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DEVELOPMENT OF THE COMPLIANCE SOFTWARE TOOL ASSISTANCE MANUAL FOR THE 2014 FLORIDA BUILDING ENERGY CODE

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Final Report

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DEVELOPMENT OF THE COMPLIANCE SOFTWARE TOOL ASSISTANCE MANUAL FOR THE 2014 FLORIDA BUILDING ENERGY CODE

Final Report - Technical Approach and Work done

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Florida Solar Energy Center
June 15, 2014 Revised June 30, 2014

BACKGROUND:

Florida Energy code compliance is essentially done through compliance software approved by the Florida Building commission. As a result, the compliance software plays a critical role in "improving the implementation and enforcement" of Florida's energy code. The Technical Assistance Manual (TAM) is part of the software approval process.

RATIONAL:

The proposed 2014 residential and commercial energy codes are principally based on IECC 2012 with the commercial code, in addition, having the option of using ASHRAE 90.1 2010. In general, both residential and commercial codes specify complex rules and procedures to determine compliance of a building. Implementation of these rules are the key to ensuring that the inputs from a user are being correctly translated per established rules and compliance determined accurately.

TECHNICAL APPROACH AND WORK DONE

REVIEWED EXISTING TECHNICAL ASSISTANCE MANUAL.

The current TAM was thoroughly reviewed for current applicability and relevant sections were extracted modified or added to conform to the requirements of the 2014 Florida Energy Code for both residential and commercial applications.

UPDATED GENERAL SOFTWARE REQUIREMENTS

General requirements that applied to both commercial and residential sections were updated that included user manual and help system requirements, user interface and error check requirements, and consistency checks.

UPDATED RESIDENTIAL ENERGY COMPLIANCE PROCEDURE

The 2014 Building Code, Energy Conservation allows for three prescriptive and one performance method for residential compliance. Previously the technical assistance manual was only written for the performance method. However, software for the last code was developed for the Total UA Alternative method and there was no established testing procedures. Furthermore some software products may want to offer software solutions for the R-Value Method or U-Factor method. Thus, procedures, tests and reports were developed for each of the prescriptive methods for software vendors to use for compliance. The performance method was updated to reflect changes to the code and a new standard reference design. The autogen test was updated to reflect the new standard reference design. A new e-ratio suite of tests was developed that allows for verifying

of the correctness of the calculating the procedure by which the energy uses of the proposed and the standard reference design estimated energy uses are compared.

DEVELOPED EVALUATION SPREADSHEETS FOR RESIDENTIAL PRESCRIPTIVE BASED METHODS.

A workbook "Residential Prescriptive Compliance Test 2014.xls" was created to test the ability of software to perform each of the prescriptive methods. Six new homes were created (See Appendix R-2 of the TAM). For the R-Value method the only calculated fields entered are the area weighted average SHGC and fenestration U-Factor. For each other parameter the vendor has to report if the software indicated too low of an R-value for envelope components and whether mandatory parameters passed or if they are not evaluated by the software. If all entries achieve the expected result then the software receives a "Pass" evaluation. The U-Factor test is similar with the selection of U-factor being too high. The Total UA Alternative method has added calculation fields of proposed and baseline Total UA values. Because there is some variability of how U-Factors may be calculated for each assembly, a 2% plus or minus band was put on the total UA values the authors calculated. The authors' calculation of U-factors and total UA values for the example houses are included in separate tabs in the workbook.

