12.7	4.1	7.7	0.42	0.00	0.95	0.0
D-MW5	Grinnell, IA	1	2234	0	2280	1594	Slab-on-Grade	100.0	0.0	3.4	11.9	0.0	0.32	0.32	0.00	0.0
D-MW6	Tama, IA	1	2042	0	2200	1519	Slab-on-Grade	100.0	0.0	6.9	9.2	0.0	0.34	0.33	0.00	0.0
D-MW7	Hawatha, IA	2	3266	2250	1104	2827	Full Basement	100.0	0.0	20.6	4.0	5.5	0.43	0.36	0.71	0.0
D-MW8	Marshalltown, IA	2	2240	1456	1456	2079	Full Basement	0.0	100.0	9.1	7.1	0.0	0.26	0.55	0.39	0.8
D-MW9	Marshalltown, IA	1	1512	1512	1512	1337	Crawlspace	0.0	100.0	1.8	12.8	0.0	0.19	0.00	0.94	0.0
D-MW10	Flint, MI	2	3252	0	1826	3332	Full Basement	87.0	13.0	13.4	4.7	8.7	0.43	1.26	0.82	0.0
Averages:		**1.6**	**2339**	**580**	**1707**	**2234**		**75.1**	**24.9**	**10.1**	**7.1**	**4.6**	**0.4**	**0.3**	**0.7**	**0.1**
Standard Deviations:		**0.5**	**630**	**866**	**417**	**684**		**40.9**	**40.9**	**5.7**	**3.2**	**4.1**	**0.1**	**0.4**	**0.4**	**0.3**

	Framing Factors - Gross (Note 2)				Framing Factors - Net (Note 2)				Window Area by Orientation							
Site Code	Ceiling	Wall	Floor	Overall	Ceiling	Wall	Floor	Overall	N	NE	E	SE	S	SW	W	NW
D-MW1	6.2	20.7		13.8	6.2	25.6		15.3	141	0	48	0	130	0	23	0
D-MW2	7.2	28.0		19.6	7.2	34.3		21.9	97	0	36	0	0	0	84	0
D-MW3	6.3	19.4		13.3	6.3	22.0		14.2	51	0	16	0	31	0	16	0
D-MW4	6.0	19.8		15.0	6.0	23.8		16.9	81	0	0	0	250	0	19	0
D-MW5	6.8	20.6		12.5	6.8	24.3		13.3	45	0	0	0	9	0	0	0
D-MW6	6.8	22.3		13.2	6.9	26.6		14.1	0	0	105	0	0	0	0	0
D-MW7	4.6	22.7	20.4	18.6	4.6	30.0	20.4	21.0	124	0	67	13	229	13	84	0
D-MW8	4.4	19.8	12.6	13.3	4.4	23.6	12.7	14.2	51	0	36	0	95	0	0	0
D-MW9	5.3	19.3	10.6	11.5	5.3	22.6	10.6	12.0	25	0	0	0	0	0	0	0
D-MW10	6.2	18.4		14.1	6.2	22.5		16.0	186	0	44	0	145	0	32	0
Averages:	**6.0**	**21.1**	**14.5**	**14.5**	**6.0**	**25.5**	**14.6**	**15.9**	**80**	**0**	**35**	**1**	**89**	**1**	**26**	**0**
Standard Deviations:	**0.9**	**2.8**	**5.1**	**2.6**	**0.9**	**3.9**	**5.1**	**3.2**	**57.3**	**0.0**	**33.8**	**4.2**	**96.5**	**4.2**	**32.8**	**0.0**

NorthEast - Detached										Ratios (Note 1)						
Site Code	Location	No. of Stry's	Floor Area Ft² /Unit	Gross Floor Area (Ft²)	Gross Ceiling Area (Ft²)	Gross Wall Area (Ft²)	Foundation	Walls -- Percent 2x4	Walls -- Percent 2x6	Window Area to Wall Area	Door Area to Wall Area	Rim Joist Area/Gross Wall Area	Corner Ht to Wall (Note 3)	Ceiling Opening to Ceiling	Exposed Perimeter to Floor (Note 3)	Floor Opening to Floor
D-NE1	Hopkinton, MA	2	3500	2191	4698	3006	Full Basement	87.5	12.5	19.7	4.4	6.1	0.66	6.7	0.61	0.0
D-NE2	Plainville, MA	2	2200	2110	1056	2593	Full Basement	100.0	0.0	8.0	5.9	3.7	0.35	5.3	1.11	0.0
D-NE3	Worchester, MA	2	1725	900	855	2096	Full Basement	27.8	72.2	11.7	6.6	4.1	0.37	0.8	0.71	0.0
D-NE4	Worchester, MA	2	2634	1295	1394	2740	Full Basement	21.1	79.0	13.0	7.4	4.2	0.28	5.5	0.86	0.0
D-NE5	Worchester, MA	2	2530	1349	2716	2308	Full Basement	0.0	100.0	12.9	5.8	3.7	0.19	5.7	0.85	0.0
D-NE6	Cranberry, Pensil	2	2632	1280	1311	2678	Full Basement	100.0	0.0	8.9	3.9	8.8	0.52	0.7	0.94	1.7
D-NE7	Township of Collie	2	3450	2056	2217	3935	Full Basement	8.8	91.2	11.8	7.6	7.8	0.65	1.3	1.07	2.8
D-NE8	Township of Collie	1	2995	2997	3026	3128	Full Basement	0.0	100.0	15.6	5.2	5.7	0.46	0.0	0.63	0.0
D-NE9	Wilwood, Pennsy	1	2784	2717	2385	2275	Full Basement	100.0	0.0	14.3	5.3	4.7	0.60	0.0	0.41	0.0
D-NE10	Lancaster, NY	2	2401	5245	1134	2606	Full Basement	100.0	0.0	11.2	0.0	3.1	0.47	2.8	0.00	0.0
Averages:		**1.8**	**2717**	**1877**	**2184**	**2751**		**49.5**	**50.5**	**12.9**	**5.8**	**5.4**	**0.5**	**2.9**	**0.8**	**0.5**
Standard Deviations:		**0.4**	**540**	**1260**	**1191**	**528**		**46.2**	**46.2**	**3.3**	**2.2**	**1.9**	**0.2**	**2.7**	**0.3**	**1.0**

