Indoor Air Quality in New Homes

Summary of Selected State Laws

Environmental Law Institute

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Indoor Air Quality in New Homes: Summary of Selected State Laws

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Introduction

The design and construction of a new home represents an important opportunity to create a healthy indoor environment. Building science and technology provide tools for preventing the build-up of pollutants that can cause poor indoor air quality (IAQ) and adversely affect residents' health and well-being. State laws and regulations can play an important role in ensuring that home construction incorporates sound building practices to prevent indoor air quality problems and promote a healthy indoor environment.

Purpose and Scope

This report describes state laws and regulations that address several key issues relating to indoor air quality in new home construction. Its purpose is to increase understanding of ways in which states have adopted legal requirements for improving indoor air quality that go beyond typical residential building code measures. There are many different building issues and strategies that can affect the quality of the air in a new home. This report covers several individual, but related, issues:

- **mechanical whole-house ventilation**
- **mechanical local ventilation**
- **combustion pollutants & fuel-burning equipment**
- **combustion pollutants & carbon monoxide alarms**
- **radon-resistant new construction**
- **moisture & crawl space construction**
- **formaldehyde in composite wood products**
- **volatile organic compounds in other construction products/materials**

There are many more issues that are important to ensuring good indoor air quality, including a wide range of moisture control strategies. The subjects included in this report were selected for two main reasons. First, they represent important opportunities for promoting good indoor air quality in new homes. Second, there are state laws and regulations on these topics that go beyond typical code provisions.

While a broad review of *local* laws is beyond the scope of this report, several examples of local laws are referenced in the sections that follow. Future Environmental Law Institute publications will investigate another area of local policy – green building – which holds promise for advancing IAQ practices through regulatory and non-regulatory mechanisms.

The focus of the report is on state laws that address single-family homes. While some

states have adopted policies that promote good IAQ in affordable housing development, those policies are not civered here because they typically involve larger, multi-family properties. The report does not cover manufactured homes, as these are governed by a separate set of federal and state regulations.

Structure

The report contains eight sections, addressing the different issues noted above. Each section provides a short description of several state laws and regulations.

Preceding the description of state laws and regulations in each section is a brief summary of the issue and of building practices that are recommended to address the issue. It is well beyond the scope of this report to review or analyze existing research on the efficacy of these building practices in improving indoor air quality. The report references other documents that provide voluntary guidance to builders on promoting good indoor air quality in homes. These builder guides differ considerably in scope and detail, but contain recommendations for most of the practices discussed in the report and are readily available over the internet:

- The American Lung Association's (ALA) *Health House Builder Guidelines*. This ALA document is focused mainly on IAQ in the home and is presented as a list of individual recommended practices that builders can incorporate to help insure a healthy indoor environment. The Health House Guidelines are available at www.healthhouse.org.

- The U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) Green Building Rating System™. *LEED™ for Homes* is a voluntary rating system that incorporates a wide range of individual design features, including several related to the indoor environment. Builders earn credits by incorporating these features into their projects, and if they earn enough credits, they may obtain LEED certification for the building from through the U.S. Green Building Council's certification process. The LEED™ for Homes rating system, which is currently in pilot form, includes a checklist and guidance document that are available at www.usgbc.org.

- The National Association of Home Builders' (NAHB) *Model Green Home Building Guidelines*. These guidelines include a range of environmental features, including indoor environment strategies, which home builders can incorporate into their projects. The guidelines provide points for items that are incorporated into the home, however the NAHB does not operate a certification system and the guidelines are designed to be used even without third-party certification. The guidelines, which include a checklist and user guide that explains the individual features, are available at http://www.nahbrc.org/greenguidelines/.

- U.S. Environmental Protection Agency's *Energy Star with Indoor Air Package Specifications*. EPA is currently pilot-testing voluntary specifications for new home construction that focus on indoor air quality and comprehensive control of moisture. The agency will soon offer builders an IAQ Label they can earn for new homes, which will be a companion label to EPA's existing Energy Star label for energy efficiency. In 2005, EPA issued in draft form its Energy Star/Indoor Air Package Specifications. The guidance, which seeks to encourage change in building practices to a broad range of builders, briefly describes each recommended practice and also references other voluntary guidelines and standards. The current version is available at:
  http://www.energystar.gov/index.cfm?c=bldrs_lenders_raters.nh_iap.

In addition to these documents, there are a variety of other technical guidance documents for that offer greater detail and analysis on how to address various indoor environmental issues in new home construction. See, for example, Lstiburek, J., and Carmody, J., Moisture Control Handbook: Principles and Practices for Residential and Small Commercial Buildings (Wiley, 1996).

Throughout the report, there are also references to certain industry standards. While voluntary, these standards are written in a manner to facilitate adoption into state and local building codes. The standards may be incorporated by reference into laws and regulations, or they may be used by building professionals and others on a voluntary basis to guide construction practices. Examples of industry standards noted in the report are those of the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) and the American National Standards Institute (ANSI). The report also notes certain provisions of the International Residential Code (IRC), a model building code developed by the International Code Council and widely adopted by state and local governments around the country. See
http://www.iccsafe.org/government/adoption.html.

1. Ventilation: Mechanical Whole-House Ventilation

Adequate ventilation is important in helping to remove and dilute indoor pollutants. While large commercial and public buildings in the United State utilize mechanical ventilation systems to introduce outside air into the building, most single-family homes rely on natural ventilation – through the opening of windows and infiltration of air through the building envelope. A variety of factors affect whether natural ventilation will provide the minimum ventilation needed to promote good indoor air quality. For example, energy-efficient homes are built to reduce the leakage of the homes' conditioned air; conversely, they also reduce the infiltration of outdoor air into the home.

In recent years, there has been increased interest in incorporating mechanical whole-house ventilation systems into single-family homes. This approach makes the introduction of fresh air intentional and controllable, rather than incidental and variable. Various voluntary guidance documents on IAQ in new homes recommend using mechanical whole-house ventilation and also recommend minimum air filter efficiencies. Some also make recommendations for including humidity control systems. *See, e.g.,* ALA Health House Guidelines (§IV); LEED™ for Homes Pilot (IEQ §§3, 4); NAHB Green Home Building Guidelines (§5.2.); EPA Energy Star/Indoor Air Package Specifications (§§4.16, 4.20).

