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Introduction

Nice house!

Now it is time to keep it that way.

Just like the engine of an automobile, your house works as a system of independent parts. Every part has an impact to the operation of many other parts. A typical home has over 10,000 parts. What happens when all the parts work together in the most desirable, optimal way? You are rewarded with a house that is durable, comfortable, healthy and energy-efficient.

✔ You can make it happen in just a few steps.

Step #1: Monitor the house
Step #2: Recognize potential problems
Step #3: Correct problems properly

This book will help you do all three steps.

If you hired a certified home inspector - that was a good decision and money well spent. As you know, the home inspector is not an expert but a generalist. Your home inspector inspected the home and reported the home's condition as it was at the time of the inspection. That is the main responsibility of the home inspector. A home inspection does not include predictions of future events. Future events (such as roof leaks, water intrusion, plumbing drips and heating failures) are **not** within the scope of a home inspection and are **not** the responsibility of the home inspector.

Who's responsible? You are. The new homeowner. Welcome to home ownership. The most important thing to understand as a new homeowner is that things break. As time moves on, parts of your house will wear out, break down, deteriorate, leak or simply stop working.

But relax. Don't get overwhelmed. You're not alone. This book is for you and every homeowner experiencing the responsibility of home ownership. Every homeowner has similar concerns and questions. And they are all related to home maintenance.

The following questions are those that all homeowners ask themselves:

#1 "What should I look for?"
#2 "What does a real problem look like?"
#3 "How should it be corrected?"

The answers to these questions are written in this book.

This book will guide you through the systems of a typical house, how they work and how to maintain them. The systems include the following: the exterior, interior, roof, structure, electrical, HVAC, plumbing, attic, insulation, bathroom and kitchen.

You will learn what to **monitor (what to look for)** as the house ages. Most of the conditions and events that you will see and experience will likely be cosmetic and minor. Most homes do not have major material defects.

Throughout the book, there will be references to the International Association of Certified Home Inspectors (InterNACHI). InterNACHI is the world's largest trade association of residential and commercial building inspectors. The InterNACHI Standards of Practice (SOP) defines what a home inspection is and lists the responsibilities of a home inspector. The SOP is located at http://www.nachi.org/sop.htm.

This book comments upon the responsibilities of a home inspector, because we are assuming that a home inspector has given you this book to read. Sometimes when a new homeowner is performing maintenance, apparent problems are discovered or revealed. Or as time goes by, things in the house leak or fail. A new homeowner experiencing a problem should refer to the Standards of Practice, which outlines the responsibilities and limitations of the home inspector.

The first nine chapters of this book describe the systems and components of a typical house.

Chapter 10 is about saving energy. This chapter describes how to make your home more comfortable and energy efficient by sealing air leaks and adding insulation —and you can do it yourself.

Chapter 11 has four maintenance checklists - one for each season.

Chapter 12 has a list of average life expectancies of systems, components and appliances in a typical home.

Home **ownership** is a great experience, and home **maintenance** is a great responsibility. This book will help you enjoy both.

Enjoy your house!

Chapter 1: InterNACHI Standards of Practice

The Standards of Practice of the International Association of Certified Home Inspectors is located at http://www.nachi.org/sop.htm. Throughout this book the Standards will be referenced and abbreviated. The complete version is not printed in this book.

According to the Standards of Practice, a home inspection is a non-invasive visual examination of a residential dwelling, performed for a fee, which is designed to identify observed material defects within specific components of said dwelling. Components may include any combination of mechanical, structural, electrical, plumbing or other essential systems or portions of the home, as identified and agreed to by the Client and Inspector, prior to the inspection process.

There's no crystal ball. A home inspection is intended to assist in evaluation of the overall condition of the dwelling. The inspection is based on observation of the visible and apparent condition of the structure and its components on the date of the inspection and **not the prediction of future conditions**.

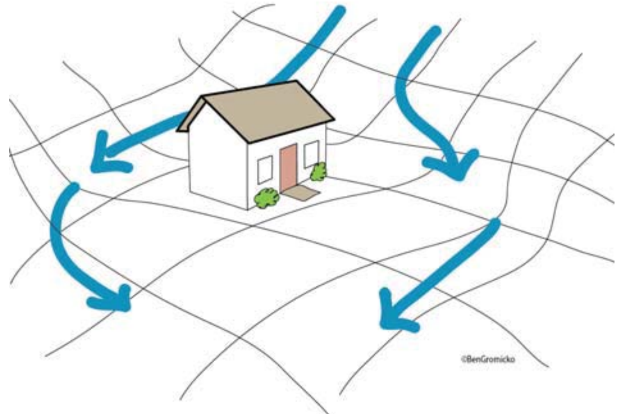
You should expect to find problems in your house that were not identified in your home inspection report. That's because a home inspection will not reveal every problem that **exists or ever could exist**, but only those "material defects" that were observed on the day of the inspection.

A "material defect" is a condition of a residential real property or any portion of it that would have a significant adverse impact on the value of the real property or that involves an unreasonable risk to people on the property. The fact that a system or component is near, at or beyond the end of the normal useful life does not make the system or component itself a material defect.

Report. An inspection report shall describe and identify in written format the inspected systems, structures and components of the dwelling and shall identify material defects observed. Inspection reports may contain recommendations regarding conditions reported or recommendations for correction, monitoring or further evaluation by professionals, but this is not required.

Chapter 2: Site and Environment

2.1 Property Drainage



During a heavy rainstorm (without lightning), grab an umbrella and go outside. Walk around your house and look around at the roof and property. A rainstorm is the perfect time to look at how the roof, downspouts and grading is performing. Observe the drainage patterns of your entire property, as well as the property of your neighbor. The ground around your house should slope away from all sides. Downspouts, surface gutters and drains should be directing water away from the foundation.

Monitor the following:

Poor drainage. Most problems with moisture in basements and crawlspaces are caused by poor site drainage. The ground should slope away from window wells, outside basement stairs, and other ways of egress. The bottom of each of these areas should be sloped to a drain.

Each drain should have piping that connects it to a storm water drainage system (if there is one) or that drains to either a discharge at a lower grade or into a sump pit that collects and discharges the water away from the building.

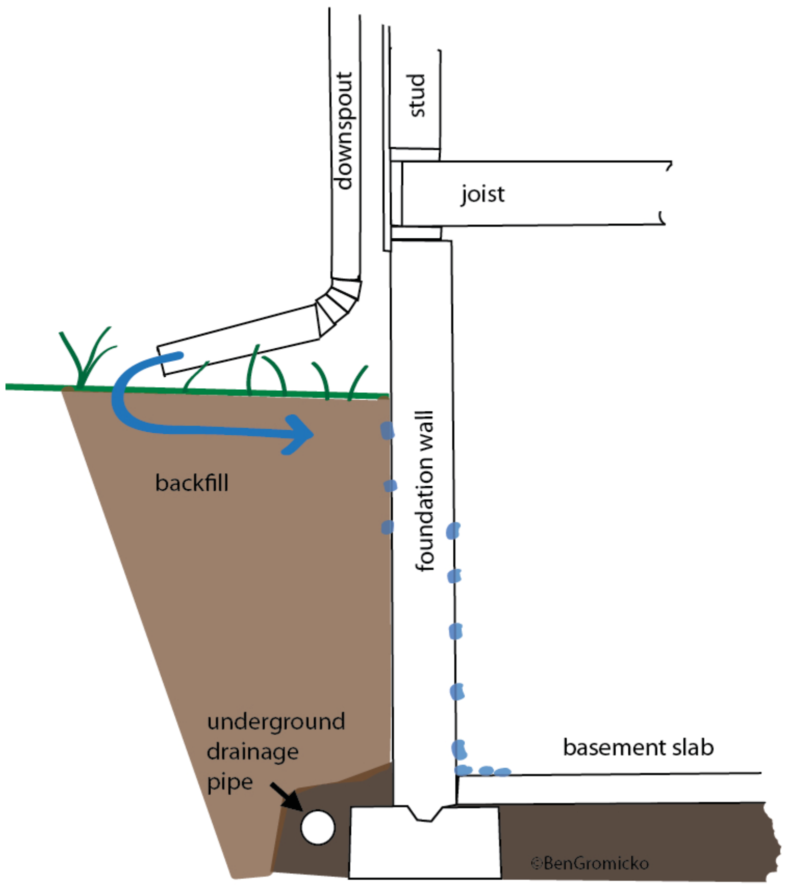
Your job is to monitor and maintain the drains and piping. Drains and piping should be open and clear of leaves, earth and debris. A garden hose can be used to check water flow, although its discharge cannot approximate storm conditions.

Hillside. Where a building is situated on a hillside, it is more difficult to slope the ground away from the building on all sides. On the high ground side of the building, the slope of the ground toward the building could be interrupted by a surface drainage system that collects and disposes of rainwater runoff. Swales can be used to direct surface water away from the foundation. There are two general types of surface drainage systems: an open system, consisting of a swale (often referred to as a ditch), sometimes with a culvert at its end to collect and channel water away and; a closed system, consisting of gutters with catch basins.

Planters.

Check the planting beds adjacent to the foundations. Plantings are often installed in a way that traps water. The structure around the planting beds acts like a dam and traps water. Flower planters should never be installed up against a house exterior wall.

Puddles are not good. The ground surface beneath decks, porches and other parts of a building that are supported by posts or cantilevered structures should be checked. It should not have any low-lying areas, but should be sloped so that water will not collect and puddle there.



Settled backfill allows water to collect next to the foundation wall and penetrates into the basement. See illustration.

Downspouts need adjustment. Water from the roof reaches the ground through gutters and downspouts or by flowing directly off roof edges. Because downspouts create concentrated sources of water in the landscape, where they discharge is important. Downspouts should not discharge where water will flow directly on or over a walk, drive, or stairs. The downspouts on a hillside building should discharge on the downhill side of the building. The force of water leaving a downspout is sometimes great enough to damage the adjacent ground, so some protection at grade such as a **splash block** or a paved drainage chute is needed. In urban areas, it is better to drain downspouts to an underground storm water drainage system, if there is one, or underground to discharge at a lower grade away from buildings.

Water that flows directly off a roof lacking gutters and downspouts can cause damage below. Accordingly, some provision in the landscaping may be needed, such as a gravel bed or paved drainage way.

Sump pump should not recycle. When a sump pump is used to keep a building interior dry, the discharge should drain away from the building and should not add to the subsurface water condition the sump pump is meant to control.

Naturally wet. Look around the entire site for the presence of springs, standing water, saturated or boggy ground, a high water table, and dry creeks or other seasonal drainage ways, all of which may affect surface drainage.

2.2 Landscaping

Well-maintained landscaping and other improvements to the property are important for the enjoyment of a healthy and durable property.

Monitor the following:

Plants, trees, and shrubs.

Check the location and condition of all trees and shrubbery. Those that are overgrown should be pruned or trimmed. Where trees or bushes have overgrown, complete removal may be necessary.

Trees need to be trimmed. Overhanging branches should not interfere with a chimney’s draft, damage utility wires, or deposit leaves and twigs on the roof, or inside gutters and drains. Trees and shrubbery that are very close to exterior walls or roofs can cause damage. They can make it difficult to perform homeowner maintenance inspections and make repairs. Branches around the perimeter of the house should be pruned back. Tree roots under concrete walks can cause damage. Roots are usually exposed near the surface and can be cut back. Tree roots can cause **foundations to crack by pushing** against foundations from the outside. Consider hiring an arborist. An arborist is a specialist in the cultivation and care of trees and shrubs, including tree surgery, the diagnosis, treatment, and prevention of tree diseases, and the control of pests. Find a certified arborist in the U.S. at http://www.natlarb.com and http://www.canadian-forests.com/urban_con.htm for Canada.

Fences fall apart and lean over. Fences are usually installed to provide physical or visual privacy. Fences should be plumb.

Check wooden fences for development of rot or insect infestation. Check metal fences for rust development. All gates and their hardware should have proper fitting, operation and clearances. Fences are often addressed in homeowner association bylaws and deed covenants. Pay special attention to fence locations and your property lines. Neighbors can get quite "un-neighborly" about property lines.

Concrete pavement cracks and settlement. Monitor paved areas. Where there is a difference in elevation in a walk or drive that creates a tripping hazard, the higher portion of concrete may be ground down to the level of the lower portion, although the grinding will change the appearance of the concrete. Paved areas immediately adjacent to a building should **slope away** from the perimeter of the building walls (foundation walls). Paving that is not sloped to drain water away from a building should be repaired. Repair any paving that has large cracks, broken sections, high areas, low areas that trap water and tripping hazards. Repairing concrete often requires total replacement. Resurfacing with a thin layer of more concrete cannot repair concrete. Concrete should be no less than three inches thick. Cracks in concrete can be cut open and sealed with a flexible sealant compound, which will extend its service life. For sidewalks that have settled downward, it may be possible to lift up sections.

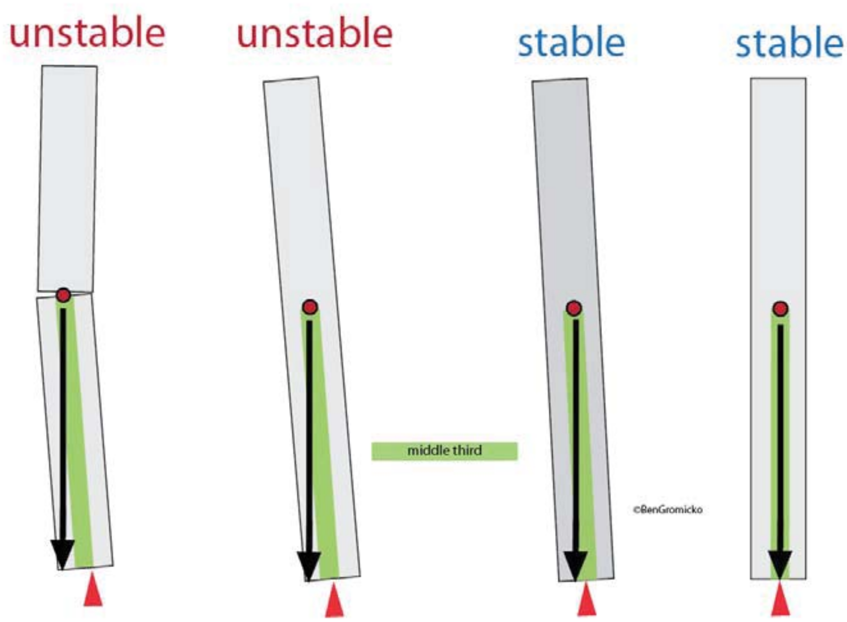
Asphalt surface. Sealing asphalt paving extends its life. Homeowners should seal coat their asphalt driveways every 3 to 5 years. Examine the paving to determine when sealing is needed. Check asphalt driveways for sunken areas that hold water. Low areas in asphalt paving can be brought to level with an asphalt repair.

Paving. Paving does not last forever. Brick or stone patio paving could be set on a concrete slab, in a mortar bed with mortar joints or in a sand bed that is laid on earth. Mortar joints can be tuck-pointed. Loose bricks or stones can be reset in a new mortar bed. Pavers set in sand can be taken up easily, sand added or removed, and the pavers replaced. The maintenance and repair of sidewalks, drive aprons and curbs at the street may be your responsibility or that of the local jurisdiction.

Exterior steps. Check the condition of exterior stairs and railings. Every once in a while, shake all railings vigorously to check their stability and inspect their fastenings. Every stair with more than three steps should have a handrail located 34 to 38 inches (865 to 965 mm) above the edges of the stair tread.

Stairs that are more than 30 inches (760 mm) above the adjacent grade and walks located more than 30 inches (760 mm) above the grade immediately below should have guards not less than 36 inches (915 mm) high and intermediate rails that will not allow the passage of a sphere 4 inches (100 mm) in diameter. Wooden steps should have proper support and strength and no rot or insect infestation should be allowed to develop. At steel stairs, look for the development of rust, weakened strength or poor attachment. Deteriorated stairs should be repaired or replaced. Stair treads should be as level as possible without holding water. Stair riser heights and tread depths should stay uniform.

Retaining walls. If possible, weep holes and related drains should be looked at following a heavy rain to make sure they are working properly. If they are not discharging



water, the drains should be cleaned out and observed again in the next rain. Retaining walls more than two feet in height should be backed with drainage material, such as gravel. There should be drains at the bottom of the drainage material. The drains should discharge water either at the end of the wall or through pipes. These drains and the drainage material behind the wall relieve the pressure of ground water on the wall. Failure to drain could be remedied by excavating behind the wall, replacing the drainage material and damaged drainage piping, and backfilling. In all but the driest climates, improper drainage of water from behind a retaining wall can cause the wall to fail.

Look for movement in your retaining walls. Bowing (vertical bulges), sweeping (horizontal bulges), and cracking in retaining walls can be caused by water pressure (or hydrostatic pressure). Bulging can also be a result of inadequate strength to resist the load of the earth behind the wall. Bowing and sweeping failures may be correctable if found early enough and if the cause is poor drainage.

There are other types of failures of retaining walls. Failure by over-turning (leaning from the top) or sliding may be caused by inadequate wall strength. In addition, water behind a wall can create moist bearing, especially in clay soils, and contribute to sliding. Retaining walls also fail due to settlement and heaving. Settlement occurs whenever filled earth below the wall compacts soon after the wall is built, or when wet earth caused by poor drainage dries out and soil consolidates. Poor drainage contributes to failure in cold climates by creating heaving from frozen ground. Both overturning and sliding may be stabilized and sometimes corrected if the amount of movement is not extreme. Settling may be corrected on small, low walls of concrete or masonry, and heaving may be controlled by proper drainage. Significant failure of any kind usually requires rebuilding or replacing all or part of a wall. Consult a qualified professional when major repairs or corrections are needed.

Buried oil tanks. A buried oil tank can be covered-up by heavy landscaping. Buried ferrous metal oil tanks are common on older properties that have the home or domestic water heated by oil. The presence of a buried oil tank usually can be determined by finding the fill and vent pipes that extend above ground. Abandoned and very old buried ferrous metal oil tanks are an **environmental hazard**. If you have a buried tank on the property the soil around it should be tested by a qualified environmental professional for the presence of oil seepage. If leaking has occurred, the tank and all contaminated soil around it must be removed. If leaking has not occurred, it may still be a potential problem. Even if a tank is empty, it still may have residual oil in the bottom that is a pollutant.

As with all underground items, a buried oil tank is not within the scope of a visual home inspection.

2.3 Other structures

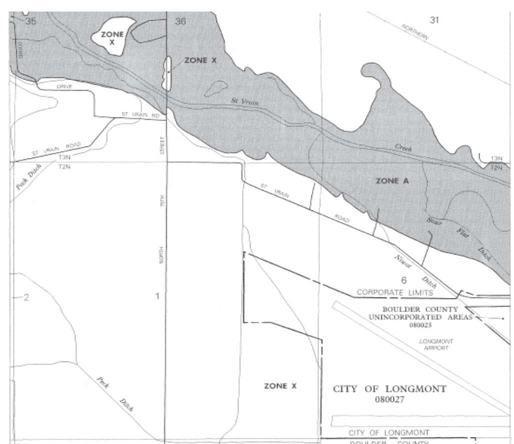
Keep detached garages, storage sheds and other outbuildings in good condition in the same way that your home is maintained. Monitor each outbuilding's water shedding capability and the adequacy of its foundations. Look for roof leaks from inside the buildings. Wood frame structures should be checked for rot and insect infestation. Check that doors and windows provide adequate weather protection and security for the buildings. Small outbuildings should have sufficient structural strength to sustain wind loads or seismic forces - this may be more than just a simple judgment call. If the site is in a hurricane or high-wind region, check all outbuildings for their ability to resist a storm without coming apart and becoming windborne debris. Consider consulting a qualified professional.

2.4 Yards and Courts

In urban areas, two or more dwelling units may share a yard or court to provide light and ventilation to interior rooms. The adequacy of the light provided to the interior rooms of the home may be a function of the dimensions of the yard or court. Check these characteristics, as well as zoning and building and housing code requirements pertaining to light, ventilation, and privacy screening for yards and courts. Such requirements may affect the reuse of the property and their implications should be understood before the property is altered.

2.5 Flood Zones

Check with local authorities to determine if your home is in a flood-risk zone. If it is, check with local building officials. Higher standards than those set by national agencies have been adopted by many communities.



The Federal Emergency Management Agency and the National Flood Insurance Program have established and defined five major flood-risk zones and created special flood resistance requirements for each. For a flood map visit http://www.msc.fema.gov/. Improperly designed grading and drainage may aggravate flood hazards to buildings and cause runoff, soil erosion and sedimentation in the zones of lower flood risk, the Interflood Zone and the Non-Regulated Flood Plain. In these locations, local agencies may regulate building elevations above street or sewer levels. In the next higher risk zones, the Special Flood Hazard Areas and the Non-Velocity Coastal Flood Areas (both Zone A), the elevation of the lowest floor and its structural members above the base flood elevation is required. In the zone of highest flood risk, the Coastal High Hazard Areas (Velocity Zone, Zone V), additional structural requirements apply.

2.6 Other Factors

The following are several factors about a home and its property that are often overlooked.

Slope. Look at the property around the house and the slope of the ground. If your house is on a ground slope of 20 degrees or more (in all seismic regions, including regions of low seismic activity), a structural engineer should be considered to further examine the building in relation to the slope.

Wind. Look for loose fences, tree limbs, landscaping materials such as gravel and small rocks, and other objects that could become windborne debris in a storm, if the building is in a hurricane or high wind region.

Floods. Check with local authorities. Major flood-risk zones have been established to define where floods occur and special flood resistance requirements have been created for each zone.

Lead. Consider checking for the presence of lead in the soil, which can be a hazard to children playing outdoors and can be brought indoors on shoes. Lead in soil can come from different sources such as discarded lead-based paint, lead-based paint chips at the perimeter of stone foundations where the paint is flaking and old trash sites where items containing lead were discarded. Consider having the soil and home tested for lead by a qualified professional inspector. For more information visit http://www.epa.gov/lead.

Wildfires. In locations where wildfires can occur, some jurisdictions have requirements for hydrant locations and restrictions on the use of certain building materials as well as restrictions on plantings close to a building. In the context of fire control, defensible space is the area around a structure that has been landscaped to reduce fire danger. Check with the local building official and the fire marshal for such requirements.

Construction Expansion. If a future construction project on the house includes expansion, an assessment of the site for this future work is critical. The use of the land around the existing house is likely restricted by coverage and set-back requirements, which define the areas of the property that can be used for future construction projects.

Site Restrictions. Homeowner association bylaws and deed covenants sometimes include requirements that can affect changes or additions to a building or out-building.

Accessibility. When universal design is a need, consult a code-certified professional inspector for detailed information about parking, walks, patios and egress.

2.7 Inspection Standards

The inspector is responsible for checking the roof gutters, downspouts and surface drainage, but is not responsible for inspecting any underground drainage pipes. The inspector is not required to inspect erosion control, earth stabilization measures, geological or soil conditions.

Chapter 3: Pitched Roof Coverings

Monitor roof covering, because any roof can leak. To monitor roofs that are inaccessible or that cannot be walked on safely, use binoculars. Look for deteriorating or loosening of flashing, signs of damage to the roof covering, and debris that can clog valleys and gutters.

Carefully watch the exterior walls and trim for deterioration developing beneath the eaves of pitched roofs that have no overhang or gutters.

Roofs are designed to be **water-resistant**. Roofs are not designed to be **waterproof**. Eventually the roof system will leak. No one can predict when, where or how a roof will leak.

Hail and wind damage. Hail and wind can cause significant damage to your asphalt shingle roof. After a storm, consider hiring a reputable roofing contractor or certified home inspector to evaluate the condition of your shingle roof. There's no need for you to risk your life doing something that an experienced professional does everyday. Hail and wind damage may likely be covered by your homeowner's insurance policy.

Thermography. An infrared camera can be used to detect areas of moisture at roof structures. Once located, these areas can be more thoroughly checked with a moisture-metering device. Such evaluations must be performed by an inspector who is trained in thermography and building science. Ask to see their certifications.

There are four general categories of pitched roof covering materials and their condition should be monitored as follows:

Asphalt shingles. Asphalt or "composition" shingles have a service life from 15 to 40 years depending upon the shingle quality, installation and maintenance. When they begin to lose their granular covering and start to curl they should be replaced. No more than two layers of asphalt shingles should normally be in place at any one time. If a second layer of asphalt shingles has been applied, check to see if all the flashing materials of the first layer were removed and replaced with new flashing at the second layer.