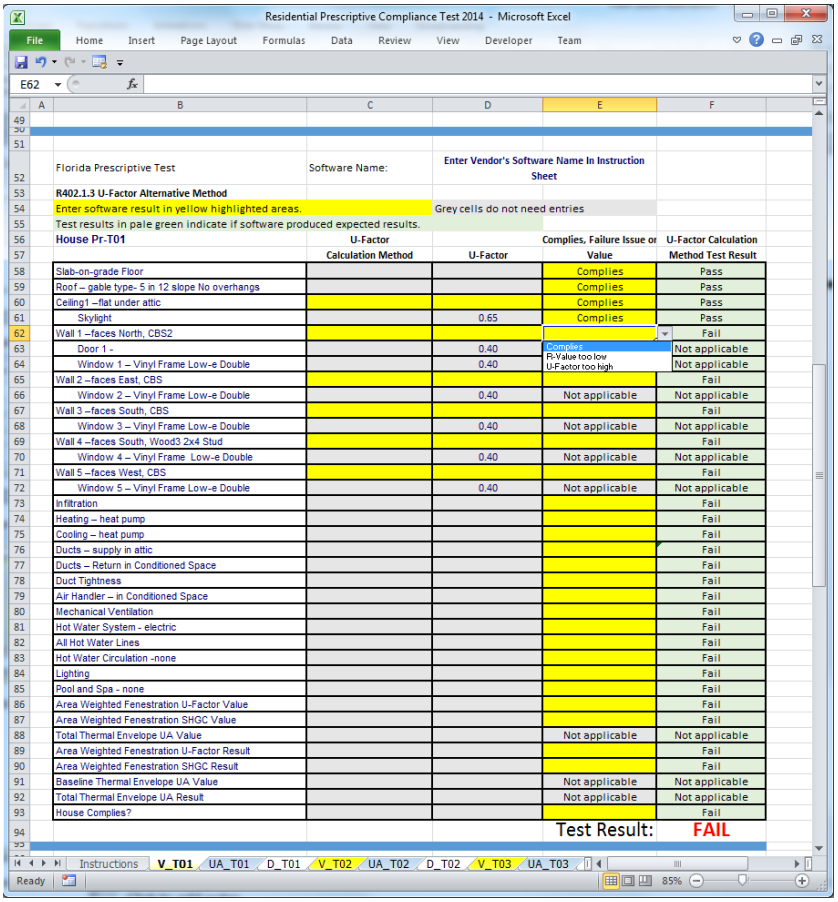


Figure 1. Section of Residential Prescriptive Spreadsheet used to show software compliance

The six test homes created for the prescriptive evaluation were chosen to catch some of the potentially common problems without necessarily trying to be exhaustive and too cumbersome for software vendors. One of the key areas tested is the fact that only the R-value method allows for 15 square feet of window and

24 square feet of door area to be excluded from the average weighted U-factor for fenestrations. Furthermore only the R-value method allows for the impact resistant glass exception in this calculation. Other tests are directed at U-factor calculation for insulated core concrete blocks and steel frame wall assemblies. There is also an obvious missed mandatory parameter that should be caught. Test cases cover climate zones 1 and 2.

DEVELOPED EVALUATION SPREADSHEETS FOR RESIDENTIAL PERFORMANCE BASED METHODS.

The autogen test was designed to verify whether compliance software is capable of generating the standard reference design building inputs using only the proposed design data. The five test cases were updated and the autogen spreadsheet was updated to the 2014 standard reference design.

A new series of tests were created to determine the ability of the software to correctly determine the ability of software compliance tools to accurately calculate the Florida Energy Code compliance eRatio given a set of Standard Reference Design End Use Loads (REUL), Standard Reference Design End Use Energy Consumptions (EC_r), Proposed Home End Use Energy Consumptions (EC_x) and the applicable manufacturer's equipment performance ratings (MEPR). This test uses the characteristics of five building descriptions used for the current performance test but alters equipment specifications in each:

Case L130A-01: Using the HERS BESTEST L130 case, create a 3-bedroom Proposed Home containing the following equipment:

Heating system – electric HP with HSPF = 7.7

Cooling system – electric A/C with SEER = 13.0

Hot Water – 40 gal electric with EF = 0.92

All the equipment are to be located inside the conditioned space and heating and air conditioning ductwork are to be located in the conditioned space and have zero (0) air leakage.

Case L100A-02: Identical to Case L130A-01 except that the hot water heater is changed to a tankless natural gas with EF = 0.82.

Case L100A-03: Identical to Case L130A-01 except that the space heating system is changed to a natural gas furnace with AFUE = 78%.

