Chapter 5: Health and Safety

This chapter addresses some of the most pressing health and safety hazards household's face, as well as those faced by weatherization professionals while auditing, installing measures, or inspecting completed work. When serious safety problems are discovered in a home, field staff should inform an immediate supervisor and the customer about the hazards. Major hazards and potentially life-threatening conditions should be corrected prior to weatherization work beginning, unless the installers are making the corrections as part of their work.

See *Health and Safety Inspection Check List* and the *Release of Liability Form* located via link on the Home Energy Plus website linked below: http://homeenergyplus.wi.gov/category.asp?linkcatid=494andlinkid=122andlocid=25

Weatherization workers should be aware of the potential causes of on-site injuries and how awareness and precautions can reduce them. Examples of potential causes include, but are not limited to:

- ✓ Slips, trips, and falls
- ✓ Extreme temperatures
- ✓ Improper tool use
- ✓ Combustibles (materials or gases)

If an emergency occurs in the field, follow the agency safety policy or dial 911. When working, weatherization professionals must follow all applicable health and safety protocols per Occupational Safety and Health Administration (OSHA) and/or the local jurisdiction having authority.

Before beginning work, assess work areas for health and safety hazards to the workers and to the customer. Resolve any hazards either before work begins or during the work process. If hazards cannot be resolved, the home may require deferral until the hazards are addressed.

Inspect all tools for safety, and use them in accordance with manufacturer's specifications.

5.1 Personal Protective Equipment

On almost a daily basis, weatherization workers find themselves in situations that necessitate the use of personal protective equipment (PPE). The employer is required to provide workers with proper PPE needed to complete their jobs.

Examples of such PPE include, but are not limited to:

- ✓ Disposable coverall garments
- ✓ NIOSH approved respirators with annual fit test (and medical documentation, if required).
- ✓ Eye and face protection
- ✓ Confined-space supplied air and ventilation
- ✓ Hearing protection
- ✓ Fall protection

5.2 Safety Data Sheet (SDS)

The SDS for a product or material contains data about material specifications and safety information. This includes information about:

1. Product and company/manufacturer
2. Hazards identification
3. Composition and ingredients
4. First-aid
5. Firefighting
6. Accidental release
7. Handling and storage
8. Exposure controls and personal protection
9. Physical and chemical properties
10. Chemical stability and reactivity
11. Toxicological effects
12. Ecological information
13. Disposal
14. Transport considerations
15. Regulatory information
16. Other

All SDS for weatherization products can be accessed through the Home Energy Plus Training and Technical Assistance website. When possible, materials that create long-term health risks for the customer and workers should be replaced with materials that present less risk.

5.3 Confined Spaces

Weatherization professionals commonly work in small spaces such as crawl spaces and attics that can be defined by OSHA as a confined space. A confined space is large enough and so configured that an employee can bodily enter and perform assigned work, but has limited or restricted means for entry or exit, and is not designed for continuous employee occupancy.

All work performed within a confined space shall be performed in accordance to OSHA standard 29 CFR Part 1926 Final Rule.

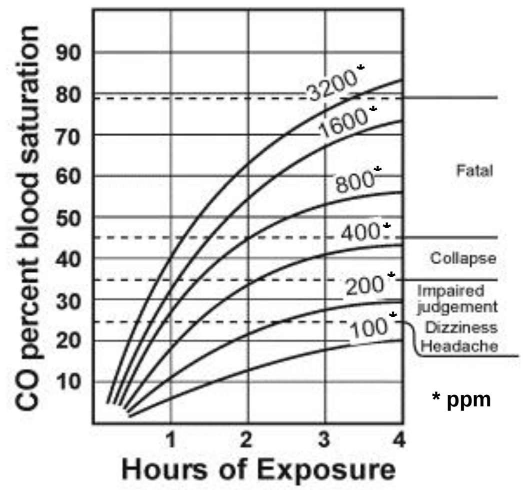
5.4 Source Pollutant Control

The control of pollutants at the source is always the best solution, especially in homes with a lower measured CFM_{50} reading. Whole-building mechanical ventilation helps remove and dilute low levels of pollutants. Technicians should be mindful of pollutant sources and exposures while performing weatherization.

The customer has significant control over the introduction and spread of many home pollutants. Always provide education to customer about corrective actions they can take to minimize pollutants in their homes.

5.4.1 Carbon Monoxide (CO)

The EPA's suggested maximum eight-hour exposure limit for CO is nine parts per million (ppm) in room air. CO at or above nine ppm is often linked to malfunctioning combustion appliances within the living space. Technicians are required to wear personal CO monitors while performing combustion safety testing.



Effects of CO: This graph's curves represent different exposure levels in parts per million (ppm).

Sources of Carbon Monoxide

CO pollution is often linked to unvented combustion appliances, back-drafting combustion appliances, gas ranges, charcoal grills, and motor vehicles idling in attached garages or near the home.

Testing for Carbon Monoxide

The most common CO testing instrument is an electronic sensor with a digital readout in parts per million (ppm). The readings will be either *AS MEASURED* or *AIR FREE.* Follow the manufacturer's recommendations on zeroing the meter — usually by exposing the meter to outside air. CO testing equipment typically requires recalibration every six months, using factory-specified procedures.

A CO test is normally completed in the appliance exhaust flue or at the exhaust port of the heat exchanger. Elevated CO can be caused by any of the following:

1. Over firing of an appliance — too much combustion fuel is supplied to the appliance. A low O_2 percentage on a combustion analyzer indicates the appliance may be over firing. Technicians may determine if the appliance is over firing by clocking the gas meter.
2. Inadequate combustion air — occurs when a combustion appliance is lacking sufficient combustion air.

3. Back drafting/spillage of combustion gases suppressing the flame.
4. Flame interference by an object (a pan over a gas burner on a range top, for example).
5. Misalignment of the burner.

Appliance service technicians should strive to identify and correct these problems.

5.4.2 Gas Range and Oven Safety

Testing Range-Top Burners

Test ranges prior to testing ovens for carbon-monoxide levels. Range-top burners must be tested *AS MEASURED* (in ambient air without adjustment for oxygen content). To test range-top burners:

1. Remove all pots and foil from the burner area.
2. Turn each range-top burner on high.
3. After 3 minutes of operation, position the testing probe 6 inches above the flame.

Table 5-1: Action Levels for Range Top Burners

As Measures CO PPM	Measuring Time	Action
< 25 PPM	After 3 minutes of operation	Should be cleaned by customer to prevent possible CO problems.
25 to 50 PPM	After 3 minutes of operation	Advise customer to have appliance serviced
>50 PPM	After 3 minutes of operation	Advise customer the appliance should not be used until either repaired or replaced.

Testing Gas Ovens

When completing oven testing:

1. Test ovens for *AIR FREE* carbon monoxide levels.
2. Remove any items stored in the oven and any foil coverings before turning the oven on.
3. Verify self-cleaning features are deactivated.
4. Insert the testing probe into the vent sleeve to sample pre-dilution-air exhaust gases.
5. Turn the oven on to its highest temperature setting and allow the oven to run continuously for 10 minutes.

6. Measure the oven during warm-up, and record the measurement at peak (after 10 minutes of run-time). Confirm the oven is indeed firing when the measurements are taken.
7. Test the ambient air in the kitchen to verify the CO level is below 35 PPM.

Table 5-2: Action Levels for Range Ovens

Air Free CO PPM	Measuring Time	Action
< 800 PPM	After 10 minutes	Should be cleaned by customer to prevent possible CO problems.
> 800 PPM, <1000 PPM	After 10 minutes	Advise customer to have appliance serviced
>1000 PPM	After 10 minutes	Advise customer the oven should not be used. Replace appliance.

5.4.3 Carbon Monoxide (CO) Alarms

Follow these instructions when installing CO alarms:

1. Install according to the manufacturer's instructions.
2. Educate the customer about the purpose and features of the alarms including what to do if an alarm sounds.
3. Leave instructions with the customer, and educate the customer about battery replacement, if applicable.