The new ASHRAE ventilation standard for low-rise residential buildings now incorporates mechanical whole-house ventilation, with the exception of houses in certain climate zones. ASHRAE 62.2 sets forth minimum ventilation rates to be achieved by a supply-air system, an exhaust-air system, or a combination of the two, and also includes minimum filtration requirements. The standard also addresses possible adverse depressurization effects of mechanical ventilation systems on combustion-fueled equipment by requiring that combustion appliances be vented and provided with adequate combustion and ventilation air. (§§6.8, 4.1, 6.4)

Most state and local laws and regulations governing new home construction incorporate natural ventilation as the approach to achieving minimum ventilation standards. Some states have begun to consider requiring mechanical whole-house ventilation in new homes. At least three (Minnesota, Washington and Vermont) have established this requirement. At least one other state (Maine) includes the requirement in its model energy code for optional local adoption. These four codes are described briefly below. Other states are considering similar changes. For example, California is considering requiring mechanical whole-house ventilation as part of the 2008 revisions to its state energy code. See http://www.energy.ca.gov/title24/2008standards/documents/KEY_TOPIC_AREAS_2008_STANDARDS.PDF and http://www.energy.ca.gov/title24/2008standards/documents/2006-07-12_workshop/RESIDENTIAL_VENTILATION_STUDY.PDF.

►**MINNESOTA** Energy Code - Minn. Rules, parts 7672.1000, 7672.0900

Minnesota's Energy Code, applicable to most new, detached single-family and two-family dwellings, requires mechanical whole-house ventilation. The code establishes a total ventilation rate based on the square footage of the house, and it also provides formulas and a table for calculating people ventilation rates (for normal occupancy) and supplemental ventilation rates (for peak occupant use). (Subpt 3) The code contains minimum sound rating requirements for ventilation system fans and directs that system components be installed to minimize noise and vibration transmission. (Subpts 4D, 5G)

In conjunction with these requirements, the code includes depressurization standards to guard against back-drafting of combustion appliances. The code contains six alternate "paths" for addressing depressurization, and requires compliance with one of those paths. There are five "prescriptive" paths and a sixth "performance" path. If the performance path is used, a carbon monoxide detector must be installed in the home.

►**WASHINGTON** Ventilation & Indoor Air Quality Code - Wa. Adm. Code, ch. 51-13

Washington's Ventilation and Indoor Air Quality Code requires a mechanical whole-house system to supply outdoor air. The code applies to new residential construction including single- and two-family homes and townhouse homes up to four stories, as well as certain additions and alterations. (§301.1, 101) The code provides a table with minimum ventilation rates based on square footage and number of bedrooms. (Table 3.2) Four prescriptive options provide specific guidance on exhaust only, supply only, and balanced systems. As an alternative, an engineer may design the system (typically based on ASHRAE 62.2). The ventilation fan must be capable of continuous operation and must have both manual and automatic controls. The code includes minimum sound rating requirements for ventilation equipment, and prohibits air inlets from being located near certain potential sources of air contaminants. (§303.2, 303.3, 303.4)

►**VERMONT** Residential Building Energy Standard

Vermont's state energy code was recently revised to require mechanical whole-house ventilation. The code applies to new construction of single- and two-family homes, to other residential structures three stories or less, and to additions over 500 square feet. There are limited exemptions, including buildings that are neither heated nor cooled. (§101.4) The code establishes minimum ventilation rates based on the number of bedrooms in the house. The system must have an automatic control or be capable of being set remotely for continuous operation. The code also includes minimum sound rating requirements for ventilation equipment, and it provides that any air intakes

must be located at least 10 feet from a source of noxious contaminants, such as vents, streets, and parking lots. (§303.5.3, 303.9.6, 303.9.7)

►**MAINE** Model Building Energy Code - Public Utilities Comm. Rules, Ch. 920

Maine's Model Building Energy Code for new residential construction incorporates ASHRAE Standard 62.2. The model code applies to detached one- or two-family dwellings and certain attached dwellings of three stories or less, but excludes additions, alterations, renovations and repairs. Although the code itself is not mandatory, if municipalities within Maine choose to adopt a new energy code, they must adopt the state model code.

2. Ventilation: Mechanical Local Ventilation

Certain areas within a home can be sources of indoor pollutants even under normal circumstances. Kitchens and bathrooms, for example, are likely to produce moisture, odors and combustion pollutants, including particles. The use of mechanical exhaust systems (fans) for these areas is sometimes called local or spot ventilation. (Clothes dryers are another source of indoor pollutants, however exhausting dryers to the outdoors is a more common feature of building codes, and those regulations are not included here.)

Voluntary guidance documents addressing IAQ in new home construction typically include recommended practices for providing local ventilation. *See, e.g.,* ALA Health House Guidelines (§IV); LEED™ for Homes Pilot (IEQ §4.1); NAHB Green Home Building Guidelines (§5.2.1); EPA Energy Star/Indoor Air Package Specifications (§4.17). In addition, ASHRAE Standard 62.2, described in the previous section, requires the installation of mechanical exhaust systems in all bathrooms and kitchens and provides minimum ventilation rates for these spaces. (§5)

Following are examples of states that have adopted a requirement for mechanical spot ventilation. Some local jurisdictions have included these requirements in their building codes as well (*e.g.,* Fairbanks, Alaska; Lincoln, Nebraska).

►**WASHINGTON** Ventilation and IAQ Code - Wa. Admin. Code ch. 51-13

In addition to requiring whole-house mechanical ventilation, as described earlier, this state code requires source-specific exhaust ventilation in each kitchen, bathroom or other room where "excess water vapor or cooking odor is produced." (§§302.2.1, 303.3.1) Exhaust ducts must terminate outside the building, and those designed to operate intermittently must be equipped with back-draft dampers. (§§302.2.3, 303.3.4) Kitchen exhaust systems must have a capacity of 100 cubic feet per minute (cfm) if operating intermittently and 25 cfm for continuously operating systems. The rates for bathrooms are 50 cfm and 25 cfm, respectively. Source-specific ventilation may also be part of the whole-house ventilation system. (Table 3-1)

►**VERMONT** Residential Building Energy Standard

This code, which mandates whole-house mechanical ventilation as described in the previous section, also requires that bathrooms not included in the whole-house system must have an exhaust fan with a minimum capacity of 50 cfm for intermittent fans or 20 cfm for continuously operated fans. (§303.2)

►**MASSACHUSETTS** State Building Code - 780 Code of Mass. Reg. 1205

The state building code requires that bathrooms in one- and two-family houses be equipped with mechanical ventilation. Every bathroom containing a bathtub and/or shower must be equipped with a mechanical exhaust fan and associated ductwork. The exhaust must vent directly to the outside and may not terminate in attics or other interior portions of the building. The fan must exhaust at rates specified in the BOCA National Mechanical Code (1993).

►**WISCONSIN** Uniform Dwelling Code - Wis. Admin. Code chap. Comm. 20-23

This code, which applies to the construction of new single- and two-family homes, requires that any room with a toilet, tub or shower be provided with exhaust ventilation capable of exhausting 50 cfm (intermittent) or 20 cfm (continuous). (§23.02(3))

►**MAINE** Model Building Energy Code - Public Utilities Comm. Rules, Ch. 920

As noted in the previous section, Maine's Model Building Energy Code adopts ASHRAE Standard 62.2. Thus, any local jurisdictions within the state that adopt a new energy code must include the provisions for local ventilation incorporated into that standard.

