A COMPARISON OF THE STRINGENCY OF THE 2001 IECC VERSUS THE 2009 IECC AND 2009 IRC

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1. Executive Summary

This report documents the differences between the 2001 IECC[1], 2009 IECC and 2009 IRC. The three codes are compared using the climate zones proposed by the 2009 IECC for the State of Texas. The comparison is carried out using the same code-compliant simulation with input variables that reflect differences between the three codes.

Both the 2001 IECC and the 2009 IECC have prescriptive as well as performance paths to achieve code compliance. The 2009 IRC, on the other hand, only specifies a prescriptive path. For a number of the components specified in the 2009 IECC, there were no specifications in the 2009 IRC. However, all components in the 2009 IRC specification have comparable 2009 IECC equivalent specifications.

Simulations were run for a single-story house with 2,500 sq. ft. of conditioned area, with windows equally distributed on all four sides. In order to compare the different codes, specific assumptions were made to the simulation inputs. This resulted in simulations for the 2001 IECC, the 2001 IECC with modifications, the 2009 IECC performance path, the 2009 IECC prescriptive path and the 2009 IRC prescriptive path for selected counties in Texas. Gas and electric heating options were both simulated and reported as site and source energy consumption. The specifications are presented in Table 1 and Table 2. The results are tabulated in Table 3, Table 4, and Table 5.

The results of the simulations show:

1. For residential construction with 15% or less window to floor ratio, the residential prescriptive provisions for the 2009 IECC and the Chapter 11 of the 2009 IRC are as stringent as the Texas Building Energy Performance Standards (TBEPS), which is based on the 2001 IECC. The Laboratory's analysis of the 2009 IECC and the Chapter 11 of the 2009 IRC indicate a marginal improvement in overall residential energy efficiency of the 2009 IECC over the energy provisions of the 2009 IRC.
2. For all other residential structures, the residential performance provisions of the 2009 IECC are as stringent as the TBEPS based on the 2001 IECC.
3. The commercial provisions of the 2009 IECC are as stringent as the TBEPS based on the 2001 IECC.

A copy of the Laboratory's recommendations to SECO is included in the appendix.

[1] Throughout this document the 2001 IECC refers to the 2000 IECC with the 2001 Supplement.

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2. Introduction

2.1. Purpose

The purpose of this report is to compare three energy codes, IECC 2001, IECC 2009 and IRC 2009, and determine the most stringent code.

2.2. Methodology

To perform the analysis, five sets of specifications were simulated. In Table 1 the first set of specifications labeled “Performance Path 2000/2001 IECC” describes the specifications proposed in the 2001 IECC. Unfortunately, these specifications could not be used to compare simulations with the 2009 IECC or 2009 IRC, therefore, a second set of simulations were created. In the second set labeled “Performance Path 2000/2001 IECC Modified,” the specifications for 2001 IECC were modified in order to be compared to the specifications in 2009 IECC. To accomplish this, changes were made to internal heat gains and the thermostat settings to match the 2009 settings.

The first column in Table 2 labeled “2009 IECC Performance” presents the specifications for the 2009 IECC performance path. The second column in this table, labeled “2009 IECC Prescriptive,” presents the specifications for the 2009 IECC prescriptive path, while the third column labeled “2009 IRC Prescriptive” presents the specifications for the 2009 IRC. For a number of components specified in the IECC 2009 there are no specifications in the 2009 IRC. Hence, assumptions were made in the 2009 IRC to match the specifications for 2009 IECC. Simulations were carried out for selected counties in the state of Texas. Details of the selection process for the counties are provided in the next section.