Case L100A-04: Identical to Case L130A-01 except that the space heating system is changed to a high efficiency HP with SEER=17 and HSPF = 10.

Case L100A-05: Identical to Case L130A-01 except that the space heating system is changed to a high efficiency natural gas furnace with AFUE = 96%.

Using the calculation spreadsheet provided (FL_eRatio-results_form.xls), software tools have to show that the reported Reference Home End Use Loads (REULs) vary by less than 0.2% across all cases and that the difference between the eRatios calculated by the software tool and the eRatios calculated by the results spreadsheet provided by the Florida Building Commission is less than 0.5% for all cases.

DEVELOPED SAMPLE REPORTS

The TAM describes the list of reports that are expected for each method of residential compliance. Appendix R lists requirements and has samples of how reports might be formatted. Seven reports are created for the R-value method

1) Form R402-2014 which includes the parameters of Table R402.1.1 ,
2) The Energy Performance Level (EPL) Display Card
3) Mandatory requirements
4) A checklist of expected reports and number of pages in each
5) A completed Air Barrier and Insulation Inspection Component Criteria checklist (Table R402.4.1.1 of the 2014 Florida Building Code, Energy Conservation with added checkboxes - one page)
6) A completed Envelope Leakage Test Report (usually one page), and
7) A completed Air Distribution System Test Report (usually one page), unless all duct work and air handler units are located with the building thermal envelope

Reports 2 -7 are also used for each other type of compliance although report 4 varies for each type. The U-Factor Alternative method and Total UA Alternative method each have their own reports. The performance method has a R405-2014 form that resembles the 2010 form but has been updated. Because software submitted may only be seeking one method of compliance some care was given in the TAM to indicate by method what is expected for reports as well as submittals. Thus, some reports are repeated in different sections of Appendix R so that vendors can see the reports for their method in one location. Thus, a total of 28 sample reports were created and are included.

UPDATED COMMERCIAL ENERGY COMPLIANCE PROCEDURE

The 2014 Florida Energy Code allows five methods of compliance for commercial buildings namely,

1. FEC Prescriptive Method
2. FEC Total Building Performance Method
3. ASHRAE Prescriptive Method
4. ASHRAE Envelope Trade-off Method
5. ASHRAE Energy Cost Budget Method

Since compliance software may cover one or more of the commercial code compliance methods listed above, appropriate test were designed to verify calculations for the each of the methods. Following were the tests developed based on the compliance methods supported.

1. FEC Prescriptive Method: Six test cases were developed for vendors to validate.
2. FEC Total Building Performance Method: Several test cases were developed for vendor to validate.
3. ASHRAE Prescriptive Method: Six test cases were developed for vendors to validate.
4. ASHRAE Envelope Trade-off Method: Two test cases were developed for vendors to validate.
5. ASHRAE Energy Cost Budget Method: Several test cases were developed for vendor to validate.

DEVELOPED EVALUATION SPREADSHEETS FOR PERFORMANCE BASED METHODS.

The performance based method evaluation was designed to verify whether compliance software is capable of generating the standard reference design building parameters using only the proposed design data. There are sixteen test cases for the performance methods based on the six prototype buildings. Each test case was designed to capture a possible practical design scenario. The spreadsheet workbook file named "***CommercialPerformanceMethodsResults.xls***" contains the standard reference design building data for performance based test methods for each of the prototype building test cases created based on the minimum requirements of the Florida Energy Code and ASHRAE 90.1 option. There are two set of data for each test case and climate zone; one based on the Florida Code and another based on ASHRAE 90.1 option. The standard

reference building data created for each prototype building type is populated in a single worksheet. The performance method results in this spreadsheet workbook were designed for side-by-side comparison of the standard reference design and those to be generated by the vendors' compliance software. A snapshot of the prototype building A1 performance based test method standard reference design minimum requirements for the Florida Energy Code (FEC) and ASHRAE 90.1 are shown in Figure 2.