3. Combustion Pollutants: Fuel-Burning Appliances

Appliances that burn fuel, such as furnaces, boilers, space heaters, wood stoves, and fireplaces may be a potential source of combustion pollutants inside the home. These combustion pollutants include carbon monoxide, nitrogen dioxide, particles, and polycyclic aromatic hydrocarbons. Carbon monoxide may cause headaches, fatigue and queasiness at high levels; at very high levels, exposure can cause brain and heart damage and death. Other combustion pollutants can cause eye, nose, and throat irritation, as well as lung disease. See generally, California Air Resources Board, Indoor Air Quality Guideline #2: Combustion Pollutants in Your Home (1994) and Supplement to the Guideline, *available at*: http://www.arb.ca.gov/research/indoor/combustf.htm and ftp://ftp.arb.ca.gov/carbis/reports/l335_1994.pdf.

Conventional combustion appliances vent their exhaust to the outside through a passive duct system. However, in some circumstances air pressure within the home can cause backdrafting, and exhaust fumes can be pulled back into the home instead of being released through the vent system. Thus, voluntary guidance documents often recommend using vented appliances that are either direct vented (getting combustion air from outside and exhausting to outside) or power vented (getting combustion air from inside, and using a fan to exhaust products out the flue). These guidance documents may also recommend avoiding the use of unvented room heaters, with the aim of reducing the potential for release of combustion pollutants indoors. *See, e.g*., ALA Health House Guidelines (§IV); LEED™ for Homes Pilot (IEQ §2.1); NAHB Green Home Building Guidelines (§5.1.1); EPA Energy Star/Indoor Air Package Specifications (§5.2). With respect to fireplaces and other solid-fuel burning equipment, guidance documents include various recommendations, such as using only sealed combustion, direct-vented fireplaces, or avoiding the use of certain types of solid-fuel burning equipment. *See, e.g*, ALA Health House Guidelines (§IV); LEED™ for Homes Pilot (IEQ §4.1); NAHB Green Home Building Guidelines (§5.1.3); EPA Energy Star/Indoor Air Package Specifications (§§5.1, 5.2).

The following state combustion safety laws and regulations fall into three general categories: (1) prohibitions on unvented room heaters, (2) requirements relating to the installation or ventilation of solid-fuel burning appliances; and (3) restrictions on ambient emissions from solid-fuel burning appliances. As discussed in Section 1, Minnesota's law requiring whole-house mechanical ventilation also addresses combustion safety by setting forth requirements for avoiding depressurization and the possible consequent buildup of pollutants indoors.

A. Prohibition on Unvented Room Heaters

Building codes generally do not prohibit unvented room heaters. A few states have taken the step of prohibiting the installation of unvented heaters in new homes. Prohibitions on installing

unvented heaters also have been enacted at the local level (*e.g.*, New Haven, Connecticut; Lakewood, Colorado; Bulverde, Texas).

►**WISCONSIN** Uniform Dwelling Code - Wis. Admin. Code chap. Comm. 20-23

This code, which applies to all new one- and two-family dwellings, prohibits the use of unvented furnaces and space heaters fueled by natural gas, kerosene, alcohol or other fuel. Such appliances are prohibited "due to concerns about oxygen depletion; contamination from carbon monoxide, carbon dioxide, nitrogen dioxide, formaldehyde and other combustion related contaminants; and water vapor buildups." (§23.04(1)(b))

►**KENTUCKY** Rev. Stat. §§227.410, 234.175; 815 Ky. Adm. Code 20:070.

Kentucky law prohibits the installation or sale of "any gas-fired room heating device of the unventable type, or other type which has not been approved as provided under state law." The law further provides that vented, gas-fired heating devices may only be installed if they have been certified by an independent testing or standards entity.

►**CALIFORNIA** Health & Safety Code § 19881

California law prohibits the sale of any new or used unvented heater designed for use inside a dwelling, with the exception of electric heaters or decorative gas logs for use in a vented fireplace. The law provides an exception for the sale of natural-gas-fueled unvented decorative gas logs and fireplaces, if the state develops standards for their use. To date, however, such standards have not been developed.

B. Ventilation and Installation Requirements for Solid-fuel Burning Appliances

The following laws require that solid-fuel burning appliances have combustion air ducted from outside the home, so that the appliances will not cause back-drafting and draw combustion pollutants into the home. Two of the laws also require tightly-fitting doors to prevent back-drafting and leakage of combustion pollutants to indoor spaces.

►**WASHINGTON** Ventilation and Indoor Air Quality Code (Wa. Admin. Code 51-13-402; Rev. Code Wash. 19.27.190).

The state IAQ code requires, with limited exceptions, that solid-fuel burning appliances, fireplaces and masonry heaters have a source of primary combustion air ducted from outside the home. The code further requires that these appliances have tightly-fitting doors in order to minimize back-drafting. (WAC §51-13-402)

►**VERMONT** Residential Building Energy Standard

Vermont's building energy code requires that most solid-fuel burning appliances have ducted combustion air from outdoors, and the code specifies location and design requirements for the exterior air intake. An exception is provided for fireplaces and other appliances with exterior air supplies installed according to manufacturers' instructions. (§304.4.2) The code also requires that solid-fuel appliances have tight-fitting doors, unless they have passed the Canadian General Standards Board 51.71 "Spillage Test." (§304.4.1)

►**CALIFORNIA** 2005 Building Energy Efficiency Standards (Cal. Code Regs., t. 24, Pt. 1, §150(e)).

California's residential energy code contains certain requirements relating to masonry or factory-built fireplaces. The code requires that such fireplaces have closeable doors over the opening, a combustion air intake drawing air from outside directly into the firebox, and a flue damper with a readily accessible control. However, a significant exception to the requirement for outside combustion-air intake is made for fireplaces that are installed over a concrete slab and not located on an exterior wall.

C. Restrictions on Ambient Emissions from Solid-Fuel Burning Equipment

The Environmental Protection Agency has adopted requirements for particulate emissions of wood heaters manufactured since 1988 or sold at retail since 1990. These requirements are aimed primarily at reducing ambient air pollution, but may also have an impact on indoor air quality. Under the regulations, devices that contain a catalytic combustor may not discharge gases that contain particulate matter in excess of a weighted average of 4.1 grams per hour (g/hr). For devices without a catalytic combustor, the standard is 7.5 g/hr. (40 C.F.R. 60.532) The regulation does not apply to open masonry fireplaces constructed on site.