Table 1: 2001 IECC Performance Path and Prescriptive Path

Building Component	Performance Path 2000/2001 IECC										Performance Path 2000/2001 IECC Modified										Comments	REFERENCE/COMMENTS 2000/2001 IECC	
	2B	3B	3C	4B	5A	5B	6B	7B	8	9B	2B	3B	3C	4B	5A	5B	6B	7B	8	9B		Section	Comment
	CAM			HAR		TAR	ELP			ARM	CAM			HAR		TAR	ELP			ARM			
Above-grade walls - U Factor/R Value	0.085	0.09	0.09	0.085	0.09	0.085	0.076	0.08	0.06	0.064	0.085	0.09	0.09	0.085	0.085	0.085	0.08	0.08	0.064	0.064		Table 402.1.1 (1)	
Above-grade floors - U Factor/R Value	R-11	R-11	R-11	R-13	R-19	R-19	R-19	R-19	R-19	R-19	R-11	R-11	R-11	R-13	R-19	R-19	R-19	R-19	R-19	R-19		Table 502.2.4 (6)	
Ceilings - U Factor/ R Value	R 30	R 30	R 30	R 30	R38	R38	R38	R38	R38	R38	R 30	R 30	R 30	R 30	R38	R38	R38	R38	R38	R38		Table 502.2.4 (6)	
Slab R-value & Depth	R-0	R-0	R-0	R-0	R-0	R-0	R-0	R-0	R-0	R-6	R-0	R-0	R-0	R-0	R-0	R-0	R-0	R-0	R-0	R-6			
Attic - Infiltration	0.0033 Frac-Leak-Area										0.0033 Frac-Leak-Area										Note B		1.5 ACH
Doors - Location and area	1- South, 1-North										1- South, 1-North										Note B		
Doors - U Factor	0.2										0.2											Sec. 402.1.3.4.3	
Glazing - Area	18% WFR										18% WFR											Sec. 402.1.1	
Glazing - U Factor	0.47	0.47	0.47	0.47	0.47	0.47	0.44	0.44	0.41	0.41	0.47	0.47	0.47	0.47	0.47	0.47	0.44	0.44	0.41	0.41		Table 402.1.1 (2)	
Glazing - SHGC	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.68	0.68	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.68	0.68		Sec. 402.1.3.1.4	
Glazing - Interior shading	Sum: 0.7 Win: 0.9										Sum: 0.7 Win: 0.9											Sec. 402.1.3.1.5	
Air exchange rate	SLA=0.00057										SLA=0.00057											Sec. 402.1.3.10	
Internal gains	3000 Btu/hr										Simulation:3909 Btu/hr										Note C	Sec. 402.1.3.6	3000 Btu/hr
Structural mass	80% carpet, 20% tile										80% carpet, 20% tile										Note B		
Heating and cooling system - Size	500 ft^2/ton										500 ft^2/ton										Note B		
Heating and cooling system - Efficiency	AC: 13 SEER; Gas Furnace: 78% AFUE; Heat Pump: 7.7 HSPF										AC: 13 SEER; Gas Furnace: 78% AFUE; Heat Pump: 7.7 HSPF											Table 503.2	
Service water heating	70 gal/day										70 gal/day											Sec. 402.1.3.7	gal/day=30*a+ (10*b) Temp.: 120 F
Service water heating - Efficiency	Gas: 0.544 Electric: 0.864										Gas: 0.544 Electric: 0.864											Table 504.2	Gas: 0.62-0.0019 V EF Electric: 0.93-0.00132 V EF
Thermal distribution system - Efficiency	1 story: 0.8										1 story: 0.8											Sec. 402.1.3.9	
Thermal distribution system - Duct insulation	Supply: R8 Return: R4										Supply: R8 Return: R4												
Thermal distribution system - Duct leakage	20%										20%										Note B		
Thermostat	Heating 68F, Cooling 78F, 5F setback										Heating 72F, Cooling 75F, No Setback										Note C	Table 402.1.3.5	

Notes:
Base Case: Single family house, 2500 sq. ft., 1 story, 4 bedrooms, Slab-on-grade floor, solar absorptance of 0.75 and remittance of 0.9 for wall and roof, ducts in the unconditioned and vented attic, no exterior shading, no slab perimeter insulation.

Note B: No guidance in the 2001 IECC code. Hence a value similar to the 2009 IECC- Performance Path is assumed.
Note C: Recalculated to match the values obtained from the 2009 IECC.

Table 2: 2009 IECC Performance and Prescriptive Path and 2009 IRC Prescriptive Path

