ASSESSMENT OF THE PROPOSED AMENDMENTS TO THE 2012 IECC PROVIDED BY THE NORTH CENTRAL TEXAS COUNCIL OF GOVERNMENTS (NCTCOG)

A Report

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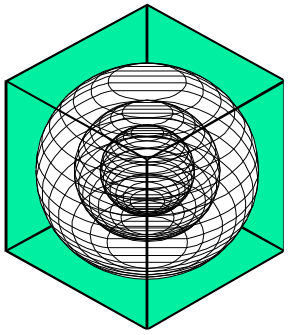

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EXECUTIVE SUMMARY

This report is in response to the letter dated October 4, 2012, from the Energy and Green Advisory Board (EGAB) of the NCTCOG to the Energy Systems Laboratory. In this letter, the EGAB requested the Laboratory to perform a stringency analysis of the amendments proposed by the EGAB to the 2012 IECC when compared to a corresponding 2012 IECC code compliant base-case house. An analysis comparing the proposed amendments to the current TBEPS (2009 IECC / 2009 IRC) was also requested. A total of ten amendments were proposed to various sections of the 2012 IECC. Three of the proposed amendments required performance path analysis. The ESL provided a response to EGAB request on October 31, 2012 with a summary of ESL's stringency analysis of all ten proposed amendments. This summary is provided below.

Synopsis of the Laboratory's Analysis of the Proposed Amendments:

No.	Proposed Amendment	Laboratory's Stringency Analysis
1.	**C101.4.2/R101.4.2 Historic Buildings.** Any building or structure that is listed in the State or National Register of Historic Places; designated as a historic property under local or state designation law or survey; certified as a contributing resource with a National Register listed or locally designated historic district; or with an opinion or certification that the property is eligible to be listed on the National or State Registers of Historic Places either individually or as a contributing building to a historic district by the State Historic Preservation Officer of the Keeper of the National Register of Historic Places, ~~are exempt from~~ shall comply with all of the provisions of this code. Exception: Whenever a provision or provisions shall invalidate or jeopardize the historical designation or listing, that provision or provisions may be exempted.	COMPLIANCE W/ CURRENT TBEPS*: The suggested amendment is as stringent as the TBEPS*. COMPLIANCE W/ 2012 IECC: The suggested amendment is as stringent as the published 2012 code. Note: • Outside the scope of a performance path analysis.
2.	**C102.1.2/R102.1.2 Alternative compliance**. A building certified by a national, state, or local accredited energy efficiency program and determined by the Energy Systems Laboratory to be in compliance with the energy efficiency requirements of this section may, at the option of the Code Official, be considered in compliance. The United States Environmental Protection Agency's Energy Star Program certification of energy code equivalency shall be considered in compliance.	COMPLIANCE W/ CURRENT TBEPS*: The suggested amendment is as stringent as the current TBEPS*. COMPLIANCE W/ 2012 IECC: As of 10/30/2012, U.S EPA has not published any information comparing the ENERGY STAR with the 2012 IECC. Notes: • Outside the scope of a performance path analysis. • For savings provided by ENERGY STAR over a 2009 IECC base-case refer to the document titled '*ENERGY STAR Qualified Homes, Version 3 Savings & Cost Estimate Summary*', http://www.energystar.gov/ia/partners/bldrs_lenders_raters/downloads/EstimatedCostandSavings.pdf (Accessed: 10/30/2012).