The roof slope. The slope (or pitch) of a roof is expressed as a ratio of the rise (vertical distance) over the run (horizontal distance). The run is usually expressed as 12, and a typical slope might be 4 in 12 or 6 in 12. A slope of 4 in 12 or steeper is referred to as normal. A slope of between 3 in 12 and 4 in 12 is referred to as low. A 45º roof slope would have a pitch in of 12 in 12. Typically asphalt shingle roofs should not be less than a 4 in 12 slope.

Underlayment. There should be underlayment installed. It should be at least a single layer of 15-pound (6.8 kg) asphalt saturated felt. Low-slope roofs should have at least two such felt layers. If ice dam flashing at overhanging eaves is needed or present, there should be additional measures taken and particular underlayment materials applied. The number of underlayment layers and the installation of underlayment are difficult to observe and would only need to be investigated if water intrusion occurs.

Wood shingles or shakes. This type of covering has a normal life expectancy of 20 to 30 years in climates that are not excessively hot and humid. Durability varies according to wood species, thickness, the slope of the roof, and whether shingles are made of heart-wood. Maintenance may include periodically treating the covering with preservative.

Shakes are hand-split on at least one face and either tapered or straight. Shingles are sawn and tapered. They should not be walked on. These materials are easily broken. The minimum slope for wood shingles is 3 in 12 and the minimum slope for shakes is 4 in 12. As wood shingles and shakes age, they dry, crack and curl. In damp locations they rot. When more than one-third shows signs of deterioration, consider replacing them.

Metal roofing. Metal can last 50 years or more if properly painted or otherwise maintained. Metal roofs may be made of galvanized iron or steel, aluminum, copper or lead. Each material has its own unique wearing characteristics.

Monitor metal roofs for the development of rusting or pitting, corrosion due to galvanic action, and loose, open, or leaking seams and joints. The types of metal, seams, and slope determine the construction details. There are three basic seam types— batten, standing, and flat—as well as flat and formed metal panels.

The slope of metal roofing can be from one-half inch per foot (1:24) to very steep. Snow guards on roofs with steeper slopes should be installed. In locations with heavy, long-lasting snow, bracket and pipe snow guards also may be necessary.

Low-slope metal roofs that are coated with tar-like material are probably patched or have pinholes and can NOT be counted on to be water-resistant and reliable.

Slate, clay tile, and asbestos cement shingles. These roof coverings are extremely durable and, if of high quality and properly maintained, may last the life of the structure. The minimum slope for roofs of these materials is 4 in 12. Slate shingles should be secured by copper nails except in the very driest of climates. Nail heads could be covered with sealant. Nails for tile roofs should be non-corroding.

All of these roof coverings are brittle materials, are easily broken and should not be walked on. Use binoculars to look for missing, broken or slipping pieces. Slate is particularly susceptible to breakage by ice or ice dams in the winter. You should have snow guards on steeper slopes, and in locations with heavy, long-lasting snow, snow guards also may be necessary. Moss will sometimes grow on asbestos cement shingles, but it can be removed with a cleaner to prevent capillary water leaks. Slate, clay tile, and asbestos shingles should be repaired or replaced by a qualified roofer.

3.1 Low-Slope Roof Coverings

A roof that is nearly level or slightly pitched is called a low-slope roof. No roof should be *actually* level and flat; it must have at least a *slight* slope to properly drain. Low-slope roofs can be expensive to repair, so care should be taken in their maintenance.

Regular maintenance and periodic inspections for low-slope roofs are necessary. Problems in low-slope roofs are common and more difficult to diagnose than pitched roof problems because the path of water leakage through flat roofs is often quite hard to trace.

Watch for signs of ponding water (or puddle formation) on the surface due to either improper drainage or sagging of the roof deck. If the cause is a sagging deck, it should be structurally corrected.

Monitor the flashing and joints around all roof penetrations, including drains, soil stacks, chimneys, skylights, hatchways, antenna mountings and other roof-mounted elements. Check to see if metal flashings need painting or re-anchoring and if asphalt or rubber flashings are brittle or cracked. Parapet wall caps and flashing may develop damage due to wall movement or moisture.

There are four categories of low-slope roof covering materials and they should be monitored as follows:

Built-up roofing. Built-up roofs are composed of several layers of roofing felt lapped, cemented together with bituminous material and protected by a thin layer of gravel or crushed stone. Built-up roofs vary greatly in life span but those used in residential buildings usually last about 20 years, depending on their quality, exposure, number of plies and the adequacy of their drainage. Because built-up roofs are composed of several layers, they can contain moisture in the form of water or water vapor between layers. Moisture not only accelerates deterioration, it can also leak into a building.

Regular maintenance and periodic inspections are necessary. Look for cracking, blistering, alligatoring and wrinkling, all of which may indicate the need for roof replacement or repair. Consult an experienced roofer or certified home inspector for a further evaluation if you have doubt about the roof's apparent condition.

Single-ply membrane roofing. A single-ply membrane roof consists of plastic, modified bitumen and synthetic rubber sheeting that is laid over the roof deck, usually in a single ply and often with a top coating to protect it from ultra-violet light degradation. Single-ply roofs are installed in three basic ways: fully adhered; mechanically attached and; loose laid with ballast. If properly installed and properly maintained, a single-ply roof should last 20 years.

Roof penetrations and seams are the most vulnerable parts of single-ply membrane roofing and should be carefully monitored. The material is also susceptible to ultraviolet light deterioration. A protective coating can be used to protect it, but the coating will need to be reapplied periodically. Check carefully for surface degradation on an unprotected roof and fading of the coating on a protected roof. Check also for signs of water ponding and poor drainage.

Roll roofing. Roll roofing should be inspecting before and after the winter season. Roll roofing consists of an asphalt-saturated, granule-covered roofing felt that is laid over the roof deck. Inspect roll roofing for cracking, blistering, surface erosion, and torn sections. Seams are the most vulnerable part of roll roofing, and should be carefully checked for separation and lifting. Also check for signs of water ponding and poor drainage.

3.2 Parapets and Gables

In seismic zones, check the bracing of masonry parapets and gables. Consider consulting a structural engineer to determine the need for additional bracing or strengthening.

3.3 Skylights

A leaking skylight is a common experience. From outside, watch the glazing for cracks or breaks, loosening of the flashing, and rusting or decaying frames. Skylights should be checked from the interior too. Don't be surprised if your skylight develops a leak.

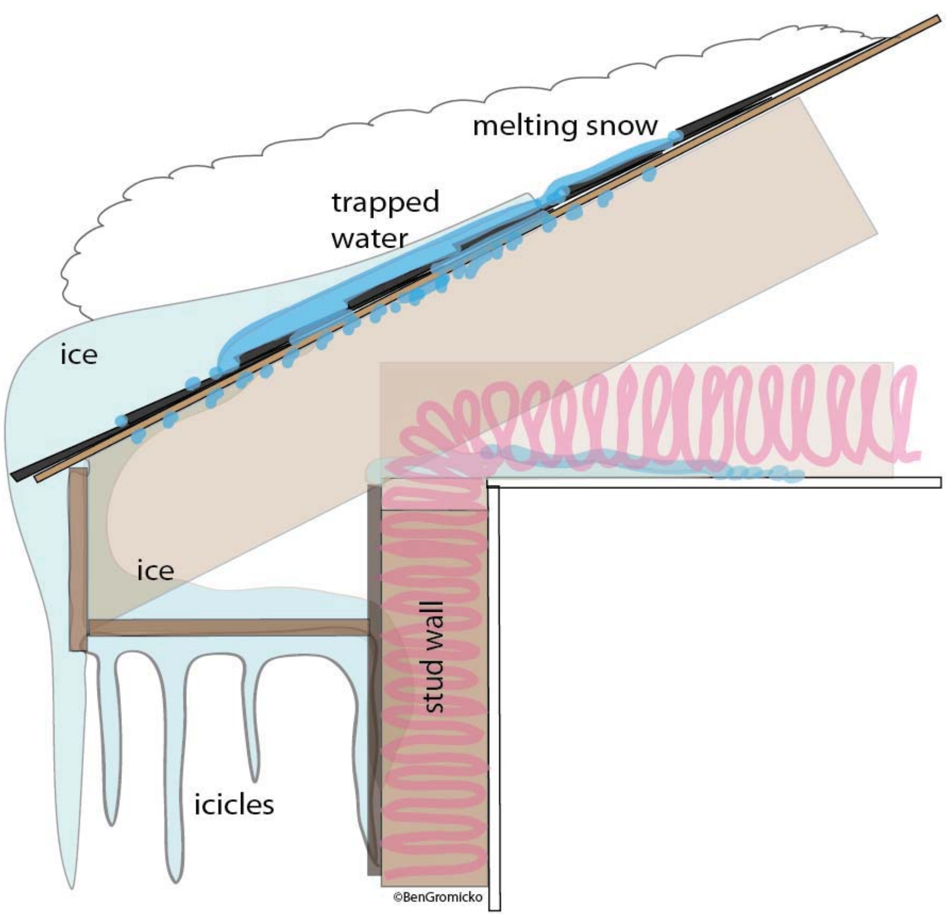
3.4 Gutters and Downspouts

All gutters need to be kept clean. They should slope uniformly, without sags, to downspouts. Gutter and downspout materials are usually galvanized steel, aluminum, copper or plastic.

Buildings with pitched roofs can have a variety of drainage systems. With a sufficient overhang, water can drain directly to the ground without being collected at the roof edge.

Drainage of low-slope roofs is accomplished in one of three ways: without gutters or downspouts; with gutters and downspouts; or by downspouts that go down through a building's interior. Drainage without gutters and downspouts can damage the exterior wall with overflow. If the roof has no gutters and downspouts or interior downspouts, carefully monitor the exterior walls for signs of water damage.

Most good, functional gutters have a minimum ratio of gutter depth to width of 3 to 4. The front edge is typically one-half inch (13 mm) lower than the back edge. Four inches is considered the minimum



width except on the roofs of canopies and small porches. If there is a screen or similar device to prevent anything but water from flowing into the gutter, its performance during a rainstorm should be checked to be sure water can actually enter the gutter. Check gutters without screens or similar devices to be sure that basket strainers are installed at each downspout.

Cleaning the gutters is a fun homeowner maintenance job.

Joints at the gutters should be soldered or sealed with mastic. Otherwise, they'll leak. The steeper your roof pitch, the lower the gutter should be placed or positioned. On roofs with lower slopes, gutters should be placed close to the roof's surface. Hangers should be placed no more than three feet apart. Where ice and snow are long lasting, hangers should be placed no more than 18 inches (460 mm) apart. The strength of a gutters fastening to the roof fascia or building exterior should be strong and secure. Rusted fasteners and missing hangers should be replaced.

Ice dams. Ice dams can form on pitched roof overhangs in cold climates subject to prolonged periods of freezing weather, especially those climates with a daily average January temperature of 30 ºF (-1 ºC) or less. Heat loss through the roof and heat from the sun (even in freezing temperatures) can cause snow on a roof to melt. As water runs down the roof onto the overhang, it freezes and forms an ice dam just above the gutter. The ice dam traps water from melting snow and forces it back under the shingles and into the building's interior.

Watch the edge of the roof overhang for evidence of ice dams and look at the eaves and soffit for evidence of deterioration and water damage. If the house has an attic, the underside of the roof deck at exterior walls can be checked for signs of water instrusion.

Downspouts. The rule of thumb for downspouts: at least one downspout for each 40 feet (12 m) of gutter. For roofs with gutters, make sure that downspouts discharge so water will drain away from the foundation. Downspouts can be checked for size. Seven square inches is generally the minimum except for small roofs or canopies. There should be attachments or straps at the top, at the bottom, and at each intermediate joint.

Downspout fasteners can rust, deform, fail or become loose. On buildings with multiple roofs, one roof sometimes drains to another roof. Where that happens, water should not be discharged directly onto roofing material. The best practice is to direct water from higher gutters to discharge into lower gutters through downspout pipes.

Occasionally, wooden gutters and downspouts are used, usually in older or historic residences. They may be built into roof eaves and concealed by roof fascias. Wooden gutters are especially susceptible to rot and deterioration and should be monitored.

Pitched roofs in older buildings may end at a parapet wall with a built-in gutter integrated with the roof flashing. At this location, drainage is accomplished by a scupper (a metal-lined opening through the parapet wall that discharges into a leader head box that in turn discharges to a downspout). The leader head box should have a strainer. Monitor the scupper for deterioration and open seams. All metal roof flashings, scuppers, leader head boxes and downspouts should be made of similar metals.

3.5 Inspection Standards

The inspector shall inspect the roof covering from the ground or eaves, vents, flashing, skylights, chimney and other roof penetrations. The inspector is not required to walk upon the roof, perform a water test or warrant the roof. Skylights are notorious for leaking water. Prediction of when, how or where a leak will develop is beyond the scope of a visual home inspection.

Chapter 4: Building Exterior

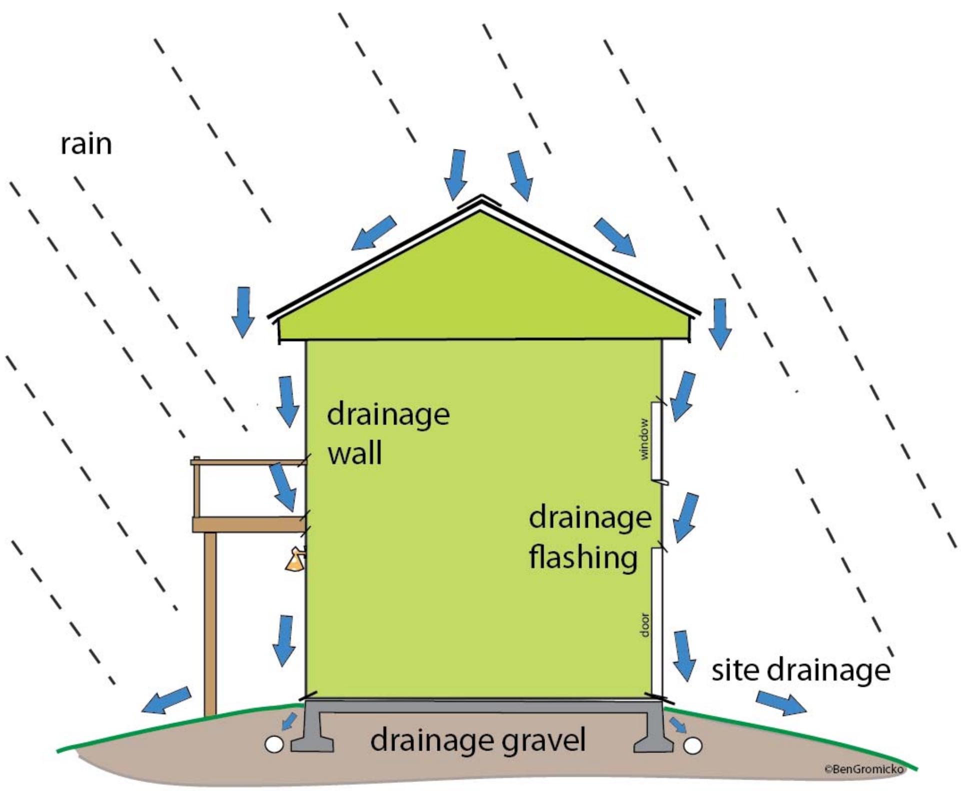
The exterior of your home is slowly deteriorating and aging. The sun, wind, rain and temperatures are constantly affecting it. Your job is to monitor the building's exterior for its **condition and weathertightness**. Check the condition of all exterior materials and look for developing patterns of damage or deterioration.

In hurricane regions, examine screen and jalousie enclosures, carports, awnings, canopies, porch roofs and roof overhangs to determine their condition and the stability of their fastenings. Then examine the following four critical areas of the exterior to determine their condition and strength: roofs; windows; doors; and garage doors.

In locations where wildfires can occur, some jurisdictions have restrictions on the use of flammable exterior materials. Check with the local building official or the fire marshal, or both, for detailed information.

4.1 Foundation Walls and Piers

It is easy to walk around the house and simply **check** the exterior of the foundation and



structural supports.

Foundation walls and piers in residential buildings are usually made of masonry and should be monitored for cracking, deterioration, moisture intrusion and structural adequacy.

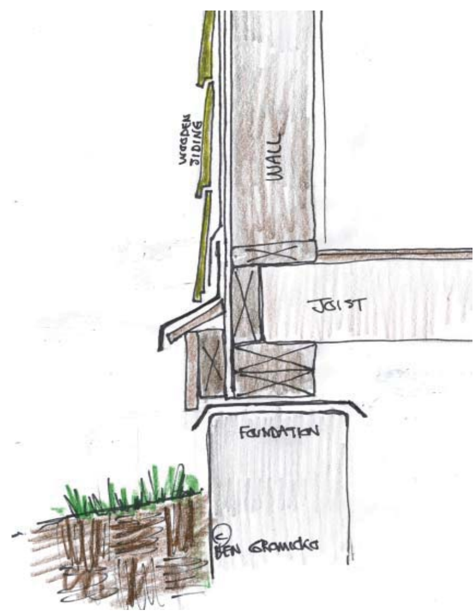
Be sure to hire a professional building inspector to properly monitor the structural integrity of your home, including wooden posts, wooden columns, concrete foundations, and concrete piers. Annual inspections are recommended. To find a certified inspector, visit www.inspectorseek.com.

4.2 Exterior Wall Covering

Exterior walls above the foundation may be covered with a variety of materials, including wood siding, aluminum, vinyl, wood or asbestos cement shingles, plywood, stucco, brick, or stone masonry or an exterior insulation and finish system.

Exterior wooden components.

Periodically look at all painted surfaces for peeling, blistering and checking. Paint-related problems may be due to vapor pressure beneath the paint, improper paint application or excessive paint build-up. Corrective measures for these problems could vary from the installation of moisture vents to complete paint removal. Mildew stains on painted surfaces do not hurt the wood and could be cleaned with a mildew remover. All wood elements should be checked for fungal and insect infestation at exposed horizontal surfaces and exterior corner joints.

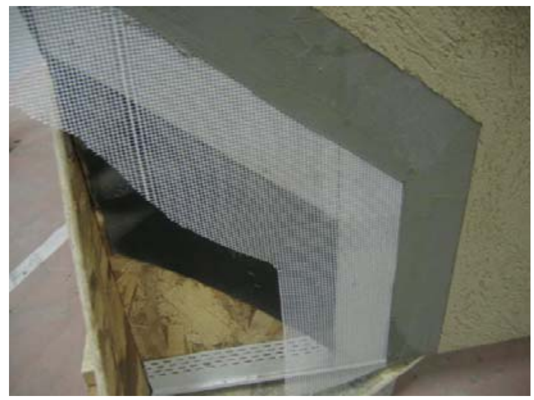


Clearance. Check the distance between the bottom of wood elements and grade. In locations that have little or no snow, the distance should be no less than eight inches. In locations with significant lasting snow, the bottom of wood elements should be no less than eight inches above the average snow depth. Do not pile up against the house wall landscaping materials such as wood chips and mulch.

Aluminum and vinyl siding. Aluminum and vinyl siding are low maintenance materials. When you are outside, you can easily look around and check the siding. Check for loose, bent, cracked or broken pieces. Seasonally, inspect all caulked joints, particularly around window and door trim. Go to Chapter 11 for seasonal checklists. Many communities require aluminum siding to be electrically grounded; confirm for such grounding.

Asbestos cement shingles. Asbestos is a hazardous material. They do not allow asbestos to be used in building materials anymore. Do no cut or sand asbestos siding. Dust containing asbestos fibers can be inhaled. Asbestos siding can be replaced with modern (safe) siding pieces. Asbestos siding can be completely removed or covered over. Read Chapter 5.12 for more information about asbestos.

Like aluminum and vinyl siding, asbestos cement shingles may cover decayed or insect-infested wood. Check for loose, cracked or broken pieces. Check around all window and door trim for signs of deterioration.



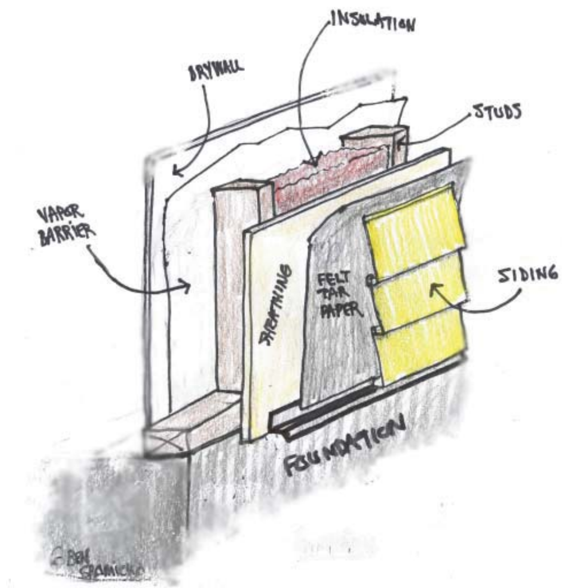
Stucco. Check stucco for cracks, crumbling sections and areas for potential water intrusion. Old and weathered cracks may be caused by the material's initial shrinkage or by earlier building settlement. New, sharp cracks may indicate movement behind the walls that should be investigated by a qualified professional. Stucco can be cleaned. It can also be painted.

Brick or stone veneers. Inspect veneers for cracking, mortar deterioration and spalling. Refer to Sections 6.3 and 6.5 for monitoring the condition of above-ground masonry walls.

EIFS. Exterior insulation and finish systems. EIFS has been in widespread residential use since the early 1990s. It generally consists of the following product layers (moving outward): insulation board, mesh and base coat layer, finish coat, and sealant and flashing. EIFS was originally designed as a non-draining water and moisture barrier system. A drainage-type EIFS that allows water and moisture to penetrate the surface and then drain away has been developed more recently. Most existing EIFS in residential applications is installed over wood framing and is of the non-draining type. Water leakage and consequent rotting of the wood framing have become serious problems in many installations, especially at wall openings such as windows and doors, where inadequate flashing details can allow water seepage into the wall interior. Manufacturers of EIFS differ in their installation methods.

Inspecting existing EIFS is difficult because it is a proprietary product and there are no standard construction details that everyone agrees with. Consult a trained stucco inspector to check for concealed water/moisture intrusion and damage.

Insulation. Exterior walls of older homes may contain little or no thermal insulation. Examine behind the siding when possible to determine the presence of insulation, if any, and assess the potential for insulating the exterior walls. Consider hiring a professional home inspector who is certified in **thermal imaging** and building evaluations. http://www.infrared-certified.com/



Moisture. Check for signs of moisture problems. Where mildew and mold are evident on exterior cladding or where interior walls are damp, there is the possibility that condensation is occurring in the walls. Moisture problems generally occur in cold weather when outside temperatures and vapor pressures are low and there are a number of water vapor sources within the building. The presence of moisture may be a result of an improperly installed or failed vapor barrier, or no vapor barrier at all. If condensation is suspected, an analysis of the wall section in question should be made. This analysis will provide the information necessary to make the needed repairs.

4.3 Windows and Doors

Windows and doors are the most complex elements of your home's exterior and require monitoring.

Exterior doors. Exterior doors should be checked often for their condition, operation, and functionality of their hardware. Door types include hinged, single and double doors of wood, steel, aluminum, and plastic with and without glazing. Monitor wood and plastic doors that are not protected from the weather. These doors should be rated for exterior use. In warm climates, jalousie doors may also be in use. Make sure the louvers close tightly for weathertightness. Some buildings use glass framed doors of fixed and operable panels that have wood, vinyl-covered wood, and aluminum frames. Check the track of these sliding doors for dents, breaks and straightness.

Doors also should be monitored for the exterior condition of their frames and sills. Check doors that are not protected from the weather for the presence of essential flashing at the head. Over time, the interior condition and hardware of exterior doors can wear out or fail. In hurricane regions, exterior doors, and especially double doors, should have dead-bolt locks with a throw length of no less than one inch.

Windows. Window frames, sills and sashes should be monitored. The interior condition and hardware of windows will change over time. In general, there are eight types of windows and six types of frame material in use in residential buildings. Frame materials are plastic, aluminum, steel, wood, plastic-clad wood and metal-clad (steel or aluminum) wood. Window types are double hung, single hung, casement, horizontal sliding, projected out or awning, projected in, and fixed. In addition to these, there are jalousies, which are glass louvers on an aluminum or steel frame.

