Keep it Maintained

In this module, we will be focusing first on maintenance in general and second on contaminants not previously addressed including those that are associated with maintenance problems such as lead-based paint and asbestos, and others such as radon.

Contaminants and Maintenance

Contaminants associated with maintenance include:

Legacy Toxics

- Lead-Based Paint
- Asbestos
  - Siding
  - Plaster
  - Insulation

Additional contaminants (not covered in this course) include:

- Chromated Copper Arsenate Wood
- Mercury
  - Thermometers & Flourescent Lamps
- Pesticide Residues

Other Problems Associated with Maintenance include:

- Cockroaches
- Mice and Rats
- Mold
- Carbon Monoxide
- Sewer Gas
- **And Then There is Radon…**

Maintenance

Proper, routine maintenance of the items below will prevent substantial moisture sources and associated health hazards.

- Solid waste storage and removal processes
- Water supply system

Learning Objectives for this module

- Identify at least three systems that require ongoing maintenance.
- Identify two maintenance actions that require the use of a professional.
- Name at least two health effects from lead.
- Identify housing targeted by the RRP rule.
- Describe the two ways to mitigate radon in a home.

- Sewer system
- Heating/cooling/dehumidification/humidification systems
- Cooking
- Cooking areas
- Ventilation
- Rainwater control/drainage
- Structural integrity
- Storage / Organization

Maintenance Actions to Remember

- Inspect
- Clean
- Lubricate
- Replace
- Repair
- Organize

The first step in maintenance is to inspect systems and appliances regularly to ensure their proper function. Routine cleaning and lubrication are needed for some systems. Repair and replace systems immediately when they fail.

Some systems have items such as filters, which must be routinely replaced (usually every 3 months) to prevent clogged filters from blocking proper air flows.

Poor maintenance of the downspout in this picture caused rainwater to be deposited next to the foundation.

How's the filter? A clogged low efficiency filter partically sucked out of the frame.

General maintenance activities should be on-going, with seasonal and annual components.

Lead and Lead-Based Paint

To the right are key sources of lead in a home.

Federal EPA standards define lead-based paint hazards to include:

- Deteriorated lead-based paint
- Lead in dust that exceeds certain thresholds. There are standards for lead dust on floors, window sills and window troughs.
- Lead in soil that exceeds certain thresholds.

EPA has also set a level of lead in drinking water that is considered a hazard. Additionally, some pottery, produced in other countries can have lead in the glazes. The Consumer Product Safety Improvement Act (CPSIA) of 2008 set new limits for the lead content in children's products and the amount of lead in the paint used on those products. The standard was phased in over a period of three years. According to the current standards:

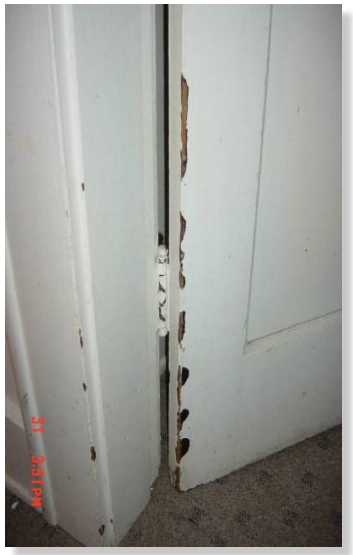
Lead and Lead-Based Paint

- Peeling, Chipping Paint / Deteriorated Paint
- Dust
- Soil
- Drinking Water
- Consumer Products such as Pottery, Cribs, Jewelry, Candle Wicks
- Cultural Items
- Contaminated Sites

- Products designed or intended primarily for children 12 and younger may not contain more than 100 ppm of lead (effective August 14, 2011).
- Paint and similar surface-coating materials for consumer use must not exceed 90 ppm of lead (effective August 14, 2009).

Why Lead?

Lead was added to paint to make it more durable. We therefore find lead-based paint more frequently on exterior surfaces and on windows and doors which require a more durable paint. We are most likely to find leaded paint outside in older homes. The second greatest use of leaded paint is on doors and windows inside older homes. Often windows have deteriorated paint, as windows experience moisture due to variations between inside and outside temperatures, causing causes paint failure.



Why Avoid Lead?

- Reduced IQ
- Learning disabilities
- Impaired hearing
- Reduced attention spans, behavior problems
- Anemia
- Kidney damage
- Damage to central nervous system
- Coma, convulsions, death

We can see deteriorated paint. It can be peeling, flaking, chipping or chalking.

Chalking is when paint leaves a whitish film. You may have walked alongside a building and then noticed a white film on your clothing. This is chalking. The paint was designed to do this and help keep the exterior clean. Unfortunately, the chalking can contain lead.

Lead: Age of Housing Matters

Of all U.S. housing stock, 40% of houses contain lead-based paint because so much of the housing stock is old. Lead was banned from use in residential paint in 1978 in the United States. The lead industry began voluntarily phasing out lead in paint in the mid 1950's. The chart to the left shows this trend. Nearly 9 of 10 homes built before 1940 have lead-based paint somewhere in the building.[1] More than ½ of homes built in the 1950's have some lead-based paint and the use of lead in paint declines sharply in the 1960's.

Year House Was Built	Percent of Houses with Lead-Based Paint
Before 1940	87 percent
1940-1959	69 percent
1960-1978	24 percent
All US Housing Stock	40 percent

Prevelance of Deteriorating Paint

- 2.1% of homes have broken plaster or peeling paint
- Conditions that deteriorate paint - in past twelve months
  - 8.5% of homes had interior water leakage
  - 11% of homes had exterior water leakage
- Source: American Housing Survey - 2011

Source: American Housing Survey - 2011

Available Testing for Lead Hazards

Besides just looking, we have tools to test for lead in paint, dust, soil and drinking water. Testing may be one of the actions recommended after analysis of the interview and inspection. People who are sampling for clearance testing usually need to be licensed.

Paint	Dust - Clearance Testing	Bare Soil	Drinking Water
Paint chip (laboratory test)	Floors: 40 micrograms per square foot (µg/ft^2)	Play areas: 400 parts per million (ppm)	Public water supply: 15 ppb
On-site test kits	Sills: 250 µg/ft^2	Other areas: 1,200 ppm	
	Troughs: 400 µg/ft^2		

EPA's Renovation, Repair, and Painting (RRP) Rule allows Certified Renovators to use an EPA-recognized paint test kit to determine whether paint is lead-based. EPA posts a list of all recognized paint test kits (www.epa.gov/lead/testkit.html#recognized).

