# Green Building Practice Summary 3/10/2011

## *Sector: Residential*

## *Category/Practice: Energy Efficiency / Air Sealing*

## Proposed GB Practice

### Description

Comprehensive air sealing to meet a moderately tight measured performance standard (4.0 ACH50 maximum) and provide an effective air barrier between living space and attached garage.

Performance testing will be performed by certified contractors.

Note: another proposed amendment lowers the whole-building leakage requirement to 3.0 ACH50 for electric-heat building (see "Electric-Heat Envelope Specifications").

### Applicability

New Construction: Applies, performance testing required (blower-door test of whole-building air leakage and zonal isolation between conditioned space and garage).

Existing Buildings/Additions: Prescriptive air sealing requirements apply to the addition but not the existing building (visual inspection, no testing required)

Existing Buildings/Alterations: Prescriptive air sealing requirements apply to portions of the building being modified, when access permits (visual inspection, no testing required)

### Intent

Capture energy, comfort, durability and health benefits by reducing uncontrolled air leakage and isolating a common source of pollutants from the living space.

## Benefits and Costs

### Triple Bottom Line Benefits

People:

- Improve indoor air quality by isolating conditioned space from exterior pollutant sources
- Enhance thermal comfort by reducing drafts and improving insulation performance
- Improve comfort by providing more occupant control over indoor humidity levels
- Improve indoor air quality by reducing moisture condensation that can support mold growth

Economic:

- Save energy by reducing the heating and cooling load associated with infiltration (Modeled savings by decreasing air leakage from ACH50=7.0 to ACH50= 4.0 ~$100/yr for gas heat, $250/yr for electric resistance heat. However, as noted below in "Context," ACH50=7.0 is a hypothetical baseline.)

- Save energy by reducing thermal bypasses through insulation (i.e. reducing air leakage helps insulation perform at its rated R-value)
- Improve building durability by preventing air-transported moisture from entering building cavities

Environment: Environmental benefits associated with lower energy use

#### Costs Passed to Owner

Builders should incur no new construction costs to meet this air sealing target, since 2007 Fort Collins practice averaged considerably tighter than the proposed requirement.

For new construction, blower-door testing costs are estimated to be "low"($200 maximum for third-party testing, if this is the only reason the testing contractor is making a site visit and this is the only performance testing being performed). In many cases, costs will be lower.

#### Lost opportunity

It is much easier and less expensive to meet tightness targets during initial construction.

## Implementation

#### Availability of Products and/or Services

Air sealing materials, the expertise to effectively install them and certified blower-door testing contractors are widely available.

#### Practicality

No practical obstacles have been identified.

#### Certification Issues

RESNET or BPI Building Analyst certification (or other credential approved by the Building Official) required to conduct performance testing. Testing may be performed by the same company that provided air-sealing services; i.e. third-party testing is allowed but not required.

To be completed: do these certifications include training re garage isolation testing?

#### Enforcement Procedures

Permit application/plan review: Building conditioned volume must be included on plans.

Field inspection: Building inspectors will visually verify prescriptive air-sealing requirements have been completed. (Higher level of detail than current procedures)

Certificate of Occupancy: For new construction, applicant must turn in signed performance-testing results documenting compliance. The document will include the testing contractor's certification number and expiration date. (Little change from current procedures, since most new homes in recent years have met air-sealing requirements via a blower-door test result.)

#### Support Materials Needs

- A field guide, illustrating required building envelope details (including acceptable and unacceptable products and techniques for air sealing, by location), would be very useful for contractors and enforcement staff.

- Reference needed for full details of garage isolation test
- Blower-door testing compliance form
- A City-maintained list of certified performance-testing contractors may prove useful

#### Training Needs - Industry

Since this proposed requirement is commonly exceeded in new construction (see "Current Practice," below), there is not a strong need for specific air sealing training. However, comprehensive contractor training on building envelope details will be useful, ideally supported with a field guide illustrating required and recommended techniques (see "Support Materials Needs" above).

Training on garage isolation testing may be needed for contractors conducting the performance testing.

#### Training Needs – Staff

Building inspectors will need training to consistently identify air barrier problems. This can be covered in more general training about inspection of building envelope details. Training will be needed to review compliance documents submitted by contractors.

## Background

#### Current Practice

A 2007 survey of new Fort Collins homes showed that tightness averaged 3.0 ACH50, with a range from 1.9 to 4.2 ACH50 (air changes per hour at the standard test pressure of 50 Pascals). The testing sample included 12 single-family detached homes. Visual inspection showed that the large holes observed in earlier surveys were generally being effectively sealed, though many smaller opportunities to further tighten the building envelope remained. The survey also tested the separation between living spaces and attached garages and generally found it quite effective.

