Achieving Energy Code Savings from Currently Available Tools, Data and Programs

State and Local Energy Code Support Programs

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PERFORMANCE SYSTEMS DEVELOPMENT

We Speak Building

What is an energy code program?

- Energy code compliance is lacking; therefore, energy code training, outreach, and education results in significant energy savings

- Common program elements:
  - Classroom training and webinars
  - Technical support via hotlines and email
  - Meetings with building departments
  - Job site visits
  - Tools (model permit application guidelines, plan review/inspection checklists, performance testing and commissioning forms, etc.)

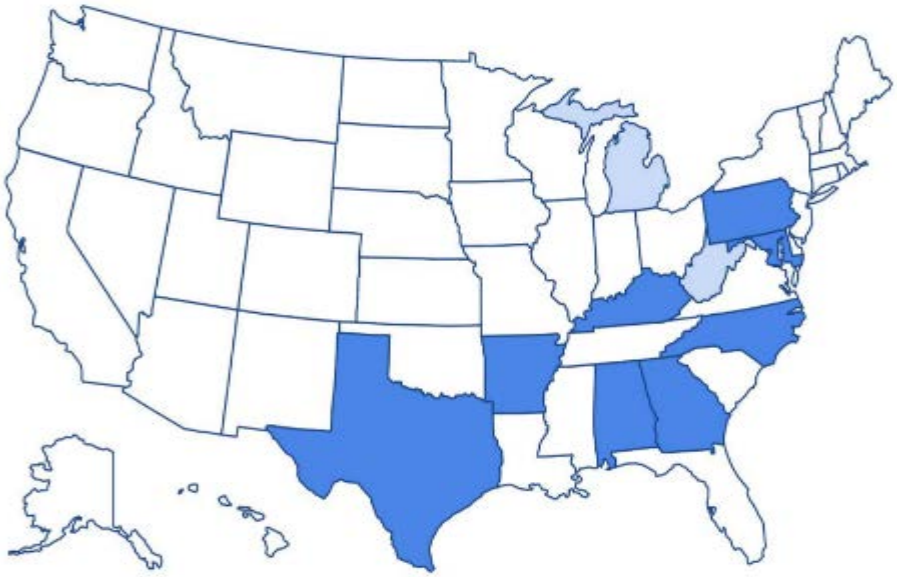
What is an energy code program?

- Funding
  - DOE State Energy Program
  - State governments
  - Local municipalities
  - Utilities
  - Non-profits

Assessing the Opportunity

U.S. DOE Residential Energy Code Field Study

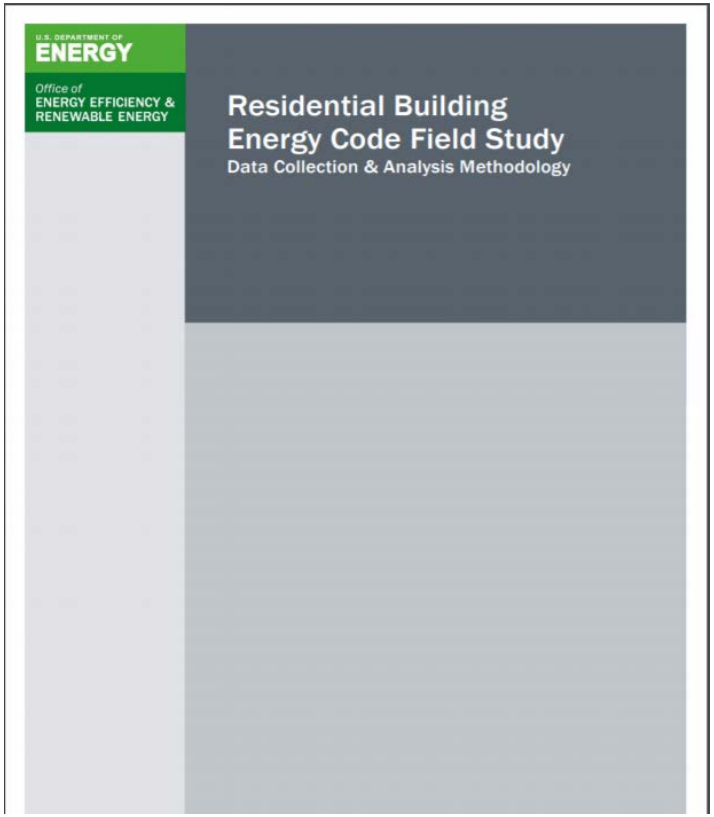
- Phase 1: Baseline field study
- Phase 2: Education and training using info from initial study
- Phase 3: Follow-up field study



U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

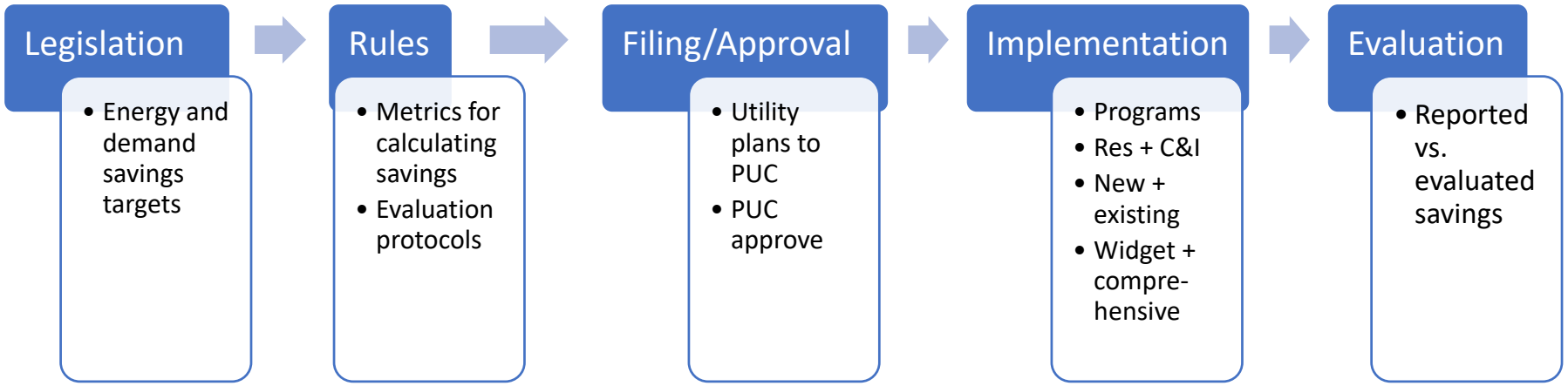
Goals of DOE Field Studies

- Provide standard model to assess compliance
- Reduce time and cost to assess compliance
- Assessment geared toward targeted key measures with highest energy impacts
- Results from studies to target additional training and resources toward areas with highest energy impact and greatest potential savings



