

3.4 Ruleset Implementation Tests

3.4.1 Introduction

The tests in this section are intended to verify that the software correctly constructs the Standard Design model and applies rules of the 2013 Nonresidential ACM appropriately to the proposed and Standard Design models. The rule set implementation tests cover representative portions of the rules for building envelope, lighting, daylighting, space use data and HVAC. For each test there is a set of three models defined:

- User Model – the user model contains the user inputs for the as-designed building. In most cases, the values for the Proposed Design will be taken from user inputs with no modification. However, there are some cases where the building input is prescribed for the Proposed Design, or constrained by mandatory minimums or other rules.
- Proposed Design Model – the proposed model is defined by the rules in the ACM Reference Manual and created by the vendor software and is the building modeled for compliance. This model takes user inputs for building geometry, building envelope, lighting and HVAC and is used in the compliance simulation.
- Standard Design Model – this is the baseline model defined by the ACM Reference Manual modeling rules, and is the basis for comparison that determines whether a building passes compliance using the performance method.

These tests do not require that simulation outputs be verified, but they do require that simulation input files for the Proposed Design and Standard Design are properly constructed according to the rules in the ACM Reference Manual. Some tests require that sizing runs be performed, for HVAC inputs whose values are dependent on autosized Standard Design systems.

3.4.2 Overview

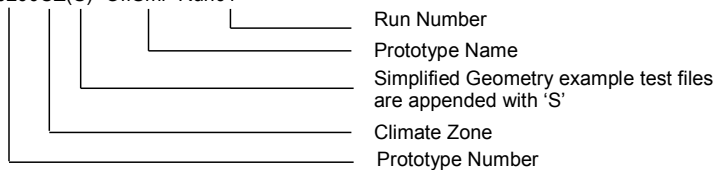
The test runs described in this section represent the Title-24 2013 Non-Residential ACM code compliance calculation and use the following Prototype Models- Small Office Building, Medium Office Building, Large Office Building, Warehouse Building and Small Hotel. For further details on the Prototype Models, refer to Appendix 3C. Each of the Standard Design test cases shall be created by modifying the Prototype Model as described in Section IV of this document. The modified Prototype Model shall form the proposed case for each test run. The Standard Design model shall be generated by compliance software as per the rules in the 2013 Nonresidential ACM. The Standard Design and proposed model files for each test case shall then be evaluated to verify that:

- The Standard Design building envelope constructions are correctly substituted for exterior opaque surfaces and fenestrations.
- Fenestration area in the Standard Design building is reduced in accordance with the 2013 Nonresidential ACM Manual, when the Proposed Design fenestration area is greater than 40% of the exterior wall.
- Skylight area in the Standard Design building is adjusted in accordance with the 2013 Nonresidential ACM Manual, when applicable.
- Default schedules of operation are applied for both the Standard Design building and the Proposed Design.
- The Proposed and Standard Design cases use the same defaults or tailored inputs for internal loads as required by the 2013 Nonresidential ACM Manual.
- The Standard Design building lighting system is correctly specified and that exterior lighting is modeled.

- Receptacle loads and process loads are modeled according to the rules in the 2013 Nonresidential ACM Manual.
 - The Standard Design building uses the correct system types as prescribed in Table 5 of the 2013 Nonresidential ACM Manual.
 - An economizer (of the right type) is included in the Standard Design building if required.
 - The primary and secondary Standard Design building systems are properly specified and sized.
 - Fan brake horsepower is correctly specified for the Standard Design building.
 - Prescribed modeling assumptions are applied for both the Standard Design building and the Proposed Design.
 - Overhangs are modeled in the Proposed Design for Test Case 7 but not the Standard Design building.
 - Unconditioned spaces are modeled.
 - Other Standard Design building specifications and/or modeling assumptions are correctly applied.
- As the software developer verifies the various test conditions, the input and output files should be annotated with comments or other methods to demonstrate that the modeling rules specified in the 2013 Nonresidential ACM Manual are correctly applied. Software developers should use the spreadsheets included in Appendix 3C, to report the results of these tests. These annotated files shall then be submitted to the Commission for further evaluation. Any errors discovered shall be corrected by making modifications to the software; the runs shall be repeated; and the new results shall be annotated for submittal to the Commission.

The Standard Design Tests are labeled using the format:

0200CZ(S) -OffSml- Run01



3.4.3 Ruleset Implementation Tests

The following tests shall be performed to verify that the compliance software correctly creates the Standard Design model and applies modeling rules as per the requirements of the Nonresidential ACM 2013. The user model shall be created by modifying the appropriate Prototype Model type. The Standard Design Model for each test case shall be generated automatically by the compliance software.

The intent of each test run, characteristics of the user model and inputs to be verified in the Proposed and Standard Design models are described below.