Some states have adopted policies aimed at reducing ambient particulate emissions from solid-fuel burning equipment. At least one state has established emissions limits that exceed EPA's

limits for wood heaters. Other states extend the coverage or applicability of the federal standards. There are also many local jurisdictions in other states that similarly restrict installation and use of such appliances, even in the absence of a state law. Such local ordinances may require the installation of certified appliances, limit the number of such appliances that may be installed in new homes, or prohibit the installation of conventional fireplaces in new construction (*e.g.*, Sebastopol, California; Nevada County, Nevada; San Francisco, California).

►**WASHINGTON** Health Code (RCW 70.94.457); State Building Code (Wa. Adm. Code 51-51-0303, -1004; 51-50-32; 51-50-31200).

Washington's health law establishes particulate air emission standards for solid-fuel burning devices other than fireplaces. These air quality standards, which apply only to devices offered for sale within the state, are more stringent than the comparable EPA standards for wood stoves, described above. The state standards are set at 4.5 grams of particulates per hour for non-catalytic devices, and 2.4 g/hr for catalytic devices. (§70-94.455)

The same law requires that factory-built fireplaces sold in the state meet EPA's standards for wood stoves, and requires the construction of new masonry fireplaces to meet state standards aimed at reducing particulate air emissions. The state building code establishes the "Washington State Standard Test Method for Particulate Emissions from Fireplaces," which covers emissions performance, approval/certification procedures, test laboratory accreditation, record keeping, reporting requirements, and the test protocol for measuring particulate emissions from fireplaces. (§51-50-31200) In order to be approved by the state, the arithmetically averaged particulate emission factors for the fireplace model may not exceed 7.3 g/kg. (§51-50-31.204.2) The state building code also prohibits the use of wood stoves as the primary heating source in all new and remodeled buildings, and prohibits the installation of *used* solid-fuel burning devices and pellet stoves unless they are certified by the U.S. EPA. (§51-51-0303)

►**ARIZONA** Rev. Stat. Ann. §§ 9-500.16, 11-875

This law, adopted in 1998, requires cities or towns that are located in certain designated regions of the state to adopt, implement and enforce a local ordinance that prohibits the installation or construction of a fireplace, wood stove or other solid-fuel burning appliance unless it is either (1) certified by EPA; (2) tested and listed by a rationally recognized agency to meet performance standards equivalent to those of EPA; or (3) determined by the local air quality officials to meet performance standards equivalent to those of EPA. The ordinances may allow installation of fireplaces that have permanently installed gas or electric log inserts. Thus, the law would apply to the installation of devices covered by EPA regulations, as well as to devices such as masonry fireplaces that are not covered. In December 1997, Phoenix, along with other municipalities in Mari-

copa County, enacted an ordinance regulating the installation of fireplaces, wood stoves and other solid-fuel burning appliances pursuant to the state law. (Phoenix City Code, Chap. 40)

►**COLORADO** Air Pollution Control Regulation No. 4

Colorado also has enacted a regulation aimed at curbing ambient emissions from wood-burning stoves and other solid-fuel burning devices. The state regulation, which applies to the 7-county Denver metropolitan area, bans the installation of traditional fireplaces in the Denver metropolitan area, unless they are equipped with an EPA or Colorado-approved wood-burning insert, an approved pellet-burning insert, gas logs or an electric heating device. The regulation also prohibits the sale and *installation* of new or used wood-burning devices unless the device is an EPA or Colorado-certified wood stove (or insert), pellet stove (or insert), or masonry heater. (The law also prohibits the *use* of uncertified devices on designated high pollution days.)

4. Combustion Pollutants: Carbon Monoxide Alarms

As noted in the previous section, carbon monoxide (CO) can be produced by a variety of combustion appliances. Motor vehicles in attached garages may also be a source of carbon monoxide in a home. At elevated levels, exposure to carbon monoxide can cause serious health effects, or even death. Various voluntary guidance documents addressing IAQ in new homes recommend installing CO alarms. *See, e.g.,* ALA Health House Guidelines (§IV); LEED™ for Homes Pilot (IEQ §2.1); EPA Energy Star/Indoor Air Package Specifications (§5.6).

Voluntary industry standards have been developed to provide recommended performance criteria for carbon monoxide alarms. See Underwriters Laboratory, Standard UL 2034 – "Single and Multiple Station Carbon Monoxide Detectors" (2002); Canadian Standards Association, CAN/CSA 6.19-01 (R2006) – "Residential Carbon Monoxide Alarming Devices." These standards are designed to ensure that alarms will protect against acute effects of CO exposure, rather than provide low-level CO monitoring. See CAN/CAS 6/19-01, §1.2; see also U.S. HUD, Healthy Homes Issues: Carbon Monoxide (2005), *available at*: http://www.hud.gov/offices/lead/hhi/CO_Final_Revised_04-26-06.pdf.

In recent years several states have adopted laws requiring installation of residential CO alarms, and some of these apply specifically to new homes. The laws typically require that detectors meeting industry standards be installed in new homes if the homes include combustion appliances or have attached garages. Depending on how the law is written, the builder may or may not be responsible for installing the device. In addition to the state laws described below, a number of municipalities have adopted similar requirements (*e.g.,* St. Louis, Missouri; Chicago, Illinois).

►**NEW YORK** Executive Law §378

Under this law carbon monoxide alarms are required in any existing or newly-constructed residences that have appliances, devices or systems that run on combustible fuels or have an attached garage. The carbon monoxide alarm must meet manufacture, design and installation standards as established by the state. The state defines new construction as a new facility or a separate building added to an existing facility.

►**WEST VIRGINIA** Code §29-3-16a

West Virginia requires that an operational carbon monoxide alarm be installed in newly-constructed residential units that include buildings with fuel-burning heating or cooking, or buildings that are attached to garages. It also requires any person installing a carbon monoxide alarm, or

doing repair work on a fuel-burning heating source or venting system, to inform residents of the dangers of carbon monoxide and to recommend the installation of a carbon monoxide alarm.

►**VERMONT** Statutes Annotated §§2882, 2883

Under this law, newly-constructed, single-family residences must have one or more carbon monoxide alarms near any of the bedrooms in the residence, and the alarm must be installed in accordance with the manufacturer's instructions. The requirement also applies to the sale or transfer of single-family homes, and sellers must provide a signed and dated certification.

►**ALASKA** Statutes §18.70.095

Alaska requires that carbon monoxide alarms be installed and maintained in all residences that contain or are serviced by a carbon-based fuel appliance or a device that produces combustion by-products. Residences that have an attached garage or carport must also have carbon monoxide detection devices installed.