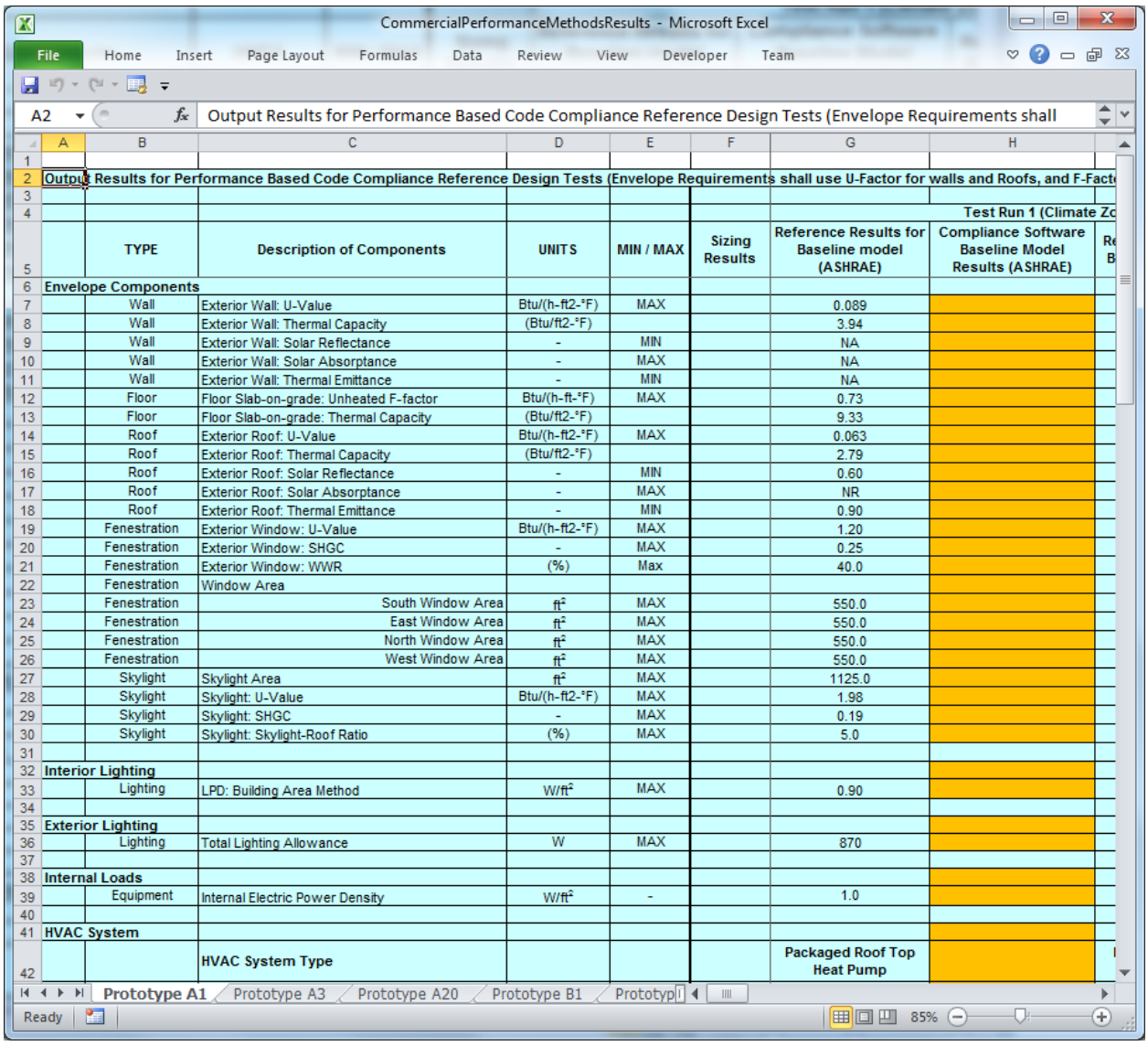


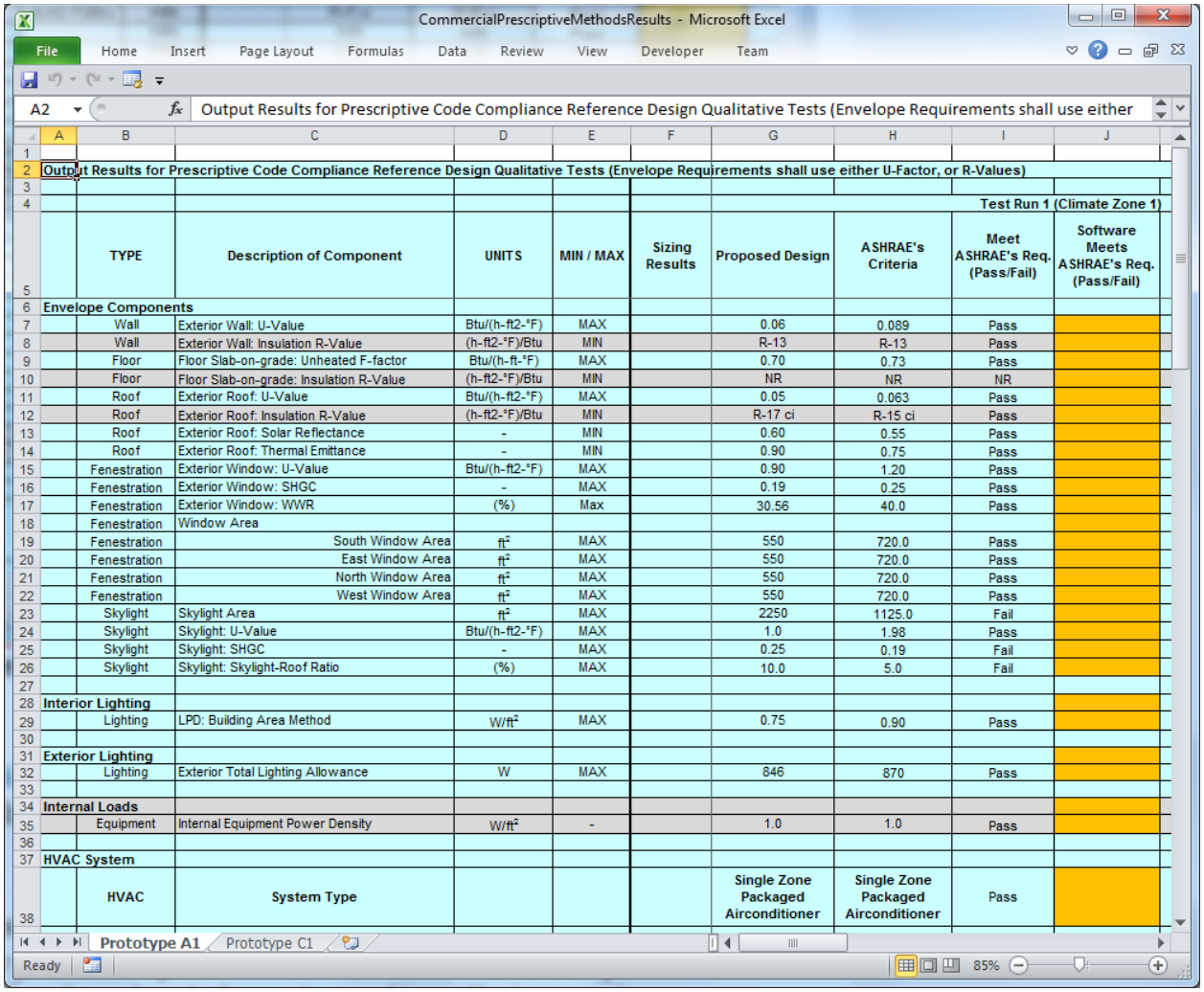
Figure 2. Performance method envelope requirements for prototype building A1

DEVELOPED EVALUATION SPREADSHEETS FOR PRESCRIPTIVE BASED METHODS.