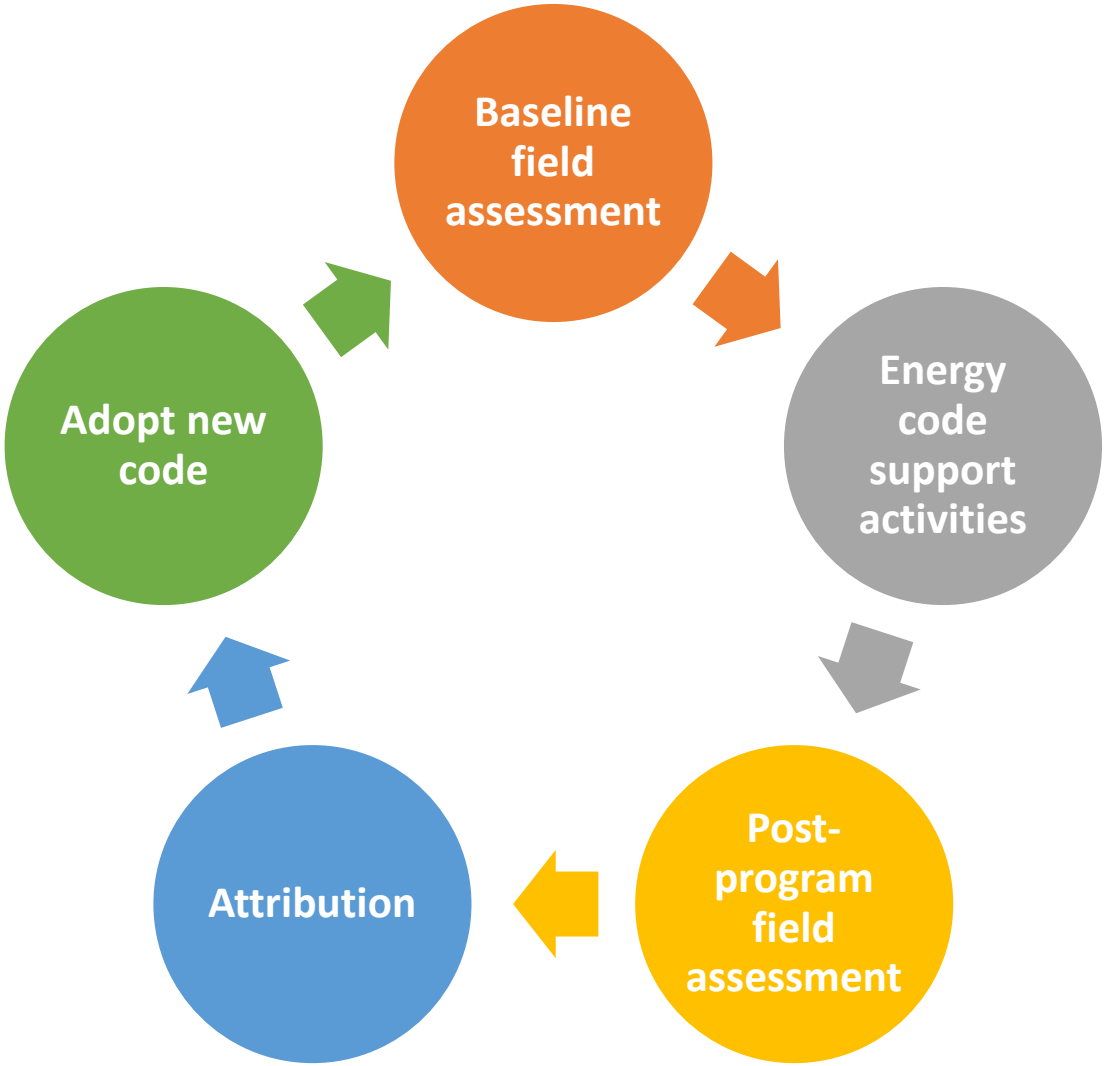
Can the case be made for private investment?

Utility-Sponsored EE Programs



- Increasing efficiency in energy codes and lighting & appliance standards challenge program participation and cost-effectiveness

Utility-Sponsored Energy Code Programs



Massachusetts Codes and Standards Compliance and Support Initiative

Past 18 months:

- 3,000 attendees
- 200 hotline/email inquiries
- 2,000 checklist/forms distributed

mass save®
Savings through energy efficiency

PERFORMANCE SYSTEMS DEVELOPMENT

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Federal- and State-Supported Programs

Pennsylvania Construction Codes Academy

- Energy code academies
- Continuing education training
  - ~20 events per year
    - Classroom training
    - Webinars
    - Custom training and process discussions

U.S. DEPARTMENT OF ENERGY

pennsylvania DEPARTMENT OF ENVIRONMENTAL PROTECTION

PCCA

PHRC PENNSYLVANIA HOUSING RESEARCH CENTER

PERFORMANCE SYSTEMS DEVELOPMENT

Local Programs – Philadelphia (Part 1)

- Commercial energy code assessment using IMT City Energy Project methodology
  - Plan submittal reviews
  - Plan reviews
  - Inspections
  - Savings potential analysis
  - Recommendations for future training