No.	Proposed Amendment	Laboratory's Stringency Analysis
3.	**C202 and R202 GLAZING AREA.** Total area of the glazed fenestration measured using the rough opening and including sash, curbing or other framing elements that enclose conditioned space. Glazing area includes the area of glazed fenestration assemblies in walls bounding conditioned basements. For doors where the daylight opening area is less that 50 percent of the door area, the glazing area is the daylight opening area. For all other doors, the glazing area is the rough opening area for the door including the door and the frame.	COMPLIANCE W/ CURRENT TBEPS*: The suggested amendment is as stringent as the TBEPS*. COMPLIANCE W/ 2012 IECC: The suggested amendment is as stringent as the published 2012 code. Note: • Outside the scope of a performance path analysis.
4.	**R402.2.2 Ceilings without attic spaces.** Where Section R402.1.1 would require insulation levels above R-30 and the design of the roof/ceiling assembly does not allow sufficient space for the required insulation, the minimum required insulation for such roof/ceiling assemblies shall be R-30. This reduction of insulation from the requirements of Section R402.1.1 shall be limited to 500 square feet (46 m^2) ~~or 20 percent of the total insulated ceiling area, whichever is less~~. This reduction shall not apply to the U -factor alternative approach in Section R402.1.3 and the total UA alternative in Section R402.1.4.	COMPLIANCE W/ CURRENT TBEPS*: The suggested amendment is as stringent as the TBEPS*. Even when amending Section R402.2.2 of the 2012 IECC, the overall energy efficiency of the entire 2012 IECC/IRC is 12% to 24% above the TBEPS* compliant base-case house**, depending on the fuel selected for space and DHW heating. COMPLIANCE W/ 2012 IECC: Amending Section R402.2.2 reduces the stringency of the 2012 IECC by less than 0.5%.
5.	***Table R402.1.1 INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT;*** *Amend by changing the WOOD FRAME WALL R-VALUE for CLIMATE ZONE 3 to read as follows:* ~~20 or 13+5~~ R-13	COMPLIANCE W/ CURRENT TBEPS*: The suggested amendment is as stringent as the TBEPS*. Even with decreased insulation values, the overall energy efficiency of the entire 2012 IECC/IRC is 10.3% to 13.3% above the TBEPS* compliant base-case house**, depending on the fuel selected for space and DHW heating. COMPLIANCE W/ 2012 IECC: Implementing the decreased wall insulation values reduces the stringency of the 2012 IECC by 2.5% to 3.7%, depending on the fuel selected for space and DHW heating.
6.	***Table R402.1.1 INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT;*** *Amend by changing the GLAZED FENESTRATION SHGC for Climate Zone 3 to read as follows:* ~~0.25~~ 0.30	COMPLIANCE W/ CURRENT TBEPS*: The suggested amendment is as stringent as the TBEPS*. Even higher SHGC values for windows, the overall energy efficiency of the entire 2012 IECC/IRC is 10.8% to 15.1% above the TBEPS* compliant base-case house**, depending on the fuel selected for space and DHW heating. COMPLIANCE W/ 2012 IECC: Implementing higher SHGC values for windows reduces the stringency of the 2012 IECC by 1.5% to 1.9%, depending on the fuel selected for space and DHW heating.
7.	***Table R402.1.3 EQUIVALENT U-FACTORS;*** *Amend by changing the WOOD FRAME WALL U-FACTOR for CLIMATE ZONE 3 to read as follows:* ~~0.057~~ 0.082	COMPLIANCE W/ CURRENT TBEPS*: The suggested amendment is as stringent as the TBEPS*. Even with decreased insulation values, the overall energy efficiency of the entire 2012 IECC/IRC is 10.3% to 13.3% above the TBEPS* compliant base-case house**, depending on the fuel selected for space and DHW heating. COMPLIANCE W/ 2012 IECC: Implementing decreased wall insulation values reduces the stringency of the 2012 IECC by 2.5% to 3.7%, depending on the fuel selected for space and DHW heating.

