Ensuring National Consistency

Verification Protocols for Rating Software Programs, Tax Credits and Energy Code Compliance

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Amendment ADMIN: 2004-02 – Testing and Verification of Rating Software Programs

Chapter 1, 4.E. – Amend as follows:

E. A home energy rating provider shall provide documentation that the energy rating software program that is used to produce energy ratings **has successfully passed the "RESNET Rating Software Testing Specifications and Verification Procedures"** to ensure that the rating software program complies with the national home energy rating technical standards that are contained in Chapter Three of these standards. The RESNET Rating Software Testing Specifications and Verification Procedures are posted on RESNET's web site at www.natresnet.org.

RESNET Rating Software Testing Specifications and Verification Procedures

1. ## HERS BESTEST
   1. Required since 1999
   2. Tests energy loads only
2. ## HERS Reference Home Test
   1. New test
   2. Tests for accurate auto-generation of HERS reference home
3. ## HERS Rating Method Test
   1. New test
   2. Test for accurate calculation of the HERS score
4. ## HVAC Energy Test
   1. New test
   2. Tests HVAC and duct system modeling

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RESNET HERS BESTEST

1. Developed at NREL
2. Tests how energy loads respond to change in shell
    1. Increased infiltration
    2. Higher ceiling/wall insulation
    3. Low-E glazing
    4. No glazing
    5. All glazing on south
    6. All glazing on S w/ overhang
    7. All glazing E/W
    8. All glazing E/W w/ fins
    9. T-stat setback
    10. No internal loads
    11. Increased infiltration, reduced insulation
    12. Increased insulation, better windows
3. Results must fall within acceptable range

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RESNET HERS BESTEST

BESTEST: Tier 1: Colorado Springs: Heating Loads: 3/96
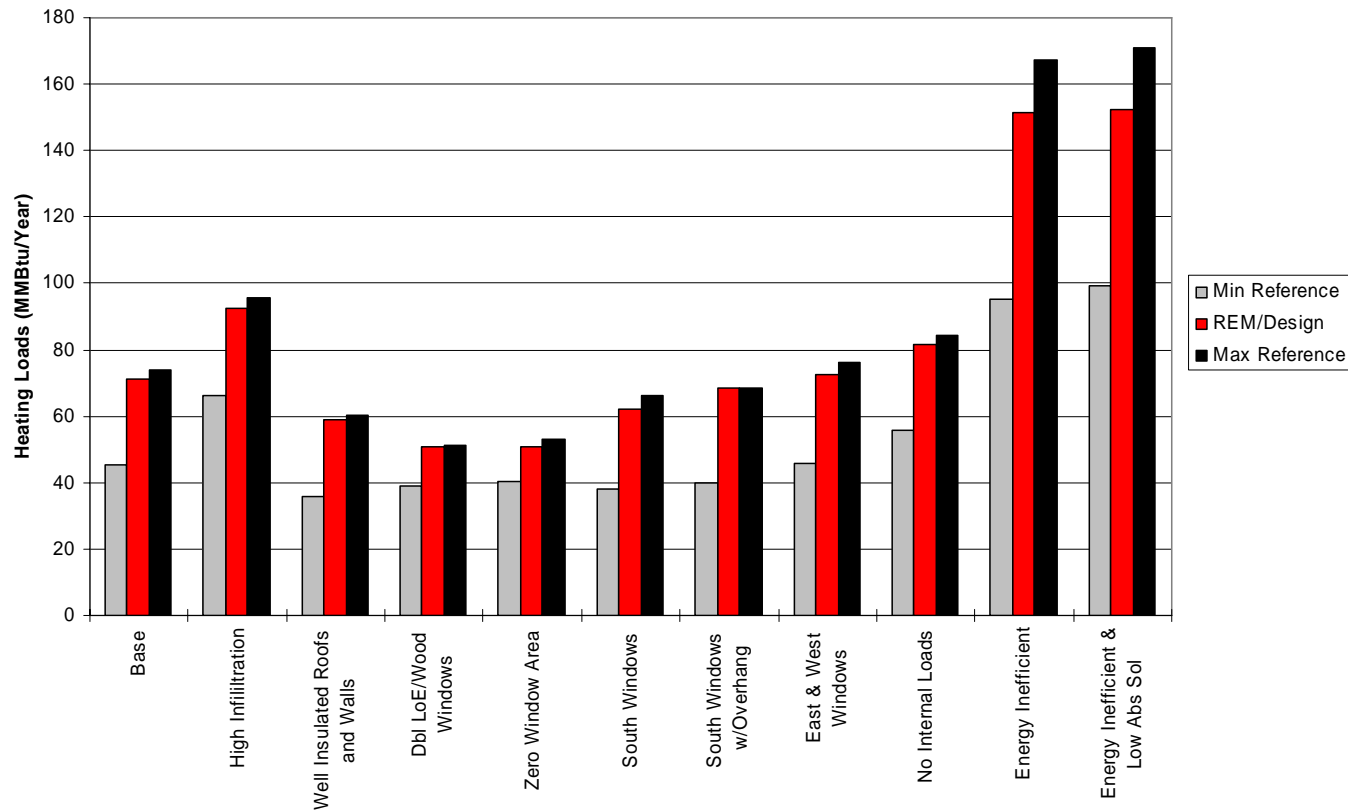
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RESNET HERS Reference Home Tests

