



WHY HOME IMPROVEMENT EXPERT?

An easy way to get a quality job.

Research findings reveal significantly reduced energy savings and potential performance risks where home improvements are not properly installed. To help homeowners address this challenge, the U.S. Department of Energy has compiled world-class expert guidance from industry leaders and national laboratories in factsheets and checklists under the name **Home Improvement Expert**. Homeowners can leverage these expert recommendations to help ensure quality installation by attaching Home Improvement Expert checklists to vendor contracts and ensuring the vendor completes and signs the checklist before accepting the work.

READY TO DO MORE?

This factsheet and accompanying checklist cover one of more than 20 home improvements covered by the U.S. Department of Energy Home Improvement Expert. Use them to help optimize energy savings and improve performance related to comfort, health, safety, and durability.

To download other checklists: basc.pnnl.gov/home-improvement-expert

For more customized home improvement recommendations:

- Get your **Home Energy Score** from a qualified assessor (www.home-energy-score.gov)
- Schedule an expert assessment through **Home Performance with ENERGY STAR®** (www.energystar.gov/homeperformance).



BENEFITS

Installed correctly, comprehensive vented attic upgrades can significantly reduce utility costs while improving comfort, indoor air quality, and durability of the attic structure.

In older homes, the attic/ceiling interface provides significant opportunity to seal excessive holes and cracks, add missing air barriers, and upgrade insulation. This will help minimize unwanted heat loss in cold weather, heat gain in hot weather, and prevent infiltration of contaminants year-round. Additionally, attics provide a great opportunity to upgrade ducts located there for heating and cooling systems as well as exhaust fans to ensure they are adequately ventilated for humidity control. A comprehensive attic package can reduce an average home's total energy use by 10 to 15%, improve comfort by reducing drafts, keep contaminants such as moisture, dust, pollen, and pests from entering your home, and reduce moisture-related durability problems.

RELATED HOME IMPROVEMENT CONSIDERATIONS

Before upgrading your attic, consider working with a qualified home energy assessor to evaluate other related home performance needs and opportunities that may involve work in the attic. This includes:

- testing for adequate combustion air with natural draft combustion equipment (e.g., furnace, boiler, and water heater) to ensure safety;
- integration of fresh air ventilation throughout the home;
- installation of exhaust fans in bathrooms to remove moisture; and
- installation of a high-capture efficiency exhaust fan in the kitchen to remove cooking emissions.

For more information on attic upgrades, please search the Building America Solution Center, basc.pnnl.gov.

TIPS FOR HIRING A CONTRACTOR

- Look for licensed, insured, and certified contractors.
- Check references and reviews on home improvement web sites.
- Get multiple bids in writing.
- Check with your utility and state, local, and federal weatherization programs for rebates and incentives.
- Include the Home Improvement Expert™ checklist in bids and contracts to ensure quality installation.
- Consider using a Residential Energy Services Network (RESNET) certified Home Energy Rating System (HERS) rater, Building Performance Institute (BPI) certified Building Analyst, or other qualified professional (e.g., licensed engineer or architect) to inspect the work.

ENCLOSURE UPGRADES

Attic Air Sealing and Insulation

Basement Wall Insulation

Comprehensive Attic Upgrade

Framed Wall Insulation

Masonry Wall Insulation

Home Air Sealing

Vented to Unvented Attic

Vented to Unvented Crawl Space

Window Replacement

HEATING & COOLING

Air Conditioner Replacement

Gas Furnace Replacement

Heat Pump Replacement

Duct Sealing and Insulation

Oil or Gas Boiler Replacement

HOT WATER HEATING

Gas Tank Water Heater

Gas Tankless Water Heater

Heat Pump Water Heater

FRESH AIR SYSTEM

Bathroom Exhaust Fan

Kitchen Exhaust Fan

Balanced HRV/ERV

Balanced Supply plus Exhaust

Supply Integrated with HVAC

PROPER SEQUENCING OF HOME IMPROVEMENTS

Through the U.S. Department of Energy's Building America research program, expert guidance has been developed for optimizing whole-house energy-efficiency upgrades. This includes a recommended sequence for home improvements (shown below) to help ensure homeowners get the most out of their upgrade investments while minimizing potential harm from safety, indoor air quality, and moisture issues.

STEP 1: ENSURE SAFE AND DURABLE

Have experts assess opportunities to improve energy efficiency and identify comfort, moisture management, health, and safety issues.

**STEP 2: ENSURE FRESH AIR**

Ensure effective ventilation before increasing air tightness.