Building Component	2009 IECC Performance				2009 IECC Prescriptive	2009 IRC Prescriptive				Comments	2009 IECC		2009 IRC	
	2A/2B	3A	3B	4B	All 2009 IECC zones	2A/2B	3A	3B	4B		Section	Comment	Section	Comment
	HAR / CAM	TAR	ELP	ARM		HAR / CAM	TAR	ELP	ARM					
Above-grade walls - U Factor/R Value	0.082	0.082	0.082	0.082	Same as Performance	0.082	0.082	0.082	0.082		Table 402.1.3 (402.1.1)		Table N1102.1.2 Equivalent U-Factors	
Above-grade floors - U Factor/R Value	0.064	0.047	0.047	0.047	Same as Performance	0.064	0.047	0.047	0.047		Table 402.1.3 (402.1.1)		Table N1102.1.2 Equivalent U-Factors	
Ceilings - U Factor/ R Value	0.035	0.035	0.035	0.03	Same as Performance	0.035	0.035	0.035	0.03		Table 402.1.3 (402.1.1)		Table N1102.1.2 Equivalent U-Factors	
Slab R-value & Depth	0	0	0	10, 2ft	Same as Performance	0	0	0	10, 2ft		Table 402.1.3 (402.1.1)		Table N1102.1 Insultation and Fenestration requirements by component	
Attic - Infiltration	0.0033 Frac-Leak-Area				Same as Performance	0.0033 Frac-Leakage-Area				Note D	Table 405.5.2 (1)			
Doors - Location and area	1-South, 1-North				Same as Performance	1-South, 1-North				Note D	Table 405.5.2 (1)			
Doors - U Factor	0.65	0.5	0.5	0.35	Same as Performance	0.5	0.5	0.5	0.5		Table 402.1.3		Table N1101.5(2) Default Door U-Values as referenced in section N1105 of the 2009 IRC	
Glazing - Area	15% WFR				No Specs	15% WFR				Note A Note D	Table 405.5.2 (1)			
Glazing - U Factor	0.65	0.5	0.5	0.35	Same as Performance	0.65	0.5	0.5	0.35		Table 402.1.3		Table N1102.1 Insultation and Fenestration requirements by component	
Glazing - SHGC	0.3	0.3	0.3	0.4	Same as Performance	0.35	0.35	0.35	0.4		Table 402.1.1		Table N1102.1 Insultation and Fenestration requirements by component	
Glazing - Interior shading	Sum: 0.7 Win: 0.85				Same as Performance	Sum: 0.7 Win: 0.85				Note D	Table 405.5.2 (1)			
Air exchange rate	SLA= 0.00036				Same as Performance	SLA=0.00036				Note D	Table 405.5.2 (1), ASHRAE 119 Section 5.1			
Internal gains	3909 Btu/hr				Same as Performance	3909 Btu/hr				Note D	Table 405.5.2 (1)	17900+23.8*CFA+4104* Nbr (Btu/day)		
Structural mass	80% carpet, 20% tile				Same as Performance	80% Carpet, 20% Tile				Note D	Table 405.5.2 (1)			
Heating and cooling system - Size	500 ft^2/ton				Same as Performance	500 ft^2/ton				Note D	Table 405.5.2 (1) IRC Sec. M1401.3			
Heating and cooling system - Efficiency	AC: 13 SEER; Gas Furnace: 78% AFUE; Heat Pump: 7.7 HSPF				Same as Performance	AC: 13 SEER; Gas Furnace: 78% AFUE; Heat Pump: 7.7 HSPF				Note D	Table 503.2.3 (2), 503.2.3 (4),			
Service water heating	70 gal/day				Same as Performance	70 gal/day				Note D	Table 405.5.2 (1)	gal/day=30+ (10*Nbr)		
Service water heating - Efficiency	Gas: 0.594 Electric: 0.904				Same as Performance	Gas: 0.594 Electric: 0.904				Note D	Table 504.2	Gas Storage: < 75,000Btu/hr: 0.67-0.0019 V EF Gas Instantaneous: >50,000 Btu/hr and <200,000Btu/hr: 0.67-0.0019 V EF Electric: <=12 KW: 0.97-0.00132 V EF >12kW: 1.73V+155SL Btu/h Heat Pump: 0.93-0.00132 V EF		
Thermal distribution system - Efficiency	Thermal Distribution Efficiency 0.88				Duct Model	Duct Model				Note D	Table 405.5.2 (1)			
Thermal distribution system - Duct insulation	N.A				N.A Supply: R8 Return: R6	N.A. Supply: R8 Return: R6				Note D Note E	Sec. 403.2.2 & 405.1		N1103.2	
Thermal distribution system - Duct leakage	N.A				N.A 11.10%	N.A. 11.10%				Note D Note E	Sec. 403.2.2	Total: 8 CFM/100 ft^2 to outdoor	N1103.2.2	Total: 8 CFM/100 ft^2 to outdoor
Thermostat	Heating 72F, Cooling 75F, No Setback				Same as Performance	Heating 72F, Cooling 75F, No Setback				Note D	Table 405.5.2 (1)		N1103.1.1	

Notes:

Base Case: Single family house, 2500 sq. ft., 1 story, 4 bedrooms, Slab-on-grade floor, solar absorptance of 0.75 and remittance of 0.9 for wall and roof, ducts in the unconditioned and vented attic, no exterior shading, no slab perimeter insulation.

Note A: No specification hence simulation assumes a value of 15%

Note D: No guidance in the 2009 IRC code. Hence a value similar to the 2009 IECC- Performance Path is assumed.

Note E: In case using thermal distribution efficiency, Duct Leakage and Duct insulation are not applicable (NA)

3. Zones

3.1. Climate Zones:

The state of Texas has been divided into different climate zones for the 2001 IECC and 2009 IECC/IRC, with each code having different climate zones. The 2001 IECC divides the State of Texas into eight zones: 2B, 3B, 3C, 4B, 5A, 5B, 6B, 7B, 8 and 9B. Five zones, 2B, 4B, 5B, 6B and 9B, were selected as representative counties which are Cameron 2B, Harris 4B, Tarrant 5B, El Paso 6B, and Armstrong 9B, respectively.

The 2009 IECC and 2009 IRC divide the state of Texas in three zones: Zone 2, 3 and 4 (classifications A and B are for Dry and Wet Regions), the representative counties for these zones are Harris or Cameron for zone 2A/2B, Tarrant for zone 3A , El Paso for zone 3B and Armstrong for zone 4B. Zoning does not change between the 2009 IECC performance and prescriptive paths. The 2009 IRC climate zones are same as 2009 IECC.