Do not install CO alarms:

- ✓ In a room that may get too hot or cold for the alarm to function properly.
- ✓ Within 5 feet of a combustion appliance, vent, or chimney.
- ✓ Within 5 feet of a storage area for vapor-producing chemicals.
- ✓ Within 12 inches of exterior doors and windows.
- ✓ Inside of a furnace closet or room.
- ✓ With an electrical connection to a switched circuit.
- ✓ With a connection to a ground-fault interrupter circuit (GFCI).
- ✓ Behind furniture or appliances.

The manufacturer’s instructions may specify stricter standards than these. If a conflict exists, follow the stricter specification.

5.4.4 Smoke Alarms

Follow these instructions when installing smoke alarms:

1. Install according to the manufacturer’s instructions.
2. Educate the customer about the purpose and features of the alarms including what to do if an alarm sounds.
3. Leave instructions with the customer, and educate the customer about battery replacement (if applicable).

Do not install smoke alarms:

- ✓ Within 12 inches of exterior doors and windows.
- ✓ On a switched circuit, if hard-wired.
- ✓ On a ground-fault interrupter circuit (GFCI).

The manufacturer’s instructions may specify stricter standards than these. If a conflict exists, follow the stricter specification.

5.4.5 Leak-Testing Gas Piping

Natural gas and LPG piping systems may leak at their joints and valves. Leaks can be located with an electronic combustible gas detector (CGD), often called a gas sniffer. A gas sniffer will find all significant gas leaks, if used properly. Remember, natural gas is lighter than air and rises from a leak, while propane falls, position the sensor accordingly. The CGD shall have a variable tick rate or changing tone based on gas concentration levels. The CGD shall have a digital display of percentage of Lower Explosive Limit (LEL) and/or provide an alarm when detecting combustible gas concentrations exceeding 10% of the LEL.

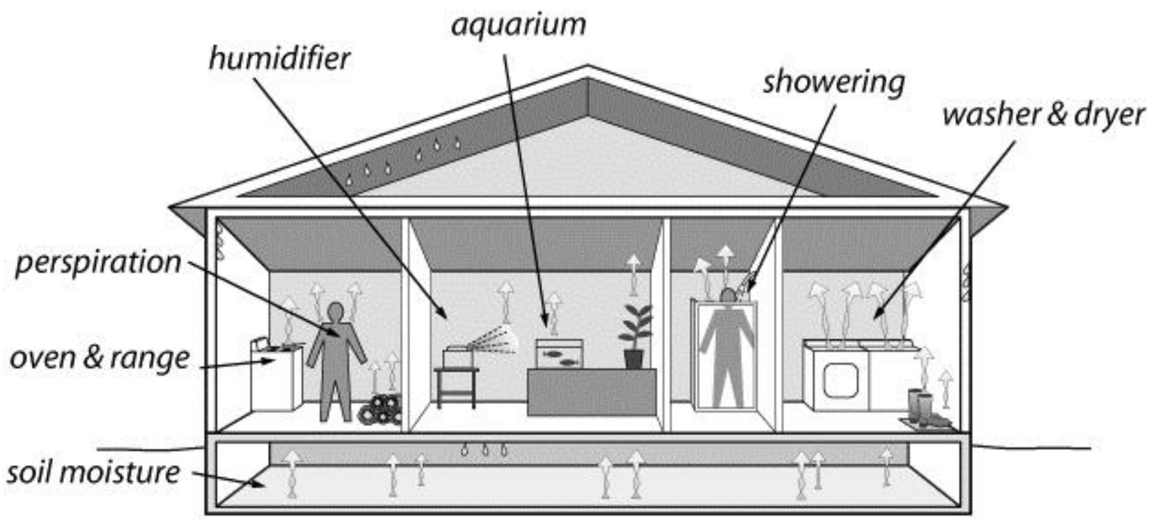
When major gas leaks are identified, cease testing immediately, inform the customer, evacuate the building, and contact the appropriate authority.

Combustible gas detector: These electronic combustible gas detectors are a fast and convenient way to find gas leaks.

Test for gas leaks by following these steps:

1. Inspect all piping from the meter or tank to all connected appliances using a combustible gas detector. Include connections to all gas appliances and gas stove valves. No verified gas leaks are allowed in the building or on the customer side of the meter or propane tank at the completion of weatherization work.

2. If the detector identifies a leak, verify the leak with a non-corrosive bubbling liquid designed for finding gas leaks.
3. Repair all gas leaks verified with bubbling liquid.
4. Replace kinked or corroded flexible gas connectors.



Moisture sources: Household moisture can often be controlled at the source by informed and motivated the customer. Indoor relative humidity should be between 30-50 percent.

5.4.6 Moisture Problems

Water and water vapor damages building materials by promoting mold and rot, dissolving glues and mortar, corroding metal, and nurturing pests like termites and dust mites. These pests, in turn, cause many cases of respiratory distress.

Water and moisture reduces the thermal resistance of insulation and other building materials. The most common sources of moisture are leaky roofs and damp foundations and basement floors. Other critical moisture sources include unvented dryers, showers, cooking appliances, and unvented gas appliances like ranges or decorative fireplaces.

Identifying and reducing sources of bulk/liquid moisture is the first priority for solving moisture problems. The next priority is to install or repair air and vapor barriers to prevent moisture from migrating into and through building cavities. Local exhaust fans located in the kitchen and bathrooms will remove high levels of moisture and other pollutants at the source.

Table 5-3: Moisture Sources and their Potential Contributions

Moisture Source	Potential Amount Pints
Ground Moisture	0-105 per day
Seasonal evaporation from materials	6-19 per day
Dryers venting indoors	4-6 per load
Dishwashing	1-2 per day
Cooking (meals for four)	2-4 per day
Showering	0.5 per shower

Relative humidity (RH) is a measurement of the degree to which air is saturated with moisture. Air at 100 percent RH is completely saturated. Home air below 30 percent RH is uncomfortably dry for many people. Air above 50 percent RH is likely to cause condensation on cold interior surfaces and in building cavities when outdoor weather is cold.

Symptoms of Moisture Problems

Condensation on windows, walls, and other surfaces may signal high RH and the need to find and reduce moisture sources. During very cold weather or rapid weather changes, condensation may occur. This occasional condensation is not a major concern. However, if window condensation is a persistent problem, reduce moisture sources, add insulation, or consider other remedies that lead to warmer interior surfaces. The colder the outdoor temperature, the more likely condensation will occur. Adding insulation helps eliminate cold areas where water vapor condenses.

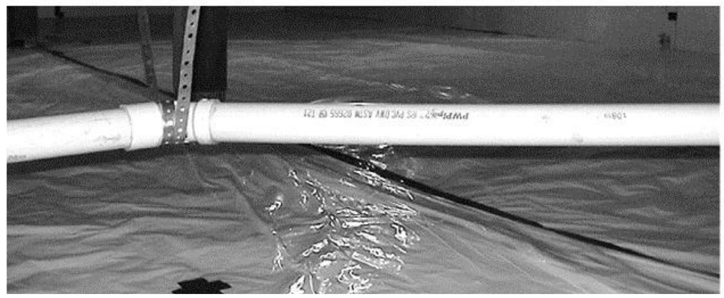
Moisture problems arise when the moisture content of building materials reaches a threshold that allows pests like termites, dust mites, rot, and fungus to thrive. Asthma, bronchitis, and other respiratory ailments can be exacerbated by moisture problems because mold, mildew, and dust mites are potent allergens. The level of moisture problem can be determined by the current state of the existing building materials. The following are examples how moisture affects building materials:

1. Rot and wood decay indicate advanced moisture damage. Unlike surface mold and mildew, wood decay fungi penetrate, soften, and weaken wood.
2. Peeling, blistering, or cracking paint may indicate moisture is moving through a wall, damaging the paint and possibly the building materials underneath.
3. Corrosion, oxidation, and rust on metal are unmistakable signs moisture is at work. Deformed wooden surfaces may appear as damp wood swells and then warps and cracks as it dries.