**STEP 3: ENSURE MOISTURE CONTROL**

Ensure adequate water protection before reducing the ability of walls to dry by adding air sealing and insulation.

**STEP 4: ENSURE DRAFT-FREE**

Capture air sealing opportunities not accessible after insulation is installed.

**STEP 5: ENSURE THERMAL COMFORT**

Insulate at least to the latest national code recommendations for your location after addressing related safety, indoor air quality, and moisture management issues.

ANYTIME: EQUIPMENT UPGRADES

Replace heating and cooling equipment, water heaters, windows, appliances, lighting, fans, and electronics when they fail or become out of date with ENERGY STAR® qualified products or better, and improve systems to operate more efficiently.



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PREPARATION

<input type="checkbox"/>	The attic shall be inspected for water leaks and moisture, structural, or pest damage. A list of all needed repairs shall be provided to the homeowner before attic work begins so remediation can be fully addressed as necessary.
<input type="checkbox"/>	If there is active knob and tube wiring present in the attic, the homeowner shall be directed to hire a licensed electrician to inspect the wiring and provide a list of any necessary repairs to the homeowner. The work shall not begin until the homeowner provides written notice that all necessary repairs in the attic are completed.
<input type="checkbox"/>	The attic shall be inspected for the presence of any existing HVAC duct insulation or taping that may contain asbestos or vermiculite attic insulation, and if present, the work shall not proceed until the homeowner can document that it does not contain asbestos or that it has been safely removed according to EPA requirements and guidelines.
<input type="checkbox"/>	A combustion safety test is recommended to be performed if any natural draft combustion equipment exists in the home to ensure there is no back-drafting or spillage. If performed, any combustion safety issues not addressed by installation measures included in this checklist shall be addressed before proceeding with the installation.
<input type="checkbox"/>	All exhaust fan ductwork in the attic shall be inspected for proper installation including no excessive length and sagging, no kinks, and termination to outdoors (i.e., exhaust fans shall not vent directly into the attic). Required modifications shall be identified and included in this scope of work.
<input type="checkbox"/>	The contractor shall remove or set aside existing insulation as required for installing air sealing, air barriers, and insulation.
<input type="checkbox"/>	Debris shall be removed from existing attic ventilation openings (e.g., ridge, gable, and soffit vents).
<input type="checkbox"/>	The existing net free attic ventilation area shall be determined, and the contractor shall choose between Attic Ventilation Area shall determine if more ventilation is needed to meet the attic ventilation requirements as specified in the local building code. Option 1 is the preferred option; this option requires 1/300 of attic area, with high and low openings. Option 2 is the less preferred option; this option requires 1/150 of attic area, with high OR low openings (see Installation below).
<input type="checkbox"/>	The contractor shall verify that new attic insulation will not block attic ventilation openings and shall plan to modify attic ventilation openings as required for adequate clearance, for example by installing baffles. Where one or more openings need to be relocated, the existing opening(s) shall be closed off with solid sheathing or other weather-resistant material and sealed and patched to match the existing finishes (e.g., exterior roofing, siding, or soffit).
<input type="checkbox"/>	Any heating and cooling and exhaust ducts located in the attic shall be inspected. Any separated or disconnected ductwork shall be secured with mechanical fasteners (e.g., screws and clamps). Damaged ducts restricting air flow or with visual leaks shall be repaired or replaced. Flexible ducts with excessive length shall be cut to proper length to ensure maximum sag is ½ inch per foot. Sharp bends shall be corrected so bends are greater than or equal to one duct diameter radius. All accessible unsealed seams in ductwork shall be sealed with UL-approved mastic, UL 181 tape, or equivalent.
<input type="checkbox"/>	All unsupported horizontal heating and cooling duct runs shall be supported with hanger strap or saddle supports that are at least 1.5 inches wide and spaced no more than 4 feet apart, in accordance with the Air Conditioning Contractors of America (ACCA) Manual D and manufacturer's recommendations. Additional supports shall be provided before and after sharp bends in the ductwork. The maximum permissible sag between supports shall be ½ inch per foot.