4. Building Envelope

Several components of the building envelope have different specifications between the three codes. A comparison was made between the three codes for each component in order to assess the stringency of the code, including glazing area, building envelope, doors, attic and air exchange rate.

4.1. Glazing Area:

The glazing area was defined in terms of window-to-floor area ratio (WFAR) as specified in both the 2000 and 2009 IECC. The WFAR is a fixed value and is dependent on the area of conditioned space and independent of the wall area for a code house for 2001 IECC. The WFAR is fixed at 18% for the 2001 IECC. For 2009 IECC, the WFAR is equal to the proposed building if the window area is less than 15% of the floor area. In case the WFAR of the proposed building is equal to or exceeds 15% of the floor area, the WFAR of the standard house was fixed at 15%. There are no specifications for the WFAR in the 2009 IRC. Hence, specifications for the 2009 IECC were used for the 2009 IRC.

4.2. Building Envelope Specifications:

The specifications for the various components of the building envelope for the 2001 IECC are stated in several different sections of the code. The wall R-value was obtained from Table

402.1.1(1). The U-Value for the fenestration was obtained from Table 402.1.1(2). Specifications of all other envelope components like the R-value for roof/ceiling, floor and crawl space wall (in case the house has a crawlspace), slab perimeter R-Value (when the foundation type is slab on grade) and basement wall R-Value (for house with basement) were found in the prescriptive tables (Table 502.2.4). These prescriptive tables for building envelope components are subdivided based on window-to-wall area ratio (WWAR) for the house.

For the 2009 IECC, the performance path references the specifications laid out in the prescriptive tables of the code. The prescriptive table for the building envelope no longer uses the WWAR as a basis of specifying the envelope characteristics. The specifications for the ceiling R-value, the roof R-value, the wall R-value and the U-factor for the glazing for the standard house were defined in Table 402.1.3. Specifications for the fenestration SHGC were provided in Table 402.1.1. As per section 402.5 of the code, the area-weighted average maximum fenestration U-factor permitted using trade-offs from section 402, was 0.48 in zones 4 and 5 and 0.40 in zones 6 through 8 for vertical fenestration. The area weighted average maximum fenestration SHGC permitted using trade-offs from section 405 in zones 1 through 3 was 0.50.

For the 2009 IRC, the prescriptive tables for the buildings eliminated the window-to-wall area ratios as the basis for specifying the building envelope parameters. The specifications for the building component U-values were available in Table N1102.1 and Table N1102.1.2. The values are the same as those in the 2009 IECC except that the SHGC values are less stringent than the values provided in the 2009 IECC.

4.3. Doors:

For the 2001 IECC prescriptive and performance paths, the U-value of the doors was set to be at 0.2 Btu/hr. sq ft F. (Sec. 402.1.3.4.3). Since the code did not give any information for locating the doors in the model, two doors were assumed, one each on the front and the back orientation. Both the 2009 IECC performance and 2009 prescriptive specifications have two doors assigned to the north orientation (Table 402.1.3). However, for the purpose of this simulation suite, two doors were assumed—one each on the front and back orientation. The specification for the U-Value of the door was the same as the specifications for the fenestration U-values. In a similar fashion, the 2009 IRC did not provide any guidelines for locating doors in the simulation model. Hence the simulation model used the same assumptions as the 2001 IECC. The U-value of the door is given in Table N1101.5 (2).

4.4. Attic Infiltration:

The 2001 IECC did not provide any guidance for attic infiltration for the performance and prescriptive path. Hence, the values were adopted from the 2009 IECC. The simulation model assumes a fractional leakage of 0.0033 when using the Sherman-Grimsrud model and 1.5 air changes per hour (ACH) when using the air change per hour method to calculate impact of infiltration. The 2009 IRC does not provide any guidance with respect to attic infiltration. Hence, the values were adopted from the 2009 IECC.

4.5. Air Exchange Rate:

Standard air leakage area is dependent on the number of stories in the house for 2001 IECC. As per Sec 402.1.3.10 of the 2001 IECC, the values are set at 0.00057 for a one-story house. The value was obtained by converting the normalized leakage of 0.57 as proposed in the code and is calculated using the Sherman-Grimsrud infiltration method. For the 2009 IECC performance, as well as the prescriptive path, the value of the air exchange rate was set at 0.00036 as per specifications from Table 405.5.2(1). The 2009 IRC did not have any specifications for the air exchange rate. Hence a value similar to 2009 IECC was used, and the SLA value was set at 0.00036.

