North Dakota Residential Construction:

Energy Efficiency-related Practices

Report

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Prepared by:

North Dakota State University Extension Service

Authors: Carl Pedersen

Kenneth Hellevang, PhD, P.E.

Contributor: John Diem, North Dakota Department of Commerce

Table of Contents

List of Tables

List of Figures

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Introduction

Purpose

The purpose of this study was to evaluate how closely current construction techniques in North Dakota meet or exceed nationally recognized building codes and identify areas on which to focus educational efforts to enable builders to meet building codes as they are updated.

Need for North Dakota Residential Current Practices Survey

With the potential inclusion of energy conservation/efficiency standards in the North Dakota State Building Code, an evaluation of current building practices would provide information on how closely structures are being built to the most current International Residential Code (IRC) and International Energy Conservation Codes (IECC). Not only will this information be important to professional builders, designers and homeowners it will also be valuable to educators, builder associations and state officials as they work to provide information to those impacted by building codes revisions.

For background information on the development of the North Dakota State Building Code consult Appendix A. Recent events that have created an impetus for inclusion of energy codes in the North Dakota building code are described in Appendix B.

Methods

Introduction

A survey was developed in cooperation with the North Dakota Association of Builders (NDAB) and North Dakota Department of Commerce. The survey was designed to develop an understanding of building practices being used in North Dakota. It included questions on the use/nonuse of specific building techniques, amount of insulation installed and the frequency that each technique was used for ceiling, wall, foundation and floor construction.

Questionnaire responses were compared with the prescriptive minimums for insulation R-values, U-values and air sealing requirements defined in the 2009 edition of the *International Energy Conservation Code*. From that comparison, areas were determined where increased awareness would have the greatest potential for improvement in current practices.

One further piece of information that is important to consider when reading this report is that the 2009 version of the IECC provides for two ways that a building can meet energy use criteria. The IECC has certain requirements that are mandatory in all residential structures, such

as the requirement that all ducts and air handlers be sealed in a home. On the other hand, the IECC makes provisions for builders to have some flexibility in their construction techniques while still reaching a desired energy performance level. A builder can choose to meet the code by one of two ways: They either can meet all the "prescriptive" requirements in the IECC or they can have the house evaluated on a "performance" basis and use that for the determination if it meets a required code level. This report does not take into account the overall performance of the construction techniques utilized but simply looks at the individual prescriptive measures.

Questionnaire Development

The builder survey questionnaire (Appendix E) contains two main sections. The first section is geared to develop an understanding of actual building practices being used in North Dakota. The questions were developed using a combination of checklists from the U.S. Department of Energy's RESCheck version 4.3.0 software and from the 2009 *International Energy Conservation Code* (IECC, 2009). REScheck is a software program developed by the Pacific Northwest National Laboratory under direction of the U.S. Department of Energy. The software can be used to test a home for compliance to various energy codes. Additional questions were created using a prescriptive list of insulation and air sealing techniques listed in Table 402.4.2 in the 2009 IECC (p. 31).

The questions in the second section of the questionnaire were designed to elicit basic beliefs and builder attitudes about energy-related building items and will not be included in this report. However, the responses will be used in a graduate research project that involves real estate professionals as well as homebuyers. This project is expected to be completed in the fall of 2010.

Delivery

To get the maximum number of surveys returned with the available funding and time permitted, a mixed-modes method of survey delivery was chosen. No definitive list of active professional builders in North Dakota is available, so ascertaining the actual number of builders and developing participation percentages would require considerable added effort. Therefore, statistical conclusions about the overall construction of residential structures in North Dakota are not possible from this survey design. The survey results do provide a valid indication of current energy efficiency practices for residential construction techniques.

Initially, surveys were provided at builder continuing education workshops, and North Dakota builders were encouraged to participate. The workshops included:

- Minnkota Power Cooperative-sponsored builder workshop, Fargo, N.D., Feb. 2, 2010.

- Minnkota Power Cooperative-sponsored builder workshop, Grand Forks, N.D., Feb. 11, 2010.
- North Dakota Association of Builders training session, Fargo, N.D., Feb. 10, 2010.

The NDAB provided input during the survey's development, as well as providing contact information for member builders, which was critical for the successful completion of the builder survey. With its help, the builder survey also was distributed via e-mail to 296 builders identified from a provided NDAB membership list. The initial list provided by NDAB included members not directly involved in building or remodeling of houses, such as banks, so any member that was judged to not be an actual home builder was not contacted. In the contact e-mail, a URL was provided that builders could use to access and complete an online version of the survey. The online version of the survey was created by the Group Decision Center (GDC) at North Dakota State University, Fargo, N.D.

A paper version of the survey was sent through the U.S. Postal Service to those builders who did not complete a survey in builder workshops or online. The survey included a postage-paid return label to encourage builder participation and was sent to 329 individuals and organizations identified as potential builders. These included builders who already had received e-mail notification of the survey.

The final method of delivery was through building inspection departments of select jurisdictions in North Dakota, which were chosen based on the number of building permits they supply, geographic location in the state and the willingness to participate. The departments that agreed to provide the survey to builders were in cities including Grand Forks, Fargo, West Fargo, Minot, Bismarck and Dickinson. When homebuilders or remodelers arrived to obtain building permits for projects, the inspections departments provided them the survey and asked for their participation.

Methodological Issues

The majority of the questions on the survey relate to the prescriptive requirements in the 2009 IECC. A determination of whether a measure does not meet, meets or exceeds code only indicates whether that particular measure compares with the individual component in the code and not the overall performance of the home. Builders can construct homes that far exceed the overall energy performance levels provided in the performance alternative section of the IECC but are below code in a singular component.

Compliance with the provisions of the 2009 IECC can be reached either by following a simplified prescriptive list or demonstrated performance. This survey made all comparisons to the simplified prescriptive list's individual building component values. Any comparisons to meeting or exceeding code are for that particular measure only and do not indicate whether the structure would achieve code limits based on the overall energy performance of the home.

A wide variety of building techniques are possible for residential construction. To keep the survey to a manageable size, each individual aspect of construction could not be investigated. The goal was to develop a general understanding of the building practices for those individuals and organizations that completed the survey. Assessing all practices was not necessary.

Any results or conclusions drawn are based on the data collected and can be attributed only to the builders who responded and not to all North Dakota homes being constructed.

Results

Response Rates

Total number of returned surveys is provided in Table 1. As discussed previously, the percent of return rates from the list of active builders for this survey could not be determined.

Table 1. Response numbers per delivery method.

Delivery Method	**Returned Responses**
Minnkota Power Cooperative workshop, Fargo, N.D., Feb. 2, 2010.	3
Minnkota Power Cooperative workshop, Grand Forks, N.D., Feb. 11, 2010.	4
North Dakota Association of Builders-training session, Fargo, N.D., Feb. 10, 2010.	13
Online survey	19
Returned by mail	25
Total	64

Reading the Results

Each section of the data tables needs to be considered separately. In the example of the Not Used/Used section (Table 2), 60 (3 + 57) builders responded to whether they use a flat or scissor truss in their building projects; below the numbers are the percentages. Of the builders who responded, three (5%) of the builders do not use a flat or scissor truss and 57 (95.0%) used them.

Table 2. Not used/used.

	Not Used	Used
Flat or scissor truss	3 5.0%	57 95.0%

The next section refers to the amount of insulation those 57 builders use in the projects that install flat or scissor trusses Three (5.2%) install insulation that is from an R14-R37, 31 (54.3%) install R38-R49 and 23 (40.3%) install above an R49 (Table 3).

Table 3. Amount of insulation installed.

Amount of Insulation Installed				
None-R13	**R14-R37**	**R38-R49**	**Above R49**	**Not Sure**
- -	3 5.2%	31 54.3%	23 40.3%	- -

Of the 57 builders who use a flat or scissor truss, 50 responded to the portion of the question that asked about the number of ceilings that have this type of construction, and the respondents indicated they install a flat or scissor truss in 69.8% of their projects (Table 4).

Table 4. Percentage of ceilings installed.