1. 020006-OffSml-Run01– This test will verify that the applicant software models the wall, floor and roof construction correctly and that the envelope and fenestration performance requirements for the Standard Design are modelled as per the requirements of 2013 Nonresidential ACM. The user model is a small office building in climate zone 6 with the following envelope characteristics:
 - Steep slope, wood frame roof with assembly U-value of 0.044, Aged Solar Reflectance of 0.75 and Thermal emittance of 0.78
 - Wood-framed wall with assembly U-value of 0.091

- Exterior soffit floor with assembly U-factor of 0.70
- Mass floor with assembly U-value of 0.039
- Fixed window with U-factor of 0.25, SHGC of 0.20 and VT of 0.45

The following inputs in the Proposed Design and Standard Design model file shall be verified and reported in the output form provided in Appendix 3C:

- Standard Design roof, wall and floor construction assembly type
- Standard Design roof, wall and floor overall U-value
- Standard Design roof, wall and floor construction assembly layer inputs
- Standard Design roof aged solar reflectance and thermal emittance
- Window U-factor, SHGC and VT

2. 020015-OffSml-Run02– This test will verify that the applicant software models the wall, floor, roof construction and fenestrations correctly and that the envelope performance requirements for the Standard Design are modelled as per the 2013 Nonresidential ACM.

The user model is a small office building in climate zone 15 with the following envelope characteristics:

- Steep sloped wood frame roof with assembly U-factor of 0.053, Aged Solar Reflectance of 0.60 and Thermal emittance of 0.70
- Metal-framed wall with assembly U-factor of 0.056
- Exterior soffit floor with assembly U-factor of 0.70
- Slab on grade floor with floor F-factor of 0.70
- Horizontal overhang of 2 feet on south facing windows and vertical fins of 2 feet on right of west facing windows

The following inputs in the Proposed Design and Standard Design model file shall be verified and reported in the output form provided in Appendix 3C:

- Standard Design roof, wall and floor construction assembly type
- Standard Design roof, wall and floor construction assembly layer inputs
- Standard Design roof, wall and floor overall U-value
- Standard Design floor slab F-factor
- Standard Design roof aged solar reflectance and thermal emittance.
- Window overhangs for south and west windows

3. 070015-HotSml-Run03 – This test will verify that the applicant software models the wall, floor and roof construction correctly and that the envelope and fenestration performance requirements for the Standard Design are modelled as per the requirements of 2013 Nonresidential ACM.

The user model is a small hotel building in climate zone 15 with the following characteristics:

- Horizontal wood frame roof with assembly U-value of 0.055, Aged Solar Reflectance of 0.60 and Thermal emittance of 0.70
- Metal-framed wall with assembly U-value of 0.082
- Mass floor with assembly U-value of 0.058
- Fixed windows in the first floor with U-factor of 0.25, SHGC of 0.20 and V.T of 0.47
- Operable windows in guest room windows with U-factor of 0.42, SHGC of 0.18 and VT of 0.35

The following inputs in the Standard Design model file shall be verified and reported in the output form provided in Appendix 3C:

- Standard Design roof, wall and floor construction assembly type
- Standard Design roof, wall and floor construction assembly layer inputs

- Standard Design roof, wall and floor U-value
 - Standard Design roof aged solar reflectance and thermal emittance.
 - Window U-value, SHGC and VT
4. 030006-OffMed-Run04 – This test will verify that mandatory minimum opaque envelope insulation requirements are applied. The user model is a small office building in climate zone 6, with a metal-framed wall containing R-5 continuous insulation on the exterior and a U-factor of 0.136.
- For this test, the user model should be **undefined**, and the compliance simulation should not run.
5. 040006-OffLrg-Run05 – Run 05 tests whether the applicant software determines the window area of the Standard Design model as per the rules in 2013 Nonresidential ACM.
- The user model is the large office building in climate zone 6 with an overall window-to-wall ratio (WWR) of 52% made of a continuous band of glass distributed evenly across all facades.
- The following inputs in the Proposed Design and Standard Design model file shall be verified and reported in the output form provided in Appendix 3C:
- Window Area (and WWR) for each orientation
 - Window Area (and Overall WWR) for the building
6. 040006-OffLrg-Run06 – Run 06 tests whether the applicant software determines the window area of the Standard Design model as per the rules in 2013 Nonresidential ACM.
- The user model is the large office building in climate zone 6 with overall building WWR-46% and 50% WWR in the west, 40% in South, 45% in East and 50% in the North façade.
- The following inputs in the Proposed Design and Standard Design model file shall be verified and reported in the output form provided in Appendix 3C:
- Window Area (and WWR) for each orientation
 - Window Area (and Overall WWR) for the building
7. 080006-Whse-Run07 – This test verifies whether the applicant software models the Standard Design skylight as per the performance requirements for skylights in 2013 Nonresidential ACM. This test checks whether the applicant software determines the skylight area of the Standard Design model correctly.
- The user model is a Warehouse building in climate zone 6 with an overall skylight-to-roof ratio (SRR) of 7%. Curb mounted glass skylight with U-value 0.55, SHGC 0.20 and VT 0.40. The building has ceiling heights of 28 feet in the warehouse and 14 feet in the office.
- The following inputs in the Standard Design model file shall be verified and reported in the output form provided in Appendix 3C:
- Skylight U-factor, SHGC and VT, and SRR
8. 080006-Whse-Run08 – This test checks whether the applicant software determines the skylight area of the Standard Design model correctly.
- The user model is a warehouse building in climate zone 6 with ceiling heights of 28 feet in the warehouse and 14 feet in the office. The SRR of the proposed building is 14%.
- The following inputs in the Standard Design model file shall be verified and reported in the output form provided in Appendix 3C:

- Skylight SRR

Detailed Geometry Model only:

- Standard Design total daylit area as a fraction of gross building area

9. 080006-Whse-Run09 – This test checks whether the applicant software determines the skylight area of the Standard Design model correctly.