5. Space Conditions

5.1. Internal Heat Gains:

In Sec 402.1.3.6 of the 2001 IECC, the internal gains were fixed at 3,000 Btu/hr regardless of the house size. To perform the analysis, the values were modified to 3,909 Btu/hr in order to match the 2009 IECC simulation which is based on the house size. In the 2009 IECC, the internal heat gains are a function of conditioned square footage and the number of bedrooms in the house. The internal heat gains were calculated by the equation provided in Table 405.5.2 (1) of the code. There were no specifications in the 2009 IRC. Hence, a value of 3,909 Btu/hr, which is the same as that in the 2009 IECC, was used.

5.2. Interior Shading:

In Sec 402.1.3.5 of 2001 IECC the values used for interior shading for summer and winter were 0.7 and 0.9 respectively. In Table 405.5.2 (1) of the 2009 IECC performance path and prescriptive path the interior shading for summer and winter has values of 0.7 and 0.85, respectively. Since the 2009 IRC does not specify any interior shading values for summer or winter, the 2009 IECC values are used, with the interior shading fixed at 0.7 for summer and 0.85 for winter.

6. Systems

6.1. Thermostat Settings:

The 2001 IECC recommends a thermostat setting of 78°F for cooling and 68°F for heating (Table 402.1.3.5), and a setback of 5°F is specified. However, the modified 2001 IECC did not have any setback, and the thermostat settings were modified to 75°F for cooling and 72°F for heating to match the specifications in the 2009 IECC.

For the 2009 IECC performance path (Table 405.5.2 (1)) the thermostat setting is specified at 75°F for cooling and 72°F for heating with no setback.

The 2009 IRC has no specification for thermostat setting and setback. The thermostat setting were fixed at 75°F for cooling and 72°F for heating with no setback, which is same as that specified in the 2009 IECC code.

6.2. Heating and Cooling System Efficiency:

Heating and cooling system efficiency trade-offs are allowed for the 2001 IECC. However, in the 2009 IECC (Table 503.2.3 (1), (2), (3)), no trade-offs are allowed. In contrast, the IRC 2009 did not specify any heating or cooling efficiency requirements so specifications similar to 2009 IECC were used.

6.3. Service Water Heating Efficiency:

In the 2001 IECC and 2009 IECC, the minimum domestic hot water heating efficiency is specified in Table 504.2, which is a function of the water heater capacity. Since there was no specification in the 2009 IRC, the specifications for the 2009 IECC were used.

6.4. Duct Leakage:

As per the specifications in section 402.1.3.9 of the 2001 IECC, the thermal distribution efficiency for one story buildings is set at 0.8. For the performance path in 2009 IECC, an option for using specified thermal distribution efficiency is provided (Table 405.5.2(2)). However, in the case of compliance using the prescriptive path the thermal distribution efficiency is not specified. Specifications in Sec. 403.2.2 for duct leakage are used instead. A duct leakage of 8 CFM/100ft^2 to outdoor is specified, which gives a value for the duct leakage equal to 11.1%. In Sec N1103.2.2 of the 2009 IRC too, the duct leakage is 8 CFM/100ft^2 to outdoor. This specification yields a value for the total duct leakage to the outdoor equal to 11.1%. The duct leakage specifications for both the 2009 IRC and 2009 IECC (prescriptive section) are the same.

6.5. Duct Insulation:

Whenever applicable the 2001 IECC prescribes the supply duct and return duct to be insulated with insulation of R-values of R-8 and R-4 respectively. The 2009 IECC recommends that both the supply and return ducts be insulated with insulation of R-8 and R-6 (Sec 403.2.1). In Sec. N1103.2.2 of the 2009 IRC, the supply and return duct is insulated with insulation of R-8 and R-6 respectively. Provisions in 2009 IRC and 2009 IECC were the same for duct insulation.

7. Simulation Test Suite and Results

Simulation runs were made for a single story house with a conditioned area of 2,500 sq ft. Simulations were run using the 2001 IECC, 2001 IECC modified, 2009 IECC performance path, 2009 IECC prescriptive path and 2009 IRC to specify the model characteristics, for different counties (climate zones) and heating options (gas/electric). The results are tabulated in Table 3, Table 4 and Table 5. The analysis was performed for a case with gas heating and gas domestic hot water and for a case with heat pump heating and electric hot water system. Percentage savings over the 2001 IECC are presented for both site and source energy.

Table 3: 2001 IECC Performance Path vs. 2009 IECC Performance Path

County	IECC 2009 Weather Zones	Energy Type**	Total Annual Savings of the IECC 2009 Performance Path compared to the IECC 2000/2001 (%)*	
			Gas Heating, DHW	Heat Pump Heating, Electric DHW
Houston (HAR)	2A	Site	10.9 %	10.9 %
		Source	11.9 %	10.9 %
Brownsville (CAM)	2B	Site	16.4 %	13.6 %
		Source	15.1 %	13.6 %
Dallas (TAR)	3A	Site	12.8 %	10.8 %
		Source	12.3 %	10.8 %
El Paso (ELP)	3B	Site	10.2 %	10.0 %
		Source	11.2 %	10.0 %
Amarillo (ARM)	4B	Site	16.0 %	14.6 %
		Source	16.7 %	14.6 %

