



Building Performance Institute, Inc.  
BPI Standards

BPI 104

# Envelope Professional Standard





# BUILDING PERFORMANCE INSTITUTE TECHNICAL STANDARDS FOR THE ENVELOPE PROFESSIONAL

## Health and Safety

### Personal Safety

All technicians performing diagnostic tests, inspections, or installations, must have access to all necessary personal safety equipment required by OSHA. Required safety equipment includes, but is not limited to:

- ✓ Fitted respirators with canister filters
- ✓ Dust masks
- ✓ Gloves
- ✓ Protective clothing
- ✓ Safety glasses
- ✓ Hard hats, as required

Technicians must be trained in proper use and applications for these devices and must adhere to OSHA regulations when on the job site.

All hand tools, power tools, ladders, and diagnostic equipment must be handled and used in a safe manner and kept in good working condition. Equipment and diagnostic tools must be maintained and calibrated according to manufacturer's specifications.

A copy of the Material Safety Data Sheets (MSDS) for all materials used on the job and installed in the home, must be kept on each crew vehicle and made available to all workers and clients upon request.

Where the presence of asbestos, lead, mold and/or other known or suspected hazardous material is present, all relevant state and federal (EPA) guidelines must be followed to ensure technician and occupant safety. Blower door depressurization tests may not be performed in homes where there is a risk of asbestos becoming airborne and being drawn into the dwelling.



Respirators with filter cartridges must be worn when working in areas where exposure to airborne mold, asbestos, lead, fiberglass, or formaldehyde is a risk.

Refer to standards on combustion safety (Building Analyst Professional) for requirements applicable to carbon monoxide exposure

### **Occupant Health and Safety**

Where moisture problems exist, moisture sources must be mitigated through elimination of the source, isolation of the source, or ventilation of the space around the source before proceeding with other shell-related measures.

The homeowner must be notified of any health and safety hazards identified during the course of inspections and installations in the home. These hazards include, but are not limited to: indoor air contaminant sources, moisture problems, structural problems, electrical problems, and fire protection issues. Wherever problems are identified or suspected that fall outside the technician's area of expertise, the technician must inform the client of the problem and recommend an evaluation by a professional who specializes in this subject.

Clothes dryers, regardless of fuel type, and bathroom exhaust fans must be vented directly outside using appropriate duct materials (metal ducts are required for gas fueled clothes dryers) before proceeding with installation of air sealing, duct sealing, or enclosed cavity insulation measures. Exhaust ducts running through unconditioned space must be insulated and have a minimum 1/4" rise for every foot of run towards wall or roof terminations.



The following are the minimum required health and safety diagnostics and specifications for Envelope Professional level certification. These requirements are in addition to those set forth in the BPI Technical Standards for Building Analyst Professional. Minimum health and safety requirements apply to all jobs with work related to energy efficiency and/or indoor air quality performed by BPI accredited firms.

### **Minimum Health and Safety Requirements (Envelope Professional)**

*(refer to main text and the Building Analyst Professional Standards for detailed descriptions and applications of the standards below)*

- Blower door tests must be performed before and after the installation of air sealing, enclosed cavity insulation representing more than 15% of the building shell area, or sealing of ductwork located outside the building envelope.
- If the measured CFM50 is less than the Building Airflow Standard, as set forth in ASHRAE 62-89, mechanical ventilation must be recommended or installed according to the standards.
- When a mechanical ventilation system is installed in a building where combustion appliances are present, a complete post-installation combustion safety diagnostic must be conducted and final conditions must meet minimum safety requirements for draft, spillage, and CAZ depressurization.
- Air sealing measures must be prioritized to reduce the stack effect and inhibit moisture migration into attics or other interstitial spaces.
- Appropriate inspection and diagnostic tests must be performed before and after installation of attic insulation and/or ventilation to ensure an effective air barrier exists between the attic and living space.
- Prior to installing insulation in an existing home, a thorough inspection of the interior and exterior of the home is required to identify areas where installation of insulation may be unsafe. Problems that are identified must be remedied prior to installation.
  - Insulation may not be installed where live knob and tube wiring exists.
  - Recessed can light fixtures that are not IC-rated, chimneys, and other heat producing obstructions must be baffled with an effective dam prior to insulating the area to maintain minimum clearances to insulation or other combustible products.



**Airflow and Mechanical Ventilation**

Blower door tests must be performed before and after the installation of any of the following measures:

- ❑ Attic insulation, in order to quantify improvements to the air barrier between the attic and the living space.
- ❑ Enclosed cavity insulation representing an area greater than 15% of the total building shell area.
- ❑ Air sealing
- ❑ Sealing of ductwork located outside the building envelope or significant duct modifications within the building envelope.

If the measured CFM50 is less than the Building Airflow Standard (BAS) as set forth in ASHRAE Standard 62-89, mechanical ventilation must be recommended or installed according to the following standards:

Condition	Action
$BAS > \text{final CFM50} > (0.7 \times BAS)$	Mechanical ventilation rated for continuous operation must be recommended to the customer as part of the work scope. System must be sized to make up the difference between the BAS and the final CFM50.
$(0.7 \times BAS) > \text{final CFM50}$	Mechanical ventilation rated for continuous operation must be installed as part of the work scope. System must be sized to provide 100% of the ventilation requirement by mechanical means.