No.	Proposed Amendment	Laboratory's Stringency Analysis
5,6,7	***Combination of proposals 5, 6 and 7 above.***	COMPLIANCE W/ CURRENT TBEPS*: The combination of the suggested amendments is also as stringent as the TBEPS*. Even with the decreased wall insulation and the higher SHGC values, the overall energy efficiency of the entire 2012 IECC/IRC is 8.6% to 12.0% above the TBEPS* compliant base-case house**, depending on the fuel selected for space and DHW heating. COMPLIANCE W/ 2012 IECC: When reverting to both the decreased wall insulation and the higher SHGC values of the 2009 IECC, the overall energy efficiency of the entire 2012 IECC/IRC is 4.3% to 5.2% less stringent than the 2012 IECC compliant base-case house.
8.	***Section R403.2.2;*** *Amend to read as follows:* R403.2.3 Building cavities (Mandatory). Building framing cavities shall not be used as supply ducts ~~and plenums~~. Building framing wall cavities in the exterior thermal envelope shall not be used as return ducts	COMPLIANCE W/ CURRENT TBEPS*: Both the 2009 IRC (Section N1103.2.3) and the 2009 IECC (Section 403.2.3) allow the use of cavities as return ducts. Therefore, this suggested amendment is as stringent as the TBEPS*. COMPLIANCE W/ 2012 IECC: The suggested amendment is as stringent as the published 2012 code, provided that the specifications of the interior building cavity are equivalent to those of a code-compliant return air duct as specified in Sections R403.2.1 and R403.2.2 of the 2012 IECC. Note: • Outside the scope of a performance path analysis.
9.	**Section C402.2.9/R402.2 Insulation installed in walls.** To insure that insulation remains in place, insulation batts installed in walls shall be totally secured by an enclosure on all sides consisting of framing lumber, gypsum, sheathing, wood structural panel sheathing, netting or other equivalent material approved by the building official.	COMPLIANCE W/ CURRENT TBEPS*: The suggested amendment is as stringent as the TBEPS*. COMPLIANCE W/ 2012 IECC: The suggested amendment is as stringent as the published 2012 code. Note: • Outside the scope of a performance path analysis.
10.	**R405.6.2;** *Add the following sentence to the end of paragraph:* Acceptable performance software simulation tools may include, but are not limited to, REM Rate™, EnergyGauge and IC3. Other performance software programs accredited by RESNET and having the ability to provide a report as outlined in R405.4.2 may also be deemed acceptable performance simulation programs and may be considered by the building official.	COMPLIANCE W/ CURRENT TBEPS*: Software simulation tools for single family residential must comply with Section 405 of the 2009 IECC to be in compliance with the current TBEPS. COMPLIANCE W/ 2012 IECC: Software simulation tools for single family residential must comply with Section R405 of the 2012 IECC to be in compliance with the 2012 IECC. Notes: • A list of compliance energy code tools is provided on the SECO website http://www.seco.cpa.state.tx.us/tbec/compliancetools.php (Accessed 10/30/2012). • As of 10/30/2012, the current version of EnergyGauge v3.0.01 does not have the capabilities of providing compliance with the 2009 and 2012 IECC. • According to Section 405.6.2 of the 2009 IECC and Section R405.6.2 of the 2012 IECC, code officials are permitted to approve tools for specific applications or limited scope

* TBEPS – Texas Building Energy Performance Standards – Currently based on the 2009 IECC / IRC.
** The analysis used a 2,325 ft2 single-family house, single-story, four bedrooms, slab-on-grade, ducts in the unconditioned, ventilated attic, window-to floor ratio: 15%, windows equally distributed (N,E,S,W) with no exterior shading. All other roof, wall and window parameters were modeled as per specifications in Chapter 4 of the 2009 IECC for the counties shown. Two base-case buildings were considered: Natural gas space heating and DHW, and heat-pump space heating and electric DHW.

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INTRODUCTION AND PURPOSE

This report is in response to the letter dated October 3, 2012, from the Energy and Green Advisory Board (EGAB) of the North Central Texas Council of Governments (NCTCOG) to the Energy Systems Laboratory. In this letter, the EGAB requested the Laboratory to analyze the decrease in stringency for the amendments proposed by the EGAB to the 2012 IECC when compared to a corresponding 2012 IECC code compliant base-case house. A total of ten amendments were proposed to various sections of the 2012 IECC. A list of the ten proposed amendments to the 2012 IECC is provided below:

