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Indoor Air Quality in Homes

State Policies for Improving Health Now and Addressing Future Risks in a Changing Climate

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CHAPTER 1

Introduction

Communities throughout the United States are experiencing a variety of conditions associated with a changing climate – hotter summers and heat waves, droughts, intense storms and flooding, increased average precipitation and humidity, and more severe wildfires. Alongside potentially far-reaching environmental and economic impacts, these conditions have direct and indirect effects on human health. Many of the health effects are associated with exposures that occur where people spend the vast majority of their time – indoors.

Indoor air quality (IAQ) is affected by complex interactions among indoor and outdoor environmental conditions and pollution sources, building features, and human activities. Pollutants found indoors can be of both indoor and outdoor origin. Pollutants can be generated indoors by sources and activities such as cooking, smoking, cleaning, fuel-burning combustion appliances, and chemicals emitted from building materials, furnishings, and household and personal care products. Pollutants that are found outdoors can also move inside buildings. Air can enter and leave a building through natural ventilation (windows and doors), infiltration (other openings or cracks in the building envelope), and mechanical ventilation systems. Outdoor conditions such as air pollution, humidity, and precipitation influence the indoor environment, depending on factors such as the building envelope, mechanical ventilation systems, and occupant behaviors.[1]

Studies by the U.S. Environmental Protection Agency (EPA) indicate that indoor levels of pollutants may be two to five times higher than outdoor levels, and occasionally as much as 100 times higher.[2] Over the past few decades public health science research has enhanced greatly our understanding of the health and productivity effects associated with indoor biological and chemical contaminants and with building conditions such as dampness and poor ventilation.[3] These health effects include upper and lower respiratory disease and symptoms, headaches, skin problems, fatigue, neurological impairment,

[1] *See generally* U.S. EPA, An Introduction to Indoor Air Quality, https://www.epa.gov/indoor-air-quality-iaq/introduction-indoor-air-quality.
[2] U.S. EPA, IAQ Tools for Schools Action Kit: IAQ Backgrounder at 1, http://www.epa.gov/iaq/schools/actionkit.html; U.S. EPA. Why Indoor Air Quality is Important to Schools, https://www.epa.gov/iaq-schools/why-indoor-air-quality-important-schools.
[3] *See generally* Calif. Air Resources Board, Health Effects of Indoor Pollutants (2013), http://www.arb.ca.gov/research/indoor/healtheffects1table1.htm; Lawrence Berkeley National Laboratory (LBNL), IAQ Scientific Findings Resource Bank: Human Performance, http://iaqscience.lbl.gov/performance-summary; U.S. EPA, Indoor Air Quality, http://www2.epa.gov/indoor-air-quality-iaq.

developmental disorders, and cancer.[4] Children are particularly vulnerable to the health effects of indoor pollutants, since their bodies are still developing and they have relatively higher rates of breathing and metabolism.[5] Many indoor pollutants that can cause or trigger asthma may have especially harmful effects on the nearly seven million children and 18 million adults in the U.S. who suffer from asthma.[6]

The growing body of public health science research demonstrates that IAQ issues are already a significant problem in the United States: "By one estimate, poor indoor conditions cost the nation's economy tens of billions of dollars a year in exacerbation of illnesses and allergenic symptoms and in lost productivity."[7] Over the past several years scientists have begun to examine and describe comprehensively how indoor environmental quality may be affected by a changing climate. Recent government and academic reports have illuminated a broad range of potential impacts on indoor air quality.

This report discusses three of these residential IAQ issues: wildfire smoke; dampness and mold; and the effect of energy efficiency upgrades on indoor air quality. The chapters that follow describe in detail current state policies and programs in these areas, highlighting approaches for consideration by other jurisdictions. State and local policymaking on these and other IAQ issues is important whether or not specific climate predictions come to pass. Regardless of the magnitude of climate change impacts in the future, "Poor indoor environmental quality is creating health problems today and impairs the ability of occupants to work and learn."[8] States thus have an opportunity to put in place policies that not only prepare for anticipated increased future risks, but also reap considerable health and economic benefits in the near term.

Recent Scientific Reviews

This report focuses on IAQ issues identified in several recent scientific reviews describing current knowledge of the anticipated effects of climate change on indoor environmental quality.[9]

In 2011, the Institute of Medicine at the National Academy of Sciences issued a comprehensive report summarizing the current state of scientific understanding with respect to the effects of climate change on indoor air quality. The report, *Climate Change, the Indoor Environment, and Health*, addresses five topic areas: indoor air pollutants; indoor dampness and mold; infectious agents, insects, and arthropods found indoors; indoor temperature and humidity; and building weatherization, ventilation, and energy

[4] *See generally* Calif. Air Resources Board, Indoor Air Pollution in California: Executive Summary at 1-9 (2005), http://www.arb.ca.gov/research/indoor/ab1173/ab1173.htm; U.S. EPA, America's Children and the Environment (3rd ed.) (2013), http://www.epa.gov/ace/.
[5] U.S. EPA, America's Children and the Environment, *supra*, at 8.
[6] Centers for Disease Control and Prevention (CDC), Fast Stats: Asthma, http://www.cdc.gov/nchs/fastats/asthma.htm.
[7] National Academy of Sciences – Institute of Medicine, Climate Change, the Indoor Environment, and Health at 3 (2011), https://www.nap.edu/catalog/13115/climate-change-the-indoor-environment-and-health. *See also* LBNL, IAQ Scientific Findings Resource Bank: Human Performance, http://iaqscience.lbl.gov/performance-summary.
[8] Institute of Medicine, Climate Change, the Indoor Environment, and Health, *supra,* at 7.
[9] In this report, footnotes citing these and other publications exclude internal references in the cited publications.

use.[10] The report concludes generally that, while there has been little research to determine the associations between climate change-induced alterations in the indoor environment and specific adverse health outcomes, "the available research indicates that climate change may make existing indoor environmental problems worse and introduce new problems…."[11]

The U.S. Global Change Research Program (USGCRP), established by presidential initiative in 1989, was mandated by Congress in the Global Change Research Act of 1990 to "assist the Nation and the world to understand, assess, predict, and respond to human-induced and natural processes of global change."[12] Two recent USGCRP reports issued as part of the National Climate Assessment process explore the state of the science on climate change in the U.S. The 2014 report, *Climate Change Impacts in the United States: The Third National Climate Assessment*, analyzes climate impacts on seven sectors – human health, water, energy, transportation, agriculture, forests, and ecosystems – and the interactions among sectors at the national level.[13] In 2016, USGCRP issued *The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment*, which focused exclusively on "the growing threat of climate change to the health and well-being of residents of the United States" and concluded that "alterations in indoor air pollutant concentrations from climate change have important health implications."[14]

In the years since publication of the Institute of Medicine report, scientists from prominent research institutions have issued papers focusing broadly on the impacts of climate change on indoor environmental issues. These include work from the National Institute of Standards and Technology (Andrew Persily and Steven Emmerich),[15] Lawrence Berkeley National Laboratory (LBNL) (William Fisk),[16] and the University of California, Berkeley (William Nazaroff).[17] In addition, LBNL has developed a web site that summarizes scientific findings on the subject of climate change and the indoor environment.[18]

[10] Institute of Medicine, Climate Change, the Indoor Environment, and Health*, supra*, at 1. Beginning in 2016, the Institute of Medicine was renamed the National Academy of Medicine; *see* http://nationalacademyofsciences.org/about-nas/mission/.
[11] *Id*. at 7-8. Following release of the report, the report committee chairman published an Editorial summarizing the work of the committee. *See* J. Spengler, Climate Change, Indoor Environments, and Health, *Indoor Air* , v. 22, issue 2 (2012).
[12] *See* US Global Change Research Program (USGCRP), About USGCRP, http://www.globalchange.gov/about.
[13] USGCRP, Climate Change Impacts in the United States: The Third National Climate Assessment (2014), http://nca2014.globalchange.gov/ [hereinafter Third National Climate Assessment].
[14] USGCRP, The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment at iv, 72 (2016), http://www.globalchange.gov/health-assessment [hereinafter Impacts of Climate Change on Human Health].
[15] A. Persily & S. Emmerich, NIST Technical Note 1882 – Indoor Environmental Issues in Disaster Resilience (2015) (reviewing indoor environmental impacts of heat waves, storms causing power failure, floods and mold exposure, wildfires, and airborne releases of chemical, biological or radiological agents), http://nvlpubs.nist.gov/nistpubs/TechnicalNotes/NIST.TN.1882.pdf.
[16] W. Fisk, Energy Technologies Area/LBNL, Review of Some Effects of Climate Change on Indoor Environmental Quality and Health and Associated No-Regrets Mitigation Measures (2015) (discussing climate change impacts on thermal stress during heat waves, dampness/mold from storms and sea level rise, wildfires, ozone, and building energy efficiency), http://bit.ly/2eb1pmy.
[17] W. Nazaroff, Exploring the Consequences of Climate Change for Indoor Air Quality, *Envtl. Research Letters*, v. 8, no. 1 (2013) (describing climate change impacts on IAQ related to indoor combustion, radon, VOCs and SVOCs, CO2, outdoor particulate matter, outdoor ozone, and other outdoor air pollutants), http://iopscience.iop.org/article/10.1088/1748-9326/8/1/015022/meta;jsessionid=C59D5CA4292FDD969EAF49D4BBAE5F26.c1.iopscience.cld.iop.org.
[18] LBNL, Indoor Air Quality Scientific Findings Resource Bank: Climate Change, https://www.iaqscience.lbl.gov/ieq-environment.

IAQ Exposures of Concern Now and in a Changing Climate

Indoor air quality issues potentially impacted by climate change can be grouped into three general categories: contaminants of outdoor origin, indoor sources of air contaminants, and climate adaptation and mitigation activities. This report covers one issue from each of these categories, focusing on sources of indoor exposures that have figured most prominently in the recent scientific literature. Although not addressed in this report, heat-related illness is another major indoor environmental concern that has received considerable attention in recent years, since much of human exposure to extreme heat occurs indoors.[19]

Pollutants of Outdoor Origin

Focus Issue: Wildfire Smoke. Wildfire smoke, a mixture of gases and fine particles, can aggravate heart and lung disease and is linked to premature death in people with those conditions.[20] Many areas of the U.S. are experiencing longer and more severe wildfire seasons. The frequency and intensity of wildfires is expected to increase as a result of higher ambient temperatures combined with episodes of drought, thus increasing emissions of particulate matter, ozone precursors, and other pollutants.[21] It is estimated that over half of the health effects caused by wildfire smoke will be the result of indoor exposure, because the outdoor emissions enter indoor spaces.[22]

Other Pollutants of Outdoor Origin. Climatic changes may increase ambient levels of a variety of pollutants that have well-documented adverse health effects.[23] For example, ground-level *ozone* in the U.S. is estimated to cause "tens of thousands of hospital and emergency room visits, millions of cases of acute respiratory symptoms and school absences, and thousands of premature deaths each year."[24] Higher temperatures and more frequent stagnant air conditions may lead to higher levels of ozone over portions of the country, and "about half of the health effects resulting from any outdoor increases in ozone…will be due to indoor ozone exposures."[25] Ozone reacts rapidly with indoor surfaces and with selected chemicals in indoor air to generate byproducts such as formaldehyde, acrolein, and ultrafine particles, which in turn have potential adverse health effects.[26]

[19] *See generally* Institute of Medicine, Climate Change, the Indoor Environment, and Health, *supra*, at 185-208; Persily & Emmerich, *supra*, at 2-6; Fisk, *supra*, at 5-7; USGCRP Impacts of Climate Change on Human Health, *supra*, at 44-68; LBNL, Indoor Air Quality Scientific Findings Resource Bank: Climate Change, https://iaqscience.lbl.gov/ieq-environment.
[20] *See* U.S. EPA, AirNow, How Smoke from Fires Can Affect Your Health, https://www.airnow.gov/index.cfm?action=smoke.index.
[21] Institute of Medicine, Climate Change, the Indoor Environment, and Health, *supra*, at 104; USGCRP, Impacts of Climate Change on Human Health, *supra*, at 77—80, 110-111; Fisk, *supra,* at 8-11; Persily & Emmerich, *supra,* at 14; LBNL, IAQ Scientific Findings Research Bank – Wildfires, https://iaqscience.lbl.gov/cc-wildfires.
[22] Fisk, *supra,* at 11.
[23] Spengler, *supra*, at 92 ("It is now appreciated that climate change will impact ambient air pollution through increased emission rates and faster chemical reaction rates associated with higher temperatures.").
[24] USGCRP, Impacts of Climate Change on Human Health, *supra*, at 72.
[25] *Id*. at 80. *See also* Fisk, *supra*, at 11-14; LBNL, Indoor Air Quality Scientific Findings Resource Bank: Ozone, https://iaqscience.lbl.gov/cc-increases.
[26] *See* Institute of Medicine, Climate Change, the Indoor Environment, and Health, *supra*, at 99; Nazaroff, *supra*, at 13; LBNL, Indoor Air Quality Scientific Findings Resource Bank: Ozone, https://iaqscience.lbl.gov/cc-increases.

Apart from wildfire events, ambient levels of *particulate matter* may increase from a variety of sources, including residential wood burning, power plants, motor vehicles, and dust associated with droughts.[27] There currently is "no consensus about the net effects of climate change on overall levels of ambient particles"; however, given the significant health impacts, "even small fractional changes in particle levels could have substantial consequences for health."[28]

Indoor *carbon dioxide* (CO_2) levels are determined primarily by exhaled indoor breath and infiltration of outdoor CO_2, and buildings provide "virtually no protection against CO_2 from the outdoors…."[29] Rising temperatures are expected to lead to increases in outdoor CO_2. These changes present an emerging issue in light of recent public health science research suggesting that exposure to indoor CO_2 itself may have direct adverse impacts on human cognition and decision-making.[30]

Indoor Sources of Air Contaminants

Focus Issue: Dampness and Mold. Indoor dampness and mold are common problems throughout the country. Over the past several years, public health science has shown an association between indoor dampness and mold and a range of respiratory diseases and symptoms. Dampness and mold problems are a result of water incursion and excess moisture in buildings, conditions that are likely to grow worse with increases in the frequency and severity of storms and increased average precipitation and humidity in some regions of the country.[31]

Other Indoor Sources. A changing climate may produce conditions that increase exposure to a variety of other air pollutants originating indoors. For example, increased storms that cause power outages may lead to additional cases of *carbon monoxide* poisoning from the improper use of portable generators in (or in close proximity to) a home.[32] Increased use of and exposure to chemical *pesticides* indoors may occur as a result of increases in structural and other pest populations, as well as degradation of building envelopes from extreme weather events and higher average precipitation.[33] Additional indoor sources identified in recent scientific reviews include: combustion pollutants (from the increased use of alternative heating sources such as unvented heaters and residential wood burning);

[27] Institute of Medicine, Climate Change, the Indoor Environment, and Health, *supra*, at 102-106; Nazaroff, *supra*, at 10-12; USGCRP, Impacts of Climate Change on Human Health, *supra*, at 76-77.
[28] LBNL, Indoor Air Quality Scientific Findings Resource Bank: Particles, https://iaqscience.lbl.gov/cc-particles.
[29] Institute of Medicine, Climate Change, the Indoor Environment, and Health, *supra*, at 98.
[30] *See* Nazaroff, *supra*, at 8-9. *See also*, U. Satish et al., Is CO_2 an Indoor Pollutant? Direct Effects of Low-to-Moderate CO_2 Concentrations on Human Decision-Making Performance, Envtl. Health Perspectives, vol. 120, issue 12 (Dec. 2012), http://ehp.niehs.nih.gov/1104789/; J. Allen, et al., Associations of Cognitive Function Scores with Carbon Dioxide, Ventilation, and Volatile Organic Compound Exposures in Office Workers: A Controlled Exposure Study of Green and Conventional Office Environments, Envtl. Health Perspectives, v. 124, issue 6 (2016), http://bit.ly/2f5KGyA.
[31] *See* USGCRP, Third National Climate Assessment, *supra,* at 222, 225; USGCRP, Impacts of Climate Change on Human Health, *supra*, at 110; Fisk, *supra*, at 74-5; Persily & Emmerich, *supra*, at 14-18; Nazaroff, *supra*, at 11-12.
[32] *See* USGCRP, Third National Climate Assessment, *supra,* at 222, 225; USGCRP, Impacts of Climate Change on Human Health, *supra*, at 102-105; Institute of Medicine, Climate Change, the Indoor Environment, and Health, *supra*, at 81-83; Persily & Emmerich, *supra*, at 7-11.
[33] Institute of Medicine, Climate Change, the Indoor Environment, and Health, *supra*, at 170. *See generally* CDC, Carbon Monoxide (CO) Poisoning Prevention, http://www.cdc.gov/features/copoisoning/.

radon; volatile and semi-volatile organic compounds; dust mites; and infectious agents, such as *Legionella.*[34]

IAQ and Climate Adaptation/Mitigation

Focus Issue: Energy Efficiency and IAQ. Reducing building energy use is a key climate mitigation strategy, and considerable public resources are devoted to encouraging and facilitating energy efficiency retrofits. Such mitigation efforts are vital to reducing greenhouse gas emissions and limiting the health and other impacts of climate change in the long term. However, if precautions are not taken, energy efficiency measures can have unintended negative consequences on indoor environmental quality in a home by disturbing hazardous materials that may be present, introducing new contaminants, or reducing ventilation rates. A variety of best practices can be implemented as part of an energy retrofit in order to avoid IAQ problems and improve indoor environmental quality.[35]

Other Mitigation and Adaptation Actions. Other climate mitigation and adaptation actions with potential IAQ impacts include increased use of *alternative fuels*, such as biomass,[36] and increased use of *air conditioning*, which may, "if accompanied by reduced ventilation rates, increase the indoor concentrations of pollutants emitted from indoor sources."[37]

Vulnerable Populations and IAQ Exposures

As policymakers consider how to reduce exposure to indoor air pollutants, it is vital to ensure that policies and programs address the needs of those who are most vulnerable.

The 2016 USGCRP report on climate change and health identified three main components of vulnerability to adverse health effects from climate change – exposure, sensitivity, and adaptive capacity – and concluded, "Social determinants of health, such as those related to socioeconomic factors and health disparities, may amplify, moderate, or otherwise influence climate-related health effects, particularly when these factors occur simultaneously or close in time or space."[38] With respect to indoor air pollution specifically, the report found that the young, older adults, asthmatics, and people whose immune systems are compromised are more vulnerable than the general population.[39]

[34] *See* Institute of Medicine, Climate Change, the Indoor Environment, and Health, *supra*, at 85-96, 156-174; Nazaroff, *supra*, at 4-8; USGCRP Impacts of Climate Change on Human Health, *supra*, at 33.
[35] *See* Institute of Medicine, Climate Change, the Indoor Environment, and Health, *supra*, at 209-238; Fisk, *supra*, at 14-16.
[36] *See* Institute of Medicine, Climate Change, the Indoor Environment, and Health, *supra*, at 84, 115. At the same time, for populations in the U.S. and other countries that already use high-emitting biomass and coal stoves, a switch to more efficient and lower-emitting equipment, or to other fuels is a climate mitigation that can significantly improve indoor air quality. See LBNL, Indoor Air Quality Scientific Findings Resource Bank: IEQ and Health Consequences of Adaption to and Mitigation of Climate Change, https://iaqscience.lbl.gov/ieq-climate.
[37] Institute of Medicine, Climate Change, the Indoor Environment, and Health, *supra*, at 115. Use of air conditioning may also lead to exposure to indoor pollutants associated with air conditioning itself. *See* LBNL, Indoor Air Quality Scientific Findings Resource Bank: IEQ and Health Consequences of Adaption to and Mitigation of Climate Change, https://iaqscience.lbl.gov/ieq-climate.
[38] USGCRP, Impacts of Climate Change on Human Health, *supra*, at 21, 103-4.
[39] *Id.* at 82.

The Institute of Medicine 2011 report also discussed the factors that may influence whether particular populations are more vulnerable to IAQ impacts, concluding: "Vulnerable populations will be disproportionately affected by climate change and its adverse effects on indoor environmental quality. Vulnerable populations include those who have less economic ability to adapt to or mitigate the effects of changes in their indoor environment and those whose age or health status renders them more susceptible to environmental stresses or insults."[40]

Scope and Structure of this Report

The following three chapters describe state policies addressing indoor wildfire smoke, dampness and mold, and the impact of energy efficiency retrofits on indoor air quality. The report discusses these issues in the *residential* context only, though they represent important issues for occupants and workers in schools and other public and commercial buildings as well. For each issue, the chapters provide background information; describe existing state laws, regulations, and other policies; and highlight considerations for the development of stronger policies and programs in the future. The final chapter of the report notes additional considerations for state policymaking.

Just as this report cannot address all IAQ exposures that may be influenced by climate change, the following chapters cannot cover all potential policy and program strategies for addressing the three issues discussed here. For example, stronger state policies governing new home siting and construction are vital to creating more resilient housing and reducing indoor exposures; however, the primary focus of this policy review is IAQ in *existing* homes, and a detailed discussion of building codes, zoning ordinances, and other policies relating to the siting and construction of new homes is beyond the scope of the report. It is also outside the scope of the report to review the numerous federal and state emergency planning and response policies and programs that have an important role to play in addressing IAQ issues related to extreme weather events.[41]

[40] Institute of Medicine, Climate Change, the Indoor Environment, and Health, *supra*, at 48.

[41] In recent years, federal agencies have developed a variety of informational resources on addressing housing conditions in post-disaster recovery. *See, e.g.*, U.S. Dept. of Housing and Urban Devt., Disaster Recovery, http://portal.hud.gov/hudportal/HUD?src=/program_offices/healthy_homes/disasterrecovery.

CHAPTER 2

Wildfire Smoke

In recent decades, the incidence of large wildfires in the United States has risen dramatically, along with average annual acreage burned.[42] In 2015, wildfires burned over 10 million acres in the country, the most on record.[43] In 2016, wildfires affected communities from California and the Pacific Northwest to the Mississippi Valley and Southeastern U.S.[44]

Federal, state, and local agencies are grappling with a multitude of risks posed by wildfires, including injury to firefighters and residents, property destruction, and ecological damage. In addition, the risks from wildfire *smoke* have important consequences for public health and the economy. The health effects "range from eye and respiratory tract irritation to more serious disorders, including reduced lung function, bronchitis, exacerbation of asthma and heart failure, and premature death."[45] Most vulnerable to these risks are older adults, children, those with preexisting health problems, and people who lack the financial and other resources needed to protect themselves.[46]

The risks from wildfire smoke exposure are not limited to people living in communities directly affected by the fire. Smoke from wildfires can increase air pollution and respiratory impacts over a very large area.[47] Consider this contemporaneous account of the 2016 Santa Clarita fire in Southern California:

> *Smoke from the fire, burning through parts of the Angeles National Forest just north of Los Angeles, is visible from the city and cast a pall over the entire region this weekend, prompting sinister scenes. Ash rained down on cars and beaches. The sun appeared as a smoky red ball in the sky in downtown Los Angeles on Saturday, and the fire was a trending topic on Twitter. Smoke from the fire has reached as far as Las Vegas.*[48]

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[42] *See* A. Westerling, Increasing Western US Forest Wildfire Activity: Sensitivity to Changes in the Timing of Spring, *Phil. Trans. R. Soc.* 371, 4 (2016), http://ulmo.ucmerced.edu/pdffiles/16RSTB_Westerling.pdf; U.S. Envtl. Protection Agency (EPA), Climate Change Indicators, Wildfires (Figs. 2, 4), https://www3.epa.gov/climatechange/science/indicators/ecosystems/wildfires.html.
[43] *See* NOAA, Nat'l. Centers for Envt'l. Information, Wildfires – Annual 2015, https://www.ncdc.noaa.gov/sotc/fire/201513; National Interagency Coordination Center, Wildland Fire Summary and Statistics Annual Report 2015 at 9, http://www.predictiveservices.nifc.gov/intelligence/2015_Statssumm/intro_summary15.pdf.
[44] As NASA recently noted, "The Mississippi Valley (and total Southeast U.S. including the Plains) actually sees more fires every fire season than the Western States which tend to receive a lot of national attention. The main difference is that the fires in the Southeast are smaller and less intense than the monster fires of the West." NASA, Fires Overtake Landscape in the Mississippi Valley (Oct. 16), https://www.nasa.gov/image-feature/goddard/2016/fires-overtake-landscape-in-the-mississippi-valley.
[45] U.S. EPA, USFS, U.S. Centers for Disease Control and Prevention, Calif. ARB, Wildfire Smoke: A Guide for Public Health Officials (rev. 2016) at 13 [hereinafter Wildfire Smoke Guide], http://bit.ly/2dXBcFG.
[46] Wildfire Smoke Guide, *supra*, at 14-17.
[47] W. Fisk, Review of Some Effects of Climate Change on Indoor Environmental Quality and Health and Associated No-Regrets Mitigation Measures at 8 (2015), http://bit.ly/2eb1pmy.
[48] E. Holthaus, "The Sand Fire in Santa Clarita Offers Omens of a Fiery Future," *Pacific Standard* (July 24, 2016), https://psmag.com/the-sand-fire-in-santa-clarita-offers-omens-of-a-fiery-future-e142811ed90e#.e6l4oh8tf.

This chapter provides background on the issue of indoor exposure to wildfire smoke and describes several key issues for consideration in developing state policies and programs to reduce exposure. These considerations are relevant not only for states that are currently most affected by wildfire smoke, but also for states that will be impacted as a result of increased wildfire activity in the future.

Background

Wildfires in the United States

The years ahead are expected to see more wildfires as a result of conditions associated with climate change.[49] In the wake of the record-setting 2015 wildfire season, a Forest Service report stated, "The U.S. burns twice as many acres as three decades ago and Forest Service scientists believe the acreage burned may double again by mid-century."[50] At the same time, there has been a marked increase in the length of the average wildfire season – now eleven to twelve weeks longer than in the 1970s.[51] As EPA has noted, "The extent of area burned by wildfires each year appears to have increased since the 1980s. According to National Interagency Fire Center data, of the 10 years with the largest acreage burned, nine have occurred since 2000, including the peak year in 2015….This period coincides with many of the warmest years on record nationwide…."[52]

Wildfires have traditionally been associated with the West, and western states have been hardest-hit by the trends described above.[53] Nevertheless, federal data show that states in other regions of the country also have experienced increases in acres burned by wildfires in recent years.[54] A recent paper by U.S. Forest Service researchers projected that wildfire potential will increase not only in the Southwest, Rocky Mountains, and Pacific coast, but also in the northern Great Plains and the Southeast.[55]

[49] *See* National Academy of Sciences – Institute of Medicine, Climate Change, the Indoor Environment, and Health at 104 (2011), https://www.nap.edu/catalog/13115/climate-change-the-indoor-environment-and-health ("Climate change is expected to increase the frequency of wildfires. Higher ambient temperatures combined with episodes of drought could lead to periods with a higher tendency for forests to burn."). *See also* J. Abatzoglou & A. Williams, Impact of Anthropogenic Climate Change on Wildfire across Western US Forests," Proceedings of the National Academy of Sciences (2016), http://www.pnas.org/content/early/2016/10/05/1607171113.abstract?tab=dsb; J. Yoon, et al., Extreme Fire Season in California: A Glimpse into the Future? Bulletin of the Amer. Meteorological Society (2015), https://www.researchgate.net/publication/283425168_Extreme_Fire_Season_in_California_A_Glimpse_Into_the_Future.

