Detailed Stringency Analysis of Suggested Amendments to Chapter 11 of the 2012 IRC and the 2012 IECC that were Submitted to the Texas State Energy Conservation Office (SECO) During March 30-April 30, 2012 Comment Period

Prepared for
Texas State Energy Conservation Office (SECO)

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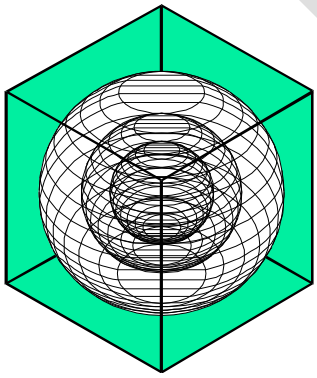

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Executive Summary

This report presents an assessment of several suggested amendments that were received as part of the public review process conducted by the Texas State Energy Conservation Office (SECO). The suggested amendments were received from Texas Association of Builders (TAB) and Newport Ventures. The suggested amendments are described below:

1. Modifications to Chapter 11, N1102.2.2, 2012 IRC and to Section R402.2.2, 2012 IECC – When the design of the roof/ceiling assembly does not allow sufficient space for the required insulation, a reduction of insulation is allowed for up to 500 square feet or 20% of the total insulated ceiling area, whichever is less. This suggested amendment removes the 20% limit.
2. Modifications to Tables N1102.1.1 and N1102.1.3, 2012 IRC, and Table R402.1.1 and R402.1.3, 2012 IECC – This suggested amendment reverts to the 2006 codes basement wall R-value and U-value in Climate Zones 6, 7 and 8.
3. Modifications to Table N1105.5.2(1), 2012 IRC, and Table R405.5.2 (1), 2012 IECC – The 2006 IECC allowed for the trade-off of more efficient HVAC equipment with building envelope requirements to demonstrate code compliance when using the performance method. The 2009 and 2012 IECC and the 2012 IRC have removed that provision; this amendment suggests reinstating the trade-off option. The suggested amendment proposes to reinstate the trade-off option reverting to the corresponding specifications in the 2006 IECC.
4. Modifications to Tables N1102.1.1 and N1102.1.3, 2012 IRC, and Tables R402.1.1 and R402.1.3, 2012 IECC – This suggested amendment reverts to the 2009 code insulation R-values for walls with wood frame construction.
5. Modifications to N1103.2.2, 2012 IRC – The code requires that duct tightness be tested either post-construction or at the rough-in stage. This suggested amendment removes the option for post-construction tests for duct leakage.
6. Modifications to N1103.2.3, 2012 IRC and R403.2.3 – The 2009 code allows using building cavities for return air, and prohibits their use for supply air. The 2012 code does not allow the use of building cavities as ducts or plenums for supply or return. This suggested amendment reintroduces the language that includes the use of building cavities as return ducts.
7. Modifications to Table R402.1.1 and Table 402.1.3, 2012 IECC – This suggested amendment reverts to the 2006 IECC specifications for Solar Heat Gain Coefficient (SHGC).
8. A modification to Section R403.5, 2012 IECC – This suggested amendment is to add the IRC requirements for specifications of mechanical ventilation systems for dwellings from Section M1507, 2012 IRC to Section 403.5, of the 2012 IECC.

A stringency analysis was performed to assess the incorporation of these suggested amendments into the 2012 code[1]. The analysis was conducted in two steps. In the first step the amended 2012 IECC was compared to the Texas Building Energy Performance Standard (TBEPS)[2].The conclusions are presented below:

1. The suggested Amendments1,4,5,6,7 and 8 are as stringent as the TBEPS;
2. The modifications suggested by Amendment 2 pertain to climate zones that were outside Texas;
3. The stringency of suggested Amendment 3 in comparison with both TBEPS and the 2012 code could only be assessed using specific trade-off measures on a case by case basis;

[1] The 2012 code includes specifications in Chapter 11 of the 2012 IRC and specifications in Chapter 4[RE] of the 2012 IECC.
[2] Texas Building Energy Performance Standard (TBEPS) is based on Chapter 11 of the 2009 IRC and Chapter 4 of the 2009 IECC.

In the second step, the modified 2012 code was compared to the published 2012 code. The conclusions are presented below:

1. The suggested Amendment 1 is as stringent as the 2012 code;
2. The suggested Amendment 2 pertains to climate zones that were outside Texas;
3. The stringency of suggested Amendment 3 in comparison with the 2012 code could only be assessed using specific trade-off measures on a case by case basis;
4. Suggested Amendments 4 and 7 are less stringent than the 2012 code; and
5. Suggested Amendments 5, 6 and 8 are as stringent as the 2012 code.

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1. Organization of the Report

This report is organized in six sections. Section 1 briefs the reader about the organization of the report. Section 2 presents the introduction and purpose of the report. Section 3 lists the suggested amendments that are analyzed by the report. Section 4 describes both the TBEPS and the 2012 code compliant base-case buildings. Section 5 presents the stringency analysis that was performed to assess the impact of implementing the suggested amendments to the 2012 code and comparing these suggested amendments with both TBEPS and 2012 code compliant base-case. Finally, Section 6 presents the conclusions of this analysis.