1. Section C101.4.2/R101.4.2, Historic buildings, providing exceptions for historical buildings to comply with the IECC 2012.
2. Section 102.1.2/R102.1.2, Alternative compliance, adding language to facilitate the various alternative compliance methods that can be adopted to comply with the 2012 IECC.
3. Section C202/R202, Glazing area, updating the definition of glazed fenestration area.
4. Section R402.2.2, Ceiling without attic spaces, removing the 20 percent limit of the total insulated ceiling area that can be exempted to use R-30 insulation.
5. Table R402.1.1, Insulation and fenestration requirements by component – Amend by changing the wood frame wall R-value for Climate Zone 3 from R-20 / R-13+5 to R-13,
6. Table R402.1.1, Insulation and fenestration requirements by component – Amend by changing the glazed fenestration SHGC for Climate Zone 3 from 0.25 to 0.3,
7. Table R402.1.3, Equivalent U-factors – Amend by changing the wood frame wall U-factor for Climate Zone 3 from U-0.057 to U-0.082,
8. Section R403.2.2, Building cavities, prohibiting the use of building cavities as supply air ducts,
9. Section C402.2.9/R402.2, Insulation installed in walls, describing methods to secure wall insulation.
10. Section R405.6.2 Specific approval, providing a list of software that can be used for code-compliance.

From the list of proposed amendments presented above, only the fourth, fifth and sixth items were selected for the simulation analysis.

This report presents the results of the simulation analysis, which used the simulation model developed by the Energy Systems Laboratory (ESL) for the International Code Compliance Calculator (IC3)[1]. The analysis was conducted for Dallas, TX, which according to the climate classification proposed by 2009 and 2012 IECC[2] , is situated in Climate Zone 3. A performance path approach as specified in the 2009 IECC[3] and IECC 2012[4] was adopted to conduct this analysis.

ORGANIZATION OF THE REPORT

This report is organized in the following order:

- Section 1 presents the introduction and purpose of the report;
- Section 2 briefs the reader about the organization of the report;

[1] BDL version 4.01.08.
[2] Table R301.1, Climate Zones of the 2012 IECC. Table 301.1, Climate Zones of the 2009 IECC.
[3] Section 405 2009 IECC.
[4] Section R405, 2012 IECC.

- Section 3 describes the method used for this analysis, which includes a description of the base case building based on the 2009 IECC and 2012 IECC standard reference house; and
- Section 4 presents the results and conclusions of the analysis.

METHODOLOGY AND ASSUMPTIONS

Overview

A building simulation model developed by the ESL for the IC3 was used for this analysis[5]. The analysis was conducted for Dallas, TX, which according to the climate classification proposed by 2009 and 2012 IECC[6] , is situated in Climate Zone 3. Accordingly, a TMY2 weather file for Tarrant County was selected to conduct the simulation.

The stringency assessment for the 2012 and 2009 IECC was conducted using source energy consumption. Source energy consumption was calculated using site to source conversion factors as specified in both the 2009 and 2012 IECC.[7,8] According to the specifications in both codes, the source energy was calculated using heating, cooling and service hot water heating energy only[9].

Description of the 2009 IECC and 2012 IECC Compliant Base-case Buildings

A single-story, single-family detached house with four bedrooms and an area of 2,325 ft^2 was selected for the analysis (NAHB 2003). The house was assumed to have 15% window to wall area ratio (WWAR) equally distributed on all four orientations, a floor to ceiling height of 8 ft., a slab-on-grade floor and an unconditioned vented attic. Mechanical systems were assumed to be in the attic.

Two sets of simulations were conducted. The first set of simulations was conducted using a 2009 IECC compliant base-case house, which is mandated by the current TBEPS. The second set of simulations was conducted using a 2012 IECC compliant base-case house. Specifications for both the 2009 and the 2012 IECC compliant base-case houses are provided in Table -1 and Table -2 and are described below in terms of the envelope, space conditions and mechanical systems. Most of the specifications were adopted from the performance path alternative specified in Section 405 of the 2009 IECC and Section R405 of the 2012 IECC.