	Framing Factors - Gross (Note 2)				Framing Factors - Net (Note 2)				Window Area by Orientation							
Site Code	Ceiling	Wall	Floor	Overall	Ceiling	Wall	Floor	Overall	N	NE	E	SE	S	SW	W	NW
D-NE1	7.0	21.7	13.6	12.9	7.4	28.6	13.6	14.4	243	0	80	0	189	0	31	0
D-NE2	5.0	19.5	3.9	11.2	5.3	22.7	3.9	12.0	0	87	0	0	0	103	0	0
D-NE3	10.5	19.4	9.0	15.1	10.6	23.7	9.0	16.7	0	12	0	111	0	33	0	74
D-NE4	8.9	20.6	9.5	15.0	9.4	25.9	9.5	16.9	163	0	81	0	81	0	0	0
D-NE5	10.3	21.6	8.1	14.4	11.0	26.5	8.1	15.3	0	0	203	0	6	0	98	0
D-NE6	6.1	19.3	10.1	13.8	6.2	22.2	10.2	14.8	0	0	130	0	0	0	87	0
D-NE7	10.1	19.7	10.2	15.0	10.2	24.4	10.5	16.4	52	0	135	0	52	0	184	0
D-NE8	7.8	19.6	15.4	14.3	7.8	24.7	15.4	15.4	216	0	122	0	97	0	24	0
D-NE9	9.0	21.0	10.2	13.3	9.0	26.1	10.2	14.0	33	20	81	20	44	0	112	0
D-NE10	9.7	18.8	22.6	16.2	10.0	21.1	22.6	20.6	60	9	67	0	54	0	80	9
Averages:	**8.4**	**20.1**	**11.2**	**14.1**	**8.7**	**24.6**	**11.3**	**15.7**	**77**	**13**	**90**	**13**	**52**	**14**	**62**	**8**
Standard Deviations:	**1.9**	**1.0**	**5.0**	**1.4**	**1.9**	**2.3**	**5.0**	**2.3**	**94.6**	**26.8**	**61.7**	**35.1**	**59.5**	**33.2**	**61.2**	**23.3**

Detached Home Averages										Ratios (Note 1)						
Area	# of Sites	No. of Stry's	Floor Area Averages Ft² /Unit	Gross Floor Area (Ft²)	Gross Ceiling Area (Ft²)	Gross Wall Area (Ft²)	Foundation	Walls -- Percent 2x4	Walls -- Percent 2x6	Window Area to Wall Area	Door Area to Wall Area	Rim Joist Area/Gross Wall Area	Corner Ht to Wall (Note 3)	Ceiling Opening to Ceiling	Exposed Perimeter to Floor (Note 3)	Floor Opening to Floor
S	10	1.6	2292	605	1737	2571		98.0	2.0	11.8	4.3	3.5	0.48	11.58	0.38	0.0
W	13	1.5	2489	1191	1522	2623		62.3	37.7	11.4	5.2	5.0	0.43	0.38	0.83	0.0
MW	10	1.6	2339	580	1707	2234		75.1	24.9	10.1	7.1	4.6	0.36	0.28	0.65	0.1
NE	10	1.8	2717	1877	2184	2751		49.5	50.5	12.9	5.8	5.4	0.45	2.9	0.80	0.5
Totals:	**43**	**1.6**	**2461**	**1072**	**1769**	**2550**		**70.6**	**29.4**	**11.5**	**5.6**	**4.7**	**0.4**	**3.5**	**0.7**	**0.1**

			Framing Factors (Note 2)				Framing Factors - Net (Note 2)				Window Area by Orientation							
Area	# of Sites	No. of Stry's	Ceiling	Wall	Floor	Overall	Ceiling	Wall	Floor	Overall	N	NE	E	SE	S	SW	W	NW
S	10	1.6	6.7	19.6	10.9	14.0	7.2	23.5	10.9	16.1	92	4	168	2	97	5	49	5
W	13	1.5	6.5	19.4	9.3	11.9	6.6	23.3	9.3	13.4	76	3	151	0	58	0	59	0
MW	10	1.6	6.0	21.1	14.5	14.5	6.0	25.5	14.6	15.9	80	0	35	1	89	1	26	0
NE	10	1.8	8.4	20.1	11.2	14.1	8.7	24.6	11.3	15.7	77	13	90	13	52	14	62	8
Totals:	**43**	**1.6**	**6.9**	**20.0**	**11.3**	**13.5**	**7.1**	**24.2**	**11.3**	**15.1**	**81**	**5**	**114**	**4**	**73**	**5**	**50**	**3**

Attached Dwellings

South - Attached										Ratios (Note 1)							
Site Code	Location	No. of Stry's	Floor Area Ft² /Unit	Gross Floor Area (Ft²)	Gross Ceiling Area (Ft²)	Gross Wall Area (Ft²)	Foundation	Walls -- Percent 2x4	Walls -- Percent 2x6	Window Area to Wall Area	Door Area to Wall Area	Rim Joist Area/Gross Wall Area	Corner Ht to Wall (Note 3)	Ceiling Opening to Ceiling	Exposed Perimeter to Floor (Note 3)	Floor Opening to Floor
A-S1	Nashville, TN	1	1342	0	1184	738	Slab-on-Grade	100.0	0.0	10.2	11.2	0.0	0.88	0.0	0.00	0.0
A-S2	Nashville, TN	2	2684	1123	1356	1559	Full Basement	81.8	18.2	7.0	8.3	2.9	0.39	0.0	0.00	0.0
A-S3	Nashville, TN	1	1674	0	1680	1101	Slab-on-Grade	100.0	0.0	8.1	7.3	0.0	0.59	0.0	0.00	0.0
A-S4	Nashville, TN	1	949	0	916	1048	Slab-on-Grade	87.5	12.5	8.5	6.2	0.0	0.52	0.0	0.00	0.0
A-S5	Arlington, TX	2	1603	387	1125	1357	Slab-on-Grade	92.9	7.1	15.8	6.5	8.5	0.70	6.1	0.45	0.0
A-S6	Arlington, TX	2	1943	242	1483	1981	Slab-on-Grade	66.7	33.3	21.3	3.2	3.7	0.51	2.5	0.23	0.0
A-S7	Nashville, TN	1	996	0	1043	645	Slab-on-Grade	100.0	0.0	8.4	9.5	0.0	0.80	0.0	0.00	0.0
A-S8	Arlington, TX	2	1655	18	855	1441	Slab-on-Grade	92.9	7.1	12.7	4.5	4.3	0.91	6.6	0.26	0.0
A-S9	Arlington, TX	2	1600	402	1065	1697	Slab-on-Grade	100.0	0.0	8.3	7.9	5.2	1.06	4.4	0.43	0.0
A-S10	Tehesee, TX	2	1200	34	561	899	Full Basement	100.0	0.0	14.8	2.5	3.8	0.89	0.0	0.22	0.0
Averages:		**1.6**	**1565**	**221**	**1127**	**1247**		**92.2**	**7.8**	**11.5**	**6.7**	**4.7**	**0.7**	**2.0**	**0.2**	**0.0**
Standard Deviations:		**0.5**	**506**	**357**	**323**	**434**		**11.0**	**11.0**	**4.6**	**2.7**	**2.8**	**0.2**	**2.7**	**0.2**	**0.0**

