RESFEN Modeling Assumptions

The following table compares the input value assumptions used for the DOE2 simulations in RESFEN versions 3.0 and 3.1. The 3.1 assumptions are consistent with efforts by NFRC Annual Energy Rating Subcommittee to develop an Annual Energy Rating Procedure (1998). These assumptions are under review and may be updated in the next version of RESFEN.

Table 1. RESFEN 3.0 and 3.1 Modeling Assumptions

PARAMETER	RESFEN Ver. 3.0	RESFEN Ver. 3.1
Floor Area (ft^2 & dimensions)	1,540[(a)] 41.5 x 41.5 x 8	Variable, from 1,000 to 4,000 square feet, input by user.
House Type	New Construction	▪ New Construction ▪ Existing Construction
Foundation	Slab, Crawlspace	Foundation is based on location. There are a maximum of three options per climate zone, chosen from: ▪ Basement ▪ Slab-on-Grade ▪ Crawlspace See Table 6-2. [(b)]
Insulation	Wall: R19 Roof: R30	Envelope insulation levels are based on location. ▪ **New construction:** See Table 6-4. (Council of American Building Officials, 1993) [(c)] ▪ **Existing construction:** See Table 6-5. (Ritschard, et al. 1992)
Infiltration	ELA=0.77 ft^2 (0.58 ACH)	▪ **New Construction:** ELA=0.77 ft^2 (0.58 ACH) ▪ **Existing Construction:** ELA=1.00 ft^2 (0.70 ACH)
Structural Mass (lb/ft^2)	≅ 4.3 lb/ft^2	3.5 lb/ft^2 of floor area, in accordance with the Model Energy Code and NFRC Annual Energy Performance Subcommittee recommendation (September 1998).
Internal Mass Furniture (lb/ft^2)	5.5 lb/ft^2	8.0 lb/ft^2 of floor area, in accordance with the Model Energy Code and NFRC Annual Energy Performance Subcommittee recommendation (September 1998).
Solar Gain Reduction	**Options:** ▪ None ▪ 2' Exterior Overhangs ▪ Exterior Obstructions a completely opaque (τ=0.0), same-height obstruction 20 feet away, intended to represent adjacent buildings. ▪ Interior Shades: Shading coefficient multiplier of 0.60 when solar gain > 30 BTU/ft^2.	**Options:** ▪ **None:** No solar gain reduction ▪ **Overhang:** 2' Exterior Overhangs ▪ **Obstruction:** Exterior Obstructions, a completely opaque (τ=0.0), same-height obstruction 20 feet away, intended to represent adjacent buildings. ▪ **Interior:** Interior shades with a Seasonal SHGC multiplier, summer value = 0.80, winter value = 0.90. ▪ **Int+Ovh:** Interior shades & 2' overhangs ▪ **Ovh+Obs:** 2' overhangs & obstructions ▪ **All:** Interior shades, 2' overhangs, & obstructions ▪ **Typical**[(d)]**:** to represent a statistically average solar gain reduction for a generic house, this option includes: ▪ Interior shades (Seasonal SHGC multiplier, summer value = 0.80, winter value = 0.90); ▪ 1' overhang; ▪ a 67% transmitting same-height obstruction 20' away intended to represent adjacent buildings. ▪ To account for other sources of solar heat gain reduction (insect screens, trees, dirt, building & window self-shading), the SHGC multiplier was further reduced by 0.1. This results in a final winter SHGC multiplier of 0.8 and a final summer SHGC multiplier of 0.7.
Window Area (% Floor Area)	Variable (base case is 3% of floor area)	Variable
PARAMETER	**RESFEN Ver. 3.0**	**RESFEN Ver. 3.1**
Window Type	Variable	Variable
Window Distribution	Variable	Variable
HVAC System	Furnace & A/C, Heat Pump	Furnace & A/C, Heat Pump