Note: Adding/Enlarging Skylights to meet 140.3C daylit area requirements currently not supported. No representative models have been created for this test, the test parameters outlined below have not been verified and are placeholders.

The user model is a warehouse building in climate zone 6 with ceiling heights of 28 feet 14 feet in the office. The SRR of the proposed building is 5% and 55% of the building area gets daylighting from skylights or sidelights.

The following Standard Design inputs shall be verified and reported in the output form provided in Appendix 3C:

- Standard Design SRR, Standard Design total daylit area as a fraction of gross building area

10. 030006-OffMed-Run10 – This test verifies whether the applicant software inserts the correct Standard Design inputs for schedules, occupant density, equipment power density, lighting power density, hot water load and ventilation rates using the Complete Building lighting method and in accordance with 2013 Nonresidential ACM.

Note: Complete Building test method currently not supported. No representative models have been created for this test, the test parameters outlined below have not been verified and are placeholders.

The user model is an office occupancy with:

- Occupant Density- 50 ft²/person
- Equipment Power Density- 3 W/ft²
- Lighting Power Density- 1.2 W/ft²
- Hot Water Load- 106 Btu/person
- Ventilation Rate- 0.15 cfm/ft²

The Proposed Design and Standard Design Standard Design model inputs shall be verified and reported in the output form provided in Appendix 3C:

- Schedules (verified shall include occupancy schedule, lighting schedule, receptacle schedule, hot water schedule, infiltration schedule and elevator schedule)
- Occupant Density
- Equipment Power Density
- Lighting Power Density
- Hot Water Load
- Ventilation Rate

Commented [SD3]: Language added to clarify that these tests are currently outside the scope of RI testing.

Commented [SD4]: The daylight area % might be much higher

Commented [SD5]: Language added to clarify that these tests are currently outside the scope of RI testing.

11. 040006-OffLrg-Run11 – This test verifies whether the applicant software inserts the correct Proposed Design and Standard Design inputs for schedules, occupant density, equipment power density, lighting power density, hot water load and ventilation rates in accordance with 2013 Nonresidential ACM. This run tests the capability of the applicant software to model Standard Design inputs for multiple space types using the Area Category lighting method.

The user model is the Large office building in climate zone six with the following characteristics:

- First Floor
 - Core and North, West Perimeter Spaces - Retail Merchandise Sales, Wholesale Showroom- Occupant Density 33 ppl/1000ft², EPD-2.0 W/ft², LPD-1.0 W/ft², Ventilation rate-7.5 cfm/person or 0.2 cfm/ft², Hot Water Load- 0.18 gal/person/hr.
 - East Perimeter Space – Corridors, Restrooms, Stairs and Support Areas - Occupant Density 10 ppl/1000ft², EPD-0.2 W/ft², LPD-0.5 W/ft², Ventilation rate-7.5 cfm/person or 0.15 cfm/ft², Hot Water Load- 0 gal/person/hr.
 - South Perimeter Space – Lobby, Main Entry - Occupant Density 67 ppl/1000ft², EPD-0.5W/ft², LPD-1.5W/ft², Ventilation rate- 7.5 cfm/person or 0.15 cfm/ft², Hot Water Load- 0.09 gal/person/hr
- Second to Sixth Floor
 - Core and South, West, North Perimeter Spaces - Medical and Clinical Care- Occupant Density 10 ppl/1000ft², EPD-1.5 W/ft², LPD-1.0 W/ft², Ventilation rate- 7.5 cfm/person or 0.2 cfm/ft², Hot Water Load- 0.24 gal/person/hr
 - East Perimeter Space – Corridors, Restrooms, Stairs and Support Areas - Occupant Density 10 ppl/1000ft², EPD-0.2W/ft², LPD-0.5W/ft², Ventilation rate- 7.5 cfm/person or 0.15 cfm/ft², Hot Water Load- 0 gal/person/hr.
- Seventh to Eleventh Floor
 - Core and South, West, North Perimeter Spaces - Office (Greater than 250 square feet in floor area)- Occupant Density 15 ppl/1000ft², EPD-1.5 W/ft², LPD-0.75W/ft², Ventilation rate- 7.5 cfm/person or 0.15 cfm/ft², except core space has additional ventilation air for transfer to 'IndirectlyConditioned' East Perimeter Space, Hot Water Load- 0.18 gal/person/hr
 - East Perimeter Space – Corridors, Restrooms, Stairs and Support Areas - Occupant Density 10 ppl/1000ft², EPD-0.2W/ft², LPD-0.5W/ft², , Hot Water Load- 0 gal/person/hr. Space ConditioningType is 'IndirectlyConditioned' and ThermalZone Type is 'Unconditioned' (no HVAC system); no ventilation air provided directly to space. Ventilation requirement met by transfer air from Core Space.
- Twelfth Floor Core Spaces
 - Core and South, West, North Perimeter Spaces – Convention, Conference, Multipurpose and Meeting Center- Occupant Density 67 ppl/1000ft², EPD-1.0 W/ft², LPD-1.2 W/ft², Ventilation rate- 7.5 cfm/person or 0.15 cfm/ft², Hot Water Load- 0.09 gal/person/hr
 - East Perimeter Space – Corridors, Restrooms, Stairs and Support Areas - Occupant Density 10 ppl/1000ft², EPD-0.2W/ft², LPD-0.5W/ft², Ventilation rate- 7.5 cfm/person or 0.15 cfm/ft² Hot Water Load- 0 gal/person/hr.

