Recommendation #1: Clarifying Building Code Requirements

December 8, 2006

The state building code sets minimum standards for residential and commercial structures in Oregon. These minimum standards focus on protecting the occupants of buildings and the general public from fire and life safety hazards. Other aspects of construction, such as reducing water intrusion, are regulated through general code provisions. Testimony and other gathered information suggested making changes to the state building code in key areas: the allowable moisture content of a building cavity, applications of flashing and additional mechanical ventilation provisions.

In the course of discussing concept papers presented during the April 11, 2006 meeting, Task Force members expressed interest in "incorporating good ideas from experts that appeared before them suggesting building code amendments into [Concept #5]."[1] At the same meeting, the Task Force also "further expressed not specifically recommending rainscreen technology."[2] During the May 24, 2006 Construction Claims Task Force meeting, the Task Force requested to "have staff come up with a list of code changes for our further review."[3] The Task Force directed staff to focus on moisture content of a building cavity, mechanical ventilation and flashing.[4]

The Task Force arrived at the recommendations in this section through testimony, background research and examining comparative approaches to building code regulation. A review of the minutes from September 21, 2005 onward showed that at least twelve presenters generally advocated clarifications to the state building code.

However, not all presenters agreed that the building code needed modification to address construction defect issues. Kraig Stevenson, CBO and Regional Manager of the International Code Council's Government Relations office, testified in January 25, 2006 that model codes deal with "life safety issues, not performance quality issues."[5] Issues ancillary to life safety issues, such as water intrusion, were "quality control issues."[6] Additionally, while the British Columbia provincial commission appointed to study construction industry practices did suggest changes to the its building code, it noted that "the provincial code is intended to represent minimum standards regarding life safety, health and structural efficiency."[7]

Given the information and direction at hand, the Task Force focused on three areas addressed below: clarifying the requirements moisture content of materials in a building cavity, clarifying mechanical ventilation requirements and clarifying flashing installations.

Moisture Content

During the November 1, 2005 building science and forensic engineers panel, Dr. George Tsongas, Professor Emeritus of Mechanical Engineering at Portland State University, suggested that framing

[1] Minutes, Construction Claims Task Force 7 (April 11, 2006).
[2] Id.
[3] Audio recording: Construction Claims Task Force (May 24, 2006) (on file with author).
[4] Id.
[5] Minutes, Construction Claims Task Force 4 (January 25, 2006).
[6] Id.
[7] COMMISSION OF INQUIRY INTO THE QUALITY OF CONDOMINIUM CONSTRUCTION IN BRITISH COLUMBIA, THE RENEWAL OF TRUST IN RESIDENTIAL CONSTRUCTION (1998), *available at* http://www.hpo.bc.ca/Overview/Barrett1/c2_ii.htm

lumber should contain a maximum moisture content of nineteen percent to discourage mold growth.[8] At the December 2, 2005 design community panel presentation, Ray Miller of Miller Consulting Engineers noted that construction problems may be resolved through protection of the building cavity and the use of dry materials.[9] Mr. Miller reiterated Dr. Tsongas' suggestion that the moisture content of building materials should not exceed nineteen percent.[10]

Staff research found no examples where another American jurisdiction required building materials destined for a cavity retain a certain percentage of moisture. However, the International Building Code (adopted by forty-eight states, including Oregon) does require fire-retardant-treat wood be dried to a moisture content of nineteen percent or less for lumber before use.[11] Research conducted on the subject by the Canadian government generally meshes with given testimony and promotes drier building materials. For example, a 1983 paper published by the National Research Council noted that "when the moisture content of the wood sheathing and structural members [of a dwelling] exceeds 22% of the weight of dry lumber for an extended period of time it can result in rot."[12]

The Task Force recommends amending the residential code to require wood construction materials destined for a building cavity should be kept at a moisture content of nineteen percent of the weight of dry lumber or less. The Task Force that the moisture content level should be measured at the time of covering up the cavity with associated sheathing (e.g., drywall). The manner in which building materials used in a cavity are kept at a moisture level of nineteen percent – whether drying out a structure, covering building materials before use, on-time delivery – should rest with the contractor. Because of the timing of construction projects, measuring the moisture content of lumber would need to be certified by the contractor. The documentation of moisture measurements may be required in order to secure a certificate of occupancy for the structure (*see* Recommendation #5).