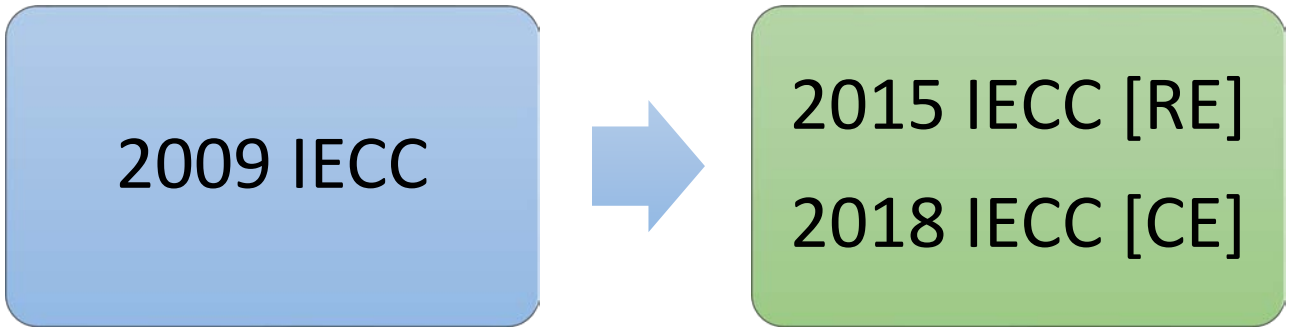
REINVESTMENT FUND
SUSTAINABLE DEVELOPMENT FUND

GREEN BUILDING UNITED

PERFORMANCE SYSTEMS DEVELOPMENT

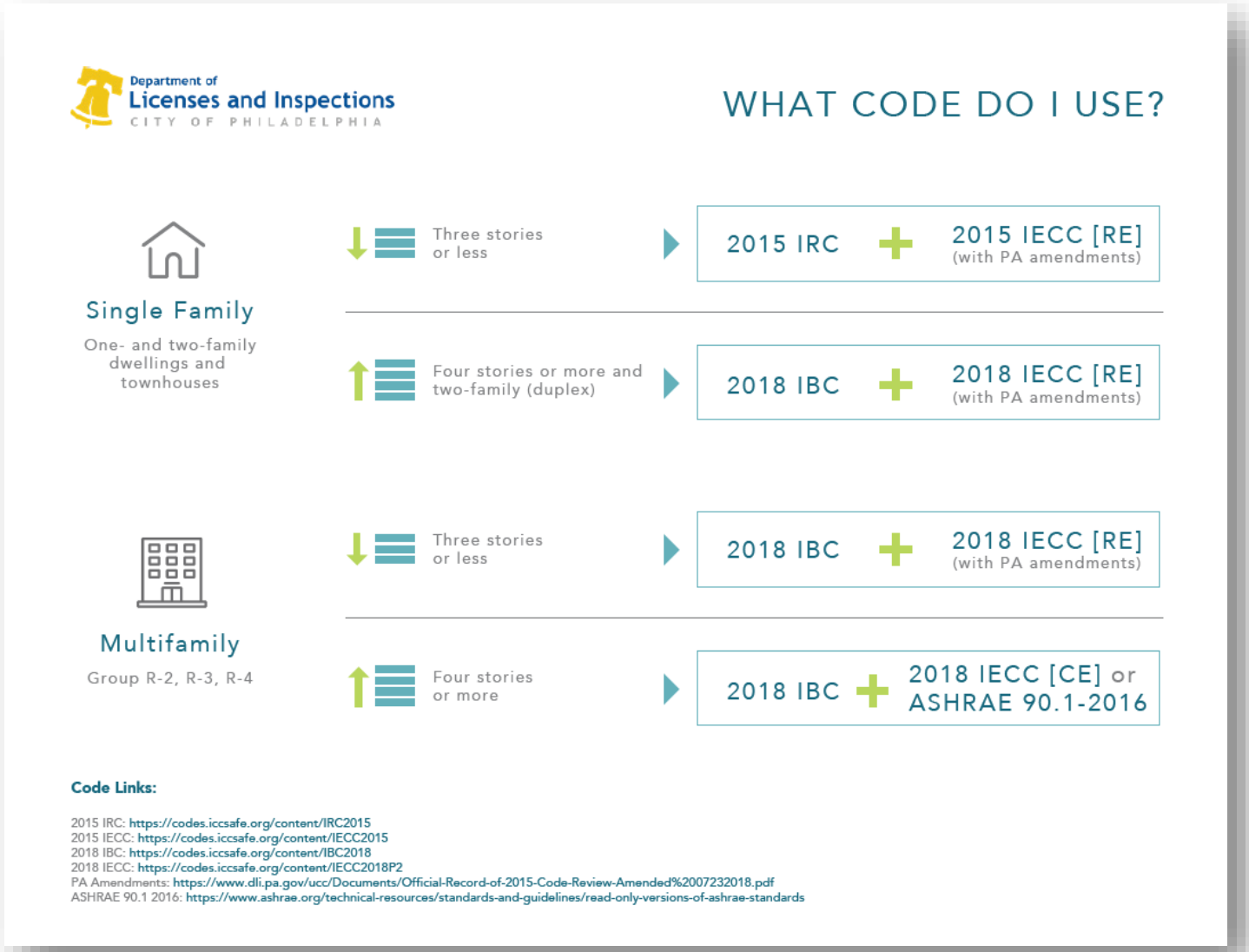
Local Programs – Philadelphia (Part 2)

Philadelphia Department of Licenses & Inspections Energy code transition support

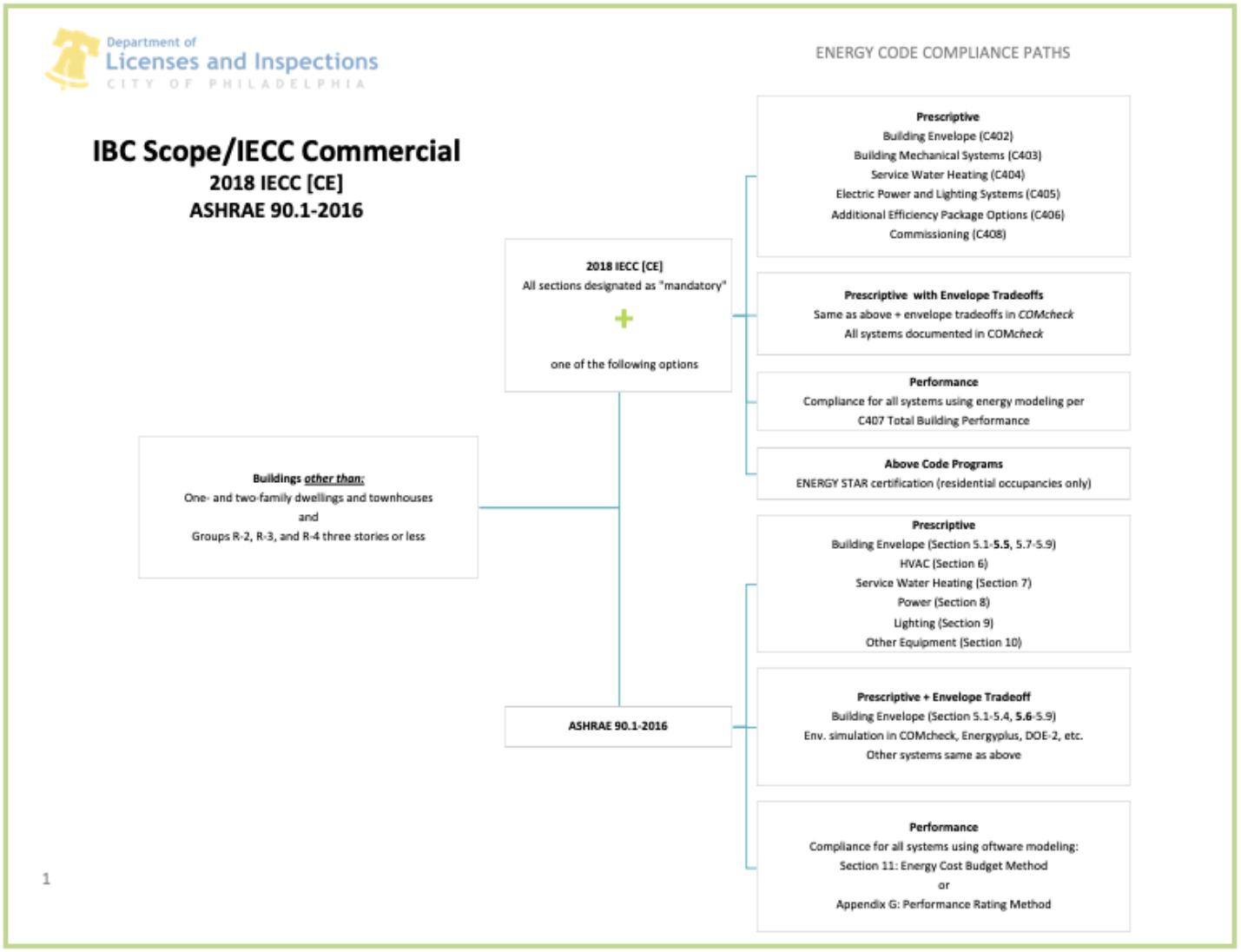


- Summary of experience from other states
- Permit application/plans detail recommendations
- Compliance forms
- Performance testing and commissioning qualification recommendations
- Plan review and inspection checklists

Fact Sheets: Choosing the Right Code



Fact Sheets: Compliance Path Trees



Fact Sheets: Enforcement Expectations

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Information Sheet:
Residential Energy Code Compliance

This document applies to any building under the scope of the Residential Energy [RE] provisions of the 2015 or 2018 International Energy Conservation Code (IECC). New one- and two-family dwellings and townhouses three stories or less in height above grade must fully comply with the requirements of the 2015 International Residential Code (IRC) and the 2015 IECC [RE]. New one- and two-family dwellings and townhouses four stories or greater in height above grade and Group R-2, R-3, and R-4 buildings three stories or less in height above grade must fully comply with the International Building Code (IBC) and the 2018 IECC [RE]. For a visual representation, please review the flow chart found here: *Which Code Do I Use*.