The prescriptive method evaluation is designed to verify whether compliance software is capable of conducting prescriptive method of commercial code compliance calculations. Two prototype buildings were used for the prescriptive methods code compliance software evaluation. The prescriptive code compliance calculation evaluation is performed using the results in the spreadsheet workbook "***CommercialPrescriptiveMethodsResults.xls***". This spreadsheet workbook file contains the proposed design building inputs and the parameters for the two prescriptive methods for each of the test cases by climate

zone. The prescriptive requirements are created for the Florida Energy Code (FEC) and ASHARE 90.1 option based on the minimum requirements of the two standards. This worksheet is designed for side-by-side comparison of the proposed design building inputs to the prescriptive code compliance requirements.

The compliance software vendor generates a list of the proposed design building elements input and the corresponding prescriptive method minimum requirements along with the decision reached and populates the results in the respective worksheet. The decision is a "Pass" or "Fail" depending on whether the proposed design input value of a building element meet the prescriptive requirements or not.



CommercialPrescriptiveMethodsResults - Microsoft Excel

A2: Output Results for Prescriptive Code Compliance Reference Design Qualitative Tests (Envelope Requirements shall use either

Output Results for Prescriptive Code Compliance Reference Design Qualitative Tests (Envelope Requirements shall use either U-Factor, or R-Values)

Test Run 1 (Climate Zone 1)

	TYPE	Description of Component	UNITS	MIN / MAX	Sizing Results	Proposed Design	ASHRAE's Criteria	Meet ASHRAE's Req. (Pass/Fail)	Software Meets ASHRAE's Req. (Pass/Fail)
Envelope Components									
	Wall	Exterior Wall: U-Value	Btu/(h-ft2-°F)	MAX		0.06	0.089	Pass	
	Wall	Exterior Wall: Insulation R-Value	(h-ft2-°F)/Btu	MIN		R-13	R-13	Pass	
	Floor	Floor Slab-on-grade: Unheated F-factor	Btu/(h-ft-°F)	MAX		0.70	0.73	Pass	
	Floor	Floor Slab-on-grade: Insulation R-Value	(h-ft2-°F)/Btu	MIN		NR	NR	NR	
	Roof	Exterior Roof: U-Value	Btu/(h-ft2-°F)	MAX		0.05	0.063	Pass	
	Roof	Exterior Roof: Insulation R-Value	(h-ft2-°F)/Btu	MIN		R-17 ci	R-15 ci	Pass	
	Roof	Exterior Roof: Solar Reflectance	-	MIN		0.60	0.55	Pass	
	Roof	Exterior Roof: Thermal Emittance	-	MIN		0.90	0.75	Pass	
	Fenestration	Exterior Window: U-Value	Btu/(h-ft2-°F)	MAX		0.90	1.20	Pass	
	Fenestration	Exterior Window: SHGC	-	MAX		0.19	0.25	Pass	
	Fenestration	Exterior Window: WWR	(%)	Max		30.56	40.0	Pass	
	Fenestration	Window Area							
	Fenestration	South Window Area	ft²	MAX		550	720.0	Pass	
	Fenestration	East Window Area	ft²	MAX		550	720.0	Pass	
	Fenestration	North Window Area	ft²	MAX		550	720.0	Pass	
	Fenestration	West Window Area	ft²	MAX		550	720.0	Pass	
	Skylight	Skylight Area	ft²	MAX		2250	1125.0	Fail	
	Skylight	Skylight: U-Value	Btu/(h-ft2-°F)	MAX		1.0	1.98	Pass	
	Skylight	Skylight: SHGC	-	MAX		0.25	0.19	Fail	
	Skylight	Skylight: Skylight-Roof Ratio	(%)	MAX		10.0	5.0	Fail	
Interior Lighting									
	Lighting	LPD: Building Area Method	W/ft²	MAX		0.75	0.90	Pass	
Exterior Lighting									
	Lighting	Exterior Total Lighting Allowance	W	MAX		846	870	Pass	
Internal Loads									
	Equipment	Internal Equipment Power Density	W/ft²	-		1.0	1.0	Pass	
HVAC System									
	HVAC	System Type				Single Zone Packaged Airconditioner	Single Zone Packaged Airconditioner	Pass	