	Framing Factors - Gross (Note 2)				Framing Factors - Net (Note 2)				Window Area by Orientation							
Site Code	Ceiling	Wall	Floor	Overall	Ceiling	Wall	Floor	Overall	N	NE	E	SE	S	SW	W	NW
A-S1	6.6	20.2		11.8	6.6	25.7		12.9	45	0	0	0	30	0	0	0
A-S2	6.0	17.6		8.8	6.0	20.8		9.4	0	0	8	0	0	0	30	0
A-S3	6.3	18.1		10.9	6.3	21.4		11.6	0	0	62	0	0	0	27	0
A-S4	5.2	19.3		13.2	5.2	22.6		13.8	0	0	32	0	0	0	57	0
A-S5	7.9	20.2	16.4	14.9	8.5	25.9	16.4	17.1	0	0	115	0	27	10	45	0
A-S6	7.7	21.5	26.2	16.0	7.9	28.5	26.2	19.0	153	15	131	0	0	0	108	0
A-S7	5.5	22.8		12.1	5.5	27.7		13.0	39	0	0	0	16	0	0	0
A-S8	10.4	22.0	13.5	17.7	11.1	26.6	13.5	20.3	76	0	52	0	0	0	47	0
A-S9	6.9	20.5	19.1	15.8	7.2	24.5	19.1	17.5	45	0	63	0	25	0	0	0
A-S10	6.3	21.3	14.4	15.5	6.3	25.8	14.4	17.3	0	0	0	1	0	0	0	68
Averages:	**6.9**	**20.4**	**17.9**	**13.7**	**7.0**	**25.0**	**17.9**	**15.2**	**36**	**1**	**46**	**0**	**10**	**1**	**31**	**7**
Standard Deviations:	**1.5**	**1.7**	**5.1**	**2.7**	**1.8**	**2.6**	**5.1**	**3.5**	**49.5**	**4.7**	**47.7**	**0.2**	**13.1**	**3.2**	**34.8**	**21.4**

West - Attached										Ratios (Note 1)						
Site Code	Location	No. of Stry's	Floor Area Ft² /Unit	Gross Floor Area (Ft²)	Gross Ceiling Area (Ft²)	Gross Wall Area (Ft²)	Foundation	Walls -- Percent 2x4	Walls -- Percent 2x6	Window Area to Wall Area	Door Area to Wall Area	Rim Joist Area/Gross Wall Area	Corner Ht to Wall (Note 3)	Ceiling Opening to Ceiling	Exposed Perimeter to Floor (Note 3)	Floor Opening to Floor
A-W1	Denver, CO	2	1540	382	2961	792	Crawlspace	100.0	0.0	20.7	3.7	3.6	0.75	2.11	1.25	0.0
A-W2	Denver, CO	2	1575	1414	2990	1669	Crawlspace	87.5	12.5	25.2	7.7	4.0	0.97	2.11	0.54	0.0
A-W3	Denver, CO	1	3325	66	1723	1482	Full Basement	100.0	0.0	25.1	6.5	0.6	0.98	0.29	0.45	0.0
A-W4	Denver, CO	2	1551	407	1785	1659	Full Basement	52.9	47.1	12.6	3.7	5.9	0.56	1.96	0.89	0.0
A-W5	Denver, CO	2	2052	821	813	1305	Full Basement	100.0	0.0	16.1	6.3	3.7	0.75	0.96	0.53	0.0
A-W6	Phoenix, AZ	2	1450	1346	1292	3169	Slab-on-Grade	90.0	10.0	12.8	9.0	13.3	0.80	0.00	1.05	0.0
A-W7	Phoenix, AZ	2	2764	1526	3406	2225	Slab-on-Grade	5.0	95.0	15.1	18.5	1.2	0.67	0.00	0.10	0.0
A-W8	Phoenix, AZ	2	2578	0	1279	2346	Slab-on-Grade	0.0	100.0	10.8	12.0	3.8	0.54	0.00	0.22	0.0
A-W9	Phoenix, AZ	2	2764	1846	1216	3174	Slab-on-Grade	0.0	100.0	10.0	11.8	3.1	0.53	0.00	0.37	0.0
A-W10	Phoenix, AZ	1	1953	1714	1567	1877	Slab-on-Grade	71.4	28.6	7.3	4.4	4.6	0.51	0.00	0.46	0.0
Averages:		**1.8**	**2155**	**952**	**1903**	**1970**		**60.7**	**39.3**	**15.5**	**8.3**	**4.4**	**0.7**	**0.7**	**0.6**	**0.0**
Standard Deviations:		**0.4**	**660**	**700**	**891**	**772**		**43.3**	**43.3**	**6.2**	**4.7**	**3.5**	**0.2**	**1.0**	**0.4**	**0.0**

	Framing Factors - Gross (Note 2)				Framing Factors - Net (Note 2)				Window Area by Orientation							
Site Code	Ceiling	Wall	Floor	Overall	Ceiling	Wall	Floor	Overall	N	NE	E	SE	S	SW	W	NW
A-W1	8.0	23.7	10.0	11.2	8.2	31.4	10.0	11.9	0	0	115	0	0	0	65	0
A-W2	8.0	22.8	3.1	11.0	8.2	34.0	3.1	12.2	0	0	115	0	127	0	64	0
A-W3	5.1	25.1	13.3	14.4	5.1	36.7	13.3	16.8	103	0	33	0	0	0	199	0
A-W4	6.1	21.7	13.6	13.7	6.3	25.9	13.6	14.8	90	0	68	0	35	0	0	0
A-W5	6.0	22.5	6.4	13.7	6.1	29.0	6.4	15.0	0	0	97	0	0	0	90	0
A-W6	5.4	18.7		7.3	5.4	23.9		12.9	0	0	130	0	72	0	48	0
A-W7	5.1	21.0		8.9	5.1	31.5		10.0	141	0	101	0	89	0	0	0
A-W8	7.5	16.7		13.5	7.5	21.6		15.8	96	0	24	0	32	0	92	0
A-W9	5.9	19.8		11.2	5.9	25.3		12.6	0	0	164	0	4	0	9	0
A-W10	5.9	11.6		6.0	5.9	13.1		6.3	48	0	0	0	30	16	20	16
Averages:	**6.3**	**20.4**	**9.3**	**11.1**	**6.4**	**27.2**	**9.3**	**12.8**	**48**	**0**	**85**	**0**	**39**	**2**	**59**	**2**
Standard Deviations:	**1.1**	**4.0**	**4.5**	**2.9**	**1.2**	**6.9**	**4.5**	**3.1**	**55.1**	**0.0**	**52.0**	**0.0**	**43.9**	**5.1**	**60.5**	**5.1**