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INSTALLATION: ATTIC AIR SEALING AND AIR BARRIERS PRIOR TO INSULATION

<input type="checkbox"/>	All accessible gaps, cracks, seams, and penetrations between conditioned and unconditioned space (such as gaps in the attic floor and attic knee walls around lighting fixtures, HVAC duct boots, electric wiring, plumbing pipes) shall be sealed with sealants if the gaps are narrow enough to meet manufacturer instructions (e.g., caulk, foam, aerosol sealant). If gaps are too large for sealants, rigid blocking material shall be used to fill the gap and shall be sealed in place with sealants per the sealant manufacturer's instructions. Fibrous insulation is not an air barrier and shall not be used for air sealing.
<input type="checkbox"/>	The seams where drywall attaches to the top plate at all interior and accessible exterior walls shall be sealed from the attic side with a caulk, spray foam, or spray-applied sealant.
<input type="checkbox"/>	Large gaps and openings between the attic and conditioned space below (e.g., dropped soffits with open framing, knee walls without attic-side solid backing, or balloon-framed gable walls without blocking) shall be closed off using a solid material such as rigid foam or OSB that is sealed at the edges and seams with caulk, sealant, or mastic.
<input type="checkbox"/>	Gaps around masonry chimneys, flues, or combustion appliance vents shall be sealed with sheet metal and high-temperature-rated caulk or foam. Insulation dams shall be constructed around chimneys, flues, and combustion appliance vents as needed with combustion clearances using heat-safe materials in accordance with local building code requirements. A masonry chimney typically requires a 2-inch clearance to combustibles; Type-B (double wall) gas vent pipe typically requires 1-inch clearance to combustibles; the air barrier may be metal that is air sealed using high-temperature-rated caulk; cellulose and fiberglass insulation are considered combustible; local building code may allow mineral wool to contact a masonry chimney but not a metal gas vent.
<input type="checkbox"/>	Attic access panels, doors, and drop-down stairs shall be insulated with a minimum of R-38 rigid foam insulation and gasketed at all edges (not caulked) to provide a continuous air seal when closed. In the case of drop-down stairs, this may require a box made of rigid insulation that is sealed at all seams with a sealant such as caulk, mastic, or tape, which is then set on the attic side of the opening.
<input type="checkbox"/>	All non-ICAT (Insulation Contact Airtight) recessed light fixtures shall be boxed with a solid material such as drywall or rigid foam that is sealed at all seams with a sealant such as caulk, mastic, or spray foam and provides clearance from the fixture as required by the local building department.
<input type="checkbox"/>	Before installing fibrous attic floor insulation, wind baffles or blocking shall be installed at all attic eaves adjoining vented soffits to prevent air flow through the edge of the insulation. A minimum of 1-inch clear air flow path shall be provided for ventilation air to flow from the soffit vents to the attic space extending at least 6 inches above the height of the attic insulation.

INSTALLATION: ATTIC DUCT SEALING

<input type="checkbox"/>	All accessible HVAC and exhaust fan duct leaks, connections, and plenums shall be sealed with UL-approved mastic, UL 181 tape, or equivalent (e.g., aerosol sealant) applied in strict accordance with manufacturer's instructions.
<input type="checkbox"/>	If the air filter is installed in a filter box attached to an air handler located in the attic, the filter access panel shall be fitted with an airtight gasket and a MERV 8 or higher filter shall be installed in the filter rack.
<input type="checkbox"/>	Duct boots located in the attic-ceiling interface shall be sealed to finished surfaces with caulk, spray foam, or other approved sealants.
<input type="checkbox"/>	All accessible HVAC ducts in the attic shall be insulated to \geq R-8 for supply ducts and \geq R-6 for return ducts.
<input type="checkbox"/>	Insulation moved during duct sealing and insulating shall be replenished to levels that meet or exceed local building code requirements.

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INSTALLATION: EXHAUST FAN DUCTWORK MODIFICATIONS

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| <input type="checkbox"/> | Exhaust fan ductwork shall be modified as required for the most direct route to the outdoors, with as few bends as possible. To reduce noise, no bends occur in the first three feet from the fan housing. |
| <input type="checkbox"/> | The exhaust duct outlet vent shall be located on the exterior of the home at least 10 feet from any air inlet and where it does not direct air flow onto a walkway. If the exhaust duct outlet needs to be relocated to meet these requirements, the existing opening shall be closed off with solid sheathing or other weather-resistant material and be sealed and patched to match existing finishes (e.g., exterior roofing, siding, or soffit). |
| <input type="checkbox"/> | All exhaust duct seams and connections shall be sealed with UL-approved mastic, UL 181 tape, or equivalent. |
| <input type="checkbox"/> | In cold climates, all accessible exhaust ducts in the attic should be insulated to $\geq R-8$ to reduce risk of condensation. |
| <input type="checkbox"/> | Where the exhaust fan terminates with a wall cap, verify the presence of a damper that closes when the fan is not operating. If there is none, a damper shall be installed per local code requirements. |