Percent of Ceilings Installed
50 69.8%

The percentages will not add up to 100% across sections since the analysis was done for each individual section. In addition, not all builders completed every section of the survey questionnaire, so the number of builders who indicated they used a particular construction technique will be higher than the number who responded to the "Amount of Insulation Installed" and "Percent of Ceilings Installed" section. Finally, the percentages will not add up to 100% in the columns since a particular builder may use a combination of construction techniques on each house. For example, they may use a flat or scissor truss and an energy truss on the same house.

Table 5. Example of ceiling construction type by response. How to read the table.

			Amount of Insulation Installed					
	Not Used	**Used**	**None-R13**	**R14-R37**	**R38-R49**	**Above R49**	**Not Sure**	**Percent of Ceilings Installed**
Flat or scissor truss	3 5.0%	57 95.0%	- -	3 5.2%	31 54.3%	23 40.3%	- -	50 69.8%

Question 1: Ceiling construction

The first question on the survey dealt with ceiling construction techniques, the amount of insulation installed and the percentage of homes in which each type of ceiling construction technique was used (Table 6). The question asked if the respondents used each of the listed construction techniques in constructing residential structures. For the responses in this question, the techniques could have been used in conjunction with other techniques, and different construction techniques could have been used on the same house; for example, a scissor truss with energy heels in one section of the house and cathedral ceilings in another. The "Percent of Ceilings Installed" column was used to determine the percent of projects in which a particular builder used each technique in his or her projects. For example, 50 builders responded to the "Percent of Ceilings Installed" portion of the question that asked if they install flat or scissor trusses in their projects. Of those 50 builders, they average installing flat or scissor trusses in 69.8% of their projects. By comparison only three builders responded to the "Percent of Ceilings Installed" section that install Structural Insulated Panels (SIPs), and they install them in an average of 4.3% of their projects.

Table 6. Ceiling construction type by response.

			Amount of Insulation Installed					
	Not Used	Used	None-R13	R14-R37	R38-R49	Above R49	Not Sure	Percent of Ceilings Installed
Flat or scissor truss	3 5.0%	57 95.0%	- -	3 5.2%	31 54.3%	23 40.3%	- -	50 69.8%
Cathedral with no attic	33 55.0%	27 45.0%	1 4.0%	7 28.0%	13 52.0%	3 12.0%	1 4.0%	24 19.1%
Raised or energy truss	5 8.3%	55 91.6%	- -	3 6.0%	28 56.0%	19 38.0%	- -	47 77.7%
SIPs[1]	56 93.3%	4 6.6%	- -	- -	3 75.0%	1 25.0%	- -	3 4.3%
Other	8 88.8%	1 11.1%	- -	- -	- -	1 100.0%	- -	- -

[1]Structrual Insulated Panels

Question 2: Above-grade exterior walls

Question 2 refers to exterior above-grade wall construction and asked for the techniques used, amount of insulation installed and the percentage that each technique was used in the respondent's projects. Results are provided in Table 7.

Table 7. Above-grade wall construction type by response.

			Amount Installed							
	Not Used	Used	None	R1-R6	R7-R13	R13-R19	R19-R21	Above R21	Not Sure	Percent of Walls Installed
2"x4"-16" oc (on center)	44 73.3%	16 26.6%	- -	- -	6 37.5%	7 43.7%	3 18.7%	- -	- -	14 31.6%
2"x4"-24" oc	60 100.0%	- -	- -	- -	- -	- -	- -	- -	- -	- -
2"x6"-16" oc	1 1.6%	59 98.3%	- -	- -	- -	11 19.6%	42 75.0%	3 5.4%	- -	54 89.5%
2"x6"-24" oc	53 88.3%	7 11.7%	- -	- -	- -	1 14.2%	6 85.7%	- -	- -	6 25.8%
SIP[1]	55 91.7%	5 8.3%	- -	1 20.0%	- -	- -	2 40.0%	2 40.0%	- -	5 20.8%
ICF[2]	50 83.3%	10 16.7%	- -	- -	- -	1 11.1%	2 22.2%	6 66.7%	- -	7 6.4%
Other	11 84.6%	2 15.4%	- -	- -	1 100.0%	- -	- -	- -	- -	2 10.0%

[1]Structural Integrated panel(SIP), [2]Insulating Concrete Form(ICF)

Question 3: Foundation construction

Question 3 referred to walls with more than 50 percent of their structure below grade (foundation walls), the amount of insulation used and the percent of time each technique was used in a particular respondent's construction projects (Table 8).

Table 8. Foundation walls technique used, insulation type and percent of foundations installed.

			Amount Installed							
	Not Used	**Used**	**None**	**R1-R5**	**R6-R10**	**R11-R15**	**R16-R18**	**Above R18**	**Not Sure**	**Percent Used**
Poured concrete	13 21.0%	49 79.0%	6 13.0%	5 10.6%	13 27.6%	18 38.3%	2 4.2%	2 4.2%	1 2.1%	44 78.3%
Empty block	60 96.8%	2 3.2%	- -	- -	1 50.0%	1 50.0%	- -	- -	- -	2 32.5%
Block with integral insulation	60 98.4%	1 1.6%	- -	- -	- -	- -	- -	- -	1 100.0%	1 5%
Wood frame	47 75.8%	15 24.2%	- -	- -	-	2 13.3%	4 26.7%	9 60.0%	- -	14 56.7%
ICF[1]	36 59.0%	25 41.0%	- -	- -	2 9.1%	3 13.6%	4 18.2%	12 54.5%	1 4.5%	24 43.6%
Other	14 87.5%	2 12.5%	- -	- -	1 33.3%	2 66.7%	- -	- -	- -	3 75.0%

[1]ICF – Insulating concrete form

Question 4: Rim joist insulation

Insulating techniques, the amount of insulation and the percentage of time each rim joist insulating technique was used in housing projects was included in question 4 (Table 9).

Table 9. Rim joist insulation type, amount installed and percent time used in projects.

			Amount Installed					
	Not Used	Used	R1-R5	R6-R10	R11-R15	Above R15	Not Sure	Percent Used
Spray foam	24 39.3%	37 60.7%	- -	2 5.7%	10 28.6%	19 54.3%	4 11.4%	35 75.0%
Fiberglass batts	20 32.8%	41 67.2%	- -	1 2.6%	8 20.5%	28 71.8%	2 5.1%	35 60.1%
Rigid board insulation	43 69.4%	19 30.6%	2 10.5%	7 36.8%	4 21.1%	3 15.8%	3 15.8%	15 48.7%
Other	10 66.7%	5 33.3%	- -	- -	1 20.0%	4 80.0%	- -	5 51.0%

Question 5: Floors over unheated space

Question 5 inquired about the insulation levels and the percentage of time specific types of construction techniques were used in areas where floors were installed over unheated space. An example would be where living space is over a garage or floors are over unheated crawl spaces. Another example is a cantilevered floor. Cantilevers are floors in which the wall structure extends beyond the foundation, such as in a bay window.

Table 10. Floors over unheated space not used/used, insulation amounts and percent of time construction technique used in homes.

			Insulation Installed					
	Not Used	Used	None-R13	R14-R37	R38-R49	Above R49	Fill Cavity	Percent Used
Living space over garage	14 25.9%	40 74.1%	- -	18 45.0%	15 37.5%	4 10.0%	3 7.5%	34 62.3%
Crawl space	34 63.0%	20 37.0%	2 10.0%	11 55.0%	5 25.0%	1 5.0%	1 5.0%	15 37.9%
Cantilever	20 37.0%	34 63.1%	- -	17 48.6%	13 37.1%	2 5.7%	3 8.6%	30 58.4%
Other	51 94.4%	3 5.6%	- -	1 100.0%	- -	- -	- -	3 83.3%

Question 6: Window and Door U-values

Window and door installations were surveyed in question 6 (Table 11). The question inquired about the U-values for fenestration installations.

Table 11. U-values for windows and door installations.