Midwest - Attached										Ratios (Note 1)							
Site Code	Location	No. of Stry's	Floor Area Ft² /Unit	Gross Floor Area (Ft²)	Gross Ceiling Area (Ft²)	Gross Wall Area (Ft²)	Foundation	Walls -- Percent 2x4	Walls -- Percent 2x6	Window Area to Wall Area	Door Area to Wall Area	Rim Joist Area/Gross Wall Area	Corner Ht to Wall (Note 3)	Ceiling Opening to Ceiling	Exposed Perimeter to Floor (Note 3)	Floor Opening to Floor
A-MW1	Ann Arbour, MI	2	2208	0	1919	2256	Full Basement	100.0	0.0	9.1	9.8	6.6	0.71	1.6	0.70	1.6
A-MW2	Cedar Rapids, IA	1	2264	1260	1392	5513	Full Basement	93.8	6.3	6.2	6.2	2.4	0.35	0.0	0.62	1.3
A-MW3	Flint, MI	1	1480	0	1266	1813	Full Basement	40.0	60.0	7.9	5.6	8.9	0.39	0.0	0.92	0.0
A-MW4		2	1480	0	1604	1919	Full Basement	93.3	6.7	12.8	19.1	5.8	0.84	2.1	0.00	0.0
A-MW5		2	1480	0	949	1330	Full Basement	100.0	0.0	12.9	7.3	4.2	1.22	0.0	0.00	0.0
A-MW6		2	1480	0	867	914	Full Basement	100.0	0.0	18.8	11.6		0.62	0.0	0.00	0.0
A-MW7		2	1280	491	493	937	Slab-on-Grade	0.0	100.0	4.5	4.7		0.24	2.0	0.00	0.1
A-MW8		2	1340	510	512	662	Slab-on-Grade	0.0	100.0	10.8	3.5		0.23	2.8	0.00	0.1
A-MW9		3	1124	451	490	1543	Slab-on-Grade	100.0	0.0	14.0	4.0		0.40	1.8	0.01	0.0
A-MW10		3	1368	261	547	1158	Slab-on-Grade	100.0	0.0	16.0	0.0		0.40	0.0	0.02	0.0
Averages:		**2.0**	**1550**	**297**	**1004**	**1804**		**72.7**	**27.3**	**11.3**	**7.2**	**5.6**	**0.5**	**1.0**	**0.2**	**0.3**
Standard Deviations:		**0.7**	**379**	**405**	**518**	**1396**		**42.5**	**42.5**	**4.5**	**5.3**	**2.5**	**0.3**	**1.1**	**0.4**	**0.6**

	Framing Factors - Gross (Note 2)				Framing Factors - Net (Note 2)				Window Area by Orientation							
Site Code	Ceiling	Wall	Floor	Overall	Ceiling	Wall	Floor	Overall	N	NE	E	SE	S	SW	W	NW
A-MW1	6.2	21.3		14.3	6.3	26.2		16.1	25	0	119	0	0	0	48	0
A-MW2	2.8	29.3		17.9	2.8	33.4		22.2	126	0	0	0	30	0	9	0
A-MW3	6.3	19.5		13.8	6.3	22.6		15.3	29	30	0	13	9	15	17	17
A-MW4	6.3	19.5		14.0	6.4	28.7		16.5	0	0	121	20	47	0	44	0
A-MW5	6.1	24.8		17.0	6.1	31.0		19.3	38	0	26	0	0	0	101	0
A-MW6	6.6	26.7		16.9	6.6	38.3		20.0	0	0	65	0	51	0	56	0
A-MW7	4.5	15.5	11.8	11.6	4.6	17.1	11.8	12.3	5	0	10	0	28	0	0	0
A-MW8	4.4	18.5	11.7	12.2	4.5	21.6	11.7	13.0	10	0	43	0	19	0	0	0
A-MW9	9.6	20.4		17.0	9.7	24.9		16.5	32	0	0	0	99	0	75	0
A-MW10	9.4	20.3		17.0	9.4	24.1		16.1	79	0	0	0	96	0	0	0
Averages:	**6.2**	**21.6**	**11.8**	**15.2**	**6.3**	**26.8**	**11.8**	**16.7**	**34**	**3**	**38**	**3**	**38**	**2**	**35**	**2**
Standard Deviations:	**2.1**	**4.1**	**0.0**	**2.3**	**2.1**	**6.2**	**0.0**	**3.0**	**40.0**	**9.5**	**48.2**	**7.2**	**35.8**	**4.8**	**35.5**	**5.4**

NorthEast - Attached										Ratios (Note 1)						
Site Code	Location	No. of Stry's	Floor Area Ft² /Unit	Gross Floor Area (Ft²)	Gross Ceiling Area (Ft²)	Gross Wall Area (Ft²)	Foundation	Walls -- Percent 2x4	Walls -- Percent 2x6	Window Area to Wall Area	Door Area to Wall Area	Rim Joist Area/Gross Wall Area	Corner Ht to Wall (Note 3)	Ceiling Opening to Ceiling	Exposed Perimeter to Floor (Note 3)	Floor Opening to Floor
A-NE1	Worchester, MA	2	1792	870	1208	1375	Full Basement	0	100	15.8	3.7	10.0	0.22	0.00	1.12	0.0
A-NE2	Worchester, MA	2	1400	824	2260	1769	Full Basement	0	100	13.1	5.4	9.2	0.51	5.70	0.01	0.0
A-NE3	Worchester, MA	3	1564	0	538	846	Slab-on-Grade	100	0	16.9	4.5	6.2	0.17	0.00	0.35	0.0
A-NE4	Niagara Falls, NY	2	1638	265	1039	1072	Full Basement	100	0	5.5	12.4	1.7	0.67	1.44	0.09	0.0
A-NE5	Niagara Falls, NY	2	1640	98	1117	1144	Full Basement	100	0	4.7	13.1	4.1	1.19	1.01	0.29	0.0
A-NE6																
A-NE7																
A-NE8	Pennsylvania	2	1793	947	870	1718	Full Basement	95	5	10.0	5.2	9.7	0.55	2.16	0.01	0.0
A-NE9		2	1142	0	571	583	Slab-on-Grade	100	0	19.9	4.0	6.9	1.06	1.61	0.22	0.0
A-NE10		2	1361	0	810	1135	Slab-on-Grade	100	0	14.3	2.0	4.0	0.93	2.89	0.21	0.0
Averages:		**2.1**	**1541.3**	**376**	**1052**	**1205**		**74**	**26**	**12.5**	**6.3**	**6.5**	**0.7**	**1.9**	**0.3**	**0.0**
Standard Deviations:		**0.4**	**226**	**428**	**545**	**406**		**45.9**	**45.9**	**5.4**	**4.1**	**3.1**	**0.4**	**1.8**	**0.4**	**0.0**