As of November 2012, EPA has recognized the following three paint test kits:

- 3MleadCheck
- D-Lead
- State of Massachusetts Lead Kit

EPA Lead Renovation, Repair and Painting (RRP) Rule

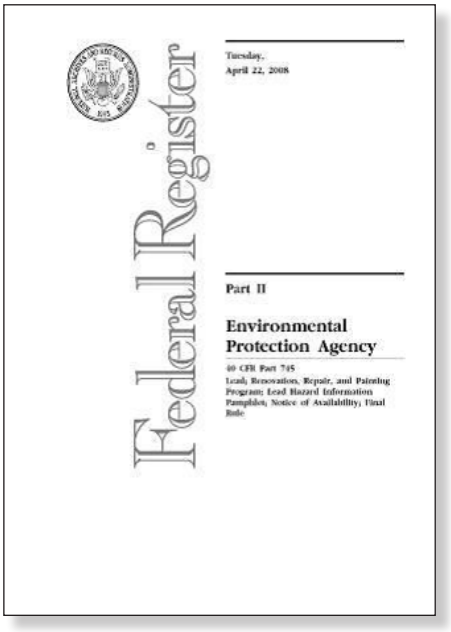
If housing is receiving federal assistance, contractors must comply with HUD's 1012/1013 regulation.

- Effective April 22, 2010
- Applies to pre-1978:
  - Target Housing (same as disclosure rule)
  - Child-occupied facilities
- Triggers:
  - Compensation
  - Paint disturbance (a/k/a renovation)
- 40 CFR 745.80 to 745.91
- April 22, 2008 Federal Register

Authorized States

Twelve states have been authorized to administer and enforce the RRP Rule.

- Alabama
- Georgia
- Iowa
- Kansas
- Massachusetts
- Mississippi
- North Carolina
- Oregon
- Rhode Island
- Utah
- Washington
- Wisconsin



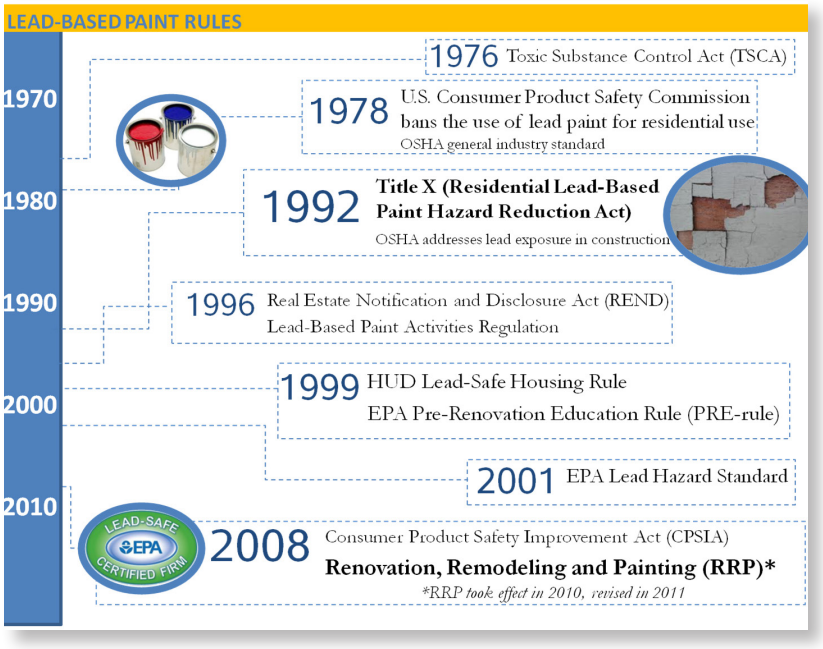
Impacts of RRP Rule

- 8.4 million renovation events annually
  - Impact may drop to 4.4 million events
- Requires certification of:
  - 210,000 renovation firms by EPA after October 22, 2009
  - 235,000 individuals by accredited trainers after April 22, 2009
- Estimated by EPA to add $35 per job

Essentials for Healthy Homes Practitioners

Why Now?

- Final major rule from the Residential Lead-based Hazard Reduction Act of 1992
- Congress required rule to be finalized in 1996
- Still to come:
  - Public buildings built before 1978
  - Commercial buildings that create lead-based paint hazards



Detailed Timeline of Lead-Based Paint Rules

- **1976 — Toxic Substance Control Act (TSCA)**
- **1978 — U.S. Consumer Product Safety Commission** bans the use of lead paint for residential use
- **1978 — OSHA** promulgates a final occupational lead standard for general industry (excluding the construction industry). The 1978 lead standard required that the permissible exposure limit be achieved, to the extent feasible, by engineering and work practice controls and in addition included a number of ancillary provisions requiring employers to provide medical surveillance, medical removal protection (MRP), hygiene facilities, appropriate respirators, and air monitoring, among other things.
- **1992 Title X**. The Residential Lead Based Paint Hazard Reduction Act, better known as Title X (ten) was enacted, amending the Toxic Substances Control Act to add a Title IV on Lead Exposure Reduction. Title X emphasized prevention of lead poisoning via lead-based paint and directed agencies to develop regulations for disclosure and other activities.
- **1992 — OSHA** proposes to amend its existing air contaminants standards to reduce the permissible exposure limit for lead in construction.
- **1996 — *The Real Estate Notification and Disclosure* 1996**
- **1996 — The Lead-Based Paint Activities** regulation (1996) has work practice, training, and certification standards for LBP "activities" which are abatement, risk assessment, and paint inspection. EPA has authorized 35 states to run the program.
- **1999 — HUD Lead-Safe Housing Rule** requires federally assisted housing to notify, evaluate, and reduce lead based paint hazards.
- **1999 — EPA Pre-Renovation Education Rule (PRE-rule)** requires distribution of the lead pamphlet, Protect Your Family from Lead in Your Home, to the owners and occupants before starting renovation work.

- **2001 — EPA Lead Hazard Standard** defined lead-based paint hazards and established limits for lead content in settled house dust and soil including clearance standards.
- **2008 — Consumer Product Safety Improvement Act (CPSIA)** of 2008 set limits for the lead content in children's products and the amount of lead in the paint used on those products and in general
- **2008 — The Renovation, Remodeling and Painting (RRP) regulation** (EPA 2008) proposed rule requires workers and contractors to be certified and follow safe practices when working in pre-1978 housing unless a paint test proves there's no lead paint in the work area.
- **2010 — RRP takes full effect** in April 2010 (superseding the PRE rule). EPA has authorized 12 states to run the program.
- **2011 — RRP updated** to allow certified renovators to collect paint chip samples for analysis by a recognized laboratory (in lieu of lead test kits), add standards for e-learning in accredited programs, articulate minimum enforcement provisions for authorized state and tribal programs and clarify the requirements for vertical containment on exterior renovation projects, the prohibited or restricted work practice provisions, and the requirements for high-efficiency particulate air (HEPA) vacuums. Some minor changes were also made to the training program accreditation and application process.