2. Introduction

In 2007, the 80th legislature mandated the Energy Systems Laboratory (Laboratory) to take part in Texas rule-making process. As detailed in the Health and Safety Code, Chapter 388, Texas Building Energy Performance Standards, Sec. 388.003 (b-1), the Laboratory is required to submit written recommendations to the State Energy Conservation Office (SECO) on whether the energy efficiency provisions of the latest published editions of the International Residential Code (IRC) or the International Energy Conservation Code (IECC) for residential or commercial energy efficiency and air quality are equivalent to or more stringent than the provisions of editions previously adopted as the Texas Building Energy Performance Standards (TBEPS). As according to the Health and Safety Code, Section 388.003 (b-3), the Laboratory is also mandated to consider all the comments collected by SECO from persons who have an interest in the adoption of energy codes on the new code editions.

This report includes a detailed analysis of the suggested amendments to Chapter 11 of the 2012 IRC and Chapter 4 [RE] of the 2012 IECC that were submitted to SECO during the March 30-April 30, 2012 comment period. The suggested amendments were compared to the TBEPS compliant base-case building. The suggested amendments were also compared to the 2012 code compliant base-case building. The analysis was conducted using Version 4.01.08 of the BDL input file prepared for the IC3. The performance path as described in 2009[3] and 2012 IECC was used for the analysis. Eight such suggested amendments were received and are described in the next section.

3. Suggested Amendments

The suggested amendments were received from Texas Association of Builders (TAB) and Newport Ventures. The suggested amendments are as follows:

1. Modifications to Chapter 11, N1102.2.2, 2012 IRC and to Section R402.2.2, 2012 IECC – When the design of the roof/ceiling assembly does not allow sufficient space for the required insulation, a reduction of insulation is allowed for up to 500 square feet or 20% of the total insulated ceiling area, whichever is less. This suggested amendment removes the 20% limit.
2. Modifications to Tables N1102.1.1 and N1102.1.3, 2012 IRC, and Table R402.1.1 and R402.1.3, 2012 IECC – This suggested amendment reverts to the 2006 codes basement wall R-value and U-value in Climate Zones 6, 7 and 8.

[3] Section N1101.2 of the 2009 IRC requires that compliance shall be demonstrated by either meeting the 2009 IECC or meeting the requirements of the 2009 IRC. The compliance with the performance path as described in the 2009 IECC is adopted for this analysis.

3. Modifications to Table N1105.5.2(1), 2012 IRC, and Table R405.5.2 (1), 2012 IECC – The 2006 IECC allowed for the trade-off of more efficient HVAC equipment with building envelope requirements to demonstrate code compliance when using the performance method. The 2009 and 2012 IECC and the 2012 IRC have removed that provision; this amendment suggests reinstating the trade-off option. The suggested amendment proposes to reinstate the trade-off option reverting to the corresponding specifications in the 2006 IECC.
4. Modifications to Tables N1102.1.1 and N1102.1.3, 2012 IRC, and Tables R402.1.1 and R402.1.3, 2012 IECC – This suggested amendment reverts to the 2009 code insulation R-values for walls with wood frame construction.
5. Modifications to N1103.2.2, 2012 IRC – The code requires that duct tightness be tested either post-construction or at the rough-in stage. This suggested amendment removes the option for post-construction tests for duct leakage.
6. Modifications to N1103.2.3, 2012 IRC and R403.2.3 – The 2009 code allows using building cavities for return air, and prohibits their use for supply air. The 2012 code does not allow the use of building cavities as ducts or plenums for supply or return. This suggested amendment reintroduces the language that includes the use of building cavities as return ducts.
7. Modifications to Table R402.1.1 and Table 402.1.3, 2012 IECC – This suggested amendment reverts to the 2006 IECC specifications for Solar Heat Gain Coefficient (SHGC).
8. A modification to Section R403.5, 2012 IECC – This suggested amendment is to add the IRC requirements for specifications of mechanical ventilation systems for dwellings from Section M1507, 2012 IRC to Section 403.5, of the 2012 IECC.

A stringency test was performed to assess the incorporation of these amendments into the 2012 IECC. The stringency test involves comparing the changes specified by the suggested amendment to the corresponding TBEPS compliant base-case building. The stringency test was also conducted by comparing the 2012 code with suggested amendments to the published 2012 code. A description of both the TBEPS compliant base-case and the published 2012 code base-case are presented in the next section.