At older sashes, the glazing compound or putty around glass panels should be monitored carefully since this is a vulnerable part of the window and its repair is time consuming.

Examine glazing tapes or strips around glass panels in steel or aluminum sashes for signs of deterioration such as hardened sealant. Check metal sashes for weep holes that have been blocked by paint, sealant or dirt. Weep holes are usually easy to clean. In hurricane regions, check all windows and glass doors that are not protected by shutters to determine if they have been tested for impact resistance to windborne debris. If they have not been so tested, determine if plywood panels can be installed for their protection at the time of a hurricane warning.

Storm windows and doors should be monitored for operation, weathertightness, overall condition and fit. Check and see if paint, sealant, dirt, or other substances have blocked any weep holes. Opening weep holes is usually easy to do. Blocked weep holes could cause wood rot and water intrusion at the window sill.

Weather-stripping. Window and door weather stripping is generally of three types: metal; foam plastic or; plastic stripping. Each type should have a good fit. Check the metal for dents, bends and straightness. Check foam plastic for resiliency and plastic stripping for brittleness and cracks. Make sure the weather stripping is securely held in place.

Shutters. Periodically check the shutters' operation and observe their condition and fit, and confirm the adequacy of the shutters for their purpose: privacy; light control; security or; protection against bad weather. Window shutters are generally of two types: decorative and functional. Decorative shutters are fixed to the exterior wall on either side of a window. Check the shutter's condition for change and pay attention to its mounting to the wall. Functional shutters are operable and can be used to close off a window.

Shutters close to the ground can be examined from the ground. Shutters out of reach from the ground should be examined from inside the house. In hurricane regions, check shutters to see if the shutter manufacturer has certified them for hurricane use. If they provide protection to windows and glass doors, determine if they have been tested for impact resistance to windborne debris.

Awnings. Monitor the condition of your awnings. The attachment to the exterior wall can become loose. Often times an attachment device in the mortar joint of a brick wall can be easily pulled or slid outward. Windows and glazed exterior doors sometimes have awnings over them, usually for sun control, but sometimes for decoration or protection from the weather. Awnings are usually made of metal, plastic, or fabric on a metal or plastic frame. Some are fixed in place, while others are operable and can be folded up against the exterior wall. If an awning can be used for sun control, its effect on energy conservation is typically a personal judgment.

Garage doors. Garage doors should be monitored for operation, weathertightness, overall condition and fit. Garage doors are made of wood, hardboard on a wood frame, steel, glass fiber on a steel frame, fiberglass, and aluminum. Garage doors can come with glazed panes in a wide variety of styles. Wood and hardboard can rot, hardboard can crack and split, steel can rust, fiberglass can deteriorate from ultraviolet light, and aluminum can dent.

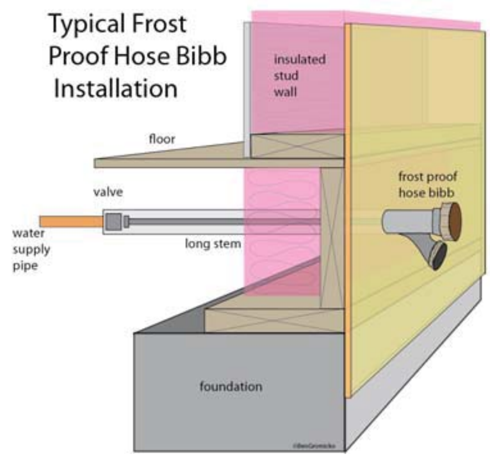
Doors with motors should be periodically tested using each of the operators on the system (key lock switch or combination lock key pad where control must be accessible on the exterior, remote electrical switch, radio signal switch, or photoelectric control switch). Check the operation for smoothness, quietness, time of operation and safety. Check for the presence and proper operation of the door safety-reversing device. Look at the exposed parts of the installation for loose connections, rust, and bent or damaged pieces. In hurricane regions, make sure the garage door, especially single doors on two-car garages, assembly (door and track) has been tested for hurricane wind loads or has been reinforced.

4.4 Decks, Water, and GFCIs

Decks, porches, and balconies are exposed to the outside elements more than most other parts of a building and therefore are more prone to deterioration.

Monitor the following:

Condition. Examine all porch, deck and balcony supports for components becoming loose or deteriorated. Masonry or concrete piers should remain plumb and stable. Structural connections to the building should remain secure and protected against corrosion or decay. Watch for signs of deflection and deterioration at porch or deck floors. Where the porch floor or deck is close to the level of the interior floor, watch for signs of water infiltration at the doorsill. There should be a sufficient pitch of the porch floor or deck to direct water away from the exterior wall.



Exterior water. Exterior hose spigots should be frost-proof. You can't see the frost-proof feature from outside. Unlike a traditional hose bib where the valve stem is an inch or two in length, the valve stem for a frost-proof hose bibb (or sillcock) could be 6 to 30 inches long. Thus, the valve is well within the exterior wall and protected from the cold and freezing.

GFCI. All exterior electric receptacles should have GFCI protection. See Section 8.2.

4.5 Masonry and Metal Chimneys

Chimneys should project at least two feet above the highest part of a pitched roof and anything else that is within 10 feet (3 m). A chimney should project at least three feet from its penetration from the roof (required minimum heights may vary slightly). Flues should not be smaller in size than the discharge of the appliance they serve.

Unlined chimneys are hazardous, and they should be further evaluated by a chimney sweep.

Flues should extend a minimum of four inches above the top of a masonry chimney.

Masonry chimneys without hoods should have stone or reinforced concrete caps at the top. Some masonry chimneys have hoods over the flues. Hoods on masonry chimneys consist of stone or reinforced concrete caps supported on short masonry columns at the perimeter of chimney tops, or sheet metal caps supported on short sheet metal columns.

If a cement wash or crown on top of the chimney is not properly sloped or is extensively cracked, spalled, or displays rust stains, it should be replaced. Reinforced concrete caps and stone caps with minor shallow spalling and cracking should be repaired. Those with extensive spalling or cracking should be replaced. Sheet metal hood caps with minor rust or corrosion should be repaired, but if rust or corrosion is extensive, replacement is needed.

Metal spark screens are sometimes used on wood and coal-burning fireplace chimneys. Keep the condition and fit of spark screens good. Dirty or clogged screens adversely affect draft and could be a fire hazard.

Where a masonry chimney is located on the side of a pitched roof, a cricket is needed on the higher side to divert water around the chimney. The cricket should extend the full width of the chimney.

In seismic zones, there should be bracing of masonry chimneys from the top of the firebox to the cap, and particularly the portion projecting above the roof.

Pre-fab metal chimney. If the chimney is a prefabricated one, encased in an exterior chase, the chase top should properly interlocked with the metal chimney's counter-flashing so that the assembly is watertight. The chimney top should drain off water. There should be a rain cap on the top.

If the chimney is prefabricated metal and not encased, the adjustable flashing at the roof should be tightly sealed to the chimney, preferably with counter-flashing, and there should be a cap installed.

4.6 Lightning Protection

Lightning is a problem in some locations. You may want lightning protection for you home.

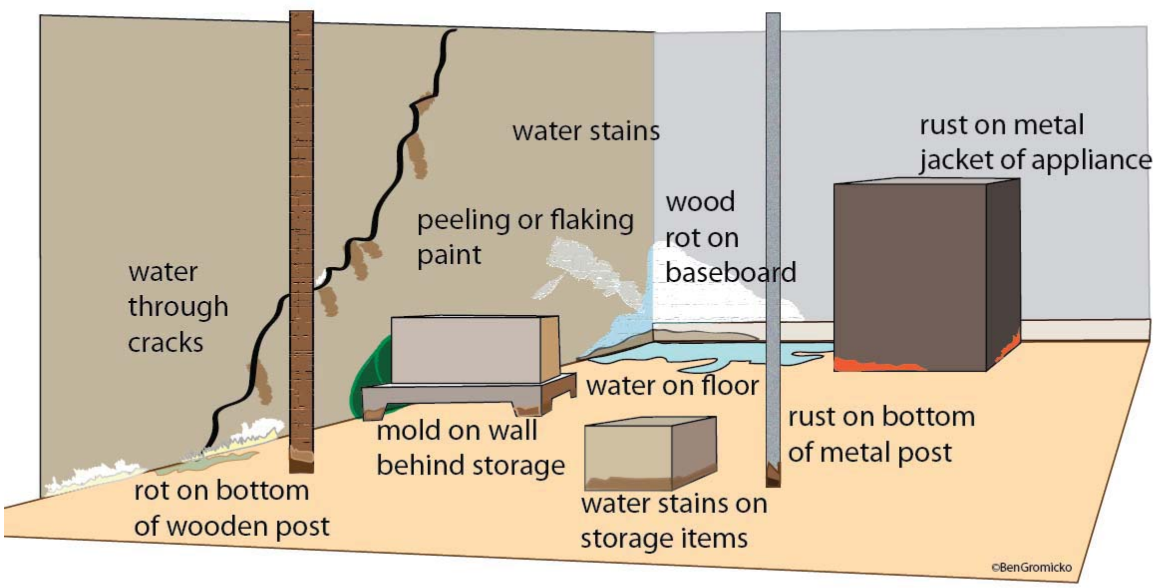
A lightning protection system consists of lightning rods located on the roof and on projections, such as chimneys; main conductors that connect the lightning rods together and connect them with a grounding system; bonds to metal roof structures and equipment; arresters to prevent power line surge damage; and ground terminals, usually rods or plates driven or buried in the earth. An electrician can install lightning surge protectors at the main electrical panelboard.

4.7 Inspection Standards

The inspector shall inspect the siding, doors, decks, and steps. The inspection should include a representative number of windows (not all). The inspector is not required to inspect exterior components that are not visible or readily accessible from the ground. Interior chimney flues are beyond the scope of a home inspection. If your house has a stucco exterior covering, consider having the system inspected by a certified stucco inspector.

Chapter 5: Building Interior

The most common problem that homeowners experience is water intrusion (in the form of outside water penetration or plumbing leaks). Inside the house, always look for signs of water intrusion or material deterioration that may indicate underlying problems in the structural, electrical, plumbing or HVAC systems. Consider hiring a home inspector who is trained in the application of infrared thermography, because thermal imaging is an excellent tool to use in the search for water intrusion problems.



5.1 Basement or Crawl Space

The basement or crawl space is often the most revealing area in the building and usually provides a general picture of how the entire building works. In most cases, the structure is exposed overhead, as are the HVAC distribution system, plumbing supply and DWV lines and the electrical branch circuit wiring.

Moisture intrusion. One of the most common problems in small residential structures is a wet basement. You will want to monitor walls and floors for signs of water penetration such as dampness, water stains, peeling paint, efflorescence and rust on exposed metal parts. In finished basements, look for rotted or warped wood paneling and doors, loose floor tiles and mildew stains. It may come through the walls or cracks in the floor, or from backed-up floor drains, leaky plumbing lines or a clogged air conditioner condensate line.

To properly correct a moisture problem, you must determine the source of the moisture. There's no point in cleaning or wiping-up a problem without investigating the source of the problem.

If moisture appears to be coming through the walls, check the roof drainage system and grading around the exterior of the building (the problem could be **as simple as a clogged gutter**). Check the sump pump, if there is one, to be sure its discharge is not draining back into the basement. Look for unprotected or poorly drained window wells, leaking exterior faucets, and signs of leakage in the water supply line near the building. Check the elevation of an earthen floor in a crawl space. If the water table is high or the drainage outside the building is poor, the crawl space floor should not be below the elevation of the exterior grade.

If the basement or crawl space is merely damp or humid, the cause simply may be lack of adequate ventilation. The ventilation could be checked by measurement and calculation, comparing the free area of vents with the floor area of the crawl space. The free vent area to crawl space area ratio should be 1 to 150 in a crawl space with an earthen floor and 1 to 1,500 in a crawl space with a vapor barrier over the earthen floor. If the calculated ratio is less, consider adding ventilation, particularly in hot and humid climates, and especially if moisture is present. Check the location of the vents through the foundation or exterior wall. There should be one vent near every corner of the crawl space to promote complete air movement. The vents should have screens with corrosion resistant mesh.

Fungal and insect infestation. Always keep an eye-out for signs of fungal growth, particularly in unventilated crawl spaces. Consider hiring a professional inspector to annually check all foundation walls, piers, columns, joists, beams and sill plates for signs of termites and other wood inhabiting insects.

Thermal insulation. If you have access to the space above unheated basements and crawlspaces, examine the amount and type of insulating material there is, if any. Determine the amount of insulation that is recommended for the space and whether additional insulation can or should be added. Check for adequate vapor barriers. If you live in a cold climate, the vapor barriers should be installed on the warm interior-side of the wall. If you live in a warm climate, the vapor barrier should be installed on the exterior-side of the wall.

5.2 Interior Spaces

Monitor the following components and conditions of the home's interior spaces:

Walls and ceilings. Check the general condition of all surfaces and **don't fret over cosmetic imperfections**. Be aware of the signs of water intrusion into the building (including exterior water penetration and interior plumbing leakage.) Look for cracks and peeling paint or wallpaper. Look for sags and bulges in plaster or drywall. Gently tap and push on areas of plaster; if an area sounds hollow or feels flexible, it is a good indication that the plaster has separated from its backing. If such areas are found, it may be best to replaster or overlay the wall or ceiling with wallboard.

Wall and ceiling cracks are usually caused by building settlement, deflection, warping of wood structural elements, or small seasonal movements of building components due to temperature and humidity variations. **Seasonal** movements will make some cracks regularly open and close; these may be filled with a flexible, paintable sealant, but otherwise cannot be effectively repaired. Cracks due to settlement, deflection or warping can be repaired if movement has stopped, as is often the case.

Large wall and ceiling cracks may indicate structural problems. See Sections 6.3 through 6.5 for cracks associated with masonry wall problems and Section 6.7 for cracks associated with structural wood framing problems.

Nail pops. Homeowners often find nail popping, joint cracks, and other signs of minor cosmetic issues, such as rust stains at fasteners and corner beads.

You can check paneled walls by pushing or tapping on the paneling to determine if it is securely attached or has become loose in some way. Veneers can become delaminated. If the paneling is obviously not original to the house, try to look behind it to see what problems may be covered up.

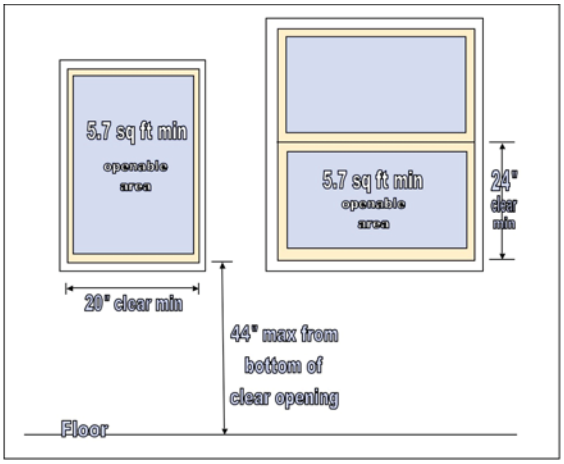
Homeowners should lift suspended ceiling panels and look above them. Check the condition of the original ceiling, if any. Tiled ceilings should be examined similarly. On top floors, inspect for ceiling penetrations that may form thermal bypasses to the unconditioned spaces above.

Interior doors. Monitor the condition of doors and door frames including the interior of entrance doors and storm doors. Check hardware for finish, wear, and proper functioning. Binding doors or out-of-square frames may indicate building settlement.

Windows. Look at the window sash and frames for damage and deterioration. Check for a good fit and apparent weathertightness. When casement windows are open, they are easily damaged by wind, and hinge damage may keep them from closing properly. Casement operating hardware should operate smoothly and easily. Older double hung windows may have old sash cords and weights that may break over time. Every once and a while, open windows above the ground floor and check their exterior surfaces, frames, sills, awnings and shutters, if any.

Safety glass. There are many areas in a house that require safety glass. These areas are hazardous because of their frequent impact by the building occupants. Glazing located in doors is of particular concern because of the increased probability of accidental impact while operating the doors. A person may often push against the glazed portion of a door in order to operate it. A large piece of glass located along a travel path where no barrier is provided is a dangerous area. If the glass is safety glass then it will have a permanent label on it located in a corner of the glass.

Ventilation. Habitable rooms should be provided with operable windows. Their required opening size is a percentage of the floor area, usually four percent. A mechanical ventilation system can be provided in lieu of this requirement.



Egress. Basements and every sleeping room should have at least one operable emergency escape and rescue opening that opens directly into a public street, public alley, yard, or court. Where basements have one or more sleeping rooms and emergency egress and rescue opening should be installed for each sleeping room, but is not required in adjoining areas of the basement.

The sill height of the emergency escape and rescue opening should not be more than 44 inches above the floor.

Because many deaths and injuries are caused by occupants being asleep at the time of a fire, the standard requires that basements and all sleeping rooms have doors or windows that can be used for rescue or escape in an emergency. During a fire, the normal means of escape will mostly likely be blocked.

If the emergency escape and rescue opening has a sill height below ground level, a window well should be provided. The window well should have a horizontal area of at least 9 square feet, with a minimum horizontal projection and width of 36 inches (with the exception of a ladder encroachment into the required dimension).

If an emergency escape window is located under a porch or deck, the porch or deck should allow the window to be fully opened and the escape path should be at least 3 feet in height.

Closets. Closets should have a clear depth of at least 24 inches (610 mm). Watch out for an improperly installed light fixture. A closet needs a proper type and location of a light fixture. A light positioned close to a shelf presents a hazardous condition.

Electrical outlets and lighting. Generally speaking, each wall should have at least one wall outlet and each room should have one switch-operated outlet or over-head light. When operating light switches, look for dimmed or flickering lights that may indicate electrical problems somewhere in the circuit. Also check the light switches for sparks (arcing) when switches are turned on and off. Feel the light switches for overheating. Switches that are worn should be replaced. When a light will not turn on, even after the bulb has been replaced, it will likely be the result of a bad switch.

HVAC source. For every room in the house, there should be a heating, cooling or ventilating source. If there is a warm air supply register but no return, make sure doors are undercut one inch (25 mm) for airflow.

Skylights. Monitor the undersides of all skylights for signs of leakage and water damage. Skylights are notorious for leaking water and causing water stains and damage.

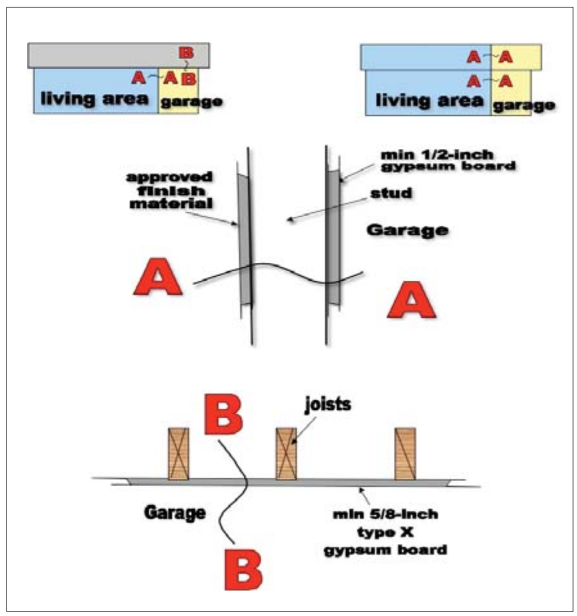
Firewall. It is common for a fire to start in an attached garage. The fire may grow unnoticed by the occupants and become a significant hazard. Therefore, a minimum amount of fire protection is needed.

The door construction and fire-rating of the door is important to know. The door between an attached garage and a dwelling unit should be a solid wood door not less than 1 and 3/8 inches in thickness, a solid or honeycomb core steel door not less than 1 and 3/8 inches in thickness or a 20-minute fire-rated door. In many jurisdictions a self-closing device on the door may be required. The entire door assembly may have to be fire-rated.

A direct opening between an attached garage and a sleeping room is not permitted. That opening would be hazardous.

There should be at least 1/2-inch drywall (gypsum board) applied on the garage-side to separate the garage from the residence and its attic space. Garages located below a habitable room shall be separated by at least 5/8-inch Type X drywall (gypsum board) or equivalent.

This standard requires a minimum level of fire protection from the garage to the dwelling unit. It allows the occupants time to escape. The separation also restricts the spread of fire from the garage to the dwelling unit until the fire can be controlled and extinguished.



5.3 Bathrooms

Plumbing. Obviously, you always want to check for water drips or leaks. Check operation of the lavatory, toilet, tub and shower. A common problem in

bathrooms is water leakage around tubs and showers.

It is a good idea to look up and check the ceiling below each bathroom for signs of water or to catch the development of a major water leak.

If the toilet is not a water-saving fixture, consider replacing it with a water-saving toilet that has a 1.6 gallon (6 L) flushing capacity. Pressure assisted toilets use water pressure to compress air in a tank that makes the 1.5 to 1.6 gallon (5.7 to 6 L) flush very effective in cleaning the fixture bowl and preventing buildup in the soil pipe.

Check the water traps for drips. Older metal (soft brass with chrome coating) trap pipes deteriorate and weaken over time.

Check the toilet for wobbling. If the toilet becomes loose and starts to wobble, a new wax seal may be needed.

A faulty shower pan may go undetected for decades until a major water leak develops. Monitor for signs of water leakage on the ceiling below all showers.

Electrical. Wherever possible, switches and outlets should not be within arm's reach of the tub or shower. Ground fault circuit interrupters (GFCIs) should be installed in the bathroom electrical outlets. The GFCIs should be tested every month.

Tub and shower. Monitor the tub and shower enclosures. The glass or glazing should be safety glazing.

Ceramic tile. Push and pound on the tiles with your hand and check for loose tiles. Pull on the soap dish. Nothing should be loose or wiggly. Periodically watch for tiles that become damaged or loose, or tiles that become scratched, pitted or dulled by improper cleaning.

Monitor the condition of all grouted and caulked joints. If a portion of the tile is defective or missing, the tile may need to be replaced. Open cracks in the tile grout may allow water to penetrate behind the tile and cause damage.

Plumbing access panels. Open up the plumbing access panels every once in a while and check for water problems developing.

Ventilation. The bathroom should be ventilated by either a window or an exhaust fan. Poor ventilation will cause mildew on the ceiling and walls. If there is an exhaust fan, it should be properly ducted to exhaust to the outside.

5.4 Kitchens

Plumbing. All by themselves, plumbing connections could develop leaks. Look often for water drips and leaks in both the supply and drainage lines. When operating the disposal and dishwasher listen and watch for smooth operation.

Counters and cabinets. Over time cabinet doors and drawers can lose their smooth operation, and wall cabinets may become insecurely attached to the wall or other cabinets.

Electrical. All kitchen counter receptacles should be protected by ground fault interrupters (GFCI). See Chapter 8.2 on GFCIs. Separate circuits should be installed for each major appliance as follows: Refrigerator 20 amp/120 volt; Dishwasher 20 amp/120 volt; Garbage 20 amp/120 volt disposal; Range 40 to 50 amp/240 volt.

All electrical appliances should be able to operate simultaneously, including exhaust fans, and run steadily without over-loading their circuits.

Ventilation. The kitchen exhaust fans and range hoods should be ducted to the outside and not to a cupboard, attic, crawl space or wall. A recirculation range hood fan is acceptable. Maintain and clean the filters. Ducts, hoods and filters should be free of grease buildup.

5.5 Storage Spaces

All closets and other storage spaces should be properly lit, ventilated and kept clean to prevent vermin infestation.

5.6 Stairs and Hallways

Light. All interior and exterior stairways should have a means to illuminate the stairs, including landings and treads. Interior stairways should have a light located at each landing, except when a light is installed directly over each stairway section. Public stair and hallway lights in multifamily buildings should be operated from centralized house controls.

Smoke detectors. Periodically check the operation of all smoke detectors by activating them with a smoke source or by pushing their test buttons. Stairs and hallways are the appropriate location for smoke detectors. Detectors should be located on or near the ceiling, near the heads of stairs, and away from the corners.

Current standards require a smoke detector in each sleeping room and in a hallway adjacent to the sleeping rooms.

Structural integrity of stairs. All stairs must be kept structurally sound. Examine basement stairs where they meet the floor and where they are attached to the floor joists above.