For each space type, the Proposed Design and Standard Design model inputs shall be verified and reported in the output form provided in Appendix 3C:

- Schedules (verified shall include occupancy schedule, lighting schedule, receptacle schedule, hot water schedule, infiltration schedule and elevator schedule)
- Occupant Density
- Equipment Power Density
- Lighting Power Density
- Ventilation Rate

- Hot Water Load

12. 030006-OffMed-Run12 – This test verifies if the applicant software applies the requirements of the Tailored Lighting Method appropriately.

The User Model is a medium office building in climate Zone 6 with the following characteristics:

- Perimeter zones on all floors are modelled as main entry spaces using the Tailored Lighting Method. The space has a general lighting of 0.5 W/ft²
- Core zones on all floors are modelled as waiting spaces using the Tailored Lighting Method. The space has a general lighting of 0.75 W/ft² and ornamental lighting of 0.2 W/ft²

For each space type, the Proposed Design and Standard Design model inputs shall be verified and reported in the output form provided in Appendix 3C:

- Lighting Power Density for main entry area
- Lighting Power Density General Lighting Power for waiting area
- Lighting Power Density Custom Lighting Power for waiting area
- Lighting Schedules

13. 030006-OffMed-Run13 – This test verifies if the applicant software applies the requirements of the Tailored Lighting Method appropriately.

The user model is a medium office building in climate Zone 6 with the following characteristics:

- Perimeter zones on all floors are modelled as main entry spaces using the Tailored Lighting Method. The space has a general lighting of 0.8 W/ft² and task lighting of 0.1 W/ft²
- Core zones on all floors are modelled as waiting spaces using the Tailored Lighting Method. The space has a general lighting of 0.6 W/ft², floor display lighting of 0.1 W/ft², and ornamental lighting of 1.2 W/ft²

For each space type, the Proposed Design and Standard Design model inputs shall be verified and reported in the output form provided in Appendix 3C:

- Lighting Power Density for main entry area
- Lighting Power Density General Lighting Power for waiting area
- Lighting Power Density Custom Lighting Power for waiting area
- Lighting Schedules

14. 020006-OffSml-Run14 – This test verifies if the applicant software models lighting power density and schedules for eligible California Power adjustment factors as required by the 2013 Nonresidential ACM.

The user model is a small office building (area=5500 sq ft) with demand responsive lighting controls. The model files shall be examined to verify whether adjustment factors are applied as per the requirements in the 2013 Nonresidential ACM.

For this test, the lighting power density of the proposed model and Standard Design are verified and reported in the output form provided in Appendix 3C:

- Lighting Power Density
- Lighting Schedules

15. 080006-Whse-Run15 – This test verifies the ability of the applicant software to model daylighting controls as per the requirements of the 2013 Nonresidential ACM. There is no simplified geometry model test required.

The user model is a warehouse building in CZ-6 with the following characteristics:

- The building has three spaces – Office, Fine Storage and Bulk Storage. The office space gets daylighting from four windows. Fine Storage and bulk storage get daylighting from skylights.
- Daylighting controls are installed in primary side daylit areas of the office and skylit daylit areas in all storage spaces.
- The installed general lighting power controlled by daylight controls in the office space is 150 Watts. The installed lighting power in the primary daylit zone is 150 Watts and the installed lighting power in the secondary daylit zone is 0 Watts.
- The primary side daylighting illuminance setpoint for the office spaces is set at 400 lux and the skylit daylighting illuminance setpoint in the fine storage and bulk storage are each set at 250 lux.

The Proposed Design and Standard Design model inputs shall be verified and reported in the output form provided in Appendix 3C:

For the office space primary daylit zone and secondary daylit zone:

- Lighting Power in Daylit Zone – for this input, the lighting power for general lighting is assumed to be uniform throughout the space for the Standard Design, so the fraction of lighting power in the space in the primary daylit zone and secondary daylit zone is equal to the fraction of space floor area that is in the primary daylit zone
- Secondary Daylit Zone Adjustment Factor – by space type, from Appendix 5.4A
- Daylight control type
- Reference position and illuminance setpoint

For the bulk storage space:

- Lighting Power in the Daylit Zone
- Daylight control type
- Reference position and illuminance setpoint

For the fine storage space:

- Lighting Power in the Daylit Zone
- Daylight control type
- Reference position and illuminance setpoint

16. 050006-RetlMed-Run16 – This test verifies the ability of the applicant software to model applies the Lighting Power Density appropriately.

The ability of the applicant software to model daylighting controls as per the requirements of the 2013 Nonresidential ACM are verified in only the Detailed Geometry Model.

- The user model is a retail building in CZ-6 with the following characteristics:
- The general lighting power in the Back_Space is 0.6 W/ft², Core_Retail is 1.2 W/ft², Front_Entry is 1.5 W/ft² and the Point_Of_Sale is at 1.2 W/ft².
- The front retail space has a general lighting power of 1.6 W/ft² and task and floor display accent lighting in the space of 0.75 W/ft² in the front half of the space closest to the exterior window.