At a minimum, all software tools must report the following values for the reference home:

1. Area and overall u-value of the ceiling, wall, floor, windows and doors.

2. Shading coefficient (SC) or solar-heat gain coefficient (SHGC) of the windows during heating season.

3. Shading coefficient (SC) or solar-heat gain coefficient (SHGC) of the windows during cooling season.

4. AFUE, COP, or HSPF of heating system, as appropriate.

5. SEER or EER of the cooling system, as appropriate.

6. EF of the water heating system.

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RESNET HERS Reference Home Tests

1. Can the software accurately auto-generate the HERS Reference Home
   1. From specified rated homes
   2. For different climates

2. Does the software calculate a rating score of 80 points for the auto-generated HERS Reference Home

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RESNET HERS Reference Home Tests

Test 1: Run BESTEST L100 building, modified to include an enclosed, vented crawlspace, in **Dallas**, TX (using 2420 HDD) with the following mechanical equipment – 95 AFUE **gas furnace**, 12 SEER **A/C** and a 40 gallon 0.56 EF **gas water heater**.

Purpose: Check U-values, infiltration rate for this climate; window area, SHGC; efficiency of gas furnace, A/C, gas water heater; distribution efficiency.

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RESNET HERS Reference Home Tests

Test 2: Run BESTEST L100 building, modified to include an enclosed, vented crawlspace, in **Las Vegas** (using 2535 HDD) with the following mechanical equipment – 7.5 HSPF / 12 SEER electric **air-source heat pump**, and a 40 gallon 0.95 EF **electric water heater**.

Purpose: Check U-values, infiltration rate for this climate; window area, SHGC; efficiency of heat pump, electric water heater; distribution efficiency.

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RESNET HERS Reference Home Tests

Test 3: Run BESTEST L100 building, modified to include an enclosed, vented crawlspace, in **Colorado Springs** (using 6353 HDD) with the following mechanical equipment – 100% efficient **electric baseboard heat**, **no A/C**, and a 40 gallon 0.95 EF **electric water heater**.

Purpose: Check U-values, infiltration rate for this climate; window area, SHGC; ensure reference home has heat pump; distribution efficiency.

RESNET HERS Reference Home Tests

Test 4: Evaluate the reference homes created in Tests 1 through 3 as if they were rated homes.

Purpose: A secondary test to help ensure reference home is being replicated correctly.