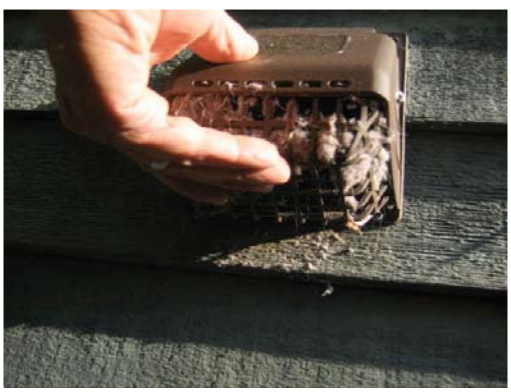
Stair handrails and guardrails. You can check a railing's stability and their fastenings by shaking them vigorously. Handrails are normally required to be 34 to 38 inches (865 to 965 mm) above the stair nosing on at least one side of all stairs with three or more risers. Guardrails are required on open sides of stairways and should have intermediate rails that will not allow the passage of a sphere 4 inches (100 mm) in diameter.

Stair treads and risers. All treads should be level and secure. Riser heights and tread depths should be, respectively, as uniform as possible. As a guide, stairs in new residential buildings must have a maximum riser of 7-3/4 inches (197 mm) and a minimum tread of 10 inches (254 mm).

Stair width and clearance. Stairs should normally have a minimum headroom of 6’-8" (2030 mm) and width of 3’-0" (915 mm).

5.7 Laundries and Utility Rooms

Laundry room. Watch for leaks or kinks developing at plumbing connections to the washer. Protect the electrical or natural gas connections to the dryer. Inspect dryer venting and make sure it exhausts to the outside and is not clogged or restricted. Gas dryer vents that pass through walls or combustible materials must be metal.



Clothes dryer exhaust. Clothes dryer exhausts pose a different problem than other exhaust systems because of the air being moist and carrying lint. The exhaust of a dryer must vent outside and not discharge into an attic or crawlspace because the wooden structural members could be affected. Exhaust vents should have a backdraft damper installed to prevent cold air, rain, snow, rodents and vermin from entering the vent.

The length of a clothes dryer exhaust ensures that the dryer exhaust blower will be able to push sufficient air volume to take away the moist air and lint. The length can be increased only when the make and model of the dryer is known, or when an approved blower fan calculation is provided.

The **maximum length** of a clothes dryer exhaust duct should not be greater than 25 feet from the dryer location to the wall or roof termination. For each 45-degree bend, the maximum length of the duct is reduced by 2 and 1/2 feet. For each 90-degree bend, the maximum is reduced by 5 feet.

The maximum length of the exhaust duct does not include the transition duct.

Screens are not permitted on the clothes dryer exhaust vent.

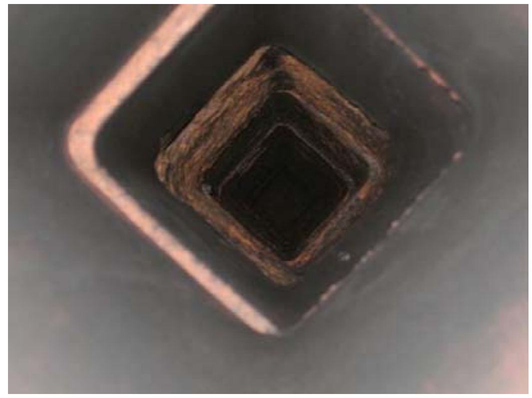
Furnace room. Rooms containing fuel-burning equipment should not be located off a sleeping room in a single-family residence and must be in a publicly accessible area in a multifamily building. Check local code requirements for applicable fire safety and combustion air criteria.

5.8 Fireplaces and Flues

Fireplaces. Each fireplace and flue in a house should be inspected by a certified chimney sweep every year. To find a sweep visit http://www.csia.org/.

Every time prior to starting a fire, check the firebox for deterioration or damage. If there is a damper, check its operation. **Make sure you open the damper prior to starting a fire!** If smoke starts to billow out from the fireplace, the damper is closed or there is a major blockage in the flue.

Hearth. The hearth should be of adequate size to protect adjacent combustible building materials. A minimum for older fireplaces is to have a depth from the face of the fireplace of 20 inches (510 mm) and a width that extends one foot (305 mm) beyond the fireplace opening on either side.



Flues. The flue lining in a masonry chimney should be inspected by a professional every year. It could be checked by your HVAC technician or a certified chimney sweep. The flue should be tight along its entire length. Linings should be intact, unobstructed and appropriate for the fuel type. An obstructed flue can usually be opened by a chimney sweep, but consult a chimney expert if the integrity of the flue is in doubt. Unlined chimneys should be updated with the installation of metal liners.

Smoke pipe connections. Every once and a while, check that the smoke pipes from furnaces, water heaters, stoves, and related devices are tightly connected to the chimney.

Ash dump and pit. If the fireplace has an ash dump at the bottom of the firebox, check the operation, fit and condition of the door and check the shaft to the ash pit to be certain it is unobstructed and not overflowing with ashes. If the chimney has an ash pit, check the operation, fit and condition of the pit access door. The fit should be tight enough to prevent dust and ash from escaping. **Cleaning the ashes** is part of regular maintenance of the fireplace.

5.9 Attics, Roof Trusses and Vents

An attic is defined here as an unconditioned space between the roof and the ceiling or walls of the building's inhabited rooms. In small residential buildings with pitched roofs, attics are usually partially or fully accessible. In buildings with low-slope roofs, they may be inaccessible or virtually nonexistent.

Roof leaks. Monitor and look for signs of water leakage from the roof above and try to locate the source of leakage. This may be difficult to do beneath built-up roofs or beneath loosely laid and mechanically fastened single-ply roofs, since water may travel horizontally between layers of roofing materials.

Attic ventilation. Signs of inadequate ventilation are rusting nails (in roof sheathing, soffits, and drywall ceilings), wet or rotted roof sheathing, and excessive heat buildup in attics. Adequate attic ventilation can be measured by calculating the ratio of the free area of all vents to the floor area. Free area of vents is their clear, open area. If a vent has an insect screen, its free area is reduced by half. The vent free area to floor area ratio should be 1 to 150. If the calculated ratio is less, consider adding ventilation, especially in hot and humid climates.

When an attic also contains an occupied space, check that the ventilation from the unconditioned, unoccupied areas at the eaves is continuous to the gable or ridge vents. Also check that the free area of eave vents is approximately equal to the free area of ridge or gable vents. If ventilation appears to be inadequate and additional vents cannot be added economically, consider adding mechanical ventilation.

Rafter space ventilation. Most buildings with low-slope roofs and some buildings with pitched roofs do not have attics. Instead, these buildings have ceilings at the bottom of joists, rafters, or trusses. The truss space and the space between each joist or rafter and above the ceiling need ventilation. At ridge, cornice, eave, or soffit vents, install insect screens.

Vents and birds. Make sure ventilation openings are clear of dirt and debris. At larger ventilation openings on a building's exterior and where louvered grilles are used, such as at gables, check for the presence of one-half-inch-square (13 x 13 mm) 14 or 16 gauge aluminum mesh bird screen. If there is none or it is in poor condition, consider having new bird screen installed.

Thermal insulation. Every homeowner should know the amount and type of insulating material existing in the house. For cold climate zones, the insulation faced with a vapor barrier should be installed face-side down with the vapor barrier closest to the conditioned space. The vapor barrier should be properly located between the ceiling and the first layer of insulation.

Determine the proper amount of insulation to the attic and whether additional insulation is needed. If attic insulation is placed against the roof sheathing, a ventilated air space between the insulation and the sheathing will be needed. If there is no air space, check for the presence of moisture and deterioration of sheathing and rafters.

Ensure that insulation is held away from recessed lighting fixtures and look at the spaces around vents, stacks, ducts, and wiring for thermal bypasses.

Inspect attic doors or access hatches, heating or cooling ducts that pass through the attic and whole-house attic fans for thermal bypasses. Check the local jurisdiction for thermal resistance (R) requirements. For more information about insulation, sealing, and saving energy go to Chapter 10.

Plumbing stacks and exhaust ducts. All plumbing stacks should continue through the roof and should not terminate in the attic. The stack pipes should not be loose, broken or damaged. Exhaust ducts should not be kinked, broken or damaged and should not terminate in the attic but either continue through the roof, gable or wall.

5.10 Whole Building Thermal Efficiency Tests

Several whole-building tests can be performed to help evaluate the thermal efficiency of the building envelope. Consider hiring an infrared-certified home inspector (www.internachi.org) to perform an energy audit or evaluation.

A building pressurization test can be used to determine air infiltration and exfiltration. The test is particularly useful for "tightening up" an older building. A tracer gas test may also be used.

A hand-held infrared camera can be used to detect building "hot spots" due to interior air leakage or excessive heat loss through un-insulated building components. This test should be performed in cold weather when the building is heated; the greater the differential between inside and outside temperatures, the more accurate the results. Thermography inspections should be performed by an energy specialist, certified home inspector or others with the proper training and equipment.

5.11 Sound Transmission

The floors and walls between dwelling units should have adequate sound transmission control using the current building code for guidance. Walls and floors that separate dwelling units in two-family residences, and walls that separate townhouses, should have an adequate sound transmission control.

5.12 Asbestos

Asbestos is a naturally occurring fibrous mineral used in many construction products. It is considered to be a carcinogen. Asbestos has been used in: sealant, putty, and spackling compounds; in vinyl floor tiles, backing for vinyl sheet flooring, and flooring adhesives; in ceiling tiles; in textured paint; in exterior wall and ceiling insulation; in roofing shingles; in cement board for many uses including siding; in door gaskets for furnaces and wood-burning stoves; in concrete piping; in paper, mill board and cement board sheets used to protect walls and floors around wood-burning stoves; in fabric connectors between pieces of metal ductwork; in hot water and steam piping insulation, blanket covering and tape; and as insulation on boilers, oil-fired furnaces and coal-fired furnaces. Use of asbestos has been phased out since 1978, but many older houses contain asbestos-bearing products.

Products containing asbestos are not always a health hazard. The potential health risk occurs when these products become worn or deteriorate in a way that releases asbestos fibers into the air. Of particular concern are those asbestos-containing products that are soft, that were sprayed or troweled on, or that have become crumbly.

The Environmental Protection Agency believes that so long as the asbestos-bearing product is intact, is not likely to be disturbed, and is in an area where repairs or rehabilitation will not occur, it is best to leave the product in place. If it is deteriorated, it may be enclosed, coated or sealed up (encapsulated) in place, depending upon the degree of deterioration. Otherwise, it should be removed.

A certified environmental professional could perform an inspection and make the decision whether to enclose, coat, encapsulate or remove deteriorated asbestos-containing products. Testing by a qualified laboratory as directed by the environmental professional may be needed in order to make an informed decision. Encapsulation, removal and disposal of asbestos products must be done by a qualified asbestos-abatement contractor.

For more information visit http://www.epa.gov/asbestos.

5.13 Lead

Lead has been determined to be a significant health hazard if ingested, especially by children. Lead damages the brain and nervous system, adversely affects behavior and learning, slows growth, and causes problems related to hearing, pregnancy, high blood pressure, nervous system, memory and concentration.

Lead-based paint. Most homes built before 1940 used paint that was heavily leaded. Between 1940 and 1960, no more than half the homes built are thought to have used heavily leaded paint. In the period from 1960 to 1980, many fewer homes used lead-based paint. In 1978, the U.S. Consumer Product Safety Commission (CPSC) set the legal limit of lead in most types of paint to a trace amount. As a result, homes built after 1978 should be nearly free of lead-based paint. In 1996, Congress passed the final phase of the Residential Lead-Based Paint Hazard Reduction Act, Title X, which mandates that real estate agents, sellers and landlords disclose the known presence of lead-based paint in homes built prior to 1978.

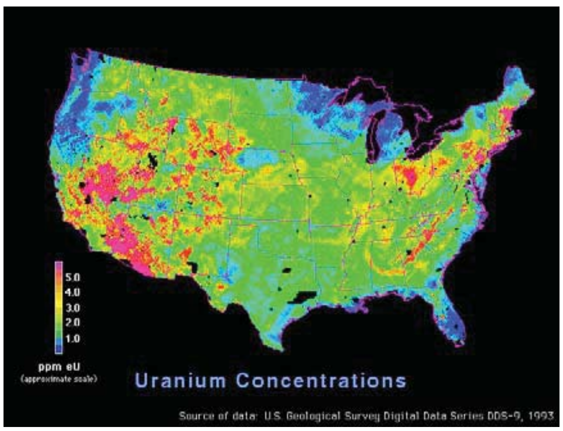
Lead in paint. Lead-based paint that is in good condition and out of the reach of children is usually not a hazard. Peeling, chipping, chalking, or cracking lead-based paint is a hazard and needs immediate attention. Lead-based paint may be a hazard when found on surfaces that children can chew or that get a lot of wear and tear, such as windows and window sills, doors and doorframes, stairs, railing, banisters, porches, and fences. Lead from paint chips that are visible and lead dust that is not always visible can both be serious hazards. Lead dust can form when lead-based paint is dry scraped, dry sanded or heated. Dust also forms when painted surfaces bump or rub together, such as when windows open and close. Lead chips and dust can get on surfaces and objects that people touch. Settled lead dust can re-enter the air when people vacuum, sweep or walk through it.

If the building is thought to contain lead-based paint, consider having a qualified professional check it for lead hazards. This is done by means of a paint inspection that will identify the lead content of every painted surface in the building and a risk assessment that will determine whether there are any sources of serious lead exposure (such as peeling paint and lead dust). The risk assessment will also identify actions to take to address these hazards. The federal government has standards for inspectors and risk assessors. Some states may have standards in place. Call local authorities for help with locating qualified local professionals. Do-it-yourself “home” tests should not be the only method used before doing rehabilitation or to ensure safety. For more information on lead-based paint consult the HUD Office of Lead Hazard Control Web site at http://www.hud.gov:80/lead or http://www.epa.gov/lead.

Lead in water. Lead in drinking water is a direct result of lead that is part of the plumbing system itself. Lead solder was used in pipe fittings in houses constructed prior to 1988. Lead has been used in plumbing fixtures such as faucets, and in some older homes the service water pipe from the main in the street to the house is made of lead. The transfer of lead into water is determined primarily by exposure (the length of time that water is in contact with lead). Two other factors that affect the transfer are water temperature (hot water dissolves lead quicker than cold water) and water acidity (“soft” water is slightly corrosive and reacts with lead). The current federal standard for lead in water is a limit of 15 parts per billion. The only way to find out whether there is lead in the house’s water is to have the water tested by an approved laboratory. If there is evidence of lead in the system, consider having water tested for lead. If the house has a water filter, check to see if it is certified to remove lead.

For more information on lead in drinking water call the Environmental Protection Agency's Safe Drinking Water Hotline: 1-800-462-4791 or visit the Web site of the EPA Office of Water at http://www.epa.gov/safewater.

5.14 Radon Gas



Radon is a colorless, odorless and tasteless gas that is present in varying amounts in the ground and in water. Radon is produced by the natural radioactive decay of uranium deposits in the earth. Prolonged exposure to radon in high concentrations can cause cancer. The EPA has set guidelines for radon levels in residential buildings.

Airborne radon. The EPA recommends that mitigation measures be undertaken in residential buildings when radon concentrations are 4 picoCuries per liter (4 pCi/L) of air and above.

The radon concentration in a house varies with time and is affected by the uranium-radium content in the soil, the geological formation beneath the house, the construction of the house, rain, snow, barometric pressure, wind, and pressure variations caused by the periodic operation of exhaust fans, heating systems, fireplaces, attic fans and range fans. Radon concentrations are variable and may be high in one house and low in an adjacent house. To determine if a house has a radon problem, it must be tested.

A long-term test is the most accurate method of determining the average annual radon concentration. However, because time is usually limited, there exists short term tests that have a testing period of three to seven days. Radon tests are available from most home do-it-your-self stores or through radon testing service companies.

Radon in water. A house's domestic water supply from it's well can contain radon. There are locations with well water containing 40,000 or more pCi/L. The health problems from drinking water with radon are insignificant compared to breathing airborne radon, but radon can be released into the air when water is run into a plumbing fixture or during a shower. It takes a high concentration of radon in water to produce a significant concentration in the large volume of air in a house.

Private well water testing is normally not a part of radon testing. Therefore, if the house has a private well, consult the local health department to determine whether water testing in the house's area is recommended.

If a building is found to have a radon problem, consult a certified radon mitigation contractor. For more information on radon visit http://www.epa.gov/radon/pubs.

5.15 Tornado Safe Room

If a building is located in a tornado-risk area, it should have a tornado shelter or safe room, and it should be structurally adequate.

5.16 Inspection Standards

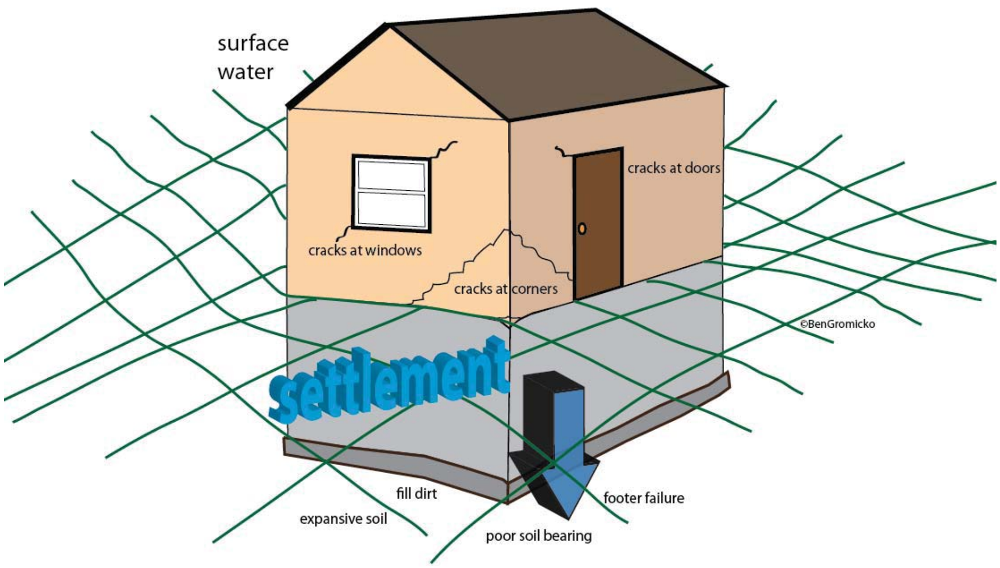
At the fireplace, the inspector shall open and close the damper, check the hearth and report major deficiencies. The inspector is not required to inspect the flue or vent system. Inspectors do not operate inserts or ignite pilot flames.

The inspector is not required to operate any appliances. Environmental hazards such as lead or radon are beyond the scope of a normal home inspection.

The inspector shall flush toilets and run water at the fixtures. The inspector shall report any present conditions or clear indications of active water penetration observed. Predicting water intrusion from either ground water or the plumbing system is beyond the scope of a home inspection.

Chapter 6: Structural System

This chapter goes over structural problems that may be found in a house. Many different types of cracking in numerous building materials are described. Most homes do not have major structural problems, but some do. In a well-maintained and kept, modern residential building, there may likely be no major structural problems. 19th-century buildings, that often show signs of settlement, may have only minor structural faults that can be readily remedied. Major structural problems, when they do develop, are usually quite obvious. It is the less obvious problems that require careful inspection and informed diagnosis. Such problems are often detected through a pattern of symptoms rather than any one symptom.

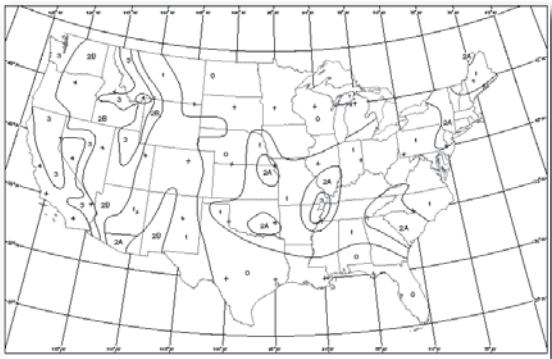


This chapter describes signs of structural distress, deterioration and damage by material type: masonry (the most difficult to assess), wood, iron, steel and concrete.

Assessing structural capacity. A thorough visual home inspection of its structural components is all that is normally necessary to verify the building's structural design or its structural integrity. Unless there is obvious overloading, significant deterioration of important structural components, or additional loading is anticipated, there is usually little need for engineering evaluations.

If the building's structural loading will be dramatically increased by such things as a new water bed, installation of a stone kitchen countertop, tile flooring, or heavy stove and oven, a quantitative analysis should be made of all the structural members involved. Simple calculations may be made or the local building code may be sufficient. More complex calculations could be performed by a qualified structural engineer.

6.1 Seismic Resistance



If the building is in seismic zones 2B, 3, and 4 (California, Idaho, Nevada, Oregon, Washington, and portions of Alaska, Arizona, Arkansas, Hawaii, Missouri, Montana, New Mexico, Utah, and Wyoming), have a structural engineer **check the following conditions** for structural vulnerability. (Note that wood frame buildings with brick or stone veneer are still considered wood frame.)

• Wood frame buildings that are not physically anchored to their foundations. Such buildings may be vulnerable to shifting or sliding.

• Wood frame buildings and wood framed portions (porches, for example) or other buildings when they are supported above ground on either short wood studs (cripple walls) or on piers of stone, masonry or concrete. Such buildings may be vulnerable to tilting or falling over.

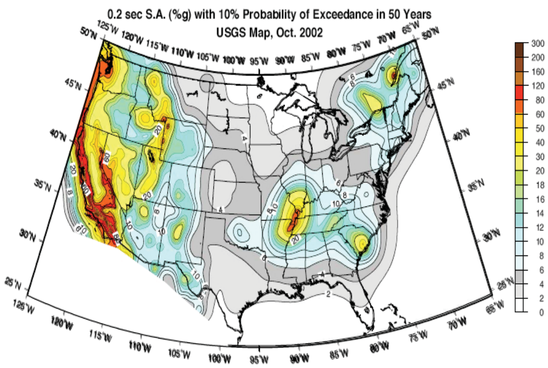
• Un-reinforced and inadequately reinforced masonry buildings. Such buildings may be vulnerable to total or partial collapse due to inadequate reinforcement or to inadequate anchorage of roofs and walls to the floors.

• Buildings of any type that have irregular shapes. Such buildings may be vulnerable to partial collapse.

• Wood frame and masonry buildings with more than one story above grade where the story at grade is a large unobstructed open space, such as a garage. Such buildings may be vulnerable to collapse of the story at grade.

• Wood frame and masonry buildings with more than one story above grade that are constructed on sloping hill-sides, and buildings of any type of construction and height that are constructed on steep slopes of 20 degree or more. Such buildings may be vulnerable to sliding.

If the building is in seismic zone 2A (Connecticut, Massachusetts, Rhode Island, South Carolina, and portions of Georgia, Illinois, Indiana, Kansas, Kentucky, Maine, New Hampshire, New Jersey, New York, North Carolina,



Oklahoma, Pennsylvania, Tennessee, Vermont, and Virginia) and has more than two stories above grade, consider having a structural engineer check for the last two conditions (large unobstructed open space at grade and sloped sites).

Buildings not of wood frame or masonry construction, such as stone, adobe, log, and post and beam structures, as well as buildings with more than one type of construction in any seismic zone, should be investigated by a structural engineer to determine their seismic vulnerability.

Masonry bearing wall buildings in seismic zones 2B, 3, and 4 should be investigated by a structural engineer for the presence of rein-forcing steel.

Have a structural engineer check the anchorage of wood framed structures to their foundations and investigate all such structures supported on cripple walls or piers in seismic zones 2, 3, and 4.

In all seismic zones, a structural engineer should investigate buildings with more than one story above grade where the story at grade is a large unobstructed open space or the building is on a sloping hillside and in seismic zones 2B, 3, and 4 buildings with an irregular shape.

