A Review of Home Airtightness and Ventilation Approaches for Florida Building Commission Research

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Definition of the Problem: In the 1990's it was identified that homes were becoming increasingly airtight and that this airtightness might lead to indoor air, humidity control, and combustion safety problems. In 1995, a report was prepared for the Florida Department of Community Affairs on the topic of building airtightness, titled "Reassessment of Airtightness Practices in the Florida Energy Code".

- The report indicated that Florida homes had become progressively more airtight, with home air leakage declining from about 22 ACH50 (air changes per hour at 50 pascals of pressure; a blower door test result) in the 1950's to about 4 or 5 ACH50 now. It reported that residential construction had reached a point where added tightening would result in natural ventilation sufficiently small as to fall substantially short of levels needed for good indoor air quality.
- The report also stated that further tightening might well necessitate installation (and of course maintenance) of mechanical ventilation systems to achieve acceptable indoor air quality. It contained recommendations that the Florida Building Code should be modified to make homes more airtight between indoors and the attic, garage, and crawlspace, but less airtight at locations in the house envelope where the entering air would be of higher quality.

Since that 1995 report, residential construction codes have been modified as reflected in Section R402.4.1.2 of the 2012 IECC Residential Energy Efficiency which requires that a "building or dwelling unit shall be tested and verified as having an air leakage rate of not exceeding 5 air changes per hour in Climate Zones 1 and 2…", which would cover all of Florida. Additionally, building practices have continued to change over time and a number of groups and programs have also begun pushing to simultaneously make homes much tighter and to require mechanical ventilation. The saying "Build it tight, ventilate right" represents a strongly held view among many within the buildings community. While this concept is appealing, there are significant problems with making the house envelope very tight. Underlying this issue is the concern that when the house envelope is made very tight and mechanical systems are therefore essential to achieving desired ventilation levels, the question arises, "Who will maintain the ventilation system and what happens to indoor air quality when the system fails or is turned off?"

One problem is that a tight house envelope creates the necessity of mechanical ventilation. The corollary to this is that when the mechanical system fails, is turned off, or diminishes in performance (such as a dirty filter or a slipping belt), the occupants of the tight home will likely suffer from poor indoor air quality. Field observations have repeatedly found that mechanical ventilation systems fail at alarmingly high rates due to motor burnout, dirty filters, slipping belts, and systems being turned off. In addition to a shortfall in fresh air, failure of the mechanical system can lead to moisture problems such as elevated indoor relative humidity and mold growth during cold weather (e.g., northern Florida in the winter).

A second problem relates to combustion safety. When a house is very tight, various forms of unbalanced air flow (such as exhaust fans without make-up air, unbalanced return air, or duct leakage) can lead to depressurization of the interior space which can lead to spillage or back-drafting of vented combustion devices (hot water heaters, furnaces, boilers, and fireplaces). This can introduce combustion gases, including carbon monoxide, into the home and create health and death risk. Negative pressure can also produce flame roll-out and the potential for a house fire.

A third problem relates to humidity in homes, which is a special concern because of the Florida climate. The most widely encouraged and employed method for providing mechanical ventilation in homes across the United States is continuous exhaust.

- Throughout much of the United States, exhaust ventilation does not create major problems. But this approach is generally unacceptable in Florida because it creates negative pressure and elevated humidity in homes. Combined with other factors beyond the control of the building code, such as homeowner thermostat set point and interior vinyl wall coverings, negative pressure has been found to cause mold growth in Florida homes and buildings.
- Alternative methods of providing mechanical ventilation, which can produce positive pressure in homes and are generally more complicated and often much more expensive. It is likely the added cost of more complex, refrigeration-based ventilation conditioning systems will be resisted by the housing industry.

Scope of Work: Our research team proposes to perform a review of literature, examination of experimental data, and prepare calculations of the energy impacts of using or not using various types of ventilation systems. The review would include house airtightness trends since 1995 and current recommendations and policies regarding house envelope airtightness. Based on

this research, alternative approaches to achieving acceptable levels of ventilation while avoiding risks associated with super-tight home enclosures and potential mechanical system failures will be developed and proposed.

Goals, Expected Outcome, and Impact on The Code: The goal of this research is to provide understanding of the consequences of recent trends in airtightness and ventilation, and by means of modifications to the Code avoid the types of problems listed above. The outcome of this research will be a report describing current trends in Florida house airtightness, problems associated with very tight construction and various ventilation approaches, and options for implementation of ventilation while avoiding risks associated with large pressure differentials, combustion safety, and elevated indoor humidity. Recommendations for airtightness targets and ventilation approaches (and suggested code language) will be provided. From the recommendations of this report, it is expected that Florida codes will be modified or adjusted to take into account the best approaches to energy efficient ventilation, envelope airtightening, indoor air quality and occupant safety, and the specific requirements of the Florida climate.

Budget: $27,800