HVAC System Sizing	DOE-2 autosizing	For each climate, system sizes are fixed for all window options. Fixed sizes are based on the use of DOE-2 auto-sizing for the same house as defined in the analysis, with the most representative window for that specific climate. An auto-sizing multiplier of 1.3 used to account for a typical safety factor. [(e)]
HVAC Efficiency	AFUE = 0.78 A/C SEER = SEER=10.0	**New Construction:** ▪ AFUE = 0.78, A/C SEER=10.0 **Existing Construction:** ▪ AFUE = 0.70, A/C SEER= 8.0
Duct Losses	Heating: 10% (fixed) Cooling: 10% (fixed)	Heating: 10% (fixed) Cooling: 10% (fixed)
Part-Load Performance	Default DOE-2 heating, cooling Part Load Ratios	New part-load curves for DOE2 (Henderson 1998) for both new and existing house types
Thermostat Settings	Heating: 70°F, Cooling: 78°F	Heating: 70°F, Cooling: 78°F Basement (partially conditioned): Heating 62°F, Cooling 85°F
Night Heating Setback	60°F (11 PM – 6 AM)	65°F (11 PM – 6 AM[(f)])
Internal Loads	Sensible: 56.1 kBtu/day Latent: 12.2 kBtu/day	Sensible: 43,033 Btu/day + (floor area * 8.42 Btu/ft^2-day for lighting) Latent: 12.2 kBtu/day
Natural Ventilation	Enthalpic – Sherman-Grimsrud (78°F / 72°F based on 4 days' history[(g)])	Enthalpic – Sherman-Grimsrud (78°F / 72°F based on 4 days' history[(g)])
Weather Data	13 TMY2, 33 WYEC2[(h)]	All TMY2[(h)]
Number of Locations	46	48 US cities[(i)] 4 Canadian cities
Calculation Tool	DOE-2.1E	DOE-2.1E

Footnotes:

(a) RESFEN 3.0 modeled two building types – a 1,540 ft^2 one-story ranch house, and a 2,240 ft^2 two-story house. The RESFEN 3.0 values in this table show the dimensions, interior wall area, and internal loads levels for the one-story house only. RESFEN 3.1 allows the floor area to vary, so floor-area-dependent parameters (such as exterior and interior wall area, perimeter area, internal gains, infiltration, and so forth) are calculated for each specific case.

(b) In Table 2, the default foundation option is the most common foundation type in that location; the other options are other foundation types found in more than 10% of the houses according to a National Association of Homebuilder's survey (Labs et al. 1988).

(c) The wall insulation R-values listed in the 1993 MEC (Council of American Building Officials, 1993) are the same for frame and masonry walls, as stated in the documentation for Prescriptive Packages: "Wall R-values represent the sum of the wall cavity insulation plus insulating sheathing (if used). Do not include exterior siding, structural sheathing, and interior drywall. For examples, an R-19 requirement could be met EITHER by R-19 cavity insulation OR R-13 cavity insulation plus R-6 insulating sheathing. Wall requirements apply to wood-frame or mass (concrete, masonry, log) wall constructions, but do not apply to metal-frame construction."

(d) These assumptions are intended to represent the average solar heat gain reduction for a large sample of houses. A one-foot overhang is assumed on all four orientations in order to represent the average of a two-foot overhang and no overhang. A 67% transmitting obstruction 20 feet away on all four orientations represents the average of obstructions (such as neighboring buildings and trees) 20 feet away on one-third of the total windows and no obstructions in front of the remaining two-thirds of windows. An interior shade is assumed to have a Solar Heat Gain Coefficient multiplier of 0.9 during the winter and 0.8 during the summer. To account for solar heat gain reducing effects from other sources such as screens, trees, dirt, and self-shading of the building, the SHGC multiplier was further reduced by 0.1 throughout the year. This amounts to a 12.5% decrease in the summer and an 11.1% decrease in the winter. The final SHGC multipliers (0.8 in the winter and 0.7 in the summer) thus reflect the combined effects of shading devices and other sources.

(e) For each climate, DOE-2's auto-sizing feature was used with the window most likely to be installed in new construction (assumed to be the MEC default). Tables 6.4 and 6.5 show the required prescriptive U-factors for windows for the 52 climates. For climates where the U-factor requirement is greater than or equal to 1.0, an aluminum frame window with single glazing (U-factor = 1.30; SHGC = 0.74) is used. For climates where the U-factor requirement is between 0.65 and 1.0, an aluminum frame window with double glazing (U-factor = 0.87; SHGC = 0.66) is used. For climates where the U-factor requirements are below 0.65, as well as in the four Canadian climates, a vinyl frame window with double glazing (U-factor = 0.49; SHGC = 0.57) is used for the sizing calculation.