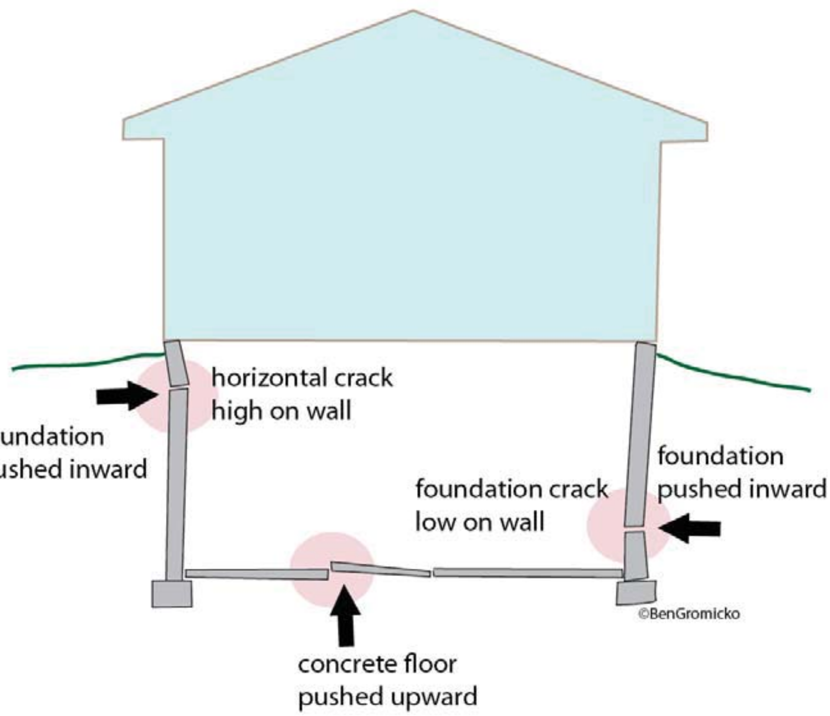
6.2 Wind Resistance

Hurricanes are large, slow moving, damaging storms characterized by gusting winds from different directions, rain, flooding, high waves and storm surges. The coasts of the Gulf of Mexico, the south- and mid-Atlantic coast, the coastal areas of Puerto Rico, the U.S. Virgin Islands and Hawaii as well as the U.S. territories of American Samoa and Guam are vulnerable to hurricanes in the late summer and early fall. Winter storms along the mid- and north-Atlantic coast can be more damaging than hurricanes because of their greater frequency, longer duration, and high erosion impacts on the coastline. Even in states not normally considered susceptible to extreme windstorms, there are areas that experience dangerously high winds. These areas are typically near mountain ranges and include the Pacific Northwest coast. Other extreme wind areas include the plains states, which are especially subject to tornadoes.

In addition to the direct effects of high winds and winter on buildings, hurricanes and other severe storms generate **airborne debris** that can damage buildings.

Debris. Debris, such as small stones, tree branches, roof shingles and tiles, building parts and other objects, is picked up by the wind and moved with enough force to damage and even penetrate windows, doors, walls and roofs. When a building's exterior envelope is breached by debris, the building can become pressurized, subjecting its walls and roof to much higher damaging wind pressures. In general, the stronger the wind, the larger and heavier the debris it can carry and the greater the risk of severe damage.


If the building is in a hurricane or high-wind region, consider having a structural engineer check its structural system for continuity of load path, including resistance to uplift forces. If there is an accessible attic, improper attachment of the roof sheathing to the roof-framing members can be checked by looking for unengaged or partially engaged nails. Hurricane hold-down clips for joists, rafters, and trusses should be present at the exterior wall. Examine the gable end walls and the roof trusses for lateral bracing. Check to see whether the exterior wall and other load-bearing walls are securely attached to the foundation.



6.3 Masonry

A homeowner should know which walls are load-bearing and which are not. Usually this can be understood by examining the beams and joists in the building's basement or crawl space or attic. All exposed masonry should be monitored for cracking, spalling, bowing (bulges vertically), sweeping (bulges horizontally), leaning and mortar deterioration.

Masonry cracking. Monitoring the masonry walls of the house is needed. Although masonry can deform elastically over long periods of time to accommodate small amounts of movement, large movements normally cause cracking. Cracks may appear along the mortar joints or through the masonry units. Cracking can result from a variety of problems: differential settlement of foundations; drying shrinkage (particularly in concrete block); expansion and contraction due to ambient thermal and moisture variations; improper support over openings; the effects of freeze-thaw cycles; the corrosion of iron and steel wall reinforcement, differential movement between building materials; expansion of salts and; the bulging or leaning of walls.

Cracks should always be further evaluated to determine their cause and whether corrective action is required.

Look for signs of movement. A clean crack indicates recent movement; a dirty or previously filled crack may be inactive. **Correlate the width of larger cracks to the age of the building.** A one-half-inch crack in a new building may be a sign of rapid settlement, but in a building 50 years old, it may indicate a very slow movement of only 1/100 of an inch (0.25 mm) per year.

Crack movement can be measured with a commercially available joint movement indicator. This device is temporarily fastened over the crack and a scribe records movement over a period of time.

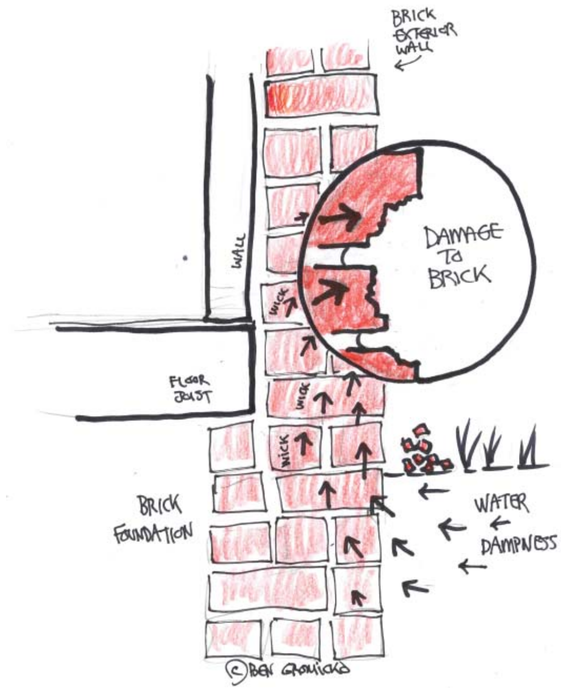
Cyclical. Cyclical movements may take six months or more to measure, but diurnal movements can be recorded over a few days. Cracks associated with thermal expansion and contraction may open and close with the season. These are cyclical cracks, which may gradually expand as accumulating mortar debris jams them farther apart after each cycle. Such cracks should be cleaned and protected by flexible sealants. Re-mortaring cyclical cracks will hold them open and cause more cracking.

When there are major masonry problems, it is advisable to hire a structural engineer. If problems appear to be due to differential settlement, a soils engineer also may be required.

Mortar deterioration. The age of the building may be a good clue in evaluating its mortar problems. The two important qualities of mortar are its ability to bond to masonry and its internal strength. Older mortar (or mortar of any age that uses hydrated lime) will be softer and may require pointing, but otherwise may be responsible for a sound wall.

Moisture. Most often, mortar deterioration is found in areas of **excessive moisture**, such as near leaking downspouts, below windows and at tops of walls. In such cases the remedy is to redirect the water flow and point the mortar joints. Pointing should be performed with mortar of a composition similar to or compatible with the original mortar. The use of high strength mortar to point mortar of a lower strength can do serious damage to the masonry since the pointing can't "flex" with or act in a similar way to the rest of the joint.

It is useful to remember that mortar acts as a drainage system to equalize hydrostatic pressure within the masonry. Nothing should be done to reduce its porosity and thereby block water flow to the exterior surface.



Deterioration of brick masonry units. The spalling, dusting or flaking of brick masonry units may be due to either mechanical or chemical damage. **Mechanical** damage is caused by moisture entering the brick and freezing, resulting in spalling of the brick's outer layers. Spalling may continue or may stop on its own after the outer layers that trapped the interior moisture have broken off. **Chemical** damage is due to the leaching of chemicals from the ground into the brick, resulting in internal deterioration. External signs of such deterioration are a dusting or flaking of the brick. Very little can be done to correct existing mechanical and chemical damage except for actually replacing the brick. Mechanical deterioration can be slowed or stopped by directing water away from the masonry surface and by pointing mortar joints to slow water entry into the wall.

6.4 Masonry Foundations and Piers

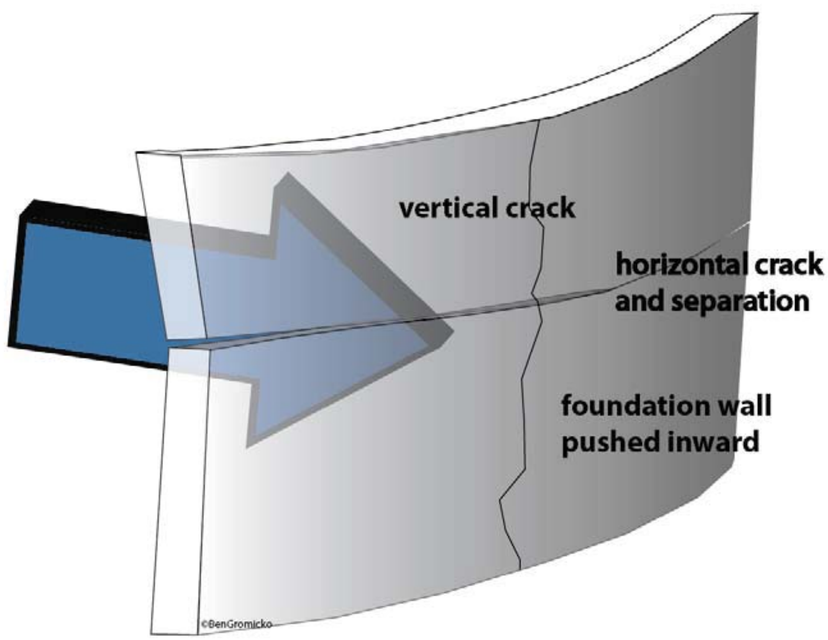
At your foundation walls (either stone, brick, concrete, or concrete block foundations) look for these following problems:

Uneven settlement. Uneven (or differential) settlement can be a major structural problem in small residential buildings. Serious settlement problems are relatively uncommon. Many signs of masonry distress are incorrectly diagnosed as settlement-related when in fact they are due to moisture and thermal movements.

Indications of differential settlement are vertical distortion or cracking of masonry walls, warped interior and exterior openings, sloped floors, and sticking doors and windows. Settlement most often occurs early in the life of a building or when there is a dramatic change in underground conditions. Often such settlement is associated with improper foundation design, particularly inadequate footers and foundation walls.

Other causes of settlement are:

- soil consolidation under the footings
- soil shrinkage due to the loss of moisture to nearby trees or large plants
- soil swelling due to inadequate or blocked



surface or house drainage
- soil heaving due to frost or excessive root growth
- gradual downward drift of clay soils on slopes
- changes in water table level
- soil erosion around footers from poor surface drainage, faulty drains, leaking water mains or other underground water movements (occasionally, underground water may scour away earth along only one side of a footer, causing its rotation and the subsequent buckling or displacement of the foundation wall above)
- soil compaction or movement due to vibration from heavy equipment, vehicular traffic, or blasting, or from ground tremors (earthquakes).

Gradual differential settlement over a long period of time may produce no masonry cracking at all, particularly in walls with older and softer bricks and high lime mortars; the wall will elastically deform instead. More rapid settlements, however, produce cracks that taper, being largest at one end and diminishing to a hairline at the other, depending on the direction and location of settlement below the wall.

Cracking is most likely to occur at corners and adjacent to openings, and usually follows a rough diagonal along mortar joints (although individual masonry units may be split). Settlement cracks (as opposed to the similar-appearing shrinkage cracks that are especially prevalent in concrete block) may extend through contiguous building elements such as floor slabs, masonry walls above the foundation, and interior plaster work.

Tapering cracks, or cracks that are nearly vertical and whose edges do not line up, may occur at the joints of projecting bay windows, porches, and additions. These cracks indicate differential settlement due to inadequate foundations or piers under the projecting element. Often settlement slows a short time after construction and a point of equilibrium is reached in which movement no longer occurs.

Minor settlement cracking is structurally harmful only if long-term moisture leakage through the cracks adversely affects building elements. Large differential settlements, particularly between foundation walls and interior columns or piers, are more serious because they will cause movements in contiguous structural elements such as beams, joists, floors, and roofs that must be evaluated for loss of bearing and, occasionally, fracture.

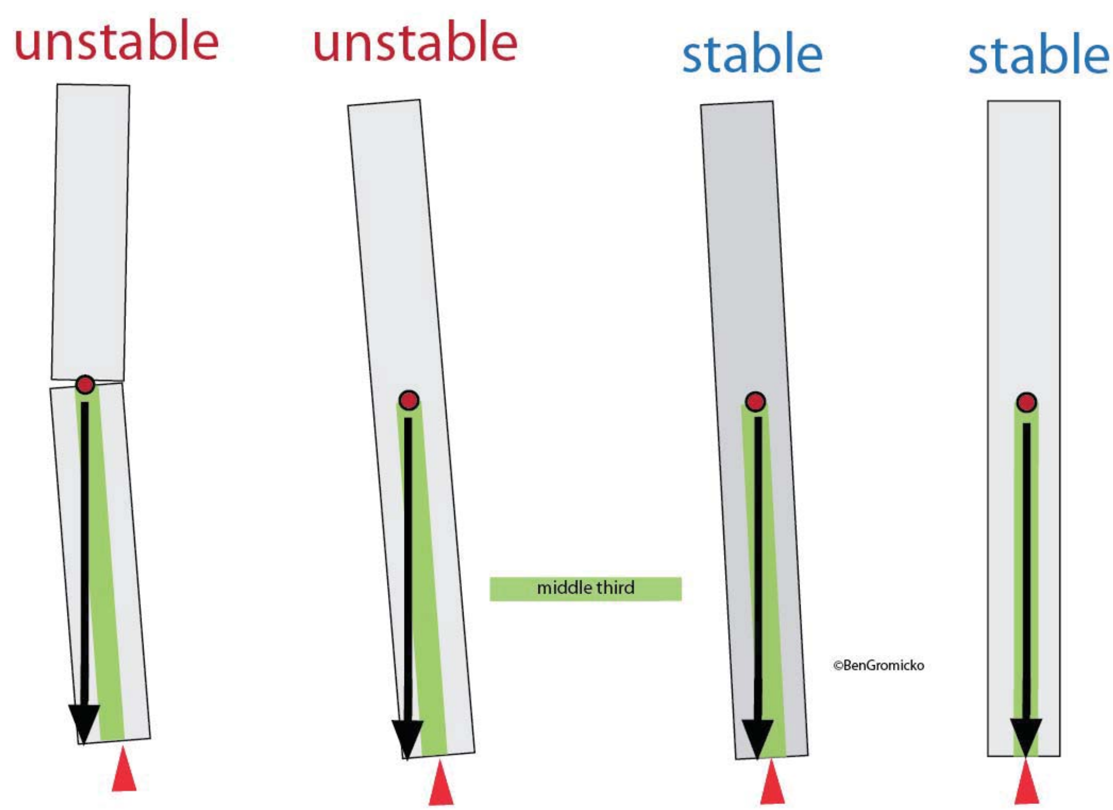
Repair. If the foundation needs repair, it can be accomplished by the addition of new structural elements, such as pilasters, or by **pressure-injecting concrete epoxy grout** into the foundation wall. If movement continues and cracking is extensive, it is possible that the problem can only be rectified by underpinning. Older buildings with severe settlement problems may be very costly to repair.

Masonry piers. Masonry piers are often used to support internal loads on small residential buildings or to support projecting building elements such as bay windows, porches, and additions. In some cases they support the entire structure. Piers often settle differentially and over a long period of time (particularly when they are exposed to the weather) they tend to deteriorate.

Pier problems:

• Piers should be plumb, without major settlement, in good condition and adequate in accepting bearing loads. Their width to height ratio, which should not exceed 1:10. Those that are deficient should be repaired or replaced. When appearance is not a factor (as is often the case), piers can be supplemented by the addition of adjacent supports.

• Settlement or rotation of the pier footing can cause a lowering or tilting of the pier and subsequent loss of bearing capacity. Wood frame structures adjust to this condition by flexing and redistributing their loads or by sagging (see Section 6.7). Masonry walls located over settled piers will crack.



• Frost heaving of the footing or pier, a condition caused by the lack of an adequate footing or one of insufficient depth can raise or tilt a pier. This could show up as movement similar to that caused by settlement or rotation of the footing. Such a condition is most common under porches and decks.

• Aboveground piers exposed to the weather are subject to freeze-thaw cycles and subsequent physical damage. Deterioration of the pier could be caused by exposure, poor construction, or overstressing. Piers for many older residential structures are often of poorly constructed masonry that deteriorates over the years. A sign of overstressing of piers is vertical cracking or bulging.

• Problems with piers can result in problems with bearing of wooden components. Structural wooden components can lose bearing when piers move or deteriorate.

• **Cracking**. Cracking can form from the drying shrinkage in concrete block foundation walls. The shrinkage of concrete block walls as they dry in place often results in patterns of cracking similar to that caused by differential settlement: **tapering cracks** that widen as they move diagonally upward. These cracks usually form during the building's first year and in existing buildings will appear as "old" cracks and exhibit no further movement. Although such cracks are often mistaken for settlement cracks, **shrinkage** cracks usually occur in the middle one-third of the wall and the footer beneath them remains intact. Shrinkage cracking is rarely serious, and in an older building may have been repaired previously. If the wall is unsound, its structural integrity sometimes can be restored by pressure-injecting concrete epoxy grout into the cracks or by adding pilasters.

• **Sweeping or horizontal cracking** of the foundation walls. The sweeping or horizontal cracking of brick or concrete block foundation walls may be caused by improper backfilling, vibration from the movement of heavy equipment or vehicles close to the wall or by the swelling or freezing and heaving of water saturated soils adjacent to the wall. Like drying shrinkage, sweeping or horizontal cracking may have occurred during the original construction and been compensated for at that time. Such distress, however, is potentially serious as it indicates that the vertical supporting member (the foundation wall) that is carrying a portion of the structure above is "bent" or "broken." It may be possible to push the wall back into place by careful jacking, and then reinforcing it with the addition of interior buttresses or by pressure-injecting concrete epoxy grout into the wall. If outside ground conditions allow, the wall can be relieved of some lateral pressure by lowering the ground level around the building.

Soil. When **expansive soils** are suspected as the cause of the cracking, examine the exterior for sources of water such as broken leaders or poor surface drainage. Suspect frost heaving if the damage is above local frost depth or if it occurred during an especially cold period.

6.5 Above-Ground Masonry Walls

For above-ground masonry walls, look for:

Brick wall cracking associated with thermal and moisture movement. Aboveground brick walls expand in warm weather (particularly if facing south or west) and contract in cool weather. This builds up stresses in the walls that may cause a variety of cracking patterns, depending on the configuration of the wall and the number and location of openings. Such cracks are normally cyclical and will open and close with the season. They will grow wider in cold weather and narrower in hot weather. Look for cracking at the corners of long walls, walls with abrupt changes in cross section (such as at a row of windows), walls with abrupt turns or jogs, and in transitions from one- to two-story walls. These are the weak points that have the least capacity for stress.

Common moisture and thermal movement cracking includes:

• Horizontal or diagonal cracks near the ground at piers in long walls due to horizontal shearing stresses between the upper wall and the wall where it enters the ground. The upper wall can thermally expand but its movement at ground level is moderated by earth temperatures. Such cracks extend across the piers from one opening to an-other along the line of least resistance. This condition is normally found only in walls of substantial length.

• Vertical cracks near the end walls due to thermal movement. A contracting wall does not have the tensile strength to pull its end walls with it as it moves inward, causing it or the end walls to crack vertically where they meet.

• Vertical cracks in short off-sets and setbacks caused by the thermal expansion of the longer walls that are adjacent to them. The shorter walls are “bent” by this thermal movement and crack vertically.

• Vertical cracks near the top and ends of the facade due to the thermal movement of the wall. This may indicate poorly bonded masonry. Cracks will tend to follow openings upward.

• Cracks around stone sills or lintels caused by the expansion of the masonry against both ends of a tight-fitting stone piece that cannot be compressed.

Cracks associated with thermal and moisture movement are usually only cosmetic problems: After their cause has been determined, they should be repaired with a flexible sealant, since filling such cyclic cracks with mortar will simply cause the masonry to crack in another location. Cracks should be examined by a structural engineer.

• Brick wall cracking can be associated with **freeze-thaw cycles** and **corrosion**. Brick walls often exhibit distress due to the expansion of freezing water or the rusting of embedded metals.

Look for:

• **Cracking** around sills, cornices, eaves, chimneys, parapets, and other elements subject to water penetration, which is usually due to the **migration of water** into the masonry. The water expands upon freezing, breaking the bond between the mortar and the masonry and eventually displacing the masonry itself. The path of the water through the wall is indicated by the pattern of deterioration.

• Cracking around iron or steel **lintels**, which is caused by the expansive force of corrosion that builds up on the surface of the metal. This exerts great pressure on the surrounding masonry and displaces it, since corroded iron can expand to many times its original thickness. Structural iron and steel concealed within the masonry, if exposed to moisture, can also corrode, and cause cracking and displacement of its masonry cover. Rust stains usually indicate that corrosion is the cause of the problem. Check to make sure the joint between the masonry and the steel lintel that supports the masonry over an opening is clear and open. If the joint has been sealed, the sealant or mortar should be removed.

These conditions usually can be corrected by repairing or replacing corroded metal components and by repairing and pointing the masonry. Where cracking is severe, portions of the wall may have to be reconstructed. Cracks should be further examined by a structural engineer.

• Wall cracking or displacement associated with the structural failure of building elements. Structure-related problems, aside from those caused by differential settlement or earth-quakes, are usually found over openings and (less commonly) under roof eaves or in areas of structural overloading.

Such problems include:

• Cracking or displacement of masonry **over openings**, resulting from the deflection or failure of the lintels or arches that span the openings. In older masonry walls with wood lintels, cracking will occur as the wood sags or decays. Iron and steel lintels also cause cracking as they deflect over time. Concrete and stone lintels occasionally bow and sometimes crack.

Masonry arches of brick or stone may crack or fail when there is wall movement or when their mortar joints deteriorate. When such lintel deflections or arch failures occur, the masonry above may be supporting itself and will exhibit step cracks beginning at the edges of the opening and joining in an inverted “V” above the opening’s midpoint. Correcting such problems usually means replacing failed components and rebuilding the area above the opening.

• Cracking or outward displacement under the eaves of a pitched roof due to failure in the horizontal roof ties that results in the roof spreading outward. The lateral thrust of the roof on the masonry wall may cause it to crack horizontally just below the eaves or to move outward with the roof. The roof will probably be leaking as well. When this occurs, examine the roof structure carefully to ascertain whether there is a tying failure. If so, additional horizontal ties or tension members will have to be added and, if possible, the roof pulled back into place. The damaged masonry can then be repaired. The weight also can be transferred to interior walls. Jacking of the ridge and rafters is possible too.

• Masonry walls sometimes show signs of **bulging** as they age. A wall itself may bulge, or the bulge may only be in the outer withe. Bulging often takes place so slowly that the masonry doesn’t crack, and therefore it may go unnoticed over a long period of time. The bulging of the whole wall is usually due to thermal or moisture expansion of the wall’s outer surface or to contraction of the inner withe. This expansion is not completely reversible because once the wall and its associated structural components are “pushed” out of place, they can rarely be completely “pulled” back to their original positions.

The effects of the cyclical expansion of the wall are cumulative, and after many years the wall will show a detectable bulge. Inside the building, separation cracks will occur on the inside face of the wall at floors, walls, and ceilings. Bulging of only the outer masonry withe is usually due to the same gradual process of thermal or moisture expansion: masonry debris accumulates behind the bulge and prevents the course from returning to its original position. In very old buildings, small wall bulges may result from the decay and collapse of an internal wood lintel or wood-bonding course, which can cause the inner course to settle and the outer course to bulge outward.

Bulging of walls. When wall bulges occur in solid masonry walls, the walls may be insufficiently tied to the structure or their mortar may have lost its bond strength. Large bulges must be tied back to the structure; the star-shaped anchors on the exterior of masonry walls of many older buildings are examples of such ties (check with local building ordinances on their use). Small bulges in the outer masonry course often can be pinned to the inner course or dismantled and rebuilt.

Leaning of walls. Masonry walls that lean represent a serious, but uncommon, condition that is usually caused by poor design and construction practices, particularly inadequate structural tying or poor foundation work.