***Important notes*:**

- Lead abatement projects are designed to permanently eliminate existing lead-based paint hazards, and may be ordered by a state or local government in response to a lead-poisoned child or other reason. Only trained and certified individuals may perform lead abatement.
- Renovation, repair and painting (RRP) projects are typically performed at the option of the property owner for aesthetic or other reasons, or as an interim control to minimize lead issues. It is not designed to permanently address lead-based paint. However, RRP projects can disturb lead-based paint in homes and buildings built before 1978 and cause lead hazards, even when none existed before. Therefore, they are also regulated and require certification. If you are seeking information on EPA's rules requiring lead-safe renovation, repair and painting to prevent lead hazards see EPA's Renovation, Repair and Painting (RRP) Program page.

The above timeline relates primarily to lead paint. EPA and CDC have other important regulations in place governing blood lead levels and lead in the soil, water and air.

Please see the following websites for additional information:

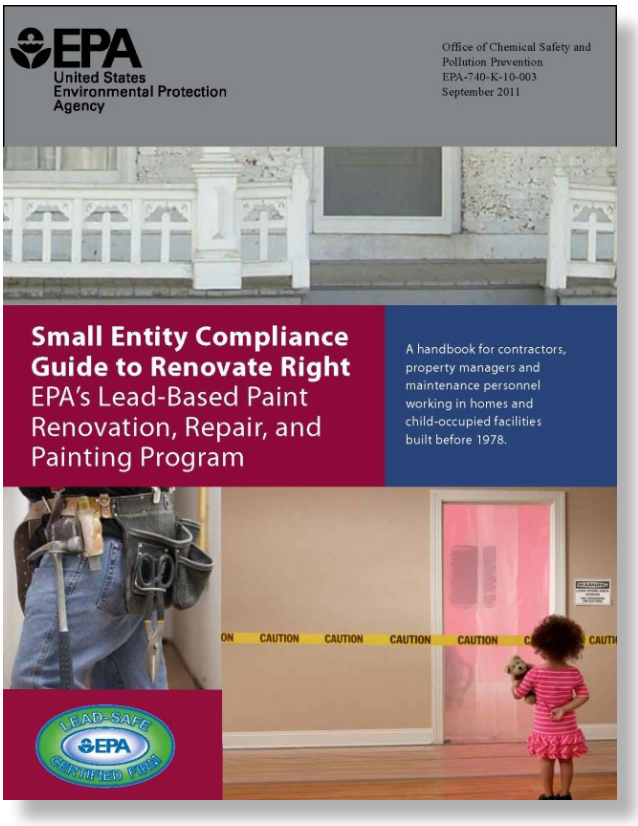
www.epa.gov/lead

www.epa.gov/lead/pubs/renovation.htm

www.hud.gov/lead

So What Will Change?

- Certified Renovation Firm Disturbs Paint
  - EPA or State Certification (after 10/22/09)
  - Fees and five-year renewal
- Certified Renovators Supervise Work
  - One-day training (after 4/22/09)
  - Five-year renewal
- Mandatory Work Practices
  - Isolate work area
  - Contain dust
  - Thoroughly clean-up work area for debris and dust
- Post-renovation Cleaning Verification
- Documentation



Summary of Requirements

- Interior
  - Containment including 6' of plastic in all directions from outer most area of disturbance (horizontal only)
  - Cover and seal to the floor all non-moveable items within plastic work area.
  - Cover and seal all windows, doors, and HVAC vents within work area.
  - Prohibited practices.
- Exterior
  - Containment including 10' of plastic in all directions from outer most area of disturbance (horizontal only).
  - Also 20' critical containment area consisting of physical barrier and posted signs.
  - If work is within 10' of neighboring property line, containment must include vertical plastic.
  - Prohibited practices.

How Clean is Clean?

Determining if the house is clean after renovation is often difficult because there are very few standards for cleaning. However, there are standards for lead dust at 40 CFR Section 765.

- 40 micrograms of lead per square foot on floors.
- 250 micrograms of lead per square foot on window sills.
- 400 micrograms of lead per square foot on window troughs.

There are also standards for lead in soil. A sugar packet of contains one gram of sugar. If the sugar would be all lead, 40 ug/ft^2 would be equivalent to spreading the sugar packet over 25,000 ft^2 —one–third of a football field. Open a packet and sprinkle it on the floor to imagine this distribution.

HUD's clearance dust standards for single–surface wipe samples are 40 ug/ft^2 for floors, 250 ug/ft^2 for interior window sills, and 400 ug/ft^2 for window troughs. The dust–lead level must be less than the applicable standard for the surface to pass clearance.

The EPA has developed a federal course for lead inspection, risk assessment and sampling technicians. Inspectors receive 3 days of training and are taught to test lead in paint using an XRF device, to sample for lead in dust, and to complete a full inspection for lead in paint. They can also do lead dust clearance testing following lead abatement and renovation work. Risk assessors have 5 days of training, which includes the 3 days of inspector training plus 2 additional days learning how to sample lead in soil and conduct a risk assessment looking for lead in paint, soil and dust. They also learn how to recommend solutions for lead hazards. Sampling technicians are the newest discipline and accepted in some but not all states. This one day course teaches students to sample lead in dust. Once they have state certification, they are qualified to perform clearance testing after lead hazard control work but not abatement work. They can also assess lead dust levels in properties to identify lead problems.

Lead Disclosure

- At property transfer, provide buyer/renter:
  - Lead warning statement
  - Summary of information on lead hazards (yes, no, don't know)
  - Documents on specific information about lead-based paint and lead hazards.
  - Tenant signature
- Rentals
  - Common Area results must be disclosed to all tenants.
  - At lease signing
  - Applies to oral leases

Housing Code Provisions Related to Paint

- **304.2 Protective treatment**.
  - All exterior surfaces, including but not limited to, doors, door and window frames, cornices, porches, trim, balconies, decks and fences shall be maintained in good condition.
  - Exterior wood surfaces, other than decay-resistant woods, shall be protected from the elements and decay by painting or other protective covering or treatment.
  - Peeling, flaking and chipped paint shall be eliminated and surfaces repainted.

- **304.6 Exterior walls**.
  - All exterior walls shall be free from holes, breaks, and loose or rotting materials and maintained weatherproof and properly surface coated where required to prevent deterioration.
- **305.3 Interior surfaces**.
  - All interior surfaces, including windows and doors, shall be maintained in good, clean and sanitary condition. Peeling, chipping, flaking or abraded paint shall be repaired, removed or covered. Cracked or loose plaster, decayed wood and other defective surface conditions shall be corrected.

Asbestos

Asbestos was used in building materials from around 1900 to 1978. It can be found in many items, including old floor tiles, siding, roofing materials, and around pipes. Some roofing and siding shingles are made of asbestos cement. Houses built between 1930 and 1950 may have asbestos insulation.