	U1.2 and Higher	U1.1-U.65	U.64-U.50	U.49-U.36	U.35&Lower	Not Sure
Window	3 3.8%	3 3.8%	7 8.8%	12 15.0%	25 31.3%	30 37.5%
Door	1 1.5%	2 2.9%	8 11.6%	6 8.7%	11 15.9%	41 59.4%
Other	1 33.3%	- -	- -	- -	- -	2 66.7%

Question 7: Heating system efficiency

While heating system efficiencies are not specified in the mandatory or prescriptive sections of the IRC code manuals, provisions in the IECC 2009 performance alternative refer to efficiency ratings. This is the reason that Question 7 was included. It asked for the specific ratings for propane, gas and heat pumps installed and the percentage of time a type of heating system was installed in construction projects (Table 12).

Table 12. Heating system efficiency ratings and percent time used in projects

	Efficiency Rating								
	78%-85%	86%-90%	91%-95%	Above 95%	HSPF[1] 7.7-8.1	HSPF 8.2-8.6	HSPF above 8.6	Not Sure	Percent Used
Natural gas furnace	1 1.8%	8 14.3%	28 50.0%	16 28.6%				3 5.4%	50 80.9%
Gas boiler	- -	- -	7 46.7%	3 20.0%				5 33.3%	11 11.6%
Propane furnace	1 3.9%	1 3.9%	15 57.7%	6 23.1%				3 11.5%	21 25.1%
Propane boiler	- -	- -	5 50.0%	1 10.0%				4 40.0%	6 10.0%
Heat pump					3 11.1%	5 18.5%	6 22.2%	13 48.3%	24 30.8%
Other	- -	1 12.5%	2 28.0%	1 12.5%	- -	- -	- -	4 50.0%	6 40.0

1 – Heating Seasonal Performance Factor (HSPF)

Question 8: Air sealing and efficient equipment checklist

Question 8 is a series of questions about air sealing techniques used in residential construction, as well as an inquiry into the installation of certain energy-efficient equipment, such as high-efficiency lighting and programmable thermostats (Table 13). If the installation technique was not used by a particular builder, such as homes with knee wall installations, the builder should have checked the "Not applicable" option.

Table 13. Air sealing and energy efficiency equipment installation checklist.

	Percent of Homes						
Air Sealing Measure or Equipment	**Never**	**25%**	**50%**	**75%**	**Always**	**Not Sure**	**Not Applicable**
Conduct duct leakage testing	28 48.3%	7 12.1%	4 6.9%	- -	4 6.9%	7 12.1%	8 13.8%
Conduct blower door test	32 53.3%	6 10.0%	2 3.3%	2 3.3%	7 11.7%	3 5.0%	8 13.3%
Seal between foundation and sill plate	- -	- -	- -	- -	56 94.9%	1 1.7%	2 3.4%
Unfaced insulation only used with air barrier, not as air barrier	2 3.4%	- -	- -	1 1.7%	53 89.8%	- -	3 5.1%
Install air barrier in rim joist	7 11. 7%	1 1. 7%	2 3.3%	6 10.0%	38 63.3%	2 3.3%	4 6. 7%
Install air sealing gasket in attic access	20 33.3%	5 8.3%	1 1. 7%	1 1. 7%	21 35.0%	2 3.3%	10 16. 7%
Install air seal in knee wall door	9 15.5%	1 1.7%	2 3.5%	1 1.7%	13 22.4%	3 5.2%	29 50.0%
Install air seal in attic drop-down stair	15 25.4%	3 5.1%	1 1.7%	1 1.7%	9 15.3%	2 3.4%	28 47.5%
Space between window jamb is air sealed	2 3.5%	1 1.7%	1 1.7%	- -	51 89.5%	1 1.7%	1 1.7%
Space in door jamb is sealed	2 3.4%	1 1.7%	1 1.7%	- -	52 88.1%	1 1.7%	2 3.4%
Recessed lights are IC rated	1 1.7%	- -	- -	- -	48 80.0%	9 15.0%	2 3.3%

Recessed lights are airtight	4 6.9%	3 5.2%	2 3.4%	5 8.6%	31 53.5%	11 19.0%	2 3.5%
Recessed lights are sealed to drywall with gasket or caulk	16 27.6%	1 1.7%	4 6.9%	3 5.2%	22 37.9%	8 13.8%	4 6.9%
Air barrier extends behind electrical boxes or use of sealed boxes	11 18.3%	2 3.3%	7 11.7%	5 8.3%	30 50.0%	1 1.7%	4 6.7%
Plumbing and HVAC penetrations to outside air sealed	1 1.7%	- -	4 6.8%	1 1.7%	49 83.1%	1 1.7%	3 5.1%
Install heating systems with ducts outside the conditioned space	32 54.2%	8 13.6%	2 3.4%	2 3.4%	3 5.1%	1 1.7%	11 18.6%
Install high-efficiency/efficacy light fixtures	5 8.5%	8 13.6%	17 28.8%	6 10.2%	10 17.0%	7 11.9%	6 10.2%
Install programmable thermostats	3 5.1%	3 5.1%	11 18.6%	11 18.6%	27 45.8%	1 1.7%	3 5.1%

Data Analysis

Data were compiled using the online survey form provided by the GDC. Responses from paper copies of the survey were entered into the online survey form. An Excel file of the data was provided and analysis was done using SAS version 9.2 to create correlative information. If applicable, the installation techniques indicated for each question were compared with code levels necessary to meet the 2009 IECC prescriptive requirements for North Dakota. The 2009 IECC was used because it was the residential code referred to in the requirements of the American Reinvestment and Recovery Act (See Appendix B). Analysis was done to identify areas where focused educational efforts would provide the most benefit, not to determine how closely builders in the state are building homes to a specific code.

Only comparisons to IECC levels were done for questions that have requirements in the 2009 IECC prescriptive list.

If a response of "not sure" is indicated, that does not indicate that it was unsure if the measure met the code based on the analysis. Not sure indicates a builder's response. If they were not sure of the insulation level of the measure they were installing they should have checked the unsure box on the questionnaire, those responses are included in the analysis.

In the ICC series of codes, North Dakota is split into two different zones based on climatic factors (Appendix F). The requirements for each climate zone are basically the same except for slight differences in the insulation levels required in wood-framed walls, mass walls and floor insulation values. Those differences are addressed during the comparison of each construction technique to the code levels.

Question 1. Ceiling construction

The 2009 IECC requirement for ceiling construction insulation for the two North Dakota climate zones is an R-value of 49. To determine what percentage of respondents build to the 2009 requirements, a simple analysis was done. According to Section 402.2.1 of the IECC (2009), an R-38 will satisfy the R-49 requirements if it extends over the wall top plate. This was the reason that if builders installed less than an R-38 in ceilings, they were given a rating of below code, an installation of R-38 to R-49 was rated as meeting code and above an R-49 exceeding code. One builder reported installing ceiling insulation other than the types listed. That builder reported installing polystyrene spray at a level that was above the prescribed code. Results are show in Table 14 and Figure 1.

Table 14. Percent of ceiling installations compared with IECC 2009 prescriptive code levels.