INSTALLATION: ATTIC VENTILATION AREA - OPTION 1: SMALLER AREA WITH BALANCED LOCATIONS (PREFERRED)

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| <input type="checkbox"/> | The minimum net free attic ventilation area shall be 1/300 of the attic area. Existing attic ventilation openings shall count towards this area and new attic ventilation openings shall be installed as required per local building code requirements. The minimum net free attic ventilation area may be based on the attic area as follows: 1.5 ft ² for up to 500 ft ² , 3 ft ² for 501 to 1,000 ft ² , 5 ft ² for 1,001 to 1,500 ft ² , 7 ft ² for 1,501 to 2,000 ft ² , and 8 ft ² for over 2,000 ft ² . |
| <input type="checkbox"/> | At least 40% of the net free attic ventilation area shall be located within 3 feet of the ridge or highest point of the attic. The remaining net free attic ventilation area shall be located in the bottom third of the attic space. |

INSTALLATION: ATTIC VENTILATION AREA - OPTION 2: LARGER AREA WITH ANY LOCATIONS (LESS PREFERRED)

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| <input type="checkbox"/> | The minimum net free attic ventilation area shall be 1/150 of the attic area. This option is used when balanced (high and low) ventilation openings are not possible or practical. Existing attic ventilation openings shall count towards this area and new attic ventilation openings shall be installed as required per local building code requirements. The minimum net free attic ventilation area may be based on the attic area as follows: 3 ft ² for up to 500 ft ² , 6 ft ² for 501 to 1,000 ft ² , 10 ft ² for 1,001 to 1,500 ft ² , 14 ft ² for 1,501 to 2,000 ft ² , and 16 ft ² for over 2,000 ft ² . |
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INSTALLATION: ATTIC VENTILATION OPENINGS AND CLEARANCE

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| <input type="checkbox"/> | Insulation shall not block the free flow of air through attic ventilation openings. |
| <input type="checkbox"/> | Attic ventilation openings shall be between 1/16 to 1/4-inch, open directly to the outdoors, and be protected from rodents, birds, etc. Attic ventilation openings greater than 1/4-inch shall be covered by material with openings between 1/16 to 1/4-inch, which meets all local building code requirements. |

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INSTALLATION: ATTIC INSULATION

- R-19 insulation shall be installed with an attic-side air barrier at attic knee walls, skylight shaft walls, vertical portions of all dropped ceilings, and any other vertical wall adjoining the conditioned space. All seams and gaps in the air barrier shall be fully sealed.
- If a kneewall exists in the attic separating conditioned space from unconditioned space, verify that cavities between the floor joists beneath the kneewall are sealed with air barrier materials.
- Attic insulation that meets or exceeds prescriptive requirements in local code shall be installed at all flat and sloped surfaces adjoining the conditioned space with less than 2% gaps, voids, and compressions.
- All attic insulations shall be uniform and shall conform to manufacturer-specified density. Fibrous insulation installation shall include attic rulers to verify full depth.

COMMISSIONING

- The home shall be inspected for the presence of a whole-house ventilation system. If one is present, the actual air flow shall be tested and verified to meet a target ventilation rate based on house size as follows: 50 cfm for up to 1,500 ft², 70 cfm for 1,501 to 2,500 ft², and 100 cfm for over 2,500 ft². If the home has no whole-house ventilation system, or if the existing system does not meet the target ventilation rate, recommendations shall be made to the homeowner to either install a new system or repair the existing system to meet the target ventilation rate.
- If an exhaust vent was installed in a wall, the wall cap damper shall be checked to ensure it is operating correctly.
- In EPA Radon Zone 1, a radon test kit shall be provided to the homeowner at the completion of the work with a recommendation to initiate a radon remediation strategy if post-retrofit radon measurements exceed EPA acceptable levels. (See <https://www.epa.gov/radon>.)
- After completion, a combustion safety test shall be performed if any natural draft combustion equipment exists in the home to ensure there is no back-drafting or spillage. After attic air sealing, a natural draft furnace or water heater located in the home may no longer have sufficient combustion air. Recommendations shall be made to the homeowner to install direct-vent equipment at time of replacement for any natural draft combustion equipment.

I hereby certify that, to the best of my knowledge and ability, all checked items on the above checklist have been accomplished as part of completion of this home upgrade.

Contractor Signature: _____ Date: ____/____/____

Contracting Organization: _____

THE U.S. DEPARTMENT OF ENERGY DOES NOT WARRANT OR ENDORSE THE WORK, PRODUCTS, OR SERVICES OF ANY OF ITS PARTNERS.