The envelope of the code compliant houses was further described in terms of the following building components: above grade walls, ceilings, roofs, attics, doors and glazing. For both the 2009 IECC and 2012 IECC compliant houses the above-grade walls were of the wood frame type, with a U-factor of 0.082 for the 2009 IECC and a U-factor of 0.057 for the 2012 IECC, a solar absorptance of 0.75 and an emittance of 0.90. The ceiling of the code-compliant houses was also constructed of wood frame with the insulation located on the ceiling. The ceiling insulation had a U-factor of 0.035 for the 2009 IECC

[5] BDL version 4.01.08.
[6] Table R301.1, Climate Zones of the 2012 IECC. Table 301.1, Climate Zones of the 2009 IECC.
[7] Section R405.1 of the 2012 IECC. Section 405.1 of the 2009 IECC.
[8] For electricity, the site to source conversion factor of 3.16 was used. For natural gas the site to source conversion factor of 1.1 for used.
[9] Section R405.3 of the 2012 IECC. Section 405.3 of the 2009 IECC.

compliant building and a U-factor of 0.30 for the 2012 IECC compliant building. The roof type was composition shingle on wood sheathing, with a solar absorbtance of 0.75 and an emittance of 0.90. The attic of both the houses was vented, with 1 ft^2 of leakage area per 300 ft^2 ceiling area. The fenestration of the 2009 IECC compliant house had a U-factor of 0. 5 and an SHGC of 0.3. The fenestration of the 2012 IECC compliant house had a U-factor of 0. 35 and an SHGC of 0.25. Two doors with a total area of 40 ft^2 were simulated in both the code compliant houses and were oriented toward the North. The doors were assigned a U-factor of 0.5 for the 2009 IECC compliant house and a U-factor of 0.35 for the 2012 IECC compliant house. For the 2009 IECC compliant house the interior shade fraction for glazing during summer (all hours when cooling is required) is set at 0.70; and during winter (all hours when heating is required) was set at 0.85. For the 2012 compliant house, the interior shading fraction was provided by the formula:

$$\text{Interior Shading} = 0.92 - (0.21 \times \text{SHGC for the standard reference design})$$

This translated to a value of 0.87 used for shading fraction in the 2012 code compliant house throughout the year. No external shading was modeled for both the code compliant houses.

The space condition of the code compliant houses was further described in terms of the following: Space temperature set point, internal heat gains, air leakage and mechanical ventilation. The space set point temperature for both the code compliant houses was set at 72°F for heating and 75°F for cooling. The internal gain for both the code houses was determined from the formula:

$$\text{IGain} = 17{,}900 + 23.8 \times \text{CFA} + 4104 \times N_{br} \text{ (Btu/day per dwelling unit)}$$

where CFA is the conditioned floor area and N_{br} is the number of bedrooms. In addition, the 2012 IECC requires that 75 percent of the lamps in permanently installed lighting fixtures to contain high efficacy lamps. The resultant values for internal heat gains assumed for both the codes are 1.15 kW for the 2009 IECC and 0.87 kW for the 2012 IECC. These values are inclusive of the number of occupants in the houses. For both the code compliant houses, the infiltration was determined in terms of standard leakage area (SLA). For the 2009 code compliant house, an SLA of 0.00036 was assumed; for the 2012 code compliant house, an SLA of 0.00015 was assumed. In addition, the 2012 IECC requires the use of mechanical ventilation. Hence, an additional air change rate of 0.20 ACH resulting from implementing mechanical ventilation in the 2012 code was added to the overall air leakage of the building. Additional energy usage of 0.82 kWh is added to the annual energy consumption of the simulated houses to account for vent fan energy usage of these mechanical systems.

The mechanical systems of the code compliant houses were further described in terms of the following: HVAC systems, DHW systems and specifications for ducts. Two types of residential building models were selected for the analysis based on the type of fuel used for space heating and DHW heating. The selected residential building models incorporated:

- Electric space cooling, natural gas space heating and DHW heater (Electric / Gas), and
- Electric space cooling, heat pump space heating and electric DHW heater (All-Electric).