	Below Code	Meet Code	Exceed Code	Not Sure
Flat or scissor truss	5.2%	54.3%	40.3%	
Cathedral	32.0%	52.0%	12.0%	4.0%
Energy truss	6.0%	56.0%	38.0%	
SIP		60.0%	20.0%	20.0%
Other			100.0%	

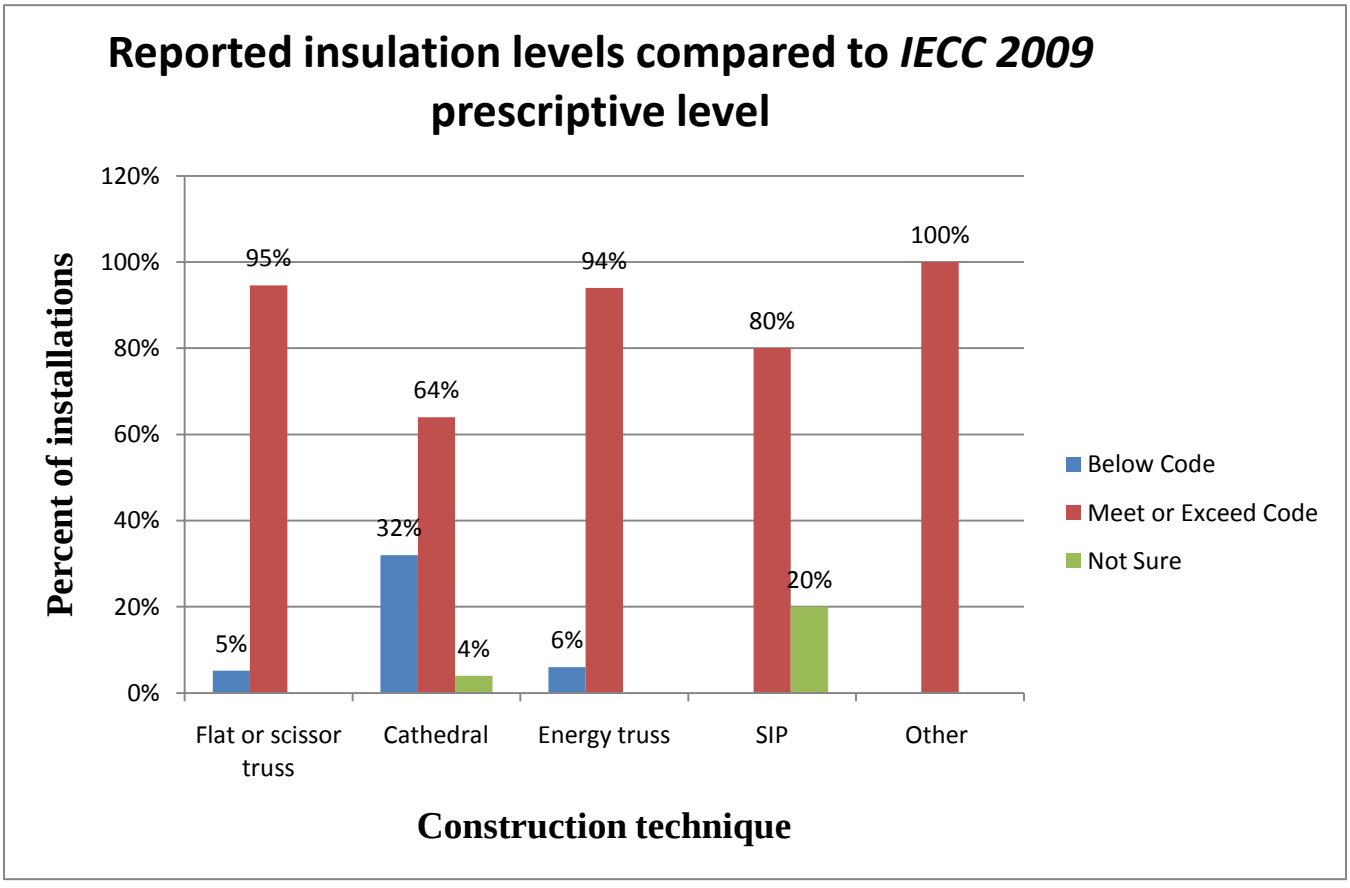

Figure 1. Ceiling insulation levels.

Question 2. Above-grade exterior walls

Three code levels are prescribed in the 2009 IECC for above-grade wall construction depending on climate zone, wall construction type and insulating technique. For the southern North Dakota climate zone (zone 6), the IECC levels call for an R-18 (R-13 cavity plus R-5 continuous) or R-20; the northern climate zone (zone 7) in the state has a requirement of R-21. Of the builders who responded, 98% are constructing walls using 2-inch by 6-inch (2"x6") studs spaced 16 inches on center in the vast majority of their housing projects, and 65% indicted they installed insulation levels from R-19 or above and 26% installed insulation levels from an R13 to R19 (Figure 2).

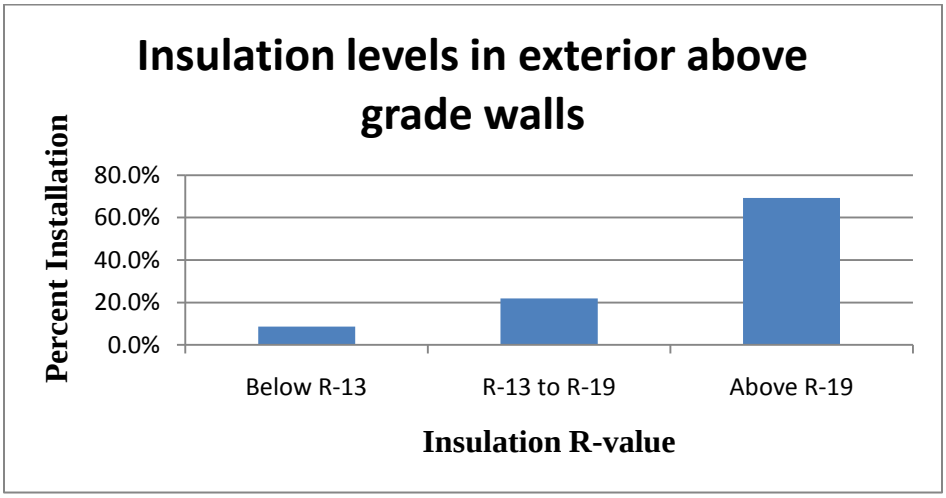

Figure 2. Exterior above-grade wall insulation levels.

Question 3. Foundation construction

A determination of meeting/exceeding code or not meeting code for foundation walls was determined by using the IECC prescriptive value of R15/19, in which 15 equals continuous insulation with an R-value of 15. The 19 would be an R-19 insulation level either continuous or R-19 in the basement framing cavity (between the studs). An additional way to meet the level would be an R-13 in the framing cavity plus at least an R-5 continuous insulation on the basement wall. A typical batt of insulation that will fit in a 2"x6" framed-wall cavity would have an R-value of R-19, and 1 inch of rigid foam board insulation typically is rated at R-5.

For poured-concrete foundations, if the respondent indicated an insulation level of R-11 to R-15, the builder was considered to have met code if he or she also indicated he or she installed continuous insulation; if he or she indicated a cavity or combination of cavity and continuous insulation, the builder was given a rating of not meeting the code. This is making the assumption that continuous insulation in this case is rigid foam, with an R-5 per inch. If they were above an R-10, they most likely would have met the code value of R-15. There is a potential for error with this assumption. If the continuous insulation was a draped blanket of insulation that did not meet the R-15 prescriptive value, there would be an overestimation of builders who were meeting the code. Given the available data and overall purpose of this study, this was an acceptable assumption. Of the builders who indicated they installed a poured concrete foundation, 78.7% installed insulation levels that were below the IECC levels, 19.1% installed insulation levels at or above the IECC requirements and 2.1% of builders were unsure of the insulation levels they were installing on foundation walls (Figure 3).

A statistical difference was found between the amount of insulation installed on poured-concrete foundations and wood-frame foundations. Builders installing wood-frame foundations installed insulation meeting or exceeding the IECC level 73% of the time.

Another interesting fact was noticed for builders that were installing basements using Insulated Concrete Forms (ICFs). They indicated insulation levels that did not meet code levels 9.1% of the time, but ICFs generally have R-values that are above the required code level of an R-15 for continuous insulation. What is unclear is if the builders are not aware of the actual R-values of the specific products they are installing or if ICF products are available that have lower R-values. For the remainder of the ICF installations, 86.3% of builders indicated installing at or above code level and 4.5% were unsure.

