



Pacific Northwest
NATIONAL LABORATORY

*Proudly Operated by **Battelle** Since 1965*

Residential Compliance Evaluation Methodology

Mark Halverson and Rosemarie Bartlett
Pacific Northwest National Laboratory



Guidance Document

- ▶ A guidance document was prepared for the Project Teams
 - Not a full-blown methodology
 - Coming soon
 - Lays out an 8-step process for conducting the evaluations
- ▶ Highlights
 - Only new, site-built single-family homes
 - Focus on compliance with individual code requirements rather than homes
 - Sample size of 63 observations of key items
 - Single site visit
 - Energy savings metric



Activities and Responsibilities

Step	Activity	Responsibility
1	Develop initial sampling plan	PNNL
2	Conduct stakeholder meeting	Project Team
3	Develop final sampling plan	PNNL
4	Contact jurisdictions and identify homes to sample	Project Team
5	Collect field data	Project Team
6	Analyze and report field data	PNNL
7	Conduct education, training and outreach	Project Team
8	Re-evaluate compliance	PNNL and Project Team



Sample Size Determination

- ▶ Identified building components with largest direct impact on energy use
 - Tens of thousands of simulations were conducted to derive the list of key items
- ▶ Determined sample size of 63 observations of each of the key items
 - Needed to achieve the goal of detecting statistically significant differences in energy use pre- and post-evaluation
- ▶ Designed sampling protocol to enable a statewide compliance metric



Key Items

- ▶ Envelope tightness (ACH50)
- ▶ Window SHGC
- ▶ Window U-factor
- ▶ Exterior wall insulation
- ▶ Ceiling insulation
- ▶ High-efficiency lighting
- ▶ Foundation insulation (floor / basement wall / slab)
- ▶ Duct leakage



Sample Size Bottom Line

63 observations of each key item
in each state

Think # of observations
rather than # of homes



State-Specific Sampling Plan

- ▶ **Initial** sampling plan
 - based on Census Bureau permit database using latest 3 years of permit data by place within the state
- ▶ **Final** sampling plan
 - developed after Project Team and Stakeholder meetings in case any changes or additions to the sampling plan are needed
- ▶ 63 observations will require visiting more than 63 homes per state
 - due to practical limitations of being able to observe all key items in a single site visit



State-Specific Sampling Plan (cont'd)

- ▶ Sampling is done on a proportional random sample approach
 - Places with more permits per year are more likely to be sampled than places with fewer permits.
 - But there is a random element involved.
- ▶ The process of re-drawing a state sample and creating a new sample plan is relatively easy and PNNL is available to make changes as needed.
- ▶ A minimal number of substitutions of one place for another that do not introduce bias into the sample are allowed
 - These changes will be discussed with project teams but DOE has to give final approval of any changes to the sampling plan



State-Specific Data Collection Form

- ▶ Combination of
 - RES*check* checklists (essentially all of the applicable code requirements),
 - Any items added or subtracted for state-specific codes, and
 - Additional items needed for energy simulation (including key items)
- ▶ Form divided into questions in four sections:
 - Home
 - Envelope
 - Mechanical
 - Lighting

Some Specific Details of the Data Collection Form

- ▶ No take-offs are required
 - Unless the Project Team decides that take-off information should be added to the form to facilitate the development of a state-specific prototype building.
- ▶ A blower door test is required
 - Unless a blower door test has already been conducted, in which case only spot checking is required.
- ▶ A duct leakage test is required
 - Unless a duct leakage test has already been conducted, in which case only spot checking is required.
- ▶ Evaluation of frame cavity insulation installation quality is required.



Example Section of Envelope Form

2009 IECC Residential Data Collection Form - Envelope

ID	Code Section	Description	Complies	Does Not Comply	Not Applicable	Not Observable	Field Observation	REScheck or HERS Value*	Format	Units	Comment
Envelope Wall All Walls (Does not include knee walls)											
Wall1	NA	Are the walls predominantly frame walls or mass walls?							Text		
IN4	303.2	Wall insulation is installed per manufacturer's instructions							Check Box		
Envelope Wall Frame (Does not include knee walls)											
IN3a	402.1.1, 402.2.5	Frame Wall insulation R-value (cavity insulation)							Number	R-value	
IN3b	402.1.1, 402.2.5	Frame Wall insulation R-value (continuous insulation)							Number	R-value	
M2	NA	What is the wall framing material wood or steel?							Text		
Wall2	NA	What is the predominant wall framing depth? (2 inch, 4 inch, 6 inch, 8 inch, etc.)							Number	inches of framing depth	
IQ3	NA	What is the frame wall insulation quality? (I,II,III) - see INFO - Insulation Grading tab							Text		