(f) RESFEN 3.1 models a moderate setback of 65° F in recognition that some but not all houses may use night setbacks. Recent studies of residential indoor conditions have shown that, during the heating season, nighttime temperatures are significantly lower than daytime temperatures (Ref: "Occupancy Patterns and Energy Consumption in New California Houses," Berkeley Solar Group for the California Energy Commission, 1990).

(g) RESFEN 3.0 and 3.1 use a feature in DOE-2 that allows the ventilation temperature to switch between a higher heating (or winter) and a lower cooling (or summer) temperature based on the cooling load over the previous four days.

(h) RESFEN 3.0 used a mix of Typical Meteorologcal Year (TMY2) weather tapes from the National Renewable Energy Laboratory and WYEC2 weather tapes from ASHRAE. There are 239 TMY2 locations with average weather data compiled from 30+ years of historical weather data. (National Renewable Energy Laboratory, 1995), but only 55 WYEC2 locations (American Society of Heating, Refrigerating, and Air-Conditioning Engineers, 1997). The two weather data sets are of comparable reliability, but RESFEN 3.1 uses only TMY2 weather tapes to maintain internal consistency. (Huang, Memorandum to NFRC 900 Working Group, "Weather data for use in NFRC900", August 5, 1998).

(i) This list of locations is based primarily on a list of 45 cities chosen in a previous LBNL project to define representative U.S. climates for simulating residential building energy use (Huang et al. 1987).

Foundation Types by Location

Table 2. RESFEN 3.1 Foundation Type Options by Location. (Ritschard, et. Al. 1992)

State	City	Default Foundation Type	2nd Foundation Option	3rd Foundation Option
AK	Anchorage	Basement	--	--
AL	Birmingham	Slab-on-Grade	Crawlspace	Basement
AZ	Phoenix	Slab-on-Grade	--	--
CA	Fresno	Slab-on-Grade	Crawlspace	Basement
CA	Los Angeles	Slab-on-Grade	Crawlspace	Basement
CA	Red Bluff	Slab-on-Grade	Crawlspace	Basement
CA	San Diego	Slab-on-Grade	Crawlspace	Basement
CA	San Francisco	Slab-on-Grade	Crawlspace	Basement
CO	Denver	Basement	Crawlspace	--
DC	Washington	Basement	--	--
FL	Jacksonville	Slab-on-Grade	--	--
FL	Miami	Slab-on-Grade	--	--
GA	Atlanta	Slab-on-Grade	Basement	Crawlspace
HI	Honolulu	Slab-on-Grade	--	--
ID	Boise	Basement	Crawlspace	--
IL	Chicago	Basement	--	--
LA	Lake Charles	Slab-on-Grade	--	--
MA	Boston	Basement	--	--
ME	Portland	Basement	--	--
MN	Minneapolis	Basement	--	--
MO	Kansas City	Basement	--	--
MT	Great Falls	Basement	--	--
NC	Raleigh	Crawlspace	Slab-on-Grade	Basement
ND	Bismarck	Basement	--	--
NE	Omaha	Basement	--	--
NM	Albuquerque	Slab-on-Grade	--	--
NV	Las Vegas	Slab-on-Grade	Crawlspace	--
NV	Reno	Slab-on-Grade	Crawlspace	--
NY	Buffalo	Basement	--	--
NY	New York City	Basement	Slab-on-Grade	--
OH	Dayton	Basement	Slab-on-Grade	Crawlspace
OK	Oklahoma City	Slab-on-Grade	--	--
OR	Medford	Crawlspace	Basement	--
OR	Portland	Crawlspace	Basement	--
PA	Philadelphia	Basement	--	--
PA	Pittsburgh	Basement	--	--
SC	Charleston	Crawlspace	Slab-on-Grade	--
TN	Memphis	Crawlspace	Basement	Slab-on-Grade
TN	Nashville	Crawlspace	Basement	Slab-on-Grade
TX	Brownsville	Slab-on-Grade	--	--
TX	El Paso	Slab-on-Grade	--	--
TX	Fort Worth	Slab-on-Grade	--	--
TX	San Antonio	Slab-on-Grade	--	--
UT	Salt Lake City	Basement	--	--
VT	Burlington	Basement	--	--
WA	Seattle	Basement	Crawlspace	--
WI	Madison	Basement	--	--
WY	Cheyenne	Basement	--	--
ON	Toronto	Basement	--	--
PQ	Montreal	Basement	--	--
AB	Edmonton	Basement	--	--
NS	Halifax	Basement	--	--