Detailed Geometry Model only:

- The building has five spaces – Front Entry, Point of Sale, Front Retail, Core Retail and Back Space. The front retail space has daylighting from 5 feet high glass on the exterior with a sill height of 3.74 ft.
- Daylighting controls are installed in primary and skylit daylit areas in all spaces and in the secondary daylit area of the Front Retail and Point of Sale spaces.
- The illuminance setpoint in all daylit spaces is set at 950 lux in all daylit spaces except for the Front_Entry Space which is at 200 lux.
- The reference position for the front retail space is 5 feet from the exterior wall, at the midpoint between the two interior walls, for the primary daylit zone, and 12 feet from the exterior wall, at the midpoint between the two interior walls, for the secondary daylit zone.

The Proposed Design and Standard Design model inputs shall be verified and reported in the output form provided in Appendix 3C:

- Lighting Power Density, General Lighting – this is calculated from the room cavity ratio and illuminance level

Detailed Geometry Model only:

For the front retail space, primary daylit zone and secondary daylit zone:

- Lighting Power in Daylit Zone – this input defines the lighting power that is controlled by daylight dimming controls
- Secondary Daylit Zone Adjustment Factor – by space type, from Appendix 5.4A
- Daylight control type
- Reference position and illuminance setpoint

Commented [S6]: 140814: currently not checking this.

17. 040006-OffLrg-Run17 – This test verifies if the 2013 Nonresidential ACM rules for exterior lighting are applied accurately for exterior lighting power, exterior lighting control and schedules. This test also verifies if the Service Hot Water systems are modelled correctly.

Note: Prescriptive Exterior Lighting Compliance are currently not supported. No representative models have been created for this test, the test parameters outlined below have not been verified and are placeholders.

Commented [SD7]: Language added to clarify that these tests are currently outside the scope of RI testing.

The user model is a large office building in climate zone 6, with the following characteristics:

- Hot water load of 106 Btu/h-person
- Thermal efficiency of 0.78
- An exterior hardscape comprising of:
 - i. Driveway of dimensions 20x30 feet with lighting load of 1115 Watts
 - ii. Parking lot of dimensions 180x56 feet with lighting load of 6566 Watts
 - iii. 2 sidewalks of dimensions 6x30 feet with total lighting load of 977 Watts
 - iv. A building entrance door light of 90 Watts.
 - v. 50 square feet of hardscape ornamental light of 2 Watts
 - vi. Lighting load of 6566 Watts on the building façade.
 - vii. Signage of 40 square feet with lighting load of 80 Watts

This test verifies that the Proposed Design and standard design are specified correctly for:

- Service Water Heating: thermal efficiency, hot water load
- Exterior Lighting Power

18. 020006-OffSml-Run18 – This test checks if the applicant software models the Standard Design HVAC system in accordance with the requirements of the 2013 Nonresidential ACM.

The user model is a small office building in climate zone 6 with the following characteristics:

- DX cooling
- SEER – 17.58 (Cooling COP-3.84, EER 13.1)
- Gas Furnace Heating
- 78% AFUE (Thermal Efficiency – 80%)
- Constant Volume Fan

The following Standard Design model inputs shall be verified and reported in the output form provided in Appendix 3C:

- HVAC System Type
- Heating and Cooling Type
- Heating and Cooling Efficiency
- System Sizing
- Maximum and minimum supply air temperature
- Fan Control Method
- Cooling and heating efficiency curve
- Cooling, Heating and Fan Schedule

19. 030006-OffMed-Run19 – This test checks if the applicant software models the Standard Design HVAC system in accordance with the requirements of the 2013 Nonresidential ACM.

The user model is a medium office building in climate zone 6 with the following characteristics:

- Office zones EPD – 0.8 W/ft² and computer rooms EPD – 18 W/ft².
- Core, Mid and Top Bottom Zones are computer rooms with a zone Cooling load greater than 110,000 Btuh-Packaged Single Zone unit and constant volume fan
- All Perimeter zones- DX Cooling and Hot water Boiler with reheat and variable volume fan
- Cooling Efficiency- COP=4 (EER - 13.65) for packaged single zone units; COP=3.8 (EER - 12.96) for VAV units serving perimeter zones
- Heating Efficiency – 80% for VAV unit serving perimeter zones

The following Standard Design model inputs shall be verified and reported in the output form provided in Appendix 3C:

- EPD of the spaces.
- HVAC System Type
- Heating and Cooling Type
- Heating and Cooling Efficiency
- System Sizing
- Maximum and minimum supply air temperature
- SAT Reset Control
- Economizer Type and limits
- Fan Power
- Fan Control Method
- Cooling and heating capacity adjustment curve
- Cooling and heating efficiency curve
- Cooling, Heating and Fan Schedule
- Terminal heat type and capacity
- Terminal minimum stop

Commented [SD8]: The EPD of the computer rooms is revised to 20 W/ft² per the ACM. Has been added to ensure this is being tested.

Commented [SD9]: Added to check for the revision of the EPD of the computer room.

- Terminal heat control type
- Boiler type and Number of boilers
- Boiler Heat loss, boiler minimum unloading ratio
- Hot water supply and return temperature

20. 040006-OffLrg-Run20 – This test checks if the applicant software models the Standard Design HVAC system in accordance with the requirements of the 2013 Nonresidential ACM.