Brick veneer walls. Brick veneer walls are subject to the forces of differential settlement, moisture-and thermal- related cracking and the effects of freezing and corrosion.

Look for:

- Cracks caused by frame shrinkage, which are most likely to be found around fixed openings where the independent movement of the veneer wall is restrained.
- Bulging, which is caused by inadequate or deteriorated ties between the brick and the wall that it is held upon.
- Vertical cracking at corners or horizontal cracking near the ground caused by thermal movement of the wall, which is similar to that in solid masonry or masonry cavity walls, but possibly more pronounced in well-insulated buildings because of the reduction in the moderating effect from interior temperatures. Thermal cracks are cyclic and should be filled with a flexible sealant. Where there is severe cracking, expansion joints may have to be installed.

Problems associated with parapet walls. Parapet walls often exhibit signs of distress and deterioration due to their full exposure to the weather, the splashing of water from the roof, differential movement, the lack of restraint by vertical loads or horizontal bracing, and the lack of adequate expansion joints.

At parapets:

• Horizontal cracking at the roof line due to differential thermal movement between the roof line and the wall below, which is exposed to moderating interior temperatures. The parapet may eventually lose all bond except that due to friction and its own weight and may be pushed out by ice formation on the roof.

• Bowing due to thermal and moisture expansion when the parapet is restrained from lengthwise expansion by end walls or adjacent buildings. The wall will usually bow outward since that is the direction of least resistance.

• Overhanging the end walls when the parapet is not restrained on its ends. The problem is often the most severe when one end is restrained and the other is not.

• Random vertical cracking near the center of the wall due to thermal contraction.

• Deterioration of parapet masonry due to excessive water penetration through inadequate coping or flashing, if any, which when followed by freeze-thaw cycles causes masonry spalling and mortar deterioration.

• Fire damage to brick masonry walls. Masonry walls exposed to fire will resist damage in proportion to their thickness. Examine the texture and color of the masonry units and probe their mortar. If they are intact and their basic color is unchanged, they can be considered serviceable. If they undergo a color change, consult a qualified structural engineer. Hollow masonry units should be examined for internal cracking, where possible, by cutting into the wall. Such units may need replacement if seriously damaged.

6.6 Chimneys

If you have a chimney, look at it. Chimneys have greater exposure to the weather than most building elements, and have no lateral support from the point where they emerge from the roof. Problems can develop at any point in time as the house ages.

Look:

• An inadequate foundation can cause differential settlement of the chimney, but the foundation is underground and not readily visible. If the chimney is part of an exterior wall, it will tend to lean away from the wall and crack where it is joined to other masonry. In some cases, the chimney can be tied to the building.

• A chimney sweep can monitor the chimney structure for you. Masonry at the top of the chimney stack can deteriorate due to a deteriorated cap that allows water into the masonry below and exposes it to freeze-thaw cycles. This cap is often made of a tapered layer of mortar, called a cement wash, which cracks and breaks after several years. If the cap is mortar and the chimney has a hood, repair the mortar. If the cap is mortar and the chimney does not have a hood, replace the mortar with a stone or concrete cap. If the cap is stone or concrete, repair it or replace it.

• The chimney could lean where it projects above the roof due to deteriorated mortar joints caused either by wind-induced swaying of the chimney or by sulfate attack from flue gases and particulates within the chimney when the chimney is not protected by a tight flue liner. Deteriorated mortar joints should be pointed, and unstable chimneys or those with a noticeable lean should be dismantled and rebuilt.

6.7 Wood Structural Components

Wood structural components in small residential buildings are often directly observable only in attics, crawl spaces, or basements. Elsewhere they are concealed by floor, wall and ceiling materials. Common signs of wood structural problems are sloping or springy floors, wall and ceiling cracks, wall bulges, and sticking doors and windows, although many such problems may be attributable to differential settlement of the foundation or problems with exterior masonry bearing walls.

The four types of problems commonly associated with such components in small residential buildings are (1) deflection and warping, (2) fungal and insect attack, (3) fire, and (4) connection failure and improper alteration.

When failures in wood structural components occur, they usually involve individual wood members and rarely result in the failure of the entire structure. Instead, an elastic adjustment takes place that redistributes stresses to other components in the building.

Deflection, warping, and associated problems. Some deflection of wood structural components or assemblies is common in older buildings and normally can be tolerated. Once permanently deflected, a wood structural component cannot be straightened.

Warping of individual wood components almost always takes place early in the life of a building. It will usually cause only superficial damage.

With wood, look for:

• **Floor sagging** near stairway openings due to gradual deflection of the unsupported floor framing. This is a common problem in older houses and usually does not present a structural problem.

• **Floor sagging** beneath doorjambs resulting from improper support below the jamb. This can be a structural concern. If needed, additional bracing can be added between the joists where the sag occurs.

• **Loss of bearing** in beams and joists over foundation walls, piers or columns due to movements caused by long-term deflection of the wood beams or joists, differential movements of the foundation elements, localized crushing or wood decay. Monitor the bearing and connections of all exposed structural elements that are in contact with the foundation and look for symptoms of bearing failure where these elements are concealed, such as bowing or sloping in the floor above, and cracking or tilting of foundation walls, piers and columns.

• **Sagging, sloping, or springing** of floors due to foundation settlement, excessive spans, cut or drilled structural elements, overloading, or removal of supporting walls or columns on the floor above or below. In older buildings, columns or walls that helped support or stabilize the floor above may have been removed during a previous alteration; conversely, partitions, bathrooms, kitchens, or similar remodeling may have been placed on a floor not designed to support such additional loads. Depending on the circumstances, sagging, sloping or springing floors may be anything from an annoyance to an indication of a potentially serious structural problem. Check below the floor for adequate supports and bearing and for sound connections between structural elements. Look for signs of supporting walls that have been removed, missing joist hangars and for inappropriate cuts or holes in joists for plumbing, electric, or HVAC lines or ducts. Also look for signs of insect or fungal attack.

• **Cracking in interior walls** around openings, which may be caused by inadequate, deflected or warped framing around the openings; differential settlement or; on the interior of masonry load-bearing walls, by problems in the exterior masonry wall. Cracking due to framing problems is usually not serious, although it may be a cosmetic concern that can be corrected only by breaking into the wall.

• **Sagging in sloped roofs** resulting from too many layers of roofing material, failure of fire retardant plywood roof sheathing, inadequate bracing or undersized rafters. Sometimes three or more layers of shingles are applied to a roof, greatly increasing its dead load. Or, when an attic story has been made into a habitable space or otherwise altered, collar beams or knee walls may have been removed. A number of factors, such as increases in snow and wind loads, poor structural design and construction errors result in undersized rafters. Look for all these conditions.

• **Failure of Fire Retardant Plywood (FRP)** used at party walls between dwelling units in some townhouses, row houses and multiple dwellings is not uncommon. Premature failure of the material could be due to excessive heat in the attic space. On the exterior, sagging of the roof adjacent to a party wall often is apparent. On the interior, check for darkening of the plywood surface, similar to charring, as an indication of failure that requires replacement of the FRP with a product of comparable fire resistance and structural strength.

• **Spreading of the roof downward and outward** due to inadequate tying. Look for missing collar beams, inadequate tying of rafters and ceiling joists at the eaves, or inadequate tying of ceiling joists that act as tension members from one side of the roof to the other. Altered trusses can also cause this problem. Check trusses for cut, failed or removed members, and for fasteners that have failed, been completely removed or partially disconnected. Spreading can be halted by adequate bracing or tying, but there may be damage to masonry walls below the eaves (see Section 6.5). It is possible that the roof can be jacked back to its proper position.

• **Deflection of flat roofs** due to too great a span, overloading, or improper support of joists beneath the roof. This is a common problem and is usually of no great concern unless it results in leaking and subsequent damage to the structure, or unless it causes water to pond on the roof, thereby creating unacceptable dead loads. In both cases, the roof will have to be strengthened or leveled.

• **Fungal and insect attack**. The moisture content of properly protected wood structural components in buildings usually does not exceed 10 to 15 percent, which is well below the 25 to 30 percent required to promote decay by the fungi that cause rot or to promote attack by many of the insects that feed on or inhabit wood. Dry wood will never decay. Check all structural and non-structural wood components for signs of fungus and insect infestation, including wood stains, fungi, termite shelter tubes, entry or exit holes, signs of tunneling, soft or discolored wood, small piles of sawdust or “frass” and related signs of infestation.

You can probe all suspect wood with a sharp instrument. Building inspectors check moisture content with moisture measurement devices. Wood with a meter reading of more than 20 to 25 percent should be thoroughly examined for rot or infestation. Sound wood will separate in long fibrous splinters, but decayed wood will lift up in short irregular pieces.

Exterior components:

- Shelter tubes can be found at foundation walls, in the cracks and corners.
- Where wood is in contact with the ground, such as wood pilings, porch and deck supports, porch lattices, wood steps, adjacent fences and nearby woodpiles.
- Frames and sills around basement or lower level window and doorframes and the base of frames around garage doors.
- Wood framing adjacent to slab-on-grade porches or patios.
- Wood near or in contact with roofs, drains, window wells or other areas exposed to periodic wetting from rain or lawn sprinklers, etc.

Interior:

- Wood frame basement partitions.
- Spaces around or within interior foundation walls and floors, crawl spaces, piers, columns or pipes that might harbor shelter tubes, including cavities or cracks.
- The sill plate that covers the foundation wall, and joists, beams, and other wood components in contact with it.
- Baseboard trim in slab-on-grade buildings.
- Subflooring and joists below kitchen, bathroom, and laundry areas.
- Roof sheathing and framing in the attic around chimneys, vents and other openings.

6.8 Iron and Steel Structural Components

Metal structural components used in residential homes are usually limited to beams and pipe columns in basements, angles over small masonry openings and beams over long spans. These components are almost always made of steel.

Problems with iron and steel structural components usually center on **corrosion**. Monitoring is needed.

Lintels and other embedded metal components in exterior masonry walls can corrode and in time become severely weakened themselves. Rain and snow often contain carbonic, sulfuric, nitric or hydrochloric acid that lowers the pH of rain water, thereby accelerating corrosion. Check the areas of embedded iron and steel. Corrosion can also displace surrounding masonry by popping off mortar joints at brick walls, for example.

Columns should be checked for adequate connections at their base and top, and for corrosion at their base if they rest at ground level.

6.9 Concrete Structural Components

Concrete is commonly used for grade and below-grade level floors and for footings. Concrete also may be used for foundations, beams, floors above grade, porches or patios built on grade, exterior stairs and stoops, sills, and occasionally as a precast or poured-in-place lintel or beam over masonry openings. Concrete structural components are reinforced. Welded steel wire mesh is used in floors at and below grade, patios built on grade, walks and drives, and short-span, light-load lintels. All other concrete structural components usually are reinforced with steel bars.

Look for:

Cracking at corners or openings in concrete foundations below masonry exterior walls due to drying shrinkage of concrete walls. This cracking will occur early in the life of the building. Minor cracks can be filled with mortar and major cracks with concrete epoxy.

Cracking of interior slabs on grade is usually due to shrinkage or minor settlement below the slab. If cracking is near and parallel to foundation walls, it may have been caused by the movement of the walls or footers. Cracking can also result from soil swelling (expanding) beneath the slab, a condition that may be caused by water from clogged or broken basement or footer drains. Cracking of exterior concrete elements, such as porches, patios, and stairs, is usually due to heaving from frost or nearby tree roots, freeze-thaw cycles or settlement.

6.10 Inspection Standards

The inspector shall inspect the basement, the foundation, the crawlspace and visible structural components. The inspector shall report any general indications of foundation movement that are observed by the inspector, such as but not limited to sheetrock cracks, brick cracks, out-of-square doorframes or floor slopes.

Inspectors do not perform engineering or architectural services. Inspectors do not report upon the adequacy of any structural system or component.

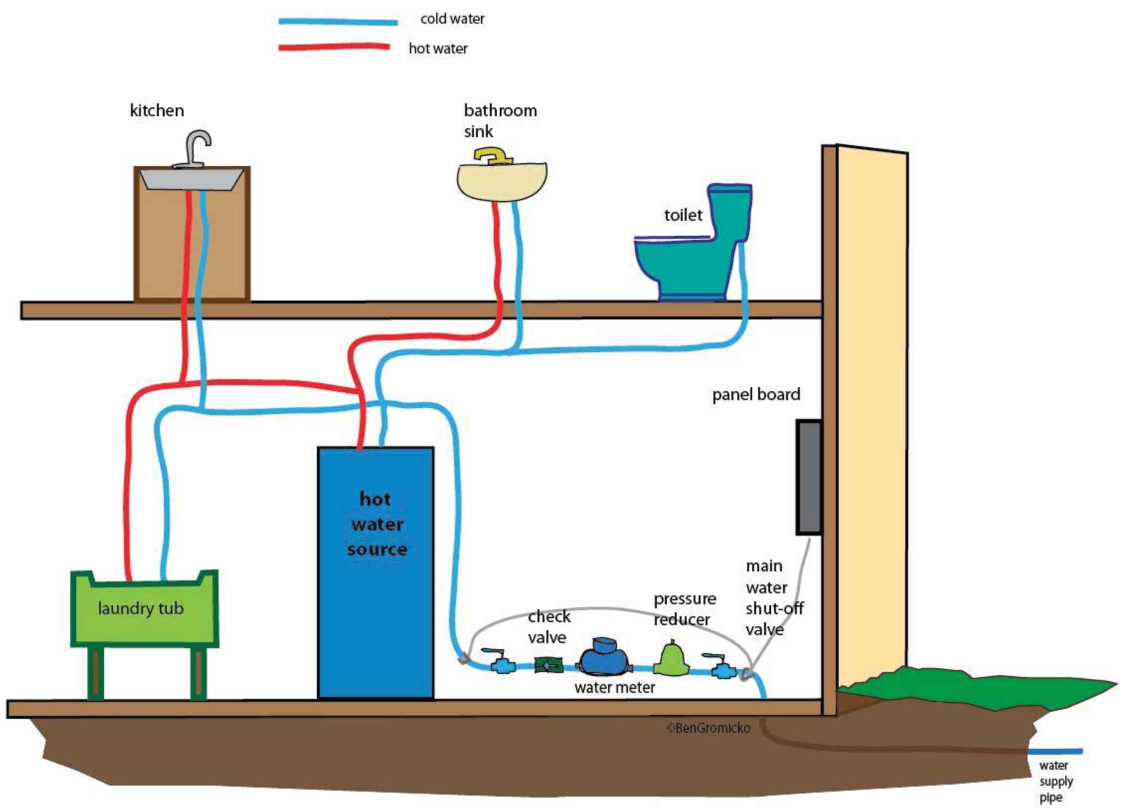
Chapter 7: Plumbing System

7.1 Water Service Entry

Curb valve. A homeowner should know where the curb valve is located. It is the way for the main water supply to be turned off. It is typically located at the junction of the public water main and the house service main, usually at the street. The curb valve is usually the responsibility of the municipal water department.

House service main. The house service main begins at the curb valve and ends at the inside wall of the building at the master shutoff valve.

Main water shutoff valve. A master shutoff valve should be located where the house service main enters the building. If the water meter is not located inside the building, the water meter will likely be outside in an underground crock. Home inspectors typically do not test this main valve during a visual-only inspection.



Water meter. The water meter is normally the property of the municipal water company and may be located near the street, adjacent to the house, or within the house. If the water meter is located inside the house, look for two shutoff valves, one on the street side and one on the house side of the meter.

7.2 Interior Water Distribution

All piping, regardless of composition, should be monitored for wet spots, discoloration, pitting, mineral deposits and leaking or deteriorated fittings.

Distribution piping. Distribution piping consists of supply mains and fixture risers. Most supply pipes can be seen from the basement or from crawl spaces, but the riser pipes are usually concealed within walls and cannot be readily examined.

The two most important factors in understanding distribution piping are the material and age.

Galvanized steel piping is subject to rusting and accumulating more mineral deposits than most other piping materials. Rusted fittings and rust-colored water, particularly from hot water lines, are signs of advanced deterioration. Low rates of flow and low water pressure are likely to be caused by galvanized steel piping clogged with rust and mineral deposits. If galvanized steel piping is found, consider replacing it.

Brass piping is of two varieties, yellow and red. Red is more common and has the longer service life—up to 70 or more years. The service life of yellow brass is about 40 years. Old brass piping is subject to pinhole leaking due to pitting caused by the chemical removal of its zinc content by minerals in the water. Often, water leaking from the pinhole openings will evaporate before dripping and leave whitish mineral deposits. Whitish deposits may also form around threaded joints, usually the most vulnerable part of a brass piping system. Brass piping with such signs of deterioration should be replaced.

Copper piping came into widespread use in most parts of the country in the 1930s and has a normal service life of 50 or more years. Copper lines and joints are highly durable and usually not subject to clogging by mineral deposits. Leakage usually occurs near joints.

Plastic piping (ABS, PE, PB, PVC, CPVC and PEX) is a relatively new plumbing material and, if properly installed, supported, and protected from sunlight and mechanical damage, should last indefinitely. However, there are several class action lawsuits pending at this time concerning polybutylene pipe (PB pipe) and fittings. Funds resulting from these suits are controlled by local jurisdictions. Check with local authorities or consumer advocate groups for details.

Some newer buildings use a **manifold** off the water main to distribute cold water and a manifold off the water heater to distribute hot water. From the manifold, flexible plastic pipes are snaked through floors and walls to each plumbing fixture.

Lead piping may be found in very old structures and may pose a health hazard to building occupants.

7.3 Drain, Waste, and Vent Piping

Fixture traps. Fixture traps are designed to hold a water seal that blocks the entry of sewer gasses into the house interior through the fixture drain. Watch for clogs and water leaks at water traps.

Vents. Vents equalize the atmospheric pressure within the waste drainage system to prevent siphoning of the water seals in the building's fixture traps. Vents should be unobstructed and open above the roof.

Drain lines. Drain lines direct wastewater from the fixture trap through the building to the sewer or septic system. Monitor for water drips and leaks particularly located at loose cleanout fittings.

7.4 Tank Water Heaters

Tank water heaters consist of a glass-lined or vitreous enamel-coated steel tank covered by an insulated metal jacket. They are gas-fired, oil-fired or electrically heated.

- Gas-fired tank water heaters have an average life expectancy of about 6 to 12 years and a fairly high recovery rate.
- Oil-fired heaters have an average life similar to that of gas-fired heaters. Their recovery rate is also high.
- Electric water heaters have an estimated service life of 5 to 10 years. They have a low recovery rate and thus require a larger storage tank.

Plan to replace a tank that is near the end of its life expectancy.

Watch for signs of leakage on the bottom of the tank, such as rust or water stains at fuel burning components or on the floor. Leaking tanks cannot usually be repaired and, therefore, must be replaced entirely.

As part of a maintenance plan, the tank should be drained regularly to remove sediment and rust.

Check the temperature/pressure relief valve (sometimes on the top or on the side of the tank), and for a discharge pipe that extends from the valve to a few inches from the floor, a floor drain or the building exterior, depending on local code requirements. This pipe should never be dripping or leaking water.

Monitor for soot or carbon deposits. Any soot or carbon that has accumulated below the draft hood of a water heater may indicate a restricted flue or chimney, or more commonly, back-drafting caused by insufficient make-up air.

7.5 Domestic Coil Water Heaters (with Boilers)

Tankless domestic coil water heaters consist of small diameter pipes coiled inside of or in a separate casing adjacent to a hot water boiler. They are designed for a rate of water flow, usually three to four gallons per minute. The recovery rate of a domestic coil water heater is instantaneous for low demand and will vary for high demand. The life expectancy of a domestic coil water heater is limited only by the deterioration of its coils and by the service life of the boiler to which it is attached.

Monitor tankless coil water heaters by checking its performance (ability to produce hot water on demand) and by checking the area where the coil is attached to the boiler. Over time water may start to leak from the gasket area or the bolts at the front mounting plate where the tankless coil is located at the boiler.

Monitor the plumbing connections and joints around the heater mounting plate for rust, water stains and mineral deposits.

7.6 Private Wells

Location and water quality. A homeowner should know the location of the well. Ideally wells that supply drinking water would be located uphill from the building and from any storm or sanitary sewer system piping. Standards usually require that the well be a minimum of 50 feet (15 m) from a septic tank and 100 feet (30 m) from any part of the absorption field. Local codes may have different separation distances based on the percolation rates of the local soils.

Pumps. Two kinds of deep well pumps are in common use: the jet pump and the submersible pump.

A jet pump is mounted above the well casing, and two pipes should extend into it; if there is only one pipe leading into the casing, the well is less than 25 feet deep and may have inherent performance problems. Submersible pumps are located at the bottom of the well casing (submerged) and a single discharge pipe and an electrical supply cable extend from the top of the casing. The life expectancy of deep well pumps is 10 years or longer, depending on the type. Submersible pumps are usually the most long lasting and trouble free.

Pressure tank. A tank under low air pressure (a hydropneumatic tank) should be located in either the well house or the building's basement. This tank regulates water pressure and flow.

Water tests. Consider hiring a professional home inspector who provides water quality sampling and well inspections to annually test the water quality. Water should be analyzed for the presence of bacterial contamination and for its mineral content.

7.7 Septic Systems

Location and layout. The homeowner should know the layout of the existing septic system. The absorption field should not be disturbed by new construction and vehicular traffic or covered by fill, trees or dense vegetation. No storm water should be directed into the septic system. A typical system has an average life expectancy of 15 to 20 years under proper use.

Septic tank. If properly maintained, it should be pumped every two to three years. Keep records about pumping. Lack of periodic pumping will cause solids to be carried into the absorption field, clogging the leaching beds and shortening their useful life.

Signs of a clogged absorption field are the presence of dark green vegetation over the leaching beds throughout the growing season (caused by nutrient-laden wastes being pushed up through the soil), wet or soggy areas in the field, or distinct sewage odors.

7.8 Gas Supply in Seismic Regions

Service entrance. If the building is in seismic zones 3 or 4 (California and portions of Alaska, Arkansas, Hawaii, Idaho, Missouri, Montana, Nevada, Oregon, Utah, Wyoming, and Washington), the gas service should not be vulnerable to differential movement where the piping enters the building. Look for adequate clearance or for flexible connections.

Emergency shutoff. If the building is in seismic zone 4 (portions of Alaska and California, and small parts of Idaho, Montana, and Wyoming), look for an automatic emergency shutoff valve for the entire house.

7.9 Inspection Standards

The inspector shall inspect and describe the water supply, drain, waste and main fuel shut-off valves, water main valve and shut-off valve. The inspector is not required to determine the size, temperature, age or life expectancy of the water heater source. Home inspectors are not septic system inspectors.

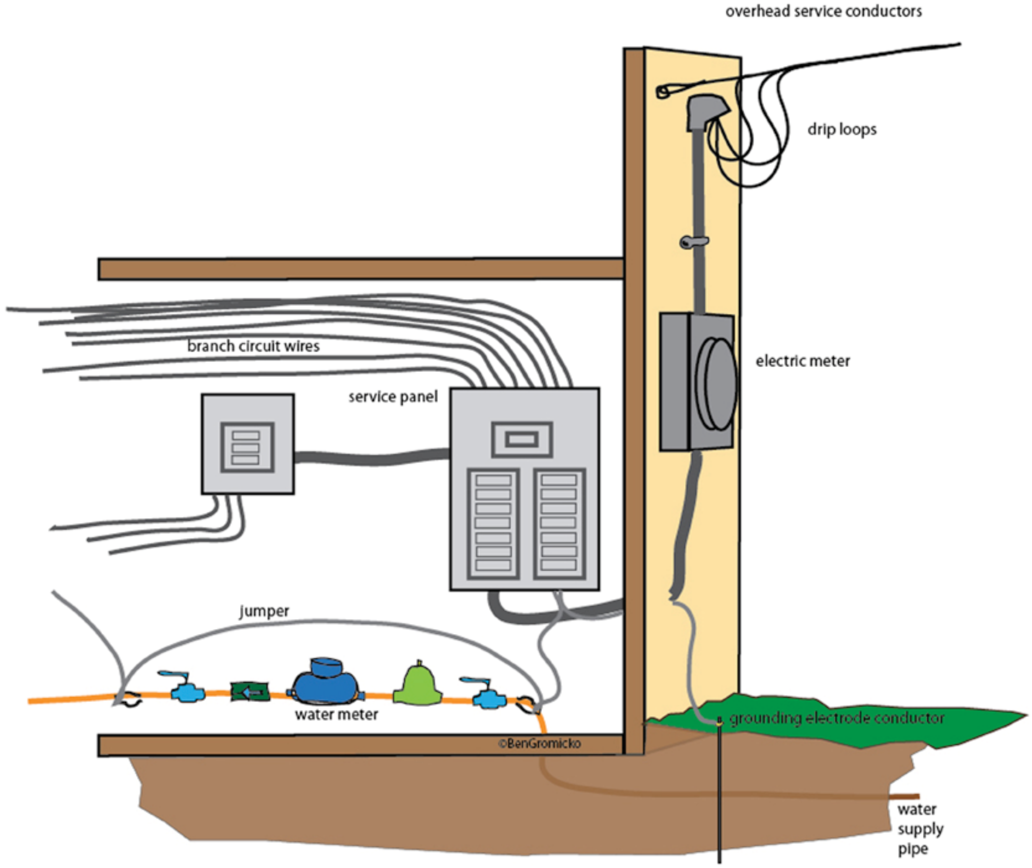
Chapter 8: Electrical System

Primary components are the service entry, service panel, and branch circuits. In unaltered buildings built since about 1940, the electrical system is likely to be intact and safe, although it may not provide the capacity required for the use of the building. Electrical capacity can be easily increased by bringing additional capacity in from the street and adding a larger service panel between the service entry and the existing panel. Existing circuits can continue to use the existing panel and new circuits can be fed through the new panel.