[50] U.S. Forest Service (USFS), The Rising Cost of Wildfire Operations: Effects on the Forest Service's Non-Fire Work at 2 (2015), http://www.fs.fed.us/sites/default/files/2015-Rising-Cost-Wildfire-Operations.pdf. "The six worst fire seasons since 1960 have all occurred since 2000. Moreover, since 2000, many western states have experienced the largest wildfires in their state's history." *Id*. at 6. *See also* Institute of Medicine, Climate Change, the Indoor Environment, and Health, *supra*, at 47, 104.

[51] USFS, The Rising Cost of Wildfire Operations, *supra*, at 2. *See also* Westerling, *supra*, at 6-8.

[52] U.S. EPA, Climate Change Indicators: Wildfires (Key Points), https://www.epa.gov/climate-indicators/climate-change-indicators-wildfires.

[53] *Id.*

[54] *See* U.S. EPA, Climate Change Indicators: Wildfires (Figure 5-Change in Annual Burned Acreage by State Between 1984-1999 and 2000-2014), https://www.epa.gov/climate-indicators/climate-change-indicators-wildfires.

[55] *See* Y. Liu, et al., Future U.S. Wildfire Potential Trends Projected using a Dynamically Downscaled Climate Change Scenario, *Forest Ecology and Management* 294, 131-133 (2013), https://www.firescience.gov/projects/08-1-6-06/project/08-1-6-06_08_1_6_06_Deliverable_01.pdf.

Wildfire smoke is already having a considerable impact on levels of particulate matter (PM) in ambient air.[56] The anticipated increase in future wildfire activity is expected to lead to an increase in the mean outdoor air levels of fine particles in the western U.S.[57] These air pollution impacts are not limited to the immediate area of a wildfire. As winds carry fine particulates and ozone precursor gases, smoke can affect people even far downwind from the fire itself.[58] Under certain conditions, wildfire smoke may have a pronounced effect on air quality hundreds of miles away, including over land not typically associated with wildfire smoke.[59]

Health Impacts of Wildfire Smoke

Wildfire smoke is a complex mix of gases and fine particles; particulate matter is the main public health threat from short-term exposure.[60] Wildfire smoke "can trigger asthma attacks and severely restrict breathing for those with other respiratory ailments. [Ultra-fine] particles in the smoke can bypass the protective filtering mechanisms in our airways. More than an irritant, [these very tiny particles] can lodge deep in the lungs and enter the bloodstream, increasing the risk of heart attack among those with cardiovascular problems."[61]

Studies of urban particulate matter have found that "short-term exposures (i.e., days to weeks) to fine particles…are linked with increased premature mortality and aggravation of preexisting respiratory and cardiovascular disease."[62] A recent review of several studies of the health effects of pollution from wildfires describes documented increases in hospital admissions, mortality, respiratory symptoms, eye and nose symptoms, and respiratory infections.[63] These health impacts can also translate into significant economic costs for individuals and communities.

In addition to increasing outdoor airborne particles during wildfire events, wildfires can cause temporary large increases in pollutants other than particulate matter – e.g., carbon monoxide, nitrogen oxides, and

[56] *See* Cal. Air Resources Bd. (ARB), Possible Wildfire Impacts on Air Quality, https://www.arb.ca.gov/smp/wildfire/wildfire.htm; J. Coco Liu et al., Particulate air pollution from wildfires in the Western US under climate change, *Climatic Change* 138 (2016) (finding that wildfire smoke is the component most responsible for the vast majority of days with fine particulate matter levels exceeding regulatory standards, especially in northern California, the Pacific Northwest, and the northern Rocky Mountains).
[57] Fisk, *supra*, at 8 (discussing findings that summertime mean outdoor-air levels of fine particles in the western U.S. will increase by 30% to 40%, and noting that percentage increases in urban areas with higher current particle concentrations are likely to be smaller); U.S. Global Change Research Program (USGCRP), The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment at 77 (2016), https://health2016.globalchange.gov/ [hereinafter Impacts of Climate Change on Health] ("By 2050, changes in wildfires in the western United States are projected to result in 40% increases of organic carbon and 20% increases in elemental carbon aerosol concentrations.").
[58] Fisk, *supra,* at 8.
[59] J. Coco Liu et al., *supra*; L. DeBell et al., A major regional air pollution event in the northeastern United States caused by extensive forest fires in Quebec, Canada, *Journal of Geophysical Research* 109 (2004), http://onlinelibrary.wiley.com/doi/10.1029/2004JD004840/full; Natural Resources Defense Council, Where There's Fire, There's Smoke: Wildfire Smoke Affects Communities Distant from Deadly Flames (2013), https://www.nrdc.org/sites/default/files/wildfire-smoke-IB.pdf.
[60] Wildfire Smoke Guide, *supra*, at 13; Fisk, *supra,* at 8.
[61] Cal. ARB, Protect Yourself form Wildfire Smoke, https://www.arb.ca.gov/videos/impacts_of_smoke.htm.
[62] Wildfire Smoke Guide, *supra*, at 13.
[63] *See* Fisk, *supra,* at 9-10. *See also* USGCRP, Impacts of Climate Change on Health, *supra*, at 77 (finding that "PM2.5 from wildfires affects human health by increasing the risk of premature death and hospital and emergency department visits").

volatile organic compounds (VOCs).[64] Two VOCs, formaldehyde and acrolein, are "two of the principal contributors to the cumulative irritant properties of smoke."[65] VOCs and nitrogen oxides are also ozone precursors, and the increase in wildfires due to climate change can lead to increased ozone concentrations near the ground.[66] According to the U.S. Global Change Research Program, climate change is expected generally to increase ozone pollution in the future throughout much of the United States, in part due to higher temperatures and more frequent stagnant air conditions.[67]

Indoor Exposure to Wildfire Smoke

Wildfire smoke is an important indoor, as well as outdoor, air quality issue. Indeed, "the adverse health effects expected from increased wildfires will substantially be the consequence of exposures to particles that penetrate to and persist indoors."[68] This is due to the fact that, while indoor particulate levels may be only about 50 percent of outdoor levels, people spend nearly all of their time indoors and are likely to spend even more time indoors when outdoor air is impacted by wildfire smoke. Thus, most of the health effects from wildfire smoke may be the result of indoor exposures.[69]

There are three main factors that determine the degree to which outdoor particles are present indoors: particle size, building ventilation rate, and filtration.[70] Residences do not generally provide significant protection from fine particles, the primary constituent of wood smoke.[71] The building ventilation rate affects the amount of outdoor air brought inside; while a lower building ventilation rate tends to provide greater protection against some outdoor pollutants, a lower ventilation rate tends to *increase* concentrations of pollutants from indoor sources. Public health science research indicates that "increased ventilation rates are, on average, associated, with fewer adverse health effects and with superior work and school performance."[72] Thus, a critical element for reducing wildfire smoke exposure is *filtration* of outside air.[73] Mechanical ventilation systems that provide supply

Most of the health effects from wildfire smoke may be the result of indoor exposures.

[64] Fisk, *supra*, at 8.
[65] Wildfire Smoke Guide, *supra*, at 13.
[66] USGCRP, Impacts of Climate Change on Health, *supra*, at 73. *See also* D. Jaffe and N. Wigder, Ozone production from wildfires: A critical review, *Atmospheric Environment* 51:1-10 (2012), https://www.researchgate.net/publication/235342520_Ozone_production_from_wildfires_A_critical_review (finding that wildfires have been shown to contribute to background ozone levels and to days that exceed air quality standards).
[67] *See* USGCRP, Impacts of Climate Change on Health, *supra*, at 80 (noting that around 45% to 75% of a person's exposure to ozone will occur *indoors*, and thus "about half of the health effects resulting from any outdoor increases in ozone…will be due to indoor ozone exposures"). *See also* Fisk, *supra,* at 76 (noting that "the amount of ozone inhaled when people are indoors is typically 25%-60% of the total amount of ozone inhaled").
[68] Fisk, *supra,* at 10.
[69] USGCRP, Impacts of Climate Change on Health, *supra*, at 79; Fisk, Effects of Climate Change, *supra,* at 11.
[70] Institute of Medicine, Climate Change, the Indoor Environment, and Health, *supra*, at 101.
[71] Fisk, *supra,* at 10.
[72] Lawrence Berkeley National Laboratory (LBNL), IAQ Scientific Findings Resource Bank: Building Ventilation, https://iaqscience.lbl.gov/vent-summary.
[73] Institute of Medicine, Climate Change, the Indoor Environment, and Health, *supra*, at 101 ("Absent active filtration, higher ventilation rates tend to produce higher indoor concentrations of outdoor particles."); National Academies of Sciences, Engineering, and Medicine – Health and Medicine Division, Health Risks of Indoor Exposure to Particulate Matter: Workshop

air can be equipped with particle filters, and "good filtration efficiency is possible at a modest cost."[74] Portable air cleaners are another option, and those devices are available in a wide range of prices.[75]

Wildfire Smoke and Vulnerable Populations

Some people face greater health risks from exposure to wildfire smoke. The groups considered to be at higher risk from wildfire smoke exposure include:

- *Those with preexisting lung and heart disease*, because wildfire smoke impacts those health conditions in particular;
- *Older adults*, due to preexisting diseases, as well as the decline of "important physiologic processes, including defense mechanisms";
- *Young children*, because they breathe more air relative to their size and because their organs are developing;
- *Pregnant women*, because "numerous physiologic changes occur during pregnancy increasing a woman's vulnerability to environmental exposures," and due to the risk of "adverse effects to their fetus, during a critical window of human development";
- *Racial minorities,* who bear a disproportionate burden of asthma and other diseases; and
- *People of low socio-economic status,* who suffer disproportionately from diseases such as asthma and who also may lack the resources needed to obtain air conditioning and take other recommended actions to protect themselves from wildfire smoke exposure.[76]

State Policies and Programs

Although states do not regulate indoor wildfire smoke directly, a variety of state and local policies and programs can be implemented to help reduce the risks of indoor smoke exposure generally and for vulnerable populations. This section describes several areas in which states and local governments have been active: monitoring air quality during wildfire events; developing guidance for reducing indoor exposures; providing information and technical assistance to local agencies and communities; providing direct material assistance to vulnerable populations; and incorporating minimum standards and best practices into regulations governing rental housing and new home construction. This chapter does not discuss the role of the Clean Air Act, smoke management programs, and other federal and state ambient air quality policies governing prescribed fires and agricultural or other outdoor/open burning.[77]

Summary at ch. 5, p. 49 (2016), https://www.nap.edu/download/23531 (summarizing comments of William Fisk, that "the filtration of incoming outdoor air and recirculated indoor air should be the first approach taken to mitigate individual exposure to PM").

[74] Institute of Medicine, Climate Change, the Indoor Environment, and Health, *supra*, at 106.

[75] Wildfire Smoke Guide, *supra*, at 13.

[76] Wildfire Smoke Guide, *supra*, at 14-17. *See also* Institute of Medicine, Climate Change, the Indoor Environment, and Health, *supra*, at 102; Fisk, *supra,* at 74-75.

[77] For general information on smoke management policies, see National Interagency Fire Center, Smoke Management, http://www.nifc.gov/smoke/.

Monitoring Air Quality and Wildfire Smoke

Air quality monitoring is a central tool for determining when action is needed to reduce wildfire smoke exposure. Air quality data are used by government agencies to warn the public about potential risks of wildfire smoke and to prompt individuals to take action. Federal, state, and local government agencies collaborate to maintain a permanent network of air quality monitoring stations throughout the country and to deploy additional monitoring stations during wildfire smoke events.

Deploying Air Monitors During Wildfires. Air quality during wildfire smoke events can be gauged using both permanent and portable air monitors. Under the federal Clean Air Act, each state must establish air monitoring stations for "criteria" air pollutants (particular matter, ozone, lead, nitrogen oxides, sulfur oxides, and carbon monoxide).[78] Nearly 300 state and local governments and tribal agencies own and operate these permanent air quality monitoring stations throughout the country, which can provide valuable data during wildfires.[79]

The capacity to deploy temporary, portable monitors during wildfires is also important, especially for communities that are not represented in the permanent monitoring network. The U.S. Forest Service's Wildland Fire Air Quality Response Program, which "was created to directly assess, communicate, and address risks posed by wildland fire smoke to the public as well as fire personnel," maintains a cache of portable air particulate matter monitoring kits that are available upon request by firefighting agencies as part of the response to wildfires.[80] The program maintains a web page displaying the availability of portable monitors.[81] In addition, the program offers Air Resource Advisors, trained personnel who can be dispatched to an incident to deploy temporary air monitors and to assist with understanding, predicting, and communicating smoke impacts to agency officials and the public.

States also have portable air monitors for supporting local jurisdictions during wildfire emergencies, though this capacity may vary from state to state due to funding and other constraints. In California, the Air Resources Board (ARB) has been able to expand resources in recent years to accommodate the increasing requests for wildfire smoke monitoring from rural communities.[82] Some local air quality districts in California also make available portable air quality monitors to expand pollutant measurements during wildfires. For example, the South Coast Air Quality Monitoring District (SCAQMD) in California "can add up to four mobile air quality monitors to its 4-county network of 38 fixed monitoring stations….The information gathered from the extra monitors will assist SCAQMD to better inform the public of appropriate precautions as suggested in SCAQMD smoke advisories….SCAQMD

[78] *See* U.S. EPA, Air Quality Monitoring, https://www3.epa.gov/airquality/montring.html.
[79] National Science and Technology Council, Air Quality Observation Systems in the United States (2013), http://bit.ly/2d17kuB.
[80] USFS, Wildland Fire Air Quality Response Program, http://www.wildlandfiresmoke.net/. The USFS' AirFire Team operates the BlueSky smoke modeling system, which provides daily smoke impact modeling of active wildfires throughout the lower 48 states, as well as the Alaska BlueSky system.
[81] *See* USFS, Wildland Fire Air Quality Response Program, Monitor Status, http://www.wildlandfiresmoke.net/monitoring/smoke-monitor-status/.
[82] These deployments typically range from two to six weeks. Communications with California Air Resources Board, Office of Emergency Response (10/13/16) (on file with ELI).

incorporates the extra data from the mobile monitors into the online interactive air quality map on an hourly basis."[83]

Communicating Air Quality Monitoring Information to the Public. EPA runs the AirNow website (www.airnow.gov) to present monitoring information from permanent and temporary air particulate monitors across the country. The AirNow website includes maps showing the locations of and data from the monitors in use throughout the country, as well as maps showing current wildfire activity and associated monitors. Air quality information is presented using EPA's Air Quality Index (AQI), which reports information about air pollution (including particulate matter and ozone) by converting ambient concentrations into general descriptors (ranging from "Good" to "Hazardous") and numbers on a scale of 0-500. AirNow's "current conditions" report uses a methodology that estimates the AQI for each hour in order to incorporate changing air quality conditions.[84]

The AQI is the central tool used by most government agencies to communicate to the public information about air quality based on monitoring data. At least one state has developed its own framework for translating monitoring data. Washington State's Air Quality Advisory (WAQA) is similar to the AQI, using color-coded categories to describe air quality, but it "shows the health effects of $PM_{2.5}$ at lower levels than the AQI does. In other words, WAQA shows that air quality is unhealthy sooner – when there is less $PM_{2.5}$ in the air."[85]

The EnviroFlash system, managed by EPA, sends state air quality forecasts and Action Day alerts to subscribers. States also play an important role in communicating air quality forecasts to the public by posting air quality monitoring data and the AQI directly on state agency web pages, as well as linking to the AirNow website. The California ARB's Air Quality Data Query Tool, for example, affords access to a wealth of data: users can select for particular pollutants and time frames, and they can examine specific locations or broader regions. Aside from being able to obtain daily or hourly measurements from areas of interest, users can view "special reports" on the same range of pollutants that highlight the findings' most significant implications (e.g., number of days above the national standard for $PM_{2.5}$ levels).[86] In addition, some states have comprehensive smoke information websites – "blogspots" – that are maintained by volunteers and that include information posted by many city, county, tribal, state and federal agencies "to coordinate and aggregate information for….communities affected by wildfire smoke."[87]

Indoor Air Monitoring. While ambient air quality monitoring during wildfires is a central governmental function, there has been relatively little activity around monitoring *indoor* air quality. To the extent that government agencies have undertaken indoor air monitoring during wildfires, those

[83] South Coast Air Quality Monitoring District, Fire Monitoring Explained, http://www.aqmd.gov/fire-monitoring-new.
[84] *See* AirNOW, https://www.airnow.gov/index.cfm?action=topics.smoke_wildfires.
[85] Wa. Dept. of Ecology, Washington Air Quality Advisory (WAQA) http://www.ecy.wa.gov/programs/air/air_monitoring_data/waqa_intro_page.html.
[86] *See* Cal. ARB, Air Quality Data (PST) Query Tool, https://www.arb.ca.gov/aqmis2/aqdselect.php.
[87] *See* http://wasmoke.blogspot.com/, http://oregonsmoke.blogspot.com/, http://californiasmokeinfo.blogspot.com/, http://idsmoke.blogspot.com/.

activities seem to have focused on public facilities, rather than on homes. For example, the Colville Tribe has purchased a monitor to measure both outdoor particulate matter and indoor PM in tribal facilities.[88]

The states of Oregon and California have developed guidance documents that address indoor monitoring. Oregon's wildfire response protocol includes as a desired outcome for state agencies, the "(a)bility to monitor indoor smoke levels in work environments and schools."[89] The protocol further states, "Indoor air quality may be poor in older dwellings. These may include schools, community centers with care centers, nursing homes, or group homes. When air quality is 'unhealthy' for an extended smoke duration, it may be worthwhile to assess indoor air quality for these and other types of facilities where people who are sensitive to smoke live or stay."[90] The protocol provides general information on monitoring equipment and indicates that the state Department of Environmental Quality (DEQ) is available to provide more specific information on the types, availability, and cost of monitoring equipment, but that the DEQ "is responsible for monitoring air quality outdoors, and does not have equipment for indoor air monitoring."[91] Individuals with questions about employee health and possible indoor air monitoring in the workplace are directed to Oregon OSHA.

California's Wildfire Smoke Response Coordination best practices guidance includes similar information about indoor air monitors and directs local agencies to contact the California ARB or CalOSHA for more information, noting that "CARB…is responsible for monitoring air quality outdoors but does have the capability to conduct limited indoor monitoring in schools, evacuations centers, incident commend posts, or other public facilities."[92]

In addition to monitoring air quality inside public buildings and workplaces, state agencies can consider how to support governmental or non-governmental efforts to conduct indoor air monitoring in the homes of sensitive individuals. In addition, as advances in sensor technology make accurate indoor air monitoring more cost-effective, state governments can play an important role in providing guidance to citizens on interpreting their own indoor monitoring data and on using that data to take appropriate action.[93]

[88] Tribal Healthy Homes Network, Tribal Healthy Homes Network Partner Profile – Kris Ray, Colville Tribe (2016), http://thhnw.org/colville-tribe/.
[89] State of Oregon, Oregon Wildfire Response Protocol for Severe Smoke Episodes at 4 (rev. 2015), http://www.deq.state.or.us/aq/burning/docs/WFresponse.pdf.
[90] *Id*. at 9.
[91] *Id*. at 12.
[92] Cal. Air Response Planning Alliance & Cal. ARB, Wildfire Smoke Response Coordination – Best Practices Being Implemented by Agencies in California (Working Draft, 2014), https://www.arb.ca.gov/carpa/iascpresentations/2016/airemergencyresponsepreparednesspacket.pdf.
[93] For information about EPA's program on sensor technology, including the agency's Air Sensor Toolbox for Citizen Scientists, Researchers and Developers, see https://www.epa.gov/air-sensor-toolbox.

Identifying Best Practices for Reducing Indoor Wildfire Smoke Exposure

Federal Guidance. Guidance documents can be an important policy tool for advancing best practices for reducing indoor exposures to wildfire smoke. Government wildfire smoke program activities rely largely on a federal/state guidance document that provides extensive background on wildfire smoke and best practices for reducing indoor exposure. *Wildfire Smoke: A Guide for Public Health Officials* was developed by federal and state officials in 2001 and revised in 2008, and it has been widely used since. In 2016, the U.S. EPA, the U.S. Forest Service, the Centers for Disease Control and Prevention (CDC) and the California ARB, issued a draft revision that builds on the Guide's core set of best practices and incorporates new information in areas such as health effects and air quality monitoring resources.[94] EPA expects to finalize the Guide in 2017, following field testing during the 2016 wildfire season.

A central recommendation of the Guide is to stay indoors with windows and doors closed. The Guide also recommends taking the following actions – either in the home generally or in a "clean room" within the home:

- Reducing Other Indoor Sources of Pollution. According to the Guide, "Smoking cigarettes, using gas, propane and wood-burning stoves and furnaces, spraying aerosol products, frying or broiling meat, burning candles and incense, and vacuuming can all increase particle levels in a home and should be avoided when wildfire smoke is present."[95]

- Using Air Conditioners and Filters. As the Guide points out, "An important drawback of advising people to stay inside and close windows and doors of homes without air conditioning during smoke events is the increased risk of heat stress."[96] Thus, in periods of very hot weather, those without air conditioning are advised to seek shelter elsewhere during wildfire smoke events. For those with air conditioning, the Guide recommends setting air conditioners to "recirculate" mode or turning off the "fresh air" component of newer air conditioners, where possible. The use of filters is critical to exposure reduction: "If possible, one should replace the central air handler filter with a pleated *medium- or high-efficiency particle filter*…..If a filter upgrade has been performed, during a wildfire smoke event the central system's circulating fan can be set to operate continuously…to obtain maximum particle removal…."[97] The Guide also notes that caution must be taken to make sure that the system can operate properly with a high efficiency filter, which increases air flow resistance.

Key actions for reducing smoke exposure include using medium- or high-efficiency particle filters and portable air cleaners.

[94] Wildfire Smoke Guide, *supra.*
[95] *Id*. at 19.
[96] *Id*. at 18.
[97] *Id*. at 19-20 (italics added).

- Operating Properly-sized Air Cleaners. According to the Guide, "High-efficiency particulate air (HEPA) filter air cleaners and ESPs [electro static precipitators] can help reduce indoor particle levels, provided the specific air cleaner is properly matched to the size of the indoor environment in which it is placed."[98] Central air cleaners can be more effective than room air cleaners, but one or more portable air cleaners can be effective if placed where people spend most of their time. Air cleaners can be used in combination with air-handling system filters to further reduce indoor particles. The Guide provides information about how to select from among different types of air cleaners for particle removal and notes that new models are available that combine particle and gas removal. The Guide warns *against* the use of ozone generators that may be sold as air cleaners since low levels of ozone can cause respiratory symptoms and worsen asthma and other chronic respiratory diseases. Indeed, because of the potential health impacts, the state of California has taken regulatory action to limit the ozone emitted from indoor air cleaning devices. (See Text Box.)

- Establishing Cleaner Air Shelters. Because sensitive individuals may not be able to protect themselves adequately inside their homes, the Guide recommends that public health agencies make available cleaner air shelters and provides detailed information for doing so.

- Using Respirators. The Guide notes that filtering facepiece respirators (e.g., "N95" respirators) can provide some level of protection, but should only be used after implementing the above strategies, and provides extensive information on proper selection and use of respirators.

LIMITING OZONE EMISSIONS FROM AIR CLEANING DEVICES:
California's Testing, Certification, and Labeling Program

Pursuant to a 2006 state law, the California Air Resources Board adopted a regulation making California the first state to limit ozone emissions from indoor air cleaning devices in order to protect public health. As of 2010, all air cleaning devices sold in the state were required to comply with the regulation, which set an ozone emission concentration standard for air cleaners and requires devices to be tested, certified, and labeled. The regulation applies to "any indoor air cleaning device for use or intended for use in occupied spaces," but exempts specified industrial devices and certain in-duct systems.

The ARB maintains a Consumer's Air Cleaner Portal web page, which includes a link to a list of ARB-certified indoor air cleaning devices, along with other background information for consumers: https://www.arb.ca.gov/research/indoor/aircleaners/consumers.htm. The ARB regulation (17 Cal. Code Regs. §§ 94800–94810) can be accessed through that page or at: https://www.arb.ca.gov/research/indoor/aircleaners/air-cleaner-regulation.pdf.

[98] *Id*. at 20.