4. Concrete and masonry efflorescence often indicates excess moisture at the home's foundation. Efflorescence is a white, crystalline deposit left by water that moves through masonry leaving behind minerals from mortar or the soil as it evaporates.

5.4.7 Foundation Moisture Control

Moisture and pollutants entering the home through foundations, basements and crawl spaces can be a substantial contributor to indoor humidity even when no wet areas are apparent and affect the indoor air quality. The pollutants and moisture can move easily through the home, driven by stack effect and by wicking of the moisture into permeable wood and concrete.



A well-sealed crawl space: The dirt floor in this crawl space is covered with a well-sealed cross-linked polyethylene ground moisture barrier.

Ground Moisture Barriers

Air, moisture, and pollutants can move through soil and into crawl spaces and dirt-floor basements. Even soil that seems dry at the surface can release a lot of moisture into the home.

Follow these instructions when installing a ground-moisture barrier to control the movement of moisture and soil gases:

1. Inspect all plumbing for leaks and repair any leaks found before installing the ground moisture barrier.
2. Cover the ground completely with an airtight barrier, such as 6-mil plastic or cross-laminated polyethylene.
3. Overlap the seams of the barriers a minimum of 12 inches with a "reverse" or "upslope lapping" technique (e.g., overlapping so water will not flow in between the seams).
4. Run the barrier up the foundation wall at least 6 inches, or attach it to the mudsill if termites are not a problem in the area.
5. Seal the edges and seams with adhesive to create an airtight seal. It may be easier to assemble and seal the barrier outside of the crawl space. When the sealing compound sets up, the barrier should be a continuous sheet.

Caution: Moisture barriers are typically for use in crawl spaces. Use in basements should be limited to basements with dirt floors and limited access. When the ground-moisture barrier is installed in a little-used basement, install walk boards to prevent the customer from slipping. Address any problems, such as plumbing leaks, prior to installing the barrier, to prevent water from pooling on top of the barrier.

Open Block Cores

Pollutants and moisture are often found in the bottom of concrete block foundations. When the top of the wall is not sealed or capped, the pollutants and moisture are pulled up into the home due to stack effect and convective lopping inside the open cores of the wall. Cap the open cores at the top of the foundation wall using rigid material and air-seal around the perimeter of the cap. Treating block cores in this fashion can limit the entrance of moisture and pollutants into the home.

5.4.8 Lead and Lead Safe Weatherization

Lead dust can damage the neurological systems of persons who ingest it. Children are more vulnerable than adults because of their rapid brain development and common hand-to-mouth behavior. Lead paint was commonly used in homes built before it was outlawed in 1978. Technicians working on these older homes should either assume the presence of lead paint; or, if they believe no lead paint is present, perform tests to rule out its presence.

Lead Safe Weatherization (LSW) is a group of work practices used by weatherization professionals when they suspect or confirm the presence of lead paint. LSW focuses on rigorous dust-prevention and housekeeping precautions. LSW is required when workers will disturb painted surfaces by cutting, scraping, drilling, or other dust-creating activities. All weatherization field workers must be trained in LSW practices.

Wall-blowing tent: This tend protects the customer and their belongings from insulation and paint dust.

Lead Safe Renovator requirements apply in pre-1978 housing when more than 6 square feet of interior painted surface per room or more than 20 square feet of exterior painted surface will be disturbed, or any time windows will be replaced or demolished. See the Wisconsin Weatherization Program Manual for specific policies and guidance regarding Lead Safe Renovator requirements and minimum standards for lead-safe weatherization.

Weatherization activities that could disturb lead paint and create lead dust include, but are not limited to, the following:

1. Removing siding for installing insulation.

2. Drilling holes in the interior or exterior of the home for installing insulation.
3. Removing trim or cutting through walls or ceilings.
4. Weather-stripping, repairing, or replacing doors.
5. Glazing, weather-stripping, or replacing windows.

When engaging in the above activities, take the following precautions:

1. Tent off the work area by taping a continuous sheet of plastic from floor to ceiling.
2. To protect installers from breathing dust, use appropriate personal protective equipment, such as fit-tested respirators, and coveralls, etc.
3. Confine the work area within the home to the smallest-possible floor area. Seal this area off carefully with floor-to-ceiling barriers made of disposable plastic sheeting, sealed at floor and ceiling with zip poles or tape.
4. Cover furniture and carpet in the work area with disposable plastic sheeting.
5. Spray water on the painted surfaces to keep dust out of the air when drilling, cutting, or scraping painted surfaces.
6. Use a dust-containment system with a HEPA vacuum when drilling holes indoors.
7. Clean up as work is performed. Vacuum affected areas with a HEPA vacuum and wet-mop these surfaces daily. Do not use the customer's cleaning tools. Do not leave the customer with lead dust to clean up.
8. Avoid taking lead dust home by not contaminating clothing, shoes, or tools. Wear boot covers while in the work area and remove them to avoid tracking debris from the work area to other parts of the house. Wear disposable coveralls, or vacuum cloth coveralls with a HEPA vacuum before leaving the work area.
9. Wash hands and face thoroughly before eating, drinking, or quitting for the day.
10. Keep customer and pets away from the work area.

Lead-safe drilling: Using a shrouded drill with a HEPA vacuum removes dust where it is generated.

For more information, refer to the DOE publication Lead Safe Weatherization, A Training Manual for Weatherization Managers and Crews.

5.4.9 Asbestos

Air-borne asbestos fibers can be dangerous, even when they are not visible to the naked eye. Exposure to asbestos can lead to a host of health problems — including, but not limited to:

1. Lung cancer
2. Mesothelioma, a rare form of cancer found in the thin lining of the lung, chest, abdomen, and heart
3. Asbestosis, a serious progressive, long-term, non-cancer disease of the lungs

Disease symptoms may take many years, or decades, to develop after exposure to asbestos. Being a smoker greatly increases the odds exposure to asbestos will lead to disease.

According to Wisconsin Department of Health Services, workers may assume asbestos is not present in wood, metal, glass, and fiberglass. All other building materials; however, should be presumed to contain asbestos, unless proven otherwise through bulk sampling by a certified Asbestos Inspector and analysis by an accredited laboratory. Asbestos containing Vermiculite is the one exception — currently, there is no EPA-approved testing method to demonstrate the presence or absence of asbestos mixed in with vermiculite insulation. Consequently, weatherization workers must always presume that asbestos is mixed in with all vermiculite insulation.

See the Wisconsin Weatherization Program Manual, for comprehensive asbestos policies.

5.5 Electrical Safety

Follow these steps for electrical safety in existing homes:

1. Confirm attics contain no exposed wiring. All splices and connections should be in junction boxes.
2. Install covers on open junction boxes in the attic or elsewhere in the building if an imminent hazard exists for the workers or customer.
3. Mark all junction boxes in the attic that will be concealed by insulation, using flags.
4. Do not insulate wall cavities containing live knob-and-tube wiring. Eliminate live knob-and-tube wiring whenever feasible.
5. If knob-and-tube is not being re-wired as part of the job, isolate live wiring in attics by building a barricade around it. There are several materials

Knob-and-tube wiring: Prior to insulating around knob-and-tube wiring, barriers must be installed to keep insulation at least 3 inches from the wires.

that work well as barricades: R-30 un-faced fiberglass batts, concrete-form tube, or other industry accepted materials. Keep the barricade materials at least 3 inches away from the live knob-and-tube wiring.

6. Inspect wiring, fuses, and circuit breakers to confirm wiring is not overloaded. Install S-type fuses where appropriate to prevent circuit overloading. Maximum fuse or breaker amperage for 14-gauge wire is 15 amps and 20 amps for 12-gauge wire.

S-type fuse: An S-type fuse prohibits the customer from oversizing the fuse and overloading an electrical circuit.