Additional locations for asbestos:

- Asbestos may be present in textured paint and in patching compounds used on wall and ceiling joints. Their use was banned in 1977.
- Artificial ashes and embers sold for use in gas-fired fireplaces may contain asbestos.
- Older products such as stove-top pads may have some asbestos compounds.
- Walls and floors around woodburning stoves may be protected with asbestos paper, millboard, or cement sheets.
- Asbestos is found in some vinyl floor tiles and the backing on vinyl sheet flooring and adhesives.
- Hot water and steam pipes in older houses may be coated with an asbestos material or covered with an asbestos blanket or tape.
- Oil and coal furnaces and door gaskets may have asbestos insulation.

Why avoid asbestos?

From studies of people who were exposed to asbestos in factories and shipyards, we know that breathing high levels of asbestos fibers can lead to an increased risk of:

- lung cancer
- mesothelioma, a cancer of the lining of the chest and the abdominal cavity
- asbestosis, in which the lungs become scarred with fibrous tissue.

The risk of lung cancer and mesothelioma increases with the number of fibers inhaled. The risk of lung cancer from inhaling asbestos fibers is also greater if you smoke. People who get asbestosis have usually been exposed to high levels of asbestos for a long time. The symptoms of these diseases do not usually appear until approximately 20 to 30 years after the first exposure to asbestos.

How to Handle Asbestos

- LEAVE IT ALONE (if in good condition).
- Look for signs of wear or damage such as tears, abrasions, or water damage but avoid touching the material.
- If damaged, or if renovation might disturb it, repair or removal by a licensed professional is needed.

Vermiculite[2]

What is Vermiculite Insulation?

Vermiculite is a naturally occurring mineral that has the unusual property of expanding into worm-like accordion shaped pieces when heated. The expanded vermiculite is a light-weight, fire-resistant, absorbent, and odorless material. These properties allow vermiculite to be used to make numerous products, including attic insulation.

Do I Have Vermiculite Insulation?

Vermiculite can be purchased in various forms for various uses. Sizes of vermiculite products range from very fine particles to large (coarse) pieces nearly an inch long. Vermiculite attic insulation is a pebble-like, pour-in product and is usually lightbrown or gold in color. The pictures above several samples of vermiculite attic insulation.

Is Vermiculite Insulation a Problem?

Prior to its close in 1990, much of the world's supply of vermiculite came from a mine near Libby, Montana. This mine had a natural deposit of asbestos which resulted in the vermiculite being contaminated with asbestos. Attic insulation produced using vermiculite ore, particularly ore that originated from the Libby mine, may contain asbestos fibers. Today, vermiculite is mined at three U.S. facilities and in other countries which have low levels of contamination in the finished material.

How can I Tell if My Vermiculite Insulation Contains Asbestos?

You should assume that vermiculite insulation is from Libby and treat the material as if it contained asbestos by not disturbing it or by using a trained professional if it needs to be removed. Since the Libby mine was estimated to be the source of over 70 percent of all vermiculite sold in the U.S. from 1919 to 1990 and vermiculite from Libby was contaminated with asbestos, further testing is not necessary to take the appropriate precautions. While you can hire a trained professional to test your attic for asbestos, this may be expensive and, depending on the methods used, might give you erroneous results. We do not recommend that you open your walls to check for vermiculite.

Asbestos Regulations

According to the U.S. EPA, asbestos is often present in a wide variety of products and materials. See http://www.epa.gov/asbestos/learn-about-asbestos.html#find. Over 3,000 products contain asbestos, including:

- Attic and wall insulation produced containing vermiculite
- Vinyl floor tiles and the backing on vinyl sheet flooring and adhesives
- Roofing and siding shingles

On April 6, 1973, the EPA prohibited spray application of products containing more than 1% asbestos by weight, and adopted a regulation prohibiting any "visible emissions" in milling and manufacturing operations and during the demolition of buildings.[3] Financial penalties applied. In 1978, the EPA expanded the spray ban to include spray application of such products for "decorative" purposes.[4]

On October 14, 1975, the EPA defined "friable asbestos material" as any material containing more than 1% asbestos by weight that can be crumbled, pulverized, or reduced to powder, when dry, by hand pressure, and required that prior removal of asbestos material occur any time > 206 linear feet of pipe insulation or 160 square feet of friable surface-applied asbestos material was disrupted during building demolition or renovation.[5] The EPA also banned installation of asbestos block insulation on boilers and water tanks in 1975.[6] These regulations remain in effect today. The EPA has a clearance level for determining whether a building is safe to occupy after asbestos removal activities have occurred. This level is currently 0.1 fibers·cm-3 as measured by transmission electron microscopy (TEM), for airborne asbestos fibers > 5 µm in length and with an aspect ratio of > 3:1.

In 1976, the Toxic Substances Control Act (TSCA) was passed, conferring additional authority upon the EPA to regulate asbestos.[7] Under the Act, the EPA was empowered to monitor chemical substances and regulate any chemical determined to pose an "unreasonable risk" to human health and/or to the environment.[7] In 1989, after determining that asbestos posed such a risk, the EPA issued a final rule under the TSCA, prohibiting the manufacture, importation, processing, and distribution of most asbestos-containing products in commerce.[8] The rule contemplated a three-stage process during which certain products would be completely phased out of commerce over a several year period.[8] In 1991, however, the Fifth Circuit Court of Appeals vacated the rule in *Corrosion Proof Fittings v. EPA, 947 F.2d 1201 (5th Cir.1991), concluding that the EPA failed to give sufficient* consideration to its statutory mandate to promulgate regulations which achieve protective purposes in the least-burdensome manner available. The court also determined that the EPA failed to provide the public with proper notice and failed to demonstrate the alleged benefits of the rule by neglecting to assess the harmfulness of likely substitute products.[9] In the aftermath of the Court's decision, the rule continues to ban only new uses of asbestos as well as asbestos containing flooring felt, rollboard, and corrugated, commercial, or specialty paper.[6]

In 1986, the EPA began enforcement of the Asbestos Hazard Emergency Response Act (AHERA), signed into law as Title II of the TSCA. AHERA required that all school buildings in the United States be inspected for asbestos-containing materials, that the location and amount of such materials be documented, and that emissions of fibers from such materials be prevented.

The Asbestos School Hazard Abatement Reauthorization Act (ASHARA), adopted in 1990, amended AHERA to require accreditation for individuals performing asbestos inspections and abatement projects in school, commercial, and public buildings. In addition to administering the contaminant-focused legislation discussed above, the EPA also monitors asbestos within the context of other pieces of legislation.

Congress adopted the Safe Drinking Water Act (SDWA) in 1974, which charges the EPA with identifying safe levels (termed maximum contaminant level goals (MCLG)), of contaminants in drinking water. The asbestos MCLG is 7 MFL (million fibers/L). In 1996, Amendments to the SDWA required the EPA to review the validity of each contaminant level every six years. To date, the EPA has conducted two such six-year reviews, confirming the appropriateness of the 7 MFL asbestos level in both 2003 and 2010.