State Guidance. States, along with tribal and local governments, have relied heavily on the recommendations in the Wildfire Smoke Guide, and the document has been disseminated extensively via state websites and other public outreach activities. Some states have created additional guidance on specific best practices described in the Guide. For example:

- The California ARB has developed guidance on air cleaning devices, including both central air system filters and portable air cleaners. The guidance explains how a filter's particle removal efficiency is rated and provides general information to help people select and use an appropriate filter or air cleaner.[99]

- The Washington State Department of Health has developed guidance on how to address ventilation and indoor air quality during wildfire events in schools and other mechanically-ventilated buildings. The guidance describes how to manage a building's ventilation to improve indoor air quality when outside air is in a hazardous or unhealthy category and offers general information on filtration and air cleaning to improve indoor air quality.[100]

A number of states have established formal guidance for coordinating their response to wildfire smoke emergencies. For example, the Oregon Wildfire Response Protocol for Severe Smoke Episodes was created by a multiagency task force established after the 2012 wildfire season and revised in 2015 to reflect the lessons learned from the 2013 and 2014 seasons. The Protocol sets forth the roles of several state agencies, detailing which entities are responsible for air monitoring, smoke forecasting and modeling, issuing health warnings, managing state websites, and recommending public actions such as canceling outdoor events or setting up shelters. The Protocol establishes a pre-season conference call, daily calls during major wildfire events, and other calls as needed among affected agencies, including public health officials.[101] In California, a working document captures "the best practices and planning efforts of [multiple] agencies, to ensure continued coordination of resources and response efforts in order to best mitigate public health impacts," and describes agency responsibilities during wildfire incidents, examples of agency actions and resources, and recommended public health actions based on the particulate concentrations and the duration of smoke exposure."[102]

Public Outreach on Indoor Wildfire Smoke Exposure

Outreach and education are vital elements of state, tribal, and local programs to reduce smoke exposure. It is especially important for information to reach households with young children, older adults, and others with preexisting medical conditions that leave them more vulnerable to health

[99] *See* Cal. ARB, Air Cleaning Devices for the Home: Frequently Asked Questions (rev. July 2014), https://www.arb.ca.gov/research/indoor/aircleaners/consumers.htm. *See also* U.S. EPA, Guide to Air Cleaners in the Home, https://www.epa.gov/indoor-air-quality-iaq/guide-air-cleaners-home.
[100] *See* Wa. Dept. of Health, Improving Ventilation and Indoor Air Quality during Wildfire Smoke Events: Recommendations for Schools and Buildings with Mechanical Ventilation, available on the WA DOH web page, Smoke from Fires: http://www.doh.wa.gov/CommunityandEnvironment/AirQuality/SmokeFromFires
[101] *See* State of Oregon, Oregon Wildfire Response Protocol for Severe Smoke Episodes (rev. 2015), http://www.deq.state.or.us/aq/burning/docs/WFresponse.pdf.
[102] *See* California Air Response Planning Alliance, Wildfire Smoke Response Coordination – Best Practices Being Implemented by Agencies in California (Working Draft) (Aug. 2014), http://bit.ly/2dy7RC8.

impacts. The Wildfire Smoke Guide includes information for public health agencies on communicating health risks and best practices through public advisories and other means.[103] Montana is an example of a state that has developed a communications toolkit addressing wildfire smoke.[104]

As noted earlier, many of the states most affected by wildfires have established extensive web sites where residents can find out about current wildfire and air quality conditions and get information on how to protect themselves. In addition to disseminating the Wildfire Smoke Guide, some states have developed extensive web pages or independent fact sheets and other publications specific to wildfire smoke. Tribal and local agencies also communicate a broad range of information about wildfire smoke through their websites, social media platforms, and other advisories.[105]

State Health Agency Information on Wildfire Smoke Exposure

State health and other agencies have created a variety of materials focused on communicating the health effects of wildfire smoke and the steps residents can take to protect themselves. Examples of state health department materials that offer extensive information, including links to other publications include:

- ***Washington*** - Smoke from Fires web page, http://www.doh.wa.gov/CommunityandEnvironment/AirQuality/SmokeFromFires.
- ***Minnesota*** - Health Hazards of Smoke from Wildfires, web page and 2-page fact sheet, http://www.health.state.mn.us/divs/eh/emergency/natural/wildfire/smokehaz.html.
- ***Oregon*** - Wildfire Smoke and Your Health, 6-page fact sheet, http://bit.ly/2fUkAlI.

Along with creating materials and web pages devoted to wildfire smoke, states can ensure that information about reducing exposure is integrated into other state outreach efforts on wildfires, including state web pages, advisories, and social media messaging. Wildfire smoke information can also be provided as part of outreach and education on emergency preparedness. The Wildfire Smoke Guide recommends that states encourage people (at greater risk) to purchase higher efficiency filters or air cleaners *before* a wildfire event. Governmental emergency preparedness materials disseminated to the public could suggest that vulnerable populations consider purchasing HEPA filters to have on hand, along with other emergency supplies. The Arizona Public Health Emergency Preparedness Program recommends that when putting together a clean air kit, people should consider including a HEPA filter to help remove contaminants from the room where they are sheltering.[106]

[103] *See* Wildfire Smoke Guide, *supra*, at 38-45.
[104] *See* Montana Dept. of Public Health and Human Services, Public Health Wildfire Communication Toolkit (rev. 2015), http://bit.ly/2gJJBgh.
[105] *See, e.g.*, Spokane Regional Health District, Wildfires-Frequently Asked Questions, http://www.srhd.org/feature.asp?id=72#Exposure; Southern Nevada Health District, Wildfire Smoke and your Health, https://southernnevadahealthdistrict.org/health-topics/wildfire-smoke.php.
[106] *See* Az. Dept. of Health, Just in Case Arizona! Make a Kit – Clean Air, http://azdhs.gov/preparedness/emergency-preparedness/just-in-case-az/index.php#kit-air.

Direct Assistance for Reducing Residential Wildfire Smoke Exposure: Supplies and Equipment for Vulnerable Populations

The dissemination of clear information on steps that residents should take during wildfire smoke episodes is vital to reducing indoor wildfire smoke exposure. Yet for some residents, information alone will not be enough. Lower-income households that include sensitive individuals may require material assistance. State and local policies and programs can be brought to bear in implementing recommended best practices for reducing indoor smoke exposure in vulnerable households.

Cleaner Air Shelters. During wildfire episodes, some sensitive individuals must move temporarily to another location because they cannot adequately reduce exposure while in their home. The Wildfire Smoke Guide discusses how to set up cleaner air shelters and recommends that, prior to fire season, government officials identify and evaluate options for providing shelters. During recent wildfire smoke episodes, many local communities impacted by wildfire smoke have made cleaner air shelters available during some or all hours of the day.[107] In addition to technical and logistical challenges in establishing and maintaining the shelters, there may be practical challenges and limitations in residents' use of cleaner air shelters. For example, residents may have difficulty traveling to the shelters or remaining in the shelters for long periods of time, given work and other obligations.[108]

Respirators. One form of direct assistance provided by some jurisdictions is the distribution of respirators. The Wildfire Smoke Guide includes detailed information on the use of respirators, which can be helpful for some people if worn properly. The N-95 masks described in the Guide are relatively inexpensive, and a number of state and local government agencies have provided these masks – along with instructions on how to use them – to community members during wildfire incidents.[109] Respirators have limitations, though. In addition to the need for a proper fit, residents with preexisting respiratory or other health problems – who are among those especially susceptible to the effects of smoke – may be unable to wear respirators. The Wildfire Smoke Guide advises, "Respirators should only be used after first implementing other, more effective methods of exposure reduction, including staying indoors, reducing activity, and using HEPA air cleaners to reduce overall smoke exposure."[110]

Air Conditioners, Air Cleaners, and In-Duct Filters. An important consideration for policymaking in this area is the provision of equipment that can help reduce indoor smoke exposure, but that may be inaccessible to some vulnerable residents.

[107] For example, in June 2016, Navajo County (AZ) Public Health Services District set up shelters at two area public schools. Navajo County Public Health Services District, Facebook Post: Heavy Smoke Warning (6/22/16), http://bit.ly/2dlgVYS. In August 2015, Trinity County (CA) Health and Human Services agency set up 24-hour and part-time cleaner air shelters in a variety of locations. Trinity County Health and Human Services, Press Release: Air Quality Update for Trinity County (8/9/15), https://lostcoastoutpost.com/2015/aug/9/air-quality-update-trinity-county/.

[108] British Columbia Centre for Disease Control, Evidence Review: Home and community clean air shelters to protect public health during wildfire smoke events (2014), http://bit.ly/2d8EN4w.

[109] *See, e.g.,* Chelan-Douglas Health District, Press Release (8/26/15)(respirator mask distribution in several county agencies in Washington State and the Colville Tribe), http://bit.ly/2d3FwTD; Amador County Public Health, Press Release (9/14/15), http://bit.ly/2dwcajp (several respirator mask distribution sites within Amador County, California, in response to the Butte Fire).

[110] Wildfire Smoke Guide, *supra*, at 24.

- Air Conditioners. As noted earlier, a core recommendation for reducing exposure to wildfire smoke indoors is to keep doors and windows closed, yet this may not be feasible or advisable for those who lack air conditioning and who rely on open windows in hot weather. As the U.S. Energy Information Administration has pointed out, "access to air conditioning by low income households is much lower relative to other households."[111]

- High Efficiency Filters and Portable Air Cleaners. High efficiency filters for forced air ventilation systems can reduce exposure to particles during wildfires. The Wildfire Smoke Guide recommends that homes with susceptible occupants upgrade filters in advance and keep extra filters on hand, since filters must be replaced regularly. Nevertheless, many existing homes in the U.S. lack such systems, or have systems that are not equipped for higher efficiency filters.[112] Ensuring that homes have HVAC systems with the capacity for high efficiency particle filtration is an important consideration for residential building codes and other policies and programs addressing new home construction. A recommended alternative (or adjunct) to high-efficiency, in-duct filtration is the use of portable air cleaners. Though air cleaners are available in a range of prices, lower-income households may nonetheless be unable to purchase these items.

Public policies and programs can play a vital role in assisting households most vulnerable to wildfire smoke exposure.

Future policy and program development for offering direct assistance should focus especially on helping vulnerable households secure air conditioning, air cleaners, and/or high efficiency (in-duct) filters for forced air systems. This equipment can potentially benefit vulnerable residents not only during wildfire events, but also during other episodes of poor outdoor and/or indoor air quality and in times of extreme heat. While agencies have undertaken to distribute filters or portable air cleaners during wildfire events, this does not appear to be a common practice.[113] Given the financial and logistical challenges of providing equipment, advance planning is important for identifying sustainable funding opportunities. Indeed, the Wildfire Smoke Guide notes, "Choosing to buy an air cleaner is a decision that ideally should be made *before* a smoke emergency occurs."[114]

Federal funding programs administered by states, tribes, and local governments may offer flexibility to use funds to pay for equipment and supplies to protect vulnerable residents. For example, the Federal

[111] U.S. Energy Information Agency, Residential Energy Consumption Survey (RECS) 2009, http://www.eia.gov/consumption/residential/reports/2009/air-conditioning.cfm.
[112] Fisk, *supra,* at 75. *See also* Institute of Medicine, Climate Change, the Indoor Environment, and Health, *supra*, at 104 ("ordinary indoor environments, especially residences, do not provide much protection" from wood-smoke particles).
[113] In August 2015, The Hoopa Valley Tribe of California declared a state of emergency due to "sustained unhealthy air quality conditions" resulting from several wildfires. The Tribal Council notified residents, "Those with a serious risk of respiratory problems may require a medical evaluation for an air filter. Air filter distribution from K'ima:w Medical Center will be decided on a case-by-case basis, depending on the severity of your medical condition." Hoopa Valley Tribal Council, Hoopa Public Health Threat: 2015 Public Service Announcement (8/20/15), http://bit.ly/2cVwvKT.
[114] Wildfire Smoke Guide, *supra*, at 20.

Emergency Management Agency (FEMA) operates a number of programs that provide assistance for wildfire emergencies and could potentially be used for home supplies that enable residents to remain in their homes and avoid hospitalizations or other medical emergencies. These programs include: the Pre-Disaster Mitigation Grant Program (PDM), whose goal is "to reduce overall risk to the population and structures from future hazard events, while also reducing reliance on Federal funding in future disasters"; the Hazard Mitigation Grant Program (HMGP) program, which "may be used to fund projects that will reduce or eliminate the losses from future disasters"; and the Assistance to Individuals and Households Program (IHP), which provides funding directly to households following a disaster and explicitly covers items such as air cleaners.[115]

Communities can also identify in advance federal and state funding programs that are *not* specific to wildfires but that may be available to assist residents in purchasing the air conditioners or air filters that will be vital during future wildfire smoke emergencies. For example, in recent years, some state, tribal, and local governments have pursued Medicaid policy changes and other innovative health care financing approaches to paying for medically necessary environmental control equipment, such as air cleaners and air conditioning, for patients with asthma or other medical conditions.[116] State programs that subsidize home repairs are another potential source of funding for such equipment.[117]

Addressing Wildfire Smoke Exposure in Rental Housing

Tenants make up nearly 60 percent of households in the U.S. living at or below the poverty line, and many will lack the resources to address an indoor wildfire smoke problem or to find alternate housing.[118] Some states and many local governments have adopted housing or property maintenance codes that establish minimum standards for health and safety that are enforced through local housing agencies. These codes include general requirements for providing natural or mechanical ventilation, but do not typically include more specific ventilation standards that are independent of state building or mechanical codes.

Although housing and property maintenance codes generally do not require air conditioning or include specific provisions governing filtration, they often include requirements for maintaining equipment in

[115] U.S. Federal Emergency Mgmt. Agency (FEMA), Pre-Disaster Mitigation Grant Program, Hazard Mitigation Grant Program, https://www.fema.gov/pre-disaster-mitigation-grant-program; FEMA, Hazard Mitigation Grant Program, https://www.fema.gov/hazard-mitigation-grant-program (noting, "Projects must provide a long-term solution to a problem….In addition, a project's potential savings must be more than the cost of implementing the project."); FEMA, Assistance to Individuals and Households Program, https://www.fema.gov/recovery-directorate/assistance-individuals-and-households .

[116] For information and case studies on state financing initiatives, see Nat'l. Center for Healthy Housing, Healthcare Financing of Healthy Homes, http://www.nchh.org/resources/healthcarefinancing.aspx; Green and Healthy Homes Initiative, Sustainable Funding and Business Case for GHHI Home Interventions for Asthma Patients (2015), http://bit.ly/2dGIorg.

[117] Examples of federal programs that fund home repairs and rehabilitation include HUD's Community Development Block Grant program and 203k Rehab Mortgage Insurance Program, and the Department of Agriculture's Section 504 Home Repair program. Minnesota's Rehabilitation Loan/Emergency and Accessibility Loan Program is an example of a state program that aims to "assist low income homeowners in financing basic home improvements that directly affect the safety, habitability, energy efficiency or accessibility of their homes."

[118] *See* American Housing Survey, Table Creator (Poverty, Tenure), http://sasweb.ssd.census.gov/ahs/ahstablecreator.html#?s_areas=a0000&s_year=n2013&s_tableName=Table1&s_byGroup1=a10&s_byGroup2=a2&s_filterGroup1=t1&s_filterGroup2=g1.

good repair. For example, the Massachusetts Sanitary Code requires that owners "maintain free from leaks, obstructions or other defects…all heating and ventilating equipment and appurtenances thereto….and all owner-installed optional equipment."[119] In the District of Columbia, if mechanical ventilation is provided, the owner must maintain the system in safe and good working condition and, if the system is not under control of the occupant, the owner must keep the equipment in constant and continuous operation.[120] Further, owners who provide air conditioning units or a central air conditioning system must maintain them in safe and good working condition and must have them inspected each year by a licensed professional.[121]

During wildfire smoke events, housing officials can prioritize inspections and use provisions such as these to ensure that air conditioning systems are functioning properly and that filters are replaced as appropriate. State and local officials can also consider strengthening their housing codes. A recently-developed model housing code incorporates filtration provisions that go beyond current housing codes. The National Healthy Housing Standard includes the following measure: "Any dwelling with a forced air system….shall have a clean air filter installed in accordance with manufacturer specifications at each change in tenancy and at least annually. This filter shall have a minimum efficiency reporting value of eight (MERV 8) unless the system is not equipped to use a MERV-8 filter." The standard includes as a "stretch" provision, the requirement that air filters be replaced at least every three months.[122]

Jurisdictions that experience the highest impacts from wildfire smoke could consider stronger policies, such as requiring landlords to provide portable air filters during wildfire smoke events, if in-duct filtration is not feasible or adequate to protect occupants. These provisions could be incorporated into housing and property maintenance codes or into landlord-tenant laws, which govern the rights and responsibilities of landlords and tenants and are enforced privately by the parties.

Addressing Ventilation and IAQ in New Residential Construction

State policies and programs addressing wildfire smoke focus primarily on how community residents can protect themselves during wildfire emergencies in their existing homes. Nevertheless, state and local policies governing new home construction affect how the future housing stock will protect residents from wildfire smoke and from other air pollutants and allergens that impact residents now and are expected to increase due to climate change.

In developing these policies, states can draw on a variety of guidance documents that advance current best practices. For example, EPA's Indoor airPLUS is a voluntary labeling program that builds on EPA's ENERGY STAR program criteria for new homes. Indoor airPLUS provides additional construction specifications on a wide range of IAQ issues to minimize exposure to airborne pollutants, "to help improve IAQ in new homes compared with homes built to minimum code." Ventilation elements include

[119] 105 Code. Mass. Regs. 410.351.
[120] D.C. Mun. Regs. 14-508.
[121] D.C. Mun. Regs. 14-510.
[122] *See* Nat'l. Center for Healthy Housing, Amer. Public Health Assoc., National Healthy Housing Standard (2014), http://www.nchh.org/policy/nationalhealthyhousingstandard.aspx.

requiring mechanical whole-house ventilation and local mechanical exhaust ventilation in bathrooms and kitchens in accordance with American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 62.2, requiring whole-house dehumidification to maintain indoor relative humidity at or below 60 percent in "warm-humid" climates, and requiring central forced-air HVAC systems to have a minimum MERV 8 filter and no ozone generators in the home.[123]

It is beyond the scope of this chapter to describe in detail the broad range of ventilation, filtration, and other building design and construction measures that influence indoor exposure to outdoor pollutants. Following is a brief description of two key policy vehicles for addressing ventilation and IAQ in new homes: building codes and government funding programs.

Building Codes. Building codes are the central state (and local) policymaking tool for establishing residential design and construction requirements. In its report on climate change and the indoor environment, the Institute of Medicine concluded, "Promoting research on and development and adoption of regionally appropriate building codes that account for the possibility of future climatic conditions not only will protect the well-being of occupants but could produce economic benefits in the form of longer building lives, lower building insurance fees, and avoided retrofitting costs."[124]

The International Residential Code (IRC) (one- and two-family low rise), along with the International Building Code (IBC) and International Mechanical Code (IMC) (larger multifamily), are model building codes that are widely used by states and local governments. According to the International Code Council, the large majority of states have adopted the IRC, with or without modifications and limitations, as a mandatory minimum statewide. In some states without a statewide code, localities have adopted the IRC.[125] Most, but not all, of these states have adopted the 2012 or later version of the IRC, which includes requirements for local exhaust ventilation in bathrooms and kitchens, as well as whole-house mechanical ventilation, and establishes minimum ventilation rates.[126] The IRC requirement for whole-house mechanical ventilation allows an exhaust-only, supply-only, or balanced system. While mechanical systems that provide supply air can be equipped with filters to remove particles, "exhaust only systems, such as continuous bathroom exhaust fans, do not provide the opportunity to deliberately filter supply air as a means of protecting occupants from outdoor particles."[127]

States can adopt the most current version of a model building code and modify the code to incorporate additional best practices for ventilation and IAQ appropriate to the state's climate. Prior to the IRC's adoption of mechanical whole-house ventilation requirements, a number of states, including Minnesota, Washington, and Vermont, incorporated such requirements in their own residential codes. California's current Building Standards Code, which also requires mechanical whole-house ventilation in all new

[123] *See* Indoor airPLUS Verification Checklist at 1, 7, 10 (rev. Oct. 2015), www.epa.gov/indoorairplus.
[124] Institute of Medicine, Climate Change, the Indoor Environment, and Health, *supra*, at 11.
[125] Int'l Code Council (ICC), U.S. Usage of the I-Codes, http://www.iccsafe.org/about-icc/overview/international-code-adoptions/.
[126] *See Id.*; Int'l Code Council (ICC), Int'l. Res. Code, R303.4, M1507, http://codes.iccsafe.org/app/book/toc/2015/I-Codes/2015%20IRC%20HTML/index.html.
[127] Institute of Medicine, Climate Change, the Indoor Environment, and Health, *supra*, at 104. Higher efficiency filters for central heating and air systems and/or portable air cleaners can be considered in homes that utilize continuous bathroom exhaust fans.

homes, includes standards from the national model codes, along with standards that have been adapted from the model codes and "extensive additions not covered by the model codes that have been adopted to address particular California concerns."[128]

One area for consideration in strengthening state building codes is minimum filter efficiency rating. The current ASHRAE standard requires a MERV 6 (low-medium) filter rating, except in areas of the country that are in non-attainment status for federal particulate matter standards.[129] However, recent research suggests that higher efficiency filters are required in order to be effective at removing particles from wildfires and in filtering outdoor air pollutants generally.[130] The Wildfire Smoke Guide underscores the importance of using medium- or high-efficiency filters during wildfire smoke events.[131]

Requirements for Projects Receiving State Housing Construction Funds and Incentives. A number of states administer programs to help finance affordable housing construction and rehabilitation. These may be state-specific programs or federal programs (such as the Low Income Housing Tax Credit or HOME Investment Partnership) that are administered by the states. Increasingly, states are establishing laws, regulations, program guidelines, and other policies requiring that these publicly-funded projects meet design and construction criteria that go beyond minimum building codes.[132] State financing programs can ensure that affordable housing built with public funds incorporates best practices for ventilation and filtration consistent with building science research.[133] These considerations apply as well to federal and state disaster recovery programs, to the extent that those programs fund housing rehabilitation and construction.[134]

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[128] Cal. Building Standards Commission, California Building Standards Code (Title 24, Calif. Code of Regulations), http://www.bsc.ca.gov/Codes.aspx.

[129] *See* ANSI/ASHRAE Standard 62.2-2013, Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings, § 6.7. California is one state that has adopted ASHRAE 62.2 and its minimum filtration requirement into the state building energy efficiency code. *See* Cal. Energy Commission, 2013 Residential Compliance Manual at 4-83 (2014), http://www.energy.ca.gov/title24/2013standards/residential_manual.html. In 2016, ASHRAE combined Standards 62.1 and 62.2 into one standard for residential buildings. *See* ANSI/ASHRAE Standard 62.2-2016, Ventilation and Acceptable Indoor Air Quality in Residential Buildings, https://www.ashrae.org/news/2016/2016-residential-iaq-standard-published-by-ashrae.

[130] *See* B. Singer, et al. (LBNL), Reducing In-home Exposure to Air Pollution (2016), https://www.arb.ca.gov/research/single-project.php?row_id=65080 (study evaluating a variety of ventilation and air cleaning systems for pollutant removal and energy use). *See also* National Academy of Sciences, Health Risks of Indoor Exposure to Particulate Matter: Workshop Summary at 61 (2016), http://www.nationalacademies.org/hmd/Activities/PublicHealth/Health-Risks-Indoor-Exposure-ParticulateMatter.aspx (summarizing remarks by William Fisk, noting that MERV 6 filters remove less than 20 percent of the particles of most sizes).

[131] *See* Wildfire Smoke Guide, *supra*, at 19-20. *See also* Institute of Medicine, Climate Change, the Indoor Environment, and Health, *supra*, at 104-106.

[132] *See generally* U.S. Dept. of Housing and Urban Devt. (HUD), Sustainable Housing Initiative, http://portal.hud.gov/hudportal/HUD?src=/program_offices/economic_resilience/sustainable_housing_initiative; HUD, Energy-efficient and Green HOME Housing, http://portal.hud.gov/hudportal/HUD?src=/program_offices/comm_planning/affordablehousing/programs/home/greenhome; Amer. Planning Assoc., Green Goes Mainstream in Low-Income Housing (2013), http://bit.ly/2e4tRCJ.

[133] In Connecticut, e.g., the state Housing Finance Authority has developed Standards of Design and Construction for multi-family housing financed through the agency, requiring "MERV 8 high-efficiency particulate air (HEPA) filters in the return air stream at the air handler, located so that return and ventilation air pass through prior to conditioning," and requiring that air handlers are sized "to accommodate the reduced air pressure caused by the filter." Conn. Housing Auth., 2015 Multifamily Design, Construction and Sustainability Standards at 45, http://bit.ly/2aMa8Jk. New Jersey requires projects participating in certain federal/state funding programs to incorporate a number of IAQ practices, including MERV 8 filtration. *See* New Jersey Housing and Mortgage Finance Agency, Green Future Guidelines 2014/15, http://bit.ly/2fSNgHK.

[134] *See generally* FEMA, National Disaster Recovery Framework: Housing Recovery Support Function, http://bit.ly/2fUFuRU.

Some states also offer financial and other incentives for privately-funded buildings to incorporate green building criteria. Such policies typically refer to third-party green building rating systems such as Leadership in Energy and Environmental Design (LEED), Enterprise Green Communities, or the National Green Building Standard (ICC/ASHRAE 700-2015). While third-party rating systems include an IAQ component, they vary in the extent to which they require specific IAQ measures in an individual project. States and municipalities can advance ventilation and other IAQ best practices in their housing policies by requiring specific IAQ measures as part of a referenced green building standard or by requiring compliance with an IAQ-focused set of criteria such as EPA's Indoor airPLUS program.

Summary

Climate change has led to larger wildfires and longer wildfire seasons, and this trend is expected to continue. As a result, wildfire smoke has become an increasingly prominent public health challenge for communities across the country. States have an important role to play in helping reduce indoor exposure to wildfire smoke in home, and this chapter has highlighted a number of areas for further policy and program development.

- Air Quality Monitoring. States have stationary and portable monitors that provide air quality data during wildfires, but increased capacity for portable monitoring equipment may become necessary to meet local demand in areas of increasing wildfire activity. States may also be called on to monitor indoor air quality in public facilities and to assist residents in interpreting their home indoor air quality measurements, especially as low-cost sensor technology becomes more widely available.

- Guidance on Best Practices. The Wildfire Smoke Guide has helped advance a common set of best practices for reducing indoor residential exposure to wildfire smoke. Further research will help refine and enhance some of these practices. For example, research on exposure to wildfire smoke constituents other than particles can help ensure the effectiveness of public health measures. Further research can also refine understanding of how well filters perform in real-world conditions and how filter technology can address smoke constituents other than particles. States can work together with federal agencies to revise the Wildfire Smoke Guide and/or develop supplemental materials in the future to reflect new research.

- Outreach and Education. States impacted by wildfires have developed numerous mechanisms for communicating information about wildfire smoke conditions, the health impacts of exposure, and practices for reducing exposure indoors. States can assist local agencies in ensuring that this information is disseminated broadly and to a diverse audience, including those who are most vulnerable. Information provided before and during wildfire episodes can also be designed to communicate information about reducing exposure from other sources of outdoor and indoor air pollutants, especially particulate matter.

- Direct Assistance. Implementation of best practices guidance is generally carried out by tribal and local governments, who work directly with community residents to reduce risks from wildfire smoke. States have an important role to play in providing information and technical assistance to tribal and local agencies, and in establishing policies that authorize, prioritize, or facilitate material assistance for households. Such policies can focus particularly on those households that include children and sensitive adults and that lack sufficient resources to follow recommended best practices such as using air conditioning for ventilation instead of windows, using higher efficiency filters, and using air cleaning devices. Research on the opportunities for leveraging existing federal and state funding programs toward this end can help facilitate efforts to protect vulnerable residents from future wildfire emergencies.

- New Construction and Rental Housing Codes and Policies. Building and housing codes represent policy opportunities for states and localities to institutionalize the use of residential mechanical ventilation and filtration systems that are effective at protecting people from outdoor particulate matter and other pollutants. States can also integrate these best practices into their programs that provide funding and incentives for housing construction and renovation.

Wildfire emergencies require agencies to respond quickly to changing situations, and the response requires close coordination among a number of state and other agencies with responsibilities for addressing wildfires. Thus, advance planning is necessary for establishing a state's capacity to address wildfire smoke effectively, and it is vital to incorporate public health and indoor air quality expertise into planning processes. States have developed a variety of planning documents to facilitate this coordination, some focused specifically on wildfire response, and others related more broadly to emergencies. State climate action plans and other climate planning initiatives are another mechanism that can help in prioritizing and facilitating action to address wildfire smoke indoors.