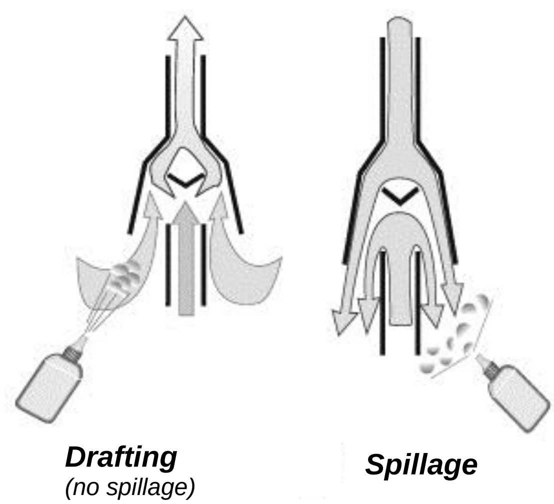
5.6 Worst-Case Draft Protocol

The main purpose of measuring draft is to confirm the combustion gases will vent safely to the outdoors. Draft is also an indicator of the effectiveness of the venting system and the stability of the combustion process. Draft is measured in inches of water column (i.w.c.) or Pascals (Pa).

5.6.1 Measuring Draft

Many combustion appliances exhaust their gases into a chimney or vent. Natural draft is produced by the difference in the weight of a column of flue gasses within a chimney or vent and a corresponding column of air of equal dimension outside the chimney or vent. A negative pressure in the chimney or vent with respect to indoors is created by natural draft. The strength of this draft (weight difference) is determined by the venting height, its cross-sectional area, and the temperature difference between the column of flue gases and the column of air. Measured natural draft in a venting system should always be negative, with respect to indoors. A positive reading indicates the flue gases are spilling into the **combustion appliance zone (CAZ)**. A CAZ is any location in a building where combustion appliances are located, most often the basement in Wisconsin.

Venting systems transport combustion gases using the flame's heat and the gases' buoyancy. Natural draft and fan assisted gas appliances are designed to operate at a natural draft of around negative 0.02 IWC, or - 5 Pascals. Tall venting systems located indoors typically produce stronger drafts, and short or outdoor venting systems produce weaker drafts. Wind and house pressures can have a big impact on natural draft in venting systems. Depressurization can cause spillage of combustion gasses into the CAZ.



Spillage: A smoke tester helps determine if spillage is occurring during appliance operation.

Natural draft appliances connected to chimneys or vents require a draft diverter to dilute the flue gases and limit the chimney temperature, keep the draft from getting too strong, and keep wind gusts from interfering with the appliance's burner. Fan-assisted appliances employ a small fan near the exhaust of their heat exchanger. This fan draws the products of combustion through the heat exchanger, but it has little or no effect on the draft up the chimneys. A poorly-functioning natural draft chimney may allow combustion gases to leak into the CAZ.

Higher efficiency appliances, including sealed combustion heating systems and power-vent water heaters, employ mechanical draft. This mechanical draft is produced by a fan. When the fan is located so as to push the flue gases through the venting system, the draft is forced. When the fan is located so as to pull the flue gases through the venting system, the draft is induced. A positive pressure in the venting system with respect to indoors is created by mechanical draft after the fan. The venting system must be airtight after the fan otherwise; the positive pressure inside the venting system will force combustion gases into the CAZ. The mechanical draft created is strong enough to resist the influence of most indoor and outdoor pressures.

Before testing, inspect the combustion venting system for damage, leaks, disconnections, inadequate slope, and other safety hazards.

Table 5-4: Acceptable Draft Test Readings for Gas Appliances

Acceptable Draft Test Readings for Gas Appliances with Respect to Outdoor Temperature			
°F	<10°	10°-90°	>90°
Pa.	-2.5	(°F_Out / 40) - 2.75	-0.5
IWC.	-.010	(°F_Out / 10,000) - 0.011	-.002

Table 5-5: Acceptable Draft Test Readings for Oil-Fired Appliances

Test Location	Acceptable Draft
Overfire Draft	-0.02 IWC or -5 Pascals
Flue Drafts	-0.04 to -0.06 or -10 to -15 Pascals

5.6.2 Depressurization Testing and Worst-Case Draft Testing

CAZ depressurization is the leading cause of back drafting and flame rollout. Depressurization testing uses the home's exhaust fans, air handler, and appliances to create worst-case depressurization in the CAZ. Using this worst-case testing protocol, the appliance draft and the indoor-to-outdoor pressure differential can be measured to check whether a natural-draft chimney works well enough to be safe.

CAZ Depressurization Test

This test measures the conditions of the building and the CAZ, both before and after weatherization work. The test also helps to determine the precautions needed for the safe operation of combustion appliances in the building. Use the Diagnostic Workbook to document the test results as well as identify possible solutions.

Before the test, run a pressure hose to the outdoors to an area unaffected by the wind and connect it to the gauge's "input" port. Then, put the building in "winter condition" — close all backdraft dampers, windows, and exterior doors (without pinching the pressure hose). Finally, open all interior doors, and close the doors to the CAZ. This procedure assumes the person completing the test can stand in the CAZ with the gauge in hand and measure and read results.

If not true, connect a pressure hose to input the tap of the digital manometer and place the other end of the hose in the CAZ. Close the door so the CAZ hose is not pinched, then continue with the test.

Set the gauge on "PR/PR" mode. The test may be started in one of two ways:

A. **Use the Automatic Baseline Feature of the Digital Pressure Gauge** — press the Baseline button on the digital pressure gauge, and then press the Start button. On windy days, allow the Baseline function to record for at least 60 seconds. After sufficient time has passed, press the Enter button. Begin at Step 2, below.

B. **Manually Record the Baseline Pressure** — begin at Step 1, below.

Follow these steps to perform the CAZ depressurization test:

1. **Baseline depressurization:** Measure and record the baseline pressure differential, or Delta P (ΔP), between the CAZ and the outdoors. If the baseline measurement seems unreasonable, ensure the pressure hose to the outdoors is not constricted.
2. **Turn on exhaust appliances:** Turn on all of the exhaust appliances in the building and record the ΔP between the CAZ and the outdoors. If the building has a power-vented water heater, turn this appliance on at this time. A pressure differential more negative than the reading from Step 1 usually indicates the exhaust fans have depressurized the CAZ. Pressure affects caused by exhaust appliances will be assessed and corrected when the impact could be harmful to the customer or building.
3. **Turn on the air handler:** Turn on the furnace's air handler, and record the ΔP between the CAZ and the outdoors. If the ΔP has become more negative than in Step 2, it usually means leaky return ducts in the CAZ or supply leaks in an attic have depressurized the CAZ. By contrast, a more-positive ΔP usually means leaking supply ducts in the CAZ or return leaks in an attic have pressurized the CAZ. If the

CAZ is pressurized by the air handler, turn it off before continuing to Step 4. Use the Diagnostic Workbook to guide duct sealing.

4. **Position interior doors:** Use the digital gauge or a smoke generating testing tool to measure the relative pressure of each room. To use a gauge, connect a hose to the input tap, leave the reference tap open to the house (i.e., not referenced to outdoors), toss the hose into the room, and close the door without pinching the hose. If the reading is negative (smoke is drawn into the room), open the door. If the reading is positive (smoke is pushed out of the room) or neutral, close the door. Return to the basement, re-connect the pressure tube(s) as before, and record the ΔP between the CAZ and the outdoors.
5. **Open the door to the CAZ:** Open the door to the CAZ, and record the ΔP between the CAZ and the outdoors. If the pressure difference is more negative than in Step 4, it may mean the exhaust fans are depressurizing the CAZ.
6. **Worst-case depressurization:** Subtract the Baseline reading from the largest negative reading (or the smallest positive) if baseline was manually measured and recorded, to get the adjusted Worst-Case Depressurization. If the automatic baseline feature was used, record the largest negative reading (or the smallest positive). ***The Diagnostic Workbook will complete this step automatically.*