Section of Envelope Form

2009 IECC Residential Data Collection Form - Envelope

Code	Section	Description	Complies	Does Not Comply	Not Applicable	Observation	Reference or IECC Value	Formed	Units	Comments
Envelope Wall All Walls (Does not include base walls)										
IN3a	402.1.1, 402.2.5	Frame Wall insulation R-value (cavity insulation)								
Envelope Wall All Walls (Does not include base walls)										
IN3b	402.1.1, 402.2.5	Frame Wall insulation R-value (cavity insulation)								
Envelope Wall All Walls (Does not include base walls)										
IN3c	402.1.1, 402.2.5	Frame Wall insulation R-value (cavity insulation)								
Envelope Wall All Walls (Does not include base walls)										
IN3d	402.1.1, 402.2.5	Frame Wall insulation R-value (cavity insulation)								
Envelope Wall All Walls (Does not include base walls)										
IN3e	402.1.1, 402.2.5	Frame Wall insulation R-value (cavity insulation)								
Envelope Wall All Walls (Does not include base walls)										
IN3f	402.1.1, 402.2.5	Frame Wall insulation R-value (cavity insulation)								
Envelope Wall All Walls (Does not include base walls)										
IN3g	402.1.1, 402.2.5	Frame Wall insulation R-value (cavity insulation)								
Envelope Wall All Walls (Does not include base walls)										
IN3h	402.1.1, 402.2.5	Frame Wall insulation R-value (cavity insulation)								
Envelope Wall All Walls (Does not include base walls)										
IN3i	402.1.1, 402.2.5	Frame Wall insulation R-value (cavity insulation)								
Envelope Wall All Walls (Does not include base walls)										
IN3j	402.1.1, 402.2.5	Frame Wall insulation R-value (cavity insulation)								
Envelope Wall All Walls (Does not include base walls)										
IN3k	402.1.1, 402.2.5	Frame Wall insulation R-value (cavity insulation)								
Envelope Wall All Walls (Does not include base walls)										
IN3l	402.1.1, 402.2.5	Frame Wall insulation R-value (cavity insulation)								
Envelope Wall All Walls (Does not include base walls)										
IN3m	402.1.1, 402.2.5	Frame Wall insulation R-value (cavity insulation)								
Envelope Wall All Walls (Does not include base walls)										
IN3n	402.1.1, 402.2.5	Frame Wall insulation R-value (cavity insulation)								
Envelope Wall All Walls (Does not include base walls)										
IN3o	402.1.1, 402.2.5	Frame Wall insulation R-value (cavity insulation)								
Envelope Wall All Walls (Does not include base walls)										
IN3p	402.1.1, 402.2.5	Frame Wall insulation R-value (cavity insulation)								
Envelope Wall All Walls (Does not include base walls)										
IN3q	402.1.1, 402.2.5	Frame Wall insulation R-value (cavity insulation)								
Envelope Wall All Walls (Does not include base walls)										
IN3r	402.1.1, 402.2.5	Frame Wall insulation R-value (cavity insulation)								
Envelope Wall All Walls (Does not include base walls)										
IN3s	402.1.1, 402.2.5	Frame Wall insulation R-value (cavity insulation)								
Envelope Wall All Walls (Does not include base walls)										
IN3t	402.1.1, 402.2.5	Frame Wall insulation R-value (cavity insulation)								
Envelope Wall All Walls (Does not include base walls)										
IN3u	402.1.1, 402.2.5	Frame Wall insulation R-value (cavity insulation)								
Envelope Wall All Walls (Does not include base walls)										
IN3v	402.1.1, 402.2.5	Frame Wall insulation R-value (cavity insulation)								
Envelope Wall All Walls (Does not include base walls)										
IN3w	402.1.1, 402.2.5	Frame Wall insulation R-value (cavity insulation)								
Envelope Wall All Walls (Does not include base walls)										
IN3x	402.1.1, 402.2.5	Frame Wall insulation R-value (cavity insulation)								
Envelope Wall All Walls (Does not include base walls)										
IN3y	402.1.1, 402.2.5	Frame Wall insulation R-value (cavity insulation)								
Envelope Wall All Walls (Does not include base walls)										
IN3z	402.1.1, 402.2.5	Frame Wall insulation R-value (cavity insulation)								
Envelope Wall All Walls (Does not include base walls)										

Key Item

IN3a

402.1.1,
402.2.5

Frame Wall insulation R-value
(cavity insulation)



Section of Envelope Form

Code Requirement

IN4	303.2	Wall insulation is installed per manufacturer's instructions
-----	-------	--



Section of Envelope Form

Simulation Input

Wall1

NA

Are the walls predominantly
frame walls or mass walls?