The user model is a Large office building in climate zone 6 with the following characteristics:

- Basement Zone is a computer room with cooling only dedicated packaged DX system.
- All other zones have a Built-up VAV system.
- Cooling Efficiency- COP 6.2 for chiller; EER 11.4 for packaged DX system
- Heating Efficiency – 82% for boiler; not applicable for packaged DX system

The following Standard Design model inputs shall be verified and reported in the output form provided in Appendix 3C:

- HVAC System Type
- Heating and Cooling Type
- Heating and Cooling Efficiency
- System Sizing
- Sizing Factor (zone, system)
- Maximum and minimum supply air temperature
- SAT Reset Control
- Economizer Type and limits
- Fan Power
- Fan Control Method
- Cooling, Heating and Fan Schedule
- Terminal heat type and capacity
- Boiler type and Number of boilers
- Boiler Heat loss, boiler minimum unloading ratio
- Boiler Performance Curve
- Hot water supply and return temperature
- Boiler pump type
- Pump motor power and efficiency
- Pump part load curve.
- Chiller Type and Number of chillers
- Chiller fuel, capacity and efficiency
- Chiller Minimum Unloading ratio
- Chiller cooling capacity and adjustment curves
- Chilled water supply and return air temperature
- Condenser Type
- Cooling Tower Fan control type and horse power
- Cooling Tower Set Point Control
- Pump Control Type, Motor Power, Efficiency and design flow rate

21. 080006-Whse-Run21 – This test checks if the applicant software models the Standard Design HVAC system in accordance with the requirements of the 2013 Nonresidential ACM.

The user model is a Warehouse building in climate zone 6 with the following characteristics:

- Warehouse zones are served by a gas furnace heat only system.
- Office Zones served by Package Single Zone system with gas furnace heating and DX cooling.
- Fine Storage HVAC system heating efficiency - 79% AFUE
- Bulk Storage HVAC system heating efficiency – 81% Thermal Efficiency
- Office HVAC system heating efficiency – 79% AFUE
- Office HVAC system cooling efficiency – 11.2 EER

The following Standard Design model inputs shall be verified and reported in the output form provided in Appendix 3C:

- HVAC System Type
- Heating and Cooling Type
- Heating and Cooling Efficiency
- System Sizing
- Maximum and minimum supply air temperature
- Sat Reset Control
- Economizer Type and limits
- Fan Power
- Fan Control Method
- Cooling, Heating and Fan Schedule

22. 07006-HotSml-Run22 – This test checks if the applicant software models the Standard Design HVAC system in accordance with the requirements of the 2013 Nonresidential ACM. The project is analyzed with respect to the 2013 Standards, with updates to HVAC efficiency requirements effective in 2015.

The user model is a four-story Hotel in climate zone 6 with a full-service restaurant, and an assembly area that uses demand control ventilation. Of the total of 35 Guestrooms spaces modeled in the project, 31 are served by a four-pipe fan coil with water-cooled chiller and boiler.

The four remaining Guestrooms are served by the zonal systems, as outlined below:

- SZAC (Packaged1Phase)
 - DX cooling: Net capacity <65,000 Btu/hr, SEER 13
 - Gas Furnace Heating: 78% AFUE (Thermal Efficiency – 80%)
 - Constant Volume fan
 - Bypass of minimum efficiency check is selected
- SZAC (Split1Phase)
 - DX cooling: Net capacity <45,000 Btu/hr, SEER 14/EER 12.2
 - Gas Furnace Heating: 78% AFUE (Thermal Efficiency – 80%)
 - Constant Volume fan
- SZHP (Packaged1Phase)
 - DX cooling: Net capacity <65,000 Btu/hr, SEER 14/EER 11.4
 - Heat Pump: 8.0 HSPF (COP 3.2)
 - Constant Volume fan

Commented [SD10]: Additional HVAC systems have been added to the four Guestrooms to test the rules for single-phase vs three-phase rules.

- SZHP (Split1Phase)
 - DX cooling: Net capacity <45,000 Btu/hr, SEER 14/EER 11.4
 - Heat Pump: 8.2 HSPF (COP 3.2)
 - Constant Volume fan

The following inputs and outputs shall be verified and reported in the output form provided in Appendix 3C:

- Proposed design:
 - Confirm code minimum efficiency requirements (SEER and EER) for single phase packaged/split air conditioners and heat pumps in the proposed design.
 - Confirm that the bypass of minimum efficiency check triggers an exceptional condition.
- Standard design:
 - Guestrooms are served by a four-pipe fan coil.
 - The common areas are served by Packaged Variable Volume DX unit with gas heating and with hot water reheat terminal units and the kitchen is served by a dedicated kitchen system with exhaust meeting ACM requirements
 - Assembly area contains demand control ventilation.

23. 030006-OffMed-Run23 – This test checks the Standard Design building for an existing, altered building that has the roof and windows replaced, as well as a new single-zone system serving an existing conditioned space that has been altered to remove all windows.