	Framing Factors - Gross (Note 2)				Framing Factors - Net (Note 2)				Window Area by Orientation							
Site Code	Ceiling	Wall	Floor	Overall	Ceiling	Wall	Floor	Overall	N	NE	E	SE	S	SW	W	NW
A-NE1	7.1	21.4	5.0	12.3	7.1	26.5	5.0	13.3	55	0	42	0	68	0	22	0
A-NE2	6.7	20.0	9.5	12.6	7.1	24.5	9.5	13.3	81	0	55	0	74	0	0	0
A-NE3	5.8	23.8		16.8	5.8	30.3		19.3	0	79	0	24	0	32	0	0
A-NE4	12.6	22.5	15.1	17.3	12.8	27.5	15.1	19.0	0	0	58	0	0	0	0	0
A-NE5	4.2	22.0	11.1	13.3	4.3	26.8	11.1	14.5	0	0	51	0	0	0	0	0
A-NE6																
A-NE7																
A-NE8	6.5	20.0	10.8	14.2	6.6	23.6	10.8	15.4	0	44	0	0	23	0	88	0
A-NE9	6.5	26.2		16.5	6.6	34.3		18.9	0	0	0	0	0	0	108	0
A-NE10	7.0	25.8		18.0	7.2	30.9		20.1	36	0	0	0	0	0	120	0
Averages:	**7.1**	**22.7**	**10.3**	**15.1**	**7.2**	**28.0**	**10.3**	**16.7**	**22**	**15**	**26**	**3**	**21**	**4**	**42**	**0**
Standard Deviations:	**2.4**	**2.4**	**3.6**	**2.3**	**2.5**	**3.6**	**3.6**	**2.9**	**32.0**	**29.9**	**27.9**	**8.4**	**32.0**	**11.2**	**53.5**	**0.0**

Attached Home Averages										Ratios (Note 1)						
Area	# of Sites	# Stories	Floor Area Averages Ft² /Unit	Gross Floor Area (Ft²)	Gross Ceiling Area (Ft²)	Gross Wall Area (Ft²)	Foundation	Walls -- Percent 2x4	Walls -- Percent 2x6	Window Area to Wall Area	Door Area to Wall Area	Rim Joist Area/Gross Wall Area	Corner Ht to Wall (Note 3)	Ceiling Opening to Ceiling	Exposed Perimeter to Floor (Note 3)	Floor Opening to Floor
S	10	1.6	1565	221	1127	1247		92.2	7.8	11.5	6.7	4.7	0.73	1.96	0.16	0.00
W	10	1.8	2155	952	1903	1970		60.7	39.3	15.5	8.3	4.4	0.71	0.74	0.59	0.0
MW	10	2.0	1550	297	1004	1804		72.7	27.3	11.3	7.2	5.6	0.5	1.0	0.2	0.3
NE	10	2.1	1541	376	1052	1205		74.4	25.6	12.5	6.3	6.5	0.7	1.9	0.3	0.0
Totals:	**40**		**1703**	**461**	**1271**	**1556**		**75.0**	**25.0**	**12.7**	**7.1**	**5.3**	**0.7**	**1.4**	**0.3**	**0.1**

			Framing Factors (Note 2)				Framing Factors - Net (Note 2)				Window Area by Orientation							
Area	# of Sites	# Stories	Ceiling	Wall	Floor	Overall	Ceiling	Wall	Floor	Overall	N	NE	E	SE	S	SW	W	NW
S	10	1.6	6.9	20.4	17.9	13.7	7.0	25.0	17.9	15.2	36	1	46	0	10	1	31	7
W	10	1.8	6.3	20.4	9.3	11.1	6.4	27.2	9.3	12.8	48	0	85	0	39	2	59	2
MW	10	2.0	6.2	21.6	11.8	15.2	6.3	26.8	11.8	16.7	34	3	38	3	38	2	35	2
NE	10	2.1	7.1	22.7	10.3	15.1	7.2	28.0	10.3	16.7	22	15	26	3	21	4	42	0
Totals:	**40**	**0.0**	**6.6**	**21.3**	**12.3**	**13.8**	**6.7**	**26.8**	**12.3**	**15.4**	**35**	**5**	**49**	**2**	**27**	**2**	**42**	**3**