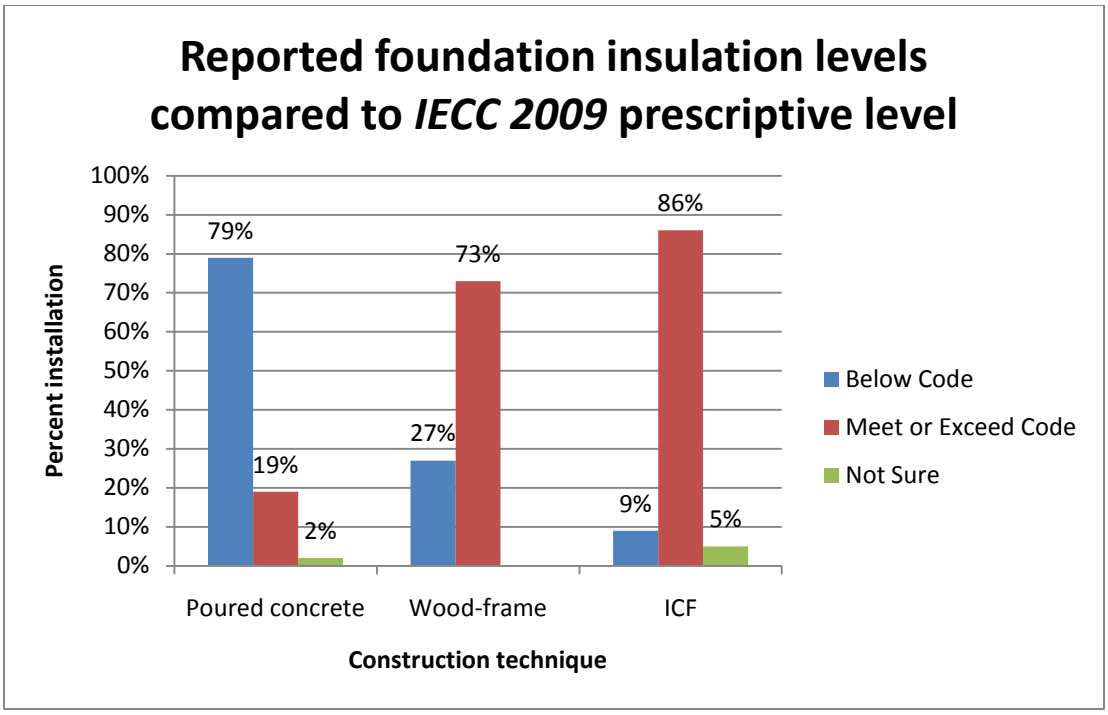

Figure 3. Reported foundation levels compared with IECC 2009.

Question 4. Rim joist insulation

Rim joist insulation levels are not addressed specifically in the IECC code but are considered an above-grade wall and as such should have insulation levels that meet any requirement prescribed for above-grade walls. This area was addressed separately in the survey since it is an area that can easily be overlooked. A comparison with current IECC levels was not done but rather an evaluation of builders who installed insulation levels above an R-15 level was done. Of those surveyed, 54.5% of builders insulate rim joists above an R-15 and 9% were unsure of the level of insulation used on rim joists.

Question 5: Floors over unheated space

Floors over unheated spaces can be found in areas such as living spaces over garages, floors over unconditioned crawl spaces and cantilevers. The required R-value for floors in the IECC 2009 is either an R-30 in the southern North Dakota climate zone, an R-38 in the northern climate zone or enough insulation to fill the entire cavity as long as it exceeds an insulation value of at least an R-19. Forty-nine percent of respondents were insulating at or above the highest IECC requirements, 49% were at or near the lower requirement and only 2% were significantly below the required minimums.

Question 6: Window and door U-values

The IECC does not refer to windows and doors specifically but incorporates them all into fenestrations. According to the IECC 2009, a fenestration is a "skylight, roof window, vertical window, opaque door, glazed door, glazed block or combination opaque/glazed door" (IECC, p.6). For the purposes of this survey, the questions referred to window and door U-values. The required U-value of U=0.35 is the same for windows and doors in both North Dakota climate zones. Of the builders surveyed, 38% were unsure of the U-values of the windows and 59% were unsure of the U-value of doors they installed. An equal number, 31%, of windows installed were at or above code as well as below code requirements. The door U-values were below the IECC code level 25% of the time and at or above code levels 16% of the time (Figure 4).

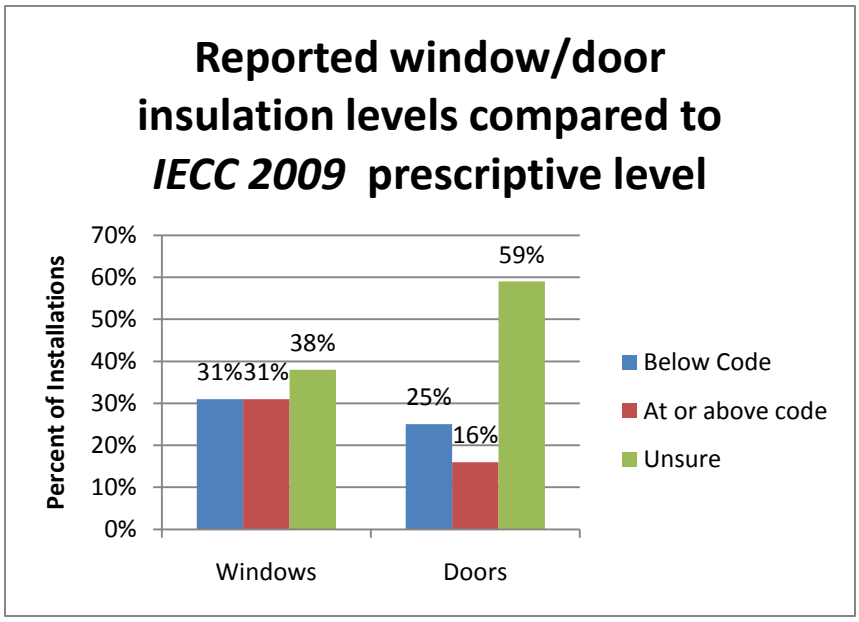

Figure 4. Window and door U-values.

Question 7: Heating system efficiency

No requirements are under the prescriptive list for heating system efficiencies for residential buildings in the 2009 IECC, so the information gathered was not compared with any specific value.

Question 8: Air sealing and efficient equipment checklist

A variety of code requirements concerning air sealing and various energy-efficient equipment installations are in the IECC. For example, Section 402.4.2 of the IECC deals with the air sealing and insulation of homes. Two options are listed for ensuring a building is constructed to an adequate level of tightness. The first option is that the building can be tested for air leaks at the "rough-in" using a blower door. The second option is to have independent verification of the buildings air sealing properties and insulation levels. Of the builders surveyed, 53% never have tested one of their buildings using a blower door and only 11% test all of their buildings.

Testing the ducts for leakage is another requirement in the IECC unless all the ducts and the air handling equipment are located within the conditioned space in a home. Eighty-six percent of builders surveyed rarely or never install ducts outside the conditioned portion of the home, so duct leakage testing would most likely not be an a substantial issue for North Dakota builders.

The majority of questions dealing with air sealing techniques were answered favorably by builders: 95% always seal between the foundation and sill plate, 90% are not using unfaced insulation as an air barrier, 90% are always sealing the space between the window jamb, 88% seal door jambs, 80% always use IC (Insulation Contact) rated recessed lights and 83% are always sealing HVAC and plumbing penetrations to the outside.

Some areas that could use attention according to the surveyed builders are air sealing techniques around attic access areas and recessed lights. An example can be seen around the attic access; only 35% of builders always install an air seal around the attic access and only 15% seal attic drop down stairs. Twenty eight percent of builders indicated they are never sealing recessed lights to the drywall. While these may seem like minor areas, the more opportunities air has to leak into or out of a home, the higher the homeowners' utility bills.

Conclusions

The survey indicates that the North Dakota builders who participated in the study are building residential structures that meet the needs of homeowners in the majority of their residential housing projects. However, builders have an opportunity for improvement concerning energy-related measures in portions of residential structures that could result in energy savings, greater comfort and compliance with the IECC. Those areas include foundation insulation, air sealing measures, and window and door U-values.

While building to recommended code levels is important for the energy performance of residential structures, understanding the reasons for the recommended insulation and air sealing measures is vital. Performing blower door tests on an increased number of houses would provide builders valuable information on areas where attention to air sealing would have the greatest impact. Heat loss through an uninsulated foundation accounts for up to 20% of heat loss from a house in North Dakota. While the proper installation of foundation insulation can add some cost at the time of construction, it can add to the comfort level and energy performance of the home significantly.