4. Base-Case Building Description

The TBEPS compliant base-case house incorporated specifications provided in Chapter 11 of the 2009 IRC and Section 405 of the 2009 IECC. A second base-case compliant with Section R405 of the 2012 IECC was also created. The base-case house for this analysis is considered to be a single-family detached house with four bedrooms and a conditioned floor area of 2,325 ft^2. The front of the house faced south. The base-case house was modeled for three climate zones in Texas as described in both the 2009 IECC and the published 2012 IECC: Climate Zone 2, Climate Zone 3 and Climate Zone 4. The base-case house is described in terms of the envelope, space conditions and systems. The base-case assumptions are presented in Table 1 of this report.

Building Envelope

The envelope is described in terms of the following building components: above grade walls, ceilings, roofs, attics, glazing and doors. The above grade walls are of the wood frame type. For the TBEPS compliant base-case the walls have an overall U-factor[4] of 0.082 for all the climate zones. For the 2012 code compliant base-case the walls have an overall U-factor[5] of 0.082 for Climate Zone 2 and 0.057 for Climate Zones 3 and 4. The ceilings are also of wood frame construction, with the insulation located on the ceiling. For TBEPS compliant base-case the overall U-factor of the ceiling construction[6] is set at 0.035 for Climate Zone 2 and 3, and 0.030 for Climate Zone 4. For the 2012 code compliant base-case the overall U-factor of the ceiling construction[7] is set at 0.030 for Climate Zones 2 and 3 and 0.026 for Climate Zone 4. A vented unconditioned attic is modeled above the ceiling of the conditioned space. The building has slab-on-grade floor construction for conditioned spaces adjacent to the ground. As per the specifications in both the TBEPS and the 2012 codes, no insulation was required for the slab[8] for Climate Zone 2 and Climate Zone 3. An insulation of R-10 for slab was provided for Climate Zone 4 in both the TBEPS and the 2012 codes.

The glazing for the suggested design house and the corresponding standard reference house is arbitrarily set at 15% of conditioned wall area and is equally distributed on four orientations (N, E, S and W)[9]. For the fenestration of the TBEPS base-case building, an SHGC[10] of 0.3 is assumed for Climate Zone 2 and Climate Zone 3 and an SHGC of 0.4 is assumed for Climate Zone 4. For the fenestration of the 2012 code base-case building, an SHGC[11] of 0.25 is assumed for Climate Zone 2 and Climate Zone 3 and an SHGC of 0.4 is assumed for Climate Zone 4. In the TBEPS compliant base-case, for Climate Zone 2 the fenestration has a U-factor[12] of 0.65; for Climate Zones 3 the fenestration has a U-factor of 0.5; and for Climate Zone 4 the fenestration has a U-factor of 0.35. In the 2012 code compliant base-case, for Climate Zone 2 the fenestration has a U-factor[13] of 0.4, and for Climate Zones 3 and 4 the fenestration has a U-factor of 0.35. No external shading is modeled for the base-case building[14]. For the TBEPS compliant base-case an interior shading fraction[15] of 0.70 and 0.85 is assumed for summer and winter months respectively. For the 2012 code compliant base-case a constant value for interior shade fraction[16] is assumed for the analysis. The value is based on the following equation:

$$\text{Interior shade fraction} = 0.92 - (0.21 \times \text{SHGC of the standard reference design})$$

Two doors are assumed in the base-case house for both the TBEPS and 2012 base-case houses. The doors face north and south orientation. The U-factor implemented for the doors was same as the U-factor implemented for glazing in the base-case houses[17].

[4] Table 402.1.3, Equivalent U-factor for frame wall, IECC.2009.
[5] Table R402.1.3, Equivalent U-factor for frame wall, IECC 2012.
[6] Table 402.1.3, Equivalent U-factor for ceiling, IECC 2009.
[7] Table R402.1.3, Equivalent U-factor for ceiling, IECC 2012.
[8] Table 402.1.1, R-value for slab, IECC 2009.Table R402.1.1, R-value for slab, IECC 2012.
[9] Table 405.5.2(1), Specification for glazing, IECC 2009.
[10] Table R402.1.1, Glazed fenestration SHGC, IECC 2012.
[11] Table R402.1.1, Glazed fenestration SHGC, IECC 2012.
[12] Table 402.1.1, Fenestration U-factor, IECC 2009.
[13] Table R402.1.1, Fenestration U-factor, IECC 2012.
[14] Table 405.5.2(1), Specifications for glazing, IECC 2009. Table R405.5.2(1), Specifications for glazing, IECC 2012.
[15] Table 405.5.2(1), Specifications for interior shade fraction, IECC 2009.
[16] Table R405.5.2(1), Specifications for interior shade fraction, IECC 2012.
[17] Table 405.5.2(1), Specifications for doors, IECC 2009. Table R405.5.2(1), Specifications for doors, IECC 2012.