All dates contained in this document refer to the date of permit application.

I. Compliance Path Options

For buildings types described above, permit applicants may choose between five main energy code compliance paths: Prescriptive, Prescriptive with Envelope Tradeoffs, Performance, Energy Rating Index, and Above Code Programs. Regardless of which compliance path is chosen, the applicant must meet all requirements in the IECC that are designated as "mandatory". For a visual representation, refer to: *Energy Code Compliance Path Flowcharts*.

A. Optional Simulated Performance Alternative

To receive a building permit under this path, the permit application shall be accompanied by a preliminary 2015 or 2018 (as applicable) IECC Report produced using REM/Rate, Ekotrope, or other RESNET-accredited Simulated Performance Path software program. To be eligible for a certificate of occupancy, permit applicants choosing this optional compliance path shall provide a final 2015 or 2018 (as applicable) IECC Report calculated based on performance testing results and as-built conditions.

B. Optional Energy Rating Index (ERI) Compliance Alternative

When following the optional Energy Rating Index (ERI) Compliance Alternative, all verification shall be performed by a RESNET-certified HERS Rater following RESNET/ICC Standard 301. Field data may be collected by a RESNET-certified Ratings Field Inspector (RFI). To receive a building permit under this path, the permit application shall be accompanied by a preliminary HERS or ERI Report produced using REM/Rate, Ekotrope, or other RESNET-accredited HERS Rating software programs. To be eligible for a certificate of occupancy, the HERS Rater or permit holder must submit to the inspector an ERI Report[1] and a completed, software-generated Energy Code Inspection Checklist.

C. Optional Above Code Programs Alternative

To receive a building permit under this path, the permit application shall be accompanied by a preliminary HERS or ERI Report produced using REM/Rate, Ekotrope, or other RESNET-accredited HERS Rating software programs. To be eligible for a certificate of occupancy, permit applicants choosing this optional compliance path shall provide an ENERGY STAR™ certificate or PECO New Home Rebates certificate to the inspector.[2]

[1] When using a HERS Rating software program that does not incorporate Pennsylvania-specific amendments, the ERI Report shall be a 2015 IECC ERI Report and may show a failing result provided the only failing items are the ERI score and building envelope air leakage. In such cases, the ERI score shall be 62 or lower and the air leakage rate shall be 5.0 ACH50 or less.
[2] A temporary certificate of occupancy may be issued to allow for completion of final certification paperwork.

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II. Duct & Envelope Testing Form

Effective April 1, 2019, the *L&I Residential Duct & Envelope Testing (DET) Form* shall be completed and signed by the entity performing the test and provided to the inspector prior to scheduling the final inspection. For Group R buildings, testing agencies may submit a summary report including a list of all units that are exempt from testing (duct leakage only) and test results for all tested units.

A. Building Envelope Air Leakage Testing

Blower door testing shall be performed in accordance with ASTM E 779 or ASTM E 1827 on each building or dwelling unit to verify the building envelope air leakage rate does not exceed 5.0 air changes per hour when tested at a pressure of 50 Pascals (ACH50).

As of July 1, 2019, blower door testing shall be performed by an approved third party who shall hold one of the following certifications:

- RESNET-Certified HERS Rater
- BPI Building Analyst
- BPI Energy Auditor
- RESNET-Certified Rating Field Inspector (RFI)
- BPI Infiltration & Duct Leakage
- Envelope Professional

B. Duct Leakage Testing

Duct leakage shall be tested for all HVAC systems (excluding standalone ventilation systems) with any part of the system not located completely within the building thermal envelope. Under the prescriptive path, all forced-air systems shall be verified as having a total leakage of ≤ 4.0 cfm per 100 square feet of conditioned floor area served by that system, or ≤ 3.0 cfm per 100 square feet if testing is performed prior to installation of the air handler, when tested at a pressure of 25 Pascals.

As of July 1, 2019, duct leakage testing shall be performed by individuals holding one of the following certifications:

- RESNET-Certified HERS Rater
- BPI Energy Auditor
- BPI Heating Professional
- RESNET-Certified Rating Field Inspector (RFI)
- BPI Infiltration & Duct Leakage
- BPI/DOE Quality Control Inspector

III. HVAC Equipment Design

The *L&I HVAC Equipment Design Form* shall be submitted with each mechanical permit application.

Equipment sizing and selection. The *L&I HVAC Equipment Design Form* will certify that the proposed mechanical equipment has been sized and selected in accordance with ACCA Manuals J and S.

Whole-house mechanical ventilation. The *L&I Whole-House Mechanical Ventilation Design Worksheet* will certify that a whole-house mechanical ventilation system has been specified and the fan meets IECC minimum airflow (CFM) and efficacy (Watts/CFM) requirements.

III. Air Barrier & Insulation Inspections

As of July 1, 2019, air barrier and insulation inspections shall be performed by an *approved* third party in accordance with the *L&I Air Barrier & Insulation Inspection Checklist*, based on IECC Table R402.4.1.1.

Approved third party inspectors shall be independent from the design and construction of the building, and individuals performing the inspection(s) shall hold one of the following certifications:

- RESNET-Certified HERS Rater
- RESNET-Certified Rating Field Inspector (RFI)

HVAC Design Form

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CITY OF PHILADELPHIA

HVAC EQUIPMENT DESIGN FORM

House Address: _____ Permit #: _____ Date: _____

Permit holder: _____ Phone: _____

HVAC SYSTEM SIZING AND SELECTION

Homes pursuing ENERGY STAR certification may attach a completed ENERGY STAR National HVAC Design Report in lieu of completing the remainder of this form. Otherwise, please fill in the following information.

Heating and cooling equipment shall be selected in accordance with Manual S, based on loads calculated in accordance with Manual J.

Design loads:

Design cooling load _____ (Btu/h)

Design heating load: _____ (Btu/h)

Equipment specifications:

Cooling system output capacity _____ (Btu/h)

Cooling equipment make: _____

Cooling equipment model: _____

Heating system output capacity: _____ (Btu/h)

Heating equipment make: _____

Heating equipment model: _____

☐ Manual J report is attached

☐ Manual S report is attached

☐ Specified cooling equipment does not exceed 1.15 times the design capacity or the next larger nominal size, whichever is greater. (Exception: Heat pumps may exceed the design capacity by 1.25 times or the next nominal size.)