Data Confidentiality

- ▶ No personally identifiable information to be reported to DOE/PNNL
- ▶ Data collection form and online tool use an identification code to identify individual homes
 - Format: Two-digit state abbreviation + a unique number assigned by the Project Team
- ▶ DOE/PNNL reporting will be done only on a STATE basis, not at the jurisdictional or home level



Pacific Northwest
NATIONAL LABORATORY

*Proudly Operated by **Battelle** Since 1965*

Backup slides

PNNL National Prototype



Pacific Northwest
NATIONAL LABORATORY

*Proudly Operated by **Battelle** Since 1965*

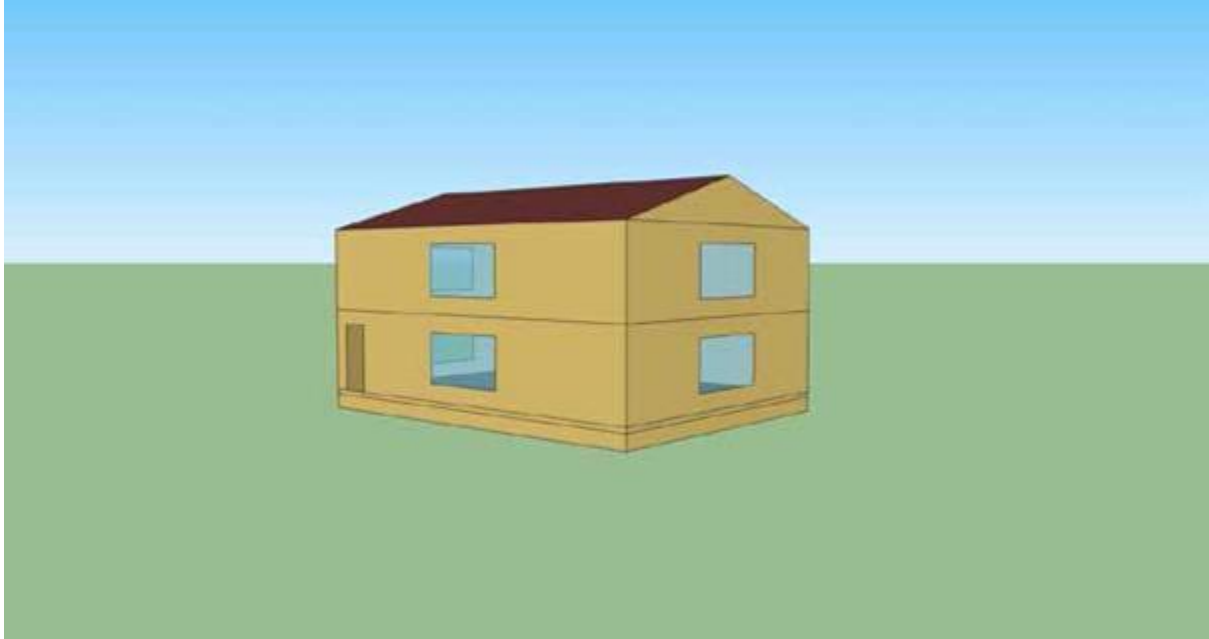


Table 2.1. Single-Family Prototype Characteristics

Parameter	Assumption	Notes
Conditioned floor area	2,400 ft ² (plus 1,200 ft ² of conditioned basement, where applicable)	Characteristics of New Housing, U.S. Census Bureau
Footprint and height	30-ft-by-40 ft, two-story, 8.5-ft-high ceilings	
Area above unconditioned space	1,200 ft ²	Over a vented crawlspace or unconditioned basement
Area below roof/ceilings	1,200 ft ² , 70% with attic, 30% cathedral	
Perimeter length	140 ft	
Gross exterior wall area	2,380 ft ²	
Window area (relative to gross wall area)	Fifteen percent equally distributed to the four cardinal directions (or as required to evaluate glazing-specific code changes)	
Door area	42 ft ²	
Internal gains	91,436 Btu/day	2006 IECC, Section 404
Heating system	Natural gas furnace, heat pump, electric furnace, or oil-fired furnace	Efficiencies will be based on prevailing federal minimum manufacturing standards.
Cooling system	Central electric air conditioning	Efficiency will be based on prevailing federal minimum manufacturing standards.
Water heating	Natural gas, or as required to evaluate domestic hot water-specific code changes	

Btu = British thermal units.

IECC = International Energy Conservation Code.