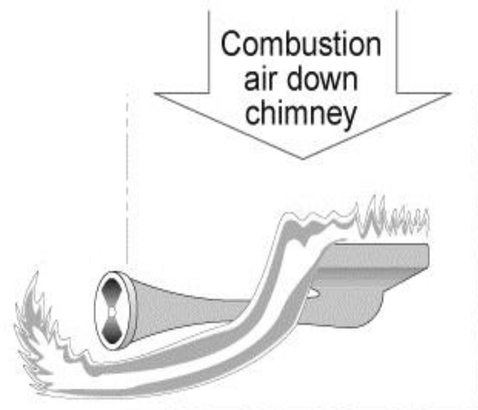
Table 5-6: Maximum Depressurization for Combustion Appliance Zones

Appliances and Venting Systems	Maximum Depressurization (Pascals)
Orphaned Natural Draft Water Heater (oversized venting system). *Note: chimney lined with clay or other liner but still oversized*	-2
Natural Draft Water Heater and Natural Draft Heating System with common venting	-3
Stand Alone Natural Draft Water Heater (properly sized venting system)	-5
Natural Draft Heating System or Stove (including wood burning systems)	-5
Natural Draft Water Heater and Fan Assisted Heating System (fan inside furnace cabinet) with common venting	-5
Natural Draft Water Heater and Induced Draft Heating System (fan at point of exit at wall) with common venting	-5
Induced Draft Heating System (fan at point of exit at wall)	-15
Power Vented Water Heater and Sealed-Combustion Heating System	-25
The Maximum Depressurization Guideline (MDG) is the most restrictive MDG in the Combustion Appliance Zone (CAZ).	

When results are entered into the Diagnostic Workbook, enter a negative pressure reading as a positive, since the workbook will “flip the signs”. For example, if a pressure of -3.8 is entered, the workbook will display +3.8.

Worst-Case Draft Test

Draft testing under worst-case depressurization conditions will discover whether the venting system will still remove the combustion gases when the combustion-zone pressure is at the most negative pressure, and most likely to cause a natural-draft chimney or vent to fail. A calibrated digital pressure gauge is essential for accurate and reliable readings of both combustion-zone depressurization and chimney draft.



Flame roll-out: Flame roll-out, a serious fire hazard, can occur when the chimney is blocked, the combustion zone is depressurized, or during very windy conditions.

Since draft and spillage testing identifies whether combustion gases are being exhausted, measure draft and note how the affect of potential back-drafting pressures such as exhaust fans, furnace-blower operation, and the opening and closing of interior doors.

If the appliance has an existing draft regulator, verify the draft regulator is functioning properly and installed according to the manufacturer’s specifications.

Follow these steps to perform a worst-case draft test at the conclusion of each work day in which envelope or duct sealing measures performed and at the final inspection:

1. Set up the house in worst-case depressurization conditions.
2. Drill an appropriately sized hole in the flue(s) of the appliances to be tested. For gas appliances, drill the test hole in the middle of the flue, halfway between the appliance and the chimney. For oil appliances, drill the test hole before the barometric damper.
3. Fire each combustion appliance, starting with the smallest BTU appliance. Check for spillage of combustion products near the flue diverter, hood, or barometric damper. Check for spillage after the appliance has operated for 2 minutes.
4. Measure the draft when the appliance has reached steady state operation.
5. Measure CO level in combustion gases. Test for CO in pre-dilution air. For natural-draft heating systems, measure the CO level in each combustion chamber, and record the highest of the measurements. See *Carbon Monoxide (CO) in Chapter 5 – Section 5.4.1.*

6. Record results on the Diagnostic Workbook. See *Tables 3-2 and Table 3-5 in Chapter 3 – Section 3.8.3 and Section 3.9.2* for minimum acceptable worst-case draft readings for gas- and oil-fired appliances.
7. If the draft is unacceptably weak at worst case, take all reasonable steps to attempt to improve worst-case draft and reduce house depressurization to acceptable levels.

Monitor ambient CO levels during draft testing. An ambient CO level above 35 ppm is a safety hazard – cease testing immediately. The CAZ should be ventilated before the resumption of draft testing and diagnosis of CO problems.

5.7 Make-Up Air Systems

Make-up air may be an option when the combustion appliance zone is excessively pressurized or depressurized and the appliance does not pass worst case draft. Use guidelines listed in *Table 5-6 in Depressurization and Worst-Case Draft Testing in Chapter 5 – Section 5.6.2* to determine acceptable pressures.

Add make-up air equal to 40 percent of the total exhaust ventilation. Multiply the total exhaust CFM (both continuous and intermittent) by 40 percent (0.40) to determine the amount of make-up air required (CFMs).

Make-up air systems provide supply air by way of fans and/or ductwork that introduce outdoor air into the home. These systems are sometimes electrically interlocked with exhaust fans elsewhere in the home so both fans run at the same time. This protects against the depressurization caused by large exhaust-only fans such as oversize range hoods. Balancing of the two airflows can be performed by balancing dampers in the fresh air duct. These systems, if properly balanced, can create house pressures closer to neutral than exhaust-only or supply-only systems. Follow the manufacturer's requirements for mixed air temperature and the location of the fresh air inlet.

When make-up air is installed, label the intake fitting “ventilation air intake” and educate the customer to keep yard debris and other contaminants clear of the intake.

5.8 Water-Heater Replacement

Occasionally, water heaters must be replaced for health and safety reasons. For information on replacement installation procedures, refer to *Water Heater Replacement in Chapter 4 – Section 4.1*. These reasons may include, but are not limited to:

1. Water heater is back-drafting/spilling. Refer *to Improving Inadequate Draft in Chapter 3 – Section 3.13.1* for guidance on how to remedy these problems.
2. The shell of the storage tank actively leaks and cannot be repaired.
3. Severe flame roll-out that cannot be repaired.

4. Carbon-monoxide measurement above 100 ppm (as-measured) that cannot be repaired.

5.9 Mechanical Ventilation

Ventilation is an important health-and-safety consideration in homes weatherized in Wisconsin. Many homes have blower-door-measured air tightness and building characteristics that necessitate mechanical ventilation as a means of keeping indoor-air quality at a safe level.

The customer may refuse the installation of ventilation in their home. Any customer refusing the installation of ventilation must sign the *Refusal of Ventilation: Release of Liability, Indemnification and Waiver of Claims*, available via the link at the beginning of Chapter 5. Refusal of ventilation does not constitute refusal of a major measure. An original copy of the waiver must be given to the customer and a copy retained in the customer's file.

5.9.1 Choosing Ventilation Systems

Ventilation systems must be matched to the home. A home may require only simple exhaust fans in bathrooms and/or kitchen. Very tight homes may require a balanced central ventilation system.

When ducted ventilation systems are installed in homes with forced-air heating or cooling systems, the ductwork can be shared in a simplified or ducted-exhaust installation. Though this hybrid approach can save some of the initial cost, these systems are more complicated and prone to pressure imbalances. Install fully ducted systems whenever possible.

In cold climates, heat-recovery ventilators (HRVs) or energy recovery ventilators (ERVs) can offset some of the heat loss from exhausted air. The heat recovery savings will be greatest when winter temperatures are the lowest.

5.9.2 Sizing Ventilation Systems

Whole building ventilation systems are sized according to the size of the home and the number of occupants as described by the ASHRAE 62.2 standard. Use the Diagnostic Workbook, to determine if whole building ventilation is required. Note: Existing ventilation may be modified to provide either continuous or intermittent ventilation at the required amount, based on the integrity of the existing installation.

5.9.3 Local Exhaust Fans

The ASHRAE 62.2 standard for acceptable indoor air quality establishes an on-demand or an optional continuous flow rate for local exhaust in bathrooms and kitchens. An alternate compliance path that increases the flow rate of whole building ventilation to offset the lack of local exhaust is available for existing homes.