Simulation Envelope Insulation Values

Table 3. RESFEN 3.1 New Construction Insulation Values (Default fndn. in bold.) (Council of American Building Officials, 1993)

ST	City	MEC Zone	Pkg #	Glz %	Window U-value	Ceil. R-value	Wall R-value	Floor R-value	Basement R-value	Slab R-value	Crawl. R-value
AK	Anchorage	17	3	15	0.400	38	19	30	**30**	--	--
AL	Birmingham	6	4	15	0.700	38	14	19	6	**6**	7
AZ	Phoenix	3	3	15	0.900	30	11	11	--	**0**	--
CA	Fresno	6	4	15	0.700	38	14	19	6	**6**	7
CA	Los Angeles	4	2	15	0.750	26	11	11	5	**0**	5
CA	Red Bluff	6	4	15	0.700	38	14	19	6	**6**	7
CA	San Diego	3	3	15	0.900	30	11	11	0	**0**	5
CA	San Francisco	6	4	15	0.700	38	14	19	6	**6**	7
CO	Denver	13	2	15	0.400	38	19	26	**11**	--	22
DC	Washington	10	3	15	0.550	38	19	19	**9**	--	--
FL	Jacksonville	3	3	15	0.900	30	11	11	--	**0**	--
FL	Miami	1	2	15	1.100	19	11	11	--	**0**	--
GA	Atlanta	7	4	15	0.650	38	19	13	5	**2**	6
HI	Honolulu	1	2	15	1.100	19	11	11	--	**0**	--
ID	Boise	12	3	15	0.400	38	19	19	**9**	--	14
IL	Chicago	14	3	15	0.400	38	19	30	**14**	--	--
LA	Lake Charles	4	2	15	0.750	26	11	11	--	**0**	--
MA	Boston	13	2	15	0.400	38	19	26	**11**	--	--
ME	Portland	15	3	15	0.400	38	19	30	**15**	--	--
MN	Minneapolis	15	3	15	0.400	38	19	30	**15**	--	--
MO	Kansas City	11	3	15	0.450	38	19	19	**8**	--	--
MT	Great Falls	15	3	15	0.400	38	19	30	**15**	--	--
NC	Raleigh	7	4	15	0.650	38	19	13	5	2	**6**
ND	Bismarck	16	3	15	0.400	38	19	30	**28**	--	--
NE	Omaha	13	2	15	0.400	38	19	26	**11**	--	--
NM	Albuquerque	9	3	15	0.600	38	19	19	--	**3**	--
NV	Las Vegas	5	3	15	0.700	30	14	11	--	**0**	6
NV	Reno	12	3	15	0.400	38	19	19	--	**4**	14
NY	Buffalo	14	3	15	0.400	38	19	30	**14**	--	--
NY	New York City	10	3	15	0.550	38	19	19	**9**	5	--
OH	Dayton	12	3	15	0.400	38	19	19	**9**	4	14
OK	Oklahoma City	8	3	15	0.650	38	19	19	--	**2**	--
OR	Medford	11	3	15	0.450	38	19	19	8	--	**12**
OR	Portland	10	3	15	0.550	38	19	19	9	--	**16**
PA	Philadelphia	10	3	15	0.550	38	19	19	**9**	--	--
PA	Pittsburgh	12	3	15	0.400	38	19	19	**9**	--	--
SC	Charleston	5	3	15	0.700	30	14	11	--	0	**6**
TN	Memphis	7	4	15	0.650	38	19	13	5	2	**6**
TN	Nashville	8	3	15	0.650	38	19	19	7	2	**8**
TX	Brownsville	2	2	15	1.100	19	13	11	--	**0**	--
TX	El Paso	6	4	15	0.700	38	14	19	--	**6**	--
TX	Fort Worth	5	3	15	0.700	30	14	11	--	**0**	--
TX	San Antonio	4	2	15	0.750	26	11	11	--	**0**	--
UT	Salt Lake City	12	3	15	0.400	38	19	19	**9**	--	--
VT	Burlington	15	3	15	0.400	38	19	30	**15**	--	--
WA	Seattle	10	3	15	0.550	38	19	19	**9**	--	16
WI	Madison	15	3	15	0.400	38	19	30	**15**	--	--
WY	Cheyenne	15	3	15	0.400	38	19	30	**15**	--	--
ON	Toronto	16	3	15	0.400	38	19	30	**28**	--	--
PQ	Montreal	16	3	15	0.400	38	19	30	**28**	--	--
AB	Edmonton	16	3	15	0.400	38	19	30	**28**	--	--
NS	Halifax	16	3	15	0.400	38	19	30	**28**	--	--