☐ Specified heating equipment does not exceed 1.40 times the design capacity or the next larger nominal size, whichever is greater

☐ Air handler has manufacturer's designation of ≤ 2% air leakage when tested in accordance with ASHRAE 193

☐ Whole-house mechanical ventilation worksheet has been completed (see reverse)

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HVAC EQUIPMENT DESIGN FORM

House Address: _____ Permit #: _____ Date: _____

Permit holder: _____ Phone: _____

WHOLE-HOUSE MECHANICAL VENTILATION DESIGN WORKSHEET

1. **Fill in the conditioned floor area and number of bedrooms for the dwelling:**

   Conditioned Floor Area = _____ ft^2 Number of bedrooms = _____

2. **Circle the required airflow value on the table below:**

IRC Table M1507.3.3(1)
Continuous Whole-House Mechanical Ventilation System Airflow Rate Requirements

Dwelling Unit Floor Area (square feet)	Number of Bedrooms				
	0-1	2-3	4-5	6-7	>7
	Airflow in CFM				
< 1,500	30	45	60	75	90
1,501 – 3,000	45	60	75	90	105
3,001 – 4,500	60	75	90	105	120
4,501 – 6,000	75	90	105	120	135
6,001 – 7,500	90	105	120	135	150
> 7,500	105	120	135	150	165

3. **Does the fan operate continuously or intermittently?** ☐ Continuous ☐ Intermittent

4. **If the fan is to be operated intermittently *on a pre-set schedule*,** multiply the airflow value from Table M1507.3.3 (above) by the appropriate value in Table M1507.3.3(2) (below).

IRC Table M1507.3.3(2)
Intermittent Whole-House Mechanical Ventilation Rate Factors

Run-time Percentage in Each 4-hour Segment	25%	33%	50%	66%	75%
Factor	4.0	3.0	2.0	1.5	1.3

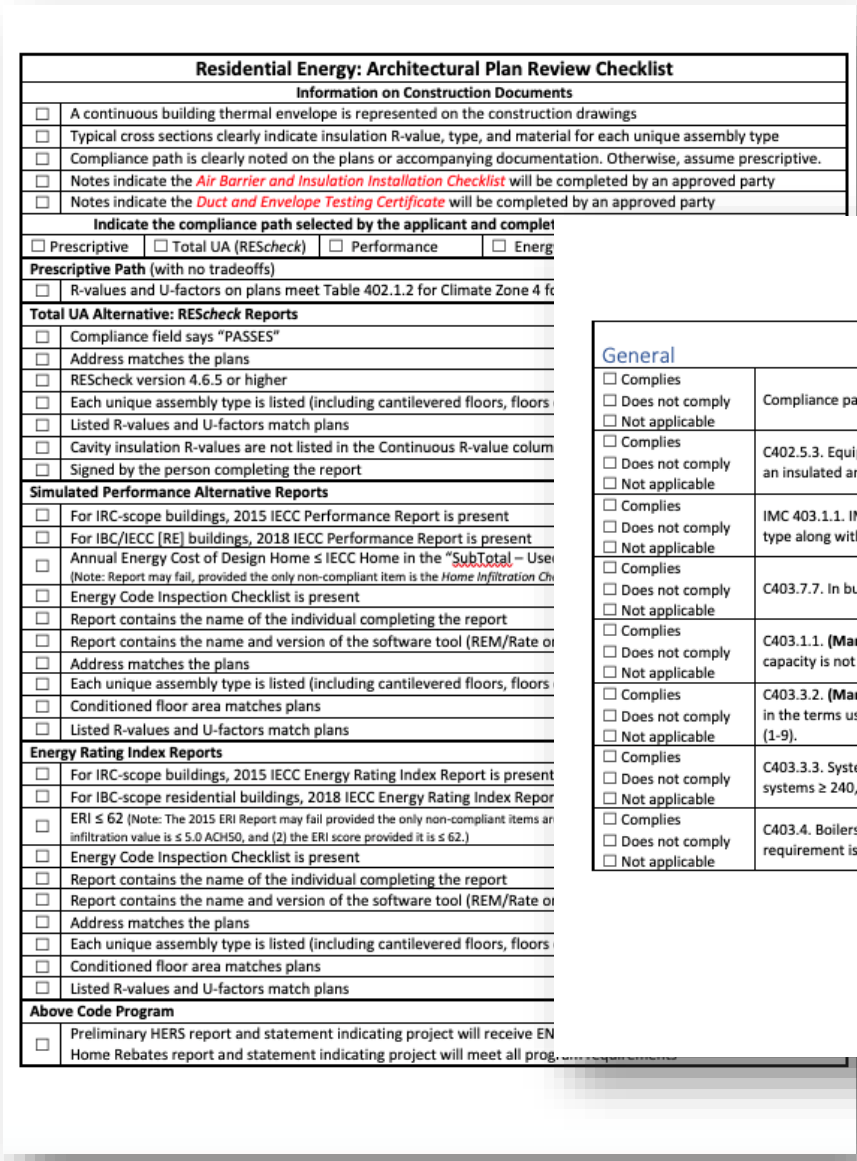
5. **Enter the required airflow =** _____ CFM

6. **Enter the following information regarding the specified fan:**

   Rated fan airflow = _____ CFM Fan make: _____

   HVI-rated fan efficacy = _____ CFM/Watt Fan model: _____

Plan Review Checklists



Residential Energy: Architectural Plan Review Checklist

Information on Construction Documents

☐	A continuous building thermal envelope is represented on the construction drawings
☐	Typical cross sections clearly indicate insulation R-value, type, and material for each unique assembly type
☐	Compliance path is clearly noted on the plans or accompanying documentation. Otherwise, assume prescriptive.
☐	Notes indicate the *Air Barrier and Insulation Installation Checklist* will be completed by an approved party
☐	Notes indicate the *Duct and Envelope Testing Certificate* will be completed by an approved party

Indicate the compliance path selected by the applicant and complet

☐ Prescriptive ☐ Total UA (RES*check*) ☐ Performance ☐ Energ

Prescriptive Path (with no tradeoffs)

☐	R-values and U-factors on plans meet Table 402.1.2 for Climate Zone 4 fo

Total UA Alternative: RES*check* Reports

☐	Compliance field says "PASSES"
☐	Address matches the plans
☐	REScheck version 4.6.5 or higher
☐	Each unique assembly type is listed (including cantilevered floors, floors
☐	Listed R-values and U-factors match plans
☐	Cavity insulation R-values are not listed in the Continuous R-value colum
☐	Signed by the person completing the report