Considering the number of builders who are using 2”x6” construction for exterior walls, an addition of the IECC requirements would have little impact to the actual construction of housing projects for the majority of builders surveyed. If using a fiberglass batt insulation to insulate wall cavities, it is relatively simple going from an R-19 batt to an R-21 batt as long as local suppliers stock the R-21 batts.

Only minor differences were found between current building practices surveyed in North Dakota and the 2009 IECC. In most instances, the surveyed homes meet or exceed the latest code requirements. Only a small percentage would require significant efforts or additions to reach the code requirements.

References

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APPENDIX A. BACKGROUND OF NORTH DAKOTA STATE BUILDING CODE

Building Code Background

The North Dakota State Building Code was created by the 46th North Dakota Legislative Assembly in 1979. In lieu of writing a code specific for the state, the Legislature adopted the International Conference of Building Officials' Uniform Building Code as the state building code. The addition of the Uniform Mechanical Code was done in 1985. The Legislature held the responsibility of updating the code until 1991, when it chose to have regularly updated versions of the Uniform Building Code and Uniform Mechanical Code act as the state building code. This was done to provide continuously updated building codes, which previously was not possible. This process was deemed unconstitutional, so the responsibility of updating the state building code was transferred to the Office of Management and Budget (OMB). In 1993, the OMB selected the Office of Intergovernmental Assistance, which is now the Division of Community Service within the Department of Commerce, to periodically update the code, provide amendments and maintain code rules. The Department of Commerce does not enforce the codes; that responsibility is left up to the jurisdictions that decide to implement the state building code.

In 1993, the North Dakota Legislature passed a law requiring that if a jurisdiction (city, township or county) in North Dakota chooses to implement a building code, it must be the state building code. Jurisdictions also were given the ability to modify the state building code to fit particular needs in local areas. Concerning energy codes, the Legislature made the state energy code the *Model Energy Code*, 1989 version.

The energy code was updated in 1995 to the 1993 version of the *Model Energy Code,* and the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 90.1 – 1989 was included in reference to commercial buildings (DSIRE, 2010).

Publication of the Uniform Building Code and the Uniform Mechanical Code was discontinued; as a result, in 2001, the International Code Council's (ICC) 2000 suite of building codes was designated as the state building code. The ICC codes adopted in North Dakota consist of the International Residential Code (IRC), International Building Code (IBC), International Fuel Gas Code (IFGC) and International Mechanical Code (IMC).

Additionally in 2001, the Building Code Advisory Committee was created to provide recommendations on proposed code amendments. The jurisdictions and the Building Code Advisory Committee are responsible for regularly updating the North Dakota State Building Code. The Building Code Advisory Committee prepares recommendations on recent versions of ICC codes to adopt and specific code revisions. The participating jurisdictions and one representative each from the North Dakota chapter of the American Institute of Architects, North Dakota Society of Professional Engineers, North Dakota Association of Builders, North Dakota Association of Mechanical Contractors, and Associated General Contractors then vote whether or not to include the code revisions in the North Dakota State Building Code. As of December

2008 the ICC codes that have been adopted as the state building code are the 2006 edition of the IRC, IBC, IFGC and IMC. The 2009 versions with revisions are slated to become the North Dakota State Building code January 1, 2011.

The *Model Energy Code,* which has not been published or updated since 1995, still was part of the North Dakota Century Code until 2009, when the 61st Legislative Assembly amended section 54-21.2-03, removing reference to it and replacing it with a statement that simply required that energy codes must be included in the state building code, making no reference to a specific code. Individual chapters in the International Residential Code and International Building Code deal with energy efficiency issues. A separate series of codes based on the Model Energy Code was developed in 1998, this being the International Energy Conservation Code *(*IECC*)*. This code combines the commercial and residential energy codes into one volume.

Table 15. North Dakota Building Code event timeline.

North Dakota Building Code Event	**Year**
Creation of North Dakota State Building Code	1979
Adoption of Uniform Building Code (UBC) as state building code	1979
Addition of Uniform Mechanical Code (UMC) to state building code	1985
Office of OMB assumes responsibility to update code	1991
North Dakota Department of Commerce -Division of Community Service assumes responsibility for code updating process	1993
Legislature creates requirement to adopt North Dakota State Building Code if a code is implemented by a particular jurisdiction	1993
State Energy Code updated to the *Model Energy Code,* 1993 version, for residential buildings	1995
Creation of the *International Energy Conservation Code* (IECC)	1998
ICC 2000 editions (IRC, IBC, IFGC, IMC) of building codes replace UBC and UMC as the North Dakota State Building code	2001
Creation of Building Code Advisory Committee	2001
Removal of reference to *Model Energy Code in* North Dakota State Century Code	2009
Legislative requirement to include energy code in state building code	2009

At the time this report was written, no statewide building code requirement was in place for any buildings except for state and local government-owned buildings in North Dakota. Individual jurisdictions can elect to implement and enforce the North Dakota State Building code if they choose. In the matter of energy-related building codes, no standards are available for any buildings, either public or private.

APPENDIX B. RECENT EVENTS CONCERNING NORTH DAKOTA RESIDENTIAL BUILDING CODES

Recent Events

The American Reinvestment and Recovery Act of 2009 (ARRA) provided North Dakota residents with the opportunity to stimulate the economy of the state while providing investment for the protection of the environment and long-term infrastructure improvements. As a condition of the receipt of ARRA funding, states were required to agree to the following language from the act:

> "The State or the applicable units of local government that have the authority to adopt building codes will implement the following: (A) A building energy code (or codes) for residential buildings that meets or exceeds the most recently published *International Energy Conservation Code*, or achieves equivalent or greater energy savings (ARRA, 2009)"

The governor of North Dakota provided assurances in a letter to U.S. Secretary of Energy Steven Chu, which indicates a request of the North Dakota Legislature to improve building energy codes (Appendix C). Governor Hoeven also stated in his letter that North Dakota is "committed to a robust improvement in energy efficiency and renewable energy…" and gave assurances the state "will move forward in these critical areas" (Hoeven, 2009).

The state also must demonstrate a plan to provide 90 percent (%) compliance with the most recent building code standards in new residential as well as commercial buildings within eight years. The plan also must show the level of training and enforcement, as well as the rate of compliance, each year. The most recent versions of ICC codes available for residential buildings are the 2009 International Residential Code (ARRA, 2009).

The North Dakota State Building Code Advisory Committee has previously voted to delete from the state building codes the chapters from the currently adopted (2006) International Residential Code and International Building Code concerning energy efficiency. However, North Dakota Senate Bill 2352 (Appendix D) signed by Governor Hoeven, requires that energy conservation standards must be included in the state building code. The advisory committee met in June 2009 and came to the consensus that the prudent way to include energy standards in the North Dakota State Building Code would be to wait until the next full adoption cycle of the ICC codes that were scheduled to take effect January 1, 2011. The adoption process takes months to complete and to attempt to include energy standards in the 2006 versions of the codes just to have to revisit the process in a few months would create an unnecessary burden on all involved. The Department of Commerce requested and was granted an extension by the Administrative Rules Committee. An energy conservation standard for the North Dakota State building Code will be complete in the fall of 2010.

APPENDIX C. GOVERNOR HOEVEN ASSURANCE LETTER

State of
North Dakota
Office of the Governor

John Hoeven
Governor

February 27, 2009

The Honorable Steven Chu
Secretary
US Department of Energy
1000 Independence Ave SW
Washington, D.C. 20585

Re: State Energy Program Assurances

Dear Secretary Chu:

As a condition of receiving our State's share of the $3.1 billion funding for the State Energy Program (SEP) under the American Recovery and Renewal Act of 2009 (H.R. 1)(ARRA), I am providing the following assurances. I have written to our public utility commission and requested that they consider additional actions to promote energy efficiency, consistent with the Federal statutory language contained in H.R. 1 and their obligations to maintain just and reasonable rates, while protecting the public. I have also written to the State Legislature and requested that they consider actions to improve building energy codes, consistent with State law and State Constitutional requirements, and to consider the statutory language contained in ARRA.