Follow these instructions when installing local exhaust fans to remove bulk pollutants and moisture:

1. Locate exhaust fans as close to the source(s) of pollutants/moisture as possible. For example, install bath fans in the shower or as close as practical, and install kitchen fans near the range.
2. Install exhaust fans as close as possible to the heated space, which usually means against the ceiling surface.
3. Consider the positioning of the new fan's exhaust port. Position ceiling fans so the exhaust port runs parallel with the ceiling joists and points toward the existing exhaust termination. If no existing termination is present, best practice is usually to point the fan's exhaust port toward the center of the attic. This makes it easier to attach exhaust ducting.
4. Avoid installing fans in vaulted ceilings, walls, or slopes if possible. These installations displace insulation and make it difficult to avoid cold spots, which foster condensation. In addition, these installations make it difficult to duct the fan to the outdoors.

5.9.4 Whole Building Exhaust Only Ventilation

The ASHRAE 62.2 standard for acceptable indoor air quality establishes a rate for whole building ventilation based on floor area and the number of occupants. When natural ventilation does not fulfill the entire established rate for whole building ventilation, mechanical ventilation is installed. In Wisconsin, the most common approach is exhaust-only ventilation. Local exhaust requirements may also be met by increasing the flow rate of installed whole building ventilation.

Surface-mounted exhaust fan: Exhaust fans aid air quality by drawing fresh air into the building as they remove indoor pollutants.

Follow these instructions for the installation of whole-building exhaust ventilation:

1. Install fans in bathrooms or kitchen when practical to reduce overall flow rate when following alternate compliance for local exhaust requirements.
2. In-line exhaust fans may be installed in a remote location such as the attic or basement. Ducting can be installed to one or two intake locations and then terminated to the outdoors. One option is to use the existing ceiling exhaust as an intake location after removing the fan assembly from the housing. This option avoids cutting new holes in ceilings.
3. Install fans with built-in controls or install a separate control to allow for the adjusting of the flow rate and frequency-of-operation as needed. Label all controls.

4. Install a service or shut-off switch if not an integral part of the fan control. Label all controls.
5. Measure the flow rate of the installed exhaust ventilation and record on Diagnostic Workbook. Record the highest flow rate in the exhaust fan section. Record the continuous or intermittent rate in the ventilation section.
6. Adjust the controls to provide the required flow rate at a continuous rate. Adjust controls for frequency-of-operation when operating intermittently. Intermittent operation should occur at least once in every three-hour time period.
7. Calculate intermittent operation using this formula: required flow / rate measured flow rate x 60. The result is the number of minutes-per-hour the ventilation should operate. The Diagnostic Workbook will assist installers in setting operational controls.

5.9.5 Exhaust Fan Ducting

Discharge exhaust fan ducting to the outdoors and not to an attic, crawl space, or garage, where moisture and pollutants can accumulate. Duct exhaust fans to the outdoors as follows:

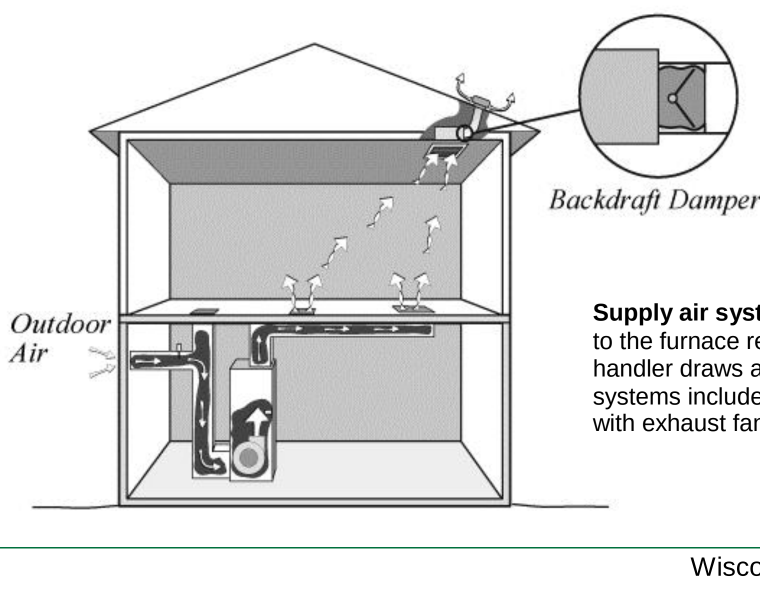
1. Use flexible or rigid ducting material.
2. Ensure a backdraft damper is present. The damper may be part of the termination hood, it may be integrated into the fan unit, or it may be installed separately in the exhaust duct.
3. Where practical, begin the ducting run by connecting a one- to two-foot section of straight rigid duct to the fan's exhaust port, in order to improve airflow.
4. Avoid installing elbows at 90-degree angles — this can reduce airflow. Instead, install elbows at as gradual and smooth of an angle as is reasonable.
5. Make duct runs as short as is practical. Avoid long duct runs, especially where they are above the insulation or running horizontally.
6. Attach the ducting material to the fan's exhaust port and to the termination hood.
7. Seal all joints in the exhaust-ducting run including at the fan and termination.
8. Insulate the ducting to a minimum of R-8 in unheated spaces. Ensure the insulation is secure and provides continuous coverage.
9. In multi-family housing, for continuous ventilation, multiple exhaust fans may be combined into a "collector box" and exhausted with an appropriately sized termination hood. In these cases, assure there is a backdraft damper integrated into every fan unit.
10. Use a termination fitting with an integrated collar. The termination shall have a screen material installed so it does not inhibit damper operation or restrict airflow.

11. Install termination hoods to the outdoors and not to a buffer zone, such as an attic, crawl space, or garage, where moisture and pollutants can collect.
12. A termination shall be installed a minimum of 3 feet away from any property line, a minimum of 3 feet away from operable openings to houses, a minimum of 10 feet away from mechanical intakes, or as required by authority having jurisdiction.
13. Install the top half of roof caps underneath the shingles, in order to prevent rainwater from leaking into the attic. Use galvanized or stainless steel fasteners, and use roofing cement to seal any leakage points.
14. Galvanized steel, stainless steel, or copper shall be used for termination fitting for kitchen exhaust fans.

5.9.6 Supply Ventilation Systems

Supply ventilation systems introduce fresh air into the home, and do not include heat recovery. They are usually installed in conjunction with forced-air heating or cooling systems. They incur an energy penalty as unconditioned air is brought into the home. It is critical with this, and any other installation utilizing the forced-air system, to follow the manufacturer's requirements for mixed air temperature and the location of the fresh air connection. Introducing very cold outdoor air directly into a forced-air furnace creates a risk of cracking the heat exchanger and will void the heating system warranty. The temperature of the air into the return side of the furnace cabinet should never be below 60° F for systems with continuous outdoor air supply or 55° F with an intermittent air system. Also, since this modification could result in cooler supply register air temperatures, the customer must understand and agree to this installation. Simple supply systems are difficult to balance effectively, especially in well-sealed homes. Central balanced ventilation systems are often a better choice considering overall efficiency and the need to balance house pressures.

The most common type of supply-only ventilation includes an outdoor air duct connected to the main return of a central forced-air heating or cooling system. The HVAC system's fan



Supply air system: Fresh air is ducted to the furnace return plenum. The air handler draws air into the home. Some systems include an electrical interlock with exhaust fans.

draws outdoor air into the plenum, delivering ventilation air to the home along with heated or cooled air. No ventilation air is supplied unless heating or cooling is needed.

The fresh air duct should have a balancing damper installed so the airflow can be adjusted during the initial installation. A motorized damper is sometimes installed to close the outdoor air duct when ventilation air is not needed.

Supply ventilation systems pressurize the home, forcing indoor air out through openings in the shell. This may keep outdoor pollutants, such as carbon monoxide from vehicles and lawn chemicals, out of the home, as long as the fresh air intake draws air from a clean location.

The positive house pressure created by supply ventilation systems can force indoor moisture into the walls. This can promote condensation in building cavities during cold weather. Moderate levels of pressurization are not usually a concern, though, if indoor RH is kept at or below 35 percent.

Supply systems introducing air to the HVAC system can be configured to provide fresh air when neither heating nor cooling systems are operating. In this mode, the HVAC fan can be set up to circulate ventilation air only. This method is most efficient when a variable speed HVAC fan allows the slower airflow required for ventilation-only operation. Single-speed HVAC fans move too much air and consume too much electrical power for efficient continuous operation.

