

Draft Protocol For Addressing IAQ During Weatherization & Energy Conserving Retrofits

Introduction:

This draft protocol provides guidance for addressing indoor air quality during weatherization and energy conserving retrofits. The intent is to simultaneously reduce the risk from indoor health hazards while retrofitting houses so they use from 20% to 70% less fuel for heating. This draft protocol assumes a minimum level of energy retrofit that is similar to those conducted by Weatherization Assistance Programs (See “Weatherize” below). It also considers more aggressive retrofits that may reduce fuel use by 50% to 70% or more. (See “Save More Fuel - Better Air Sealing and More Insulation” below).

Weatherization Assistance Programs have various policies addressing health and safety issues and activities as part of their ongoing programs. The specific hazards, hazard assessment methods and responses to any hazards found in a particular building vary from program to program. The Building Performance Institute (BPI) is a national organization that provides training, certification and standards for building performance contractors and auditors (<http://www.bpi.org/content/home/index.php>). In October BPI issued the *BPI Home Energy Auditing Standard Revised 10/19/09* for public comment. The public comment period closed on January 5, 2010. The public comment standard addresses general health and safety, combustion equipment safety, local exhaust and whole house ventilation and potential moisture problems, these sections can be found in Appendix A. A copy of the entire standard can be found at http://www.bpi.org/documents/BPI-EA-7_Standard.pdf.

Health and IAQ Requirements:

This draft protocol addresses nine indoor hazards that may occur in buildings undergoing energy conserving retrofits. Energy retrofits that reduce the ventilation rate, reduce drying or disturb a contaminant source in a house may result in indoor exposures. For example air sealing, filling cavity walls with blown insulation and replacing atmospherically vented combustion equipment with high efficiency combustion equipment reduce the ventilation rate and increase drying time. This may increase contaminant concentrations, humidity levels and the length of time materials stay wet. Some weatherization activities reduce indoor hazards – e.g. air sealing top floor ceilings in the attic may fix condensation on the roof deck and stop ice dam problems. Radon, lead paint and asbestos are contaminants that may be disturbed or increased by energy saving activities. The last hazard is rodent infestation. Saving energy often includes air sealing. If rodents move into a house they will chew through most of the materials used to air seal a house. Rodents also are associated with some diseases. By using rodent resistant materials when sealing holes in foundations and attics, the house becomes more resistant to rodent colonization and the air sealing becomes more durable.

Each of the nine hazards in the protocol are associated with assessment tools. Information gathered during the assessment is used to select fixes for the any of the nine hazards found in a

building. This draft protocol currently relies on the following documents to provide assessment and corrective actions for the potential hazards:

- a) the BPI public review standard to address ventilation, combustion equipment safety and some of the moisture problems; at http://www.bpi.org/documents/BPI-EA-7_Standard.pdf .
- b) the Environmental Health Watch moisture problem audit;
http://www.ehw.org/Healthy_House/HH_Moist_Audit.htm)
- c) the Maine Radiation Control Program
(http://www.maine.gov/dhhs/eng/rad/Radon/hp_radon.htm) for radon;
- d) the Maine Lead Hazard Prevention Program
(<http://www.maine.gov/dep/rwm/lead/index.htm>) for lead paint;
- e) the Maine and EPA guidance for asbestos
(<http://www.epa.gov/region01/topics/pollutants/asbestos.html>);
- f) rodent exclusion is directly addressed in a simple list in this document.

Draft Scope:

For every level of energy conservation effort this protocol requires the following activities:

1. Evaluate & Address Potential for Backdrafting of Combustion Gases
 - a. Tools: BPI Home Energy Audit Section 7
 - b. Tools: Maine CO fact sheet
<http://www.maine.gov/dhhs/eohp/air/documents/COFINAL.pdf>
2. Evaluate & Address Need for Planned Combustion Make Up Air
 - a. Tools: BPI Home Energy Audit Section 7
3. Evaluate & Address Need for Bath and Kitchen Exhaust Fans
 - a. Tools: BPI Home Energy Audit Section 8.7
4. Evaluate & Address Need for Whole House Ventilation
 - a. Tools: ASHRAE Std. 62.2 Criteria
 - b. Tools: BPI Home Energy Audit Section 8.4