**Base-case Simulation Assumptions:* Analysis used single-family house, 2,500 ft^2, single story, four bedrooms, slab-on-grade, ducts in the unconditioned, ventilated attic, window-to-floor ratio: 18% for 2001 IECC, 15% for 2009 IECC, windows equally distributed (N,E,S,W), and no exterior shading. HVAC Distribution efficiency: 0.8 for 2001 IECC, 0.88 for 2009 IECC. All other roof, wall and window parameters as per 2001 IECC and 2009 IECC for county shown in Table 1 and Table 2 (from IC3 ver. 3.03.02).
***Source Energy Consumption*: A factor of 3.16 was used to calculate the source electricity consumption. A factor of 1.1 is used to calculate source gas energy consumption.

Table 4: 2001 IECC Performance Path vs. 2009 IECC Prescriptive Path

County	IECC 2009 Weather Zones	Energy Type**	Total Annual Savings of the IECC 2009 Prescriptive Path compared to the IECC 2000/2001 (%)*	
			Gas Heating, DHW	Heat Pump Heating, Electric DHW
Houston (HAR)	2A	Site	7.8 %	8.7 %
		Source	9.1 %	8.7 %
Brownsville (CAM)	2B	Site	14.3 %	11.6 %
		Source	13.0 %	11.6 %
Dallas (TAR)	3A	Site	9.6 %	8.6 %
		Source	9.6 %	8.6 %
El Paso (ELP)	3B	Site	7.0 %	8.3 %
		Source	8.9 %	8.3 %
Amarillo (ARM)	4B	Site	10.7 %	11.9 %
		Source	13.1 %	11.9 %

**Base-case Simulation Assumptions:* Analysis used single-family house, 2,500 ft^2, single story, four bedrooms, slab-on-grade, ducts in the unconditioned, ventilated attic, window-to-floor ratio: 18% for 2001 IECC, 15% for 2001 IECC modified, 2009 IECC and 2009 IRC, windows equally distributed (N,E,S,W), and no exterior shading. HVAC Distribution efficiency: 0.8 for 2001 IECC, for 2009 IECC, HVAC distribution efficiency simulated using R8 insulation for supply, R6 for return ducts and a total duct leakage of 11% to the outdoor. All other roof, wall and window parameters as per 2001 IECC and 2009 IECC for county shown in Table 1 and Table 2 (from IC3 ver. 3.03.02).
***Source Energy Consumption*: A factor of 3.16 was used to calculate the source electricity consumption. A factor of 1.1 is used to calculate source gas energy consumption.

Table 5: 2001 IECC Performance Path vs. 2009 IRC Prescriptive Path

County	IECC 2009 Weather Zones	Energy Type**	Total Annual Savings of the IRC 2009 compared to the IECC 2000/2001 (%)*	
			Gas Heating, DHW	Heat Pump Heating, Electric DHW
Houston (HAR)	2A	Site	7.7 %	7.7 %
		Source	8.3 %	7.7 %
Brownsville (CAM)	2B	Site	13.7 %	10.4 %
		Source	11.8 %	10.4 %
Dallas (TAR)	3A	Site	9.9 %	7.8 %
		Source	9.0 %	7.8 %
El Paso (ELP)	3B	Site	7.1 %	7.1 %
		Source	7.9 %	7.1 %
Amarillo (ARM)	4B	Site	10.7 %	11.9 %
		Source	13.1 %	11.9 %

**Base-case Simulation Assumptions:* Analysis used single-family house, 2,500 ft^2, single story, four bedrooms, slab-on-grade, ducts in the unconditioned, ventilated attic, window-to-floor ratio: 18% for 2001 IECC, 15% for 2009 IRC, windows equally distributed (N,E,S,W), and no exterior shading. HVAC Distribution efficiency: 0.8 for 2001 IECC; for 2009 IRC, HVAC distribution efficiency was simulated using R8 insulation for supply, R6 for return ducts and total duct leakage of 11% to outdoor. All other roof, wall and window parameters as per 2001 IECC and 2009 IRC for county shown in Table 1 and Table 2 (from IC3 ver. 3.03.02).
***Source Energy Consumption*: A factor of 3.16 was used to calculate the source electricity consumption. A factor of 1.1 is used to calculate source gas energy consumption.

8. Conclusions

The results of the simulations show:

1. For residential construction with 15% or less window to floor ratio, the residential prescriptive provisions for the 2009 IECC and the Chapter 11 of the 2009 IRC are as stringent as the Texas Building Energy Performance Standards (TBEPS), which is based on the 2001 IECC. The Laboratory's analysis of the 2009 IECC and the Chapter 11 of the 2009 IRC indicate a marginal improvement in overall residential energy efficiency of the 2009 IECC over the energy provisions of the 2009 IRC.
2. For all other residential structures, the residential performance provisions of the 2009 IECC are as stringent as the TBEPS based on the 2001 IECC.
3. The commercial provisions of the 2009 IECC are as stringent as the TBEPS based on the 2001 IECC.