The EPA also regulates asbestos under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), enacted by Congress in 1980. CERCLA, often referred to as Superfund, provides that the term "hazardous substance," as contemplated by the Act, includes any hazardous pollutant identified in Section 112 of the Clean Air Act, which incorporates asbestos. The Act authorizes the EPA to ensure that entities responsible for releasing hazardous substances into the environment cooperate in short-term removal or long-term remedial response cleanup efforts. To date, several clean-up sites targeted under CERCLA have been contaminated by asbestos. The EPA has developed a resource entitled "Asbestos Compendium of Technical Resources," to guide investigative efforts at asbestos-contaminated superfund sites.

National Emission Standard for Air Hazardous Air Pollutant (NESHAP)

- Applies to buildings with more than 4 units
- Work practices, training and notice to EPA

Model Asbestos Program for States

- Applies to buildings with more than 10 units
- Work practices and training

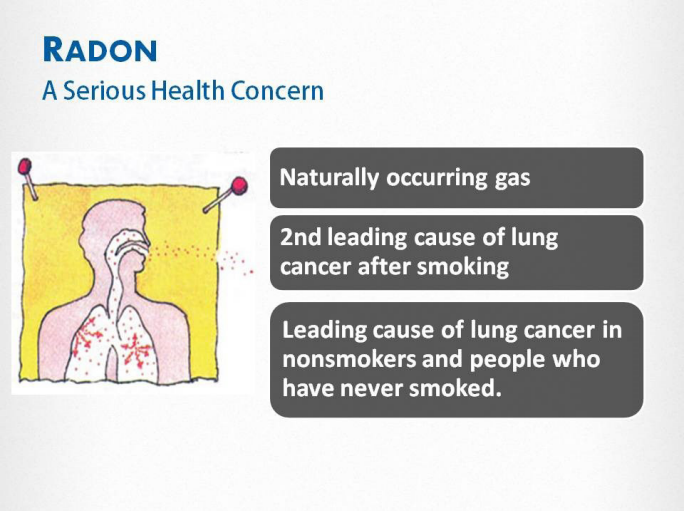
EPA's Ban on Asbestos in Products Reversed in 1992

OSHA Standards for Workers

- http://www.osha.gov/SLTC/asbestos/standards.html

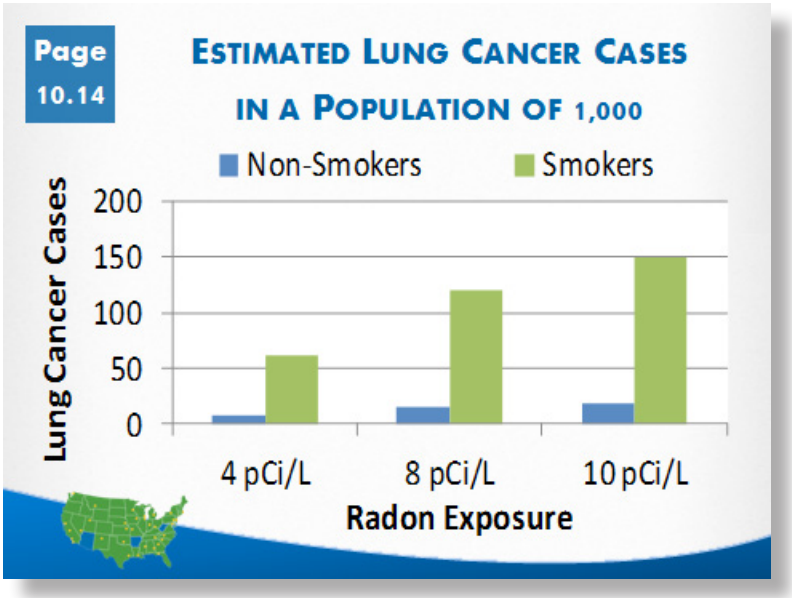
Radon

Radon is a naturally occurring gas produced by the breakdown of uranium and radium in soil, rock, and water. Naturally occurring uranium and radium exist in the ground –especially in granite, shale, phosphate, or pitchblend. Uranium spontaneously breaks down into radium and radium spontaneously breaks down into radon. Radon is a gas that can be carried into the home. Radon spontaneously breaks down into radioactive elements (sometimes called radon decay products) that have a static charge which attracts them to particles such as smoke and dirt. Residents breathe the radioactive elements into their lungs. Residents who smoke breathe in more radioactive elements deep into their lungs. The radioactive elements spontaneously break down to release bursts of energy which damages DNA in the lungs. This can lead to cancer.



Radon is a Class A carcinogen. The National Academy of Sciences (NAS) has determined that radon is the second leading cause of lung cancer overall and the leading cause of lung cancer in non-smokers. In its "Assessment of Risks from Radon in Homes,"[10] EPA estimated that out of a total of 146,600 lung cancer deaths nationally in 1995, 21,100 (14.4%) were radon related. Among non-smokers, an estimated 26% were radon-related.

EPA's reports estimate that there are about 3,000 deaths due to radon from lung cancer in people who have never smoked. EPA reports that this number is three times more than environmental tobacco smoke-related lung cancer deaths in people who have never smoked.[11]



Data for the figure to the left were obtained from EPA's "Home Buyer's and Seller's Guide to Radon".[12]

EPA recommends that action to reduce radon be taken whenever levels are above 4 pCi/L or picoCuries per liter of air; a unit of measure for radon.

For smokers, the risk of lung cancer is even more significant than for non-smokers due to the synergistic effects of radon and smoking. In a population of 1,000 exposed to 4 pCi/L of radon over their lifetimes, EPA estimates that 7.3 people will get lung cancer. The risk is much greater for smokers exposed to the same level of radon. EPA estimates that 41 out of 1,000 smokers exposed to this level of radon over their lifetimes will get cancer.

Put another way, a person who never smoked and is exposed to 1.3 pCi/L of radon has a 2 in 1,000 chance of lung cancer; while a smoker in a similar scenario has a 20 in 1,000 chance of lung cancer. The above chart shows the increased risk of lung cancer for smokers versus non smokers exposed to the same level of radon. At 8 pCi/L the risk to smokers is six times the risk to non-smokers. For non-smokers, EPA estimates that radon and environmental tobacco smoke are the leading causes of lung cancer.

One out of every 15 homes is estimated to have an elevated radon level (above EPA action level of 4 pCi/L). Some regions have higher radon levels; radon is found in every state. A map showing radon levels across the nation is available on-line at www.epa.gov/radon/zonemap.html. Each block is a county (or a parish in Louisiana).