CHAPTER 3

Dampness and Mold

Molds are a type of fungi whose tiny spores can be found in indoor and outdoor air or settled on indoor and outdoor surfaces. Molds can grow almost anywhere provided they have nutrients and water. Since organic nutrients that mold can digest are generally always available, *controlling moisture* in buildings is the key to controlling dampness and mold indoors.[135] While this chapter discusses dampness and mold, indoor dampness may also lead to other problems, such as bacterial growth, increased dust mites, cockroach and rodent infestations, and off-gassing of chemicals from building materials and furnishings.[136] Flooding of a home presents additional health and safety risks.[137]

The past two decades have witnessed considerable advances in public health and building science, yielding a clearer understanding of both the health effects of exposure to indoor dampness and mold and the technical approaches to preventing and remedying those conditions. Yet despite these scientific advances, indoor dampness and mold remain pervasive. As the Institute of Medicine concluded in its 2011 report on climate change and the indoor environment, the potential impact of changing climatic conditions on indoor dampness and mold "increase the urgency with which prevention and interventions must be pursued."[138] A number of states have underscored this point by incorporating dampness and mold issues into their climate planning documents.[139]

This report discusses two areas of state policy for facilitating best practices to prevent and remedy dampness and mold problems – licensing of mold service providers and establishment of minimum standards governing rental housing. Following brief background information on the problem of dampness and mold, the chapter describes current state laws and regulations and suggest considerations for states in strengthening their policies.

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[135] *See generally* U.S. EPA, Mold Remediation in Schools and Commercial Buildings: App. B – Introduction to Molds, http://www.epa.gov/mold/append_b.html.

[136] National Academy of Sciences – Institute of Medicine, Damp Indoor Spaces and Health at 1 (2004), https://www.nap.edu/download/11011.

[137] *See* U.S. EPA, Protecting Children's Health During and After Natural Disasters, https://www.epa.gov/children/protecting-childrens-health-during-and-after-natural-disasters; Centers for Disease Control and Prevention (CDC), Natural Disasters and Severe Weather, http://www.cdc.gov/disasters/floods/; Conn. Dept. of Health, Hurricanes: Important Health Information, http://www.ct.gov/dph/cwp/view.asp?a=3115&q=513014.

[138] National Academy of Sciences – Institute of Medicine, Climate Change, the Indoor Environment, and Health at 134-135 (2011), https://www.nap.edu/download/13115.

[139] *See, e.g.,* Cal. Natural Resources Agency, Safeguarding California: Implementation Action Plans: Public Health Sector Plan at 166 (2016), http://resources.ca.gov/docs/climate/safeguarding/Public%20Health%20Sector%20Plan.pdf; Delaware Sea Level Rise Advisory Comm., Preparing for Tomorrow's High Tide Sea Level Rise: Vulnerability Assessment for the State of Delaware at 93 (2012), http://www.dnrec.delaware.gov/coastal/Documents/SeaLevelRise/AssesmentForWeb.pdf; Mass. Exec. Office of Envtl. Affairs and Adaptation Advisory Committee, Climate Change Adaptation Report at 80-82 (2011), http://www.mass.gov/eea/docs/eea/energy/cca/eea-climate-adaptation-report.pdf.

Background

Indoor Dampness and Mold in the U.S. Indoor dampness and mold are already significant problems in the United States. A review of several studies concluded that approximately half of U.S. homes have visible evidence of a dampness problem or mold contamination.[140] According to the U.S. EPA, "Excessive moisture accumulation plagues buildings throughout the United States, from tropical Hawaii to arctic Alaska and from the hot, humid Gulf Coast to the hot, dry Sonoran Desert."[141] Climate change is expected to make this problem even more significant.

Among the climate-related factors that impact indoor dampness are "extreme weather events, local changes in temperature and humidity, and the adaptations that occupants make and mitigation strategies that they use in response to changed environmental conditions."[142] The U.S. Global Change Research Program has found that the "frequency of heavy precipitation events has already increased for the nation as a whole, and is projected to increase in all U.S. regions."[143] Recent heavy storms – from Superstorm Sandy in 2012 to Tropical Storm Hermine in 2016 – have caused severe damage to homes and other infrastructure. But dampness and mold contamination are not problems that are limited to the aftermath of major storms. Increasing average precipitation and outdoor humidity in some regions of the country makes it more likely that indoor humidity, condensation, and dampness will rise as well.[144] In the continental U.S., 2015 was the third-wettest year on record, and 2016 has seen record-breaking rainfall totals in many areas of the country – from Houston and parts of Kentucky, to the Willamette Valley in Oregon.[145]

Indoor dampness and mold are already significant problems in the U.S.

Health Effects of Exposure to Dampness and Mold. In addition to damaging buildings, dampness and mold are associated with a variety of respiratory and allergic effects. This chapter addresses not only mold, but dampness as well, because public health science studies have shown that both conditions are associated with health effects to exposed occupants. A recent policy statement issued by the

[140] Lawrence Berkeley National Laboratory (LBNL), Indoor Air Quality Scientific Findings Research Bank: Prevalence of Building Dampness, https://iaqscience.lbl.gov/dampness-prevalence.
[141] U.S. EPA, Moisture Control Guidance for Building Design, Construction and Maintenance at 1 (2013), https://www.epa.gov/sites/production/files/2014-08/documents/moisture-control.pdf.
[142] Institute of Medicine, Climate Change, the Indoor Environment, and Health, *supra*, at 134.
[143] U.S. Global Change Research Program (USGCRP), Climate Change Impacts in the United States: The Third National Climate Assessment at 224 (2014), http://nca2014.globalchange.gov/ [hereinafter Third National Climate Assessment].
[144] USGCRP, The Impacts of Climate Change on Human Health: A Scientific Assessment at 81 (2016), https://health2016.globalchange.gov/downloads [hereinafter Impacts of Climate Change on Human Health] (noting also, "Outdoor humidity is usually the largest contributor to indoor dampness on a yearly basis.").
[145] Natl. Oceanic and Atmospheric Administration, National Centers for Environmental Information (NOAA NCEI), https://www.ncdc.noaa.gov/sotc/national/201513; NASA Earth Observatory, Record Rainfall in Southeast Texas, http://earthobservatory.nasa.gov/IOTD/view.php?id=87907&src=eorss-iotd&utm_source=twitterfeed&utm_medium=twitter; NOAA NCEI, National Overview July 2016, http://www.ncdc.noaa.gov/sotc/national/201607; KGW Portland, Rainfall Records Shattered this October, http://www.kgw.com/weather/october-in-oregon-brings-record-rainfall/345127225.

California Department of Public Health summarized current knowledge, based on recent scientific research:

> Human health studies have led to a consensus among scientists and medical experts that the presence in buildings of (a) visible water damage, (b) damp materials, (c) visible mold, or (d) mold odor indicates an increased risk of respiratory disease for occupants. Known health risks include: the development of asthma; the triggering of asthma attacks; and increased respiratory infections, allergic rhinitis, wheeze, cough, difficulty breathing, and other symptoms. Available evidence suggests that the more extensive, widespread, or severe the water damage, dampness, visible mold, or mold odor, the greater the health risks, and also that children are more sensitive to dampness and mold than adults.[146]

A review at Lawrence Berkeley National Laboratory (LBNL) concluded that building dampness and mold are associated with "30% to 50% increases in a variety of respiratory and asthma-related health outcomes."[147] Related studies found that an estimated 21 percent of current U.S. asthma cases (and an associated $3.5 billion), as well as an estimated 8 to 10 percent of respiratory infections and bronchitis, were attributable to dampness and mold in homes.[148] According to a recent review, most studies of dampness and mold have found that the more severe or extensive the dampness and mold, the greater the increased risks for adverse health effects.[149] A recent review on climate change and indoor environmental quality by LBNL found that, while "even moderate increases in dampness and mold in buildings would be of concern," taking action makes sense regardless of climate change, given the health effects and financial cost related to current mold and dampness.[150]

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[146] Calif. Dept. of Public Health, CDPH Statement on Building Dampness, Mold, and Health (rev. 2016), https://www.cdph.ca.gov/programs/IAQ/Pages/IndoorMold.aspx#DMHStatement. *See also*, World Health Organization, WHO Guidelines for Indoor Air Quality: Dampness and Mould (2009), http://www.who.int/indoorair/publications/7989289041683/en/; M. Mendell, et al., Respiratory and Allergic Health Effects of Dampness, Mold, and Dampness-related Agents: A Review of the Epidemiologic Evidence, Envtl. Health Perspectives, 119:748-756 (2011), http://ehp.niehs.nih.gov/1002410/.

[147] *See* LBNL, Indoor Air Quality Scientific Findings Research Bank: Dampness-Related Health Risks, https://iaqscience.lbl.gov/dampness-risks; W. Fisk, et al., Meta-analyses of the Associations of Respiratory Health Effects with Dampness and Mold in Homes, Indoor Air, 17(4):284-96 (2007).

[148] *See* LBNL, Indoor Air Quality Scientific Findings Research Bank: Dampness-Related Health Risks, https://iaqscience.lbl.gov/dampness-risks; D. Mudarri & W. Fisk, Public Health and Economic Impact of Dampness and Mold, Indoor Air, 17(3):226-35 (2007) (Erratum in: Indoor Air. 2007 Aug;17(4):334), https://www.ncbi.nlm.nih.gov/pubmed/17542835; W. Fisk, et al., Association of Residential Dampness and Mold with Respiratory Tract Infections and Bronchitis: a Meta-analysis, Envtl. Health, 9:72 (2010), https://ehjournal.biomedcentral.com/articles/10.1186/1476-069X-9-72.
A study published in 2016 found that "the total annual cost to society attributable to dampness and mold is estimated to be $3.7 (2.3-4.7) billion for allergic rhinitis, $1.9 (1.1-2.3) billion for acute bronchitis, $15.1 (9.4-20.6) billion for asthma morbidity, and $1.7 (0.4-4.5) billion for asthma mortality." D. Mudarri, Valuing the Economic Costs of Allergic Rhinitis, Acute Bronchitis, and Asthma from Exposure to Indoor Dampness and Mold in the US, *J. Envtl. Public Health*, v. 2016 (2016), https://www.hindawi.com/journals/jeph/2016/2386596/.

[149] *See* M. Mendell & K. Kumagai, Observation-based Metrics for Residential Dampness and Mold with Dose-response Relationships to Health: A Review, Indoor Air, (Sept. 24, 2016) (early online), http://onlinelibrary.wiley.com/doi/10.1111/ina.12342/abstract.

[150] W. Fisk, Review of Some Effects of Climate Change on Indoor Environmental Quality and Health and Associated No-Regrets Mitigation Measures at 7-8 (2015), http://bit.ly/2eb1pmy (estimating that a 25% increase in dampness and mold in U.S. buildings can be expected to lead to 1.2 million additional cases of current asthma, with an annual cost of approx. $1 billion, and a 2%-5% increase in common respiratory infections).

Preventing and Remedying Indoor Dampness and Mold Problems. Significant indoor moisture problems are common, but they are not inevitable. Advances in building science have established best practices for controlling moisture in building design, construction, and management, and there are numerous technical guidance documents discussing these practices.[151] Nevertheless, strategies for preventing dampness and mold problems are "well established, although not necessarily widely implemented."[152] The 2004 Institute of Medicine report, *Damp Indoor Spaces and Health*, concluded that "the prevalence and nature of dampness problems suggest that what is known about their causes and prevention is not consistently applied in building design, construction, maintenance, and use."[153]

Recent U.S. EPA moisture control guidance notes two basic elements of moisture control: Preventing water intrusion and condensation in areas of a building that must remain dry; and limiting the areas of a building that are routinely wet because of their use (e.g., bathrooms, spas, kitchens and janitorial closets) and drying them out when they do get wet. The guidance discusses strategies for preventing moisture problems by maintaining key building elements, including site drainage, foundation, walls, roof and ceiling assembly, plumbing, and HVAC system.[154]

Numerous governmental and non-governmental materials provide guidance on remediating mold contamination. California's mold policy statement summarizes the basic steps recommended by public health agencies:

- Identification and correction of the source of water that may allow microbial growth or contribute to other problems;
- Rapid drying or removal of damp materials; and
- Cleaning or removal of mold and moldy materials, as rapidly and safely as possible, to protect the health and well-being of building occupants, especially children.[155]

Public health and building science guidance documents emphasize that laboratory testing is not generally necessary or useful before decisions are made on remediating a mold contamination problem.[156]

Vulnerable Populations. Individuals with respiratory disease and others who are susceptible to respiratory health problems are particularly vulnerable to the impacts of indoor dampness and mold. Currently there are 17.7 million (7.4%) adults and 6.3 million (8.6%) children in the U.S. with asthma.[157] According to the National Institutes of Health, "The rates of hospitalizations and deaths due to asthma are both 3 times higher among African Americans than among whites….[and] compared to white

[151] *See generally* CDC, Mold Cleanup and Remediation, http://www.cdc.gov/mold/cleanup.htm; Institute of Medicine, Climate Change, the Indoor Environment, and Health, *supra*, at 146.
[152] Institute of Medicine, Climate Change, the Indoor Environment, and Health, *supra*, at 146.
[153] Institute of Medicine, Damp Indoor Spaces and Health, *supra*, at 4.
[154] *See* U.S. EPA, Moisture Control Guidance for Building Design, Construction and Maintenance at 1, 87-103, https://www.epa.gov/indoor-air-quality-iaq/moisture-control-guidance-building-design-construction-and-maintenance.
[155] Calif. Dept. of Public Health, CDPH Statement on Building Dampness, Mold, and Health (rev. 2016), https://www.cdph.ca.gov/programs/IAQ/Pages/IndoorMold.aspx#DMHStatement.
[156] *Id*. *See also* U.S. EPA, Mold Testing or Sampling, https://www.epa.gov/mold/mold-testing-or-sampling.
[157] CDC, Most Recent Asthma Data, https://www.cdc.gov/asthma/most_recent_data.htm.

children, asthma prevalence is higher in children who are Puerto Rican (2.4 times), African American (1.6 times), and American Indian/Alaska Native (1.3 times)."[158]

Socio-economic status may also be an important risk factor for mold exposure. Asthma prevalence is higher among those living below the poverty line.[159] A recent study found socio-economic status correlated with mold conditions in homes.[160]

Policy Strategies Discussed in this Chapter. Given the current extent of dampness and mold in existing housing and the potential for these conditions to worsen in many parts of the country due to increased storms, average precipitation, and humidity, it is important for states to make sure they have in place an adequate legal framework for addressing dampness and mold problems on an ongoing basis and following storm events. This chapter looks in depth at two policy strategies that have been pursued by a growing number of states in recent years.

- Regulation of Mold Service Providers. The assessment and remediation of mold-contaminated buildings require adherence to best practices in order to safeguard the health and safety of workers and occupants. After a storm involving heavy precipitation or flooding, it may be especially important to protect consumers against inferior work or fraudulent business practices involving mold assessment and remediation. Having a licensing program or other policy in place *before* the next severe storm is one strategy states have employed to help ensure that mold assessment and cleanup services are performed adequately, safely, and responsibly.

- Regulation of Dampness and Mold in Rental Housing. Approximately one-third of all homes in the U.S. are rental dwellings, and many jurisdictions create and enforce minimum standards governing these properties. Yet addressing dampness and mold in rental housing continues to be a particularly challenging problem not only for landlords and tenants, but also for the housing and health officials called on to assist in individual situations. Renewed focus on strengthening state laws to address dampness and mold is especially important in light of the fact that families living in rental properties make up nearly 60 percent of households living at or below the poverty line, and many will lack the resources needed to ensure the problem is fixed or to find alternate housing.[161]

Other Policy Strategies – New Homes. The policies discussed in the remainder of the chapter focus on preventing and remedying dampness and mold conditions in *existing* homes. In order to prevent problems in the future housing stock, it is also important to strengthen state policies governing

[158] National Institutes of Health-National Heart, Lung, and Blood Institute, Reducing Asthma Disparities, http://www.nhlbi.nih.gov/health-pro/resources/lung/naci/discover/disparities.htm.
[159] CDC, Most Recent Asthma Data, https://www.cdc.gov/asthma/most_recent_data.htm.
[160] *See* T. Reponen, et al., Family and home characteristics correlate with mold in homes, *Environmental Research*, v. 124 at 67-70 (2013), http://www.sciencedirect.com/science/article/pii/S0013935113000832 (analyses finding, "Overall lower socioeconomic position is associated with higher Environmental Relative Moldiness Index").
[161] *See* American Housing Survey, Table Creator (Poverty, Tenure), http://sasweb.ssd.census.gov/ahs/ahstablecreator.html#?s_areas=a0000&s_year=n2013&s_tableName=Table1&s_byGroup1=a10&s_byGroup2=a2&s_filterGroup1=t1&s_filterGroup2=g1.

new homes – e.g., policies addressing siting homes in flood-prone areas or establishing design and construction requirements that make new homes less susceptible to moisture problems. As the Institute of Medicine's 2011 report noted,

> If climatic conditions in a particular area change – for example, if there are more severe or more frequent episodes of intense precipitation – buildings constructed under existing codes and designed to operate under previously existing conditions may fail to perform as designed under the new conditions. That suggests that careful consideration must be given to revising building codes and practices to anticipate future climatic conditions and to taking a coordinated approach to addressing risks.[162]

Building codes are a key policymaking opportunity for institutionalizing best practices. The majority of states have adopted residential building codes based on the model International Residential Code (IRC), which includes minimum measures for addressing moisture control – e.g., in provisions governing foundations, walls, and roofs – as well as provisions governing flood resistance.[163] As part of the regular code review process, states (and localities) can incorporate the most recent version of the model code, as well as additional best practices appropriate for their circumstances. For example, following Superstorm Sandy, New York City amended its building code to require the use of mold-resistant gypsum board and cement board in moisture-prone areas of a building; existing buildings undergoing repairs or renovation must also follow these mold protection provisions, even if the project is not otherwise subject to the code.[164]

In addition to revising their building codes, states can establish policies requiring that publicly-funded housing construction projects meet specific design and construction criteria for moisture control that go beyond minimum building codes. These state policies can draw on guidance documents, such as EPA's Indoor airPLUS program, which establishes construction specifications on a wide range of moisture control and other IAQ issues, and the agency's *Moisture Control Guidance for Building Design, Construction and Maintenance*, which explains how to address key moisture control principles.[165]

Regulation of Mold Service Providers: Summary of State Laws and Regulations

A small but growing number of states have established laws or regulations governing mold-related services performed inside residential properties. Such requirements can help protect consumers and workers by ensuring that professional services are performed in accordance with industry standards to protect health and safety. Regulatory requirements can also enhance public confidence in the profession and create a set of common standards for businesses operating within a state.[166]

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[162] Institute of Medicine, Climate Change, the Indoor Environment, and Health, *supra*, at 147.
[163] ICC, Int'l. Res. Code, http://codes.iccsafe.org/app/book/toc/201/I-Codes/2015%20IRC%20HTML/index.html.
[164] New York City Local Law No. 13 (2014); New York City Building Code, §§ 2506.3.
[165] *See* U.S. EPA, Indoor airPLUS Construction Specifications, v. 1, § 1 (rev. Oct. 2015), www.epa.gov/indoorairplus; U.S. EPA, Moisture Control Guidance for Building Design, Construction and Maintenance, https://www.epa.gov/indoor-air-quality-iaq/moisture-control-guidance-building-design-construction-and-maintenance.
[166] *See generally* U.S. Department of Treasury, Council of Economic Advisers, & U.S. Department of Labor, Occupational Licensing: A Framework for Policymakers at 11 (July 2015), http://bit.ly/2eBMqUe.

This section begins with a summary of the key features of occupational licensing regimes in several states. The latter part of the section briefly notes other approaches to the regulation of mold professionals, such as requiring third-party certification and establishing a set of minimum work practices. It is important to keep in mind that this section only addresses regulation of *mold* professionals. In some states, licensing or certification requirements for other professions (e.g., general or home improvement contractors, home inspectors, pest control applicators) may apply to residential mold remediation projects in certain circumstances; where such policies exist, they may provide another avenue for regulating aspects of mold assessment and remediation.[167]

State Occupational Licensing Programs

A direct approach to regulating mold-related services is to require state licensing of mold professionals. This chapter discusses laws establishing licensing programs for mold professionals in five jurisdictions – Florida, Louisiana, New York, Texas, and the District of Columbia. Two additional states – Maryland and Illinois – have laws authorizing regulation of mold professionals, but the laws have not been implemented as of 2016.[168] In Maryland, the Mold Remediation Services Act was enacted in 2008; however, "due to budget constraints, the [Maryland Department of Labor, Licensing, and Regulation] has postponed the implementation of the law indefinitely."[169] In Illinois, the 2007 Mold Remediation Registration Act provides that the state Department of Public Health "*may* adopt rules…to implement a program establishing procedures for parties that provide mold remediation services to register with the State and provide evidence of financial responsibility," but the agency has not yet acted on this authority.[170] Though not discussed here, local jurisdictions in some states may also regulate mold service providers.[171]

Several states have enacted policies regulating mold professional services.

The remainder of this section describes the laws in the five jurisdictions that have established licensing programs. Where the licensing agency has adopted regulations implementing those laws – Florida,

[167] In a few states, the licensing regulations for general construction contractors specify that mold remediation may be included in the types of work performed by such a contractor, but do not establish qualifications or requirements specific to license applicants who intend to perform that type of work. *See, e.g.*, R.I. Admin. Code 2-2-2:2.1. In Tennessee, "mold remediation" is one of the specialty classifications available under the broader Special/Environmental contractor license. Under the law's implementing regulations, applicants for a license issued with this specialty classification are required to provide information about experience, training, and certifications with their initial license application and "keep abreast of all applicable state and federal requirements" as a condition of license renewal. Tn. Code §§ 62-6-102, 62-6-112; Tn. Admin. Code 0680-01-.16 (consisting of Appendix A of Rule 0680-01-.12).

[168] In addition, at least two states have enacted and then repealed laws authorizing mold licensing programs. *See* 2011 Ar. Acts, Act 518, § 1; 2012 Va. Acts, cc. 803 and 835, cl. 56.

[169] Maryland Dep't. of Labor, Licensing, and Regulation, Mold Remediation Services – Home Improvement Commission, https://www.dllr.state.md.us/license/mhic/mhicmoldwork.shtml. *See also* Md. Code Bus. Reg. §§ 8-701—718;

[170] 410 Il. Con. Stat. §§ 105/1 et seq. (emphasis added).

[171] The City of Philadelphia is an example of a local jurisdiction that regulates residential mold service providers. The Philadelphia Health Code prohibits any person from engaging in the business of residential mold inspections unless the person has obtained a license from the Department of Licenses and Inspections. To qualify for a license, an applicant must complete a mold inspection training program that qualifies or certifies mold inspectors. Philadelphia Code § 6-904.

Texas, and the District of Columbia – the regulations are discussed as well.[172] The policies vary in their details, but in general they address several key elements of a licensing regime: scope of practice, applicant qualifications, work practice requirements, and disciplinary standards and penalties.

Scope of Practice. Among the states that require a mold professional license, there is some variation in the types of services and service providers that fall within the scope of regulation. Scope of practice provisions identify the specific practices for which a license is required and limit the practices in which a license holder is permitted to engage.

Defining Assessment and Remediation. The types of services provided by mold professionals can be divided into two broad categories: mold assessment and mold remediation. Florida, New York, Texas, and the District of Columbia all require licenses for both mold assessment and mold remediation. Louisiana requires a license for mold remediation, but does not require or issue a license for mold assessment. There is some variation between states in terms of what practices specifically are authorized in these broad categories.

For instance, in New York, mold assessment is defined simply as "an inspection or assessment of real property that is designed to discover mold, conditions that facilitate mold, [or] indicia of conditions that are likely to facilitate mold."[173] In other states, the definition of mold assessment includes specific activities that may occur in connection with a visual inspection, such as: planning and conducting surveys and taking measurements; collecting samples; conducting laboratory analysis; preparing remediation protocols; and/or performing post-remediation clearance evaluations, among others.[174] In Texas, licensing regulations establish separate license categories to cover different aspects of the practice.[175] In general, mold remediation means the removal, cleaning, sanitizing, demolition, or other treatment of mold or mold-contaminated matter, and there are few differences in how states define the practices covered by a mold remediation license.

Addressing Underlying Causes of Mold Contamination. A key element in addressing a mold contamination problem is correcting the underlying source of moisture. Unless the underlying cause of the problem is rectified, mold remediation will likely provide only a temporary solution. The underlying causes of mold and moisture problems may relate to a variety of building and property conditions, including site drainage, roof and other building envelope leaks, or internal plumbing leaks. Correcting those problems may not require a mold remediation license; however, mold licensing laws can help

[172] Licensing laws in all of five states authorize the licensing agency to adopt rules and regulations; however, regulations have not been adopted in Louisiana or New York as of this writing.
[173] 32 N.Y. Labor Law § 930.
[174] *See, e.g.*, D.C. Mun. Regs. 20-3203.1(a)-(i) (permitting a mold assessment professional to, e.g., record observations, take measurements and collect samples; carry out surveys to determine the extent of mold; prepare assessment reports; develop a mold management plan a nd a mold remediation protocol; and/or evaluate a mold remediation project to verify that indoor mold has been remediated). Indoor mold assessment professionals in the District of Columbia are *required* to provide a mold remediation protocol to the client before a remediation project begins, if indoor mold growth is identified in a mold assessment. *Id.* at 3204.6(c).
[175] 25 Tx. Admin Code 295.311-313, 317. The regulations provide for four categories of assessment licenses: "mold assessment technician," "mold assessment consultant," "mold assessment company," and "mold analysis laboratory."

ensure that the underlying moisture problem is addressed. For example, the Texas licensing regulations require mold assessment consultants to include in a mold remediation protocol "the procedures to be used in determining whether the underlying cause of the mold identified for the project has been remediated so that it is reasonably certain that the mold will not return from that same cause."[176] In New York, the regulation's minimum standards for mold assessment require that the mold remediation plan specify, "when possible, the underlying sources of moisture that may be causing the mold and a recommendation as to the type of contractor who would remedy the source of such moisture."[177]

State licensing laws can help ensure that mold remediation also addresses the underlying moisture problem.