Mechanical Ventilation

At the November 1, 2005 building science and forensic engineers panel, Dr. George Tsongas proposed a number of changes designed to address improving ventilation in bathrooms and kitchens and mitigating high humidity indoor environments.[13] Noting that one-third of Northwest homes have visible mold problems indoors, Dr. Tsongas suggested that the Task Force consider greater ventilation standards for bathrooms and kitchens, including discouraging recirculating kitchen range hoods.[14] In later written submissions, Dr. Tsongas recommended the following:

- Require minimum flow rate of 80 cfm (cubic feet per minute) for bathroom exhaust fans;
- Do not allow sale of noisy bathroom fans with sone (noise) levels over 2.5;[15]
- Require bathroom fans be located directly over the shower or tub to maximize moisture capture;
- Require some type of fan control that automatically engages without occupant action;

[8] Minutes, Construction Claims Task Force 5 (November 1, 2005).
[9] Minutes, Construction Claims Task Force 6 (December 2, 2005).
[10] Id.
[11] See INT'L BUILDING CODE § 2303.2.5 (2003).
[12] JACQUES ROUSSEAU, DIVISION OF BUILDING RESEARCH, NATIONAL RESEARCH COUNCIL, RAIN PENETRATION AND MOISTURE DAMAGE IN RESIDENTIAL CONSTRUCTION 1 (1983), http://irc.nrc-cnerc.gc.ca/pubs/bsi/83-1-print_e.html.
[13] Minutes, Construction Claims Task Force 5 (November 1, 2005).
[14] Id.
[15] 2.5 sone levels is roughly equal to 40 decibels. For reference, the Centers for Disease Control estimates a hair dryer to run at about 90 decibels. *See* CENTERS FOR DISEASE CONTROL, NATIONAL INSTITUTE FOR OCCUPANT HEALTH AND SAFETY, NIOSH SOUND METER, *available at* http://www.cdc.gov/niosh/topics/noise/abouthlp/noisemeter_html/hp90.html

- Do not allow kitchen fans that simply recirculate humid air from cooking and do not exhaust that moisture to the outdoors; and
- Do not allow kitchen fans with sone (noise) levels greater than 4.0.[16]

Other research publications address the need for proper ventilation. A 1983 paper from the National Research Council concluded that mechanical ventilation systems needed to continuously move air at a rate of thirty-five liters per second (approximately seventy-five cubic feet per minute) to maintain air quality in homes.[17] The publication also recommended that ventilation systems needed to be able to move air at a rate of seventy-five liters per second (approximately one-hundred and sixty cubic feet per minute) to provide intermittent humidity control and contaminant removal.[18] Noting that "natural forces cannot be relied upon to provide such rates under all circumstances," the publication suggested that "a positive, mechanical ventilation system is desirable."[19]

A 1998 Construction Technology Update by the National Research Council further developed the characteristics of mechanical ventilation systems. This update suggested that an ideal ventilation system would operate only when needed, provide the needed amount of air exchange, operate quietly, and not interfere with other environmental systems or the building envelope.[20] The update suggested that a "demand-controlled" ventilation system would meet ideal criteria.[21] This system would be controlled by sensors that monitored humidity and interior pollutants; if the sensors detected unacceptable levels of humidity or pollutants, the system would bring in fresh air.[22]

Looking at comparative approaches, several states surveyed by staff amend their building codes or energy codes in ways that may address the concerns brought before the Task Force. In terms of mechanical ventilation, Minnesota requires single-family homes built since April 2000 be constructed with a mechanical ventilation system.[23] Minnesota's mechanical code also requires all domestic range hoods to discharge outdoors.[24] Washington's administrative code sets performance and prescriptive mechanical ventilation criteria for Group R occupancies (e.g., residential structures) four stories or less.[25] Kitchens, bathrooms, and laundry rooms must possess so-called "source specific ventilation;" exhaust fans installed in these rooms must exhaust 50 cubic feet of air per minute in bathrooms and 100 cubic feet per minute for kitchens.[26] No states surveyed specifically adopted prescriptive code sections that would require moisture sensors.