The electrical systems of residential buildings built prior to about 1940 may require overhaul or replacement, depending on the condition of the electrical system. Parts of these older systems may function adequately.

8.1 Service Entry

Service. Service is a term used to describe the conductors and equipment for delivering electricity from the utility company to the wiring system of the building served. Only one is typically installed for a dwelling. A minimum of 100-amp



service is needed for a single residential dwelling unit.

Service panel. It is typically referred to as the "panelboard" or "main electric panel." The first point of disconnect for the conductors from the utility company is at the "main panel."

Overhead wires. Overhead wires from the street should be greater than 10 feet above the ground, not in contact with tree branches or other obstacles, and not reachable from nearby windows or other accessible areas. The wires should be securely attached to the building and have drip loops where they enter the weatherhead. Wires should not be located over swimming pools.

Electric meter. The electric meter and its base should be weatherproof and securely fastened. Advise the utility company of any problems with the meter.

Service entrance conductor. The insulation of the service entrance conductor should be completely intact. If the main service panel is located inside the building, the conductor's passage through the wall should be sealed against moisture.

8.2 Main Electrical Service Panel (Breaker Box)

The main electrical service panel is the distribution center for electric service within the building. The primary function of the breakers or fuses (overcurrent protection devices) is to protect the house wiring from overloads.

All service panels must have covers or dead fronts. All openings should be closed.

Main disconnect. A means of disconnect for service must be located either outside or inside the dwelling unit nearest the point of entrance of the service conductors. No more than six hand movements or no more than six circuit breakers may be used to disconnect all service. Typically a main disconnect switch is required by the local authority. The main disconnect should be clearly marked to identify it as the service disconnect.

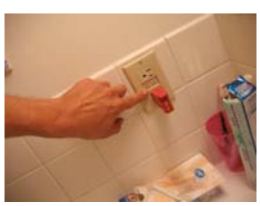
Condition and location. Water marks or rust on a service panel mounted inside the building may indicate water infiltration along the path of the service entrance conductor. Service panels mounted outdoors should be watertight. The service panel should have a workable space in front of it. The service panel should not be located inside a bathroom, over the stairs, or inside a clothes closet.

Amperage rating. The amperage rating of the main disconnect should not be less than 60-amps. It should be labeled or identified 100-amps or greater.

The ampacity of the service entry conductor may be determined by a building inspector by noting the markings (if any) on the conductor cable and finding the rating. If the service entry conductor is in a conduit, there may be markings on the conductor wires as they emerge from the conduit into the service panel. The ampere rating may be found on the service panel or service disconnect switch.

Grounding. A building inspector may be able to confirm that the service panel is properly grounded. Its grounding conductor should run to an exterior grounding electrode or be clamped to the metal water service inlet pipe between the exterior wall and the water meter.

Grounding electrode is a device that makes an electrical connection to the earth. A grounding electrode can be rebar in a footer, a metal underground water supply pipe within 10 feet of contact with the earth and a **grounding rod**.



GFCI. A GFCI (ground fault circuit interrupter) outlet is a device that adds a greater level of safety by reducing the risk of electric shock. Most building codes now require that GFCI protection be provided in wet locations such as the following: all kitchen counter receptacles; all bathroom receptacles; all exterior receptacles; receptacles in laundry and utility rooms; receptacles next to wet bar sinks; all garage and unfinished basement receptacles, except receptacles that are not readily accessible or single receptacles for appliances that are not easily moved; receptacles near a pool, spa, or hot tub and; light fixtures near water.

Downstream. A GFCI outlet may be wired in a branch circuit, which means other outlets and electrical devices may share the same circuit and breaker. When a properly wired GFCI trips, the other devices downstream from it will also lose power.

If you have an outlet that doesn't work, and the breaker is not tripped, look for a GFCI outlet that may have tripped. The non-working outlet may be downstream from a GFCI device. The “dead” outlets may not be located near the GFCI outlet; they may be several rooms away or even on a different floor.

GFCI outlets should be tested periodically - at least once a year. All GFCI devices have test buttons.

AFCI. All 15-amp and 20-amp 120-volt circuits for dining rooms, living rooms, bedrooms, sunrooms, closets, hallways, or similar areas must be AFCI protected. An arc fault circuit interrupter (AFCI) is a circuit breaker designed to prevent fires by detecting non-working electrical arcs and disconnect power before the arc starts a fire. The AFCI should distinguish between a working arc that may occur in the brushes of a vacuum sweeper, light switch, or other household devices and a non-working arc that can occur, for instance, in a lamp cord that has a broken conductor in the cord from overuse. Arc faults in a home are one of the leading causes for household fires.

AFCIs resemble a GFCI (Ground-Fault Circuit Interrupter) in that they both have a test button, though it is important to distinguish between the two. GFCIs are designed to protect against electrical shock, while AFCIs are primarily designed to protect against fire.

Overcurrent protection. A breaker or fuse is referred to as an overcurrent protection device. It is recommended that a homeowner should turn all circuit breakers on and off manually and make sure they are in functional condition.

The rating of the fuse or circuit breaker for each branch circuit may be checked by a building inspector or electrician. The amperage of the fuse or circuit breaker should not exceed the capacity of the wiring in the branch circuit it protects. Most household circuits use #14 copper wire, which should have 15-amp protection. There may be one or more circuits with #12 copper wire, which should have 20-amp protection. Large appliances, such as electric water heaters and central air conditioners, may require 30-amp service, which is normally supplied by #10 copper wire. If there were an electric range, it would require a 40-amp or 50-amp service with #6 copper wire.

Identification. Each circuit should be clearly and specifically identified as to its purpose. No two circuits should be labeled the same. No circuit should be identified in a way that may be subject to change with occupancy. For example, no breaker should be labeled "Ben's room."

8.3 Branch Circuits

The oldest wiring system that may still be acceptable, and one still found fairly often in houses built before 1930, is "**knob and tube**." This system utilizes porcelain insulators (knobs) for running wires through unobstructed spaces, and porcelain tubes for running wires through building components such as studs and joists. Knob and tube wiring should be replaced during rehabilitation; but if it is properly installed, needs no modification, has adequate capacity, is properly grounded, has no failed insulation, and is otherwise in good condition, it can be an acceptable wiring system and is still allowed in many localities. Check with local building code officials. Also check the terms and conditions of the **home insurance policy** to see if "knob and tube" wiring is excluded. The greatest problem with such wiring is its insulation, which turns dry and brittle with age and often falls off on contact, leaving the wire exposed. Knob and tube wiring is known to have caused house fires.

Approved wire types include:

- NM (non-metallic) cable, often called by the trade name "Romex", a plastic covered-cable for use in dry locations (older NM cable may be cloth covered).
- NMC, similar to NM but rated for damp locations.
- UF (underground feeder), a plastic-covered waterproof cable for use underground.
- AC (armored cable), also called BX, a flexible metal-covered cable.
- MC (metal-clad cable), a flexible metal-covered cable with a green insulated ground conductor.
- EMT (electrical metallic tubing), also called "thinwall," a metal conduit through which the wires are run in areas where maximum protection is required.

Aluminum wire. Aluminum wire was used in residential buildings primarily during the 1960s and early 1970s, and is a potential fire hazard.

According to the U.S. Consumer Product Safety Commission, fires and even deaths have been caused by the use of aluminum wiring in residential homes. Problems due to expansion and arcing at the connections can cause overheating between the wire and the devices, or at wire splices. The connections can become hot enough to start a fire.

Aluminum wire should be attached only to approved devices (marked "CO-ALR" or "CU-AL") or with connectors.

Problems with aluminum wiring occur at connections, so feel cover plates for heat, smell for a distinctive odor in the vicinity of outlets and switches, and look for sparks and arcing in switches or outlets and for flickering lights. Whenever possible, aluminum wire and its devices should be replaced with copper wire and devices appropriate for copper. It is difficult to find aluminum branch wiring in a home during a visual inspection. For a thorough investigation, an electrician should be hired.

Smoke Detectors. After moving in, consider replacing all of the smoke/fire detectors in the entire house. The building should have functioning smoke detectors. Detectors should be wired to a power source and also should contain a battery. Smoke detectors do not last forever. Replace detectors according to manufacturer's recommendations. Test the detectors regularly.

Replace batteries when you change your clocks for daylight savings time changes.

8.4 Inspection Standards

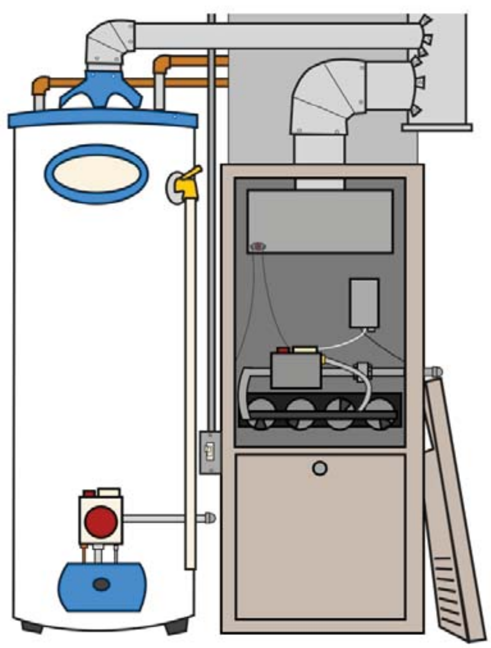
The inspector is required to inspect the service panel and overcurrent devices, but is not required to operate or reset overcurrent devices. During a home inspection, a representative number of switches, receptacles, lighting fixtures, and AFCI-protected receptacles are inspected - not each and every one.

The inspector shall report the presence of solid conductor aluminum branch circuit wiring ONLY if it is readily visible. The measurement of the amperage or voltage of the electrical service is not required by the SOP. Exterior accent wiring is not part of a home inspection.

Chapter 9: HVAC System

Most HVAC (heating, ventilating, air conditioning) systems in small residential buildings are relatively simple in design and operation. They consist of four components: controls, fuel supply, heating or cooling unit and distribution system. The **adequacy** of heating and cooling is often quite **subjective** and depends upon occupant perceptions that are affected by the distribution of air, the location of return air vents, air velocity, the sound of the system in operation and similar characteristics.

This chapter describes oil-fired and gas-fired warm air, hot water, and steam heating systems; electric resistance heaters; chilled air and evaporative systems; humidifiers; unit air conditioners; and attic fans.



9.1 Thermostatic Controls

Residential HVAC controls consist of one or more thermostats and a master shut-off switch for the heating or cooling unit.

Thermostats. Thermostats are temperature-sensitive switches that automatically control the heating or cooling system. Thermostats should be located in areas with average temperature conditions and away from heat sources such as windows, water pipes or ducts.

Once a year, take off the thermostat cover and check for dust on the spring coil and dirty or corroded electrical contact points. Plan to replace worn or defective thermostats. There may be more than one thermostat. Sometimes two thermostats separately control the heating and cooling system, and sometimes the living unit is divided into zones, each with its own thermostat.

Master (or service) shut-off switch. Every gas-burning and oil-burning system should have a master switch that serves as an emergency shutoff for the burner. Master shut-off switches are usually located near the burner unit or, if there is a basement, near the top of the stairs.

9.2 Fuel-Burning Units

Oil-fired or gas-fired furnaces and boilers provide heat to the majority of small residential buildings. Such fuel-burning units, whether they are part of a warm-air or a hot-water system, should be maintained regularly and continuously monitored.

No fuel-burning unit should be located directly off sleeping areas or close to combustible materials.

Seismic vulnerability. If the building is in a seismic zone, the HVAC unit should have seismic bracing to the structure.

Fuel supply. Gas supply lines should be made of black iron or steel pipe (some jurisdictions allow copper lines with brazed connections). Shutoff valves should be easily accessible. A gas shut-off valve should be next to the HVAC unit.

Oil tanks should be maintained in accordance with local regulations. All tanks must be vented to the outside and have an outside fill pipe. Buried tanks normally have a 550, 1000, or 1500 gallon (2080, 3785, or 5680L) capacity; basement tanks are usually sized to a 275-gallon (1040 L) capacity.

An oil filter should be installed on the oil supply line that runs from the storage tank to the oil burner. The filter needs to be maintained every year.

Ventilation and access. Make sure the fuel-burning unit has adequate combustion air and is easily accessible for servicing with at least three feet clear on each side of the unit requiring service.

Condition. On hot air furnaces, look for signs of rust on the furnace jacket from basement dampness or flooding, and, if an air conditioning evaporator coil is located over the furnace, look for rust caused by condensate over-flow. On hot water boilers, look for rust caused by dampness and by leaking water lines and fittings.

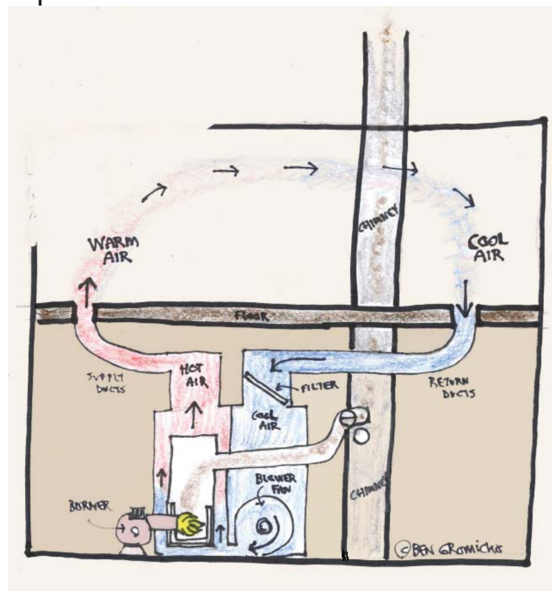
Flame. Once the unit has been activated, closely observe the combustion process. In oil-fired units, the **flame** should be clear and clean, and have minimal orange-yellow color. Flame height should be uniform.

Gas-fired units should have a **flame** that is primarily bluish in color. Check gas burners for rust and clogged ports. Soot or carbon build-up on the burners could be a sign of inefficient combustion. In oil-fired units, look for soot below the draft regulator, on top of the unit's housing and around the burner. The odor of smoke near the unit is another sign of poor combustion.

Have a service technician service and clean the system each and every year. Keep maintenance records up to date.

9.3 Forced Air Heating

Warm air heating systems are of two types, **forced air or gravity**. Gravity systems are occasionally still found in older single-family houses, but most gravity systems either have been replaced or converted to forced air.



Most forced warm air systems use natural gas or fuel oil as a heat source, but some systems use electric resistance heaters or heat pumps. The circulation blower and air distribution ductwork for electric resistance heating systems (and heat pumps) are identical to those of gas-fired and oil-fired warm air systems and should be regularly serviced and maintained.

Heat exchanger. The heat exchanger is located downstream of the burner in gas-fired and oil-fired furnaces and separates the products of combustion from the air to be heated. It is critical that the heat exchanger be intact and contains no cracks or other openings that could allow combustion products into the warm air distribution system. Visual detection of cracks, even by heating experts, is a difficult (if not impossible) process.

Monitor. Look for signs of soot at supply registers and smell for oil or gas fumes. Observe the burner flame as the furnace fan turns on; a disturbance or color change in the flame may indicate air leakage through a crack in the exchanger. A major cause of premature exchanger failure is water leakage from humidifiers or blocked air conditioner condensate lines. Check for signs of water leakage. The durability of the heat exchanger determines the service life of the furnace.

Circulation blower fan. If the fan is worn or misaligned, or has excessive dust and dirt on the fins, the fan may rumble or make sounds that are unwarranted or may actually shake the ductwork.

Distribution system. The distribution system is made up of supply and return ducts, filters, dampers and registers. Supply and return ducts may be made of sheet metal, glass fiber or other materials. Check ducts for open joints and air leakage wherever the ducts are exposed. Air ducts can be cleaned by an HVAC contractor or a professional duct-cleaning contractor. Ducts could be cleaned every 5 years. Cleaning ducts is part of maintaining a healthy home. There should be no openings in return ducts in the same room as a combustion furnace.

Check the air filter. Air filters are usually located on the return side of the furnace next to the blower, but they may be found anywhere in the distribution system. Check for their presence and examine their condition. Homeowners should check and replace the air filter every month (or according to the manufacturer's recommendations).

Humidifiers may be located in the *supply* air ducts. They should not be located in *return* air ducts because the moist air will pass through the heat exchanger and evaporator coil, rendering the humidification ineffective and corroding the heat exchanger. Humidifiers require regular maintenance.

9.4 Forced Hot Water or Hydronic

Hot water heating systems, like warm air systems, are of two types, forced or "hydronic" and gravity. Gravity systems are sometimes found in older single-family houses, but in most cases such systems have been replaced or converted to a forced hot water system. Gravity systems have no water pump and use larger piping. They tend to heat unevenly, are slow to respond and can only heat spaces above the level of their boiler. Like gravity warm air systems, they are considered inefficient. Forced hot water systems are usually heated by gas-fired or oil-fired boilers.

Boilers. Monitor all boilers for signs of corrosion and leakage. Most hot water and steam heating systems have steel boilers with a service life of about 20 years. Cast iron boilers have a service life of about 30 years. Water leaking from the exchanger of the boiler is likely an indication of a major defect requiring replacement.

Expansion tank. The expansion tank is usually located above the boiler and is connected to the hot water distribution piping. The pressure relief valve should discharge water from the system when the boiler pressure reaches 30 psi (207 kPa). Look for signs of water near the valve or below it on the floor. High-pressure conditions are usually due to a waterlogged expansion tank. If the boiler also generates domestic hot water, high pressure may be caused by cracks in the coils of the water heater, since the domestic water supply pressure usually exceeds 30 psi (207 kpa). Any water drips coming from the relief valve is unacceptable and may indicate a safety hazard.

Circulating pump and controls. The circulating pump forces hot water through the system at a constant flow rate, usually stated in gallons per minute (gpm). It should be located adjacent to the boiler on the return pipe near the boiler. Monitor the condition and operation of the pump itself. Listen for smooth operation. A loud pump may have bad bearings or a faulty motor. Look at the gasket seal between the motor and the pump housing for signs of leakage. Look for scorching at all electrical wiring and connections. Circulating pumps should be lubricated regularly (read manual).

Distribution piping. The forced hot water distribution system consists of distribution piping, radiators and control valves. Distribution piping may be one of three types: series-loop; one-pipe and; two-pipe.

In a **series-loop** system, radiators are connected by one pipe in a series. In a **one-pipe** system each radiator is separately attached to the water distribution pipe with a regulating, diverter fitting. A **two-pipe** system uses two pipes - one for *supply* water and one for *return*.

Monitor the distribution piping, valves, connections and radiators for water leaks.

Radiators and control valves. Radiators are of three types: cast iron (which in most cases are free standing but sometimes are hung from the ceiling or wall; convector (which may have a circulating fan) and; baseboard. Older residential buildings usually have cast iron radiators that are extremely durable. Baseboard radiators are considered the most desirable for residential use because they are the least conspicuous and distribute heat most evenly throughout the room. Monitor for water leaks. When a leak is detected, have the service technician flush the piping to check for galvanic corrosion.

9.5 Steam Heating

Steam heating systems are seldom installed now in small residential buildings but are still common in many older ones. They are simple in design and operation, but require a higher level of maintenance than modern residential heating systems. A homeowner should have plans to keep the system **maintained continuously**.

Steam boiler controls. Unlike hot water boilers, steam boilers operate only about three-fourths full of water and at much lower pressures, usually 2 to 5 psi. Steam boilers should be equipped with a water level gauge, a pressure gauge, a high-pressure limit switch, a low water cut-off and a safety valve.

Look at the water level gauge that indicates the level of the water in the steam boiler. The **gauge** should normally read about **half full**, though the actual level of the water is not critical as long as the level is showing. If the gauge is full of water, the boiler is flooded and water must be drained from the system. If the gauge is empty, the boiler water level is too low and must be filled (either manually through the fill valve or automatically through the automatic water feed valve, if the boiler has one). Unsteady, up and down motion of water in the gauge could mean the boiler is clogged with sediment or is otherwise operating incorrectly and must be repaired. The clarity of the boiler water should be checked when checking the gauge. If the gauge is too dirty to judge the water level, it needs to be removed and cleaned. Consider hiring a HVAC professional to maintain the system.

Steam distribution pipes. The steam distribution system consists of distribution piping, radiators and control valves. Distribution piping may have either a one-pipe or two-pipe configuration.

In a one-pipe system, steam from the boiler rises under pressure through the pipes to the radiators. There, it displaces air by evacuation through the radiator vent valves, condenses on the radiator's inner surface, and gives up heat. Steam condensate flows by gravity back through the same pipes to the boiler for reheating. The pipes, therefore, must be pitched no less than one inch in ten feet in the direction of the boiler to ensure that the condensate does not block the steam in any part of the system. All piping and radiators must be located above the boiler in a one-pipe system.

In a two-pipe steam system, steam flows to the radiators in one pipe and condensate returns in another. A steam trap on the condensate return line releases air displaced by the incoming steam. If the condensate return piping is located below the level of the boiler, it should be brought back up to the level of the boiler and vented to the supply piping in a "Hartford Loop." This prevents a leak in the condensate return from emptying the boiler.

Steam distribution piping should be checked for leaks at all valves and connections. Make sure all piping is properly pitched to drain toward the boiler. "Pounding" may occur when oncoming steam meets water trapped in the system by improperly pitched distribution piping or by shutoff valves that are not fully closed or fully open.

The valve to the steam radiator should NOT be turned on partway (it must be either completely on or completely off) or banging may occur. Variable sir vent valves are good because you can properly balance the system and turn down the heat, if need be.

9.6 Electric Resistance

Electric resistance heating elements commonly are used in heat pump systems, wall heaters, radiant wall or ceiling panels, and baseboard heaters. They are less frequently used as a heat source for central warm air or hot water systems. Such heating devices require some maintenance.

Electric resistance heaters. Electric resistance heaters are used in warm air and hot water systems and in heat pumps. They incorporate one or more heavy duty heating elements that are actuated by sequence relays on demand from the thermostat.

Electric wall heaters. These compact devices are often used as supplementary heating units. They may have one or more electric heating elements, depending on their size. Wall heaters often have a small circulation fan. Look for dirt build up on the fan blades and motor housing.

Radiant wall and ceiling panels. Electric heating panels that are embedded in wall or ceiling surfaces cannot be directly inspected, but all radiant surfaces should be monitored for signs of surface or structural damage.

Baseboard heaters. Baseboard heater heating fins can be damaged and become clogged with dust. Once a year remove heater covers and clean the unit. Bent heating fins can often be straightened by "combing." The thermostat may be on an adjacent wall or in the unit itself.

9.7 Central Air

Central air conditioning systems are defined here as electrically operated refrigerant-type systems used for cooling and dehumidification. Heat pumps are similar to central air conditioners, but are reversible and can also be used as heating devices. Air conditioning systems should be operated only when the outside air temperature is above 65 ºF (18 ºC); below that temperature, the systems will not operate properly, may shut down due to safety controls and could be damaged by operating in cool temperatures.