Mold Contamination Threshold. It is common for state mold licensing laws to exempt situations involving mold contamination below a minimum square footage threshold. U.S. EPA guidance explains that in most cases involving a moldy area less than 10 square feet, individuals can handle the job by following the agency's Mold Cleanup Tips and Techniques.[178] Laws in Florida, New York, and the District of Columbia set the licensing threshold at 10 square feet of affected indoor area,[179] while Louisiana and Texas set the minimum threshold somewhat higher.[180]

Exclusions and Exemptions. Licensing laws often exempt certain activities, such as routine cleaning, residential real estate or pest control inspections, maintenance or repair of appliances and fixtures, and construction-related work, provided those activities are not undertaken for the purpose of mold assessment or remediation.[181]

Licensing laws and regulations also list certain situations where an individual does not need a license to perform the work. One significant exemption in most state laws is for work performed by a person in a residential property they own or occupy. Florida, Louisiana, and New York provide broad exemptions for

[176] 25 Tx. Admin. Code 295.321.
[177] N.Y. Labor Law § 945.
[178] *See* U.S. EPA Office of Air & Radiation, Doc. No. EPA 402-K-02-003, A Brief Guide to Mold, Moisture, and Your Home at 4 (2012), https://www.epa.gov/sites/production/files/2016-10/documents/moldguide12.pdf. The EPA guide notes, however, that if the mold damage was caused by contaminated water (e.g., sewage), a professional should perform the cleanup work. *Id*. at 5; *see also* Mary Brandt et al., CDC, Mold Prevention Strategies and Possible Health Effects in the Aftermath of Hurricanes and Major Floods (2006), http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5508a1.htm.
[179] Fl. Stat. § 468.8411; N.Y. Labor Law § 930; D.C. Stat. § 8-241.02(a)(1).
[180] Louisiana uses 20 square feet, but only persons who are licensed residential contractors may provide mold assessment or remediation for areas under that threshold. La. Stat. § 37:2185(b)(5). In Texas, a person need not be licensed to perform mold *remediation* in an area in which the mold contamination affects a total surface area of less than 25 contiguous square feet. Tx. Occ. Code § 1958.102(c).
[181] *See, e.g.*, N.Y. Labor Law § 930; D.C. Stat. § 8-241.02(a)(1); La. Stat. § 37:2183; Tx. Occ. Code § 1958.002.

a residential property owner (or the owner's employee/agent[182]) to perform mold assessment and/or mold remediation services on his or her own property.[183] The laws in Florida and Louisiana also allow *tenants* to perform mold assessment and/or mold remediation in properties they lease without having a license.[184] In Texas, subject to certain limitations, the licensing law exempts owners and tenants who are conducting mold assessment on properties they own or lease, including residential owners of properties with fewer than 10 dwelling units.[185]

Such broad exemptions allow landlords to perform mold assessment and/or remediation on property they own, which may leave tenants without adequate recourse if landlords or their agents fail to follow best practices. The District of Columbia addresses this issue by providing an exemption for owners only if the property is *owner-occupied*, and does not provide any exemption for tenants.[186] States with and without mold licensing laws can help ensure effective mold remediation by providing technical guidance to individuals who are not required to obtain a mold assessment or remediation license. (See Text Box.)

Applicant Qualifications**.** An important feature of many professional licensing regimes is a set of criteria applicants must meet in order to qualify for a license. For mold professionals, these criteria typically include minimum age, education, training, and/or experience. Some states require applicants to take and pass a licensing examination before the license may be issued. Other eligibility requirements may include documentation of financial responsibility, moral fitness, or other criteria.

Training Requirements. In addition to minimum standards for age, educational, and/or experience, states generally require license applicants to provide documentation of mold training. The number of required training hours varies by state and, in some states, by license category.[187] In most cases, the training must be in the form of courses approved (if not administered) by the licensing agency. In some states, licensing laws and regulations establish accreditation or approval standards for training providers.[188]

Mold licensing laws and regulations commonly establish a required curriculum or identify specific topics that must be covered in the training. Topics include, but are not limited to, sources of indoor mold and

[182] The provision usually includes a caveat that the exemption does not apply to persons who hold themselves out as mold professionals or engage in the business of performing mold-related services for the public.
[183] Fl. Stat. 468.841; La. Stat. § 37:2185; N.Y. Labor Law § 933.
[184] Fl. Stat. 468.841; La. Stat. § 37:2185.
[185] Tx. Occ. Code § 1958.102. Additionally, a person is exempted if they perform mold assessment or remediation at the same time they are performing improvement or construction work on a one- or two-family dwelling.
[186] D.C. Mun. Regs. 20-3201.4.
[187] In Louisiana and the District of Columbia, initial license applicants must complete 24 hours of training. In Texas, requirements for initial training depend on the licensing category, ranging from 4 hours (remediation workers) to 40 hours (assessment consultants and remediation contractors). La. Stat. § 37:2186; D.C. Mun. Regs. 20-3208.4; 25 Tx. Admin. Code 295.320. New York's Mold Program guidance explains that training requirements are dictated by the activities a licensee intends to perform: mold assessor training is 4 days; mold remediation contractor training is 3 days; and mold abatement worker training is 2 days. N.Y. Dept. of Labor, Required Training Courses to Obtain Mold-Related Licenses, https://labor.ny.gov/workerprotection/safetyhealth/mold/pdf/mold-training-course-guidelines.pdf**.**
[188] Texas regulations, e.g., contain detailed requirements for the accreditation of mold training providers. 25 Tx. Admin. Code 295.318**.** In the District of Columbia, training providers must be approved by the licensing agency, which is directed to "give preference to" providers that meet certain standards of quality. D.C. Mun. Regs. 20-3208.9. *See also* N.Y. Department of Labor, Mold Training Providers: Frequently Asked Questions, https://labor.ny.gov/workerprotection/safetyhealth/mold/frequently-asked-questions-training-providers.shtm**.**

mold-creating conditions; potential health effects from mold exposure; workplace hazards and safety, including use of personal protective equipment; technical and legal considerations, including regulatory requirements; and work practices relevant to the license category.

Providing Mold Remediation Guidance for Individuals Not Required to Obtain a License

The District of Columbia's licensing regulations include a set of "minimum work guidelines and requirements" applicable to *non-licensed* individuals performing mold assessments on areas potentially affected by less than 10 square feet of indoor mold growth. The guidelines require that personal protective equipment be worn if assessment work might disturb indoor mold growth. The guidelines also require that if indoor mold growth or water-damaged materials are identified through visual inspection, remediation must be conducted according to a non-regulatory guidance document developed by the District's Department of Environment for individuals assessing and remediating mold in circumstances that do not require a license – i.e., performing work in a home they own and occupy or performing work on less than 10 square feet of indoor mold in a rental property. D.C. Code 3206; D.C. Mun. Regs. 20-3206.

In Connecticut, where a mold license is not required for mold-related work, state legislation directed the Department of Public Health to publish guidelines establishing voluntary mold abatement protocols, including acceptable methods for performing mold remediation or abatement work. The Department issued its voluntary Guidelines for Mold Abatement Contractors in 2006. Ct. Stat. §19a-111L; Conn. Dept. of Public Health, Connecticut Guidelines for Mold Abatement Contractors (2006), http://www.ct.gov/dph/lib/dph/environmental_health/eoha/pdf/ct_guidelines_for_mold_abatement_contractors_rev032011.pdf.

Local jurisdictions may also issue guidance for non-licensed individuals. For example, after Hurricane Sandy, New York City published detailed instructions for the public on removing mold in a home that has been damaged by flooding. City of New York, Removing Mold: Detailed Instructions, Hurricane Sandy Recovery and Your Health (2014), http://www.nyc.gov/html/doh/em/html/repairs/mold-inst.shtml.

Texas and the District of Columbia are examples of jurisdictions that require accredited training courses to cover topics specified in the licensing regulations.[189] In New York, separate guidance developed by the Department of Labor establishes detailed outlines for training courses.[190] In Louisiana, the law requires mold remediation license applicants to complete not only the training covering mold remediation and basic mold assessment, but also four hours of instruction under Louisiana's Unfair Trade Practices and Consumer Protection Law.[191]

[189] 25 Tx. Admin. Code 295.320; D.C. Mun. Regs. 20-3208.7.
[190] *See* N.Y. Dept. of Labor, Course Outlines for Assessor, Remediator, and Worker, https://labor.ny.gov/workerprotection/safetyhealth/mold/training.shtm.
[191] La. Stat. § 37:2186.

Licensees are generally required to complete some form of continuing education or refresher training in the period between initial licensing and license renewal. For example, in the District of Columbia, where the term of each license is two years, an indoor mold assessment or remediation license holder must complete a four-hour "refresher training" in the two years preceding license renewal. Florida's requirements are more extensive: in the same period, licensees must complete at least 14 hours of "continuing education."[192]

Licensing Examination. The District of Columbia, Florida, and Texas require applicants to demonstrate competency in relevant areas of practice by passing an examination.[193] The law may authorize the licensing agency to administer its own examination and/or allow or require applicants to provide documentation of passing an approved certification examination offered by another entity, such as a nationally-recognized mold assessment and remediation industry organization.[194]

Financial Responsibility. It is common for a state's occupational licensing laws to include requirements related to the applicant's financial responsibility. All five of the jurisdictions reviewed here require applicants to submit documentation of general liability insurance coverage, though the minimum coverage amount varies.[195] In addition to certificates of insurance, a state may require license applicants to submit financial statements to the licensing agency and/or satisfy a minimum net worth requirement.[196]

Application Fees. In all five states, licensing programs collect application and renewal fees, which generally are used to cover administration of the program. In the District of Columbia, fees also are used in part to fund a financial assistance program to help low-income residents obtain professional mold services in their dwellings.[197] (See Text Box).

Reciprocity and Third-Party Certifications. State mold licensing programs may allow applicants to satisfy certain licensing requirements by providing evidence that they have obtained certification or licensure through another body. To the extent that such provisions increase the availability of professional mold services, they may be especially helpful following severe storms when demand for mold services is high.

Reciprocity with Other Jurisdictions. Florida's mold licensing regulations provide a "license by endorsement" option, which is available to individuals licensed to perform the relevant mold-related service in another state. The District of Columbia also accepts a valid license issued by another state, providing that, "Submission of a current, valid license for mold assessment or remediation that is issued by another state, as approved by the Department following the standards established in this

[192] D.C. Mun. Regs. 20-3208.5; Fl. Stat. § 468.8416. *See also* 25 Tx. Admin. Code 295.320; N.Y. Labor Law § 934.
[193] D.C. Mun. Regs. 20-3202.3; Fl. Stat. § 468.8413; Tx. Occ. Code § 1958.105, 25 Tx. Admin. Code 295.305.
[194] *See, e.g.,* Fl. Regs. 61-31.102 ("Any person desiring an initial license by examination as a mold assessor or remediator must pass one of the written examinations approved by the Department for each license type, a list of which may be found at http://www.myfloridalicense.com/dbpr/pro/mold/approved_exams.html.").
[195] Some states require licensees to have general liability insurance coverage of at least $1 million. *See* D.C. Mun. Regs. 20-3207; Fl. Stat. § 468.8421; 25 Tx. Admin. Code 295.309. Another approach is to require $50,000 in liability insurance as well as evidence of workers' compensation insurance coverage under state law. *See* La. Stat. § 37:2186; N.Y. Labor Law § 932.
[196] *See, e.g.*, La. Stat. § 37:2186 (requiring evidence of net worth, a bond, a letter of credit, or other security).
[197] D.C. Mun. Regs. 20-8-241.03, .07.

[regulation], is sufficient for practice as an indoor mold assessment or remediation professional in the District of Columbia."[198]

The District of Columbia Indoor Mold Assessment and Remediation Fund

The District of Columbia Indoor Mold Assessment and Remediation law establishes a special Indoor Mold Assessment and Remediation Fund, to consist of the revenue from fees collected from applicants and licensees. The Fund is used first to administer the licensing program. Where there is money in the Fund in excess of the amount needed for program administration, that money must be used to provide financial assistance grants for certain mold-related services. Such grants may be provided to residential property owners without financial means to comply with the remediation requirements of the law, but they also may be provided directly to low-income D.C. residents for the purpose of having a professional mold assessment conducted in their premises, in the event that the owner of the property fails to comply with the law's requirements.

Source: D.C. Code § 8-241.07

Certification by a Third-Party Organization. Licensing programs might allow mold professionals to satisfy the state's training, examination, and other licensing requirements by submitting proof of certification by a third-party organization approved by the state. For example, in the District of Columbia, the Director of the Department of the Environment is authorized to recognize certification programs of "other states or independent bodies that the Director determines to be sufficient to ensure professional conduct of indoor mold assessment or remediation."[199]

Minimum Industry and Work Practice Standards. A number of governmental and non-governmental guidance documents describe best practices for mold remediation. U.S. EPA's *Mold Remediation in Schools and Commercial Buildings* sets forth best practice guidance for remediation of mold and moisture problems and can serve as a reference for mold and moisture remediators in residential buildings.[200] The Institute of Inspection, Cleaning and Restoration Certification (IICRC) has developed a procedural standard for professional mold remediation "based on reliable remediation and restoration principles," as well as a complementary reference guide to better apply the standard.[201] The New York City Department of Health and Mental Hygiene has developed guidelines for use by building owners, managers, and workers, environmental contractors and consultants, or "anyone concerned about indoor mold growth."[202]

[198] D.C. Mun. Regs. 20-3202.11; D.C. Code § 8-241.03. *See also* Fl. Stat. § 468.8414.
[199] D.C. Code §8-241.03.
[200] *See* U.S. EPA, Mold Remediation in Schools and Commercial Buildings (2008), https://www.epa.gov/sites/production/files/2014-08/documents/moldremediation.pdf.
[201] *See* ANSI/IICRC S520 Mold Remediation, http://www.iicrc.org/standards/iicrc-s520/.
[202] *See* New York City Dept. of Health and Mental Hygiene, Guidelines on Assessment and Remediation of Fungi in Indoor Environments (rev. 2008), https://www1.nyc.gov/assets/doh/downloads/pdf/epi/epi-mold-guidelines.pdf.

Scope of Work Practice Standards. Minimum work practices governing a project's key elements may be set forth directly in state laws or regulations. In Texas and the District of Columbia, the laws require the licensing agency to establish minimum performance standards and work practices for licensees, which are set out accordingly in the licensing regulations. In New York, minimum work standards are included in the statute itself; the law also authorizes the Department of Labor to adopt regulations.[203] Florida and Louisiana do not include work practice standards directly in their licensing laws or regulations.

The work practices included in state mold licensing laws and regulations address five core principles established by the IICRC: health and safety, contaminant control, contaminant removal, contaminant prevention, and project documentation. For mold assessment, the standards generally cover areas including, but not limited to: use and care of personal protective equipment (PPE); sampling and data collection procedures for laboratory analysis; and preparation of a mold remediation protocol. Mold remediation minimum work practice standards address, for example: preparation of a remediation work plan; containment requirements; personal protective equipment; and posting signs to notify occupants and visitors that mold remediation is underway.

Use of Disinfectants, Biocides, and Antimicrobials. The work practice standards in the regulations of New York, Texas, and the District of Columbia also address another important issue: the potential for occupant exposure to disinfectants, biocides, and antimicrobial coatings used in mold remediation. The District of Columbia authorizes mold professionals to use disinfectants, biocides, and antimicrobial coatings "only if their use is specified in a mold remediation protocol, if they are registered by the District of Columbia and the United States Environmental Protection Agency for the intended use, and if the use is consistent with the manufacturer's labeling instructions." The District of Columbia regulation also requires that any "decision by an indoor mold assessment professional to use [a disinfectant, biocide, or antimicrobial coating] shall take into account the potential for occupant sensitivities and possible adverse reactions to chemicals that have the potential to be off-gassed from surfaces coated with such products."[204] The Texas and New York regulations include nearly identical provisions.[205]

Clearance. Licensing laws or regulations also may include standards for post-remediation assessment and clearance to verify that mold has been remediated. For example, in New York, the post-remediation assessment must determine whether the work area is free of visible mold and the work meets clearance criteria specified in the remediation work plan. Post-remediation assessment must, to the extent feasible,

> determine that the underlying cause of the mold has been remediated so that it is reasonably certain that the mold will not return from that remediated area. If it has been determined that the underlying cause of the mold has not been remediated, the mold assessment licensee shall

[203] Tx. Occ. Code § 1958.054, 25 Tx. Admin. Code 295.321, 322; D.C. Code § 8-241.02, D.C. Mun. Regs. 20-3205; N.Y. Labor Law §§ 945, 946.
[204] D.C. Mun. Regs. 20-3205.
[205] 25 Tx. Admin. Code 295.321; N.Y. Labor Law § 945.

make a recommendation to the client as to the type of contractor who could remedy the source of the mold or the moisture causing the mold.[206]

Texas' mold licensing regulations include similar language.[207]

Other Issues Addressed in Work Practice Standards. In the District of Columbia, indoor mold remediation professionals must inquire of the client whether any hazardous materials — including lead-based paint and asbestos — are present in the project area, and follow appropriate work practices if necessary.[208] The Texas regulations include a separate set of work practices specifically for projects involving mold in heating, ventilation, and air conditioning (HVAC) systems.[209]

Documentation, Notice, Reporting, and Recordkeeping. Licensing laws and regulations frequently identify specific documents that licensees are required to prepare, maintain, and/or provide to customers. In a few states, the agreement to perform mold assessment or mold remediation must be in the form of a written contract signed by the parties.[210] Before work begins, it is common to require mold professionals to prepare and provide to the client a written work plan for the project; similarly, licensees may be required to provide each client a written report after a project ends.[211] In Texas, a mold remediator licensee also must provide the property owner with copies of photographs of the scene of the mold remediation taken before and after the project. [212]

Mold licensing laws and regulations include requirements for reporting to the licensing agency. For example, in the District of Columbia, an indoor mold assessment professional must notify the Department of Environment when he or she determines that a property has ten or more square feet of indoor mold growth in an affected area, and an indoor mold remediation professional must notify the Department before a remediation is performed.[213] Some of the licensing regimes also include detailed requirements for recordkeeping.[214]

Conflicts of Interest and Professional Ethics. An important issue addressed by state licensing laws is the potential conflict of interest when a company conducts both assessment and remediation services at the same property or project. In Texas, New York, and Louisiana, this prohibition on providing both types of

[206] N.Y. Labor Law § 947.
[207] 25 Tx. Admin. Code 295.324. *See also* D.C. Mun. Regs. 20-3205 (specifying what must be described in the mold remediation protocol, including a post-remediation assessment).
[208] 20 D.C. Mun. Regs. 20-3204.7. *See also* Tx. Admin. Code 295.312, 315 (establishing responsibility of mold professionals to inquire of the client about presence of hazardous materials in the work area).
[209] *See* 25 Tx. Admin. Code 295.323.
[210] *See* Fl. Stat. § 468.8422; D.C. Mun. Regs. 20-3210.1; Tx. Occ. Code § 1958.156.
[211] *See, e.g.*, N.Y. Labor Law § 935.
[212] Tx. Occ. Code § 1958.156.
[213] D.C. Mun. Regs. 20-3209.1. *See also* Tx. Admin. Code 295.325.
[214] *See, e.g.*, 20 D.C. Mun. Regs. 3210 (requiring mold remediation licensees to maintain various records and documents on-site at a project for its duration, including: a copy of the mold remediation work plan and all mold remediation protocols used in its preparation; the names and license numbers for all individuals working on the project; and any contract related to the project); Tx. Occ. Code § 1958.156 (requiring a mold remediator to maintain a record for each mold remediation for at least three years, containing: (1) photographs taken before and after; (2) the written contract; (3) all invoices issued; and (4) any other material required by the agency).

services is absolute.[215] In Florida, licensees are prohibited from performing or offering to perform any mold remediation if they provided mold assessment on the structure within the last 12 months.[216] The laws and regulations may also prohibit a licensee from having a financial interest that may pose a conflict of interest.[217]

Other ethics provisions address issues such as: keeping clients' information confidential; not performing work while impaired; reporting to the agency about violations of the licensing laws or regulations or other illegal or unethical conduct of another licensee; and providing false, deceptive, or misleading information in advertising to clients or to the agency.[218] In Texas and the District of Columbia, licensees are specifically prohibited from making any representations designed to take advantage of the fears or emotions of the public or customers.[219]

Disciplinary Standards, Penalties, and Enforcement. Mold licensing laws and regulations typically authorize licensing agencies to investigate and enforce violations according to established standards for disciplinary action (e.g., suspension or revocation of a license). State laws may also provide for assessment of administrative fines and/or penalties, injunctive relief, and recovery of enforcement costs.

Other Approaches to Regulation of Mold Professionals

Some states that do not have statewide mold professional licensing regimes have adopted other policies to help protect consumers and establish minimum standards for mold assessment and remediation.

Third-Party Certification Requirement. As an alternative to establishing a program for issuing state licenses, states can require service providers to submit proof that they have obtained certification from a recognized or approved third-party certifying organization. New Hampshire has taken this approach for mold assessment services. In 2015, the state revised its occupations and professions law to require that any person performing residential mold assessment services for remuneration must possess "a valid national third party certification for mold assessment." The statute specifies that a valid "third party certification" means a certification approved by a national nonprofit organization whose programs are accredited by a recognized accrediting body and that certification holders must meet the requirements set by the third-party certification organization in order to be recertified. Any person who offers mold assessment services for a fee but does not comply with the requirement is guilty of a violation (individual) or misdemeanor (business entity).[220]

[215] Tx. Occ. Code § 1958.155; N.Y. Labor Code § 936; La. Stat. § 37:2187.
[216] Fl. Stat. § 468.8419 (prohibition applies unless the licensee is a certified Division I contractor).
[217] *See, e.g.*, Tx. Occ. Code § 1958.155; D.C. Mun. Regs. 20-3204.5.
[218] *See, e.g.,* D.C. Mun. Regs. 20-3204.5; 25 Tx. Admin. Code 295.304**;** Fl. Stat. § 468.842.
[219] 25 Tx. Admin. Code 295.304; D.C. Mun. Regs. 20-3204.5. Other examples from the Code of Ethics set out in the Texas regulation include requirements to "provide only necessary and desired services to a client and not sell unnecessary or unwanted products or services" and "provide mold-related services at costs in keeping with industry standards." *Id*.
[220] N.H. Rev. Stat. § 310-A:189-b. The law provides an exemption for any professional hired for remuneration by a homeowner, in which the primary work contracted for is not mold assessment.

Required Work Practice Standards for Mold Remediators. Kentucky has enacted a law requiring "mold remediation companies" (entities that perform mold remediation for compensation) to follow minimum standards established by the state.[221] The law establishes that the minimum standards, to be adopted by the Department of Law, must be based on the five general principles of mold remediation created by the Institute of Inspection, Cleaning and Restoration Certification: safety and health; project documentation; contaminant control; contaminant removal; and contamination prevention.

The law's implementing regulation establishes requirements to address each of these principles. Among the areas covered are: training, education, and experience; provision of a mold assessment and remediation plan, as well as a post-remediation report; and work practice standards.[222] Pursuant to the regulation, mold remediators must provide a copy of the most recent edition of U.S. EPA's *A Brief Guide to Mold, Moisture, and Your Home,* as well as a copy the state's *Read This About Mold Before You Sign A Contract* (Form MRC-1), and *Read This About Indoor Environmental Professionals Before You Sign A Contract* (Form MRC-2). Additionally, if a company has not identified or cannot determine the source of moisture or measures to remedy and manage the moisture, the customer must sign a copy of the state's *Notice of Moisture Problem* (Form MRC-3) prior to contracting for remediation services.[223]

States without mold licensing laws can adopt other policies to protect consumers and advance best practices.

While the law does not delegate oversight or administration of these professional standards to any state agency or program, it provides that the standards may be enforced by the state Attorney General in a civil action.[224]

Standards for Mold Remediation in Rental Property. As discussed further in the next part of this chapter, Virginia's landlord-tenant law requires landlords to respond promptly to tenant notifications of mold on the property and provides that where a mold condition materially affects the health or safety of a tenant, the tenant may be required to temporarily vacate the premises while the landlord performs "mold remediation in accordance with professional standards." The law specifies that mold remediation in accordance with professional standards means,

> "mold remediation of that portion of the dwelling unit or premises affected by mold, or any personal property of the tenant affected by mold, performed consistent with guidance documents published by the United States Environmental Protection Agency, the U.S. Department of Housing and Urban Development, the American Conference of Governmental Industrial Hygienists (the Bioaerosols Manual), Standard Reference Guides of the Institute of

[221] Ky Rev. Stat. § 367.83805.
[222] Ky. Rev. Stat. § 367.83805, 40 Ky. Admin. Rules 2:330.
[223] *Id*.
[224] Ky. Rev. Stat. § 367.83807. *See generally* Kentucky Office of the Attorney General, Mold Remediation, http://ag.ky.gov/family/consumerprotection/mold/Pages/default.aspx.

Inspection, Cleaning and Restoration for Water Damage Restoration and Professional Mold Remediation, or any protocol for mold remediation prepared by an industrial hygienist consistent with said guidance documents."[225]

Conflict of Interest Provisions. In at least two states – Oklahoma and Maine – laws restrict a person from performing both mold assessment and mold remediation services at the same property. In Maine, the state commerce and trade law provides, "A person may not provide both mold assessment and remediation services on a building project unless the person has provided to the owner of the building or the owner's agent a signed disclosure statement regarding the potential for conflict of interest in providing both mold assessment and remediation services."[226] Oklahoma law provides that any person or entity that inspects houses for mold may not also render services for removing the mold, unless the total cost of both inspection and removal is $200 or less.[227]

Summary

Mold and dampness are common problems currently and may become more prevalent due to increased average precipitation and more frequent heavy storms in many parts of the country. Several states have put in place mold licensing programs to ensure that professional mold assessment and remediation activities are carried out adequately, safely, and responsibly. The policies reviewed here differ in some respects, but most address several key elements of a licensing framework – scope of work subject to licensing; minimum training, experience, examination, and other requirements for obtaining a license; mandatory work practice standards; consumer protection provisions such as conflict of interest and financial responsibility; and enforcement.

Key issues for consideration by jurisdictions developing policies to regulate the provision of mold assessment or remediation services include:

- Third-Party Certification. Given the existence of multiple national, third-party certifiers, state licensing laws might authorize the regulating agency to establish a list of approved certifications that would be accepted to satisfy some of the minimum requirements for obtaining the state license. This approach would allow state agencies to determine which certifications meet state standards and to revise that list as certification programs evolve. States that do not pursue a licensing regime could require mold service providers to submit proof of a valid third-party certification in order to provide services in the state; such a policy involves a lesser degree of state oversight, but may nonetheless require allocation of agency resources for administration of the requirement.

- Rental Properties. Given the different legal and economic considerations governing rental housing, states should consider limiting landlords' exemption from mold licensing requirements. For example, states could limit exemptions for property owners to those owners who occupy

[225] Va. Code § 55-248.18:2.
[226] Me. Rev. Stat. t. 10, § 1480.
[227] Ok. Stat., t. 15 § 765.4.

their properties. States could also establish remediation guidelines that must be followed by landlords who are not required to obtain a license; in order to strengthen enforceability, such requirements could be incorporated into the state's landlord-tenant laws as well.

- Addressing the Underlying Causes of Mold Contamination. It is important for mold licensing programs to include provisions to help ensure that the underlying causes of mold contamination are addressed in a home remediated by a licensed professional. For example, laws and regulations could include provisions that require mold assessors to identify potential underlying causes and that require mold assessment, remediation, and clearance reports to incorporate information on the nature and status of the underlying moisture problems.