Building Space Conditions

The space conditions are described in terms of space temperature set-points, air exchange rate, mechanical ventilation, and internal gains. For both the TBEPS and the 2012 base-case, space temperature set points are set at 72°F for space heating and 75°F for space cooling[18]. No set back is simulated. The attics are vented, with 1 ft^2 of leakage area per 300 ft^2 of ceiling area[19]. In the TBEPS base-case the building envelope was not tested. Hence, a specific leakage are (SLA)[20] of 0.00036 was considered for the analysis. For the 2012 code compliant base-case an air leakage rate[21,22] of 5 ACH_{50} was modeled for Climate Zone 2 and an air leakage rate of 3 ACH_{50} was modeled for Climate Zones 3 and 4. Mechanical ventilation[23] is now mandatory in the 2012 IECC and was included in the calculations. The mechanical ventilation rate was calculated using the formula:

$$\text{Mech. ventilation rate (cfm)} = 0.01 \times CFA + 7.5 \times (N_{br} + 1)$$

In addition, electricity consumption for mechanical ventilation is calculated using the equation:

$$\text{Usage (kWh/yr)} = 0.03942 \times CFA + 29.565 \times (N_{br} + 1)$$

The internal heat gain in both the TBEPS and the 2012 compliant base-case for the simulated building is calculated using the equation:

$$I_{gain} \text{ (Btu/day per dwelling unit)} = 17{,}900 + 23.8 \times CFA + 4104 \times N_{br.}$$ [24]

Where:
CFA = Conditioned floor area, and
N_{br} = Number of bedrooms

The result of this calculation is divided between lighting and equipment using the procedure described in a report by Hendron (2008). The report discusses the Building America research benchmark building. However, in the 2012 code compliant base-case there is also a mandatory requirement for 75% of the lighting equipment to be high efficacy lamps[25]. This mandatory requirement has been accounted for in the provisions for internal heat gain in the 2012 code compliant base-case.

Building Mechanical Systems

The mechanical systems are described in terms of space cooling and heating system, duct position, duct leakage, duct insulation, and the domestic hot water (DHW) system. Two options were assumed for the base-case buildings: electric cooling and natural gas heating systems (Electric / Gas); and electric cooling and heat-pump operated heating systems (All-electric). The space cooling system is operated using

[18] Table R405.5.2(1), Specifications for thermostat settings, IECC 2012. Table R405.5.2(1), Specifications for thermostat settings, IECC 2012.
[19] Table 405.5.2(1), Specifications for attics, IECC 2009. Table R405.5.2(1), Specifications for attics, IECC 2012.
[20] Table 405.5.2(1), Specifications for air exchange rate for the standard reference design house, IECC 2009.
[21] Table R405.5.2(1), Specifications for air exchange rate for the standard reference design house, IECC 2012.
[22] The air leakage rate was calculated at a pressure of 50 Pa.
[23] Table R405.5.2(1), Specifications for air exchange rate for the standard reference design house, IECC 2012.
[24] Table 405.5.2(1), Specifications for internal gains for the standard reference and suggested design houses, IECC 2009. Table R405.5.2(1), Specifications for internal gains for the standard reference and suggested design houses, IECC 2012.
[25] Section R404.1.1 Lighting equipment, IECC 2012.

electricity and has an efficiency of SEER 13[26]. The space heating system using natural gas has an efficiency of 0.78 AFUE[27]. The space heating system using an electric heat-pump has an efficiency of 7.7 HSPF[28]. For the base-case house, the ducts are positioned in the attic. For the TBEPS compliant base-case the duct leakage is modeled as leakage of 8 cfm to the outside per 100 ft^2 of conditioned floor area[29]. For the 2012 code base-case the duct leakage is modeled as leakage of 4 cfm to the outside per 100 ft^2 of conditioned floor area[30, 31]. For both the base-case buildings the value of supply duct insulation is set at R-6 and the value of return duct insulation is set at R-6[32].

For both TBEPS and 2012 code compliant base-cases, the tank temperature is set at 120°F. The efficiency of the DHW heater using natural gas as fuel is provided by the formula:

$$EF = 0.67 - 0.0019V$$ [33]

The efficiency of the DHW heater using electricity is provided by the formula:

$$EF = 0.97 - 0.00132V$$ [34]

Where:
EF = Energy Factor for Natural Gas Fired Water Heaters
V = Rated storage capacity of the DHW tank (gallons)

The storage capacity for a house with four bedrooms is assumed to be 40 gallons for a gas water heater and 50 gallons for an electric water heater[35]. This results in a minimum efficiency of 0.594 for the electric/gas house and an efficiency of 0.904 for the all-electric house. Domestic hot water usage for both the TBEPS and the 2012 code base-case is calculated using the following equation:

$$\text{Usage (gallons/day)} = 30 + 10 \times N_{br}$$ [36]