Results of the comparison of the 2001 IECC with the values obtained from implementing the 2009 IECC performance path, when considering gas heating, the site energy savings are in the range of 10.2% to 16.4%. The source energy savings are in the range of 11.2% to 16.7%. When considering the heat pump option, both the site and source energy savings are in the range of 10% to 14.6%.

Results of the comparison of the 2001 IECC with the values obtained from implementing the 2009 IECC prescriptive path, when considering gas heating, the site energy savings are in the range of 7% to 14.3%. The source energy savings are in the range of 8.9% to 13.1%. When considering heat pump heating, both the site and source energy savings are in the range of 8.3% and 11.9%.

Results of the comparison of the 2001 IECC with the values obtained from implementing the 2009 IRC prescriptive path, when considering gas heating, the energy savings for site are in the range of 7.1% to 13.7%. The energy savings for source is in the range of 7.9% to 11.8%. When considering heat pump heating, the energy savings for both source and site energy are in the range of 7.1% to 11.9%.

9. Appendix

ENERGY SYSTEMS LABORATORY
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September 29th, 2009

Mr. Felix Lopez, P.E.
Senior Engineer
State Energy Conservation Office
Comptroller of Public Accounts
111 East 17th Street, Room 114
Austin, Texas 78701

Dear Felix:

In accordance with the Health and Safety Code Section 388.003, as amended, the Laboratory reviewed and considered the comments received and performed a technical analysis that compared the stringency of the Texas Building Energy Performance Standards, based on the 2000 International Energy Conservation Code with the 2001 Supplement (2000/2001 IECC), to the 2009 IECC and Chapter 11 of the 2009 IRC.

The Laboratory recommends that Texas, through the State Energy Conservation Office's (SECO) rulemaking process, adopt the 2009 IECC and the Chapter 11 of the 2009 IRC, as statewide energy codes. The state should immediately begin educating, training, and providing technical assistance for building professionals and enforcement officials to enable statewide compliance.

The Laboratory's analysis has determined that:

1. For residential construction with 15% or less window to floor ratio, the residential prescriptive provisions of the 2009 IECC and the Chapter 11 of the 2009 IRC are as stringent as the Texas Building Energy Performance Standards (TBEPS), which is based on the 2000/2001 IECC (see attached tables for details). The Laboratory's analysis of the 2009 IECC and the Chapter 11 of the 2009 IRC indicate a marginal improvement in overall residential energy efficiency of the 2009 IECC over the energy provisions of the 2009 IRC.

2. For all other residential structures, the residential performance provisions of the 2009 IECC are as stringent as the TBEPS based on the 2000/2001 IECC.

3. The commercial provisions of the 2009 IECC are as stringent as the TBEPS based on the 2000/2001 IECC.

The Laboratory recognizes that several major municipalities are in the process of adopting energy codes that are equal to the 2009 IECC and/or the energy provisions of the 2009 IRC Codes. Although builders, suppliers, and manufacturers will be required to meet the newly adopted codes, and will need to retrain their employees and restock their supplies to meet the new requirements of the more stringent code, implementation of improved codes should be effected as soon as possible in order to maximize desired emissions reductions. An increased number of raters, inspectors and code officials will also be required to handle the increased demand. The Laboratory recognizes the challenge of these efforts and is ready to assist SECO. The Laboratory is also in the process of updating the International Code Compliance Calculator (IC3) to facilitate compliance with the new residential provisions of the 2009 IECC.

Notwithstanding the comparisons in overall energy efficiency, the Laboratory observes the potentially greater reduction in peak demand associated with the 0.30 SHGC limitations found in the 2009 IECC. This, in addition to the corresponding emissions reduction resulting from the peak demand savings, provides enhanced benefits over a higher SHGC in compliance with the goals of the Texas Building Energy Performance Standards in the Health & Safety Code Section 388. 001.

The Laboratory recommends compliance with the 2009 IECC or the Chapter 11 of the 2009 IRC when using the prescriptive path for residential evaluation of residences with 15% or less window to floor ratio, since both are more stringent than the current TBEPS. The Laboratory also recommends using the 2009 IECC when using the performance path for all other residential evaluations.

These new codes will further Texas' Emission Reduction Plan (TERP) goals in improving air quality. Furthermore, adoption of the 2009 IECC is a requirement for securing American Recovery and Reinvestment Act (ARRA) Federal funding for Texas.