We are prioritizing our energy investments to take advantage of existing programs and expand programs where appropriate.

Our State is committed to a robust improvement in energy efficiency and renewable energy, as well as a balanced State energy policy. I want to assure you that, within the limits of my authority, we will move forward in these critical areas.

We look forward to immediate distribution of the Federal SEP funds to permit my State to make progress in energy efficiency and renewable energy.

Respectfully Submitted,

John Hoeven
Governor

38:34:58

C: Gil Sperling
Director, Office of Weatherization and Intergovernmental Programs
U.S. Department of Energy
Jim Boyd, ND Dept. of Commerce
David Terry, Executive Director
National Association of State Energy Officials

600 E Boulevard Ave.
Bismarck, ND 58505-0001
Phone: 701.328.2200
Fax: 701.328.2205
www.nd.gov

APPENDIX D. NORTH DAKOTA SENATE BILL 2352

Sixty-first Legislative Assembly of North Dakota
In Regular Session Commencing Tuesday, January 6, 2009

SENATE BILL NO. 2352
(Senators Wardner, Holmberg, Horne)
(Representatives Carlson, Klein, S. Meyer)

AN ACT to amend and reenact section 54-21.2-03 of the North Dakota Century Code, relating to energy conservation standards for new buildings.

BE IT ENACTED BY THE LEGISLATIVE ASSEMBLY OF NORTH DAKOTA:

SECTION 1. AMENDMENT. Section 54-21.2-03 of the North Dakota Century Code is amended and reenacted as follows:

54-21.2-03. Energy conservation standards. ~~The standards~~ Standards for energy conservation in new building construction, for thermal design conditions and criteria for buildings, and for adequate thermal resistance in regard to the design and selection of mechanical, electrical service, and illumination systems and equipment which will enable the effective use of energy in new buildings, must ~~at least equal the Energy Conservation Code based on the Council of American Building Officials Model Energy Code, 1980 Edition. The department of commerce shall adopt rules to implement, update, and amend the Model Energy Code~~ be included in the state building code.

President of the Senate

Speaker of the House

Secretary of the Senate

Chief Clerk of the House

This certifies that the within bill originated in the Senate of the Sixty-first Legislative Assembly of North Dakota and is known on the records of that body as Senate Bill No. 2352.

Senate Vote:	Yeas	46	Nays	0	Absent	1
House Vote:	Yeas	93	Nays	0	Absent	1

Secretary of the Senate

Received by the Governor at _____ M. on _____, 2009.

Approved at _____ M. on _____, 2009.

Governor

Filed in this office this _____ day of _____, 2009,

at _____ o'clock _____ M.

Secretary of State

APPENDIX E. BUILDER QUESTIONARE

The NDSU Extension Service, in cooperation with the North Dakota Department of Commerce, is asking for your help.

We are conducting a research survey of builders in North Dakota to understand current building practices.

This information can be used by individuals and organizations (builders, building officials, architects/designers, building trades organizations, etc.) as they evaluate North Dakota building codes and by educators to tailor programs specifically to fit the needs of North Dakota builders.

In addition, a few questions relate to personal preferences about building projects and will be used in conjunction with a survey of Realtors and prospective homebuyers to develop an understanding of homeowners' desires for home purchases. This information will be made available so builders can better determine how to concentrate their marketing efforts.

The survey is completely voluntary and should take less than 10 minutes to complete. Individual responses will be kept confidential. If you have any questions, please call Carl Pedersen, NDSU Extension Service, at (701) 231-5833 or send an e-mail to carl.pedersen@ndsu.edu.

When answering the following questions, provide information on the building components in each section of what you are installing or having installed in new construction and/or remodeling projects. Include the percentages of each installation for your jobs. If you use the technique described, check the "Used" column and provide the rest of the information in that row. If you do not use a technique listed, simply check the "Not Used" box and move to the next line.

North Dakota
DEPARTMENT OF COMMERCE
Office of Renewable Energy & Energy Efficiency

NORTH DAKOTA ASSOCIATION OF BUILDERS

Example

If the question is asking what color and type of roofing material you or your contractors install and you install green asphalt shingles on 40% and gray asphalt shingles on 60% of your homes, your answer would look like this:

			Color					Type			
Roofing Material	Not Used	Used	Brown	Gray	Black	Green	Not sure	Asphalt	Slate	Steel	Percentage of Installations
6/12 roof pitch	○	●	○	○	○	●	○	●	○	○	40%
9/12 roof pitch	○	●	○	●	○	○	○	●	○	○	60%
Flat roof	●	○	○	○	○	○	○	○	○	○	_____

If a question does not provide answer possibilities for a specific type of construction that you utilize, please describe that in the comments section after each question or at the end of the survey.

NDSU Extension Service
North Dakota State University
Fargo, North Dakota 58108
February 2010

For questions about the rights of research participants or to report a problem, please contact the NDSU Human Research Protection Program at (701) 231-8908.

1. **For ceiling construction, please provide the amount of insulation and the insulation technique used. Of all the ceilings installed in new and remodeling projects, what percentage of each ceiling construction type do you use?** (Continuous insulation refers to insulation that is not interrupted by framing members. For example, if you blow cellulose between ceiling joists, that would be considered a cavity installation, but if it extends above the framing, that would count as combination. If you add an inch of rigid board on the outside of the house, that would be continuous.)

Ceiling Construction	Not Used	Used	Amount of Insulation Installed					Insulating Technique			Percentage of ceilings installed
			None to R-13	R-14 to R-37	R-38 to R-49	R-49+	Not sure	Continuous	Cavity, in-between framing	Combination (continuous and cavity)	
Flat ceiling or scissor truss	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	_____
Cathedral with no attic	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	_____
Raised or energy truss	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	_____
Structural Insulated Panels (SIPs)	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	_____
Other (specify) _____	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	_____
Other (specify) _____	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	_____

COMMENTS

2. **For <u>exterior</u> above-grade wall construction, please provide the amount of insulation, the insulation technique used and the percent of time each type was used in your housing projects.**

Wall Construction (more than 50% above grade)	Not Used	Used	Amount of Insulation Installed							Insulating Technique			Percentage of walls installed
			None	R-1 to R-6	R-7 to R-13	R-13 to R-19	R-19 to R-21	Above R-21	Not sure	Continuous	Cavity, in-between framing	Combination (continuous and cavity)	
2" x 4" – 16" o.c. (on center) wood	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	_____
2" x 4" – 24" o.c. wood	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	_____
2" x 6" – 16" o.c. wood	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	_____
2" x 6" – 24" o.c. wood	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	_____
Structural Insulated Panels (SIP)	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	_____
Insulated Concrete Forms (ICF)	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	_____
Other (specify) _____	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	_____
Other (specify) _____	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	_____

COMMENTS

3. For walls with more than 50% below grade (foundation), please provide the amount of insulation, the insulation technique used and the percent of time each construction type was used in your housing projects.

Foundation Construction	Not Used	Used	Amount of Insulation Installed							Insulating Technique				Percentage of basements installed
			None	R-1 to R-5	R-6 to R-10	R-11 to R-15	R-16 to R-18	Above R-18	Not sure	Continuous outside/ outdoors	Continuous inside/ indoors	Cavity, in-between framing	Combination (continuous and cavity)	
Poured concrete	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	_____
Masonry block with empty cells	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	_____
Masonry block with integral insulation	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	_____
Wood frame	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	_____
Insulated Concrete Forms (ICF)	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	_____
Other (specify) _____	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	_____
Other (specify) _____	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	_____

COMMENTS

4. For rim joists, please provide the amount of insulation, the insulation technique used and the percent of time each construction type was used in your housing projects.

Rim Joist Installation	Not Used	Used	Amount of Insulation Installed					Insulating Technique			Percentage of rim joist
			R-1 to R-5	R-6 to R-10	R-11 to R-15	Above R-15	Not sure	Continuous	Cavity, in-between framing	Combination (continuous and cavity)	
Spray foam	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	_____
Fiberglass batts	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	_____
Rigid board insulation	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	_____
None	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	_____
Other (specify) _____	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	_____
Other (specify) _____	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	_____

COMMENTS

5. For floors installed over unheated space, please provide the amount of insulation, the insulation technique used and the percent of time each construction type was used in your housing projects.