The user model is a medium office in climate zone 6, with the following characteristics:

- New metal building roof, R-15 continuous insulation, with assembly U-value of 0.065.
- Fenestration on the top floor South elevation replaced with new windows of the same size (Window Status = New). New Window Properties:
 - Fixed, low-e, double glazed
 - NFRC Rated performance: U=0.40, SHGC=0.33 and VT=0.50.
- Windows removed from the wall of the top floor, west zone, and replaced with new, in-fill opaque metal frame wall with U-value – 0.068.
- All other windows on the North, East, West and South facades are existing, unchanged windows. Existing Window Properties:
 - Fixed, Single Pane
 - U=0.55, SHGC=0.56, VT=0.6.
- A new single-zone HVAC system has been installed to serve the Perimeter_top_ZN_4 Thermal Zone, which has been altered to remove all glazing and the opening replaced with a new in-fill wall

The following Standard Design Inputs shall be verified and reported in the output form provided in Appendix 3C:

- Top floor South elevation fenestration properties U, SHGC, and VT.
- All other facades fenestration properties U, SHGC and VT.
- HVAC System Type
- New single-zone system serving Perimeter_top_ZN_4 Thermal Zone:
 - Proposed: SEER-18.0/~EER 13 DX cooling efficiency, 79% AFUE/80.5% furnace thermal efficiency, no economizer.
 - Baseline: Baseline System 3, SEER-13.0 (EER-10.8), no economizer, 80% furnace thermal efficiency.
- All other zones are served by the existing HVAC systems and are the same in baseline and proposed.
- Heating and Cooling Type
- Heating and Cooling Efficiency
- Baseline construction and u-value for New roof

- Baseline construction and u-value for New west wall.

24. 020006-OffSml-Run24– This test checks the Standard Design building for an existing, altered building.

The user model is a small office in climate zone 6, with the following characteristics:

- Building WWR = 21%. All fenestration on the south elevation replaced with windows of the same size (Window Status = Altered, no area increase).
- Altered Window Properties:
 - Fixed, low-e, double glazed
 - NFRC Rated performance: U=0.40, SHGC=0.33 and VT=0.50.
- Existing Fenestration has the following properties
 - Fixed, Single Pane
 - NFRC Rated Performance U=0.55, SHGC=0.56, VT=0.6.
- South perimeter zone HVAC systems is replaced with packaged single zone unit having SEER-18.0/~EER 13 DX cooling efficiency, 78.8% furnace thermal efficiency, no economizer

The following Standard Design Inputs shall be verified and reported in the output form provided in Appendix 3C:

- South elevation fenestration properties U, SHGC, and VT.
- All other facades fenestration properties U, SHGC and VT.
- HVAC System Type
- New single-zone system serving Perimeter_ZN_1 Thermal Zone :
 - Proposed: SEER-18.0/~EER 13 DX cooling efficiency, 78.8% furnace thermal efficiency, no economizer.
 - Baseline: Baseline System 3, SEER-13.0 (EER-10.8), no economizer, 80% furnace thermal efficiency.
- All other zones are served by the existing HVAC systems and are the same in baseline and proposed.
- Heating and Cooling Type
- Heating and Cooling Efficiency
- System Sizing
- Maximum and minimum supply air temperature
- Fan Control Method
- Cooling and heating efficiency curve
- Cooling, Heating and Fan Schedule

25. 020006-OffSml-Run25– This test checks the Standard Design building for an existing, altered building.

The user model is a small office in climate zone 6, with the following characteristics:

- Building WWR = 42%. All fenestration on the south elevation replaced with windows of the same size (Fenestration Status = Altered). Window Properties:
 - Fixed, low-e, double glazed
 - NFRC Rated performance: U=0.40, SHGC=0.33 and VT=0.50.
- Existing Fenestration has the following properties
 - Fixed, Single Pane
 - NFRC Rated Performance U=0.55, SHGC=0.56, VT=0.6.
- South perimeter zone HVAC systems is replaced with packaged single zone unit having SEER-18.0/~EER 13 DX cooling efficiency, 78.8% furnace thermal efficiency, no economizer.

The following Standard Design Inputs shall be verified and reported in the output form provided in Appendix 3C:

- South elevation fenestration properties U, SHGC, and VT.
- All other facades fenestration properties U, SHGC and VT.
- West Façade and Overall Window Wall Ratio

26. 020006-OffSml-Run26– This test checks the Standard Design building for an existing, altered building.

The user model is a medium retail building in climate zone 6 with the following characteristics:

- All fenestration on the south elevation replaced with larger windows (Fenestration Status = New)
- Added window area increases WWR to 42% and have the following properties:
 - Fixed, low-e, double glazed
 - NFRC Rated performance: U=0.35, SHGC=0.32 and VT=0.53.
- Existing Fenestration has the following properties
 - Fixed, Single Pane
 - NFRC Rated Performance U=0.55, SHGC=0.56, VT=0.6.
- South perimeter zone HVAC systems is replaced with packaged single zone unit having SEER-18.0/~EER 13 DX cooling efficiency, 78.8% furnace thermal efficiency, no economizer

The following Standard Design Inputs shall be verified and reported in the output form provided in Appendix 3C:

- South elevation fenestration properties U, SHGC, and VT.
- All other facades fenestration properties U, SHGC and VT.
- West Façade and Overall Window Wall Ratio

27. 050006-RetlMed -Run27– This test checks the Standard Design building for an addition, modeled alone.