5.9.7 Balanced Ventilation Systems

Balanced ventilation systems provide measured fresh air via planned pathways. Of all the ventilation schemes, they can do the best job of controlling pollutants in the home when properly installed. (Note: Wisconsin Uniform Dwelling Code does allow ventilation to be balanced through the use of unplanned pathways when no atmospheric combustion appliances are located in the building. Make-up is required when the combustion appliance zone is excessively pressurized or depressurized. For weatherization purposes, use the Building Depressurization Guidelines to deter excessive depressurization.) See *Table 5-6 in Chapter 5 – Section 5.6.2*.

Balanced systems move equal amounts of air into and out of the home. Most balanced systems incorporate heat recovery ventilators that reclaim some of the heat and/or moisture from the exhaust air stream. Simple mixing boxes are occasionally used to temper incoming air by mixing it with exhaust air, but their cost approaches that of heat recovery ventilators, and they incur an energy penalty as conditioned air is lost to the outdoors.

Balanced systems, when operating properly, reduce many of the safety problems and moisture-induced building damage possible with unbalanced ventilation. Balanced systems are not trouble-free, however. Proper design, installation, and maintenance are required for effective operation.

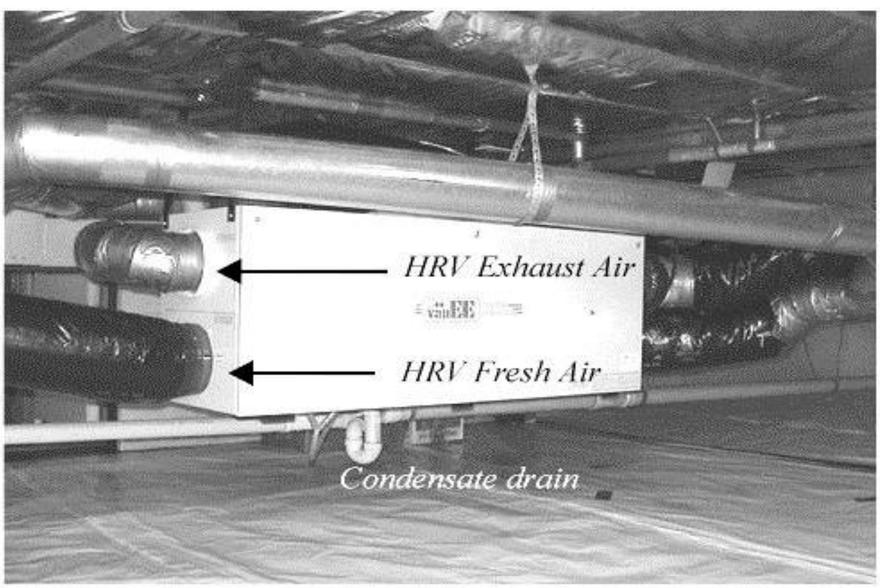
These complicated systems can improve the safety and comfort of home, but they require regular customer maintenance and periodic service (preferably by a knowledgeable professional) to assure they operate properly. Testing and commissioning is vital during both the initial installation and periodic service calls.

Variation 1: Fully-Ducted Balanced Systems

The most effective central ventilation systems include dedicated ductwork for both supply and exhaust air. All the system ducting leads to a central ventilator, which includes an HRV core to reclaim heat.

Fully-ducted systems are installed independently of other forced-air ducting. This gives the designer a high level of control over airflow and house pressure. They are most easily installed in new construction and are more difficult to install during weatherization.

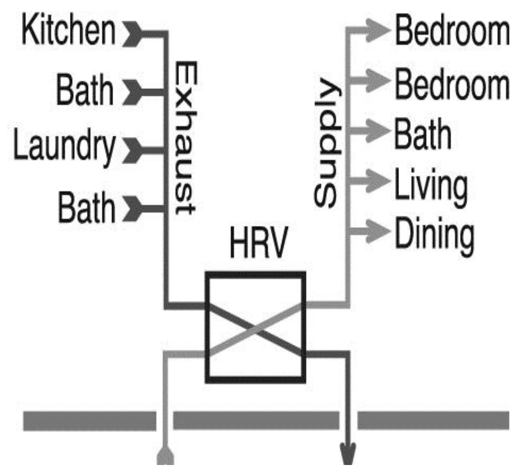
High-quality ductwork is a critical component of successful ventilation systems. Ducts should be sized large enough to minimize static pressure and reduce noise, and hard metal ducting used wherever possible. All seams and joints should be sealed using mastic or metallic tapes or other UL181 approved material. Exhaust grilles should be installed near the sources of contaminants in bathrooms, kitchens, or other areas where other pollutant-producing activities take place.



Fully-ducted heat recovery ventilator: Matched exhaust and supply fans provide balanced airflow. Dedicated exhaust ducting collects pollutants from bathrooms and kitchen. Supply ducting carries fresh air to bedrooms and central living areas. A heat-recovery core reduces energy loss from exhausted air.

Variation 2: Ducted-Exhaust Balanced Systems

Ducted-exhaust systems are connected to central forced-air systems. Dedicated ducting collects pollutants from bathrooms and kitchens. The exhaust air passes through a central HRV core before being exhausted to the outdoors. Fresh air is brought in through the HRV core, collects the heat extracted from the exhausted air, and is introduced to the forced-air system at either the supply or return plenum. Always follow the manufacturer's instructions for mixed air temperature, the location of the fresh air insert, and minimum return air temperature.



Fully-ducted central ventilator: Fully-ducted systems do the best job of collecting pollutants. Installed independently of heating and cooling systems, fully-ducted systems work well in homes with hydronic or electric baseboard heat where no ducting is installed.

The airflow should be balanced in ducted-exhaust systems so house pressures remain close to neutral. In practice, this is harder to achieve than in fully-ducted systems because of the influence of the forced-air blower. With typical airflows of 50-200 CFM, central ventilators are easily overwhelmed by the 500-1500 CFM airflows of forced-air systems. A high level of care is needed during design, installation, and commissioning of ducted-exhaust ventilation systems to achieve proper airflows and to achieve reliably balanced house pressures.

Polyethylene HRV core: This flat-plate counter flow heat exchanger slides out for cleaning.

Variation 3: Simplified Balanced Systems

Simplified, or volume ventilation, systems are connected to central forced-air heating or cooling systems. This is the least-favored ducting option.

Simplified systems draw exhaust air from the forced-air return air plenum. This air passes through the central ventilator that includes an HRV. Most of the exhaust airstream's heat is transferred to supply airstream, and fresh air is re-introduced to the forced-air return ducting. Always follow the manufacturer's recommendation for interlocking the air handler with the fresh air inlet. This system requires regular, effective customer maintenance, as system failure will result if maintenance requirements are not followed.

5.9.8 Heat Recovery Ventilators

Heat recovery ventilators (HRVs) are often installed in conjunction with balanced whole-house ventilation systems. The HRV core is usually a flat-plate aluminum or polyethylene air-to-air heat exchanger in which the supply and exhaust airstreams pass one another and exchange heat through the flat plates.

5.9.9 Heat Recovery Ventilator (HRV) and Energy Recovery Ventilator (ERV) Installation

Follow the specifications below when installing a balanced ventilation system:

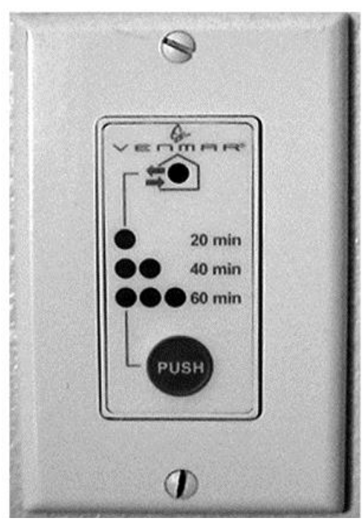
1. Install the system following the manufacturer specifications.
2. Install a backdraft damper between the heat recovery ventilator (HRV) or energy recovery ventilator (ERV) and the exterior.
3. Insulate ducts installed outside of the thermal envelope to a minimum of R-8.
4. Seal the gap between registers or grills and interior surface.
5. When connected to the heating system, exhaust air shall not draw directly from the heating system. Supply ducts should be installed as close to the HVAC system's fan as possible.
6. Educate the customer about how and when to change filter and clean the drain pan, according to manufacturer specifications.