5. Evaluate & Address Potential for Moisture Problems & Moisture Mitigation Strategies
 - a. Basement and or Crawlspace
 - b. Other areas of the buildings
 - c. Tools: Environmental Health Watch Moisture Audit Form
http://www.ehw.org/Healthy_House/HH_Moist_Audit.htm
 - d. Tools: Temperature and Relative Humidity Measurement to compare indoor dewpoint to outdoor dewpoint during Assessment and After Retrofit

6. Evaluate & Address Potential Need for Radon Mitigation
 - a. Tools: Provide Radon Follow-up Testing Devices
 - b. Tools: Maine Radiation Control Tipsheet#1 – background
<http://www.maine.gov/dhhs/eng/rad/Radon/Radon%20in%20Maine.pdf>
 - c. Tools: Maine Radiation Control Tipsheet#2 – measurement
<http://www.maine.gov/dhhs/eng/rad/Radon/Test%20Your%20Home.pdf>
 - d. Tools: Maine Radiation Control Tipsheet#6 – treatment
<http://www.maine.gov/dhhs/eng/rad/Radon/Treat%20the%20Air.pdf>

7. Evaluate & Address Lead Paint Hazard
 - a. Tools: State regulation
 - i. If house was built before 1978 assume lead paint and use lead-safe work practices or
 - ii. Test for lead:
http://www.maine.gov/dhhs/eohp/lead/documents/PBTip4_509.pdf
 - iii. Tools: Maine lead safe practices for home owners
http://www.maine.gov/dhhs/eohp/lead/documents/Eng_low-res_web%205-4-09.pdf
 - iv. Tools: Contractors providing test or abatement services are required to have Maine Department of Environmental Protection (DEP) training and certification <http://www.maine.gov/dep/rwm/lead/leadtrcourses.htm>
 - b. Tools: EPA regulation: After April 2010, federal law will require contractors that disturb lead-based paint in homes, child care facilities and schools, built before 1978 to be certified and follow specific work practices to prevent lead contamination. Therefore beginning in April 2010, ask to see your contractor's certification.
<http://www.epa.gov/lead/pubs/rrp.htm>
 - c. Tools: EPA/HUD Lead Paint Safety: A Field Guide for Painting, Home Maintenance, and Renovation Work

8. Evaluate and Address Asbestos Hazard
 - a. Test vermiculite for asbestos
 - b. Tools: EPA asbestos guidance <http://www.epa.gov/asbestos/pubs/ashome.html>

(Maine Indoor Air Quality Council)
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9. Use rodent exclusion materials on all openings in the foundation and attic greater than $\frac{1}{4}$ inch by $\frac{3}{8}$ inch
 - a. Steel sheet metal, hardware cloth, lath, sheet rock corner bead
 - b. Concrete
 - c. Copper mesh (stuff fit)
 - d. Aluminum sheet metal, sheet rock corner bead
 - e. $>\frac{3}{4}$ inch solid lumber
 - f. $>\frac{1}{2}$ inch plywood or OSB
 - g. EPA Region Nine IPM Manual
 - h. Stephen Franz EPA Rat Control Manual

Levels of Energy Conserving Measures Overview:

Energy conserving levels are often divided into two general levels:

- 1) Basic Weatherize and
- 2) Save More Fuel – Better Air Sealing and More Insulation.

The following section provides typical descriptions of these levels and conditions that may help determine which specific measures may apply to a particular home.

I. Basic Weatherization

- 1) Fix the enclosure first
 - a. Air seal the enclosure
 - i. Attics
 - ii. Basements
 - iii. Between house and attached garage
 - iv. Non-weatherstripped windows
 - b. Air seal ductwork in attics or crawlspaces
 - c. Add insulation to the easy places (flat attics, empty wall or vaulted ceiling cavities, basement/crawlspace rim joist and walls)
- 2) Tune, repair or replace furnace or boiler along with or after the sealing and insulating actions
 - a. Conduct Combustion safety test (RESNET or BPA)
 - b. If unit passes the test, there are no code problems and the system is in good condition, tune burners, replace filter
 - c. If it fails or there are code problems:
 - i. Repair code problems and
 - ii. Provide make-up air too burner or
 - iii. Replace unit with correctly sized new hi efficiency unit