►**NEW JERSEY** Admin. Code §5:23-3.21

New Jersey has amended its uniform construction code for one- and two-family dwellings to adopt the 2006 version of the IRC. The state has modified the IRC by adding a section (R325) on carbon monoxide alarms. New Jersey's code requires that alarms be installed and maintained in the immediate vicinity of each sleeping area in any dwelling unit that contains fuel-burning appliances or has an attached garage.

5. Radon: Radon-resistant New Construction

According to the U.S. EPA, radon is the second leading cause of lung cancer in the U.S., with an estimated 20,000 radon-related lung cancer deaths each year. See http://www.epa.gov/radon/healthrisks.html. The naturally-occurring gas can get into homes through building foundations, cracks in floors and walls, construction joints, and gaps around service pipes. EPA has established an "action level" of 4 picoCuries/liter (pCi/L) – the level at which a building owner should take action to reduce radon. EPA's map of radon zones shows the radon potential for each county in the nation. Although high radon levels can be found in any region, "Zone 1" counties have the highest potential, with predicted average indoor radon screening levels greater than 4 pCi/L. See http://www.epa.gov/radon/zonemap.html.

The most widely used technique for radon-resistant new construction (RRNC) is the sub-slab or sub-membrane depressurization system, which pulls radon from beneath the house and vents it to the outdoors. This system may be passive, or it may be an active system that uses a fan to draw air from beneath the house. The EPA has developed a detailed guidance document discussing radon-resistant new construction techniques. See U.S. EPA, Building Radon Out: A Step-by-Step Guide on How to Build Radon-Resistant Homes (2001), *available at*: http://www.epa.gov/radon/images/buildradonout.pdf. The key RRNC elements described in the guidance are: a gas permeable layer; a plastic sheeting material placed on top of the gas permeable layer; a vertical vent pipe terminating above the roof; an electrical junction box (in case a fan is needed later); and sealing and caulking. Building Radon Out at 19.

Voluntary guidance documents that address IAQ in new home construction typically recommend including similar RRNC practices. *See, e.g.,* ALA Health House Guidelines (§II), LEED™ for Homes Pilot (IEQ §9), NAHB Green Home Building Guidelines (§5.2.5), EPA Energy Star/Indoor Air Package Specifications (§2). The American Society for Testing and Materials also has developed a standard practice – ASTM E1465 – for RRNC in low-rise residential construction. Some model building codes address RRNC as well. For example, the International Residential Code includes RRNC as a voluntary appendix. (IRC App. F). The National Fire Protection Association has incorporated RRNC requirements into the body of its Building Construction and Safety Code, NFPA 5000. (§49.2.5)

At least three states have enacted policies requiring RRNC in new homes located in areas of high radon potential, and in general these requirements include the basic elements contained in the EPA guidance. Other states, such as Virginia and Florida, include radon-resistant construction practices as a voluntary component of their model state building codes. In some states without RRNC requirements, municipalities have adopted their own local requirements (*e.g.,* Brentwood, Tennessee; Ft. Collins, Colorado; E. Moline, Illinois).

►**NEW JERSEY** Radon Hazard Subcode (N.J. Admin. Code §5:23-10; N.J.Stat. Ann §52:27D-123a).

New Jersey law requires RRNC features in all new residential construction in areas of high radon potential, as defined by the New Jersey Department of Environmental Protection. The provisions in New Jersey's Radon Hazard Subcode address the basic components for a passive RRNC system wired to provide for future activation.

►**WASHINGTON** Admin. Code §51-51-60101

As part of its Ventilation and Indoor Air Quality Code, Washington developed its own RRNC standards for homes located in the state's radon Zone 1 counties. In 2006, however, the state adopted new RRNC requirements. As part of its adoption of the 2006 version of the IRC, the state now requires Zone 1 counties to include the IRC Appendix F in their local building ordinances.

►**MICHIGAN** Admin. Code Regs. § 408.30401

The Michigan Residential Code adopts the IRC with amendments, including adoption of IRC Appendix F. The RRNC requirements are applicable to Zone 1 counties within the state.

6. Moisture Control: Crawl Space Construction

Moisture in homes can contribute to mold growth and poor indoor air quality. One aspect of home construction that can affect moisture levels is the crawl space. The use of ventilation openings has been the accepted practice for building crawl spaces, and most building codes traditionally have included crawl space ventilation requirements. In recent years, however, building research has suggested that this approach may exacerbate moisture problems.

Voluntary guidance documents that discuss IAQ in home construction have begun to incorporate the use of unvented, conditioned crawl spaces as a recommended approach for preventing moisture accumulation in a new home. *See, e.g.,* ALA Health House Guidelines (§II); EPA Energy Star/Indoor Air Package Specifications (§1.21).

Model building codes have typically called for vented crawlspaces. In 2006, however, the International Residential Code was amended to allow the *option* of building an unvented crawl space. If this option is chosen, the code requires mechanical ventilation of the under-floor space and use of a vapor retarder. (R408.3)

Some states have begun to change their laws and regulations to allow the option of unvented crawl spaces in appropriate situations. The laws described below vary somewhat in defining when and how unvented crawl spaces may be constructed.

►**WASHINGTON** State Building Code - WAC §51-51-0327; State Energy Code - WAC §51-11-1313

Washington recently adopted the 2006 version of the IRC, including the option of unvented crawl spaces. However, the code also addresses the issue of radon in the context of crawl space construction. The code prohibits the use of unvented crawl spaces in high radon potential zones. The code also requires that if unvented crawl spaces are used in new homes in other radon zones, the homes must also incorporate the radon-resistant construction provisions of IRC Appendix F. In addition, the state energy code requires that all crawl spaces (vented or unvented) have a vapor retarder, lapped twelve inches and extending to the foundation wall.

►**NEW JERSEY** Admin. Code §5:23-3.21

New Jersey's uniform construction code for one- and two-family dwellings has adopted the 2006 version of the IRC, including the option of building unvented crawl spaces. (R408.3)

►**NORTH CAROLINA** Building Code §§R408-R409

The North Carolina building code allows either vented or unvented crawl spaces. Unvented crawl spaces must be built to minimize the entry of outdoor air, including use of air sealing caulk, gaskets or sealants. Unvented crawl spaces also must be provided with mechanical drying capability to control moisture, as specified in the code. The code further requires that both vented and unvented crawl spaces be provided with a vapor retarder with joints lapped at least 12 inches, and be graded to drain water away from the crawl space foundation.