Simulated Performance Alternative Reports

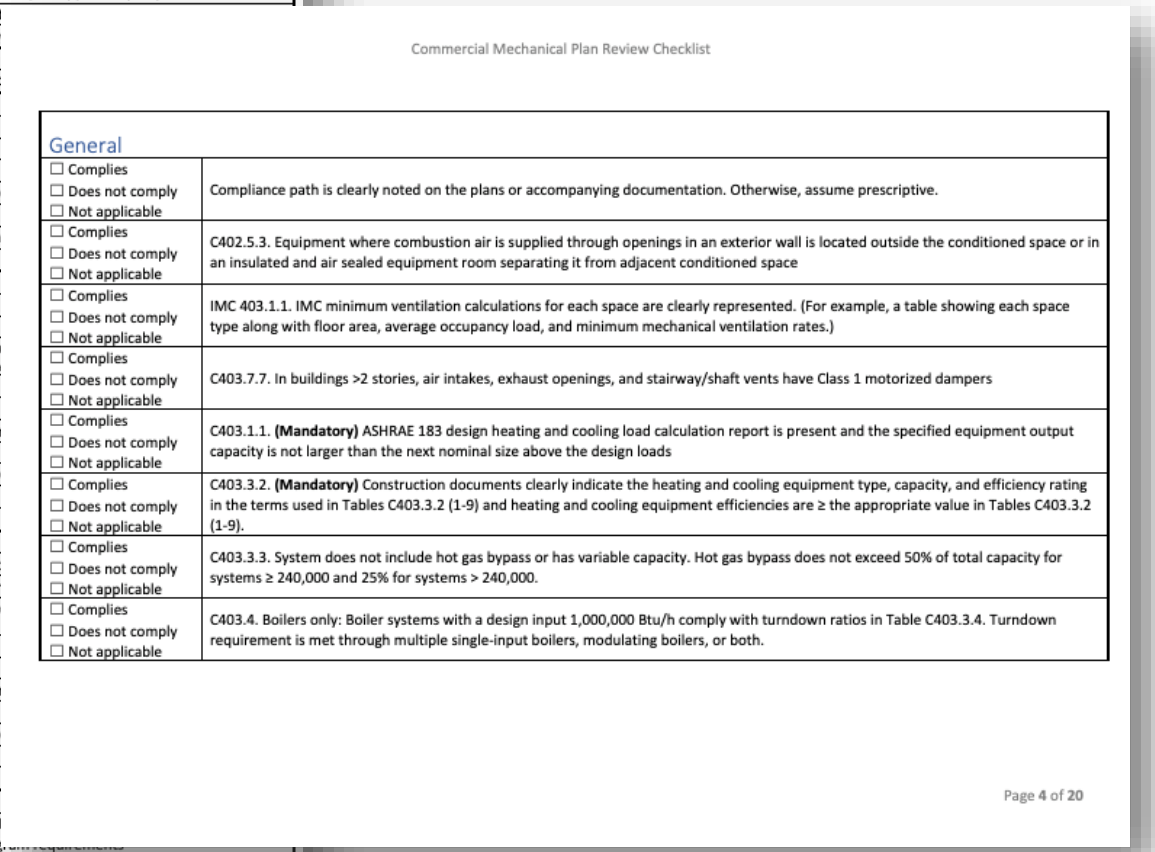
☐	For IRC-scope buildings, 2015 IECC Performance Report is present
☐	For IBC/IECC [RE] buildings, 2018 IECC Performance Report is present
☐	Annual Energy Cost of Design Home ≤ IECC Home in the "SubTotal – Use (Note: Report may fail, provided the only non-compliant item is the *Home Infiltration Ch*
☐	Energy Code Inspection Checklist is present
☐	Report contains the name of the individual completing the report
☐	Report contains the name and version of the software tool (REM/Rate or
☐	Address matches the plans
☐	Each unique assembly type is listed (including cantilevered floors, floors
☐	Conditioned floor area matches plans
☐	Listed R-values and U-factors match plans

Energy Rating Index Reports

☐	For IRC-scope buildings, 2015 IECC Energy Rating Index Report is present
☐	For IBC-scope residential buildings, 2018 IECC Energy Rating Index Repor
☐	ERI ≤ 62 (Note: The 2015 ERI Report may fail provided the only non-compliant items ar infiltration value is ≤ 5.0 ACH50, and (2) the ERI score provided it is ≤ 62.)
☐	Energy Code Inspection Checklist is present
☐	Report contains the name of the individual completing the report
☐	Report contains the name and version of the software tool (REM/Rate or
☐	Address matches the plans
☐	Each unique assembly type is listed (including cantilevered floors, floors
☐	Conditioned floor area matches plans
☐	Listed R-values and U-factors match plans

Above Code Program

☐	Preliminary HERS report and statement indicating project will receive EN Home Rebates report and statement indicating project will meet all prog



Commercial Mechanical Plan Review Checklist

General

☐ Complies ☐ Does not comply ☐ Not applicable	Compliance path is clearly noted on the plans or accompanying documentation. Otherwise, assume prescriptive.
☐ Complies ☐ Does not comply ☐ Not applicable	C402.5.3. Equipment where combustion air is supplied through openings in an exterior wall is located outside the conditioned space or in an insulated and air sealed equipment room separating it from adjacent conditioned space
☐ Complies ☐ Does not comply ☐ Not applicable	IMC 403.1.1. IMC minimum ventilation calculations for each space are clearly represented. (For example, a table showing each space type along with floor area, average occupancy load, and minimum mechanical ventilation rates.)
☐ Complies ☐ Does not comply ☐ Not applicable	C403.7.7. In buildings >2 stories, air intakes, exhaust openings, and stairway/shaft vents have Class 1 motorized dampers
☐ Complies ☐ Does not comply ☐ Not applicable	C403.1.1. **(Mandatory)** ASHRAE 183 design heating and cooling load calculation report is present and the specified equipment output capacity is not larger than the next nominal size above the design loads
☐ Complies ☐ Does not comply ☐ Not applicable	C403.3.2. **(Mandatory)** Construction documents clearly indicate the heating and cooling equipment type, capacity, and efficiency rating in the terms used in Tables C403.3.2 (1-9) and heating and cooling equipment efficiencies are ≥ the appropriate value in Tables C403.3.2 (1-9).
☐ Complies ☐ Does not comply ☐ Not applicable	C403.3.3. System does not include hot gas bypass or has variable capacity. Hot gas bypass does not exceed 50% of total capacity for systems ≥ 240,000 and 25% for systems > 240,000.
☐ Complies ☐ Does not comply ☐ Not applicable	C403.4. Boilers only: Boiler systems with a design input 1,000,000 Btu/h comply with turndown ratios in Table C403.3.4. Turndown requirement is met through multiple single-input boilers, modulating boilers, or both.