- Providing Information and Training on Mold Remediation. Because many states do not have mold licensing laws and all existing mold licensing laws exempt some individuals from regulations, states can help advance public health and safety by providing information and training on proper mold remediation practices. This information would be especially useful following severe storms, when demand for mold professional services may exceed capacity, leading homeowners and tenants to take action on their own. Following Superstorm Sandy, several federal agencies collaborated to develop the *Homeowner's and Renter's Guide to Mold Cleanup After Disasters*.[228] The state of New Jersey also developed a guide for New Jersey residents on understanding mold investigations and remediation, including tips for hiring a consultant and checklists for what to expect from inspection and remediation services.[229]

Dampness and Mold in Rental Housing: Summary of State Laws and Regulations

State laws establishing property maintenance requirements for rental housing can be an important vehicle for preventing housing conditions that lead to mold and dampness and for ensuring adequate remediation of mold, moisture, and dampness problems.[230] There are two main types of state laws and regulations that incorporate minimum habitability standards for rental properties and that can serve as vehicles for addressing dampness and mold.[231]

- Housing Codes. Housing codes, which may also be referred to as property maintenance or sanitary codes, are the primary regulatory vehicle for establishing minimum conditions that must be maintained in rental housing.[232] Indeed, most state and local governments that have addressed dampness and mold in rental housing explicitly have done so through their housing

[228] *See* Hurricane Sandy Rebuilding Task Force – Indoor Environmental Pollutants Work Group, Homeowner's and Renter's Guide to Mold Cleanup After Disasters (2015), http://www.cdc.gov/mold/cleanup.htm (available in English and Spanish).
[229] *See* N.J. Dept. of Health, Mold: Guidelines for New Jersey Residents (2013), http://www.state.nj.us/humanservices/home/Mold%20Guidelines.pdf.
[230] *See* Fisk, *supra*, at 73 ("Improved maintenance of building envelopes can…reduce dampness problems, for example replacing roofs before they leak and fixing leaks quickly after they are detected.).
[231] Federal regulations add another set of standards for federally subsidized housing. For example, HUD's housing quality standards set forth the minimum health and safety criteria for the rental dwellings subsidized through the agency's Housing Choice Voucher program. *See* 24 CFR Part 982.
[232] In some states, these codes apply to owner-occupied housing as well as rental properties.

codes. Housing codes are enforced *publicly* by government agencies, typically housing or health authorities. The codes often include authority for conducting inspections, issuing citations, and pursuing administrative, civil and criminal enforcement actions in the event of noncompliance.

Many, but not all, local jurisdictions in the U.S. are covered by a state or local housing code. At least a quarter of all states have promulgated state-wide housing codes. State housing codes may give localities the authority to promulgate their own codes, provided the provisions in the local code are at least as stringent as those in the state code. In states without state-wide housing codes, many localities have adopted their own codes.

- Landlord-Tenant Laws. Nearly all states have enacted laws that govern certain aspects of the landlord-tenant relationship. These laws set forth the rights and responsibilities of landlords and tenants and are enforced *privately* by the parties. They cover an array of issues – from security deposits and prohibited lease terms to legal remedies in the event of noncompliance with the law. They also typically include general provisions requiring landlords to maintain the premises in habitable condition; in contrast to housing codes, however, they normally do not set forth detailed housing standards. Many state landlord-tenant laws follow closely a model law, the 1972 Uniform Residential Landlord and Tenant Act (URLTA).[233] At least one state – Virginia – has incorporated responsibilities for mold remediation into its landlord-tenant law.

Housing codes and landlord-tenant laws are key policy vehicles for addressing dampness and mold in rental housing.

Other types of state laws are also used to address mold and dampness problems in rental housing. For example, public health laws often establish nuisance authority that can be used by state or local health officials to require remediation of housing conditions that pose a threat to health and safety. Such provisions are usually framed broadly and could be enforced in cases of severe mold contamination.[234] In general, nuisance laws offer the state or local government recourse as a last resort, rather than serving as a routine mechanism for addressing housing violations.

Programs that fund or finance housing repairs and renovations are another opportunity for state policy to can facilitate remediation of mold and dampness problems in rental housing.[235] In addition to

[233] *See* Uniform Law Commission, Uniform Residential Landlord and Tenant Act (URLTA) (1972), http://bit.ly/29VRa1a. As of 2012, 22 states had adopted statutes based on the URLTA. *See* Uniform Law Commission, Reporter's Memo – Warranty of Habitability (2012), http://www.uniformlaws.org/Committee.aspx?title=Residential%20Landlord%20and%20Tenant%20Act.

[234] San Francisco is an example of a local jurisdiction whose nuisance law explicitly includes in the definition of a nuisance, "Any visible or otherwise demonstrable mold or mildew in the interiors of any buildings or facilities." 11 San Fran. Health Code § 581.

[235] As noted in Chapter 2, federal programs that help fund repairs and rehabilitation to affordable housing include HUD's 230k Rehab Mortgage Insurance Program (http://portal.hud.gov/hudportal/HUD?src=/program_offices/housing/sfh/203k/203k--df) and Home Investment Partnership Program (http://portal.hud.gov/hudportal/HUD?src=/program_offices/comm_planning/affordablehousing/programs/home/), and the

including IAQ-related measures in program regulations, state can develop program guidance documents to ensure funded projects will address mold and dampness. In developing such guidance, states can consult guidance documents such as the U.S. Department of Housing and Urban Development's Green Building Retrofit Checklist, created to "promote and encourage the use of energy efficiency and green building practices by helping communities to seamlessly incorporate these practices into their residential improvement programs." Among other mold and IAQ items, the checklist includes: "Inspect the interior and exterior of the building for evidence of moisture problems. Document the extent and location of the problems, and implement the proposed repairs according to the Moisture section of the EPA Healthy Indoor Environment Protocols for Home Energy Upgrades."[236]

This section provides an overview of the types of provisions in existing housing codes and landlord-tenant laws that address mold, dampness, and underlying moisture problems. The term "housing code" is used generally to include housing, property maintenance, and sanitary codes that establish minimum standards for rental properties and are enforced by public agencies.

Housing Codes

The following summary is based on a review of housing codes in 13 states and the District of Columbia. These are not necessarily the only states that have such laws and regulations. And, as noted above, many local jurisdictions have their own housing codes which may include provisions governing mold, moisture, and dampness.

Of the states reviewed here, a handful – Illinois, Maryland, New York, and Rhode Island[237] – have adopted a state-wide property maintenance code based largely on the International Property Maintenance Code (IPMC), a model code published by the International Code Council.[238] Relevant provisions of the IPMC are described below to reflect the minimum standards in those states. The other states reviewed here – California, Connecticut, Delaware, Massachusetts, Michigan, New Hampshire, New Jersey, Tennessee, and Vermont – have developed their own housing codes, and examples from those codes are provided below.[239] The District of Columbia has enacted both a property maintenance code and a separate housing code.[240]

Department of Agriculture's Section 504 Home Repair program (http://www.rd.usda.gov/programs-services/single-family-housing-repair-loans-grants).

[236] U.S. Dept. of Housing & Urban Dev't. (HUD), Green Building Retrofit Checklist and Guidance, https://www.hudexchange.info/resource/3684/guidance-on-the-cpd-green-building-checklist/.

[237] *See* 23 Il. Admin. Code 180.60; Code Md. Regs. 05.02.03.03; 19 N.Y. Admin. Regs. 1226.1; R.I. Regs. t. 10, rule 6. Additional states have adopted the IPMC as the standard that local jurisdictions must use, but only if the locality chooses to adopt a housing maintenance code. *See, e.g.*, Ga. Code § 8-2-20; S.C. Stat. § 6-9-60; S.D. Stat. § 11-10-11. *See also* W.V. Code St. R. 87-4-4 (4.1.e) (adopting the IPMC but with the proviso that it "may be rejected at the option of the local jurisdiction").

[238] Int'l. Code Council, International Property Maintenance Code (2015), http://bit.ly/29QY06o. The IPMC is updated every three years. This summary describes provisions in the most recent (2015) version. Though some states have adopted older versions of the code, those versions do not differ significantly in terms of the provisions discussed here.

[239] *See* Ca. H&S Code § 17910–17998.3; Ct. Stat. § 47a-50--67; 31 De. Code t. 31, § 4101 et seq.; 105 Code Ma. Regs. 410.001–.990; Mi. Code § 125.401–.543; N.H. Stat. § 48–a:1–:15; N.J. Admin. Code 5:28-1.1–.13; Tn. Code § 68-111-101—108; Vt. Admin. Code 12–5–25:1.0–:11. Some of these codes are limited in their applicability or implementation. *See, e.g.,* N.H. Rev. Stat. § 48-A:14 (applies only in the absence of a local code); Mi. Stat. § 125.401 (applies only to localities with a population of at least

Housing Code Enforcement as a Climate Change Adaptation Strategy: Massachusetts

Many state climate planning documents acknowledge increased building dampness and mold as potential consequences of climate change. Massachusetts is unusual in addressing housing code enforcement explicitly as a climate adaptation strategy. Among the long-term strategies for addressing IAQ issues, the 2011 Massachusetts Climate Change Adaptation report recommended the following as especially applicable to vulnerable populations:

> *Continue using the State Sanitary Code (105 CMR 410.000: Minimum Standards of Fitness for Human Habitation, State Sanitary Code, Chapter II) to protect tenants, and require property owners take action to remediate water-damaged building materials, including mold contaminated materials. Resources to assist the DPH and local boards of health to enhance this activity should be considered (VP).*

Source: Mass. Exec. Office of Envtl. Affairs and Adaptation Advisory Committee, Climate Change Adaptation Report at 80-82 (2011), http://www.mass.gov/eea/docs/eea/energy/cca/eea-climate-adaptation-report.pdf.

These codes often include general standards that can be applied to address mold and dampness problems – e.g., requiring landlords to maintain the premises (and in some cases specific components of the premises) in good repair and in a safe and sanitary condition.[241] The codes may also include basic requirements for tenants to maintain their units in a sanitary and safe condition.[242] Following are examples of housing code provisions that address more specifically the landlord's duty to prevent and fix dampness and mold problems.

Mold and Chronic Dampness. While the IPMC does not address mold or chronic dampness explicitly, several state housing codes include such provisions. These codes reflect a variety of approaches to framing requirements for property owners.

- California's housing law includes "dampness of habitable rooms" in a list of conditions that render a building "substandard" to the extent that the condition "endangers the life, limb, health, property, safety, or welfare of the public or the occupants." In 2015, the law was amended to add the following condition to this list: "Visible mold growth, as determined by a health officer or a code enforcement officer…excluding the presence of mold that is minor and found on surfaces that can accumulate moisture as part of their properly functioning and intended use."[243]

10,000 or, in the case of one and two-family dwellings, to cities with a population of 100,000 or more); Tn. Code § 68-111-108 (complaint and inspection provisions do not apply to tenants who pay their rent monthly or for a term greater than monthly).

[240] D.C. Mun. Regs. 12-101A, 14- 300–899.

[241] The IPMC, e.g., states, "A person shall not…permit another person to occupy premises that are not in a sanitary and safe condition…." IPMC § 301.2. *See also, e.g*., D.C. Mun. Regs. 14-400.3; 31 De. Code § 4112(3*);* N.J. Admin. Code 5:10-6.1.

[242] The IPMC states, "Occupants of a dwelling unit….are responsible for keeping in a clean, sanitary and safe condition that part of the dwelling unit…which they occupy and control." IPMC § 301.2. *See also, e.g.,* 31 De. Code § 4120, 105 Code Ma. Regs. 410.352.

[243] Ca. Health & Safety §17920.3.

- In 2014, the District of Columbia amended its environmental (air quality) law to add mold remediation and disclosure requirements, enforceable through the District's housing code.[244] Within seven days of receiving a tenant complaint, a landlord must inspect for mold and must remediate the condition within 30 days of the inspection. The law is notable for requiring that the work be conducted by a professional certified and licensed by the District if it is above a certain area threshold.[245] Even below the threshold, landlords who are not licensed must conduct the remediation in accordance with general guidelines issued by the District.[246]

  In addition to these provisions, the District's housing code provides that "the floors and interior wall surfaces of residential buildings shall be maintained reasonably free of dampness. In any habitable room where any wall or floor surface is damp, that condition shall be corrected, and the wall or floor shall be maintained in a corrected condition."[247]

- In Massachusetts, the state sanitary code governing all dwelling units, including leased units, broadly requires dwelling owners to maintain structural elements (including foundation, floors, walls, doors, windows, ceilings, and roofs) in good repair and "free from chronic dampness."[248] The code defines chronic dampness as "the regular and/or periodic appearance of moisture, water, mold or fungi."[249] The code also addresses mold and moisture in basements by prohibiting use or habitation of a room if more than half of its floor-to-ceiling height is below grade and is subject to chronic dampness.

- Similarly, Vermont's Rental Housing Health Code requires that "[e]very dwelling, dwelling unit, rooming house or rooming unit shall be maintained to be free from the regular or periodic appearance of standing water or excessive moisture which may result in visible mold growth."[250]

- Pursuant to New Jersey's Multiple Dwellings Code, "Basements, cellars and crawl spaces are to be free of moisture resulting from liquid penetration from the exterior and shall be provided with ventilation as required herein to prevent accumulations of moisture and dampness."[251]

[244] D.C. Code § 8-241.04.
[245] D.C. Code § 8-241.03; D.C. Mun. Regs. 20- 3200 et seq. The threshold requiring a licensed professional is a "total surface area of…ten square feet (10 ft.^{2}) of indoor mold growth in an affected area." D.C. Mun. Regs. 20- 3201.2.
[246] The District Department of Energy & Environment has adopted regulations setting forth guidelines for mold assessment by non-licensed individuals. D.C. Mun. Regs. 20- 3206. The agency has published on its web site a guidance document on mold remediation for non-licensed individuals. D.C. DOEE, Guidance for Non-Licensees (2016), http://doee.dc.gov/moldlicensureregs ("Mold Licensure – Guidance Document").
[247] D.C. Mun. Regs. 14- 706.5-.6.
[248] 105 Code Ma. Regs. 410.500.
[249] 105 Code Ma. Regs. 410.020.
[250] Vt. Admin. Code 12-5-25:10.0. The code also prohibits the use of vaporizers or humidifiers by occupants or owners "in such ways that cause an elevated relative humidity (above 60%), promoting the growth of microorganisms and visible mold." Vt. Admin. Code 12-5-25:8.0.
[251] N.J. Admin. Code 5:10–8.1. The code applies to buildings with three or more units. N.J. Admin. Code 5:10-2.2.

- In Michigan, rooms in occupied basements must be "well drained and dry," and the floor must be "water-proof and damp-proof."[252]

In addition to provisions addressing mold explicitly, some state housing codes require more generally that interior surfaces and components be kept clean. For example, New Jersey's Multiple Dwellings Code provides, "Floors, walls, ceilings and other exposed surfaces shall be kept clean, free from visible foreign matter, sanitary and well-maintained at all times."[253]

Weathertightness. In addition to the above provisions addressing dampness, a common element of housing codes is the requirement that the premises be maintained in weathertight condition. Such requirements can be applied to prevent and address water incursion into a home from the outside, which can lead to mold and dampness problems. The requirement may apply generally or to specific structural elements. The IPMC requires exterior walls to be maintained in weatherproof condition, and also provides, "Roof drainage shall be adequate to prevent dampness or deterioration in the walls or interior portion of the structure."[254] Individual state housing codes include variations on this theme.

- Vermont's Rental Housing Health Code requires that owners provide and maintain the structural elements of a dwelling to be weathertight, watertight, and in good repair.[255]

- Delaware's Housing Code requires, "Every exterior wall shall be free of…any other condition which might admit rain or dampness to the interior portions of the walls or to the occupied spaces of the building."[256]

- Under Michigan's housing code, "The roof shall be so maintained as not to leak and the rain water shall be drained and conveyed therefrom…so as to avoid dampness in the walls and ceilings and insanitary conditions."[257]

- New Jersey's Multiple Dwellings Code states, " All exterior walls, roofs, windows, window frames, doors, door frames, skylights, foundations and other parts of the structure shall be maintained as to keep water from entering the structure, to prevent excessive drafts or heat loss during cold or inclement weather and to provide a barrier against infestation."[258]

- According to Tennessee's regulations, "Every foundation, roof and exterior wall, door, skylight, and window shall be reasonably weathertight, watertight, and dampfree, and shall be kept in sound condition and good repair."[259]

[252] Mi. Code § 125.468.
[253] N.J. Admin. Code 5:10–8.2.
[254] IPMC §§ 304.6, .7.
[255] Vt. Admin. Code 12-5-25:10.0.
[256] De. Code t. 31, § 4113(e). *See also* 105 Code Ma. Regs. 410.501 (structural elements must be watertight and weathertight, and elements are considered weathertight only if "all cracks and spaces are caulked or filled in as to prevent infiltration of exterior air or moisture").
[257] Mi. Code § 125.471. *See also, e.g.,* D.C. Mun. Regs. 14-702.1; N.H. Rev. Stat § 48-A:14; N.J. Admin. Code 5:28–1.10 (d); De. Code t. 31, § 4113(f).
[258] N.J. Admin. Code 5:10–7.4.
[259] Tn. Admin. Code 1200-01-02-.05.

Local Housing Codes

Though only a minority of states have adopted mandatory statewide housing codes, many counties, cities, and towns around the country have established and enforce housing codes applicable to rental properties within their jurisdictions. Similar to the state policies discussed in this chapter, local housing codes include a variety of provisions related to mold and dampness. For example, in Hillsborough County, Florida, the interiors of all buildings and facilities "shall be kept free of any visible or otherwise demonstrable growth of mold or mildew." In Seattle, "Every foundation, roof, exterior wall, door, skylight, window, and all building components shall be reasonably weathertight, watertight, damp-free and rodentproof, and shall be kept in a safe, sound and sanitary condition and in good repair." Atlanta is an example of a local housing code that addresses dampness of basements: "No basement shall be used as a habitable room or dwelling unit unless….the floor and walls are impervious to leakage of underground and surface run-off water and are adequately protected against dampness."

Sources: Hillsborough County Mun. Code § 8-115; Seattle Mun. Code § 22.206.080; Atlanta Housing Code of 1987, Art. I, § 24(d).

Housing codes also usually include general provisions addressing internal leaks – e.g., requiring plumbing systems to be maintained leak-free and in good repair, and bathroom surfaces to be non-absorbent.[260]

Other Provisions. Housing codes may include a number of other requirements related to moisture control. For example, the IPMC contains a provision requiring grading around a structure to be maintained in such a way as to ensure that water drains from the facility and does not accumulate.[261] State code requirements for adequate ventilation, including ventilation in bathrooms and kitchens, are also important for preventing moisture problems. Vermont's housing code states, "Every bath, toilet or shower room shall be ventilated by direct access with the external air either by window, airshaft or ventilation fan. If a ventilation fan is used, it shall be vented directly to the exterior of the building and be of sufficient size to prevent the buildup of moisture."[262]

Landlord-Tenant Laws

As noted earlier, the rights and responsibilities set forth in state landlord-tenant laws are enforced privately by the parties to a lease. Most of these laws require landlords to comply with applicable state and local housing codes, thereby incorporating any dampness- and mold-related provisions contained in those codes. Landlord-tenant laws themselves also typically include provisions addressing the landlord's and tenant's duty to maintain the property in habitable condition. While relatively few of these landlord-tenant provisions address mold and dampness conditions explicitly, a notable exception is the state of Virginia, which has amended its landlord-tenant law to establish specific requirements for

[260] *See* IPMC §§ 504.1, 503.4; *see also, e.g.,* 105 Code Ma. Regs. 410.351.
[261] IPMC § 302.2.
[262] Vt. Admin. Code 12-5-25:8.0.

landlords to remediate mold contamination. Though not discussed in this report, landlord-tenant laws also may come into play in determining landlord and tenant responsibilities under the lease in the event a rental dwelling is rendered uninhabitable by old or other conditions following a storm.

General Habitability and Good Repair Standards. The Uniform Residential Landlord Tenant Act of 1972, which serves as a model for around half of all state landlord-tenant laws, addresses the landlord's responsibility to maintain the premises by requiring compliance with applicable building and housing codes and by requiring the landlord to "make all repairs and do whatever is necessary to put and keep the premises in a fit and habitable condition…keep all common areas of the premises in a clean and safe condition….and maintain in good and safe working order and condition all …plumbing…and other facilities and appliances…."[263] As described below, in 2015 the URLTA was amended significantly to add specific provisions relevant to dampness and mold.

Some state landlord-tenant laws include additional detail in describing the general habitability and good repair requirement. For example, Oregon's law requires floors, walls, and ceilings to be kept in good repair and states that "a dwelling unit shall be considered uninhabitable if it substantially lacks….Buildings, grounds and appurtenances…[that are] clean, sanitary and free from all accumulations of debris, filth, rubbish, garbage, rodents and vermin…"[264] A few states link the maintenance requirement to conditions that pose a threat to health. For example, Maryland's landlord-tenant law "provides a remedy and imposes an obligation upon landlords to repair and eliminate….any condition which presents a health or fire hazard to the dwelling unit."[265] Wisconsin's landlord-tenant law includes a provision authorizing the tenant to vacate the premises if they become "untenantable" because of damage by water or any other violation materially affecting the tenant's health or safety and the landlord fails to promptly repair or eliminate the hazard.[266]

Weathertightness. In some states, the landlord's duty to provide a habitable dwelling specifically includes weathertightness. In Colorado, for example, a dwelling is deemed uninhabitable if it substantially lacks "[w]aterproofing and weather protection of roof and exterior walls maintained in good working order, including unbroken windows and doors."[267] In Nevada, a dwelling unit is not habitable if it "substantially lacks…[e]ffective waterproofing and weather protection of the roof and exterior walls, including windows and doors."[268] North Carolina's law is more specific, requiring landlords to remedy any "imminently dangerous" condition, defined to include: "Excessive standing water, sewage, or flooding problems caused by plumbing leaks or inadequate drainage that contribute to mosquito infestation or mold."[269]

[263] URLTA § 2.104.
[264] Or. Rev. Stat. t. 10, § 90.320; *see also, e.g.,* Fl. Stat. § 83.51.
[265] Md. Code Ann., Real Property § 8-211. *See also, e.g.,* Tx. Prop. Code Ann. § 92.052; Id. Code § 6-320; De. Code t. 25, § 5305; Me. Stat. t. 14 § 6026.
[266] Wi. Stat. § 704.07.
[267] Co. Rev. Stat. § 38-12-505.
[268] Nv. Rev. Stat. § 118A.290. *See also, e.g.,* Or. Rev. Stat. § 90.320; Ca. Civ. Code § 1941.1; Id. Code § 6-320.
[269] N.C. Gen. Stat. § 42-42.

Tenant Notification. Many states require disclosure of dampness, mold, and moisture conditions during sale or transfer of residential real estate. (See Text Box.) While those property condition disclosure laws typically do not apply to the lease transaction, at least three states – Georgia, Washington, and Virginia – have landlord-tenant laws that require landlords to provide information related to mold, moisture, and dampness problems. Washington's law requires landlords to:

> Provide tenants with information provided or approved by the department of health about the health hazards associated with exposure to indoor mold. Information may be provided in written format individually to each tenant, or may be posted in a visible, public location at the dwelling unit property. The information must detail how tenants can control mold growth in their dwelling units to minimize the health risks associated with indoor mold. Landlords may obtain the information from the department's web site or, if requested by the landlord, the department must mail the information to the landlord in a printed format….The information must be provided by the landlord to new tenants at the time the lease or rental agreement is signed.[270]

In Georgia, landlords must "notify the prospective tenant in writing of the property's propensity of flooding if flooding has damaged any portion of the living space covered by the lease…at least three times during the five-year period immediately preceding the date of the lease."[271] Virginia's landlord-tenant law, discussed below, requires that landlords disclose "whether there is any visible evidence of mold in areas readily accessible within the interior of the dwelling unit" as part of the mandatory written move-in inspection report.[272]

[270] Rev. Code Wa. § 59.18.060
[271] Ga. Code § 44-7-20.
[272] Va. Stat. § 55-248.11:2. If the report indicates there is mold, the tenant may choose to terminate the tenancy or to take possession; in the latter case, the landlord must remediate the mold. If the report indicates there is no visible mold and the tenant does not object in writing within five days, the law creates a rebuttable presumption that no mold existed at the time of the move-in inspection.

Addressing Dampness and Mold in the Real Estate Transaction

The purchase and sale of a home is a key opportunity for addressing potential health and safety problems, since the parties are already negotiating and financing various aspects of the transaction that may involve repairs and improvements to the property. Laws or regulations mandating property condition disclosures during the residential real estate transaction can help encourage correction of chronic moisture problems that may eventually lead to dampness and mold contamination. This may be especially important for conditions or issues that have occurred in the past but may not be readily apparent during the transaction.

A majority of states have laws or regulations mandating property condition disclosures when a home is sold. The Environmental Law Institute reviewed those policies and found that nearly all require disclosure of one or more of the following types of conditions relating to mold, moisture, or dampness:

- *Mold*: Several states require disclosure of the presence of mold, and some require disclosure of any mold inspections or mold remediation of the property.
- *Basement Dampness:* Nearly half of all state disclosure laws require disclosure of dampness or water intrusion involving the basement.
- *Water or Moisture Damage*: Several states require disclosure of any damage that has occurred on the property as a result of water, moisture, or flooding problems.
- *Other Defects*: A majority of states with disclosure laws require disclosure of defects in a building's plumbing, sump pump, grading/drainage, and/or roof, which can contribute to the later development of dampness and mold problems.

States can augment these disclosure provisions by requiring sellers to provide pamphlets or other written materials that inform prospective buyers about the health effects of exposure to dampness and mold and about resources for obtaining additional information.

Duty to Address Mold/Dampness: Virginia. Virginia's Residential Landlord-Tenant Act (VRLTA) includes several provisions that address mold and dampness explicitly, including a duty to maintain and repair the premises and a requirement for tenant relocation in the event of mold contamination. The requirements apply to most rental properties, with certain exemptions.[273] Key provisions include:

- Duty to Maintain. Under the VRLTA, landlords must "[m]aintain the premises in such a condition as to prevent the accumulation of moisture and the growth of mold…." The law also directs tenants to use reasonable efforts to maintain the dwelling so as to prevent moisture and mold and to "promptly notify the landlord of any moisture accumulation that occurs or of any visible evidence of mold discovered by the tenant."[274]

[273] For example, single-family rental homes are exempt unless the owner owns multiple single-family rental homes. Va. Stat. § 55-248.5. Rental properties exempted from the VRLTA are governed by separate provisions in state law, which include certain mold/dampness requirements. *See* Va. Stat. § 55-225.3--.9.
[274] Va. Stat. §§ 55-248.13, 55-248.16.

