Investigation of the Effectiveness and Failure Rates of Whole-house Mechanical Ventilation Systems in Florida

Jeffrey K. Sonne
Florida Solar Energy Center
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Research Purpose and Goal: This proposed study will investigate the effectiveness and failure rates of whole-house mechanical ventilation systems installed in Florida homes over the last 15 years and seek to determine the reason(s) for any issues identified.

Definition of the Problem: The new 2014 Florida Energy Code will require a tested ACH50 <= 5 for new Florida homes. At the same time, the 2014 Florida Mechanical Code will require that mechanical ventilation be provided for any home that has an ACH50 < 5. The combination of these two requirements means that most new Florida homes will need mechanical ventilation. If houses are tighter requiring ventilation, what happens when a system fails? Do occupants repair it? Are failures a common enough problem that this is a concern? Answering these questions will help the Commission determine if there should be a limit to how tight a home can be built or if other steps should be taken to warn occupants of mechanical ventilation failures.

While the 2014 Code's airtightness requirement is only slightly tighter than typical new construction in the state (Withers et. al. 2012 and Cummings 2003), it will still tend to make Florida homes more airtight. As described in FSEC's recently completed Airtightness and Ventilation Approaches report (Sonne and Vieira 2014), there are serious concerns related to mechanical ventilation failure in very tight houses:

- Decrease in indoor air quality
- Moisture problems such as elevated indoor humidity levels and mold growth during cold weather
- Combustion safety problems from unbalanced air flow: in very tight homes, unbalanced air flow (due to e.g. exhaust fans without make-up air, unbalanced return air, or duct leakage) can cause depressurization of the interior space which in turn can cause spillage or back-drafting of atmospherically vented combustion devices (hot water heaters, furnaces, boilers, and fireplaces). This can introduce combustion gases, including carbon monoxide, into the home. Flame roll-out and the potential for a house fire are also possible in more extreme cases.

A 1999 Canadian field study (CMHC 1999) provides an example of the combustion safety problems that depressurization due specifically to mechanical ventilation failure can create:

> *In one house, the supply fan was not functioning. The homeowners were not aware of the problem because they still heard the sound of the exhaust fan. The result was backdrafting of the fireplace and the potential for backdrafting of other combustion appliances.*

While sealed combustion equipment is gaining popularity in northern states, mild Florida winters make high efficiency sealed combustion furnaces less cost effective here, so the state is likely to continue to see significant use of atmospherically vented combustion equipment. Atmospherically vented gas water heaters are also popular in Florida and operate year round. As a result, the depressurization issues described above will continue to be concerns.

As also discussed in the recent FSEC airtightness and ventilation report noted above, limited available research raises concerns about mechanical ventilation system failure rates. A 2002 Washington State research study (Lubliner et al. 2002) included a survey which showed occupants in homes with mechanical ventilation to believe ventilation is important for health, but testing in the same homes found significant problems with the ventilation systems:

> *Only 29% (5/17) of the systems integrated with central heating systems complied with either the prescriptive or performance requirements of the code. … The field research data reveal that the technical details of the whole house ventilation requirements are widely misunderstood. Only 32% of all systems surveyed met VIAQ performance requirements. Exhaust systems not integrated with central heating were more compliant than other systems, complying with the code 71% (10/14) of the time (all prescriptively). Only 60% of those also met the performance airflow targets of the code.*

The 1999 Canadian field study noted above found 12% of the 60 heat recovery ventilators (HRVs) inspected for the project not to be operational due to component failure and also identified balancing, installation faults and a lack of homeowner understanding as issues.

A forthcoming report on research recently completed by a major University in another state (unreleased study, publication pending) indicates that significant mechanical ventilation issues continue. Out of 29 mechanical ventilation systems inspected during this study, fourteen were found to have control issues, eight had dirty intakes, six had been installed incorrectly, and all 29 were missing code-required labeling.

Also, based on FSEC staff conversations with Florida raters, mechanical designers and builders, it is speculated that a significant number of whole-house mechanical ventilation systems are

immediately deactivated upon occupancy, or else are set to operate at minimum levels that do not achieve the design ventilation rate.

Considering the significant increase in whole-house mechanical ventilation the new Florida Code requirements will bring about, the potential for problems from mechanical ventilation failure as homes get tighter, and findings of the effectiveness and failure research available to date from other states, it is important that an assessment of the effectiveness and failure rates of Florida ventilation systems be made.

Magnitude of Opportunity: The magnitude for health and safety is difficult to discern due to a lack of studies of health and home air change rate. However, as codes force mechanical ventilation for indoor air quality it seems combustion safety and indoor air quality issues from system failures would be even more important.

Approach to the research: A field research study is proposed to investigate the effectiveness and failure rates of whole-house mechanical ventilation systems installed in Florida over the last 15 years. The study will be conducted in 30 homes around the state that had mechanical ventilation systems installed and include:

- A homeowner survey for each home to assess awareness of the ventilation system and its purpose and maintenance practices
- Inspection and testing of each home's ventilation system to assess its operational status, level of ventilation it is currently providing and likely reason(s) for any issue discovered.

Expected Outcome and Impact on The Code: The outcome of this research will be a report summarizing project activities and ventilation system effectiveness and failure findings. Recommendations based on the research results will also be made which should be very useful in informing future Florida Code airtightness and ventilation requirements and provide direction for whole-house ventilation education in the state.

Estimated Budget: $59,500

References

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