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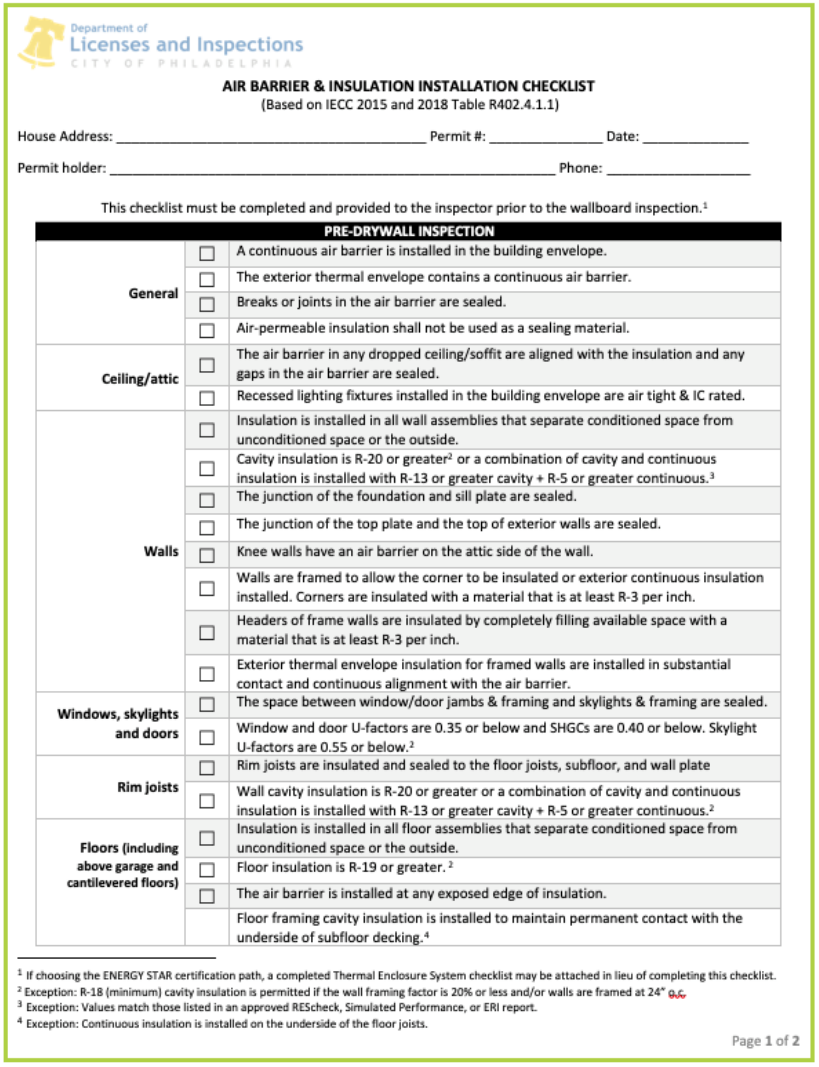
Inspection Checklists



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CITY OF PHILADELPHIA

AIR BARRIER & INSULATION INSTALLATION CHECKLIST
(Based on IECC 2015 and 2018 Table R402.4.1.1)

House Address: _____ Permit #: _____ Date: _____

Permit holder: _____ Phone: _____

This checklist must be completed and provided to the inspector prior to the wallboard inspection.[1]

PRE-DRYWALL INSPECTION		
General	☐	A continuous air barrier is installed in the building envelope.
	☐	The exterior thermal envelope contains a continuous air barrier.
	☐	Breaks or joints in the air barrier are sealed.
	☐	Air-permeable insulation shall not be used as a sealing material.
Ceiling/attic	☐	The air barrier in any dropped ceiling/soffit are aligned with the insulation and any gaps in the air barrier are sealed.
	☐	Recessed lighting fixtures installed in the building envelope are air tight & IC rated.
Walls	☐	Insulation is installed in all wall assemblies that separate conditioned space from unconditioned space or the outside.
	☐	Cavity insulation is R-20 or greater[2] or a combination of cavity and continuous insulation is installed with R-13 or greater cavity + R-5 or greater continuous.[3]
	☐	The junction of the foundation and sill plate are sealed.
	☐	The junction of the top plate and the top of exterior walls are sealed.
	☐	Knee walls have an air barrier on the attic side of the wall.
	☐	Walls are framed to allow the corner to be insulated or exterior continuous insulation installed. Corners are insulated with a material that is at least R-3 per inch.
	☐	Headers of frame walls are insulated by completely filling available space with a material that is at least R-3 per inch.
	☐	Exterior thermal envelope insulation for framed walls are installed in substantial contact and continuous alignment with the air barrier.
Windows, skylights and doors	☐	The space between window/door jambs & framing and skylights & framing are sealed.
	☐	Window and door U-factors are 0.35 or below and SHGCs are 0.40 or below. Skylight U-factors are 0.55 or below.[2]
Rim joists	☐	Rim joists are insulated and sealed to the floor joists, subfloor, and wall plate
	☐	Wall cavity insulation is R-20 or greater or a combination of cavity and continuous insulation is installed with R-13 or greater cavity + R-5 or greater continuous.[2]
Floors (including above garage and cantilevered floors)	☐	Insulation is installed in all floor assemblies that separate conditioned space from unconditioned space or the outside.
	☐	Floor insulation is R-19 or greater. [2]
	☐	The air barrier is installed at any exposed edge of insulation.
		Floor framing cavity insulation is installed to maintain permanent contact with the underside of subfloor decking.[4]

[1] If choosing the ENERGY STAR certification path, a completed Thermal Enclosure System checklist may be attached in lieu of completing this checklist.
[2] Exception: R-18 (minimum) cavity insulation is permitted if the wall framing factor is 20% or less and/or walls are framed at 24" o.c.
[3] Exception: Values match those listed in an approved REScheck, Simulated Performance, or ERI report.
[4] Exception: Continuous insulation is installed on the underside of the floor joists.

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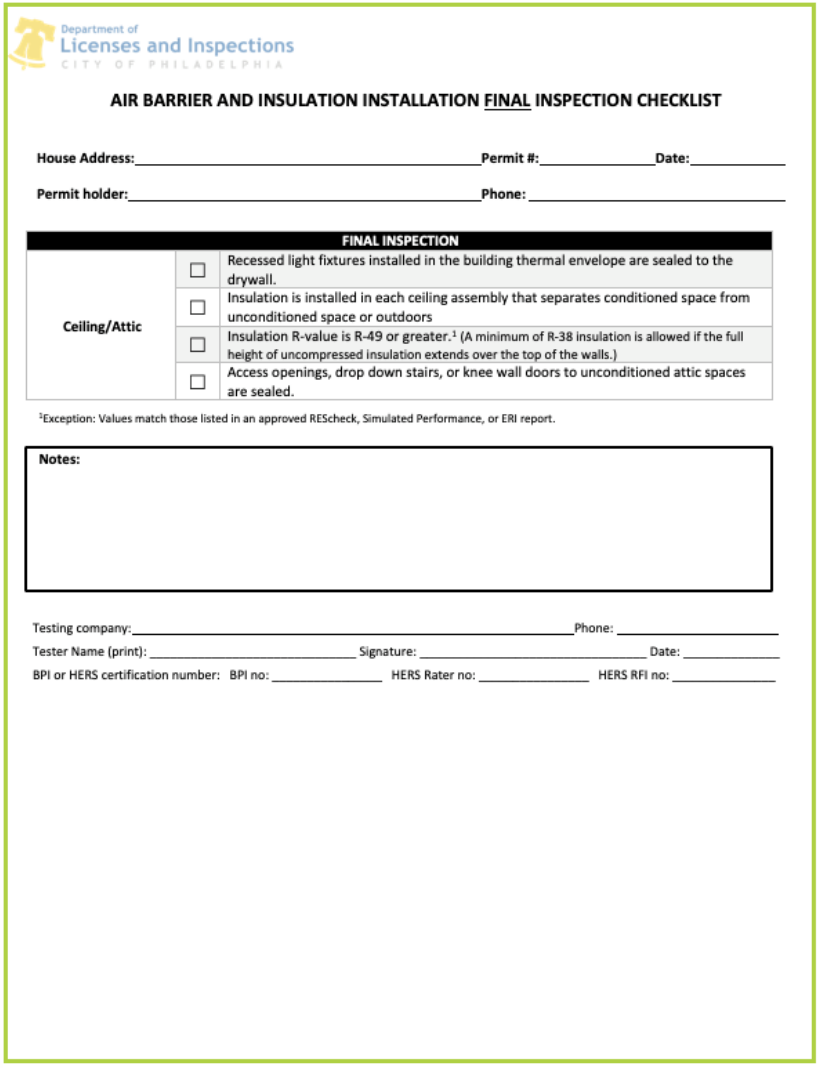

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AIR BARRIER AND INSULATION INSTALLATION FINAL INSPECTION CHECKLIST

House Address: _____ **Permit #:** _____ **Date:** _____

Permit holder: _____ **Phone:** _____

FINAL INSPECTION		
Ceiling/Attic	☐	Recessed light fixtures installed in the building thermal envelope are sealed to the drywall.
	☐	Insulation is installed in each ceiling assembly that separates conditioned space from unconditioned space or outdoors
	☐	Insulation R-value is R-49 or greater.[1] (A minimum of R-38 insulation is allowed if the full height of uncompressed insulation extends over the top of the walls.)
	☐	Access openings, drop down stairs, or knee wall doors to unconditioned attic spaces are sealed.