[16] GEORGE TSONGAS, RECOMMENDED BUILDING CODE CHANGES 3-4 (2005), a*vailable at* http://www.oregon.gov/DCBS/CCTF/submitted/112805_document_tsongas.pdf. 4.0 sone levels is approximately 48 decibels. *See* Note 16.
[17] GUSTAV O. HANDEGORD, DIVISION OF BUILDING RESEARCH, NATIONAL RESEARCH COUNCIL, VENTILATION OF HOUSES 12 (1983), http://irc.nrc-cnerc.gc.ca/pubs/bsi/83-4-print_e.html.
[18] Id.
[19] Id.
[20] J.C. HAYSOM AND J.T. REARDON, INSTITUTE FOR RESEARCH IN CONSTRUCTION, NATIONAL RESEARCH COUNCIL, CONSTRUCTION TECHNOLOGY UPDATE NO. 14, WHY HOUSES NEED MECHANICAL VENTILATION SYSTEMS 4-5 (1998), http://irc.nrc-cnerc.gc.ca/pubs/ctus/14-print_e.html.
[21] Id., at 4.
[22] Id.
[23] MINN. R. 7672.1000.
[24] MINN. R. 1346.0505.
[25] WASH. ADMIN. CODE. 51-13-303.
[26] WASH. ADMIN. CODE. 51-13-303.3.1 through 51-13-303.3.2.

Based on the foregoing discussion, particularly on the testimony provided by panelists and staff research, the Task Force recommends specific changes to the building code in regard to mechanical ventilation:

1. For mechanical ventilation systems in bathrooms and similar facilities over a certain size, require a minimum flow rate of 80 cubic feet per minute (cfm), measurable at the termination of the vent.
2. In bathrooms, require humidity sensors or other automatic means to activate ventilation fans when a certain level of moisture is detected.[27]
3. Restrict the noise level of bathroom fans to less than 2.5 sone levels (approximately 40 decibels).
4. Locate bathroom fans adjacent to or as close as possible to the shower or tub area.
5. Prohibit the installation of recirculating kitchen range hoods (i.e., range hoods must vent outdoors), or provide for approved forms of active ventilation.
6. Noise produced by kitchen fans should not exceed 4.0 sone levels (approximately 48 decibels).

Flashing

During the opening Task Force meeting in September 25, 2005, Joe Johnson of Johnson Construction Consulting noted that one solution to the construction claims issue lay in the development of easily applied standards for flashing.[28] Additionally, Larry Peabody, contractor, Superior Exteriors, stated that standards should focus on certain areas, like flashing.[29] During the November 1, 2005 building science and forensic engineers panel, Dr. George Tsongas proposed a number of modifications to the state building code. In written submissions, Dr. Tsongas testified that metal flashing could be improved through the use of 'z' shaped metal flashing over "plant-on" trim, as well as requiring soldered joints.[30] During the December 2, 2005 design community panel presentation, Ray Miller suggested that ensuring the proper installation of flashing around openings would help reduce construction defects.[31]

Staff research located guides produced by the Canadian government that demonstrate the importance of flashing. The Canadian Mortgage and Housing Corporation, a federal crown corporation responsible for mortgage securities and housing assistance, publishes a series of best practice guides on building technology. One of the best practice guides specifically addresses the design, installation and inspection of flashing in residential structures.[32]