Floor Over Unheated Space	Not Used	Used	Amount of Insulation Installed: None to R-13	R-14 to R-37	R-38 to R-49	Above R-49	Fill the framing cavity	Not sure	Insulating Technique: Continuous	Cavity, in-between framing	Combination (continuous and cavity)	Percentage of installations
Living space over garage	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	_____
Crawl space	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	_____
Cantilever floor	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	_____
Other (specify) _____	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	_____
Other (specify) _____	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	_____

COMMENTS

6. For the majority of windows and doors, please provide the U-value installed in your housing projects.

U-values	U-value: U-1.2 or higher	U-.65 to U-1.1	U-.50 to U-.64	U-.36 to U-.49	U-.35 and lower	Not sure	Double pane	Triple pane	Percentage of installations
Windows	❍	❍	❍	❍	❍	❍	❍	❍	_____
Windows	❍	❍	❍	❍	❍	❍	❍	❍	_____
Doors	❍	❍	❍	❍	❍	❍	❍	❍	_____
Doors	❍	❍	❍	❍	❍	❍	❍	❍	_____
Other (specify) _____	❍	❍	❍	❍	❍	❍	❍	❍	_____
Other (specify) _____	❍	❍	❍	❍	❍	❍	❍	❍	_____

COMMENTS

7. For the heating systems you or your contractors install, please provide the efficiency ratings and percent of installations for equipment utilized in your housing projects.

Heating Systems	Efficiency Rating								Percentage of installations
	78% to 85%	86% to 90%	91% to 95%	Above 95%	HSPF 7.7 to 8.1	HSPF 8.2 to 8.6	HSPF above 8.6	Not sure	
Natural gas furnace	❍	❍	❍	❍				❍	_____
Natural gas boiler	❍	❍	❍	❍				❍	_____
Propane furnace	❍	❍	❍	❍				❍	_____
Propane boiler	❍	❍	❍	❍				❍	_____
Heat pump					❍	❍	❍	❍	_____
Other (specify) _____	❍	❍	❍	❍	❍	❍	❍	❍	_____
Other (specify) _____	❍	❍	❍	❍	❍	❍	❍	❍	_____

COMMENTS

8. Please indicate how often either you or your contractors are performing the following air sealing measures or installing the following pieces of equipment on your housing projects. If you do not use the construction technique, indicate "Not applicable." For example, if you do not build homes with knee walls, indicate "Not applicable" for that question.

Air Sealing Measures	Percent of Homes						
	Not sure	Never	25% of homes	50% of homes	About 75% of homes	Always	Not applicable
1. Conduct duct leakage testing	❍	❍	❍	❍	❍	❍	❍
2. Conduct blower door test for air infiltration levels	❍	❍	❍	❍	❍	❍	❍
3. Seal between foundation and sill plate	❍	❍	❍	❍	❍	❍	❍
4. Unfaced insulation is only used in conjunction with an air barrier, not as an air barrier	❍	❍	❍	❍	❍	❍	❍
5. Install air barrier in rim joist	❍	❍	❍	❍	❍	❍	❍
6. Install air sealing gasket in attic access	❍	❍	❍	❍	❍	❍	❍
7. Install air seal in knee wall door	❍	❍	❍	❍	❍	❍	❍
8. Install air seal in attic drop-down stair	❍	❍	❍	❍	❍	❍	❍
9. Space between window jamb is air sealed	❍	❍	❍	❍	❍	❍	❍
10. Space in door jamb is air sealed	❍	❍	❍	❍	❍	❍	❍
11. Recessed lights are IC rated	❍	❍	❍	❍	❍	❍	❍
12. Recessed lights are airtight	❍	❍	❍	❍	❍	❍	❍
13. Recessed lights are sealed to drywall with gasket or caulk	❍	❍	❍	❍	❍	❍	❍
14. Air barrier extends behind electrical boxes or sealed boxes are used	❍	❍	❍	❍	❍	❍	❍
15. Seal plumbing and HVAC penetrations to outside with expanding foam or other proper air sealing	❍	❍	❍	❍	❍	❍	❍
16. Install heating systems with ducts outside the conditioned portion of the home	❍	❍	❍	❍	❍	❍	❍
17. Install high-efficiency/efficacy light fixtures	❍	❍	❍	❍	❍	❍	❍
18. Install programmable thermostats	❍	❍	❍	❍	❍	❍	❍
19. How often do homeowners ask for upgraded energy-related items	❍	❍	❍	❍	❍	❍	❍

COMMENTS

The following questions refer to personal beliefs and not specific building code requirements. The answers to these questions will be used in conjunction with similar surveys of Realtors and homebuyers to establish views about energy use in residential structures. Please answer to the best of your ability.

1. **Who is responsible for decisions related to building quality? Rate in order of responsibility, with 5 being the most responsible and 1 the least responsible.**
   - _____ State regulators/legislators
   - _____ Builders
   - _____ Designers/architect
   - _____ Homeowner/homebuyer
   - _____ Building code official
   - _____ Other _____

2. **Who is responsible for informing the homebuyer/homeowner about energy-related issues? (Check all that apply.)**
   - ❑ Realtors
   - ❑ Builders
   - ❑ Designers/architect
   - ❑ Public officials
   - ❑ Homeowner/homebuyer themselves
   - ❑ Other _____

3. **How concerned are you with energy efficiency aspects of homes you construct?**
   - ❑ Not concerned
   - ❑ Slightly concerned
   - ❑ Neutral
   - ❑ Somewhat concerned
   - ❑ Very concerned

4. **How concerned are homeowners/homebuyers with energy efficiency aspects of homes they buy?**
   - ❑ Not concerned
   - ❑ Slightly concerned
   - ❑ Neutral
   - ❑ Somewhat concerned
   - ❑ Very concerned

5. **What reason would cause you to consider energy issues when building/retrofitting a home? Rank in order of importance from 1 to 7.**
   - _____ Comfort
   - _____ Energy cost
   - _____ Consumption of natural resources
   - _____ Not want to spend more than comparable homes
   - _____ Carbon footprint
   - _____ Quality of product I am selling
   - _____ Code
   - _____ Other _____

6. **Based on your observations, please answer the following statements.**
   - ■ If given the option, the majority of homeowners would rather spend money on granite countertops than on additional insulation.
     - ❑ Always True
     - ❑ Sometimes True
     - ❑ Rarely True
     - ❑ Never True
   - ■ Homeowners generally only consider the initial cost of installed appliances and not the cost to operate them through time.
     - ❑ Always True
     - ❑ Sometimes True
     - ❑ Rarely True
     - ❑ Never True
   - ■ I am often asked to build a "green home."
     - ❑ Always True
     - ❑ Sometimes True
     - ❑ Rarely True
     - ❑ Never True

7. **Where would you go to find more information on energy-related issues in buildings? (Check all that apply.)**
   - ❑ Building trade organizations
   - ❑ Internet
   - ❑ Other builders
   - ❑ Workshops
   - ❑ Trade schools
   - ❑ Trade shows
   - ❑ Already know all I need to know
   - ❑ Other _____

8. **Please give an estimate of the percentage of each type of home you build in a year.**
   - _____ Starter spec homes
   - _____ Middle price range spec homes
   - _____ High-end spec homes
   - _____ Starter custom homes
   - _____ Middle price range custom homes
   - _____ High-end custom homes
   - _____ Other _____

   100%

9. **Which North Dakota city is closest to where you build the majority of your homes?**
   - ❑ Williston ❑ Minot ❑ Grand Forks
   - ❑ Dickinson ❑ Bismarck ❑ Fargo

For tracking purposes only, please provide your name and/or the name of the construction company for which you work. Identification will not be tied to any provided answers and is simply used for tracking purposes to ensure the survey is completed only once.

Name _____

APPENDIX F. NORTH DAKOTA CLIMATE ZONE MAP

North Dakota IECC climate zones.