Where:
N_{br} = Number of bedrooms

[26] Minimum National Appliance Energy Conservation Act (NAECA 2006) Standard for SEER values of the residential space cooling systems.
[27] Minimum NAECA Standard (NAECA2006) for AFUE value of the residential space heating systems.
[28] Minimum NAECA Standard (NAECA2006) for HSPF value of the residential space heating systems.
[29] Section 403.2.2 Mandatory sealing requirements for all ducts, 2009 IECC.
[30] Section R403.2.2, Mandatory sealing requirements for all ducts, IECC 2012.
[31] The value for 'total leakage' as proposed by the code is modified to a value for 'total leakage to the outside'. The modified value is accepted by the simulation model.
[32] Section 405.2, Mandatory insulation requirements for all supply and return ducts not located within the building thermal envelope, IECC 2009. Section R405.2, Mandatory insulation requirements for all supply and return ducts not located within the building thermal envelope, IECC 2012.
[33] Table 504.2, Specifications for minimum performance for storage gas water heaters ≤ 75,000 Btu/hr, IECC 2009. Table C 404.2, Specifications for minimum performance for storage gas water heaters ≤ 75,000 Btu/hr, IECC 2012.
[34] Table 504.2, Specifications for minimum performance for storage electric water heaters ≤ 12 kW, IECC 2009. Table C 404.2, Specifications for minimum performance for storage electric water heaters ≤ 12 kW, IECC 2012.
[35] Assumptions for the IC3 calculator.
[36] Table 404.5.2(1), Specifications for domestic hot water usage, IECC 2009. Table R404.5.2(1), Specifications for domestic hot water usage, IECC 2012.

Table 1: Specifications for the 2012 IECC Base-Case

Characteristics	2009 IECC			2012 IECC		
	CZ 2	CZ 3	CZ 4	CZ 2	CZ 3	CZ 4
	Harris	Tarrant	Potter	Harris	Tarrant	Potter
Building						
Building Type	Single family, detached house					
Gross Area	2,325 sq. ft. (48.21 ft. x 48.21 ft.)					
Number of Floors	1					
Number of Bedrooms	4					
Floor to Floor 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					
Roof Emittance	0.9					
Ceiling Insulation (Btu/hr-sq.ft.-°	0.035	0.035	0.03	0.03	0.03	0.026
Wall Absorptance	0.75 (Assuming brick facia exterior)					
Wall Insulation (Btu/hr-sq.ft.-°F)	0.082	0.082	0.082	0.082	0.057	0.057
Slab Perimeter Insulation	None	None	R-10/2ft	None	None	R-10/2ft
U-Factor of Glazing (Btu/hr-sq.ft.-	0.65	0.5	0.35	0.4	0.35	0.35
Solar Heat Gain Coefficient (SHC	0.3	0.3	0.4	0.25	0.25	0.4
Window Area	15% of conditioned floor area (87.1875 ft^2 on each orientation)					
Door Area	20 ft^2 x 2					
Orientation of Door	North & South					
U-factor of Door (Btu/hr-sq.ft.-°F)	0.65	0.5	0.35	0.4	0.35	0.35
Interior Shading	Summer: 0.7 Winter: 0.85	Summer: 0.7 Winter: 0.85	Summer: 0.7 Winter: 0.85	0.87	0.87	0.84
Exterior Shading	None					
Roof Radiant Barrier	No					
Slope of Roof	5:12 (23 degrees)					
Space Conditions						
Space Temperature Set point	72°F Heating, 75°F Cooling					
Internal Heat Gains	Lighting: 0.46 kW; Equipment: 0.63 kW			0.87^2 kW Lighting: 0.21 kW; Equipment: 0.66 kW		
Number of Occupants	None (Assuming internal gains include heat gain from occupants)					
Air Leakage (SG)[1]	SLA=0.00036			SLA= 0.00025	SLA= 0.00015	SLA= 0.00015
Mechanical Ventilation	Mechanical ventilation not implemented			60.75 cfm (0.20 ACH)		
Electricity Consumption due to Mechanical Ventilation				0.72 MMBtu/yr.		
Mechanical Systems						
HVAC System Type	Electric / Gas: Electric cooling (air conditioner) & Natural gas heating (gas fired furnace) All Electric: Electric cooling (air conditioner) & Electric heating (heat pump)					
HVAC System Efficiency	For Air-conditioner: SEER 13 For Furnace: AFUE 0.78 For Heat-pump: HSPF 7.7					
Cooling Capacity (Btu/hr)	55,800 (= 500 sq. ft./ton)					
Heating Capacity (Btu/hr)	55,800 (= 1.0 x cooling capacity)					
DHW System Type	For Electric / Gas: 40-gallon tank type gas water heater For All-Electric : 50-gallon tank type electric water heater					
DHW Usage	70 gal/day					
DHW Heater Energy Factor	For gas water heater: 0.594 For electric water heater: 0.904					
Duct Distribution System Efficiency[3,4]	5.56% Supply and return duct leakage			4.2% Supply and return duct leakage		
Duct Insulation	R-6 / R-6					
Supply Air Flow (CFM/ton)	360					

Note:
1. For 2012 IECC specifications: Air exchange rate = air leakage rate in addition to the mechanical ventilation rate.
2. Considering a mandatory assumption that 75% of the lamps permanently installed shall be high-efficacy lamps.
3. The mechanical systems of the houses were assumed to be located in unconditioned attic, which requires a duct tightness test for both codes.
4. Calculated from a maximum total duct leakage specified in 2012 IECC Sec. R403.2.2: 3 cfm per 100 sq.ft. of CFA .