The space cooling requirements of the two code compliant houses were met by an electrically operated air-conditioner with an efficiency rating of 13 SEER. The electric/gas house implemented a natural gas

operated space heating system and DHW system. The efficiency for the space heating system was set to be at 0.78 AFUE. The efficiency of the corresponding DHW system was determined from the equation:

$$\text{Energy Factor (EF)} = 0.67 - 0.0019V$$

where 'V' is the rated volume in gallons. The EF of the corresponding DHW system was calculated to be 0.594. The All-Electric house implemented a heat pump for the space heating system. The corresponding DHW system was electrically operated. The efficiency for the heat pump was set to be 7.7 HSPF. The efficiency of the corresponding DHW system was determined from the equation:

$$\text{Energy Factor (EF)} = 0.97 - 0.0013V$$

where 'V' is the rated volume in gallons. The EF of the corresponding DHW system was calculated to be 0.904. The ducts in both the code compliant houses were positioned in the vented attic and were required to be tested by both the codes. The duct distribution system efficiency for the 2009 IECC compliant house was determined to be 11.12% (supply ducts: 5.56% , return ducts: 5.56%). The duct distribution system efficiency for the 2012 IECC compliant house was determined to be 4.2%[10] (supply ducts: 2.1% , return ducts: 2.1%).

Simulation Matrix

To assess the proposed amendment to Section R402.2.2 of the 2012 IECC, one half of the ceiling area above the conditioned floor area of the house was modeled under an attic. The remaining half was modeled as a cathedral ceiling. According to the 2009 IECC and the 2012 IECC, reduced ceiling insulation was applied to either 500 ft^2 or 20% of the total ceiling area, whichever is less. According to the proposed amendment, the reduced insulation is applied to 500 ft^2 of the ceiling area regardless of the conditioned floor area.

To assess the proposed amendments to Table R402.1.1, the amended specifications for reduced wall insulation and increased window SHGC were first assessed on an individual basis. The proposed amendments were then combined and compared against the corresponding 2009 and 2012 IECC compliant base-case houses.

[10] The 2012 IECC includes only 'total duct leakage' option, which is 4 cfm per 100 sq.ft. of conditioned floor area (CFA) per Section R403.2.2. Hence a 3 cfm per 100 sq.ft. of CFA was assumed for 'duct leakage to outdoors,' which results in 4.2% duct leakage.

Table 1: Specification for IECC 2012 and IECC 2009 Compliant Standard Reference Houses

Characteristics	Climate Zone 3 Tarrant County, TX		References
	IECC 2012	IECC 2009	
Building			
Building Type	Single family, detached house		
Gross Area	2,325 sq. ft. (48.21 ft. x 48.21 ft.)		NAHB 2003
Number of Floors	1		
Number of Bedrooms	4		
Floor to Ceiling Height (ft.)	8		
Orientation	South facing		
Construction			
Construction	Light-weight wood frame with 2x4 studs spaced at 16" on center		
Floor	Slab-on-grade floor		
Roof Configuration	Unconditioned, vented attic		
Roof Absorptance	0.75		2012: Table R405.5.2(1) 2009: Table 405.5.2(1)
Roof Emittance	0.9		2012: Table R405.5.2(1) 2009: Table 405.5.2(1)
Ceiling Insulation (hr-sq.ft.-°F/Btu)	R-33.7 (U-0.030)	R-27.84 (U-0.035)	2012: Table R402.1.3 2009: Table 402.1.3
Wall Absorptance	0.75 (Assuming brick facia exterior)		
Wall Insulation (hr-sq.ft.-°F/Btu)	R-11.8 + 5 (U-0.057)	R-11.8 (U-0.082)	2012: Table R402.1.3 2009: Table 402.1.3
Slab Perimeter Insulation	None		2012: Table R402.1.1 2009: Table 402.1.1
U-Factor of Glazing (Btu/hr-sq.ft.-°F)	0.35	0.5	2012: Table R402.1.3 2009: Table 402.1.3
Solar Heat Gain Coefficient (SHGC)	0.25	0.3	2012: Table R402.1.1 2009: Table 402.1.1
Window Area	15% of conditioned floor area ($87.1875\ ft^2$ on each orientation)		2012: Table R405.5.2(1) 2009: Table 405.5.2(1)
Door Area	$20\ ft^2$ x 2		2012: Table R405.5.2(1) 2009: Table 405.5.2(1)
Orientation of Doors	North		2012: Table R405.5.2(1) 2009: Table 405.5.2(1)
U-factor of Door (Btu/hr-sq.ft.-°F)	0.35	0.5	2012: Table R405.5.2(1) 2009: Table 405.5.2(1)
Interior Shading	0.87	Summer = 0.70 Winter = 0.85	2012: Table R405.5.2(1) 2009: Table 405.5.2(1)
Exterior Shading	None		2012: Table R405.5.2(1) 2009: Table 405.5.2(1)
Roof Radiant Barrier	No		
Slope of Roof	5:12 (23 degrees)		