Keep in mind that:

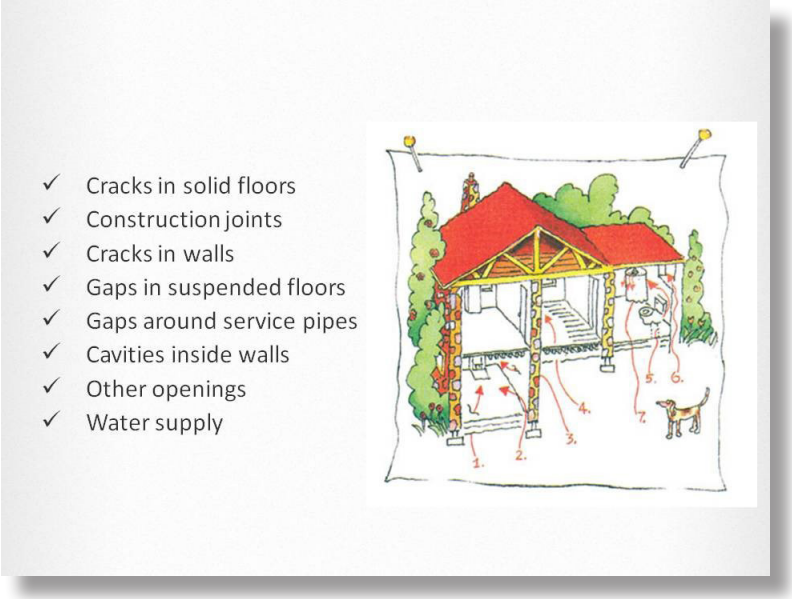
- Some states and EPA regions consider the map to be outdated—some states have better and newer maps. Many states have collected radon data over the past ten years and have more current data than EPA. Some states, such as Florida and New Jersey, have identified their radon high-risk areas.
- The map should be used for radon-resistant new construction only when no local information is available. It should also be used for prioritizing radon outreach activities. The map provides general guidance on anticipated indoor radon levels, i.e., areas of the country where homes are likely to have measurable radon. The map is not an exact predictor of indoor radon levels.
- The only way to know if radon is a problem is to test for it. The map may not be accurate for your specific location. The U.S. Surgeon General recommends testing all homes for radon—not just those in some areas on the map.
- Radon comes from uranium and radium in rock, soil and water. Consequently, the location of radon is not unified in the country. EPA's map of radon zones show trends in radon levels. Although a Zone 1 designation reflects the high risk potential for radon, elevated radon levels are found in all states.

Map Key:

- Red - Zone 1 is where radon is the biggest problem. EPA predicts that red counties have a predicted average indoor radon screening level greater than 4 picocuries per liter (pCi/L).
- Orange - Zone 2 is where EPA predicts that counties have a predicted average indoor radon screening level between 2 and 4 pCi/L.
- Yellow - Zone 3 is where EPA predicts that counties have a predicted average indoor radon screening level less than 2 pCi/L.

How Radon Gets into a Home

This graphic was taken from EPA's "Citizen's Guide to Radon" (EPA 402-K-02-006, May 2004, pg 4).[17]



You cannot see or smell radon. It is an invisible radioactive gas that comes from the natural decay of uranium that is found in nearly all soils. Air pressure inside the home is usually lower than the pressure in the soil around the home's foundation. Because of this difference in pressure, the house can act as a vacuum, drawing air and radon in through foundation cracks, and other openings. It typically moves up through the ground to the air above and into your home through cracks and other holes in the foundation. A home can trap radon inside, where it can build up. Any home may have a radon problem. This means new and old homes, well-sealed and drafty homes, and homes with or without basements.

Radon from soil gas is the main cause of radon problems. Although the ground is the major source of radon for most homes, sometimes radon enters the home through well water. An NAS report (BEIR VI) issued earlier this year confirmed that there are drinking water related cancer deaths primarily due to lung cancer (less than 200 lung-cancer deaths per year).

The NAS report confirms that the estimated risk posed by radon from drinking water is small, relative to exposure to radon in indoor air, but is larger than the risk from other regulated drinking water contaminants. Most of the cancer risk from radon in drinking water arises from the transfer of radon into indoor air, and exposure through inhalation, although there is some risk from ingesting water containing radon. In a small number of homes, the building materials can give off radon, too. However, building materials rarely cause radon problems by themselves.

Testing for Radon

Detector Types: Charcoal canister devices absorb radon or its products on to the charcoal. Alpha track detectors have a plastic film that gets etched by the alpha particles that strike it. Electric ion detectors have a Teflon disc, which is statically charged. When an ion generated from radon decay strikes the Teflon disc, the electrical charge is reduced. The top photo on the next page is a short-term test kit. The bottom photo is a long-term test kit.

How/When to Test: In new construction, test homes after construction is complete but before occupancy. In existing housing, EPA and the US Surgeon General recommend testing all homes below the third floor. Be sure to test before and after renovation, at purchase, or at new occupancy.

Essentials for Healthy Homes Practitioners

Short Term
- Minimum 48 hours
- $10-$20
- Useful results (home sales, rental, occupancy)

Long Term
- 91 days to 1 yr
- $20-$30
- Better indicator of need to mitigate

If result is 4 pCi/L or higher take a follow-up test OR fix the home

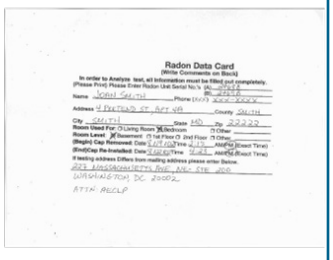
As summarized in EPA's "Citizen's Guide to Radon" (EPA-402-K-02-006, May, 2004, pg. 6)17 and "Home Buyers and Sellers Guide to Radon (pg. 15)15, EPA recommends these testing steps:

1. Take a short-term test (or take 2 short-term tests at the same time). If your result is 4 pCi/L or higher take a follow-up test (Step 2).
2. Follow up with either a long-term test or a second short-term test. For a better understanding of year-round average radon level, take a long-term test. If you need results quickly, take a second short-term test. The higher your initial short-term test result, the more certain you can be that you should take a short-term rather than a long-term follow up test. If your first short-term test result is more than twice EPA's 4 pCi/L action level, you should take a second short-term test immediately.
3. If you followed up with a long-term test: Fix your home if your long-term test result is 4 pCi/L or more. If you followed up with a second short-term test: The higher your short-term results, the more certain you can be that you should fix your home. Consider fixing your home if the average of your first and second test (or the 2 simultaneous tests) is 4 pCi/L or higher.

You can purchase radon test kits in the local hardware store, via the Internet or from the National Safety Council. You can also hire a radon professional.

If you use a home test kit, it will likely contain at least one radon testing device, a mailing bag and label, and a sheet or card to record the key data. Follow the sampling instructions.

Testing Options:
- **For kits call 1-800-SOS-RADON, purchase retail, or from certified company**
- **Hire a professional**



The photos on the right on the previous page show examples of a radon data card and form. The person completing the sampling fills out the radon data card and form to tell the lab the property address, location of the sample, test start and completion date, the serial number for the testing device, building type, whether the home was closed during testing, and the location/address where the result should be mailed. Be sure to promptly send the testing device to the lab.