Multi-Family Dwellings

South - Multi						Ratios (Note 1)							Areas						
Site Code	Location	No. of Stry's	Floor Area Ft² /Unit	Foundation	Number of Units	Window Area to Wall Area	Door Area to Wall Area	Rim Joist Area/ Gross Wall Area	Corner Ht to Wall (Note 3)	Ceiling Opening to Ceiling	Exposed Perimeter to Floor (Note 3)	Floor Opening to Floor	Celing Framing Area (Ft²)	Celing Area (Ft²)	Floor Framing Area (Ft²)	Floor Area (Ft²)	Wall Framing Area (Ft²)	Wall Area (Ft²)	Rim Joist Area (Ft²)
M-S1	Nashville, TN	3	1110	Slab-on-Grade	12	15.9	3.5	8.9	0.83	0.0	0.58	0.00	64	1080	0	0	161	687	61
M-S2	Nashville, TN	3	1215	Slab-on-Grade	24	9.5	6.5	8.0	0.48	0.0	0.69	0.00	76	1256	0	0	250	997	80
M-S3	Nashville, TN	2	975	Slab-on-Grade	12	6.4	8.6	8.8	0.36	0.0	0.76	0.00	63	975	0	0	161	797	70
M-S4	Arlington, TX	3	975	Slab-on-Grade	24	10.9	0.9	2.6	0.11	0.0	0.00	0.00	5	87	0	0	36	125	3
M-S5	Nashville, TN	3	978	Full Basement	8	13.1	2.7	15.6	0.52	0.0	1.67	0.00	69	908	0	0	217	995	155
M-S6	Dallas, TX	3	1399	Full Basement	24	10.3	1.8	2.6	0.13	0.0	0.00	0.00	17	275	0	0	52	263	7
M-S7	Nashville, TN	2	665	Slab-on-Grade	6	2.5	9.8	0.0	0.43	0.0	0.00	0.00	39	665	0	0	120	598	0
M-S8	Georgetown, TX	2	1109	Slab-on-Grade	8	10.8	1.3	8.6	0.22	0.0	0.00	0.00	18	219	0	0	113	446	20
M-S9	Round Rock, TX	3	753	Slab-on-Grade	24	12.7	2.0	7.9	0.19	0.0	0.00	0.00	4	67	0	0	50	192	10
M-S10	Austin, TX	3	1104	Slab-on-Grade	12	9.9	1.0	8.1	0.16	0.0	0.00	0.00	12	185	0	0	132	495	27
Averages:		**3**	**1028**		**15**	**10.2**	**3.8**	**7.1**	**0.3**	**0.0**	**0.4**	**0.0**	**37**	**572**	**0**	**0**	**129**	**559**	**43**
Standard Deviatinos:		**0.5**	**212.7**		**7.7**	**3.7**	**3.3**	**4.4**	**0.2**	**0.0**	**0.6**	**0.0**	**28.6**	**454.9**	**0.0**	**0.0**	**71.1**	**313.2**	**49.0**

	Framing Factors - Gross				Framing Factors - Net				Window Area by Orientation							
Site Code	Ceiling	Wall	Floor	Overall	Ceiling	Wall	Floor	Overall	N	NE	E	SE	S	SW	W	NW
M-S1	5.9	23.4		12.7	5.9	29.1		13.8	0	0	69	0	0	0	30	0
M-S2	6.0	25.1		14.4	6.0	29.8		15.5	0	31	0	25	0	0	0	31
M-S3	6.5	20.2		12.6	6.5	23.8		13.6	0	0	0	0	47	0	0	0
M-S4	6.0	14.4		19.4	6.0	16.3		11.8	310	0	0	0	0	0	0	0
M-S5	7.5	21.8		15.0	7.5	25.9		16.3	0	0	0	0	0	90	0	16
M-S6	6.1	9.8		12.7	6.1	11.2		8.4	119	64	0	0	0	0	37	0
M-S7	5.9	20.1		12.6	5.9	22.9		13.4	0	15	0	0	0	0	0	0
M-S8	8.2	25.3		19.7	8.2	28.8		21.4	30	0	60	0	90	0	120	0
M-S9	6.7	26.0		21.0	6.7	30.4		23.6	0	0	0	0	81	0	456	0
M-S10	6.3	26.5		21.0	6.3	29.8		22.8	180	0	38	0	240	0	88	0
Averages:	**6.5**	**21.3**	**0.0**	**16.1**	**6.5**	**24.8**	**0.0**	**16.1**	**64**	**11**	**17**	**3**	**46**	**9**	**73**	**5**
Standard Deviations:	**0.8**	**5.4**		**3.7**	**0.8**	**6.5**		**5.0**	**106.8**	**21.3**	**27.9**	**7.9**	**77.1**	**28.4**	**141.0**	**10.5**

West - Multi						Ratios (Note 1)							Areas						
Site Code	Location	No. of Stry's	Floor Area Ft² /Unit	Foundation	Number of Units	Window Area to Wall Area	Door Area to Wall Area	Rim Joist Area/ Gross Wall Area	Corner Ht to Wall (Note 3)	Ceiling Opening to Ceiling	Exposed Perimeter to Floor (Note 3)	Floor Opening to Floor	Celing Framing Area (Ft²)	Celing Area (Ft²)	Floor Framing Area (Ft²)	Floor Area (Ft²)	Wall Framing Area (Ft²)	Wall Area (Ft²)	Rim Joist Area (Ft²)
M-W1		3	1160	Slab-on-Grade	24	7.8	2.0	2.1	0.1	0.0	0.0	0.0	27	435	0	0	188	968	21
M-W2		3	1254	Slab-on-Grade	18	5.7	1.9	0.0	0.2	0.0	0.0	0.0	28	427	0	0	242	1142	0
M-W3		3	952	Slab-on-Grade	20	6.4	1.9	0.0	0.2	0.0	0.0	0.0	38	579	0	0	328	1477	0
M-W4		2	750	Slab-on-Grade	8	8.8	16.6	0.0	0.1	0.0	0.6	0.0	0	717	0	750	114	544	0
M-W5		2	1106	Slab-on-Grade	8	3.6	6.8	0.0	0.5	0.0	1.0	0.0	55	1061	0	1106	209	1435	0
M-W6		2	1026	Slab-on-Grade	16	2.7	1.9	0.0	0.0	0.0	1.0	0.0	11	513	0	499	128	667	0
M-W7		2	1134	Slab-on-Grade	14	7.3	0.7	0.0	0.1	0.0	1.1	0.0	55	1106	0	1160	324	1654	0
M-W8		2	821	Slab-on-Grade	28	7.4	0.8	0.0	0.1	0.0	1.5	0.0	20	258	0	781	231	1363	0
M-W9		3	1173	Slab-on-Grade	9	17.3	2.5	0.0	0.2	0.0	0.5	0.0	28	442	0	13	150	625	0
M-W10		3	811	Slab-on-Grade	20	7.5	1.9	0.0	0.2	0.0	0.0	0.0	23	361	0	0	184	751	0
Averages:		**3**	**1019**		**17**	**7.5**	**3.9**	**0.2**	**0.2**	**0.0**	**0.6**	**0.0**	**29**	**615**	**0**	**479**	**213**	**1097**	**2**
Standard Deviations:		**0.5**	**176.0**		**6.9**	**4.0**	**4.8**	**0.7**	**0.1**	**0.0**	**0.6**	**0.0**	**17.3**	**287.8**	**0.0**	**487.0**	**73.8**	**405.4**	**6.6**