Table 2: Specification for IECC 2012 and IECC 2009 Compliant Standard Reference Houses (Contd …)

Characteristics	Climate Zone 3 Tarrant County, TX		References
	IECC 2012	IECC 2009	
Space Conditions			
Space Temperature Set point	72°F Heating, 75°F Cooling		2012: Table R405.5.2(1) 2009: Table 405.5.2(1)
Internal Heat Gains	0.87 kW[1] Light.: 0.21 kW; Eq.: 0.66 kW	1.15 kW Light.: 0.49 kW; Eq.: 0.66 kW	2012: Table R405.5.2(1), Section R404.1 2009: Table 405.5.2(1)
Number of Occupants	None (Assuming internal gains include heat gain from occupants)		
Air Leakage (SG)[2]	SLA= 0.00015 (0.13 ACH)	SLA = 0.00036	2012: Table R405.5.2(1) 2009: Table 405.5.2(1)
Mechanical Ventilation	60.75 cfm (0.20 ACH)	N.A	2012: Table R405.5.2(1) 2009: Table 405.5.2(1)
Electricity Consumption due to Mechanical Ventilation	0.82 MMBtu/yr.[3]	N.A	2012: Table R405.5.2(1) 2009: Table 405.5.2(1)
Mechanical Systems			
HVAC System Type	COOLING Electric cooling (air conditioner) HEATING Nat. gas heating (gas fired furnace) Electric heating (heat pump)		
HVAC System Efficiency	For Air-Conditioner: SEER 13 For Furnace: AFUE 0.78 For Heat Pump: HSPF 7.7		2012: Table C403.2.3(1), Table C403.2.3(4) 2009: Table 503.2.3(1), Table 503.2.3(4)
Cooling Capacity (Btu/hr)	55,800 (= 500 sq. ft./ton)		
Heating Capacity (Btu/hr)	55,800 (= 1.0 x cooling capacity)		
DHW System	For tank type gas: 40-gallon For tank type electric: 50-gallon		
DHW Usage	70 gallons/day		2012: Table R405.5.2(1) 2009: Table 405.5.2(1)
DHW Heater Energy Factor	For gas water heater: 0.594 For electric water heater: 0.904		2012: Table C404.2 2009: Table 505.2
Duct Leakage [3]	4.2% [4] Supply and return duct leakage	11.12% Supply and return duct leakage	2012: Table R405.2 2009: Table 405.2
Duct Insulation	R-6/R-6		
Supply Air Flow (CFM/ton)	360		

Notes:
1. Considering a mandatory assumption that 75% of the lamps permanently installed shall be high-efficacy lamps.
2. Air exchange rate = air leakage rate in addition to the mechanical ventilation rate per 2012 IECC Table R405.5.2(1).
3. Calculated using the equation kWh/yr = 0.03942 x CFA + 29.565 x (Nbr+1), where CFA is the conditioned floor area and Nbr is the number of bedrooms.
4. The mechanical systems of the houses were assumed to be located in unconditioned, vented attic, which requires a duct leakage test.
5. Calculated from a maximum total duct leakage specified in 2012 IECC Sec. R403.2.2: 4 cfm per 100 sq.ft. of CFA .

RESULTS AND CONCLUSIONS

For the proposed amendment for Section R402.2.2 of 2012 IECC:

The results of the stringency comparison with the 2009 IECC and the 2012 IECC are presented in Table 3 and Table 4, respectively.