There are two types of central air conditioning systems: integral and split. In the integral system, all mechanized components—compressor, condenser, evaporator, and fans—are contained in a single unit. The unit may be located outside the building with its cold air ductwork extending into the interior, or it may be located somewhere inside the building with its exhaust air ducted to the outside.

In the split system, the compressor and condenser are located outside the building and are connected by refrigerant lines to an evaporator inside the building's air distribution ductwork. Split systems in buildings heated by forced warm air usually share the warm air system's circulating fan and ductwork. In such cases, the evaporator is placed either directly above or below the furnace, depending on the furnace design.

Compressor and condenser. The compressor pumps refrigerant gas under high pressure through a condenser coil. Compressors have a service life of 12 to 15 years and are the most critical component in the air conditioning system.

Pay attention to the compressor. It should start smoothly and run continuously; noisy start up and operation indicates a worn compressor. The condenser fan should start simultaneously with the compressor. After several minutes of operation, the air flowing over the condenser (the unit outside on a split system) should be warm. If it isn't, either the compressor may be faulty or there may not be enough refrigerant in the system.

3 feet of clearance. If the compressor, condenser, and condenser fan are part of a split system and are located in a separate unit outside, check the airflow around the outside unit to make sure it is unobstructed.

Look inside and check for dirt and debris, particularly on the condenser coils and fins, and look at the electrical wiring and connections. The unit **should be level** and supported well. Outdoor units often settle or slide. An **electrical disconnect switch** for use during maintenance and repairs should be located within sight of the exterior unit (not located behind the unit).

Refrigerant lines. Refrigerant lines form the link between the interior and exterior components of a split system. The larger of the two lines carries low-pressure (cold) refrigerant gas from the evaporator to the compressor. It is about the diameter of a broom handle and should be insulated along its entire length. The smaller line is not insulated and carries high pressure (warm) liquid refrigerant to the evaporator.

Touch the lines. While the unit is operating, the smaller line should feel warm, and the larger should feel cool to the hand. You could check both lines for signs of damage and make sure the insulation is intact on the larger line. Sometimes a sight glass is provided on the smaller line; if so, the flow of refrigerant should look smooth through the glass. Bubbles in the flow indicate a deficiency of refrigerant in the system. Frost on any exposed parts of the larger line also indicates a refrigerant deficiency.

Evaporator. The evaporator is enclosed in the air distribution ductwork and can only be observed by removing a panel or part of the furnace plenum. High-pressure liquid refrigerant enters the evaporator and expands into a gas, absorbing heat from the surrounding air.

Air is pushed past the evaporator coil by the circulation blower; in the process, water vapor from the air condenses on the evaporator coil and drips into a drain pan. From there, it is directed to a condensate drain line that may sometimes include a condensate pump. The drain line could empty into a house drain or be discharged to the building's exterior.

Monitor the ductwork around the evaporator for signs of air leakage and check below the evaporator for signs of water leakage due to a blocked condensate drain line. Such leakage can present a serious problem if the evaporator is located above a warm air furnace, where dripping condensate water can cause rust to develop on the heat exchanger, or above a ceiling, where it can damage the building components below. Follow the condensate line and make sure that it terminates in a proper location.

In split systems where the evaporator is located in an attic or closet, the condensate drain pan should have an auxiliary condensate drain line located above the regular drain line, and that would drain into a water leak catch pan. The auxiliary drain pan that is separately drained should discharge to an area that is conspicuous. If you see this pipe leaking water, it is a sign of a water leak problem.

Geothermal heating and cooling systems. Geothermal systems are relatively new and operate similarly to air-to-air heat pump systems, but differ in design and installation. What might be considered the condenser are pipes buried in the ground in dry wells or other in-ground systems suitable for transferring or displacing heat. The system is closed and its piping is PVC so corrosion is not a potential problem. Geothermal systems are normally installed without a back-up or emergency heating system, and all their components (except the buried coils) are usually inside the house.

A geothermal heating and cooling system can be operated in a heating or cooling mode under any outside temperature. Although expensive to install, they normally are efficient and economical to operate.

9.8 Central Gas-Absorption Cooling Systems

Gas-absorption cooling systems occasionally may be found in older residential buildings. Such systems use the evaporation of a liquid, such as ammonia, as the cooling agent, and like a gas refrigerator, are powered by a natural gas or propane flame. It should start smoothly and run quietly.

9.9 Heat Pumps

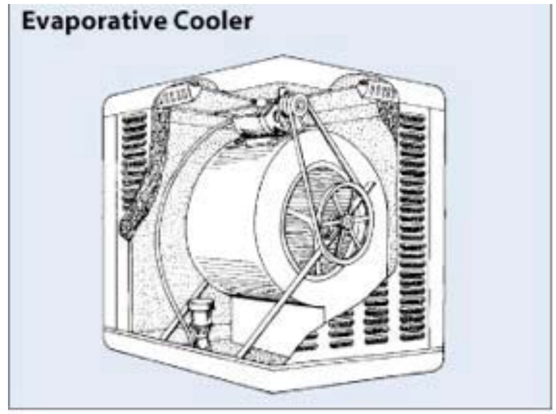
Heat pumps are like central air conditioners that can operate in reverse. Electric heat pumps are electrically operated, refrigerant-type air-conditioning systems that can be reversed to extract heat from outside air and transfer it indoors.

Cold temperatures. Do not operate air-to-air heat pumps in outdoor temperatures below 65 ºF (18 ºC) on the cooling cycle and above 55 ºF (13 ºC) on the heating cycle. Electric resistance auxiliary heaters are designed to activate when the outdoor temperature is around 30 ºF (-1 ºC), and the air-to-air heat pump cannot produce enough heat to satisfy the thermostat.

Improper defrosting. During cold, damp weather, frost or ice may form on the metal fins of the coil in an outdoor unit. Heat pumps are designed to defrost this build up by reversing modes either at preset intervals or upon activation by a pressure-sensing device.

9.10 Evaporative Cooling Systems (Swamp Coolers)

Evaporative cooling systems are simple and economical devices. They pass air through wetted pads or screens and cooling takes place by evaporation. Such systems can only be used in dry climates where evaporation readily takes place and where dehumidification is not required.



Evaporative coolers consist of evaporator pads or screens, a means to wet them, an air blower, and a water reservoir with a drain and float-operated water supply valve. These components are contained in a single housing, usually located on the roof, and connected to an interior air distribution system. In wetted-pad coolers, evaporator pads are wetted by a circulating pump that continually trickles water over them; in slinger coolers, evaporator pads are wetted by a spray; and in rotary coolers, evaporator screens are wetted by passing through a reservoir on a rotating drum.

The water in evaporative coolers often contains **algae** and **bacteria** that emit a characteristic **"swampy" odor**. These can be removed easily with bleach. Some systems counteract this pattern by treating the water or by continually adding a small amount of fresh water.

Monitor for signs of leakage and check the cleanliness and operation of the water reservoir, float-operated supply valve and drain. Listen for unusual sounds or vibrations.

9.11 Humidifiers

Humidifiers require consistent maintenance. Do not delay cleaning the humidifier, because a dirty humidifier can cause air quality problems.

A humidifier should only operate when the furnace fan is on, the system is in the heating mode and the indoor humidity is lower than the humidistat setting.

Humidifiers are sometimes added to warm-air heating systems to reduce interior dryness during the heating season. They are installed with the air distribution system and are controlled by a humidistat that is usually located in the return air duct near the humidifier housing.

Types of humidifiers:

Stationary pad: air is drawn from the furnace plenum or supply air duct by a fan, blown over an evaporator pad, and returned to the air distribution system.

Revolving drum: water from a small reservoir is picked up by a revolving pad and exposed to an air stream from the furnace plenum or supply ductwork.

Atomizer: water is broken into small particles by an atomizing device and released into the supply air ductwork.

Steam: water is heated to temperatures above boiling and then injected into the supply air duct.

Monitor for mineral build up on the drum or pad. Examine the humidifier's water supply and look for signs of leakage, especially at its connection with the house water supply. Check all electrical wiring and connections.

9.12 Unit (Window) Air Conditioners

Unit air conditioners are portable, integral air conditioning systems without ductwork. Look at the seal around each unit and its attachment to the window or wall. It should be adequately supported. It should not be obstructed. Look for proper condensate drainage. After several minutes, the air from the unit should feel quite cool. It should start smoothly and run quietly. Check for water dripping from the condensate discharge on the exterior side of the unit.

9.13 Whole House Fans

Whole house fan. The louvers of the whole house fan should open completely when the fan is running. Clean the louvers when they are dirty. Be sure to cover the fan opening when the unit is not being used, especially during the winter in cold climates. The fan thermostat should be set at around 95 ºF (35 ºC). The fan should start and run smoothly.

9.14 Inspection Standards

The HVAC (heating, ventilating, air conditioning) system is inspected using normal operating controls. The inspector is not required to inspect the flues or chimneys, fire chambers, heat exchangers, humidifiers, electronic air filters or geothermal systems. Underground or concealed fuel storage systems are beyond the visual scope of a home inspector. The inspector is not required to check uniformity, BTU, temperature, flow, balance, distribution, or adequacy of the HVAC system. The inspector is not required to activate a system that has been shutdown. An inspector is not required to operate the cooling system when the weather is cold, or operate the heating system when the weather is hot.

Chapter 10: Making Your Home Energy Efficient

Sealing and **insulating** your home is one of the most cost-effective ways to make a home more comfortable and energy efficient—and you can do it yourself.

In this chapter, you will learn how to find and seal hidden attic and basement air leaks; determine if your attic insulation is adequate and learn how to add more; make sure your improvements are done safely; and reduce energy bills and help protect the environment.

You will notice your home's air leaks in the winter more than any other time of year. Most people call these air leaks "drafts." You may feel these drafts around windows and doors and think these leaks are your major source of wasted energy. In most homes, however, the most significant air leaks are hidden in the attic and basement. These are the leaks that significantly raise your energy bill and make your house uncomfortable.

In cold weather, warm air rises in your house, just like it does in a chimney. This air, which you have paid to heat, is just wasted as it rises up into your attic and sucks cold air in all around your home—around windows, doors, and through holes into the basement. Locating these leaks can be difficult because they are often hidden under your insulation. This chapter will help you find these leaks and seal them with appropriate materials.
An inspector who is certified in the thermography and building science can help find these air leaks. To find a certified inspector go to www.inspectorseek.com. Ask the inspector if they are infrared-certified and look for the infrared-certified logo.

Infrared
certified

10.1 Getting started

Sealing attic air leaks will enhance the performance of your insulation and make for a much more comfortable home.

Attic air sealing and adding insulation are do-it-yourself projects if your attic is accessible and not too difficult to move around in. The projects in this chapter can usually be completed in two days and will provide rewards for years to come.

If you find any major problems in the attic space such as roof leaks, mold, unsafe working conditions, inadequate flooring, inadequate ventilation, knob-and-tube wiring, recessed "can" lights, we recommend hiring a contractor to help you and/or correct these problems before proceeding.

Look around your house for any dropped-ceiling areas, dropped soffits over kitchen cabinets, slanted ceilings over stairways, and where walls (interior and exterior) meet the ceiling. These areas may have open spaces that could be huge sources of air leaks.

10.2 Working in the Attic

Be sure to use a work light to make sure that your work area is lit adequately.

Use personal protective equipment. To work in an attic, you need kneepads, coveralls, gloves and a hat to keep itchy and irritating insulation off your skin. Use an OSHA-approved particulate respirator or a high-quality dust mask.

Be safe. Do not work in the attic area if you feel that it is dangerous in any way. It's not worth risking life or property. Simply hire a qualified contractor to perform the work you need to get done. If you work in a hot attic, drink plenty of water.

Watch your step. Walk on joists or truss chords. Watch your head - there will be sharp nails and things sticking out above you and all around your head.

10.3 What You Will Need

- Reflective foil insulation or other blocking material such as drywall or pieces of rigid foam insulation to cover soffits, open walls, and larger holes
- Unfaced fiberglass insulation and large garbage bags
- Silicone or acrylic latex caulk for sealing small holes (1/4 inch or less)
- Expanding spray foam insulation for filling larger gaps (1/4 inch to 3 inches)
- Special high-temperature (heat-resistant) caulk to seal around flues and chimneys
- Roll of aluminum flashing to keep insulation away from the flue pipe
- Tape measure
- Utility knife and sheet metal scissors
- Staple gun (or hammer and nails) to hold covering materials in place
- Plastic garbage bag

10.4 Plug the Large Holes

The biggest savings will come from sealing the large holes. Locate the areas from the attic where leakage is likely to be greatest: where walls (interior and exterior) meet the attic floor; dropped soffits (dropped-ceiling areas) and; behind or under attic knee walls. **Look for dirty insulation**. Dirty insulation (black/brown stains on the underside of the insulation) indicates that air is moving through it. Push back the insulation or pull it out of the soffits. You will place this insulation back over the soffit once the stud cavities have been plugged and the soffits covered.

Dropped soffit. After removing insulation from a dropped soffit, cut a length of reflective foil or other blocking material (rigid foam board works well). Apply a bead of caulk or adhesive around the opening. Seal the foil to the frame with the caulk/adhesive and staple or nail it in place, if needed.

Under a wall. Cut a 24-inch long piece from a batt of fiberglass insulation and place it at the bottom of a 13-gallon plastic garbage bag. Fold the bag over and stuff it into the open joist spaces under the wall (a piece of rigid foam board sealed with spray foam also works well for covering open joist cavities). Cover with insulation when you're done.

Finished rooms built into attics often have open cavities in the floor framing under the sidewalls or knee walls. Even though insulation may be piled against or stuffed into these spaces, they can still leak air. Again, look for signs of dirty insulation to indicate air is moving through. You need to plug these cavities in order to stop air from traveling under the floor of the finished space.

Flue. The opening around the flue or chimney of a furnace or water heater can be a major source of warm air moving in the attic. Because the pipe gets hot, building codes usually require 1-inch of clearance from metal flues (2 inches from masonry chimneys) to any combustible material, including insulation. This gap can be sealed with lightweight aluminum flashing and special high-temperature (heat-resistant) caulk. Before you push the insulation back into place, build a barrier out of the metal aluminum to keep the insulation away from the pipe.

10.5 Seal the Small Holes

Look for areas where the insulation is darkened. This is the result of dusty air coming from the house interior, and moving into and being filtered by the insulation. In cold weather, you may also see frosty areas in the insulation caused by warm, moist air condensing and then freezing as it hits the cold attic air. In warmer weather, you'll find water staining in these same areas. Use expanding foam or caulk to seal the **openings around plumbing vent pipes and electrical wires**. When the foam or caulk is dry, cover the area again with insulation. After sealing the areas, just push the insulation back into place. If you have blown insulation, a small hand tool can be helpful to level it back into place.

10.6 Attic Access

Seal up the attic access panel with weather stripping. Cut a piece of fiberglass or rigid foam board insulation the same size as the attic hatch and glue it to the back of the attic access panel.

If you have pull-down attic stairs or an attic door, these should be sealed in a similar manner using weather stripping and insulating the back of the door. Treat the attic door like an exterior door to the outside.

10.7 Ducts

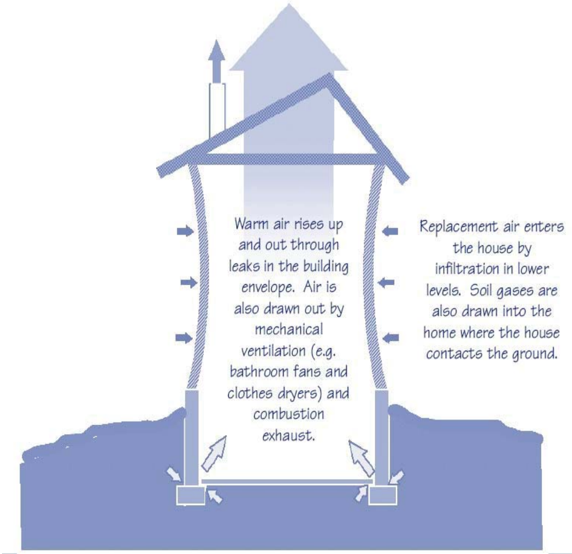
Sealing and insulating your ducts can increase the efficiency of your HVAC system. Leaky ducts waste an incredible amount of energy. Check the duct connections for leaks - seal the joints with mastic or foil tape (household duct tape should not be used). Pay special attention to all the duct penetrations going through the attic floor. Seal these with foam.

HVAC ducts should also be insulated—if your ducts are uninsulated or poorly insulated, seal them first, then add insulation. Use duct insulation material rated at least R-6. Duct sealant, also known as duct mastic, is a paste, which is more durable than foil duct tape. It is available at home improvement centers.

10.8 “Can” Lights

Recessed “can” lights (also called high-hats or recessed lights) can make your home less energy-efficient. These recessed lights can create open holes that allow unwanted airflow from conditioned spaces to unconditioned spaces. In cold climates, the heat from the airflow can melt snow on the roof and cause the development of ice dams. Recessed “can” lights in bathrooms also cause problems when warm, moist air leaks into the attic and causes moisture damage.

Warning: You can create a fire hazard if the “can” light is not insulated or sealed properly. It may be best to consult a professional before sealing “can” lights or coming in contact with any electrical components.



10.9 Stack Effect

Like a chimney. Outside air drawn in through open holes and gaps in the basement is drawn in by a chimney stack effect created by air leaks in the attic. As hot air generated by the furnace rises up through the house and into the attic through open holes, cold outside air gets drawn in through open holes in the basement to replace the displaced air. This makes a home feel drafty and contributes to higher energy bills. After sealing attic air leaks, complete the job by sealing basement leaks, to stop the stack effect.

Basement air leaks. Along the top of the basement wall where floor system meets the top of the foundation wall is a good area to look for open holes and gaps. Since the top of the wall is above ground, outside air can be drawn in through cracks and gaps where the house framing sits on top of the foundation.

Sealant or caulk is best for sealing gaps or cracks that are 1/4 inch or less. Use spray foam to fill gaps from 1/4 inch to about 3 inches. We also recommend you seal penetrations that go through the basement ceiling to the floor above. These are holes for wires, water supply pipes, water drainpipes, the plumbing vent stack, and the furnace flue.

Attic and basement air sealing will go a long way to improve your comfort because your house will no longer act **like an open chimney**.

10.10 Attic Insulation Thickness

Look. One quick way to determine if you need more insulation on the floor of your attic is to simply look across the floor of your attic. If the insulation is level with or below your floor joists, more insulation is needed. If the insulation is well above the joists, you may have enough. There should be no low spots.

R-Value. Insulation levels are specified by R-Value. R-Value is a measure of insulation's ability to resist heat flow. The higher the R-Value, the better the thermal performance of the insulation. The recommended level for most attic floors is R-38 or about 10 to 14 inches (depending on the type of insulation and your climate).

When adding insulation, you do not have to use the same type of insulation that currently exists in your attic. You can add loose fill on top of fiberglass batts or blankets, and vice-versa. If you use fiberglass over loose fill, make sure the fiberglass batt has no paper or foil vapor barrier. The insulation needs to be "unfaced."

Laying out or spreading fiberglass rolls is easy. If you have any type of insulation between the rafters, install the second layer over and perpendicular to the first. This will help cover the tops of the joists and reduce heat loss or gain through the frame.

NEVER! Never lay insulation over recessed light fixtures or soffit vents. Keep all insulation at least 3 inches away from "can" lights, unless they are rated IC (Insulated Ceiling). If you are using loose fill insulation, use sheet metal to create barriers around the openings. If using fiberglass, wire mesh can be used to create a barrier.

Rafter vent trays. To completely cover your attic floor with insulation out to the eaves you need to install rafter vents or trays (also called insulation baffles). Rafter vents ensure the soffit vents are clear and there is a clear opening for outside air to move into the attic at the soffits and out through the gable or ridge vent for proper ventilation.

10.11 Additional Information

For additional information on Indoor Air Quality (IAQ) issues related to homes such as combustion safety, indoor air contaminants, and proper ventilation, visit: http://www.epa.gov/iaq/homes/hip-front.html.

ENERGY STAR is a government-backed program helping businesses and individuals protect the environment through superior energy efficiency. To learn more about the wide variety of energy-efficient ENERGY STAR products and processes visit http://www.energystar.gov.

Chapter 11: Checklists for the Seasons

These are checklists that you can use and incorporate into your regular maintenance program for your house. They are broken up into seasons.

In the Spring:
- Check for damage to your roof
- Check all the fascia and trim for deterioration
- Have a professional air conditioning contractor inspect and maintain your system as recommended by the manufacturer
- Check your water heater
- Replace all extension cords that have become brittle, worn or damaged
- Check your fire extinguishers
- Clean the kitchen exhaust hood and air filter
- Review your fire escape plan with your family
- Repair all cracked, broken or uneven driveways and walks to help provide a level walking surface
- Check the shutoff valve at each plumbing fixture to make sure they function
- Clean clothes dryer exhaust duct, damper, and space under the dryer
- Inspect and clean dust from the covers of your smoke and carbon monoxide alarms

In the Summer:
- Check kids playing equipment
- Check your wood deck or concrete patio for deterioration
- Check the nightlights at the top and bottom of all stairs
- Check exterior siding
- Check all window and door locks
- Check your home for water leaks
- Check the water hoses on the clothes washer, refrigerator icemaker and dishwasher for cracks and bubbles

In the Fall:
- Check your home for water leaks
- Have a heating professional check your heating system every year
- Protect your home from frozen pipes
- Run all gas-powered lawn equipment until the fuel is gone
- Test your emergency generator
- Have a certified chimney sweep inspect and clean the flues and check your fireplace damper
- Remove bird nests from chimney flues and outdoor electrical fixtures

- Inspect and clean dust from the covers of your smoke and carbon monoxide alarms
- Make sure the caulking around doors and windows is adequate to reduce heat/cooling loss
- Make sure that the caulking around your bathroom fixtures is adequate to prevent water from seeping into the sub-flooring

In the Winter:

- Clean the gutters and downspouts
- Confirm firewood at least 20 feet away from your home
- Remove screens from windows and install storm windows
- Familiarize responsible family members with the gas main valve and other appliance valves
- Clean the clothes dryer exhaust duct, damper and space under the dryer
- Make sure all electrical holiday decorations have tight connections
- Clean the kitchen exhaust hood and air filter
- Check the water hoses on the clothes washer, refrigerator icemaker and dishwasher for cracks and bubbles
- Check your water heater
- Test all AFCI and GFCI devices

Chapter 12: Service Life Expectancies

Appliance
Life Expectancy in Years

Air conditioner compressor
12-15
Asphalt, wood shingles & shakes
15–40
Asphalt composition shingle
15–40
Asphalt driveways
8-12
Baseboard systems
15-25
Boilers, hot water or steam
25-35
Brick and concrete patios
15-25
Brick and stonewalls
100+
Built-up roofing, asphalt
10–26
Central air conditioning unit
12-15
Compactors
6-10
Concrete block foundations
100+
Concrete walks
10-20
Dishwashers
8-10
Dryers
8-14
Disposal
8-10
Electric ranges
14-18
Electric water heater
5-12
Exhaust fans
5-10
Faucets
10-15
Fences
10-15
Forced air furnaces, heat pump
12-18
Freezers, standard
10-20
Furnaces, gas- or oil-fired
15-20
Garage door opener
8-12
Garage doors
20 to 25
Gas ovens
10-18
Gas ranges
12-20
Gas water heater
6-12
Gravel walks
4-6
Gutters and downspouts
25-30
Heat Exchangers, shell-and-tube
10-15
Humidifier
5-7
Microwave ovens
9-13
Poured concrete foundations
100+
Pumps, sump and well
5-12
Refrigerators
10-18
Rooftop air conditioners
14-18

Sheet metal
20-50
Siding, aluminum
20-40
Siding, steel
30-50
Siding, vinyl
30-45
Siding, wood
12–100
Sinks, china
15-20
Sinks, enamel cast iron
20-30
Sinks, enamel steel
5-10
Slate
40-100
Smoke detectors
5-10
Sprinkler systems
10-14
Stucco
20-40+
Swimming pools
10-20
Termite proofing
5-7
Tile
30-40+
Washers, clothes
12-16

Waste piping, cast iron
50-100
Window a/c unit
5-8
Wooden decks
12-20