	Framing Factors - Gross				Framing Factors - Net				Window Area by Orientation							
Site Code	Ceiling	Wall	Floor	Overall	Ceiling	Wall	Floor	Overall	N	NE	E	SE	S	SW	W	NW
M-W1	6.1	19.5		15.3	6.1	21.6		16.4	0	0	198	0	239	0	0	0
M-W2	6.7	21.1		16.5	6.7	22.9		18.2	0	0	95	0	379	0	0	0
M-W3	6.6	22.2		17.8	6.6	24.2		18.9	580	0	191	0	758	0	248	0
M-W4	5.5	16.6		9.4	5.5	22.3		6.9	0	0	0	0	0	0	0	0
M-W5	10.6	17.4		11.1	10.6	19.4		10.5	0	0	0	0	48	0	0	0
M-W6	2.2	19.2		8.3	2.2	20.2		8.5	48	0	24	0	0	0	0	0
M-W7	4.9	19.6		9.7	4.9	21.3		10.0	78	0	105	15	72	15	65	0
M-W8	7.8	16.9		10.5	7.8	18.5		11.0	211	0	118	0	108	0	48	0
M-W9	6.4	24.1		16.6	6.4	30.0		18.7	0	0	80	0	494	0	290	0
M-W10	6.3	24.4		18.5	6.3	27.0		19.8	1429	0	819	0	758	0	497	0
Averages:	**6.3**	**20.1**	**0.0**	**13.4**	**6.3**	**22.7**	**0.0**	**13.9**	**235**	**0**	**163**	**2**	**286**	**2**	**115**	**0**
Standard Deviations:	**2.1**	**2.8**		**3.9**	**2.1**	**3.5**		**5.0**	**457.2**	**0.0**	**240.7**	**4.7**	**297.9**	**4.7**	**172.3**	**0.0**

Midwest - Multi						Ratios (Note 1)							Areas						
Site Code	Location	No. of Stry's	Floor Area Ft² /Unit	Foundation	Number of Units	Window Area to Wall Area	Door Area to Wall Area	Rim Joist Area/ Gross Wall Area	Corner Ht to Wall (Note 3)	Ceiling Opening to Ceiling	Exposed Perimeter to Floor (Note 3)	Floor Opening to Floor	Celing Framing Area (Ft²)	Celing Area (Ft²)	Floor Framing Area (Ft²)	Floor Area (Ft²)	Wall Framing Area (Ft²)	Wall Area (Ft²)	Rim Joist Area (Ft²)
M-MW3	Ann Arbour, MI	2	1604	Full Basement	18	17.6	2.1	6.9	0.1	0.0	0.4	0.0	30	742	22	231	178	779	54
M-MW4	Ames, IA	3	1240	Slab-on-Grade	12	7.3	1.6	4.2	0.3	0.0	1.0	0.0	5	103	10	104	39	239	10
M-MW5	Marshalltown, IA	2	594	Slab-on-Grade	8	8.4	1.2	0.0	0.3	0.0	0.0	0.0	5	74	0	0	41	223	0
M-MW6	Marshalltown, IA	2	486	Slab-on-Grade	8	1.4	6.1	0.4	0.5	0.0	0.0	0.0	5	61	7	81	43	217	1
M-MW7	Wisconsin	2	1509	Slab-on-Grade	8	10.2	1.6	5.9	0.1	0.0	0.7	0.0	0	5	1	6	293	1265	75
M-MW8	Oak Creek, Wisconsin	2	1207	Full Basement	8	9.6	1.7	0.0	0.1	0.0	0.0	0.0	21	327	0	0	115	515	22
M-MW9	Franklin, Wisconsin	2	1346	Full Basement	8	13.5	2.0	0.1	0.1	0.8	0.0	0.0	23	351	35	334	106	491	39
M-MW10	Franklin, Wisconsin	2	1242	Full Basement	8	9.1	3.4	0.0	0.2	0.6	0.0	0.0	27	396	31	348	138	602	23
Averages:		**2**	**1087**		**10**	**9.6**	**2.4**	**2.2**	**0.2**	**0.2**	**0.3**	**0.0**	**14**	**257**	**13**	**138**	**119**	**541**	**28**
Standard Deviatinos:		**0.4**	**404.0**		**3.6**	**4.7**	**1.6**	**3.0**	**0.1**	**0.3**	**0.4**	**0.0**	**11.8**	**247.2**	**14.1**	**146.9**	**86.6**	**355.7**	**26.5**

	Framing Factors - Gross				Framing Factors - Net				Window Area by Orientation							
Site Code	Ceiling	Wall	Floor	Overall	Ceiling	Wall	Floor	Overall	N	NE	E	SE	S	SW	W	NW
M-MW3	4.1	22.8	9.4	13.1	4.1	28.4	9.4	14.4	244	0	144	0	242	0	0	0
M-MW4	5.3	16.6	9.9	12.5	5.3	18.2	9.9	13.0	48	0	48	0	105	0	0	0
M-MW5	6.8	18.5		15.6	6.8	20.4		16.8	69	0	28	0	38	0	16	0
M-MW6	7.4	19.9	8.1	15.1	7.4	21.5	8.1	15.8	24	0	0	0	0	0	0	0
M-MW7	6.4	23.2	19.2	23.1	6.4	26.3	19.2	26.1	147	0	41	47	147	0	29	0
M-MW8	6.3	22.3		16.1	6.3	25.1		17.3	240	0	0	0	28	0	110	0
M-MW9	6.4	21.6	10.4	13.9	6.5	25.5	10.4	14.9	45	25	50	38	317	13	0	0
M-MW10	6.9	23.0	8.9	14.6	6.9	26.2	8.9	15.5	94	0	100	0	216	0	0	0
Averages:	6.2	21.0	**11.0**	15.5	**6.2**	**24.0**	**11.0**	**16.7**	**114**	**3**	**51**	**11**	**137**	**2**	**19**	**0**
Standard Deviations:	**1.1**	**2.4**	**4.1**	**3.3**	**1.1**	**3.5**	**4.1**	**4.0**	**87.4**	**8.8**	**49.1**	**19.7**	**114.1**	**4.4**	**38.2**	**0.0**