Recommended or installed mechanical ventilation must be designed appropriately to provide adequate air exchange to meet the occupancy ventilation requirements provided by ASHRAE 62-89.

When a mechanical ventilation system is installed in a building where combustion appliances are present, a complete post-installation combustion safety diagnostic must be conducted and conditions must meet all minimum safety requirements for draft, spillage, and CAZ depressurization as established in the BPI Building Analyst Professional Standards.

All ventilation duct systems, including local exhaust, must be appropriately ducted to provide the most direct route outside as possible. When determining installed airflow rates, friction losses through the ducts must be accounted for either through direct measurement using a flow hood or similar device, or by calculating the friction losses and subtracting them from the rated cfm airflow of the fan.



Ventilation exhaust ductwork must have a minimum rise of ¼” per foot of run and when located outside the building shell, must be fully insulated to a minimum R-7.

Mechanical ventilation systems that include a supply and return must be tested and verified for adequate airflow and balance after installation.

## **Installation Requirements**

An effective and continuous thermal and pressure boundary shall be established in each home through the installation of appropriate air sealing and insulation measures. Wherever possible, air sealing and insulation strategies shall be designed to align the thermal and pressure boundaries to create a single continuous Thermal Envelope. Minimum insulation levels shall be determined based on local codes. Air sealing strategies shall be determined based on blower door diagnostic results, visual inspection of critical by-pass areas, and indoor air quality evaluations for each home.

### **Air Sealing**

Air sealing measures shall be prioritized to reduce the stack effect and inhibit moisture migration into attics or other interstitial spaces. Blower door quick tests should be performed during air sealing to track progress and verify results.

Appropriate inspection and diagnostic tests (listed below) must be performed before and after installation of attic insulation and/or ventilation to ensure an effective air barrier exists between the attic and living space.

The effectiveness of the air barrier shall be determined using the following techniques:

- ✓ Pressure differential diagnosis, including: series leakage tests and/or “add a hole” method where applicable. (Refer to the blower door instruction manual for details on how to perform these tests.)
- ✓ Visual inspection of the attic. Visual indicators include all of the following:
  - Inspect the attic floor underneath the insulation to locate thermal by-passes and cavities requiring air sealing.
  - Inspect for areas where moisture migration into the attic is apparent and determine the source of the moisture.
  - Insulation that has turned black is an indicator of air movement through the insulation. Identify the source.
- ✓ With the blower door running under depressurization, use a smoke stick in the attic to verify the integrity of installed air sealing measures.

If communication between the attic and living space is identified using any of the tests listed above, the area must be sealed prior to installation of insulation and/or ventilation



in the attic. Whenever air sealing is recommended, leakage paths to the attic must be given the highest priority on the work scope.

The following checklist shall be used as a guide during air sealing installations:

- ✓ Air seal communication between the attic and living space first. Areas to seal include: by-passes around chimneys, ducts, drop soffits, shower inserts or other large penetrations; interior and exterior wall top-plates; and plumbing and wiring penetrations.
- ✓ Leakage paths identified between attached or tuck-under garages and the living space must always be sealed.
- ✓ After establishing an effective air barrier between the attic and living space, basement air sealing may be completed. Areas to be sealed in basements shall be determined based on the use of the basement area. Conditioned or tempered basements shall be sealed at the rim joist and other connections to outside. In unconditioned basements, air sealing shall be targeted at reducing the communication between the basement and the conditioned space above.
- ✓ Reduce air leakage paths through building cavities by using manual air sealing, high density cavity insulation (see below) or air impermeable spray foam.
- ✓ If the house CFM50 is still higher than the Building Airflow Standard after sealing the attic, garage, and basement, interior air-sealing may be performed as needed including: sealing around plumbing penetrations, caulking around window and door casings, caulking around molding and baseboards, or other significant leakage areas identified using the blower door.

Air sealing installations must be installed to be permanent improvements to the structure. Products with an expected lifespan of less than 20 years shall not be used.

Pressure differential analysis shall be used to assist in identifying leakage paths and prioritizing air sealing measures.

### **Using Insulation for Air Sealing**

For leakage paths through enclosed cavities which cannot be accessed or reasonably sealed using conventional air sealing techniques, BPI requires installation of high density pneumatically applied insulation - which complies with BPI-102 “Standard for Air Resistance of Thermal Insulation Used in Retrofit Cavity Applications – Material Specification” - or air impermeable foam insulation, to reduce airflow through the building shell.

Cellulose insulation used in an enclosed cavity shall be installed at 3.5 pounds per cubic foot or greater density. Blown fiber glass, mineral fiber, rock and slag wool, or spray foam used in an enclosed cavity shall be installed at or above the manufacturer’s recommended density to limit airflow that corresponds to an air permeance value of  $\leq 3.5$  cfm/sq ft at 50 Pascals, as measured using BPI-102 “Standard for Air Resistance of Thermal Insulation Used in Retrofit Cavity Applications – Material Specification” or ASTM C 522, E 283 or E 2178. The test report shall be provided to BPI.