The photo on the bottom left on previous page shows radon testing canisters in a basement area that is not livable. Consumers should place test kits in the lowest lived-in level of their home (according to the EPA Citizen's Guide to Radon[17]). Please note that in some states, radon professionals who do testing may be required to test areas that are suitable for occupancy but are not the lowest lived-in level (according to EPA Home Buyers and Sellers Guide[15]).

Conduct the test in a room to be used regularly (e.g., family room, living room, playroom, den, bedroom); do not test in a kitchen, bathroom, laundry room or hallway. Put the test kit at least 20 inches off the ground, in an area where it will not be disturbed during the sampling period. Shut off all exhaust fans and keep doors and windows closed during testing (except for normal entry and exit).

Interpreting Radon Results

This information was taken from EPA's from "Citizen's Guide to Radon" (EPA-402-K-02-006, May 2004, pg 7).[17]

- Short term test > 4 pCi/L
  - Take second short term test or long term test
- Short term average or long term test >4 pCi/L
  - Fix home for radon

What Your Test Results Mean:

The average indoor radon level is estimated to be about 1.3 pCi/L, and about 0.4 pCi/L of radon is normally found in the outside air. The U.S. Congress has set a long-term goal that indoor radon levels be no more than outdoor levels. While this goal is not yet technologically achievable in all cases, most homes today can be reduced to 2 pCi/L or below.

Sometimes short-term tests are less definitive about whether or not your home is above 4 pCi/L. This can happen when your results are close to 4 pCi/L. For example, if the average of your two short-term test results is 4.1 pCi/L, there is about a 50% chance that your year-round average is somewhat below 4 pCi/L. However, EPA believes that any radon exposure carries some risks - no level of radon is safe. Even radon levels below 4 pCi/L pose some risk, and you can reduce your risk of lung cancer by lowering your radon level.

If your living patterns change and you begin occupying a lower level of your home (such as a basement) you should retest your home on that level. Even if your test result is below 4 pCi/L, you may want to test again sometime in the future.

Radon Reduction Systems

You cannot prevent exposure to radon, but you can minimize the exposure.

- New Construction
  - Passive Sub-Slab Depressurization System
  - Active Sub-Slab Depressurization System
- Existing Housing
  - Active Sub-Slab Depressurization System

Passive System: Has no fan. Radon passively moves from below slab up through pipe to vent outside through the roof.

Active System: Has fan to actively pull radon gas from below the slab through a pipe and outside through the roof.

Other mitigation methods exist, and not all houses have slabs; however, these two methods are the most common.

Passive vs. Active

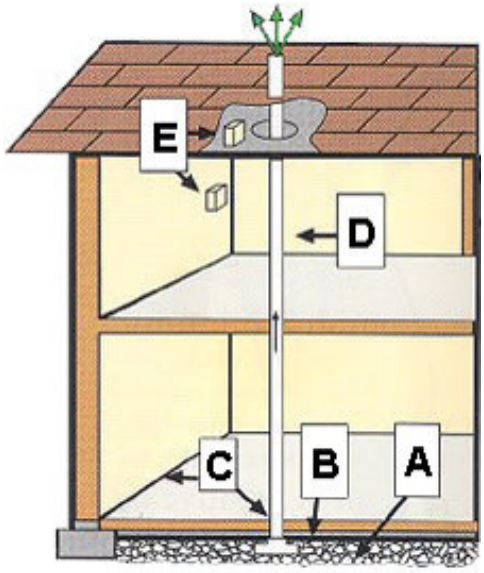
In Zone 1, EPA recommends building passive radon systems into all new construction or substantial renovation jobs where a slab or crawl space is being created. This gives the property owner the option of converting to an active system if test results show radon levels above 4 pCi/L.

In Zones 2 and 3, a given property may still experience high radon levels and hence testing post construction (before occupancy) is appropriate. If levels exceed 4 pCi/L the contractor can then add a fan to an existing passive system or add an active system to suck radon gas out from below the slab through the venting.

Radon Fixes: New Construction

Passive Sub-Slab Depressurization System (New Construction)

A.	• Gas-Permeable Layer
B.	• Plastic Sheeting
C.	• Seal and Caulk
D.	• Vent Pipe
E.	• Junction Boxes



This picture is taken from EPA's webpage at www.epa.gov/radon/construc.html18. This system should be used for new construction. EPA does not recommend a passive system for existing sub-slab construction.

Five important steps in a passive system:

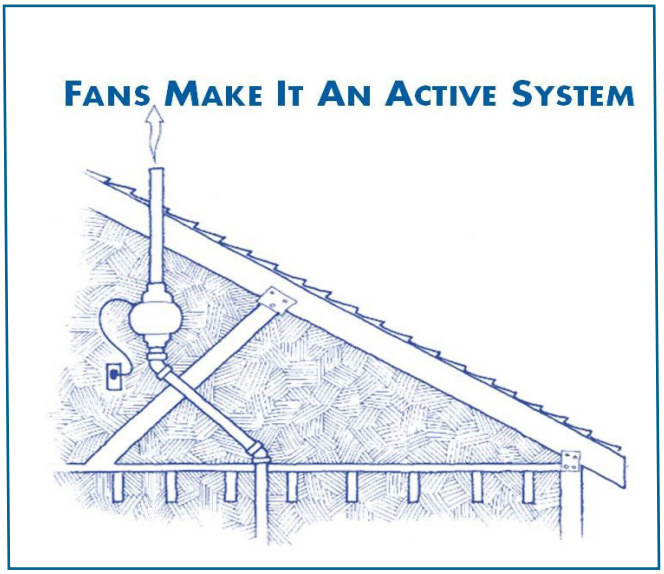
1. Put a gas permeable layer beneath the slab or flooring system to allow soil gas to move freely underneath the house.
2. On top of the gas permeable layer, put plastic sheeting to help prevent the soil gas from entering the home.
3. Seal and caulk all below grade openings in the foundation and walls to reduce soil gas entry into the **home.**
4. Install vent pipe – 4 inches preferred – from gas permeable layer to roof to safely vent radon and other soil gases to the outside.
5. Install junction boxes to make wiring and installation of a vent fan for an active system easier.

For passive systems installation in crawl spaces, cover the floor with poly sheeting, lay a perforated collection pipe below the poly sheeting and connect the pipe to a radon vent riser. It is also important to close openings between the crawl space and basement or crawl space and the living areas. The recommended installation is a T- joint at the bottom of the stack with corrugated pipe running in both directions.

Please note that the pipe (stub up) must be connected to a vent pipe that goes through the interior of the house and vents to the outside. Otherwise, it is not a passive system and radon is vented in the house instead of outside or creates a situation where the pipe (stub up) could be misused for something else such as a commode. Vent pipes passing through the house are required to be labeled.