Sincerely,

Bahman Yazdani, P.E.	Charles Culp, P.E., Ph.D.	Jeff Haberl, P.E., Ph.D.
Associate Director	Associate Director	Associate Director

cc: David Claridge, P.E., Ph.D., Director – ESL

Table 1: 2000/2001 IECC Performance Path vs. 2009 IECC Performance Path

County	IECC 2009 Weather Zones	Energy Type**	Total Annual Savings of the IECC 2009 Performance Path compared to the IECC 2000/2001 (%)*	
			Gas Heating, DHW	*Heat Pump Heating, Electric DHW
Houston (HAR)	2A	Site	10.9 %	10.9 %
		Source	11.9 %	10.9 %
Brownsville (CAM)	2B	Site	16.4 %	13.6 %
		Source	15.1 %	13.6 %
Dallas (TAR)	3A	Site	12.8 %	10.8 %
		Source	12.3 %	10.8 %
El Paso (ELP)	3B	Site	10.2 %	10.0 %
		Source	11.2 %	10.0 %
Amarillo (ARM)	4B	Site	16.0 %	14.6 %
		Source	16.7 %	14.6 %

**Base-case Simulation Assumptions:* Analysis used single-family house, 2,500 ft^2, single story, four bedrooms, slab-on-grade, ducts in the unconditioned, ventilated attic, window-to-floor ratio: 18% for 2000/2001, 15% for 2009, windows equally distributed (N,E,S,W), and no exterior shading. HVAC Distribution efficiency: 0.8 for 2000/2001, 0.88 for 2009. All other roof, wall and window parameters as per 2000/2001 and 2009 IECC for county shown (IC3 ver. 3.03.02).
***Source Energy Consumption*: A factor of 3.16 was used to calculate the source electricity consumption. A factor of 1.1 was used to calculate source gas energy consumption.

Table 2: 2000/2001 IECC Performance Path vs. 2009 IECC Prescriptive Path

County	IECC 2009 Weather Zones	Energy Type**	Total Annual Savings of the IECC 2009 Prescriptive Path compared to the IECC 2000/2001 (%)*	
			Gas Heating, DHW	Heat Pump Heating, Electric DHW
Houston (HAR)	2A	Site	7.8 %	8.7 %
		Source	9.1 %	8.7 %
Brownsville (CAM)	2B	Site	14.3 %	11.6 %
		Source	13.0 %	11.6 %
Dallas (TAR)	3A	Site	9.6 %	8.6 %
		Source	9.6 %	8.6 %
El Paso (ELP)	3B	Site	7.0 %	8.3 %
		Source	8.9 %	8.3 %
Amarillo (ARM)	4B	Site	10.7 %	11.9 %
		Source	13.1 %	11.9 %

**Base-case Simulation Assumptions:* Analysis used single-family house, 2,500 ft^2, single story, four bedrooms, slab-on-grade, ducts in the unconditioned, ventilated attic, window-to-floor ratio: 18% for 2000/2001, 15% for 2009, windows equally distributed (N,E,S,W), and no exterior shading. HVAC Distribution efficiency: 0.8 for 2000/2001; for 2009 IECC, HVAC distribution efficiency simulated using R8 insulation for supply, R6 for return ducts and total duct leakage of 11% to outdoor. All other roof, wall and window parameters as per 2000/2001 and 2009 IECC for county shown (IC3 ver. 3.03.02).
***Source Energy Consumption*: A factor of 3.16 was used to calculate the source electricity consumption. A factor of 1.1 was used to calculate source gas energy consumption.

Table 3: 2000/2001 IECC Performance Path vs. Chapter 11 of the 2009 IRC Prescriptive Path

County	IECC 2009 Weather Zones	Energy Type**	Total Annual Savings of the IRC 2009 compared to the IECC 2000/2001 (%)*	
			Gas Heating, DHW	Heat Pump Heating, Electric DHW
Houston (HAR)	2A	Site	7.7 %	7.7 %
		Source	8.3 %	7.7 %
Brownsville (CAM)	2B	Site	13.7 %	10.4 %
		Source	11.8 %	10.4 %
Dallas (TAR)	3A	Site	9.9 %	7.8 %
		Source	9.0 %	7.8 %
El Paso (ELP)	3B	Site	7.1 %	7.1 %
		Source	7.9 %	7.1 %
Amarillo (ARM)	4B	Site	10.7 %	11.9 %
		Source	13.1 %	11.9 %

**Base-case Simulation Assumptions:* Analysis used single-family house, 2,500 ft^2, single story, four bedrooms, slab-on-grade, ducts in the unconditioned, ventilated attic, window-to-floor ratio: 18% for 2000/2001, 15% for 2009 IRC, windows equally distributed (N,E,S,W), and no exterior shading. HVAC Distribution efficiency: 0.8 for 2000/2001; for 2009 IRC, HVAC distribution efficiency simulated using R8 insulation for supply, R6 for return ducts and total duct leakage of 11% to outdoor. All other roof, wall and window parameters as per 2000/2001 and 2009 IRC for county shown (IC3 ver. 3.03.02).

***Source Energy Consumption*: A factor of 3.16 was used to calculate the source electricity consumption. A factor of 1.1 was used to calculate source gas energy consumption.