- Duty to Repair. The Act's mold provisions require landlords to "promptly respond to any notices from a tenant." The landlord must "promptly remediate the mold conditions…and reinspect the dwelling unit to confirm that there is no longer visible evidence of mold."[275]

- Repair Standards. The VRLTA is notable for including a remediation standard in its landlord-tenant law. The VRLTA requires that landlords remediate mold conditions "in the portion of the dwelling unit or premises affected by mold, or any personal property of the tenant affected by mold…consistent with guidance documents published by the [U.S. EPA], the United States Department of Housing and Urban Development, the American Conference of Governmental Industrial Hygienists (the Bioaerosols Manual), Standard Reference Guides of the Institute of Inspection, Cleaning and Restoration for Water Damage Restoration and Professional Mold Remediation, or any protocol for mold remediation prepared by an industrial hygienist consistent with said guidance documents." The landlord is responsible for the costs of remediation unless the mold contamination is the result of the tenant's failure to comply with the tenant's duty to maintain. [276]

- Tenant Relocation. Virginia's law is also unusual in addressing tenant relocation in the context of mold and dampness problems. The law authorizes a landlord to relocate a tenant for up to 30 days during mold remediation where a mold condition "materially affects the health and safety" of occupants. Relocation must be provided at the landlord's cost, to a comparable dwelling unit or hotel room.[277]

Summary

Preventing and remedying mold and dampness problems in rental housing pose considerable challenges for landlords, tenants, and government housing and health agencies. States can build on the policy approaches discussed in this chapter to help create a sound framework for addressing these problems now and in a changing climate. Toward this end, policy makers should focus on two key areas: strengthening property maintenance standards and ensuring effective implementation of those standards.

Strengthening Standards. Many state and local **housing codes** already have provisions that can be used to address dampness and mold conditions. Nevertheless, strengthening and clarifying the language used in housing codes can encourage better housing maintenance practices and facilitate more effective enforcement by housing agencies. For example, while many codes include requirements for maintaining clean and sanitary surfaces and structural elements, code officials may be reluctant to use those general requirements to address mold and dampness. In such cases, policymakers can add explicit code language requiring premises to be maintained free of mold and/or persistent moisture and dampness.

[275] Va. Stat. § 55-248.13.
[276] Va. Stat. §§ 55.248-13, 8.01-226.12.
[277] Va. Stat. § 55-248.18.

One challenge in implementing explicit requirements relating to mold and dampness is ensuring consistency in identifying and enforcing violations. California's prohibition on "visible mold" seeks to address this issue by defining the term to exclude minor mold contamination and mold found on surfaces that accumulate moisture as part of their proper functioning. Massachusetts defines "chronic dampness" as the "regular and/or periodic appearance of moisture, water, mold or fungi."

Even where housing codes include explicit prohibitions on mold contamination and chronic dampness and moisture, another challenge is for property owners and housing code officials to determine when a violation has been corrected – that is, what constitutes proper mold remediation and effective repair of underlying sources of water intrusion or persistent dampness. It is important that landlords understand the correct way to address mold and dampness problems. The District of Columbia addresses this issue by not only requiring mold remediation, but also establishing required mold remediation standards and work practices. State laws requiring licensing or certification of mold professionals can be an important complement to rental housing standards.

A model healthy housing standard developed in 2014 by the National Center for Healthy Housing and the American Public Health Association includes provisions aimed at ensuring that mold and dampness problems are properly remediated.[278] In addition to requirements that structural elements have "no signs of visible mold growth or chronic or persistent excessive dampness or moisture," the National Healthy Housing Standard requires that "the underlying cause of excessive dampness or moisture, or moldy or earthy odor shall be investigated and corrected."[279] Section 6.1.5 of the Standard includes language specifying how this is to be accomplished:

- Building material that is discolored or deteriorated by mold or mildew or causes a moldy or earthy odor shall be cleaned, dried, and repaired.
- Removal and repair of moldy material shall be conducted in accordance with New York City's *Guidelines on Assessment and Remediation of Fungi in Indoor Environments*, the Institute of Inspection, Cleaning and Restoration Certification's *IICRC S520 Standard and Reference Guide for Professional Mold Remediation*, or the EPA guidelines for *Mold Remediation in Schools and Commercial Buildings*.

Another reason it is important to include mold and dampness provisions in housing codes is that most state **landlord-tenant laws** require landlords to comply with the minimum standards of state and local housing codes, thereby establishing private remedies for tenants in the event of violations. Virginia's landlord-tenant law is unique in establishing detailed mold remediation and notification requirements and requiring remediation in accordance with best practice standards referenced in the law.

The recently developed Revised Uniform Residential Landlord and Tenant Act of 2015 (RURLTA) provides another model for incorporating mold provisions directly into a state landlord-tenant law. Commentary

[278] *See* Nat'l. Center for Healthy Housing and Amer. Public Health Assoc., National Healthy Housing Standard (2014), http://www.nchh.org/Policy/NationalHealthyHousingStandard.aspx.
[279] *Id*. at § 6.1. This section of the Standard also includes several "stretch" provisions on moisture control related to building materials and ventilation.

to the RURLTA states, "Because many jurisdictions do not have building, housing, or health codes applicable to rental housing, it is appropriate that this statute incorporate minimum standards of maintenance."[280] Under the RURLTA, landlords have a nonwaivable duty to ensure, among other things, that the premises "have effective *waterproofing and weather protection* of the roof and exterior walls, including windows and doors" and "have reasonable measures in place…to prevent exposure to unsafe levels of radon, lead paint, asbestos, toxic *mold,* and other hazardous substances…."[281]

Implementation. The extent to which minimum standards included in state (and local) housing codes are used to address mold and dampness problems depends largely on the government programs set up to implement the law. Though tenants in most states have legal recourse in the event of violations of minimum standards, they face significant obstacles to using the law to remedy serious conditions, including a lack of legal representation, information about the legal system, and alternative housing options. Alongside development of standards, states and localities should consider allocating resources for and carrying out programs to strengthen enforcement and implementation of those standards.[282]

Enforcement of **housing codes** is typically a local function. States can support local enforcement by providing training for housing code inspectors to facilitate greater effectiveness and consistency in the application of state and local housing codes. Training is important not only where laws explicitly address mold and dampness, but also where they contain more general provisions that can be *applied* to ensure that mold contamination is remedied and the underlying causes fixed. State policymakers should also consider options for providing financial and technical support to local initiatives that focus on dampness and mold in rental housing.

Many tenants face significant obstacles in enforcing laws addressing mold and other substandard conditions

State **landlord-tenant laws**, in addition to including requirements for addressing mold contamination and chronic dampness, might also establish procedural provisions to facilitate private enforcement of habitability requirements. Such provisions could include: requiring landlords to provide information to tenants about past mold and dampness conditions and remediation activities; providing for reimbursement of the cost of mold assessments if tenants demonstrate a violation in court; and establishing the right of tenants to terminate their tenancies.

Many states have developed written materials and/or webpages to provide tenants information on state law and how to use legal remedies, and some have developed written materials specifically

[280] Uniform Law Commission, Revised Uniform Residential Landlord and Tenant Act of 2015 (RURLTA) with Prefatory Comments at 28, http://www.uniformlaws.org/Act.aspx?title=Residential%20Landlord%20and%20Tenant%20Act%202015.
[281] RURLTA § 302(a) (emphasis added).
[282] For information on how several local jurisdictions have implemented their housing codes to address IAQ issues, see Envtl. Law Inst., Improving Indoor Air Quality in Rental Dwellings: A Review of Policies in Five U.S. Localities (2003), http://www.eli.org/research-report/improving-indoor-air-quality-rental-dwellings-review-policies-five-us-localities.

addressing dampness and mold in rental housing.[283] State courts can also help tenants navigate the legal system by establishing specialized housing courts or forms for filing cases. In the District of Columbia, "the Housing Conditions Calendar allows tenants to sue landlords for D.C. Housing Code violations on an expedited basis. Cases on the Housing Condition Calendar will have the first hearing scheduled less than a month after the suit is filed."[284] A court-created form that tenants can use to initiate the case provides a checklist of potential housing violations, including mold/mildew, plumbing leaks, inadequate ventilation, and clogged gutters.[285]

[283] *See, e.g.,* Minnesota Dept. of Health, Mold in Rental Housing, http://www.health.state.mn.us/divs/eh/indoorair/mold/renters.html; Washington State Dept. of Health, Renters, Landlords, and Mold, http://www.doh.wa.gov/YouandYourFamily/HealthyHome/Contaminants/Mold/RentersLandlordsandMold; Attorney General of Texas, Tenant Rights, https://www.texasattorneygeneral.gov/cpd/tenant-rights.

[284] District of Columbia Courts, Housing Conditions Calendar, http://www.dccourts.gov/internet/public/aud_civil/housingconditionscal.jsf.

[285] *See* Superior Court of the District of Columbia, Civil Div.-Civil Actions Branch, Verified Complaint to Enforce Housing Regulations, http://www.dccourts.gov/internet/documents/HCC_HousingCodeComplaint.pdf.

CHAPTER 4

IAQ and Home Energy Efficiency Retrofits

Because residential energy use accounts for about 20 percent of carbon dioxide (CO_2) emissions in the United States, government policies and programs have promoted home energy efficiency as a cost-effective strategy for reducing greenhouse gas emissions while also lowering residents' energy bills.[286] Improving the energy efficiency of buildings is a strategy commonly recommended in state climate planning documents.[287] Following the American Recovery and Reinvestment Act of 2009, billions of dollars in new federal funding was made available for residential energy efficiency improvements, including through the Department of Energy's Weatherization Assistance Program.[288] Between federal programs and a wide range of efforts by states, local jurisdictions, and utilities, a "virtual cornucopia of mandatory and voluntary programs and policies" were established.[289]

As political, institutional, and public support for home energy upgrades continues, it is important that the programs and policies advancing these efforts take IAQ and health effects into account. Energy efficiency upgrades have the potential to affect indoor air quality in both positive and negative ways, but there is broad recognition that it is possible to achieve both energy efficiency and IAQ goals in a home energy retrofit project. The Institute of Medicine's 2011 report on climate change and health, which devoted a chapter to building ventilation, weatherization, and energy use, noted that, "Government and consensus organizations are beginning to recognize the importance of this issue and have established or are establishing voluntary guidelines and codes that account for the links between energy efficiency, indoor environmental quality, ventilation, and occupant health and productivity."[290]

This chapter describes existing state policy strategies for integrating indoor air quality and energy efficiency. The chapter focuses on the federal Weatherization Assistance Program (WAP) for low-income households as a case study in how states can integrate IAQ considerations into home energy efficiency retrofits – not only in implementing that federal program, but also in developing other state energy

[286] *See* National Academy of Sciences – Institute of Medicine, Climate Change, the Indoor Environment, and Health at 210 (2011), http://www.nationalacademies.org/hmd/Reports/2011/Climate-Change-the-Indoor-Environment-and-Health.aspx.
[287] *See, e.g.,* Cal. Natural Resources Agency, Safeguarding California: Implementation Action Plans: Public Health Sector Plan at 156, 162 (2016), http://bit.ly/2fKW85n; Mass. Executive Office of Energy and Environmental Affairs, Massachusetts Clean Energy and Climate Plan for 2020 (2010), http://www.c2es.org/docUploads/states/climate-action-plan/ma_2020-clean-energy-plan_dec2010.pdf.
[288] *See* U.S. Dept. of Energy (DOE), Weatherization Assistance Program: American Recovery and Reinvestment Act of 2009, https://energy.gov/sites/prod/files/2014/01/f7/wx_recovery_fact_sheet.pdf. Some of the many other federal programs and initiatives funded under the Act include the DOE's Residential Energy Efficiency Tax Credit, the U.S. Dept. of Agriculture's Rural Energy for America Program Renewable Energy Systems & Energy Efficiency Improvement Loans and Grants, and the U.S. EPA's Energy Star Energy Efficient Mortgages program.
[289] National Safe and Healthy Housing Coalition, Integrating Energy Efficiency and Healthy Housing at 1 (rev. 2010), http://www.nchh.org/Portals/0/Contents/Coalition_briefing_paper_energy.pdf.
[290] Institute of Medicine, Climate Change, the Indoor Environment, and Health, *supra*, at 5.

efficiency retrofit initiatives. Following a detailed description of the Weatherization Assistance Program and state WAP implementation policies, the chapter highlights strategies for addressing IAQ and health in other state residential energy efficiency programs.[291]

Background

Energy Efficiency Retrofits, Indoor Air Quality, and Occupant Health

Many of the most common energy efficiency improvements for existing homes are weatherization measures, which are intended to improve a home's energy efficiency by sealing or tightening the building envelope. In a typical home, air leakage accounts for 25 to 40 percent of the energy used for heating and cooling; thus tightening the building can significantly reduce the amount of energy required.[292]

Typical building tightening measures for residential buildings include: sealing air leaks around floors, walls, ceilings, windows, doors, and fireplaces (using caulk, weather stripping, and/or spray foam); installing more energy-efficient windows and doors; and sealing air ducts and making sure they are properly connected.[293] Other weatherization measures that help tighten the building envelope include tune-ups or upgrades of heating and cooling systems and replacement of atmospherically-vented combustion equipment with high-efficiency equipment. As a complement to building tightening measures, it is common to add insulation to exterior walls, basements, crawl spaces, and attics to reduce unintended heat exchange.[294]

In addition to saving money on utility bills, weatherizing a home may provide important non-energy benefits for its occupants, in the form of improved indoor air quality, comfort, and health.[295] For instance, tightening a building can reduce the entry of drafts and noise, as well as dust, pollen, and other outdoor air pollutants.[296] In a national survey evaluating the impacts of the federal Weatherization Assistance Program, occupants of weatherized homes reported general health and well-being improvements, fewer asthma symptoms, fewer colds and headaches, and fewer missed days of work.[297]

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[291] For a discussion of state policies addressing IAQ and school energy efficiency upgrades, see Envtl. Law Institute, Addressing Indoor Air Quality in School Energy Efficiency Upgrades: Review of Selected State Policies (Jan. 2016), https://www.eli.org/research-report/addressing-indoor-air-quality-school-energy-efficiency-upgrades-review-selected-state-policies.

[292] *See* U.S. EPA, Air Sealing: Building Envelope Improvements (2005), https://www.energystar.gov/ia/home_improvement/home_sealing/AirSealingFS_2005.pdf; *See also* U.S. DOE, Why Energy Efficiency Upgrades, http://energy.gov/eere/why-energy-efficiency-upgrades.

[293] U.S. DOE, Why Energy Efficiency Upgrades, http://energy.gov/eere/why-energy-efficiency-upgrades; *see also* Institute of Medicine, Climate Change, the Indoor Environment, and Health, *supra*, at 212.

[294] U.S. DOE, Why Energy Efficiency Upgrades, http://energy.gov/eere/why-energy-efficiency-upgrades.
Other energy efficiency improvements for existing homes include installing more efficient hot water heaters, appliances, and lighting.

[295] *See* Lawrence Berkeley National Laboratory (LBNL), Indoor Air Quality Scientific Findings Resource Bank: Building Energy Efficiency, https://www.iaqscience.lbl.gov/cc-building.

[296] U.S. DOE, Building Energy Resource Guide: Air Leakage Guide at 1 (2011), https://www.energycodes.gov/sites/default/files/documents/BECP_Buidling%20Energy%20Code%20Resource%20Guide%20Air%20Leakage%20Guide_Sept2011_v00_lores.pdf.

[297] B. Tonn et al., Weatherization Works – Summary of Findings from the Retrospective Evaluation of the U.S. Department of Energy's Weatherization Assistance Program at xv, 23 (2014), http://weatherization.ornl.gov/Retrospectivepdfs/ORNL_TM-

But energy efficiency retrofits can also have negative consequences for IAQ and health if proper precautions are not taken. For example, retrofit activities themselves may disturb building materials containing hazardous substances such as lead, asbestos, and PCBs, creating new exposure risks for workers and occupants. Air-sealing can alter the internal air pressure of a home, which may lead to insufficient makeup air, back drafting of carbon monoxide and other combustion gases, and the intrusion of radon and other gases from soil.[298]

Perhaps most important from an IAQ perspective, increasing the airtightness of buildings through weatherization measures may decrease rates of outdoor air ventilation.[299] Adequate ventilation and filtration of outside air are key components of good indoor air quality. Many existing homes were designed to rely on air infiltration through holes and cracks in the building envelope as a source of fresh air exchange.[300] Reduced ventilation rates may result in higher concentrations of pollutants generated indoors, including carbon monoxide, radon, chemicals (e.g., formaldehyde), fine particulates, mold and moisture, and tobacco smoke.[301] Lower ventilation rates may also lead to increased concentrations of carbon dioxide indoors, and an emerging body of research suggests that increased indoor concentrations of carbon dioxide itself are associated with adverse impacts on occupants' health and performance.[302]

There is broad recognition that it is possible to achieve both energy efficiency and IAQ goals in a home energy retrofit.

In addition to ensuring that IAQ problems are not created or exacerbated, energy retrofits can serve as a vehicle for implementing measures to enhance indoor air quality. For example, energy efficiency projects can incorporate removal or isolation of existing pollutants (e.g., combustion gases, mold, pests) and installation of carbon monoxide alarms – though "these opportunities may be missed due to lack of information on IAQ and/or funding limitations."[303]

2014_338.pdf; B. Tonn et al., Health and Household-Related Benefits Attributable to the Weatherization Assistance Program at xvi (2014), http://weatherization.ornl.gov/Retrospectivepdfs/ORNL_TM-2014_345.pdf/.

[298] Institute of Medicine, Climate Change, the Indoor Environment, and Health, *supra*, at 224-6; U.S. EPA, Energy, Weatherization, and Indoor Air Quality, https://www.epa.gov/indoor-air-quality-iaq/energy-weatherization-and-indoor-air-quality.

[299] Institute of Medicine, Climate Change, the Indoor Environment, and Health, *supra*, at 6 ("Climate change may make ventilation problems more common or more severe in the future by stimulating the implementation of energy efficiency (weatherization) measures that limit the exchange of indoor air with outdoor air.").

[300] W. Chan et al., Analysis of air leakage measurements of US Homes, *Energy & Buildings* 66 (2013) 616, http://eetd.lbl.gov/sites/all/files/chan_analysis_of_air_leakage.pdf.

[301] U.S. Global Change Research Program (USGCRP), Impacts of Climate Change on Human Health at 79, https://health2016.globalchange.gov/.

[302] *See, e.g.,* U. Satish et al., Is CO_2 an Indoor Pollutant? Direct Effects of Low-to-Moderate CO_2 Concentrations on Human Decision-Making Performance, *Envtl. Health Perspectives,* v. 120, at 1671 (2012), http://ehp.niehs.nih.gov/wp-content/uploads/120/12/ehp.1104789.pdf.

[303] U.S. EPA, Energy, Weatherization, and Indoor Air Quality, https://www.epa.gov/indoor-air-quality-iaq/energy-weatherization-and-indoor-air-quality.

Integrating Energy Efficiency and IAQ in Climate Planning: California

In 2016, the state of California identified healthy, energy efficient buildings as an area "where State leadership is needed to fill current gaps in the implementation of California's adaptation strategy." Toward this end, the state's Public Health Sector Plan recommended that the state:

- "Facilitate greater collaboration between organizations that design and implement energy efficiency programs and those organizations that implement programs to improve health-related housing quality."
- "Explore partnerships that combine funding for energy efficiency, indoor air improvements, and health improvement."
- "Develop funding or evaluative mechanisms to ensure that energy efficiency upgrades are installed and operate as intended and do not adversely affect building ventilation or other indoor environmental quality factors and health consequences."

Source: Calif. Natural Resources Agency, Safeguarding California: Implementation Action Plans: Public Health Sector Plan at 162-3 (2016), http://resources.ca.gov/docs/climate/safeguarding/Public%20Health%20Sector%20Plan.pdf

Best Practices Guidance for Addressing IAQ in Energy Efficiency Retrofits

In recent years, both U.S. EPA and the Department of Energy (DOE) have published best practice documents and other guidance materials for addressing IAQ and health issues in home energy retrofits. EPA's *Healthy Indoor Environment Protocols for Home Energy Upgrades* contains technical guidance for assessing, maintaining, and improving IAQ as part of residential energy retrofits. The protocols are "intended for use by the home energy retrofit industry….They are also intended for voluntary adoption by federal, state, tribal and local weatherization assistance programs, federally funded housing programs, industry standards organizations, private sector home performance contracting organizations and public and environmental health professionals."[304]

The guidance covers 20 priority issues that may relate to typical home retrofits, organized according to specific indoor contaminants, critical building systems, and worker/occupant safety hazards.[305] For each priority issue, the guide includes information on EPA-recommended Assessment Protocols and Minimum Actions to ensure that work does not create new IAQ problems or exacerbate existing

[304] U.S. EPA, Healthy Indoor Environment Protocols for Home Energy Upgrades: Guidance for Achieving Safe and Healthy Indoor Environments During Home Energy Retrofits at i, (2011), https://www.epa.gov/sites/production/files/2014-12/documents/epa_retrofit_protocols.pdf [hereinafter EPA Home Energy Upgrade Protocols].

[305] The priority issues covered in the guide include: asbestos; belowground contaminants (except radon); building products and emissions; CO and other combustion appliance emissions (nitrogen oxides, VOCs and particulates); environmental tobacco smoke; garage air pollutants; lead; moisture (mold and other biologicals); ozone; pests; polychlorinated biphenyls (PCBs); radon; wood smoke and other solid fuel emissions; HVAC equipment; combustion safety; source ventilation; whole-house ventilation; multi-family ventilation; home safety; and jobsite safety. *Id*.

conditions; for many issues, the protocols include Expanded Actions that can be taken to further improve and promote a healthy indoor environment where circumstances and resources permit.[306] Best practices include, but are not limited to:

- Assurance of adequate whole-building ventilation (in accordance with ASHRAE Standard 62.2), including adequate filtration of outdoor ventilation air;[307]
- Local exhaust of kitchen fans, bath fans, and clothes dryers to the outdoors;
- Repair of interior and exterior water leaks and elimination of standing water;
- Measures for preventing condensation in the building enclosure, managing air pressure, and controlling indoor humidity sources;
- Compliance with lead-safe practices in older homes (if necessary);
- Radon testing (and, if necessary, precautionary measures);
- Identification of potential asbestos hazards (and, if necessary, implementation of exposure controls); and
- Installation of carbon monoxide alarms. [308]

The 2011 guide is oriented toward retrofit activities in single-family homes and low-rise residential buildings. In early 2016, EPA released separate guidance, *Energy Savings Plus Health: Indoor Air Quality Guidelines for Multifamily Building Upgrades*, for use during energy efficiency upgrades, renovations, and remodeling in residential buildings with at least five units.[309] It includes assessment protocols and recommended actions for addressing 24 priority issues, including a number of issues that can be different in, or unique to, multifamily buildings. A companion tool, the *Energy Savings Plus Health: Checklist Generator for Multifamily Building Upgrades*, is an interactive Microsoft Excel sheet that can be used to create a custom-tailored checklist to verify that appropriate assessment protocols and recommended actions are implemented during a particular project.[310]

These EPA protocols are incorporated in complementary guidance developed by the Department of Energy. DOE's *Guidelines for Home Energy Professionals* program provides Standard Work Specifications (SWS) for home energy retrofit projects, which include safe work practices, relevant codes, and many of the EPA protocols described above. Reflecting the "whole-house approach" to energy efficiency, the

[306] For example, Minimum Actions to address moisture problems include repairing roof leaks before air sealing or insulating the attic and addressing water pooling near the foundation before insulating basement or crawlspaces, while Expanded Actions in this category include repairing plumbing leaks and retrofitting crawlspaces to be unvented, sealed, insulated, and waterproofed. *Id*. at 9-10.

[307] The EPA Protocols' Minimum Actions for multi-family ventilation call for minimum MERV 6 filters on supply ventilation systems. *Id*. at 23. The Protocols also recommend, as an Expanded Action, to "[c]onsider using filters with a high MERV rating (11 or above) if equipment capacity is sufficient to accommodate the pressure drop. For existing systems, check with the manufacturer to determine whether MERV 11 filters can be installed." *Id*. at 17.

[308] *Id*. at 1-2, 6, 8-10, 12-15, 17-18, 21-23.

[309] U.S. EPA, Energy Savings Plus Health: Indoor Air Quality Guidelines for Multifamily Building Upgrades (2016), https://www.epa.gov/sites/production/files/2016-02/documents/esh_multifamily_building_upgrades_508c_02_09_2016.pdf.

[310] U.S. EPA, Energy Savings Plus Health: Checklist Generator for Multifamily Building Upgrades, https://www.epa.gov/indoor-air-quality-iaq/energy-savings-plus-health-indoor-air-quality-guidelines-multifamily-building. EPA has also developed guidance tailored to school building upgrades. *See* U.S. EPA, Energy Savings Plus Health: Indoor Air Quality Guidelines for School Building Upgrades (2014), https://www.epa.gov/iaq-schools/protecting-iaq-during-school-energy-efficiency-retrofit-projects-energy-savings-plus.

SWS are intended to "describe acceptable outcomes for weatherization or home performance upgrades – effective, durable, and safe improvements" for the specific housing type."[311]

The EPA protocols and DOE's Standard Work Specifications provide a technical framework and best practice resource for the many governments, organizations, businesses, and individuals involved in funding, planning, and implementing home energy retrofits.

The Weatherization Assistance Program: Opportunities for Integrating Indoor Air Quality and Energy Efficiency

One of the largest energy efficiency programs in the U.S., DOE's Weatherization Assistance Program (WAP) has taken notable steps in recent years to integrate weatherization and health goals.[312] This section describes how the program's protocols and guidance address indoor air quality in low-income home weatherization projects and highlights state efforts to advance IAQ goals as they create plans, policies, and procedures to implement the federal program.

Background. First established by Congress in 1976, the Weatherization Assistance Program has funded retrofits of over seven million homes.[313] WAP provides grants to states, territories, and tribes to "increase the energy efficiency of dwellings owned or occupied by low-income persons, reduce their total residential energy expenditures, and improve their health and safety."[314] Appropriated funds are provided to states, the District of Columbia, U.S. territories, and some tribal governments ("grantees"), which then contract with local governments, community action agencies, and non-profit organizations ("sub-grantees") to implement weatherization projects in their service areas.