Active System

The drawing to the right was taken from EPA's "Building Radon Out" (EPA-402-K-01-002, April 2001, pg 62) and shows an in-line fan in the attic.[19]



An active system adds a fan to a passive system to pull radon from the ground and exhaust it outside through the roof, avoiding radon exposure in the home.

EPA recommends that if a radon fan is used that it be installed in an unoccupied space to avoid radon exposures if the fan leaks or fails. In the case displayed above, the fan is in the attic and we see a gable vent to the right.

Radon Fixes: Existing Housing

- ✓ Seal floor and cracks
- ✓ Vent radon gas from below slab
- ✓ Fan sucks air from below slab –active system
- ✓ Sump suction reduces radon gas entry

This information is taken from EPA's "Consumer's Guide to Radon Reduction" (EPA-402-K-03-002, February 2003, pg 9-12).[20] There are several proven methods to reduce radon in your home, but the one primarily used is "subslab suction," a vent pipe system and fan, which pulls radon from beneath the house and vents it to the outside. This system, known as a soil suction radon reduction system, does not require major changes to your home. Sealing foundation cracks and other openings makes this kind of system more effective and cost-efficient. Similar systems can also be installed in houses with crawl spaces. Radon contractors can use other methods that may also work in your home. The right system depends on the design of your home and other factors.

Active Subslab Suction (also called subslab depressurization) is the most common and usually the most reliable radon reduction method. One or more suction pipes are inserted through the floor slab into the crushed rock or soil underneath. They also may be inserted below the concrete slab from outside the house. The number and location of suction pipes that

are needed depends on how easily air can move in the crushed rock or soil under the slab, and on the strength of the radon source. Often, only a single suction point is needed. A contractor usually gets this information from visual inspection, diagnostic tests, and/or experience. A radon vent fan connected to the suction pipe(s) draws the radon gas from below the house and releases it into the outdoor air while simultaneously creating a negative pressure (vacuum) beneath the slab. Common fan locations include attics, garages and the exterior of the house.

Passive Subslab Suction is the same as active subslab suction except it relies on natural pressure differentials and air currents instead of a fan to draw radon up from below the house. Passive subslab suction is usually associated with radon-resistant features installed in newly constructed homes. Passive subslab is generally not as effective in reducing high radon levels as active subslab suction.

Some houses have drain tiles or perforated pipe to direct water away from the foundation of the house. Suction on these tiles or pipes is often effective in reducing radon levels.

All radon systems should be labeled to alert the owners, occupants and contractors about the purpose of various pipes and tubing. The picture to the right shows labeling of the radon control pipes by the contractor clearly showing the purpose of the pipe. This photo also shows potential mistakes. Why is duct tape used? And the pressure tube to ensure there is a vacuum is too high for more people. Also, it appears that there are holes in the walls. This is not good for many reasons.

Label Radon Systems

Radon Mitigation Costs

The chart below shows average costs to mitigate radon in the U.S. Actual costs to mitigate radon may be lower or higher in different regions of the US. For example, costs for radon-resistant new construction vary with local code requirements, such as those which require gravel for drainage. Such costs would not be included as part of RRNC costs, although they are necessary to complete the mitigation activities.

Radon Mitigation Costs	
	Average Costs
New Construction	
Passive only	$350 - $500
Active system	$650 - $800
Existing Homes	$800-$2,500

It is more cost-effective to do radon-resistant new construction than it is to fix a home once it is built. However, remember that even in new homes, testing is needed upon home occupation even if radon-resistant new construction is done. All existing homes should have pre- and post-mitigation testing performed.

Source: This information is taken from EPA's "Home Buyer's and Seller's Guide to Radon" (EPA-402-K-05-005, May 2005, pg. 9) [15].

Finding a Qualified Contractor

EPA recommends that you use a state-certified and/or qualified radon mitigation contractor trained to fix radon problems. You can determine a service provider's qualifications to perform radon measurements or to mitigate your home in several ways. First, check with your state radon office.

Many states require radon professionals to be licensed, certified, or registered, and to install radon mitigation systems that meet state requirements. Most states can provide you with a list of knowledgeable radon service providers doing business in the state. In states that do not regulate radon services, ask the contractor if they hold a professional proficiency or certification credential, and if they follow industry consensus standards such as the American Society for Testing and Materials (ASTM) Standard Practice for Installing Radon Mitigation Systems in Existing Low-Rise Residential Buildings21, or the U.S. EPA's "Radon Mitigation Standards" (EPA-402-R-93-078, April, 1994).

You can contact private proficiency programs for lists of privately-certified professionals in your area. Such programs usually provide members with a photo-ID, which indicates their qualification(s) and the ID-card's expiration date. For more information on private proficiency programs contact:

- State radon offices
- EPA's web site www.epa.gov/radon/proficiency.html
- National Environmental Health Association (NEHA)www.neha-nrpp.org/
- National Radon Safety Board (NRSB) www.nrsb.org

Resources

Additional resources for radon information include:

- State Radon Contacts: (www.epa.gov/iaq/whereyoulive.html)
- Radon Mitigation: 800-644-6999

EPA supports these hotlines to best serve consumers with radon-related questions and concerns:

- 1-800-SOS-RADON (767-7236). Radon Hotline, operated by the National Safety Council (NSC) in partnership with EPA. Obtain coupons for radon test kits (for consumers, individual kits, not in bulk). ($10 for short-term kit; $20 for long-term kit).
- 1-800-55RADON (557-2366). For live help with your radon questions. Operated by the National Safety Council (NSC) in partnership with EPA.
- 1-800-438-4318. The Indoor Air Quality (IAQ) Information Clearinghouse is privately operated under contract to EPA. You can order copies of EPA consumer-oriented radon publications and get general information on radon and indoor air quality issues.
- 1-800-426-4791. Safe Drinking Water Hotline, privately operated under contract to EPA. For general information on drinking water, radon in water, testing and treatment, and radon drinking water standards.

Sewer Gas

The term sewer gas refers to a mixture of gases generated by bacteria and fungi while they are digesting wastes. Sewer gas often contains methane, hydrogen sulfide, ammonia, carbon dioxide, and carbon monoxide. Sewer gas comes from dried out traps in drains, especially in floor drains or homes that have been vacant for awhile. Make sure that there is water in the P trap to help prevent build-up.

Key Messages

- Systems should be inspected regularly to ensure proper function.
- Some maintenance activities require the use of professionals.
- Lead causes a variety of serious health effects.
- Contractors doing renovation should be certified to work on houses with lead paint.
- Deteriorating products or areas with asbestos need to be addressed by a certified professional.
- There are two ways to address high radon levels in a home.

Learning Objectives

- Name at least three systems that require ongoing maintenance.
- Identify two maintenance actions that require the use of a professional.
- Name at least two health effects from lead.
- Identify housing targeted by the RRP rule.
- Describe the two ways to mitigate radon in a home.