- The three south facing zones are modeled as an addition alone.
- Walls between the addition and the existing building (not modeled) area modeled as adiabatic
- WWR of the south façade is 45%.
- All fenestration on the south elevation is New. Fenestration Properties:
 - Fixed, low-e, double glazed
 - NFRC Rated performance: U=0.35, SHGC=0.32 and VT=0.53.
- Lighting Power Density
 - Front Entry space – 1.2 W/ft²
 - Front Retail – 1.6 W/ft² general lighting and 0.75 W/ft² Tailored Floor Display Allowance
 - Point of Sale – 1.15 W/ft²
- The HVAC system is a dedicated package single zone unit serving the entire addition.

The following Standard Design Inputs shall be verified and reported in the output form provided in Appendix 3C:

- Wall type and construction assembly properties of the adiabatic surfaces
- South elevation fenestration properties U, SHGC, and VT.
- HVAC System Type
- Heating and Cooling Type
- Heating and Cooling Efficiency

- System Sizing
- Maximum and minimum supply air temperature
- Fan Control Method
- Cooling and heating efficiency curve
- Cooling, Heating and Fan Schedule

28. 050006-RetlMed -Run28– This test checks the Standard Design building for an addition modeled with an existing building which includes envelope alterations.

The user model is a medium retail building in climate zone 6 with the following characteristics:

- The three south facing zones are modeled as an addition.
- The two north zones have altered envelope surfaces.
Core retail west wall is heavy mass altered wall
Core retail east wall is light mass altered wall
Core retail roof is wood frame and other altered roof
Back space west wall is heavy mass new wall
Back space east wall is metal frame altered wall
Back space north wall is metal building altered wall
Back space roof is metal building altered roof
- The HVAC system is a dedicated package single zone unit serving the addition.

The following Standard Design Inputs shall be verified:

- Standard Design roof, wall and floor construction assembly type
- Standard Design roof, wall and floor construction assembly layer inputs
- Standard Design roof, wall and floor U-value
- Standard Design roof aged solar reflectance and thermal emittance.
- Window Area (and WWR) for each orientation
- Window Area (and Overall WWR) for the building
- Lighting Power Density
- HVAC System Type
- Heating and Cooling Type
- Heating and Cooling Efficiency
- System Sizing
- Maximum and minimum supply air temperature
- Fan Control Method
- Cooling and heating efficiency curve
- Cooling, Heating and Fan Schedule
- Boiler type and Number of boilers
- Boiler Heat loss, boiler minimum unloading ratio

29. 030006-OffMed -Run29– This test checks the Standard Design building for an Envelope Only, partial compliance project.

The user model is a medium office building in climate zone 6 with the following characteristics:

- Flat, insulation above deck roof with assembly U-value of 0.065, Aged Solar Reflectance of 0.75 and Thermal emittance of 0.78
- Metal frame wall with assembly U-value of 0.068
- Mass floor with assembly U-value of 0.039
- Fixed windows with U-factor of 0.35, SHGC of 0.32 and VT of 0.53
- No lighting or mechanical system is specified in the user input model (envelope only compliance)

The following inputs in the Proposed Design and Standard Design model file shall be verified and reported in the output form provided in Appendix 3C:

- Standard Design roof, wall and floor construction assembly type
- Standard Design roof, wall and floor overall U-value
- Standard Design roof, wall and floor construction assembly layer inputs
- Standard Design roof aged solar reflectance and thermal emittance
- Window U-factor, SHGC and VT
- Lighting Power Density
- HVAC System Type
- Heating and Cooling Type
- Heating and Cooling Efficiency
- System Sizing
- Maximum and minimum supply air temperature
- Fan Control Method
- Cooling and heating efficiency curve
- Cooling, Heating and Fan Schedule
- Boiler type and Number of boilers
- Boiler Heat loss, boiler minimum unloading ratio

30. 020006-OffMed –Run30– This test checks the Standard Design building for a Lighting and Mechanical partial compliance project

The user model is a medium office building in climate zone 6 with the following characteristics:

- DX cooling
- Cooling COP-3.84 (EER 13.1)
- Hot water Boiler with reheat
- Constant Volume Fan
- Space Function – Open Office (Greater than 250 square feet in floor area)
- Lighting:
 - Core Spaces: New Lighting, 0.8 W/ft² w/ Occupant Sensing Controls
 - South Perimeter Spaces: New Lighting, 0.8 W/ft², no controls specified
 - Perimeter Spaces: Existing Lighting, 1.2 W/ft²

Detailed Geometry Model only:

- Daylighting:
 - Primary sidelit daylighting controls specified, compliant with mandatory minimums. No Secondary sidelit daylighting controls specified

The following Standard Design model inputs shall be verified:

- HVAC System Type
- Heating and Cooling Type
- Heating and Cooling Efficiency
- System Sizing
- Maximum and minimum supply air temperature
- Fan Control Method
- Cooling and heating efficiency curve
- Cooling, Heating and Fan Schedule
- Lighting Power Density Lighting Power in the Daylit Zone

Detailed Geometry Model only:

- Daylight control type
- Reference position and illuminance setpoint Lighting Power in Daylit Zone – this input defines the lighting power that is controlled by daylight dimming controls

3.4.3.1 Results Comparison

The applicant shall perform all tests specified in Section IV and report the outputs in the forms provided in Appendix 3C. Note that the Standard Design for some inputs, such as cooling efficiency and pump power, are dependent upon the autosizing of the HVAC equipment. The ruleset implementation tests do not check that the autosized capacity matches the Reference Method, but rather, that the Standard Design input is properly defined in relation to the autosized capacity.