When comparing the proposed amendments with the 2009 IECC compliant base-case building, the results show that:

- In the case of Electric / Gas building, the source energy consumption of the amended 2012 IECC was in the range of 15% to 18% above the 2009 IECC compliant base-case house.
- In the case of an All-Electric building, the source energy consumption of the amended 2012 IECC case was in the range of 12% to 24% above the corresponding 2009 IECC compliant base-case house.

When comparing the proposed amendments with the 2012 IECC compliant base-case building for both the Electric / Gas building and the All-Electric building, the change in the source energy consumption was within 0.5% and hence considered negligible.

Table 3: Impact of Amending Table R402.2.2 of 2012 IECC on the Corresponding 2009 IECC Compliant Base-Case House

House Size	% Difference in Total Energy Consumption (2009 IECC Source)	
	Electric / Gas	All-Electric
1600	15%	24%
1800	16%	24%
2000	16%	23%
2200	16%	23%
2400	16%	23%
2600	17%	23%
2800	17%	22%
3000	17%	16%
3200	18%	14%
3400	18%	12%

Table 4: Impact of Amending Table R402.2.2 of 2012 IECC on the Corresponding 2012 IECC Compliant Base-Case House

House Size	% Difference in Total Energy Consumption (2012 IECC Source)	
	Electric / Gas	All-Electric
1600	0%	0%
1800	0%	0%
2000	0%	0%
2200	0%	0%
2400	0%	0%
2600	0%	0%
2800	0%	0%
3000	0%	0%
3200	0%	0%
3400	0%	0%

For the proposed amendment for Table R402.1.1 of 2012 IECC:

The results of the stringency comparison with the 2009 and the 2012 IECC are presented in Table 5 and Table 6, respectively.

When comparing the proposed amendments with the 2009 IECC compliant base-case building, the results show that:

- In the case of the Electric / Gas building, decreasing the wall insulation decreased the source energy consumption of the amended case by 13.3%; increasing the SHGC decreased the source energy consumption of the amended case by 15.1%; and implementing both the amendments decreased the source energy consumption of the amended case by 12.0% over the corresponding base-case house.
- In the case of the All-Electric building, decreasing the wall insulation decreased the source energy consumption of the amended case by 10.3%; increasing the SHGC decreased the source energy consumption of the amended case by 10.8%; and implementing both the amendments decreased the source energy consumption of the amended case by 8.6% over the corresponding base-case house.

When comparing the proposed amendments with the 2012 IECC compliant base-case building, the results show that:

- In the case of the Electric / Gas building, decreasing the wall insulation increased the source energy consumption of the amended case by 3.7%; increasing the SHGC increased the source energy consumption of the amended case by 1.5%; and implementing both the amendments increased the source energy consumption of the amended case by 5.2% over the corresponding base-case house.

- In the case of the All-Electric building, decreasing the wall insulation increased the source energy consumption of the amended case by 2.5%; increasing the SHGC increased the source energy consumption of the amended case by 1.9%; and implementing both the amendments increased the source energy consumption of the amended case by 4.3% over the corresponding base-case house.

Table 5: Impact of Amending Table R402.1.1 of 2012 IECC on the Corresponding 2009 IECC Compliant Base-Case House

Amendment to Table R402.1.1 2012 IECC	% Difference in Total Energy Consumption (2009 IECC Source)	
	Electric / Gas	All-Electric
Decreased Wall Insulation From R13+5 to R-13	13.3%	10.3%
Increased SHGC From 0.25 to 0.3	15.1%	10.8%
Combined Amendments	12.0%	8.6%

Table 6: Impact of Amending Table R402.1.1 of 2012 IECC on the Corresponding 2012 IECC Compliant Base-Case House

Amendment to Table R402.1.1 2012 IECC	% Difference in Total Energy Consumption (2012 IECC Source)	
	Electric / Gas	All-Electric
Decreased Wall Insulation From R13+5 to R-13	-3.7%	-2.5%
Increased SHGC From 0.25 to 0.3	-1.5%	-1.9%
Combined Amendments	-5.2%	-4.3%

REFERENCES

NAHB (2003). National Association of Home Builders

ICC (2009). *2009 International Energy Conservation Code*. Washington, DC: International Code Council, Inc., Country Club Hills, IL.

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