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UNIVERSITY OF CENTRAL FLORIDA

EXECUTIVE SUMMARY

Review and Consider Possible Technical Changes to section 553.9065, Florida Statutes

Submitted to
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Office of Codes and Standards
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EXECUTIVE SUMMARY

Pursuant to section 553.9065, Florida Statutes, the Florida Building Commission (FBC) has been tasked with the review and consideration of the legislative requirements for unvented attics as outlined in section 553.9065, Florida Statutes. The purpose of the review is to provide proposed technical changes and to report such changes to the Legislature by December 31, 2024. Specific language of relevance is provided here:

Section 553.9065 Thermal efficiency standards for unvented attic and unvented enclosed rafter assemblies.

(1) Unvented attic and unvented enclosed rafter assemblies that are insulated and air sealed with a minimum of R-20 air impermeable insulation meet the requirements of sections R402 of the Florida Building Code, 8th Edition (2023), Energy Conservation, if all of the following apply:
   (a) The building has a blower door test result of less than 3 ACH50.
   (b) The building has a positive input ventilation system or a balanced or hybrid whole-house mechanical ventilation system.
   (c) If the insulation is installed below the roof deck and the exposed portion of roof rafters is not already covered by the R-20 air-impermeable insulation, the exposed portion of the roof rafters is insulated by a minimum of R-3 air-impermeable insulation unless directly covered by a finished ceiling. Roof rafters are not required to be covered by a minimum of R-3 air impermeable insulation if continuous insulation is installed above the roof deck.
   (d) All indoor heating, cooling, and ventilation equipment and ductwork is inside the building thermal envelope.

This report provides a literature review of moisture and energy research related to unvented attics. This report supplements that literature review with data on house tightness and duct tightness relative to vented and unvented Florida attics. This report also provides results of 348 hourly building simulations to examine the annual energy impacts of the Section 553.9065, Florida Statutes specifications with respect to the current prescriptive R402 code compliance requirements and other possible alternatives.

There are currently a number of builders using unvented attics in Florida. Most homes comply by the section R405 performance methodology. Under the R405 methodology, homes with R20 roof insulations can comply through energy-use trade-off allowances. There have been a limited number of research projects examining unvented attics in Florida as well as some in other parts of the country. The literature search finds mixed results regarding moisture and energy use in unvented attics. One of the key parameters that is not regularly measured is the air leakage between the unvented attic and the outside. This can significantly impact moisture and energy use. Most moisture research has not found issues with roof sheathing wood moisture content exceeding 20% in Florida homes with unvented attics having air-impermeable insulation at the roof sheathing. When this 20% moisture content threshold is approached the studies have found that it tends to occur for only short periods of time. Any regulatory changes to the application

with respect to moisture would apply to unvented attic homes complying by both the prescriptive and the performance methods.

Published data on measured attic tightness and duct leakage shows there is a wide variability in both. Tests on duct leakage in unvented attics indicates on average there is some duct leakage to outdoors. On occasion, some unvented attics are found to be leakier than desired, which may result in more duct leakage lost to outdoors and increased infiltration. This may make attic moisture control more difficult. Excessive unvented attic moisture levels are sometimes remediated by supplemental dehumidification of the attic space, and if the attic is not well sealed this may result in much higher than expected energy costs for homeowners. An attic tightness-to-outdoors test protocol capable of indicating a reasonable assuredness of attic tightness to outdoors is needed. If possible, such a test should not require guarded testing, if possible, to enable a relatively quick and inexpensive means of evaluation. The legislation requires a tested house airtightness blower door test of less than 3 ACH50. That test should be conducted according to section R402.4.1.2 of the Florida Building Code, 8th Edition (2023), Energy Conservation where it states:

> *If an attic is both air sealed and insulated at the roof deck, interior access doors and hatches between the conditioned space volume and the attic shall be opened during the test and the volume of the attic shall be added to the conditioned space volume for purposes of reporting an infiltration volume and calculating the air leakage of the home.*

This requirement, combined with the less than 3 ACH50 requirement, should reduce the risk of excessive unvented attic leakage.

There is a dearth of detailed data on leakage from unvented attics to the outside and attic duct leakage to outside in the literature on energy simulations. As a result, it is still difficult or impossible to compare results between different simulation studies. This is due to issues such as using different assumptions about attic, house, and duct tightness, attic and house geometries, and different levels of roof and ceiling insulation R values being compared. Generally, energy simulations comparing benefit of unvented attic with insulation at the underside of roof sheathing to a conventional vented attic with insulation at the ceiling found that more benefit is likely: with cold dominated climates, with a greater proportion of attic ducts, with higher rates of assumed attic duct leakage, and with a very little unvented attic leakage to outside.