Prototype A1 | Prototype C1

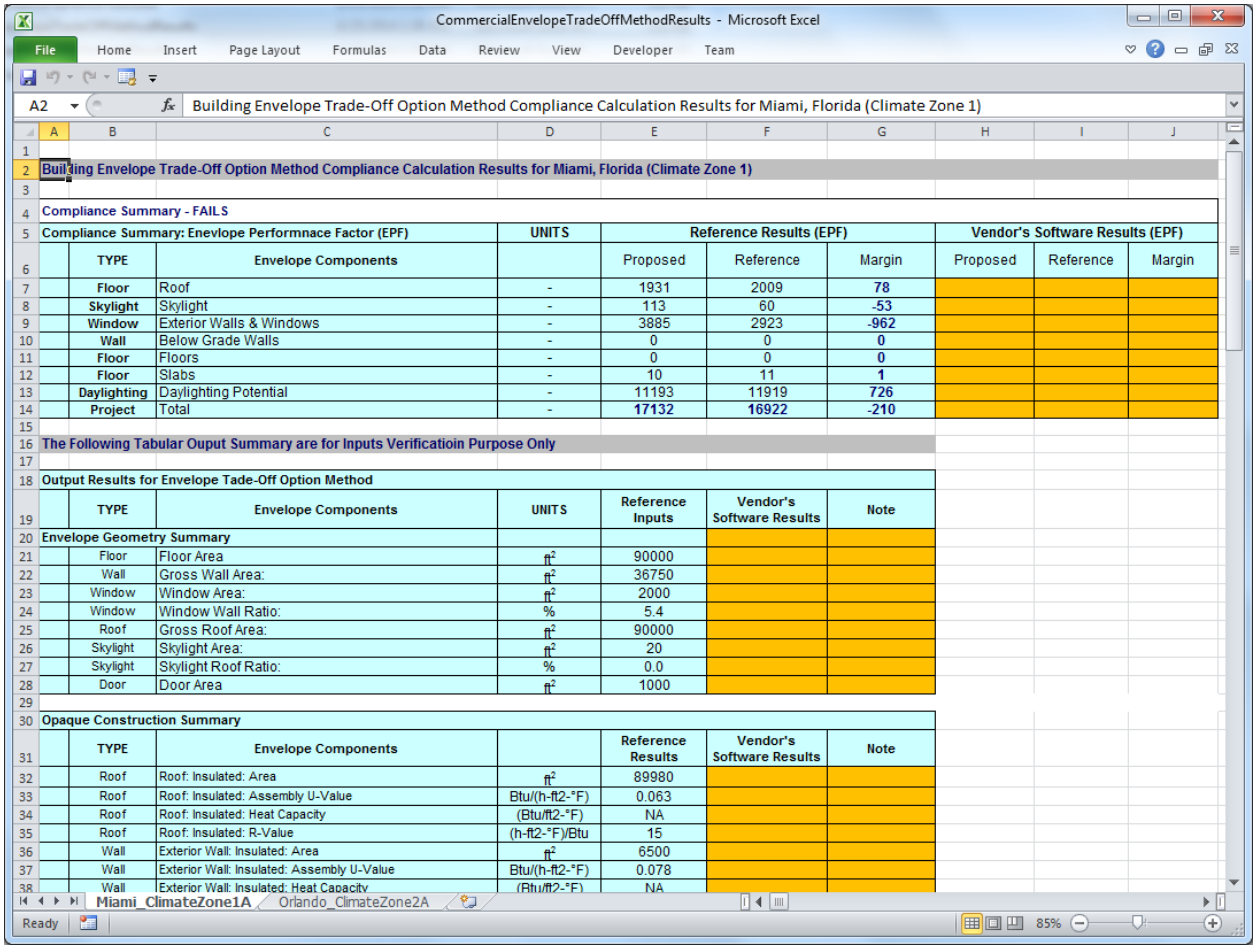
Ready

Figure 3 Prescriptive method compliance requirements for prototype building A1

DEVELOPED EVALUATION SPREADSHEETS FOR ASHRAE ENVELOPE TRADE-OFF OPTION

A snapshot of the Envelope trade-off option compliance results spreadsheet for Miami, Florida is shown in **Figure** 4. This spreadsheet contains the compliance summary of *Envelope Performance Factors (EPF)* generated for each element of the proposed and standard reference buildings, and summary of the proposed building inputs for verification. Results for Miami-Dade, FL and Orlando, FL climate zones are provided. The envelope trade-off code compliance simulation results are presented for just the original orientation of the building instead of averaging the results obtained by rotating the proposed building by 90, 180, and 270 angles as required in ASHRAE 90.1 The reference results, which are generated using the EnvStd 6.0 program,

are used as acceptance criteria for the ASHRAE Envelope Trade-Off Option Method. The EnvStd 6.0 program comes with ASHRAE Standard 90.1-2007 User's Manual where building rotation in not required.



CommercialEnvelopeTradeOffMethodResults - Microsoft Excel

Building Envelope Trade-Off Option Method Compliance Calculation Results for Miami, Florida (Climate Zone 1)

Compliance Summary - FAILS

Compliance Summary: Enevlope Performnace Factor (EPF)			UNITS	Reference Results (EPF)			Vendor's Software Results (EPF)		
	TYPE	Envelope Components		Proposed	Reference	Margin	Proposed	Reference	Margin
	Floor	Roof	-	1931	2009	78			
	Skylight	Skylight	-	113	60	-53			
	Window	Exterior Walls & Windows	-	3885	2923	-962			
	Wall	Below Grade Walls	-	0	0	0			
	Floor	Floors	-	0	0	0			
	Floor	Slabs	-	10	11	1			
	Daylighting	Daylighting Potential	-	11193	11919	726			