II. Save More Fuel - Better Air sealing and more insulation

- 2) Attics – vented or unvented
 - a. Conditions that indicate air sealing and adding insulation to flat ceilings is a good approach:
 - i. Good access to ceiling from attic
 - ii. Little or no insulation in attic (less than R-38)
 - iii. No air handlers or ducts in attic (other than bath exhaust fans)
 - iv. No can lights or what can lights are present are fairly easy to deal with

- v. Roofing is in good condition
- b. Conditions that indicate insulating the roof-line and gable walls is a good approach (either by adding insulation and an air barrier from the attic side or by adding layers of foam board and new roof to the outside):
 - i. Easy access to bottom of roof sheathing
 - ii. Lots of barriers to getting a good air barrier at ceiling
 - iii. Air handlers or ductwork located in attic
 - iv. Many can lights in ceiling
 - v. Sloped or vaulted ceilings with no insulation in them
 - vi. Roofing needs to be replaced (add layers of foam board and new roof)
- 3) Basements and crawlspaces – the walls or the floor above
 - a. Conditions that indicate sealing and insulating the basement walls is a good idea:
 - i. Rain water is well managed or can be fixed as part of the retrofit
 - ii. HVAC-DHW located in basement/crawlspace
 - iii. Good access to walls and rim joist
 - iv. Concrete floor in place or earth floors that can easily be covered
 - v. Plumbing leaks are fixed
 - b. Conditions that indicate sealing and insulating the floor between the house and the basement or crawlspace is a good idea:
 - i. No HVAC or DHW located in basement/crawlspace
 - ii. Pipes are nearly all within the floor framing system so they can be insulated from below
 - iii. Poor access to walls (but good access to rim joist)
 - iv. Earth or bare rock floor that are difficult to cover with vapor barrier
 - v. A river runs through it
- 4) Exterior Above Grade Walls
 - a. Conditions that indicate added, improved air sealing and adding significant insulation to exterior walls is a good idea:
 - i. No insulation in wall cavities (blow insulation into cavities)
 - ii. Interior being gutted for remodel (add air barrier, cavity insulation and interior board foam)
 - iii. Siding being replaced (add layers of foam board and new siding)
- 5) Windows and doors
 - a. Conditions that indicate fixing existing windows and doors (weatherstrip, rebuild, add storms) is a good idea:
 - i. Windows or doors are in good shape (little or no decay, structurally sound)
 - ii. There is no weatherstripping or the weatherstripping is poorly installed, worn or damaged

- b. Conditions that indicate fixing existing windows and doors is a good idea
 - i. Windows or doors are in poor condition
 - ii. Siding is being replaced (with added air sealing and insulation)
 - iii. All the other insulating and air sealing has been done
- 6) Furnaces and boilers
 - a. Conditions that indicate replacing boilers, furnaces or hot water heaters is a good idea (replace with units sized according to Manual J):
 - i. The existing units are at the end of their lifetime, broken or dangerously installed
 - ii. All the other sealing and insulating has been done

Appendix A BPI Home Energy Auditing Standard Revised 10/19/09

3. Health and Safety Related Requirements

BPI's first principle is to do no harm. To avoid harm, a BPI-certified energy auditor must understand and communicate with customers and colleagues about common health and safety concerns related to energy systems and retrofit work. In the process of recommending ECMs and developing work scopes, auditors must strive to maintain or improve existing levels of health and safety, and to recommend mitigation of identified hazards to the customer. The energy auditor must fulfill the following requirements.

- 3.1. Identify and anticipate hazards that may be exacerbated by energy retrofits, and specify preventative measures.*
- 3.2. Inform customers about identified and anticipated fire, health, and safety hazards related to energy systems and retrofit work.*
- 3.3. Interview customers about energy-related home hazards.*
- 3.4. Protect yourself and the building residents from identified and anticipated hazards during the energy audit and follow-up work.*
- 3.5. Test combustion appliances for safety problems in accordance with this standard.*
- 3.6. Inspect the home for signs of common moisture problems in accordance with this standard.*
- 3.7. Evaluate ventilation requirements in accordance with this standard.*
- 3.8. Specify that workers never disturb known or suspected lead, asbestos, or mold, unless the workers are qualified and using approved containment, cleaning, and/or abatement procedures.*
- 3.9. Inform customers about potential radon risk. Recommend radon testing in accordance with EPA guidelines in every home.*
- 3.10. Specify that identified electrical hazards, which may hinder planned energy conservation measures (ECMs), are mitigated in the work scope. Examples: some jurisdictions forbid insulation where knob-and-tube wiring is present; obsolete fuse boxes interfere with photovoltaic (PV) installation.*
- 3.11. Specify appropriate safe work practices in the work scope, for example: scaffold and lead-containment equipment.*