5. Stringency Analysis of the Suggested Amendments

The analysis was conducted to assess the impact of the suggested amendments to the 2012 code on the TBEPS. The analysis also assessed the impact of the suggested amendments to the 2012 code on the published 2012 code. The analysis was carried out by calculating a percent difference in the source energy consumption[37]. For the comparison with the TBEPS base-case, source energy consumption was calculated as per specifications in the 2009 IECC[38]. This comparison requires compliance with the 2009 IECC to be established using heating, cooling, and service water heating only. A factor of 3.16 was used to calculate the source energy generation for electricity consumption and a factor of 1.1 was used to calculate source energy generation for natural gas consumption reported at site[39]. For the comparison with the 2012 code compliant base-case, source energy consumption was calculated as per specifications in the 2012 IECC[40], which is similar to the specifications in the 2009 IECC.

The sub-sections below describe the suggested amendment to the 2012 IECC citing the commenter, the analysis conducted to assess the stringency of this amendment with the TBEPS and the published 2012 code, the results, and finally the conclusion of the analysis.

Suggested Amendment 1

This amendment has been suggested by the Texas Association of Builders (TAB), and suggests modifications to Chapter 11, N1102.2.2, 2012 IRC and to Section R402.2.2, 2012 IECC. Currently the 2012 IECC requires that when the design of the roof/ceiling assembly does not allow sufficient space for the required insulation, a reduction of insulation is allowed for up to 500 square feet or 20% of the total insulated ceiling area, whichever is less. The amendment suggests removing the 20% limit from the language in the 2012 IECC.

For this analysis, a weighted average of the ceiling insulation was compared for 10 different house sizes. In the analysis, one half of the ceiling area of each house was modeled as being under an attic and the remaining ceiling was modeled as a cathedral ceiling. As suggested by the amendment, the weighted average for the test house was obtained by implementing a reduced ceiling insulation of R-30 to 500 ft^2 of ceiling area regardless of the house size. This was compared to a corresponding base-case house with a weighted average of ceiling insulation as prescribed by Section 402.2.2 of the 2009 IECC. The analysis was performed for the three climate zones of Texas as described in the TBEPS. The weighted average for the ceiling insulation was calculated using the formula:

$$\text{Weighted R-Value} = [CA_1 \times R_1 + CA_2 \times R_2] / CA$$

Where:
CA_1 = Ceiling area with R-value as per the 2012 IECC,
CA_2 = Ceiling area with reduced R-value,
R_1 = R-value as specified by 2012 IECC,
R_2 = Reduced R-value, and

[37] Percent Difference in Total Energy Consumption:
[Base-case energy consumption– Test-case energy consumption] / Base-case energy consumption %.
[38] Section R405.1, 2012 2009 IECC.
[39] Section 405.3, 2009 IECC.
[40] Section R405.1, Section R405.3, 2012 IECC.

CA = Total ceiling area.

Table 2 compares the annual energy consumption for the 2012 IECC compliant test-case implementing the reduced ceiling R-values to 500 ft2 of ceiling area with the TBEPS compliant base-case. Results indicate that the suggested amendment is more stringent than the TBEPS compliant base-case.

Table 2: Comparing Annual Energy Consumption for the 2012 IECC Compliant Test-Case Implementing Reduced Ceiling R-values to 500 ft^2 of Ceiling Area with the TBEPS Compliant Base-Case

County	2009 IECC Climate Zones	House Size (ft^2)	% Difference in Total Energy Consumption (2009 IECC Source) Positive values indicate increase in stringency	
			Gas Heating, Gas Domestic Hot Water (DHW)	Heat Pump Heating, Electric Domestic Hot Water (DHW)
Harris	**2**	1600	19%	16%
		1800	19%	15%
		2000	18%	15%
		2200	18%	15%
		2400	18%	14%
		2600	17%	14%
		2800	17%	13%
		3000	17%	13%
		3200	17%	13%
		3400	17%	13%
Tarrant	**3**	1600	20%	16%
		1800	20%	16%
		2000	20%	17%
		2200	21%	16%
		2400	21%	16%
		2600	21%	16%
		2800	22%	17%
		3000	22%	17%
		3200	22%	17%
		3400	23%	18%
Potter	**4**	1600	8%	6%
		1800	8%	6%
		2000	9%	7%
		2200	10%	7%
		2400	10%	8%
		2600	11%	8%
		2800	11%	8%
		3000	12%	9%
		3200	12%	10%
		3400	13%	11%

The analysis also compares the suggested amendment to the 2012 IECC to the published 2012 IECC. Table 3 compares the annual energy consumption for the 2012 IECC compliant test-case implementing the reduced ceiling R-values to 500 ft2 of ceiling area with the 2012 code compliant base-case. Results indicate that the suggested amendment is as stringent as the 2012 code compliant base-case.