#### Context

New homes have gradually become tighter over several decades, due to customer expectations of greater thermal comfort (fewer drafts and cold spots), increasing use of sheet goods in construction, increasing energy costs, availability of specialized air sealing tools and products, increasing awareness of where buildings leak and how to seal the holes, increasing use of blower-door testing to quantify performance and provide feedback, and increasing building code attention to this topic. However, until recently, model code air-sealing language left wide latitude for interpretation.

Building scientists have been stressing the benefits of a complete "air barrier" since the early 1980s. Fort Collins has provided builder training about building a quality building envelope since the late 1980s. The City was a leader when it developed the 1996 energy code. This code allowed builders to either follow a detailed prescriptive checklist of air-sealing locations or demonstrate compliance with the air sealing requirement with a blower-door test result of 5.0 ACH50 or less. Since then, builders have increasingly used the performance-testing option.

A survey of Fort Collins homes built in the mid- to late-1990s showed moderately tight construction. The average leakage rates for homes built before and after the code change were 5.6 and 4.7 ACH50, respectively. The overall range of tightness was more than a factor of four, from 2.4 to 11.4 ACH50. Large "thermal bypasses" were frequently observed.

The City of Fort Collins Builder's Guide to Energy Efficient Construction, published in 1997, reinforced required and recommended building envelope practices, including tight construction.

A tight construction fact sheet, developed by the City and E-Star Colorado, has been widely distributed since 2003.

In 2006, the U.S. EPA introduced the "Thermal Bypass Checklist," with accompanying field guide, as part of its ENERGY STAR New Homes program guidelines. The checklist addresses important air sealing and insulation details and provides a systematic inspection approach.

Since the Fort Collins code was updated in 2005, builders have largely used the "Simulated Performance Alternative" path to demonstrate compliance with the energy code as a whole. This has led to a close working relationship between builders and third-party energy raters. This, in turn, has provided ongoing educational opportunities in the field, as energy raters spot building envelope problems and coach builders and trade partners on effective details to plug leaks. The "Thermal Bypass Checklist" was informally used in this process. The 2007 new home survey results, reported in "Current Practice," illustrates the progress that has been made since the 1990s survey: an approximately 40% reduction in average air leakage and much more consistency in house tightness.

The 2009 IRC is the first edition of the model codes to reference "air barrier" and include an air-leakage testing option to document code compliance. However, it takes a big step back in performance, setting a requirement of 7.0 ACH50 in all climate zones, i.e. 40% greater than the 1996 Fort Collins code benchmark and more than twice the average measured leakage of new Fort Collins homes built in 2007. Though no explanation is given in the code documents about how this level was chosen or why it does not vary with climate, it is almost certainly related to long-held misperceptions about the relationship of air tightness and indoor air quality (that are referenced in widely published standards). The City's current code includes the 2009 IRC tightness standard.

The City's green amendment proposals support a systems approach to improving indoor air quality; a tight building envelope is a key component (see "Related Green Building Practices" below).

The proposed tightness standard (4.0 ACH50) represents a readily achievable level; through training, the City will encourage even tighter buildings. (See another proposed amendment that would require new buildings with electric resistance heat to achieve a lower leakage rate: 3.0 ACH50 maximum.)

National voluntary energy efficiency and green building rating systems encourage tighter construction as part of a systems approach. The proposed tightness standard matches the ENERGY STAR New Homes Version 3 guideline for this climate zone (to be fully effective in January 2012). LEED/Homes sets a maximum leakage rate of 5.0 ACH50 and awards points for leakage reduction to 3.5 and 2.5 ACH50; NGBS awards points for air leakage rates from 5.0 to 1.0 ACH50.

The draft 2012 International Energy Conservation Code includes a tightness requirement of 3.0 ACH50 in this climate zone, with a mandatory blower-door test.

The requirement for an effective air barrier between living space and garage recognizes that the garage is a frequent source of pollutants: automobile exhaust, gasoline, other chemicals stored in the garage. The 2009 IRC provides an explicit requirement that "walls and ceilings separating a garage from conditioned spaces" be sealed. The proposed code measure reinforces that with required performance testing to verify the intent of this requirement is being met.

#### Related Green Building Practices

A tight envelope is a key part of a systems approach to buildings that are comfortable, durable, energy efficient and have healthy indoor air. These practices go hand-in-hand:

- Tight construction
- Insulation thermal specifications and installation practices
- Safer combustion appliances
- Controlled ventilation

## Known Objections

- Some feel that tighter buildings have poorer indoor air quality.