7. Combustion Appliance Testing

BPI-certified energy auditors must inspect combustion systems for common safety problems that may be related to ECMs. Specify remediation of conditions as required by the following procedures. Specify that post-retrofit combustion-appliance testing be conducted. Note: When an auditor acts as the agent of a BPI-accredited contractor and offers a work scope in the form of a binding contract or contract offer, pre-work combustion appliance testing may be deferred and specified as part of the work scope. When the contract specifies that a combustion appliance is removed or replaced, pre-work testing isn't required for that appliance.

- 7.1. Identify, communicate, and suggest appropriate solutions to emergency problems — such as a gas leak or a dangerous level of carbon monoxide — clearly and immediately to the customer, landlord, utility representative, and/or your supervisor.*

- 7.2. *Test for gas leakage at connections of natural-gas and propane piping systems. Specify repair for leaks and replacement for hazardous or damaged flexible gas connectors.*
- 7.3. *Inspect for oil leakage in oil-fired heating and water-heating systems.*
- 7.4. *Inspect combustion venting systems for damage, leaks, disconnections, and other safety hazards.*
- 7.5. *Conduct combustion-appliance-zone (CAZ) pressure tests, carbon monoxide (CO) tests, and spillage tests on all combustion appliances venting into atmospheric chimneys, including fan-assisted gas appliances, as follows.*
 - 7.5.1. *Monitor for ambient CO during combustion testing, and discontinue testing if ambient CO level exceeds 35 parts per million (ppm).*
 - 7.5.2. *Measure baseline pressure in the CAZ with reference to (WRT) outdoors.*
 - 7.5.3. *Activate exhaust fans, clothes dryer, and air handler to maximize negative pressure in the CAZ. Don't activate whole-house fans designed for night cooling.*
 - 7.5.4. *Open or close interior doors as needed to maximize negative pressure in the CAZ.*
 - 7.5.5. *Measure the change in CAZ pressure WRT outdoors that is induced by exhaust fan, air handler, and door position, as compared to the baseline pressure obtained in 7.5.2. If the change in pressure is more than 5 Pa in the negative direction, specify measures to mitigate that induced negative pressure in the CAZ.*
 - 7.5.6. *Operate open-combustion appliances, beginning with the smallest input, and test for spillage at the draft diverter, barometric draft control, or burner inlet (fan-assisted appliances). If a combustion appliance spills for longer than 1 minute, specify measures to mitigate spillage.*
 - 7.5.7. *Test for CO in undiluted flue gases of combustion appliances. If CO in undiluted flue gases is more than 100 ppm as measured or 200 ppm air-free measurement, specify service to reduce CO to below these levels (unless your CO measurement is within manufacturers specifications).*
- 7.6. *Conduct a CO test on all sealed-combustion and power-vented appliances (without atmospheric chimneys).*
- 7.7. *When cost-effective and feasible, recommend replacing open-combustion equipment with high-efficiency, sealed-combustion equipment or power-vented equipment (or noncombustion equipment such as a heat pump).*
 - 7.7.1. *CO testing is required for newly installed sealed-combustion and power-vented appliances.*
- 7.8. *Test gas ovens for CO.*
 - 7.8.1. *If ovens produce more than 200 ppm of CO (or 400 ppm air-free measurement) in undiluted flue gases tested in the oven vent, specify service or replacement.*
 - 7.8.2. *Specify that every kitchen be ventilated as required in Section 8.7.*
- 7.9. *Specify smoke alarms for homes that don't already have them installed.*
- 7.10. *Specify CO monitors/alarms in homes with combustion appliances or attached garages, one per floor level.*
- 7.11. *Specify final combustion testing at project completion, to ensure compliance.*

8. Indoor Air Quality and Ventilation

BPI-certified energy auditors must strive to assure that their work scopes maintain or improve

indoor air quality. Energy auditors must evaluate each home, and specify improvements to reduce pollution sources and to provide adequate ventilation as follows.