Table 3: Comparing Annual Energy Consumption for the 2012 IECC Compliant Test-Case Implementing Reduced Ceiling R-values to 500 ft^2 of Ceiling Area with the 2012 IECC Compliant Base-Case

County	2012 IECC Climate Zones	House Size (ft^2)	% Difference in Total Energy Consumption (2012 IECC Source) Positive values indicate increase in stringency	
			Gas Heating, Gas Domestic Hot Water (DHW)	Heat Pump Heating, Electric Domestic Hot Water (DHW)
Harris	**2**	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%
Tarrant	**3**	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%
Potter	**4**	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%

Suggested Amendment 2

This amendment, presented by the Texas Association of Builders (TAB), suggests modifications to Tables N1102.1.1 and N1102.1.3, 2012 IRC, and Table R402.1.1 and R402.1.3, 2012 IECC. The suggested amendment reverts to the 2006 codes basement wall R-value and U-value in Climate Zones 6, 7 and 8.

The suggested amendment does not impact the stringency of either the TBEPS or the published 2012 code, since it proposes changes to climate zones that fall outside of Texas. Hence the stringency analysis was not performed.

Suggested Amendment 3

This amendment was suggested by the Texas Association of Builders (TAB). The amendment suggests modifications to Table N1105.5.2 (1), 2012 IRC, and Table R405.5.2 (1), 2012 IECC. The 2006 IECC allowed for the trade-off of more efficient HVAC equipment with building envelope requirements to demonstrate code compliance when using the performance method. The 2009 and 2012 IECC and the 2012 IRC have removed that provision. This amendment suggests reinstating the trade-off option.

The impact of the suggested amendment on the stringency of either the TBEPS or the published 2012 code can only be assessed using specific trade-off measures on a case by case basis.

Suggested Amendment 4

This amendment has been suggested by the Texas Association of Builders (TAB). The amendment suggests modifications to Tables N1102.1.1 and N1102.1.3, 2012 IRC, and Tables R402.1.1 and R402.1.3, 2012 IECC. This amendment suggests reverting to the 2009 code insulation R-values for walls with wood frame construction.

For this analysis, the specifications for wall insulation were changed from R-13+5 as specified in Table R402.1.3, 2012 IECC to R-13 as specified in the suggested amendment. The suggested amendment was modeled by removing the exterior sheathing with an insulation value of R-5 incorporated in the 2012 IECC compliant base-case house. The analysis was performed for Climate Zone 3 and Climate Zone 4 as specified in the TBEPS[41].

Table 4 compares the annual energy consumption for the 2012 IECC compliant test-case with wood frame insulation of R-13 with the TBEPS compliant base-case. The analysis concludes that the suggested amendment is more stringent than the TBEPS compliant base-case.

[41] The suggested amendment also proposes changes to the climate zones that fall outside of Texas. Analysis for these climate zones is not part of TBEPS.

Table 4: Comparing Annual Energy Consumption for the 2012 IECC Compliant Test-Case w/ Wood Frame Wall Insulation of R-13 in Climate Zone 3 and 4 with the TBEPS Compliant Base-Case

County	2009 IECC Climate Zones	% Difference in Total Energy Consumption (2009 IECC Source) Positive values indicate increase in stringency	
		Gas Heating, Gas Domestic Hot Water (DHW)	Heat Pump Heating, Electric Domestic Hot Water (DHW)
Tarrant	**3**	18%	14%
Potter	**4**	6%	5%

The analysis also compares the suggested amendment to the 2012 IECC with the published 2012 IECC. Table 5 presents a comparison of the annual energy consumption for the 2012 IECC compliant test-case with a wood frame wall insulation of R-13 with the corresponding 2012 IECC compliant base-case. The suggested amendment is less stringent than the published 2012 IECC.

Table 5: Comparing Annual Energy Consumption for the 2012 IECC Compliant Test-Case w/ Wood Frame Wall Insulation of R-13 in Climate Zone 3 and 4 with the 2012 IECC Compliant Base-Case

County	2012 IECC Climate Zones	% Difference in Total Energy Consumption (2012 IECC Source) Negative values indicate decrease in stringency	
		Gas Heating, Gas Domestic Hot Water (DHW)	Heat Pump Heating, Electric Domestic Hot Water (DHW)
Tarrant	**3**	-3%	-3%
Potter	**4**	-4%	-3%

Suggested Amendment 5

This amendment was suggested by the Texas Association of Builders (TAB). Modifications to N1103.2.2, 2012 IRC – The code requires that duct tightness be tested either post-construction or at the rough-in stage. This suggestion removes the option for post-construction tests for duct leakage.

The analysis concluded that adding the suggested amendment does not impact the stringency of either the TBEPS or the 2012 IECC. This suggested amendment addresses the issue of the stage of testing for leakage. It does not discuss the extent of leakage.

Suggested Amendment 6

This amendment, suggested by the Texas Association of Builders (TAB), suggests modifications to N1103.2.3, 2012 IRC. The 2009 code allows using building cavities for return air, and prohibits their use for supply air. The 2012 code does not allow the use of building cavities as ducts or plenums for supply or return. The suggested amendment reintroduces the language that includes the use of building cavities as return ducts.