7. Chemical Emissions: Formaldehyde Emissions from Composite Wood Products

Formaldehyde is a colorless, strong-smelling gas. It is used in glues that bind pressed-wood products, as a preservative in some paints and coatings, and in certain insulation materials (urea-formaldehyde foam insulation and fiberglass insulation). Other sources of indoor exposure to formaldehyde include certain consumer products and fabrics, tobacco smoke, and combustion appliances. EPA considers formaldehyde a probable human carcinogen (Group B1). The International Agency for Research on Cancer (IARC) reclassified formaldehyde from "probably carcinogenic to humans" to "carcinogenic to humans" in 2004, based on epidemiologic studies showing the increased risk of nasopharyngeal cancer. See http://www.iarc.fr/ENG/Press_Releases/archives/pr153a.html. Formaldehyde also has been designated as a toxic air contaminant in California, with no safe level of exposure. See California Air Resources Board, Indoor Air Quality Guideline #1: Formaldehyde in the Home (2004, *available at*: http://www.arb.ca.gov/research/indoor/formaldGL08-04.pdf. Acute and chronic inhalation exposure to formaldehyde in humans can also result in respiratory symptoms, and eye, nose, and throat irritation. U.S. EPA, Formaldehyde Hazard Summary, *available at*: http://www.epa.gov/ttnatw01/hlthef/formalde.html.

Some of the most significant sources of formaldehyde in building materials are pressed-wood products made using adhesives that contain *urea-formaldehyde* (UF) resins. These products include: particleboard (sub-flooring, cabinetry, furniture); medium-density fiberboard or MDF (drawer fronts, cabinets, furniture tops); and plywood (decorative wall covering, cabinets, furniture). Medium-density fiberboard contains a higher resin-to-wood ratio and is generally recognized as being the highest formaldehyde-emitting pressed-wood product. See generally, National Institute of Building Sciences, Building Products and Materials, *available at*: http://ieq.nibs.org/products/formaldehyde.php?p=1. A second type of formaldehyde resin contains phenol formaldehyde (PF). Pressed-wood products using this resin (typically products made for exterior construction) emit formaldehyde at lower rates than those using urea-formaldehyde. *Id.*

In 1984, the U.S. Department of Housing and Urban Development (HUD) adopted a regulation establishing maximum formaldehyde emission levels for plywood and particleboard materials installed in *manufactured* homes. According to the regulation, plywood materials may not produce formaldehyde concentrations in excess of 0.20 ppm during a standard test for formaldehyde in pressed-wood products. See 24 CFR 3280.406 (air chamber test method). The HUD standard for particleboard is 0.30 ppm. There is no HUD standard for MDF. The regulations exclude products that use an exclusively phenol-formaldehyde resin system or finish. (24 CFR 3280.308)

The American National Standards Institute (ANSI) has developed voluntary formaldehyde emission levels for particleboard, MDF and hardwood flooring. The standard for particleboard (ANSI A208.1) establishes limits for both industrial particleboard (0.30 ppm) and particleboard flooring

(0.20 ppm). The MDF standard (ANSI A208.2) includes a limit of 0.30 ppm, while the standard for wall paneling/plywood (ANSI/HPVA HP-1) is 0.20 ppm.

The voluntary industry standards in place since the 1980s have helped increase the availability of pressed-wood products with lower formaldehyde levels. The Composite Panel Association runs a program that certifies composite panels meeting at least the relevant ANSI formaldehyde limits. States that adopt the International Residential Code generally will incorporate the IRC's requirement that particleboard meet the ANSI standards. Few states have gone beyond these measures. Two states described below (Minnesota and Washington) have adopted laws that apply HUD standards beyond manufactured housing. One additional state (California) is proposing to adopt new, more stringent standards.

►**MINNESOTA** Minn. Stat. Ann. §325F.181

Minnesota law provides that all plywood and particleboard used in newly-constructed housing units, or sold to the public for use as building materials, must comply with HUD's formaldehyde emission standards. Thus, Minnesota extends the HUD requirement to non-manufactured housing. The law further requires that MDF used in newly-constructed housing or sold as building materials also comply with the HUD emission standard for particleboard, even though MDF is not specifically covered by the federal regulation.

Another Minnesota law (Minn. Stat. Ann. §325F.18) addresses formaldehyde in building materials by establishing that builders may not sell or lease a housing unit containing urea formaldehyde to the initial occupant, unless the builder provides a written disclosure to the purchaser or lessee. The law specifies the contents of the disclosure, which states that some of the building materials used in the home emit formaldehyde. The disclosure includes information about the health effects of formaldehyde and recommends adequate ventilation to reduce the level of formaldehyde and other indoor air contaminants. The requirements also apply to those who manufacture building materials containing urea formaldehyde.

►**WASHINGTON** Ventilation and Indoor Air Quality Code -WAC §51-13-401, Rev. Code Wash. §19.27.190

Washington's IAQ Code requires that all structural panel components, such as plywood, particle board, wafer board, and oriented strand board, located within the conditioned space of a new home, must use exterior-type (phenol formaldehyde) adhesives (and identified as "EXPOSURE 1" or "EXTERIOR") or comply with HUD's formaldehyde standards (and identified as "HUD-APPROVED").

In addition to these two states, the **California** Air Resources Board (CARB) has proposed a draft regulation establishing emission standards for composite wood products that are sold, supplied, or manufactured for sale in California. The proposed standards are more stringent than current federal or industry standards in the U.S.: (1) particleboard (0.18 ppm by 2009 and 0.08 ppm by 2011); (2) MDF (0.21 ppm by 2009 and 0.08 ppm by 2012); (3) hardwood plywood veneer core (0.07 by 2009 and 0.03 by 2011); and (4) hardwood plywood composite core (0.09 by 2009 and 0.05 by 2012). See CARB, Proposed Regulation Order: Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products (Oct. 2006), *available at*: http://www.arb.ca.gov/toxics/compwood/061013%20Draft%20CWP%20Reg%20Oct%20Wkshp.pdf. The regulation would apply to manufacturers and retail sellers, thus affecting the type of products that are made available for use in home construction. Because the regulation would also apply to "fabricators" – defined as any person who uses composite wood products to make other products for sale or supply in California – it would require those who build new homes to ensure that they use only products that meet the new requirements. *Id.*

8. Chemical Emissions: VOC Emissions from Other Construction Products/Materials

Chemical emissions from products other than composite wood may also affect indoor air quality in new homes. Paints and other architectural coatings such as finishes and stains are used in new home construction both on the inside and outside of a home. They are applied to a variety of surfaces indoors – not only to structural components such as floors and walls, but also to cabinets and fixtures. Adhesives and sealants are also used inside the home in a number of applications. Volatile organic compounds (VOCs) are used in these products to enhance their performance and durability. VOC emissions result from the evaporation of solvents during and after application and drying of the products.