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RESNET HERS Reference Home Test Acceptance Criteria

	Test 1	Test 2	Test 3	Test 4
Reference Home Characteristics				
Ceiling Uo (Btu/hr/sf/F)	0.036	0.036	0.026	–
Wall Uo (Btu/hr/sf/F)	0.085	0.085	0.058	–
Floor Uo (Btu/hr/sf/F)	0.070	0.050	0.050	–
Window Area – North (sf)	69.3	69.3	69.3	–
Window Area – South (sf)	69.3	69.3	69.3	–
Window Area – East (sf)	69.3	69.3	69.3	–
Window Area – West (sf)	69.3	69.3	69.3	–
Window U-value (Btu/hr/sf/F)	0.542	0.526	0.338	–
Window SC/SHGC (heating)	0.675/0.581	0.675/0.581	0.675/0.581	–
Window SC/SHGC (cooling)	0.541/0.466	0.541/0.466	0.541/0.466	–
Door Area (sf)	40.0	40.0	40.0	–
Door Uo (Btu/hr/sf/F)	0.200	0.200	0.200	–
Infiltration (ach)	0.51	0.46	0.56	–
Heating Nominal Efficiency	78% AFUE	6.8 HSPF	6.8 HSPF	–
Cooling Nominal Efficiency	10 SEER	10 SEER	10 SEER	–
DHW Nominal Efficiency	0.54 EF	0.88 EF	0.88 EF	–
Distribution System Efficiency	0.80	0.80	0.80	
Rating Score	–	–	–	>=79.9 and <=80.1

RESNET Rating Method Tests

1. Can the software accurately calculate the HERS Score
   1. Using the designated method: nMEUL
   2. For different fuel types

RESNET Rating Method Tests

At a minimum, all software tools must report the following values:

1. Reference Home End Use Loads (REUL) to the nearest 0.1 Mbtu

2. Reference Home End Use Energy Consumption (EC_r) to the nearest 0.1 Mbtu

3. Rated Home End Use Energy Consumption (EC_x) to the nearest 0.1 Mbtu

4. Manufacturer's Equipment Performance Ratings (MEPR)

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RESNET Rating Method Tests

<u>Simulation Cases.</u> Home Energy Ratings for the following cases, located in Colorado Springs, CO, shall be computed, reporting the values listed above.

<u>Case L100A-01</u>: Using the HERS BESTEST L100 case, create a 3-bedroom Rated Home containing the following equipment:
  i.   Heating system – electric HP with HSPF = 6.8
  ii. Cooling system – electric A/C with SEER = 10.0
  iii. Hot Water – 40 gal electric with EF = 0.88
  iv. 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.

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RESNET Rating Method Tests

Simulation Cases. (cont.)

Case L100A-02: Identical to Case L100-01 except that the hot water heater is changed to a 40 gal natural gas with EF = 0.54.

Case L100A-03: Identical to Case L100-01 except that the space heating system is changed to a natural gas furnace with AFUE = 0.78.

Case L100A-04: Identical to Case L100-01 except that the space heating system is changed to a high efficiency HP with HSPF = 9.85.

Case L100A-05: Identical to Case L100-01 except that the space heating system is changed to a natural gas furnace with AFUE = 0.96.

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RESNET Rating Method Tests

Acceptance Criteria. Using a calculation spreadsheet provided by this Test Standard, software tools shall demonstrate the following:

a. That reported Reference Home End Use Loads (REULs) vary by less than 0.1% across all cases.

b. That the difference between the reported HERS scores for cases L100A-01 and L100A-02 is less than 0.1% of the smaller score.

c. That the difference between the by the software tool and the HERS scores calculated by the calculation spreadsheet provided by this Test Standard is less than 0.2% of the score reported by the software tool for all cases.

RESNET Rating Method Tests

Acceptance Criteria.