- 8.1. *Discuss identified sources of indoor air pollution with customers, and recommend removal or control.*
- 8.2. *Verify that exhaust fans and clothes dryers vent to outdoors.*
- 8.3. *When an attached garage exists, specify sealing of air leaks between the garage and house, and specify sealing of air handlers and ducts that are located in the garage.*
- 8.4. *Use the following approach — based on ASHRAE Standard 62.2 – 2007 — to determine mechanical ventilation requirements.*
 - 8.4.1. *As an alternate, a legacy approach based on ASHRAE 62-1989 is permitted; see Appendix A. This alternate is permitted for new work scopes until July 1, 2013.*
- 8.5. *Specify whole-house mechanical ventilation for all homes based on ASHRAE Standard 62.2 – 2007, Section 4, as follows:*
 - 8.5.1. *Determine nominal fan size to continuously provide airflow in cubic feet per minute (CFM), based on the number of bedrooms and the conditioned floor area of the home. Determine the fan’s CFM by using either the formula or the table that follows. The formula for CFM fan flow is:
CFM = (0.01 x conditioned floor area) + 7.5 (number of bedrooms + 1)
 The table for CFM fan flow follows:*

Table 1: Accepted Sizing for Continuous Ventilation Fans

	Number of Bedrooms				
Floor Area (sq. ft.)	0-1	2-3	4-5	6-7	>7
< 1500	30	45	60	75	90
1501-3000	45	60	75	90	105
3001-4500	60	75	90	105	120
4501-6000	75	90	105	120	135
6001-7500	90	105	120	135	150
> 7500	105	120	135	150	165

From ASHRAE Standard 62.2-2007, Table 4.1

- 8.6. *The following exceptions can reduce or eliminate the need to install a whole-house ventilation system.*
 - 8.6.1. *Whole-house ventilation systems aren’t required for homes in International Energy Conservation Code (IECC) Zones 3B or 3C; or for homes without mechanical cooling in IECC Zones 1 and 2; or for homes that are conditioned for less than 876 hours per year. These exceptions all require that the local jurisdictional authority determines that windows are an acceptable method of ventilation (ASHRAE Standard 62.2 – 2007, Section 4.1).*

- 8.6.2. *An infiltration credit may be applied to reduce whole-house mechanical ventilation requirement. The credit may be determined using ASHRAE Standard 62.2-2007, Section 4.1.3, if the building enclosure has been tested with a blower door. When the infiltration credit is larger than the nominal fan size specified in 8.5.1, a wholehouse mechanical ventilation system isn't required.*
- 8.7. *Specify local (spot) ventilation for kitchens and bathrooms according to ASHRAE Standard 62.2 – 2007, Section 5. There are two options for complying with the kitchen and bathroom requirements. Both bathroom and kitchen requirements may be met by dedicated exhaust fans and/or a central ventilation system.*
- 8.7.1. *Option 1: Specify that each bathroom receives a minimum of 50 CFM of intermittent exhaust (with appropriate controls), or 10 CFM of continuous exhaust. Also specify that each kitchen receives a minimum of 100 CFM of intermittent exhaust or 5 air changes per hour (ACH) of continuous exhaust.*
- 8.7.2. *Option 2: If existing ventilation equipment can't be used to fulfill Option 1, and new equipment isn't specified, then airflow from the whole-house ventilation system may be increased to compensate, according to ASHRAE 62.2 – 2007, Appendix C.*

9. Moisture Control

Excessive moisture contributes to mold, indoor air pollution, and building durability problems. BPI-certified energy auditors must inspect each home for moisture problems and specify prevention and remediation, as applicable to proposed ECMs.

- 9.1. *Inspect for evidence of exterior water intrusion, such as roof leaks, foundation leaks, and ground-water intrusion.*
- 9.2. *Inspect for evidence of interior water sources, such as plumbing leaks.*
- 9.3. *Inspect the building for effects of water damage, such as mold, mildew, insect damage, efflorescence, and stains.*
- 9.4. *Inspect for existing vapor retarders, flashing, or other moisture-control strategies.*
- 9.5. *Specify measures to prevent potential moisture problems or mitigate identified moisture problems, as applicable, in the work scope.*