Currently, the principal regulatory strategy for lowering VOC releases from these types of products is aimed at improving *ambient* air quality. Federal and state regulations that limit the VOC content of products aim to reduce ground level ozone. It is important to note that products such as paints and coatings that meet these VOC regulatory requirements may still contain or emit other "odorous, toxic, or otherwise undesirable ingredients such as ammonia, formaldehyde, crystalline silica, odor masking agents, and many other compounds, including fungicides and bactericides." Nat'l Inst. of Building Sciences, Whole Building Design Guide, §09900: Paints & Coatings, *available at*: http://www.wbdg.org/design/greenspec_msl.php?s=09900. Nevertheless, the VOC regulations discussed below are included in this report because they may have the effect of reducing pollutant loads and potential exposures within the home in which the products are used.

The remainder of this section discusses three types of products that are regulated in this manner: paints and architectural coatings; adhesives and sealants; and other "consumer products."

A. Paints and Architectural Coatings

In 1998, EPA promulgated the National Volatile Organic Compound Emission Standards for Architectural Coatings, in response to the determination that these products have the potential to contribute to non-attainment of ambient air quality standards for ozone. (40 CFR Part 59, Subpt. D) The rule applies only to those who manufacture or import these products for use in the U.S. (not directly to those who use the products) and excludes coatings sold in containers of 1 liter or less, as well as coatings sold in non-refillable aerosol containers. The rules includes the following VOC limits in grams/liter: flat coatings (250); non-flat coatings (380); primers and undercoaters (350); sealers (400); stains (350-550); varnishes (450); and floor coatings (400). (40 CFR Pt. 59, Subpt D, Table 1)

In addition to the federal regulations, several states have adopted regulations governing VOC emissions from architectural coatings.

►**CALIFORNIA** Suggested Control Measure for Architectural Coatings; Cal. Aerosol Coating Products Regulation (17 Cal. Admin. Code §§94520-94528)

The California Air Resources Board has issued a Suggested Control Measure (SCM) for Architectural Coatings. See http://www.arb.ca.gov/coatings/arch/2000scm.pdf The most recent version took effect in 2003, and the CARB is currently planning to update and amend the SCM again in 2007. The SCM is not mandatory state-wide, but rather serves as a model for California local air districts to develop architectural coatings rules. Those districts that do not adopt their own rules are bound by EPA's national rule. For most product categories, the SCM establishes VOC limits (in grams/liter) that are more stringent than the national limits – *e.g.,* flat coatings (100); non-flat coatings (150 regular or 250 high gloss); primers, sealers and undercoaters (200); stains (250); and floor coatings (250). (SCM Table 1)

The SCM applies not only to manufacturers, importers and distributors, but also to any person who "applies or solicits the application of" any architectural coating. Thus, under the rule, those who build homes would also be required to use products that comply with the rule. (SCM §1.1) The SCM includes a 3-year sell-through period during which manufacturers and distributors may continue to sell products that were produced before the effective date of the rule, even if they do not meet the more stringent VOC limits. In addition, coatings manufactured *before* the effective date may be *applied* at any time, provided they met the standards in effect at the time of manufacture and they display the appropriate date code. (SCM §§3.3, 4.1) The SCM also addresses painting practices, providing that anyone who applies the coatings must ensure that all containers from which coatings are applied directly must be closed when in use. (SCM §3.4) The SCM does not apply to products sold in containers with a volume of one liter or less.

The majority of California's air districts – covering most of California's population – has adopted AIM rules. See http://www.arb.ca.gov/coatings/arch/rules/localrules.htm. Most of the rules contain the same basic provisions found in the SCM, including the specific VOC limits. One district – the **South Coast Air Quality Management District** – has adopted a more stringent rule. SCAQMD covers almost half of the population of the state of California, including Los Angeles, Orange County and parts of other nearby counties area. The SCAQMD adopted Rule 1113 in the 1970s, and amended the rule most recently in 2006. The amended rule establishes new VOC limits that go beyond the state levels for many categories. For example, new standards in effect July 1, 2006 include (in grams/liter): clear wood varnishes and lacquers (275); floor coatings (50); non-flat coatings (50); primers, sealers and undercoaters (100); and waterproofing sealers (100). New standards in effect for future years include: flats (50 - 2008); non-flat high gloss (50 – 2007); quick-dry enamels (50 – 2007); and exterior stains (100 - 2007). (Rule 1113(c)) The rule provides for certain exemptions to these limits, and prohibits the use of industrial maintenance coatings in the residential context. (Rule 1113(c)(2); (g))

The SCM does not apply to aerosol coatings, and the state has enacted a regulation establishing mandatory photochemical reactivity limits on these products. The regulation sets mandatory limits for numerous categories of general and specialty coatings, and also prohibits the use in these products of certain toxic air contaminants (such as trichloroethylene, perchloroethylene and methylene chloride) and limits the use of ozone-depleting compounds. (17 Cal. Adm. Code §94522(c),(d))

►**NORTHEASTERN AND MID-ATLANTIC STATES** - Architectural and Industrial Maintenance Coatings Rules

In 2001, the Ozone Transport Commission (OTC) released a model rule for the control of VOCs from architectural coatings. OTC, Model Rule - AIM Coatings, *available at*: http://www.otcair.org/interest.asp?Fview=stationary#. The OTC is a multi-state organization created under the federal Clean Air Act, responsible for advising EPA on transport issues and for developing and implementing regional solutions to the ground-level ozone problem in the Northeast and Mid-Atlantic regions. The OTC's model rule is based on the California SCM. It excludes aerosol coating products.

Following are states that have adopted regulations based on the OTC model. With few exceptions, the rules contain similar VOC standards. The rules differ slightly in terms of their sell-through provisions, and a couple of states allow requests for exemptions and variances.

- *Delaware*: Regulation: Del. DNREC Rule No. 41
- *District of Columbia*: DC Municipal Regs. title 20, sec. 750
- *Maine*: Code of Maine Rules 06-096, ch. 151
- *New Jersey:* N.J. Adm. Code 7:27-23
- *New York*: N.Y. State Dept of Env. Cons. Rules & Regs, Ch. IIIA, Pt. 205
- *Pennsylvania*: Pa. Admin. Code, title 25, sec. 130.601 *et seq*.
- *Virginia* (northern counties): 9 Va. Admin. Code 5-40-7120, *et seq*.
- *New Hampshire*: Chap. Env-A 4200
- *Maryland*: COMAR 26.11.33

B. Adhesives and Sealants

Although there is no federal regulation governing VOC emissions from adhesives and sealants, there is a model rule in California that forms the basis for local air district regulations. In addition, the **Ozone Transport Commission** released a new model rule on this subject in 2006. OTC Model Rule for Adhesives and Sealants (Final Draft), *available at:* http://www.otcair.org/projects_details.asp?FID=99&fview=stationary#. The scope of the OTC

model rule, and the specific VOC limits adopted, are very similar to the California model. Once finalized, the OTC rule will likely lead to the adoption of new state regulations in that region.