In American jurisdictions, flashing requirements have changed from the typical model code standards. For example, Florida makes minor changes related to suitable flashing materials for residential structures, but nothing related to the shape of the material or how the material connects. As part of the state building code, Georgia also adopts no less than four appendices – Appendix 'H', 'I', 'J',

[27] Although other American jurisdictions do not specifically require humidity sensors in ventilation systems, testimony and research lead staff to conclude that automatic moisture sensing will be effective in moving moist air out of a structure.
[28] Minutes, Construction Claims Task Force, September 21, 2005, 6.
[29] Id.
[30] GEORGE TSONGAS, RECOMMENDED BUILDING CODE CHANGES 1 (2005), *available at* http://www.oregon.gov/DCBS/CCTF/submitted/112805_document_tsongas.pdf)
[31] Minutes, Construction Claims Task Force 6 (December 2, 2005).
[32] *See* CANADIAN MORTGAGE AND HOUSING CORPORATION, BEST PRACTICE GUIDE: FLASHING (2005) (on file with author).

and 'K'[33] – that deal with testing and performance of exterior insulation finish systems. Additionally, Georgia gives local jurisdictions the option of adopting Appendix 'M' to Georgia building code; the model drawings in Appendix 'M' call for 'z'-shaped flashings in certain types of EIFS installations. However, the appendix does not specify soldering as a means of joining flashing together.

The Minnesota building code requires corrosion-resistant flashing be installed in various locations of a residential structure[34], but does not mandate any particular shape. Minnesota does differ from the base International Residential Code in two ways. First, Minnesota simply requires flashing at the "top of all exterior windows and door openings in such a manner as to be leakproof," which differs from the International Residential Code's allowance of self-flashing windows and jamb flashing.[35] Second, Minnesota requires flashing in areas where "exterior material meets in other than a vertical line," which is a requirement not found in the 2003 International Residential Code.[36] North Carolina makes changes from the base model code to flashing requirements, but also does not specify a particular shape or call for soldered joints. Instead, North Carolina amends the base model code (currently the 2003 IRC) to prohibit aluminum flashing from being installed on concrete-type materials.[37] North Carolina also requires the installation of flashing "under and at the ends of masonry, wood or metal copings."[38]

However, no state surveyed specifically called for soldered joints to bring together flashing materials.

The Task Force recommends, on the basis of gathered testimony and research, that the Task Force endorse the use of appropriate horizontal metal flashing in ''plant-on' applications, such as 'z'-metal configurations.

[33] See GA. COMP. R. & REGS. r. 110-11-1.04.
[34] MINN. R. § 1309.0703 (2005). Compare INT'L RESIDENTIAL CODE § R703.8 (2003).
[35] Id.
[36] *See* INT'L RESIDENTIAL CODE § R703.8 (2003).
[37] N.C. RES. CODE. § R703.8 (2002). Presumably, the interaction with the chemicals in concrete and the aluminum flashing can lead to undue wear.
[38] Id.

Summary

Recommendation #1: Task Force recommends the following changes to the state building code.

Moisture Content

1. *Prohibit building components within a cavity from exceeding 19% at the time of covering.*

Mechanical Ventilation

2. *For mechanical ventilation systems in bathrooms, laundry rooms and similar facilities, require a minimum flow rate of 80 cubic feet per minute (cfm).*
3. *In bathrooms, require humidity sensors or other acceptable methods of automation to activate ventilation systems.*
4. *Restrict the noise level of active bathroom ventilation to less than 2.5 sone levels (approximately 40 decibels).*
5. *Locate bathroom fans as close as is practicable to the shower or tub area.*
6. *In kitchens, prohibit the use of recirculating range hoods or provide for other approved forms of active ventilation .*
7. *Noise produced by active kitchen ventilation should not exceed 4.0 sone levels (approximately 48 decibels).*

Flashing

8. *Require appropriate, horizontal flashing over all plant-on trims and appropriate assemblies, such as 'z' metal flashing configurations and decks.*