	Project	Total	-	17132	16922	-210			

The Following Tabular Ouput Summary are for Inputs Verificatioin Purpose Only

Output Results for Envelope Tade-Off Option Method

	TYPE	Envelope Components	UNITS	Reference Inputs	Vendor's Software Results	Note
Envelope Geometry Summary						
	Floor	Floor Area	ft^2	90000		
	Wall	Gross Wall Area:	ft^2	36750		
	Window	Window Area:	ft^2	2000		
	Window	Window Wall Ratio:	%	5.4		
	Roof	Gross Roof Area:	ft^2	90000		
	Skylight	Skylight Area:	ft^2	20		
	Skylight	Skylight Roof Ratio:	%	0.0		
	Door	Door Area	ft^2	1000		

Opaque Construction Summary

	TYPE	Envelope Components		Reference Results	Vendor's Software Results	Note
	Roof	Roof: Insulated: Area	ft^2	89980		
	Roof	Roof: Insulated: Assembly U-Value	Btu/(h-ft2-°F)	0.063		
	Roof	Roof: Insulated: Heat Capacity	(Btu/ft2-°F)	NA		
	Roof	Roof: Insulated: R-Value	(h-ft2-°F)/Btu	15		
	Wall	Exterior Wall: Insulated: Area	ft^2	6500		
	Wall	Exterior Wall: Insulated: Assembly U-Value	Btu/(h-ft2-°F)	0.078		
	Wall	Exterior Wall: Insulated: Heat Capacity	(Btu/ft2-°F)	NA		

Miami_ClimateZone1A | Orlando_ClimateZone2A | Ready | 85%

Figure 4 Envelope trade-off option compliance method results spreadsheet

WROTE COMPLIANCE SOFTWARE TOOL APPROVAL MANUAL (CSTAM) FOR 2014 FLORIDA BUILDING ENERGY CODE

A detailed approval manual was written that contains details of the software requirements, test cases and how a vendor might evaluate compliance of their specific software and file for approval.

BUDGET & SCHEDULE:

The project was on time and within budget of 6 months and $ 70,000.

OUTCOME/DELIVERABLE:

FSEC has delivered a technical assistance manual and supplementary data that provides guidance to approve compliance software tools with the 2014 Florida Building Energy Code for both residential and commercial buildings.