[1]Exception: Values match those listed in an approved REScheck, Simulated Performance, or ERI report.

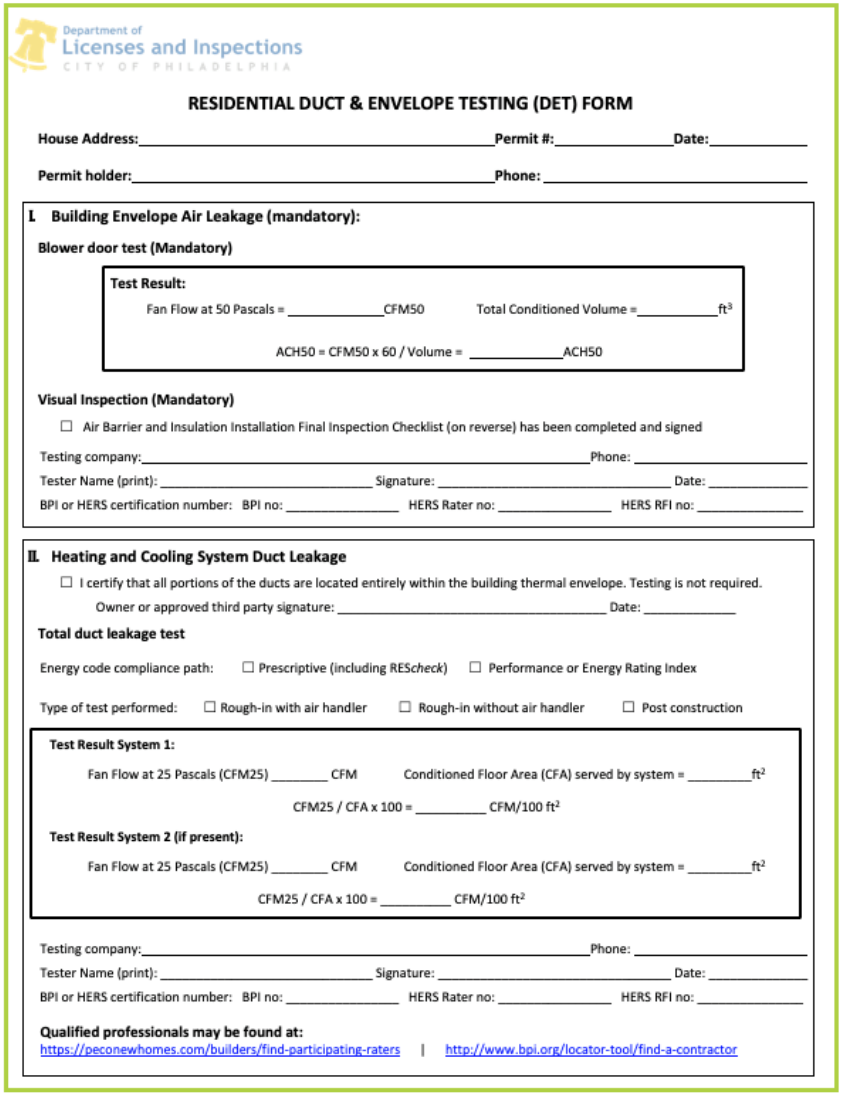
Notes:

Testing company: _____ Phone: _____

Tester Name (print): _____ Signature: _____ Date: _____

BPI or HERS certification number: BPI no: _____ HERS Rater no: _____ HERS RFI no: _____

Performance Testing Form



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RESIDENTIAL DUCT & ENVELOPE TESTING (DET) FORM

House Address:_____ **Permit #:**_____ **Date:**_____

Permit holder:_____ **Phone:** _____

I Building Envelope Air Leakage (mandatory):

Blower door test (Mandatory)

Test Result:

Fan Flow at 50 Pascals = _____ CFM50 Total Conditioned Volume = _____ ft^3

ACH50 = CFM50 x 60 / Volume = _____ ACH50

Visual Inspection (Mandatory)

☐ Air Barrier and Insulation Installation Final Inspection Checklist (on reverse) has been completed and signed

Testing company:_____ Phone: _____

Tester Name (print): _____ Signature: _____ Date: _____

BPI or HERS certification number: BPI no: _____ HERS Rater no: _____ HERS RFI no: _____

II Heating and Cooling System Duct Leakage

☐ I certify that all portions of the ducts are located entirely within the building thermal envelope. Testing is not required.

Owner or approved third party signature: _____ Date: _____

Total duct leakage test

Energy code compliance path: ☐ Prescriptive (including RES*check*) ☐ Performance or Energy Rating Index

Type of test performed: ☐ Rough-in with air handler ☐ Rough-in without air handler ☐ Post construction

Test Result System 1:

Fan Flow at 25 Pascals (CFM25) _____ CFM Conditioned Floor Area (CFA) served by system = _____ ft^2

CFM25 / CFA x 100 = _____ CFM/100 ft^2

Test Result System 2 (if present):

Fan Flow at 25 Pascals (CFM25) _____ CFM Conditioned Floor Area (CFA) served by system = _____ ft^2

CFM25 / CFA x 100 = _____ CFM/100 ft^2

Testing company:_____ Phone: _____

Tester Name (print): _____ Signature: _____ Date: _____

BPI or HERS certification number: BPI no: _____ HERS Rater no: _____ HERS RFI no: _____

Qualified professionals may be found at:

https://peconewhomes.com/builders/find-participating-raters | http://www.bpi.org/locator-tool/find-a-contractor

Other Notable Programs (just a few)

- Arizona Public Service and Salt River Project
- California Statewide Codes and Standards Program
  - Compliance Improvement Subprogram
- Northwest Energy Efficiency Alliance
- NYSERDA Energy Code Training & Support Services
- Rhode Island Code Compliance Enhancement Initiative

Utility-Sponsored Codes and Standards Adoption Support

- California Statewide Codes and Standards Program
  - Building Codes Advocacy Subprogram
  - Reach Codes Subprogram
- Arizona – Utility attribution for encouraging local jurisdictions to adopt latest code
- Massachusetts (planned)

Questions?

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Director of Energy Codes & New Homes Programs

PERFORMANCE SYSTEMS DEVELOPMENT

We Speak Building