The simulations run by FSEC for this analysis indicate some increase in energy use for the minimal Section 553.906, Florida Statutes/R402 compliance path in many but not all simulated homes. Simulations were run in Miami (Climate Zone 1) and Tallahassee (Climate Zone 2) using three prototype homes: a detached 2000 ft^2 one-story home, a detached 2400 ft^2 detached two-story home, and a multifamily attached unit with 1200 $ft^2$of conditioned space. Our simulations indicate that reducing the prescriptive requirement from R30 on the ceiling in Climate Zone 1 (or R38 on the ceiling in Climate Zone 2) to a roof insulation level of R20 by itself, leaving all other parameters the same, will increase energy use even without any attic dehumidification. Also, higher roof pitches will diminish any energy benefit of an unvented attic as the thermal surface boundary area of the attic increases. However, since the statute change requires a very tight home with whole-house mechanical ventilation, the type of ventilation system and the energy

impact it has must also be considered. Balanced mechanical ventilation with enthalpy recovery used less energy than the three other types simulated. The statute requirements for a tight house led to the legislative prescriptive alternative saving some energy in our two-story simulation results with best case whole-house mechanical ventilation, while using more energy in our single floor simulation results.

With respect to the current R402 prescriptive code base case, the worst case for the 2000 ft^2 single story home using the statute method of R20 roof insulation without any ceiling insulation, with a balanced ventilation system without enthalpy recovery, led to an increase of 18% in heating, cooling and ventilation energy in Climate Zone 2 and 9% increase in Climate Zone 1. The best-case scenario with R20 roof insulation and no ceiling insulation is the two-story home modeled with an enthalpy-recovery ventilation system. Relative to the current R402 levels of insulation and air tightness, this home saved 1% of HVAC energy in Climate Zone 2 and 4% in Climate Zone 1.

Two alternatives to the statute proposal were originally simulated. One alternative configuration had R20 insulation on the roof plane and R19 at the ceiling. This alternative should meet the current R402 code. The simulation results of this system were better than just having insulation at the ceiling or just at the roof for low slope (4 in 12) roofs prior to adding ventilation. The second alternative had R20 insulation on the roof plane and R11 at the ceiling. On average, of the 24 comparative cases we simulated for Climate Zone 2 this showed minimal difference (0.5% higher HVAC energy use) from the current R402 base case. In Climate Zone 1, the R20 roof with R11 ceiling insulation showed improvement on average for the 24 comparative cases simulated (1.6% reduction in HVAC energy use) versus the current Climate Zone 1 R402 base case. With 2x4 trusses, this level of ceiling insulation would allow plywood flooring in the attic for those residents desiring a safer storage area.

However, adding ceiling insulation may not be desirable for some builders as it creates a thermal barrier between the two spaces and insulating it all at one time may be problematic. Further simulations were run and an alternative was found if the duct leakage requirement contained in the Florida Building Code, 8^{th} Edition, Energy Conservation, Section R403.3.4 was reduced from 4 total cubic feet per minute total per 100 square feet of conditioned floor area, when tested at 0.1 inch w.g. (25 Pa), to 2 cubic feet per minute to outside leakage per 100 square feet of conditioned floor area, when tested at 0.1 inch w.g. (25 Pa). Energy equivalency from the simulations were achieved with the R20 roof insulation in Climate Zone 1 but needed to be a minimum of R23 in Climate Zone 2.

Because Section 553.906, Florida Statutes includes a targeted reduction in air leakage and employs whole-house mechanical ventilation, the homes complying by this method may have better air quality potential as long as the ventilation system runs and is maintained. Thus, it may be reasonable to accept slightly higher energy use for this alternative, as the home should have improved indoor air quality if the ventilation system is maintained. Unfortunately, previous research for the Florida Building Commission has shown that rarely are whole house mechanical ventilation systems maintained and operated in their designed condition.[1]

[1] https://publications.energyresearch.ucf.edu/wp-content/uploads/2018/06/FSEC-CR-2002-15.pdf

In summary, based on the current literature, there are no technical changes to the legislation required for unvented attics for moisture control. To achieve approximately the same equivalent energy use it is recommended that a requirement for either R11 ceiling insulation or reduced duct leakage be included and that balanced ventilation systems would be required to have enthalpy recovery. Such changes are indicated with strikethrough/underline text below:

Unvented attic and unvented enclosed rafter assemblies that are insulated and air sealed with a minimum of R-20 air impermeable insulation meet the requirements of sections R402 of the Florida Building Code, 8th Edition (2023), Energy Conservation, if all of the following apply:

(a) The building has a blower door test result of less than 3 ACH50.

(b) The building has a positive input ventilation system, ~~or a balanced or~~ hybrid whole-house mechanical ventilation system, or an enthalpy recovery ventilation system.

(c) If the insulation is installed below the roof deck and the exposed portion of roof rafters is not already covered by the ~~R-20~~ full air-impermeable insulation, the exposed portion of the roof rafters is insulated by a minimum of R-3 air-impermeable insulation unless directly covered by a finished ceiling. Roof rafters are not required to be covered by a minimum of R-3 air impermeable insulation if continuous insulation is installed above the roof deck.

(d) All indoor heating, cooling, and ventilation equipment and ductwork is inside the building thermal envelope, which includes the unvented, insulated attic.

(e) A minimum of R-11 insulation is located at the ceiling of the conditioned space below the attic.

Exception: No insulation is required at the ceiling if:
1. The tested leakage to outdoors of the ductwork of each heating or cooling system is at or below 2 cubic feet per minute per 100 square feet of conditioned floor area when measured according to post construction test of R403.3.3 of the Florida Building Code, Energy Conservation and
2. In Climate Zone 2, the unvented attic and unvented enclosed rafter assemblies are insulated and air sealed with a minimum of R-23 air impermeable insulation.