Table 4. RESFEN 3.1 Existing Construction Insulation Values. (Ritschard, et. al. 1992)

State	City	Window U-value	Ceiling R-value	Wall R-value	Floor R-value	Basement R-value	Slab R-value	Crawlspace R-value
AK	Anchorage	0.650	22	7	0	0	0	0
AL	Birmingham	0.650	19	7	0	0	0	0
AZ	Phoenix	0.650	11	7	0	0	0	0
CA	Fresno	1.100	11	7	0	0	0	0
CA	Los Angeles	1.100	11	7	0	0	0	0
CA	Red Bluff	1.100	11	7	0	0	0	0
CA	San Diego	1.100	11	7	0	0	0	0
CA	San Francisco	1.100	11	7	0	0	0	0
CO	Denver	0.650	11	7	0	0	0	0
DC	Washington	0.650	11	7	0	0	0	0
FL	Jacksonville	0.650	11	7	0	0	0	0
FL	Miami	0.650	11	7	0	0	0	0
GA	Atlanta	0.650	11	7	0	0	0	0
HI	Honolulu	0.650	11	7	0	0	0	0
ID	Boise	0.650	19	7	0	0	0	0
IL	Chicago	0.650	19	7	0	0	0	0
LA	Lake Charles	0.650	19	7	0	0	0	0
MA	Boston	0.650	22	7	0	0	0	0
ME	Portland	0.650	22	7	0	0	0	0
MN	Minneapolis	0.650	22	7	0	0	0	0
MO	Kansas City	0.650	22	7	0	0	0	0
MT	Great Falls	0.650	19	7	0	0	0	0
NC	Raleigh	0.650	11	7	0	0	0	0
ND	Bismarck	0.650	22	7	0	0	0	0
NE	Omaha	0.650	19	7	0	0	0	0
NM	Albuquerque	0.650	11	7	0	0	0	0
NV	Las Vegas	0.650	11	7	0	0	0	0
NV	Reno	0.650	11	7	0	0	0	0
NY	Buffalo	0.650	11	7	0	0	0	0
NY	New York City	0.650	11	7	0	0	0	0
OH	Dayton	0.650	19	7	0	0	0	0
OK	Oklahoma City	0.650	19	7	0	0	0	0
OR	Medford	0.650	19	7	0	0	0	0
OR	Portland	0.650	19	7	0	0	0	0
PA	Philadelphia	0.650	11	7	0	0	0	0
PA	Pittsburgh	0.650	11	7	0	0	0	0
SC	Charleston	0.650	11	7	0	0	0	0
TN	Memphis	0.650	11	7	0	0	0	0
TN	Nashville	0.650	11	7	0	0	0	0
TX	Brownsville	0.650	19	7	0	0	0	0
TX	El Paso	0.650	19	7	0	0	0	0
TX	Fort Worth	0.650	19	7	0	0	0	0
TX	San Antonio	0.650	19	7	0	0	0	0
UT	Salt Lake City	0.650	11	7	0	0	0	0
VT	Burlington	0.650	22	7	0	0	0	0
WA	Seattle	0.650	19	7	0	0	0	0
WI	Madison	0.650	22	7	0	0	0	0
WY	Cheyenne	0.650	11	7	0	0	0	0
ON	Toronto	0.650	22	7	0	0	0	0
PQ	Montreal	0.650	22	7	0	0	0	0
AB	Edmonton	0.650	22	7	0	0	0	0
NS	Halifax	0.650	22	7	0	0	0	0