►**CALIFORNIA** RACT/BARCT Determination for Adhesives and Sealants

In 1998, the California Air Resources Board issued a "RACT/BARCT Determination for Adhesives and Sealants." See http://www.arb.ca.gov/ractbarc/ractbarc.htm. This RACT/BARCT Determination was developed to assist the state's local air pollution control districts in developing regulations to attain state air quality standards. (RACT/BARCT Det. p.1) The Determination is essentially a model rule that requires the use of low-VOC or low-vapor pressure materials, or the use of equipment or procedures that will reduce VOC emissions. The Determination applies to those who supply, sell or use the products within the district, with exceptions for small users and products that are sold in small containers. (RACT/BARCT Det. pp.12-14) It includes VOC emission limits for a variety of adhesive applications (*e.g.,* indoor floor covering installation -150 g/l) and sealant applications (*e.g.*, architectural – 250 g/l). For products that do not fit within any of the specified applications, the Determination includes a general category of adhesives applied onto various substrates (*e.g.,* flexible vinyl – 250 g/l). (RACT/BARCT Det. pp.6-7) The RACT/BACT does not apply to *aerosol* adhesives. The state has adopted mandatory VOC regulations governing aerosol adhesives as part of its general consumer product regulation described in section C, below.

Several regional air pollution control districts have enacted regulations based on the state's RACT/BARCT Determination. One of those regional rules, issued by the **South Coast Air Quality Management District,** contains VOC limits for adhesives that go beyond the state model – *e.g.,* indoor carpet adhesives (50 g/l), wood flooring adhesives (100 g/l); and dry wall/paneling adhesives (50 g/l). The SCAQMD rule also establishes an overall limit of 250 g/l on any adhesives not specified in the rule. (SCAQMD Rule 1168)

C. Consumer Products

Federal and state governments have adopted regulations limiting the VOC content of a variety of "consumer products." While most of these products are for personal use, the rules also cover a few products that are used in new home construction but fall outside the scope of the VOC regulations discussed above.

In 1988, EPA issued its National Volatile Organic Compound Emission Standards for Consumer Products based on "the Administrator's determination that VOC emissions from the use of consumer products can cause or contribute to ozone levels that violate the national ambient air quality standards (NAAQS) for ozone." 63 Fed. Reg. 48819. pt 59. The rule, which applies to products manufactured or imported for use within the U.S., includes VOC content limits for over 42

product categories and sub-categories, some of which are used in new home construction. For example, the rule contains limits for the following adhesive sub-categories: aerosol (75%); contact (80%); construction and panel (40%); general purpose (10%); and structural waterproof (15%). 40 CFR Pt. 59, Subpt. C, Table 1. The regulation excludes adhesives sold in containers of one ounce or less, and thus those products are not covered by federal VOC regulations. 40 CFR 59.201(c)

At the state level, California has a state-wide regulation imposing mandatory limits on VOCs in consumer products. The Ozone Transport Commission has issued a model rule based on the California regulation, and several states in the Northeast and Mid-Atlantic region have adopted regulations based on the OTC model rule. Other states are considering regulating these products.

► **CALIFORNIA** Consumer Products Regulation, 17 Cal. Code of Regulations §§94507-94517

The California Air Resources Board has issued regulations governing the manufacture, supply and sale of a variety of consumer products for use within the state. (§§94507, 94520). This general consumer products regulation covers a broad range of products, including aerosol adhesives, and *small-quantity, non-aerosol* adhesives, sealants and caulks. The regulation sets mandatory VOC limits for these products, and also may prohibit or limit the sale of products containing certain toxic air contaminants (such as trichloroethylene, perchloroethylene and methylene chloride) and ozone-forming compounds. (§94509(e)(i)(m)) The regulations provide an alternate method of complying with the VOC limits, by allowing parties to enter into "alternative control plans" to average the emissions of products and/or to earn surplus emission reduction credits. (§§94540-94555)

With respect to products used in home construction, the CARB regulations establish VOC limits that are more stringent than the existing federal limits in a few categories. For example, the agency recently lowered the VOC limit for construction adhesives from 15 to 7 percent, effective December 31, 2008. See http://www.arb.ca.gov/regact/cpwg2006/cpwg2006.htm. Other product limits that require lower VOC content than federal standards include: mist or web spray aerosol adhesives (55-65%); non-aerosol general purpose contact adhesives (55%); and sealants and caulking compounds (4%). (§94509)

► **NORTHEASTERN AND MID-ATLANTIC STATES** – Consumer Products Regulations

In 2001, the Ozone Transport Commission issued a Model Rule for Consumer Products. See http://www.otcair.org/projects_details.asp?FID=99&fview=stationary#. The OTC model rule establishes VOC limits similar to those noted above in the California regulations, with the exception of the new lower VOC limit for construction adhesives and the limit for general purpose contact adhesives. The Model Rule contains provisions for alternate control plans and also establishes limita-

tions and prohibitions on the sale and manufacture of certain products containing methylene chloride, perchloroethylene, or trichloroethylene, as well as several listed ozone-depleting substances. (§3(f)(h)) The OTC is currently considering modifications to its Model Rule. See OTC Model Rule for Consumer Products (Draft 2006), *available at*: http://www.otcair.org/projects_details.asp?FID=99&fview=stationary.

The following states have adopted regulations based on the OTC model. Most of these regulations are very similar to the OTC Model Rule in terms of limitations on chemical content, though some state regulations may vary with respect to certain other provisions.

- *Delaware*: Regulation: Del. DNREC Rule No. 41
- *District of Columbia*: DC Municipal Regs. title 20, sec. 750
- *Maine*: Code of Maine Rules 06-096, ch. 152
- *New Jersey:* N.J. Adm. Code 7:27-24
- *New York*: N.Y. State Dept of Env. Cons. Rules & Regs Ch. IIIA, Pt 235
- *Pennsylvania*: Pa. Admin. Code, title 25, sec. 130.201 et seq.
- *Virginia* (northern counties): 9 Va. Admin. Code 5-40-7240 *et seq*.
- *New Hampshire*: Chap. Env-A 4100
- *Maryland*: COMAR 26.11.32

Conclusion

Much has been learned about technical strategies for preventing indoor air quality problems in new homes. This report has described how state laws and regulations have incorporated some of these strategies into their new construction requirements. In some cases – *e.g.,* radon-resistant new construction, or formaldehyde in composite wood – the state policies are fairly straightforward. In other cases – *e.g.*, crawl space construction or whole-house ventilation – the policies are more complex, to allow flexibility for addressing project-specific conditions. The report has not attempted to create an exhaustive compilation of laws and regulations that promote advanced practices in this area. The policies described here provide a starting point for considering the current state of regulation in this area. As building science continues to evolve, so too will the body of state policy.

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