		User input data fields indicated by pale yellow			Test result fields indicated by pale green						
Test Case	HERS Score	Reference Home End Use Loads (REUL)			Reference Home End Use Energy Consumption (EC_r)			Rated Home End Use Energy Consumption (EC_x)			HERS Score Tests
		Winter (MBtu)	Summer (MBtu)	Hot Water (MBtu)	Heating (MBtu)	Cooling (MBtu)	Hot Water (MBtu)	Heating (MBtu)	Cooling (MBtu)	Hot Water (MBtu)	
L100A-01	70.6	25.2	18.6	15.0	15.8	7.9	16.9	34.9	6.7	16.9	PASS
L100A-02	70.0	25.2	18.6	15.0	14.9	8.5	27.0	33.9	7.2	27.2	PASS
L100A-03	71.0	25.2	18.6	15.0	38.8	7.9	16.9	84.9	6.7	16.9	PASS
L100A-04	76.5	25.2	18.6	15.0	15.8	7.9	16.9	24.1	6.7	16.9	PASS
L100A-05	76.0	25.2	18.6	15.0	38.8	7.9	16.9	71.8	6.7	16.9	PASS
REUL Tests:		PASS	PASS	PASS							

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RESNET HVAC Energy Tests

Can the software Rating Tool accurately predict difference in energy use when:

1. Equipment efficiencies are changed
    1. For electric furnaces & air conditioners
    2. For natural gas furnaces
    3. For service hot water systems

2. Duct system characteristics are changed
    1. For insulation changes
    2. For air leakage changes
    3. For location changes

3. Thermostat types are changed

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RESNET HVAC Energy Tests

Capabilities

1. Tools must be capable of generating HVAC results using system type and efficiency as inputs. Tools must also account for duct leakage, duct insulation levels and the presence of a programmable thermostat.

2. System types that must be supported by all tools:

   1. Compressor based air conditioning system
   2. Gas furnace
   3. Electric furnace
   4. Air source heat pump

RESNET HVAC Energy Tests

Test 1: Test to ensure that there is differential electrical cooling energy consumed by **cooling systems** when the efficiency is varied between the code minimum and a higher efficiency unit.

Test #	System Type	Location	Efficiency
HVAC1a	Air cooled compressor based air conditioner	Las Vegas, NV	10 SEER
HVAC1b	Air cooled compressor based air conditioner	Las Vegas, NV	13 SEER

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RESNET HVAC Energy Tests

Test 2: Test to ensure that there is differential electrical and/or fuel **heating energy** consumed for each system type when the efficiency is varied between the code minimum and a higher efficiency system.

Test #	System Type	Location	Efficiency
HVAC2a	Gas Furnace	Colorado Springs, CO	0.78 AFUE
HVAC2b	Gas Furnace	Colorado Springs, CO	0.90 AFUE
HVAC2c	Electric Furnace	Colorado Springs, CO	0.95 AFUE
HVAC2d	Air Source Heat Pump	Colorado Springs, CO	6.8 HSPF
HVAC2e	Air Source Heat Pump	Colorado Springs, CO	8.0 HSPF

RESNET HVAC Energy Tests

Test 3: Impact of **duct** insulation, duct leakiness and duct location.

Test #	System Type	Location	Duct Location	Duct Leakage	Duct Rval
HVAC3a	Gas Furnace	Colorado Springs, CO	100% conditioned space	0%	R0
HVAC3b	Gas Furnace	Colorado Springs, CO	100% unconditioned space	0%	R0
HVAC3c	Gas Furnace	Colorado Springs, CO	100% unconditioned space	0%	R4.2
HVAC3d	Gas Furnace	Colorado Springs, CO	100% unconditioned space	28%	R4.2
HVAC3e	Air Conditioner	Las Vegas, NV	100% unconditioned space	0%	R4.2
HVAC3f	Air Conditioner	Las Vegas, NV	100% unconditioned space	28%	R4.2

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RESNET HVAC Energy Tests

Test 4: Impact of programmable setback **thermostats** schedule.

Test #	System Type	Location	Efficiency	Thermostat Type
HVAC4a	Gas Furnace	Colorado Springs, CO	0.78 AFUE	Programmable
HVAC4b	Gas Furnace	Colorado Springs, CO	0.78 AFUE	Non-Programmable

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RESNET HVAC Energy Tests

Acceptance Criteria

1. **TBD**

2. **Will stem from work of IECC/Tax Credit Software Verification Committee**

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