NorthEast - Multi						Ratios (Note 1)							Areas						
Site Code	Location	No. of Stry's	Floor Area Ft² /Unit	Foundation	Number of Units	Window Area to Wall Area	Door Area to Wall Area	Rim Joist Area/ Gross Wall Area	Corner Ht to Wall (Note 3)	Ceiling Opening to Ceiling	Exposed Perimeter to Floor (Note 3)	Floor Opening to Floor	Celing Framing Area (Ft²)	Celing Area (Ft²)	Floor Framing Area (Ft²)	Floor Area (Ft²)	Wall Framing Area (Ft²)	Wall Area (Ft²)	Rim Joist Area (Ft²)
M-NE1		3	463	Slab-on-Grade	44	11.3	0.0	4.3	0.1	0.0	0.0	0.0	11	234	0	0	51	281	12
M-NE2		3	552	Slab-on-Grade	5	20.0	0.0	8.2	0.0	0.0	0.0	0.0	0	72	0	0	61	353	29
M-NE3		3	732	Slab-on-Grade	12	15.9	2.0	4.4	0.2	0.0	0.0	0.0	40	654	1	7	163	739	33
M-NE4	Pennsylvania Forest	3	1062	Slab-on-Grade	10	13.1	1.7	6.4	0.2	0.0	0.9	0.0	12	177	0	70	84	340	22
M-NE5	Pennsylvania	3	796	Slab-on-Grade	16	17.1	1.6	7.0	0.1	0.0	0.0	0.0	6	101	0	0	46	200	14
M-NE6	Cranberry, Pennsylvania	3	892	Slab-on-Grade	24	5.3	2.5	2.7	0.1	0.6	0.0	0.0	5	62	0	0	45	182	5
M-NE7	Wexford, Pennsylvania	3	631	Slab-on-Grade	48	14.0	1.1	0.5	0.2	0.0	0.0	0.0	5	79	0	0	40	165	1
M-NE8	Canonsburg, Pennsylvar	3	875	Slab-on-Grade	24	21.1	0.9	5.9	0.2	0.0	0.0	0.0	5	73	0	0	29	134	8
M-NE9	Township of Robinson, P	3	892	Slab-on-Grade	20	5.8	2.1	6.2	0.1	0.0	0.0	0.0	6	90	0	0	41	197	12
M-NE10	Township of Collier, Penr	3	845	Slab-on-Grade	24	7.0	1.7	5.5	0.2	0.0	0.0	0.0	5	70	0	0	48	200	11
Averages:		**3**	**732**		**23**	**13.1**	**1.4**	**5.1**	**0.1**	**0.1**	**0.1**	**0.0**	**11**	**197**	**0**	**11**	**70**	**323**	**16**
Standard Deviatinos:		**0.0**	**181.0**		**13.9**	**5.7**	**0.9**	**2.2**	**0.1**	**0.2**	**0.3**	**0.0**	**11.3**	**181.9**	**0.2**	**22.0**	**38.7**	**177.4**	**10.2**

	Framing Factors - Gross				Framing Factors - Net				Window Area by Orientation							
Site Code	Ceiling	Wall	Floor	Overall	Ceiling	Wall	Floor	Overall	N	NE	E	SE	S	SW	W	NW
M-NE1	4.8	18.1		12.0	4.8	20.4		12.8	0	0	0	93	0	0	0	0
M-NE2	0.0	17.3		14.3	0.0	21.6		17.2	0	0	0	0	0	0	282	0
M-NE3	6.1	22.0	10.7	14.5	6.1	26.8	10.7	16.1	421	0	0	0	0	0	0	0
M-NE4	6.7	24.6		16.3	6.7	28.8		17.8	72	0	45	0	0	0	300	0
M-NE5	6.4	23.0		17.4	6.4	28.3		19.9	105	12	65	12	0	0	280	0
M-NE6	7.8	24.9		20.5	7.8	27.0		21.8	162	0	0	0	0	0	54	0
M-NE7	6.1	24.0		18.2	6.1	28.3		20.3	36	0	534	0	232	0	180	0
M-NE8	6.7	21.6		16.3	6.7	27.7		19.1	0	0	0	0	639	0	0	0
M-NE9	6.6	20.8		16.4	6.6	22.6		17.4	57	0	19	0	0	0		0
M-NE10	7.1	23.8		19.5	7.1	26.1		20.8	0	0	45	0	270	0	0	0
Averages:	**5.8**	**22.0**	**10.7**	**16.6**	**5.8**	**25.8**	**10.7**	**18.3**	**85**	**1**	**71**	**10**	**114**	**0**	**122**	**0**
Standard Deviations:	**2.2**	**2.6**		**2.5**	**2.2**	**3.1**		**2.7**	**129.7**	**3.8**	**164.5**	**29.2**	**212.1**	**0.0**	**136.8**	**0.0**

Multi-Family Home Averages					Ratios (Note 1)								Areas						
Area	# of Sites	No. of Stry's	Floor Area Ft² /Unit	Foundation	Number of Units	Window Area to Wall Area	Door Area to Wall Area	Rim Joist Area/ Gross Wall Area	Corner Ht to Wall (Note 3)	Ceiling Opening to Ceiling	Exposed Perimeter to Floor (Note 3)	Floor Opening to Floor	Celing Framing Area (Ft²)	Celing Area (Ft²)	Floor Framing Area (Ft²)	Floor Area (Ft²)	Wall Framing Area (Ft²)	Wall Area (Ft²)	Rim Joist Area (Ft²)
S	10	2.7	1028		15.4	10.2	3.8	7.1	0.3	0.0	0.4	0.0	37	572	0	0	129	559	43
W	9	2.5	1019		16.5	7.5	3.9	0.2	0.2	0.0	0.6	0.0	29	615	0	479	213	1097	2
MW	6	2.2	1087		9.8	9.6	2.4	2.2	0.2	0.2	0.3	0.0	14	257	13	138	119	541	28
NE	7	3.0	732		22.7	13.1	1.4	5.1	0.1	0.1	0.1	0.0	11	197	0	11	70	323	16
Totals:	**32**	**10.4**	**972**		**16.2**	**9.9**	**3.0**	**3.8**	**0.2**	**0.0**	**0.4**	**0.0**	**25**	**443**	**2**	**163**	**138**	**630**	**23**

		Framing Factors - Gross				Framing Factors - Net				Window Area by Orientation							
Area	# of Sites	Ceiling	Wall	Floor	Overall	Ceiling	Wall	Floor	Overall	N	NE	E	SE	S	SW	W	NW
S	10	6.5	21.3	0.0	16.1	6.5	24.8	0.0	16.1	64	11	17	3	46	9	73	5
W	9	6.3	20.1	0.0	13.4	6.3	22.7	0.0	13.9	235	0	163	2	286	2	115	0
MW	6	6.2	21.0	11.0	15.5	6.2	24.0	11.0	16.7	114	3	51	11	137	2	19	0
NE	7	5.8	22.0	10.7	16.6	5.8	25.8	10.7	18.3	85	1	71	10	114	0	122	0
Totals:	**32**	**6.3**	**21.0**	**10.8**	**15.3**	**6.3**	**24.3**	**10.8**	**16.1**	**126**	**4**	**76**	**5**	**145**	**4**	**85**	**1**