5.9.10 Ventilation Control Strategies

Controls provide an opportunity for fine-tuning ventilation systems. Controls let the installer and customer choose when the system runs and how much air it moves.

Controls also provide an opportunity to adjust the system performance over time. The customer should be advised a periodic review of the control scheme should be performed, perhaps during service visits, to assure the system is providing sufficient fresh air for customer and acceptable moisture control for the building.

Locate the controls in a representative location on a main floor interior wall, and about 48 to 60 inches above the floor. Do not install them on an exterior wall, in a drafty location, or in direct sunlight.



Manual override control: A central heat recovery ventilator, normally operating at low speed, is boosted to high speed by this push-button countdown timer.

Manual Control

Simple on/off manual controls allow the customer to ventilate as needed. These are often used for exhaust fans in bathrooms and kitchens. Their effectiveness relies on a customer's perception of air quality.

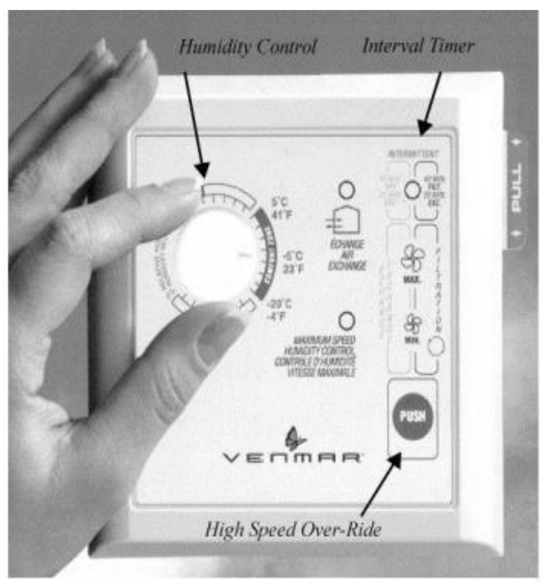
Manual controls sometimes include countdown or time-delay timers activated by customer and run for a specific period of time. In non-owner-occupied homes or other situations where a customer understands and cooperation is unlikely, fan-delay timers can be run in conjunction with bathroom lights to give a set period of ventilation whenever the bathroom lights are used.

Humidity Control

De-humidistats operate equipment based upon indoor humidity levels. They are used with either simple exhaust fans or central ventilation equipment. De-humidistats can be set for a range of humidity levels, and have the advantage of automatic operation that does not require much customer management. They should be set to keep indoor humidity low enough to prevent indoor condensation in the winter. This will vary from 30–50% RH, depending upon the outdoor temperature, effectiveness of windows and insulation, and other factors.

Combination Controls

Central ventilation systems are often operated by a combination of manual and automatic controls. The most common strategy utilizes a multi-speed fan that runs on low or medium speed to provide continuous ventilation. Override switches in the kitchen and bathrooms activate high-speed operation to provide intermittent high-speed operation during polluting activities such as cooking, bathing, or cleaning. The total airflow requirement specified by ventilation standards refers to this high-speed operation.



Central combustion control: The system can be controlled by humidity, time interval, or manually.

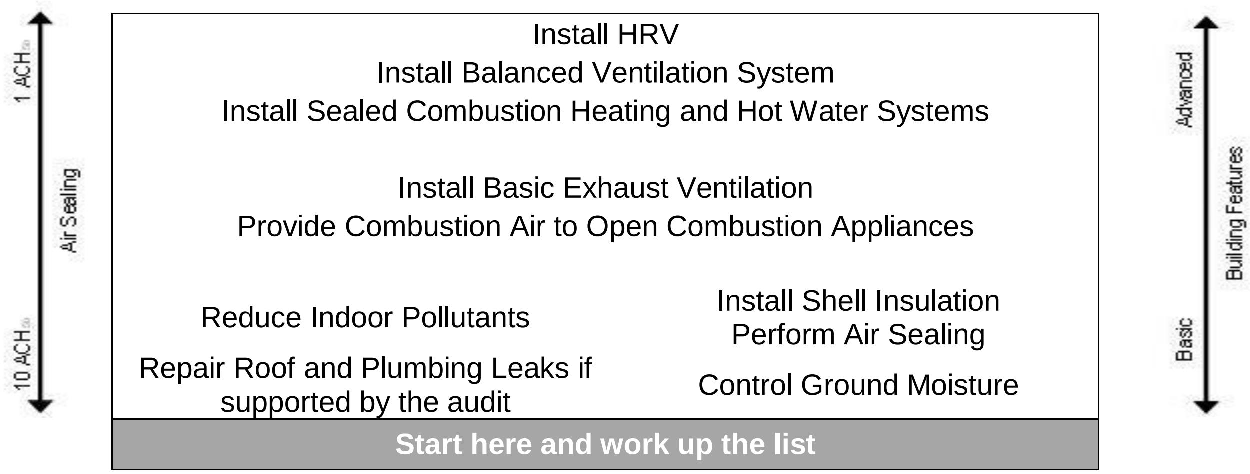
Timers allow the low-speed operation to be set for variable intervals such as 20 minutes on/40 minutes off per hour, 30 minutes on/30 minutes off, or whatever total ventilation time is needed. This adjustable interval provides an effective method of matching the ventilation capacity to the customer's needs.

5.9.11 Priorities for Existing Homes

There are some advantages to designing ventilation systems for existing homes. First, the home provides an observable history from which to work. Stained ceilings, peeling paint, and mildewed attic framing all tell the story of how a building operates. The customer may identify problems not immediately apparent, such as periodic back drafting of combustion appliances. In addition, the existing home has already aged, allowing lumber to dry and modern materials to out-gas, reducing the pollutant load on the ventilation system.

First, identify any major sources of moisture and other pollutants, and remove them or seal them away from the house. No ventilation system can effectively handle excess amounts of any pollutants.

Complete shell measures to assure reliable pressure and thermal boundaries. The heating, cooling, and ventilation systems depend on these measures to operate effectively.



Hierarchy of housing needs: Keep the entire structure in mind as you design and install mechanical systems.

The choice of ventilation equipment will depend upon the building's structure, airtightness, customer understanding and commitment to maintenance, and mechanical systems. Many homes may require only exhaust fans. A blower door test, worst-case draft depressurization test, and an assessment of the home's existing ventilation will provide the information to determine the home's ventilation needs. See *Worst-Case Draft Protocol in Chapter 5 – Section 5.6.*

5.9.12 Installation Best Practices

A high level of quality control is needed to assure ventilation systems work as intended. Properly designed and installed systems help create a healthy indoor environment and a long-lived building, while poorly executed systems can be ineffective or dangerous. Complex central heat-recovery ventilation systems require the most attention to design and installation.

Final Inspection and Quality Assurance Standards

Acceptable installation shall meet the following standards:

1. All Health and Safety measures were completed when appropriate to eliminate or reduce existing hazards or to eliminate or reduce hazards created as a result the installation of weatherization materials.
2. CO alarms are installed where required.
3. Smoke alarms are installed where required.

Ventilation for Indoor Air Quality

1. Whole building ventilation and local exhaust were installed as required.
2. Measured flow rate of whole building mechanical ventilation is between 90% and 150% of the ASHRAE 62.2 minimum calculated rate, as determined by the diagnostic workbook.
3. Installed whole-building ventilation operates continually or on an intermittent basis with a customer shut-off switch.
4. The customer signed a “refusal of ventilation” when ventilation was declined.
5. Ventilation Form filled out completely and left with customer.