## Duct Sealing

Due to the fact that duct sealing may affect building airflow characteristics and air sealing measures may affect duct leakage characteristics, the Envelope Professional must evaluate the need for duct sealing and a work scope for duct sealing must be developed in conjunction with shell measures using the standards listed below.

Duct leakage must be quantified before and after duct sealing installations. These tests may be performed by the inspector or the installer. The results of these tests must be documented and used to verify the effectiveness of the installation.

Whenever possible, retrofit duct leakage rates to outside should be below the standards established by the EPA for Energy Star Ducts. The sum of the supply and return leakage to outside, measured in cfm<sub>25</sub>, divided by the fan flow should be no more than 10%.

### **Maximum Allowable Duct Leakage Calculation Example**

**System Airflow:** 1200 cfm

**Formula:**

$$\text{Total\_Allowable\_Duct\_Leakage} = \text{System\_Airflow} \times 0.10$$

**Example:**

$$\text{Total\_Allowable\_Duct\_Leakage} = 1200 \times 0.10 = 120 \text{ cfm}_{25}$$

*Note: This calculation is based on duct leakage to outside. Leakage to outside must be determined through direct testing using a duct leakage pressurization device in conjunction with the blower door. If a blower door is not available, duct leakage to outside may be estimated by measuring total duct leakage and estimating the percentage of measured leakage that is leaking to outside based the location of the ductwork.*

When quantifying duct leakage, an appropriate type of measurement system shall be used, which includes a metered and calibrated duct pressurization device. Pre and post-installation duct leakage shall be measured and documented any time that duct sealing is part of the work scope to verify the success of the installation.

Duct leakage areas must be diagnosed using appropriate duct leakage testing equipment and/or pressure pan tests to prioritize leakage areas (treating the largest leaks and the highest pressure areas first) anytime duct sealing is installed.

Use the following checklist as a guide for prioritizing duct sealing installations:

- ✓ Seal the largest leaks first. These include: disconnected ducts, missing end-caps, and other catastrophic holes





- ✓ Seal the areas of highest pressure. These include all the connections near the air-handler cabinet and supply and return plenums, flexible canvas plenum connectors, and filter slot covers.
- ✓ Seal return leaks that may contribute to negative pressures in the combustion appliance zone.
- ✓ Seal all accessible connections between duct sections, at branches, and where take-offs connect to main trunk lines.
- ✓ Seal take-off connections to register boots and boot connections to floors, walls, and ceilings.

Sheet metal and flexible ductwork shall be sealed at all duct connections using duct mastic or similar product designed for sealing ducts. Duct tape is not an allowable duct sealing material. Aluminum FSK tape may be used on ductboard systems and at the connections to the air handler cabinet.

### **Insulation**

Prior to installing insulation in an existing home, a thorough inspection of the interior and exterior of the home is required to identify areas where installation of insulation may be unsafe. Problem areas include: areas with knob and tube wiring, recessed light fixtures, areas where moisture is present or suspected, and structurally unsound building elements (suspended acoustical tile ceilings, wood paneling, etc.) Problems that are identified must be remedied prior to insulating.

Insulation may not be installed in areas of homes where live knob and tube wiring exists.

Attic insulation may not be installed without first verifying the presence of an effective air barrier between the attic and living space via visual inspection and pressure differential testing as identified in the standards for air sealing listed above.

Attic ventilation may not be installed without first verifying the presence of an effective air barrier and thermal barrier between the attic and the living space. Refer to local codes for minimum requirements for insulation and ventilation.

Recessed can light fixtures that are not IC rated and chimneys must be baffled with an effective dam prior to insulating to maintain a minimum 3” clearance to the insulation being installed. Single-walled flue pipes require a minimum 6” clearance to insulation or other combustible materials. Refer to NFPA 54 for additional requirements for specific chimney materials.

Where soffit vents are present, and access is viable, appropriate blocking or baffles are required to provide protection from wind-washing where insulation exists.

Batt insulation shall be installed at full loft with the insulation in full contact with the warm building surface. Gaps between the insulation and the building elements must be avoided. Insulation batts shall not be compressed, folded, tucked, rolled, or otherwise compromised when installed for insulation purposes.



Insulation installed in kneewalls or other exposed vertical areas must be covered on the cold side with an air barrier such as plywood or housewrap to protect the insulation from wind-washing and free convection within the insulation. This measure is not necessary if rigid foam insulation is used.

Blown insulation shall be installed at appropriate air pressure and material quantity to ensure complete coverage and manufacturer's recommended density to achieve the prescribed R-value without voids, gaps, or settling in enclosed cavities.

All attic access openings, including doors, hatches, and pull-down stairs shall have a tightly fitting cover which is insulated to a minimum R-14.

### **Windows**

Windows shall be installed according to manufacturer's instructions to assure proper operation and moisture protection. Rough openings shall be sealed to be air tight prior to installation of casings and sills. Newly installed windows shall be inspected and verified for proper operation of all hardware and locking mechanisms.

Refer to EPA guidelines and local codes for requirements for retrofit window installations in locations where lead and/or asbestos may be present.