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. On the other hand, the suggested amendment is as stringent as the published 2012 code, provided that the specification of the building cavity is equivalent to a code-compliant return air duct as specified in Sections R403.2.1 and R403.2.2 of the 2012 IECC.

Suggested Amendment 7

This amendment has been suggested by the Texas Association of Builders (TAB). The amendment suggests modifications to Table R402.1.1 and Table R402.1.3, 2012 IECC. The suggested amendment reverts to the specifications in the 2006 IECC for Solar Heat Gain Coefficient (SHGC).

For this analysis the specifications for window SHGC were changed from 0.25 as specified in Table R402.1.3, 2012 IECC to 0.4 as specified in the suggested amendment. This was compared to a corresponding TBEPS compliant base-case house. The analysis was performed for Climate Zone 2 and Climate Zone 3 as described in the TBEPS. Results of the analysis are presented in Table 6. The analysis concludes that the suggested amendment is more stringent than the TBEPS compliant base-case.

Table 6: Comparing Annual Energy Consumption for 2012 IECC Compliant Test-Case w/ 0.4 SHGC in Climate Zone 3 and 4 with the 2009 IECC Compliant Base-Case

County	2009 IECC Climate Zones	% Difference in Total Energy Consumption (2009 Source) Positive values indicate increase in stringency	
		Gas Heating, Gas Domestic Hot Water (DHW)	Heat Pump Heating, Electric Domestic Hot Water (DHW)
Harris	**2**	13%	9%
Tarrant	**3**	17%	12%

The analysis also compares the suggested amendment to the 2012 IECC with the published 2012 IECC. Table 7 compares annual energy consumption for the 2012 IECC compliant test-case with a wood frame wall insulation of R-13 with the corresponding 2012 IECC compliant base-case. The suggested amendment is less stringent than the published 2012 IECC.

Table 7: Comparing Annual Energy Consumption for 2012 IECC Compliant Test-Case w/ 0.4 SHGC in Climate Zone 3 and 4 with the 2009 IECC Compliant Base-Case

County	2012 IECC Climate Zones	% Difference in Total Energy Consumption (2012 Source) Negative values indicate decrease in stringency	
		Gas Heating, Gas DHW	Heat Pump Heating, Electric DHW
Harris	**2**	-7%	-7%
Tarrant	**3**	-5%	-6%

Suggested Amendment 8

This amendment has been suggested by Newport Ventures. The amendment suggests modifications to Section R403.5, 2012 IECC. The suggestion adds the IRC requirements for specifications of mechanical ventilation systems for dwellings from Section M1507, 2012 IRC to Section R403.5, 2012 IECC.

The analysis concluded that the suggest amendment adds tables from the Section M1507, 2012 IRC to Section R403.5, 2012 IECC to provide consistency and clarity. The suggested amendment does not impact the stringency of either the TBEPS or the published 2012 code.

6. Conclusions

This report presents an assessment of eight suggested amendments that were received as part of the review process initiated by State Energy Conservation Office (SECO). Seven of the suggested amendments were received from Texas Association of Builders (TAB) and one suggested amendment was received from Newport Ventures.

The analysis presents the following conclusions:

1. The suggested amendment proposing modifications to Chapter 11, N1102.2.2, 2012 IRC and to Section R402.2.2, 2012 IECC does not impact the stringency of either the TBEPS or the published 2012 code.
2. The suggested amendment proposing modifications to Tables N1102.1.1 and N1102.1.3, 2012 IRC, and Table R402.1.1 and R402.1.3, 2012 IECC does not impact the stringency of either the TBEPS or the published 2012 code, since it proposes changes to climate zones that fall outside of Texas.
3. The suggested amendment proposing modifications to Table N1105.5.2(1), 2012 IRC, and Table R405.5.2 (1), 2012 IECC can only be assessed using specific trade-off measures on a case-by-case basis.
4. The suggested amendment proposing modifications to Tables N1102.1.1 and N1102.1.3, 2012 IRC, and Tables R402.1.1 and R402.1.3, 2012 IECC is more stringent than the TBEPS and less stringent than the published 2012 code.
5. The suggested amendment proposing modifications to N1103.2.2, 2012 IRC does not impact the stringency of either the TBEPS or the published 2012 code.
6. The suggested amendment proposing modifications to N1103.2.3, 2012 IRC does not impact the stringency of the TBEPS. The suggested amendment does not impact the stringency of the published 2012 code provided the cavity characteristics are equivalent to a code compliant return air duct.
7. The suggested amendment proposing modifications to Table R402.1.1 and Table R402.1.3, 2012 IECC is more stringent than the TBEPS and less stringent than the published 2012 code.
8. The suggested amendment proposing modifications to Section R403.5, 2012 IECC does not impact the stringency of either the TBEPS or the published 2012 code.

7. References

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