The program takes a "whole house" approach to energy efficiency that addresses the building envelope, heating and cooling systems, and certain appliances.[315] After a home energy audit, WAP crews and/or contractors implement energy conservation measures identified as cost-effective for that household.[316] In addition to energy saving measures, the program covers the costs of energy-related health and safety

[311] DOE, Guidelines for Home Energy Professionals Standards Work Specifications, https://energy.gov/eere/wipo/guidelines-home-energy-professionals-standard-work-specifications. The SWS address three different building types: single-family homes, multifamily residential building, and manufactured homes.
[312] In addition to the WAP policies described in this chapter, in 2012 DOE launched the *Weatherization Plus Health* initiative in partnership with the National Association for State Community Services Programs (NASCSP). The initiative provides tools and support to facilitate partnerships and coordination between WAP grantees and the Healthy Homes service providers implementing projects to address health hazards in the homes of low-income families. *See* NASCSP, Weatherization Plus Health, http://www.nascsp.org/Healthy-Homes/776/Weatherization-Plus-Health.aspx?iHt=41.
[313] U.S. DOE, Celebrating 40 Years of America's Weatherization Assistance Program, http://energy.gov/eere/articles/celebrating-40-years-america-s-weatherization-assistance-program.
[314] U.S. DOE, About the Weatherization Assistance Program, http://energy.gov/eere/wipo/what-weatherization (citing 42 USC § 6861).
[315] *See generally* DOE, The History and Evolution of America's Weatherization Network (2016), http://energy.gov/eere/articles/history-and-evolution-america-s-weatherization-network.
[316] 42 U.S.C. § 6863 (b)(3).

measures that must be taken to perform weatherization work safely and effectively, or which are necessary as a result of weatherization (e.g., in response to changes made to the building envelope).[317]

As part of the annual application for DOE funding, states prepare a *Health and Safety Plan* (H&S Plan), which serves as a central policy tool for integrating health and safety measures in WAP projects. The H&S Plan reflects the amount of program funding the state intends to allocate to health and safety expenditures in the upcoming year and the specific types of measures that will be implemented. DOE requires states to establish a health and safety spending limit, expressed as a percentage of the average cost per dwelling unit, in their H&S Plan. DOE approves, but does not mandate, the amount of the spending cap; therefore, health and safety expenditures can vary widely by state (and even by year), according to each state's priorities and needs.

A health and safety component was formally incorporated into WAP by federal regulation in 1993, and since then, DOE has issued a series of guidance documents, known as Weatherization Program Notices (WPNs), to clarify federal requirements and recommendations.[318] *WPN 11-6: Health and Safety Guidance*[319] includes a comprehensive Health and Safety Guidance Table addressing ten categories of health and safety hazards related to weatherization: ventilation in compliance with ASHRAE 62.2; mold and moisture; asbestos; lead-based paint; radon; combustion appliance safety and heating systems; replacements; codes and structure; OSHA; and occupant wellness.[320] For each issue, the Guidance Table identifies actions to address the hazard that are "allowable" uses of DOE funds. In some cases, the Guidance Table indicates that a certain action is "required," which means it must be included in states' H&S Plans. (See Text Box.) A few actions are categorically prohibited. For each issue, the Guidance Table also clarifies requirements for testing, client education, and training.

States are responsible for ensuring that their networks of WAP providers are following minimum standards set forth in *WPN 11-6* and other DOE guidance, including *WPN 15-4*, which requires that all measures performed on client homes meet the specifications, objectives, and outcomes outlined in DOE's Standard Work Specifications (SWS) for Home Energy Upgrades. WAP agencies and contractors are also required to comply with Occupational Safety and Health Administration (OSHA) regulations, in addition to any federal, state, or local laws and regulations that apply to a specific activity or pollutant.

WPN 11-6 explains that where health and safety problems exist that cannot be addressed through allowable health and safety measures, it may be necessary to defer weatherization at that home until

[317] 10 C.F.R. 440.18. These costs must be "reasonable," and health and safety measures can only be funded if energy efficiency measures are also installed in the home. 10 C.F.R. 440.16.
[318] Along with the federal enabling statute (42 U.S.C. §§ 6861 et seq.) and regulations (10 C.F.R. Part 440), a series of Weatherization Program Notices issued by DOE establish a framework of federal requirements that guide development of state programs to implement annual WAP grants from the federal government.
[319] In July 2016, DOE's Weatherization and Intergovernmental Program Office issued a memorandum to the WAP network requesting comments on a draft revised Health and Safety WPN, which would streamline guidance and update (if not supersede) previous WPNs, including WPN 11-6. As of the end of 2016, a final version of this draft WPN had not been released as policy. *See* Memorandum from Weatherization & Intergovernmental Program Office to Weatherization Assistance Program Network, WAP Memorandum 017, Health and Safety Draft WPN Request for Comment (July 29, 2016), www.waptac.org.
[320] U.S. DOE, Weatherization Program Notice 11-6, Weatherization Health and Safety Guidance (Jan. 12, 2011), http://waptac.org/data/files/website_docs/government/guidance/2011/wpn%2011-6.pdf [hereinafter WPN 11-6].

the problems are resolved (by the owner, another agency, or using alternative funding).[321] In H&S Plans, states set forth guidelines for determining whether a potential health and safety issue may: be remedied as part of weatherization; be referred to other agencies (e.g., health department); result in "partial weatherization"; or result in deferral.[322]

While federal WAP policies and guidance materials establish parameters within which states must design and implement their programs, states have considerable flexibility to design their H&S Plans, procedures, and other state policies in ways that will maximize the IAQ and health benefits of WAP in their service territories. Following are examples of how some state programs are taking the opportunity to strengthen IAQ considerations in their program policies.

Required Health and Safety Measures in WAP Home Weatherization Projects

Pursuant to Department of Energy guidance, home weatherization projects funded by WAP *must* include the following health and safety measures:

- Evaluation for compliance with ASHRAE 62.2;
- Measures to meet the most current edition of ASHRAE 62.2 to the fullest extent possible (including updating existing fans and blower systems if not adequate) and follow-up testing to ensure compliance;
- Proper venting to the outside for combustion appliances, including gas dryers;
- Removal of pollutants (e.g., formaldehyde, VOCs) that pose a risk to workers;
- Compliance with EPA's Lead; Renovation, Repair and Painting Program (RRP) and training of all weatherization crews working in pre-1978 housing in Lead Safe Weatherization (LSW);
- Visual assessment of mold and moisture conditions (diagnostics such as moisture meters are recommended pre-project and prior to final inspection, though mold testing is not an allowable cost);
- Covering exposed dirt with a vapor barrier, whenever site conditions permit;
- Taking precautions wherever radon may be present "to reduce the likeliness of making radon issues worse";
- Removal of unvented space heaters (except certain secondary heat units) prior to weatherization;
- Following EPA recommendations when working with spray polyurethane foam.

Sources: U.S. Dept. of Energy, Weatherization Program Notice 11-6: Weatherization Health and Safety Guidance (Jan. 12, 2011), http://bit.ly/2htozlP.

[321] The auditor may use judgment in making this determination, and the Guidance Table also specifies certain situations where deferral of a weatherization project is required, including: pollutants pose a risk to workers and removal cannot be performed or is not allowed by the client; the extent and condition of lead-based paint in the house would potentially create further health and safety hazards; and severe mold and moisture issues exist and cannot be addressed as health and safety costs. *Id.*
[322] WPN 11-6, *supra*, at 10.

WAP Budgeting to Maximize IAQ Benefits. When states develop their WAP budgets, they make several important choices about use of program funds for health and safety measures. States can include key budgeting provisions in their annual plans or establish budgeting requirements in their laws and regulations, to maximize IAQ and health benefits for WAP clients in their service territories.

Amount of Health and Safety Allocation. In advance of receiving appropriated funds from DOE each year, states establish their spending caps for health and safety in their H&S Plans. Because federal policies and guidance do not mandate the cap, there is significant variation across states; many states also change the caps from year to year. States can ensure transparency by including the rationale for their spending cap in the annual plan.

DOE guidance recommends that states express the H&S spending cap as a percentage of total average cost per dwelling unit.[323] While some states allocate 10 percent or less of their total program funds to Health and Safety expenditures, other states allocate 20 percent or more. New Mexico, for example, allocated 22 percent to Health and Safety in 2016.[324] In Iowa, where actual health and safety expenditures (including supplemental, non-DOE funds) reached nearly 40 percent in recent years, the allowable per-unit average for the 2016 program year was 25 percent.[325] In Texas, the cap for expenditures in the health and safety category is fixed by regulation at 20 percent.[326] By establishing a minimum H&S percentage through law or regulation, state policymakers can help ensure that health and safety remains a program priority.

States can address IAQ goals in their policies implementing the Weatherization Assistance Program.

States can clarify in the H&S Plan whether the average cost limit for health and safety must be applied to each unit individually, or whether WAP sub-grantees may distribute the funds across dwellings more flexibly. The Maine plan, for example, explains that sub-grantees are allowed to spend up to 11.6 percent of their program funds on health and safety measures, which is equivalent to $800 dollars per unit; however, because sub-grantees need only manage to the $800-dollar average over the life of the grant, WAP providers maintain the "flexibility to shift funds from homes that need little or no hazard abatement or have benefited from other leveraged monies to homes that have no other resources."[327] Other states allow sub-grantees to manage their health and safety funds over the life of the grant, but also establish a firm per-unit maximum in the H&S Plan. Some states' H&S Plans also specify how much may be spent on specific measures.

[323] *See* WPN 11-6, *supra*.
[324] New Mexico H&S Plan 2016-2017 at 3, http://www.housingnm.org/assets/content/CommunityDev/EnergySmart/Health_and_Safety_Plan.pdf.
[325] Iowa H&S Plan 2016 at 1, https://humanrights.iowa.gov/sites/default/files/media/5_Wx_H%26S_Plan_0.pdf.
[326] 10 Tx. Admin. Code 5.528.
[327] Maine Annual Plan 2015 at V.7, http://www.mainehousing.org/docs/default-source/Public-Notices/doe-15-state-plan---combined-version.pdf?sfvrsn=0.

Addressing Cost-Effectiveness Constraints. In general, WAP service providers may only implement weatherization measures that the home energy auditor calculates will be cost-effective for a household.[328] Such a requirement could impede inclusion of certain health and safety measures that do not themselves generate energy savings. However, DOE provides the option to either include H&S expenditures in the overall program operations budget, or create a separate budget category to track those expenditures.[329] When health and safety measures are assigned to a separate budget category, they are not required to be cost-justified by the audit.[330] Moreover, health and safety expenses falling within a separate budget category can be excluded from the overall average per-unit cost calculation.

As with the spending cap, states must indicate in their annual H&S Plans whether they are exercising the option to create a separate budget category for health and safety. Most states do exercise this option, and some provide additional instructions in their H&S plans for how measures should be categorized. Maine's H&S Plan explains, "Health and Safety measures not producing an energy savings factor will be reported on a separate line item on the DOE Weatherization Reporting Form. Any Health and Safety measures that have an energy savings factor do not have to be tracked separately and should be included with the energy conservation measures."[331]

Leveraging Other Funds to Augment WAP Funding. Although federal law limits WAP expenditures to an average cost per dwelling unit of $6,500 (adjusted for inflation), states and their sub-grantees are free to augment WAP funding with other funding sources.[332] In fact, federal WAP regulations require states' annual plans to identify other federal and non-federal resources to be applied to the program, and to describe how federal funds will be used to.[333]

States can use their annual H&S Plans to encourage sub-grantees to leverage other funding where possible, and to identify some of the potential funding sources that sub-grantees should consider. Maine's state plan encourages sub-grantees to consider seeking funding for non-cost effective measures from a wide range of public and private sources listed in the plan.[334] State laws can also be a mechanism

[328] U.S. DOE, WPN 13-5, Revised Energy Audit Procedures (2013), at 3 ("Except for the cost of materials needed to eliminate health and safety hazards existing before or because of the installation of weatherization materials, all weatherization measures must be "cost effective" as defined by DOE. 'Cost effective' means that each measure and package of measures installed in a dwelling unit must have a savings-to-investment ratio (SIR) which meets or exceeds 1.0."), http://www.waptac.org/data/files/Website_docs/Government/Guidance/2013/WPN-13-5-Revised-Energy-Audit-Procedures-Final.pdf.

[329] *See* WPN-11, *supra*.

[330] WPN 11-6, *supra*, at 2 ("Grantees should carefully consider the approach…taken when they draft…health and safety procedures. While ease of accounting is an important consideration, Grantees should keep in mind that activities assigned to the health and safety budget category do not have to be cost justified by the energy audit. The same items assigned to incidental repair, weatherization materials, or installation cost categories must be cost-justified.").

[331] Maine Annual Plan, *supra*, at V.7.

[332] 42 U.S.C. §6865. For program year 2016, the average expenditure limit was $7,105. *See* U.S. DOE, WPN 16-1, Program Year 2016 Weatherization Grant Guidance at 4 (Dec. 31, 2015), http://www.waptac.org/data/files/Website_docs/Government/Guidance/2016/WPN-16-1.pdf.

[333] 10 C.F.R. 440.14.

[334] The state plan encourages consideration of Maine Housing's Lead Hazard Control Program and Home Rehabilitation Program; the Central Heating Improvement Program; Community Development Block Grants; the USDA Rural Economic Development program; HUD programs; city or town assistance; local church and community groups; the Building Materials Bank; Habitat for Humanity; donations from local businesses; and landlords. Maine Annual Plan, *supra*, at V.7.

for facilitating the use of leveraged funds to address health and safety in weatherization activities. In Vermont, state law requires the State Office of Economic Opportunity to "supplement, or supplant, any federal program with a State Home Weatherization Assistance Program" to "provide an enhanced weatherization assistance amount exceeding the federal per unit limit allowing amounts up to an average of $8,000.00 per unit allocated on a cost-effective basis." The law further directs the agency to develop the state program in a way that provides "flexibility to accommodate special circumstances in which greater energy savings can be realized *or health and safety problems may be alleviated*."[335]

Washington State recently invested several million dollars in activities combining weatherization and health. As part of the legislature's weatherization appropriations for the 2015-2017 biennium, $4.1 million was reserved for a new Weatherization Plus Health initiative, $2.2 million was set aside for several projects to "test health partnerships to reduce asthma risks and save energy," and $2 million was dedicated to "basic measures to improve home health such as green cleaning kits, mold and moisture reduction, and dust mite covers."[336] The legislature also revised its home weatherization law to authorize grantees to propose utilizing program awards and matching funds to make healthy housing improvements to homes undergoing weatherization, noting that "there is emerging scientific evidence linking residents' health outcomes such as asthma, lead poisoning, and unintentional injuries to substandard housing."[337]

Washington State recently invested significant funding for activities that combine weatherization and health.

Prioritizing Health and Safety in WAP Eligibility Determinations. States make decisions in their weatherization policies, procedures, and plans about how eligible homes will be prioritized, given annual funding caps and other administrative limitations. Federal policy requires programs to give priority to elderly and disabled persons, families with children, and households with high energy use and/or a high energy burden.[338] There also may be opportunities for states to incorporate health-based prioritization criteria. For example, Montana's weatherization assistance regulations provide that a home may be given a higher priority than is dictated by its energy usage if "there exists a weatherization related imminent threat to the health or safety of an eligible household."[339] Massachusetts' 2016 WAP plan, which establishes mandatory statewide prioritization criteria, also authorizes sub-grantees to set aside up to 25% of their annual production for weatherization of "hardship" households – defined to include those with "a condition that endangers the health and safety of the eligible low income household" – outside the normal ranking system.[340]

[335] Vt. Stat. 33 § 2502 (emphasis added).

[336] *See* Wa. Dep't of Commerce, Weatherization Plus Health, http://www.commerce.wa.gov/growing-the-economy/energy/weatherization-and-energy-efficiency/matchmaker/weatherization-plus-health-wxh/.

[337] Rev. Code Wa. §§ 70.164.010, 040. According to the law, "[I]t is the intent of the legislature that state funds be dedicated to weatherization and energy efficiency activities *as well as the moderate to significant repair and rehabilitation of residential structures that are required as a necessary antecedent to those activities."* Rev. Code Wa. § 70.164.010 (emphasis added).

[338] 10 C.F.R. 440.16.

[339] Mt. Admin. R. 37.71.601.

[340] Mass. Office of Housing and Economic Development, U.S. Department of Energy Weatherization Assistance Program (WAP) State Plan/Master File Worksheet at 8 (2016), http://www.mass.gov/hed/docs/dhcd/cd/wap/wapmasterfile.pdf.

Designating Eligible WAP Health and Safety Measures. While some of the health and safety items listed in *WPN 11-6* are required or categorically prohibited, many are listed in the federal guidance as "allowable." *WPN 11-6* explains that for each allowable item, states must determine whether to allow the measure in their service territory, indicating their decisions in the state H&S Plan each year. Some of the allowable health and safety measures that may relate to IAQ considerations are:

- Testing for asbestos, for lead hazards, and for radon in high radon potential areas;
- Correction of venting for combustion appliances, if testing indicates problem;
- Removal of pollutants (e.g., formaldehyde, VOCs);
- Maintenance, repair, and replacement of primary indoor heating units, if occupant health/safety is a concern;
- Limited water damage repairs that can be addressed by weatherization workers and correction of moisture- and mold-creating conditions, when necessary to weatherize the home and ensure the long-term stability and durability of the measures; and
- Testing of carbon monoxide levels and installation of carbon monoxide alarms.

In general, state annual plans indicate which allowable health and safety measures may be addressed with program funding. Many states include most of the allowable measures, though there is some variation, particularly in issue areas such as asbestos testing/encapsulation and radon testing.

Addressing Individual IAQ Pollutants in WAP Projects. Unintended adverse impacts of weatherization activities include disturbing existing pollutants, introducing new pollutants, and diminishing air quality as a result of changes to the building envelope and systems. Following are examples of how states have used their WAP plans, manuals, and policies to incorporate best practices for addressing several specific IAQ issues that may arise in home weatherization projects: lead-based paint; asbestos; polychlorinated biphenyls (PCBs); radon; moisture and mold; ventilation; and combustion safety.

Asbestos. Weatherization projects have the potential to disturb asbestos fibers that may be present in insulation, siding, ceilings, piping, and other building components, creating a risk of exposure. Weatherization projects in multifamily housing with five or more units may be subject to EPA's National Emission Standard for Hazardous Air Pollutants (NESHAP) regulation for asbestos, if the amount of asbestos-containing material to be disturbed is at or above the federal regulatory threshold.[341] The asbestos NESHAP includes inspection, notice, and work practice requirements that apply during demolition and renovation activities in covered buildings.[342]

According to *WPN 11-6*, there are two asbestos actions that state H&S Plans *must* include for all projects: assess whether vermiculite insulation is present, and inspect the exterior wall surface for asbestos siding prior to cutting or drilling to install or replace insulation. States determine in their H&S Plans what happens after asbestos has been identified in a dwelling unit, including whether and to what extent weatherization work can proceed at the unit. At least a few states have determined that

[341] The threshold is 160 linear feet, 260 square feet, or 35 cubic feet. 40 C.F.R. 61.145(a).
[342] *See generally* U.S. EPA, Asbestos NESHAP, https://www.epa.gov/asbestos/asbestos-neshap.

weatherization work must be deferred entirely if there is any asbestos present in the home. Another approach is to prohibit the implementation of any weatherization measures that would disturb the area where asbestos is located (e.g., attic, siding), but allow "partial weatherization" to proceed in other areas of the home.

Most states have specified that certain "allowable" asbestos remediation or removal activities may be implemented as part of energy-saving weatherization measures. *WPN 11-6* and the Standard Work Specifications include several basic recommendations for how these measures should be implemented to help prevent adverse exposures. States can provide additional protection for occupants and workers by affirming, specifying, or expanding on these federal recommendations to formalize best practices for asbestos safety in their H&S Plans.[343] Some states' H&S Plans require all asbestos-related work to be performed by a qualified asbestos control professional, including removal of asbestos siding.[344] Other states have set limits on the amount of Asbestos Containing Materials (ACM) that may be addressed by WAP crews, beyond which an asbestos professional must be hired to perform the work.[345] The H&S Plan can specify the type of training or professional credential required to perform encapsulation or removal work on small surfaces.[346]

Lead. Lead-based paint is an important consideration during weatherization projects in homes built before 1978.[347] Weatherization program funds may not be used for lead abatement or lead paint stabilization; however, if installing energy saving measures will disturb painted surfaces in a pre-1978 home, health and safety funds can be used to minimize potential lead hazards.

Lead-based paint is regulated at the federal level, and some of the requirements apply to home weatherization projects. EPA's Renovation, Repair and Painting Rule applies to anyone paid to perform renovation, repair, and painting projects that will disturb at least six square feet of interior paint in pre-1978 homes (unless the paint has been tested by an EPA-certified professional and found to be lead-

[343] For example, Oregon's Health & Safety Plan explicitly prohibits blower door testing, or at least negatively pressurized blower door testing, in homes where vermiculite attic insulation or other friable asbestos is present, to avoid drawing asbestos fibers into the living space. Oregon H&S Plan 2015-2016 at 83, https://www.oregon.gov/ohcs/CRD/SOS/docs/USDOE_Oregon_State_Plan_2015-2016_FINAL.pdf. The Texas H&S Plan requires lead-safe work (LSW) practices where asbestos siding exists and specifies practices that must be used if asbestos siding is temporarily removed. Texas H&S Plan 2015-2016 at 8, https://www.tdhca.state.tx.us/board/docs/books/150312-Item1d-Draft-2015-DOE-WAP-State-Plan-150309.pdf.

[344] *See, e.g.*, Delaware H&S Plan 2012-2013 at 5-7, http://www.waptac.org/data/files/website_docs/health_and_safety/delaware-wap-health-and-safety-plan-9-5-13.pdf.

[345] In Utah, for example, less than 3 ft^2 or 3 linear feet of asbestos is not regulated by the Utah Department of Environmental Quality (DEQ), and ACM below that threshold may be removed to facilitate HVAC system installation. Between that threshold and the NESHAP threshold, a weatherization agency can remove asbestos to facilitate HVAC system installation only if agency staff have obtained specified state asbestos certifications and have obtained specified insurance. Utah Weatherization Assistance Program Guidelines at E3 (2015), https://jobs.utah.gov/housing/wap/documents/Utah_Weatherization_Guidelines_6-1-2015.pdf.

[346] Delaware's H&S Plan requires any asbestos work, including removal and reinstallation of asbestos siding, be completed by a licensed asbestos abatement contractor (after competitive bidding). Delaware H&S Plan 2012-2013, *supra*, at 5-7.

[347] In 1978, the U.S. Consumer Product Safety Commission banned the sale of lead-based paint, with certain exceptions. *See* 16 CFR Part 1303.

free).[348] The RRP rule requires certification and training for those performing renovations, provision of an EPA pamphlet to owners/occupants, and compliance with specific work practice standards.[349] The RRP rule specifically applies to weatherization, among other types of renovation.[350]

DOE guidance requires all weatherization crews working on pre-1978 homes to be accompanied by an EPA Certified Renovator, and all crew members must be trained on Lead-Safe Weatherization work practices (LSW) established in *WPN 02-6* and refined through subsequent DOE guidance.[351] Unlike the RRP rule, LSW does not exclude weatherization work that disturbs less than six square feet of painted surface.[352] Instead, LSW includes two different sets of standards: "Level 1 Containment" standards apply if up to six square feet of interior paint will be disturbed, while more stringent "Level 2 Containment" standards apply to areas six square feet or larger. Like the RRP rule, LSW does not affirmatively require lead testing, but its requirements apply by default unless paint is tested and found to be lead-free.

All WAP programs must comply with RRP and LSW protocols in pre-1978 homes. Some states have additional provisions in their H&S Plans to clarify or strengthen these requirements, such as: requiring weatherization crews and contractors to assess all pre-1978 homes *prior* to conducting an audit, to ensure that blower door and/or duct leakage testing is not performed in homes with flaking lead paint or noticeable amounts of potentially lead-contaminated dust;[353] including a comprehensive list of weatherization activities that require lead-safe practices, as a minimum guideline for weatherization agencies and contractors;[354] and identifying potential funding sources for lead abatement activities that may be necessary or advisable, but are not covered by WAP.[355]

*PCBs***.** Polychlorinated biphenyls (PCBs) were used in certain building materials, including caulk, from the 1950s to the late 1970s. Building occupants may be exposed through inhalation of PCBs that have off-gassed from building materials, through ingestion of PCB-containing dust and residues, and

[348] The RRP Rule is codified in the Code of Federal Regulations at 40 C.F.R. 745, Part E. Window replacement work is subject to RRP requirements, regardless of square footage to be disturbed. *See* 40 C.F.R. 745.83. *See generally* U.S. EPA, Lead Renovation, Repair, and Repainting Program Rules, https://www.epa.gov/lead/lead-renovation-repair-and-painting-program-rules.
[349] *See* 40 C.F.R. 745.84, 745.90, 745.85. Federal law allows states, tribes, and territories to request EPA approval to administer and enforce the federal lead-based paint requirements; 15 states had received federal approval to administer their own RRP programs as of 2014. *See* U.S. EPA, Renovation, Repair and Painting Program: Contractors, http://www2.epa.gov/lead/renovation-repair-and-painting-program-contractors.
[350] *See* 40 C.F.R. 745.83.
[351] *See* U.S. DOE, WPN 11-1, Program Year 2011 Weatherization Grant Guidance at 23-24 (2010), http://www.waptac.org/data/files/website_docs/government/guidance/2011/wpn11-1%20final%20grant%20guidance.pdf.
[352] *See* U.S. DOE, WPN 02-6, Weatherization Activities and Federal Lead-Based Paint Regulations (July 12, 2002), http://www.waptac.org/data/files/technical_tools/wpn02-6.pdf. WPN 02-6 required LSW when the amount of disturbed lead-based surface exceeds two square feet per room or 10% of a small component (e.g., window), of if the amount of lead dust to be generated would exceed OSHA emission limits for airborne lead. Current guidance on the WAPTAC website explains that because "OSHA does not recognize 'de minimus' levels, and since there can be confusion on the taking and calculation of measurements, which could be an issue in a lawsuit situation, it is recommended that agencies follow LSW practices any time paint and dust are disturbed in pre-1978 homes." WAPTAC, FAQs – Lead Safe Weatherization, http://www.waptac.org/Additional-Pages/FAQ-Lead-Safe-Weatherization.aspx.
[353] *See, e.g.*, Texas H&S Plan, *supra*, at 32.
[354] *See, e.g.,* Texas H&S Plan, *supra*, at 33; Colorado H&S Plan 2013-2014 at 30, http://www.waptac.org/Best-Practices.aspx.
[355] *See, e.g.*, Oregon H&S Plan, *supra*, at 118.

through touching PCB-contaminated materials.[356] EPA regulations under the Toxic Substances Control Act do not include affirmative requirements to test for PCBs in existing building materials, though the regulations prohibit use (including continued use) of building materials containing at least 50 ppm PCBs and establish requirements for disposal of such materials.[357]

In July 2015, EPA released updated guidance documents on PCBs in schools and other buildings. The guidance explains federal legal requirements and provides recommendations and best practices for addressing PCBs in building materials, including caulk and fluorescent light ballasts. The agency has developed suggested work practices for building owners and contractors conducting renovation and repair projects in older buildings, including: "employing protective measures during a renovation; leaving the work area clean and safe for building occupants after completing the job; and properly disposing of waste materials."[358] In EPA's *Indoor Air Quality Guidelines for Multifamily Building Upgrades*, PCBs are identified as a priority issue. The guide recommends that prior to renovation work, contractors should assess whether caulk will be disturbed, considering the age of the building; if "PCBs are potentially present in caulk and the caulk will be disturbed during the building upgrades (e.g., window or door replacement, improved weatherization sealing)," renovation contractors should "take steps to minimize exposure."[359]

PCBs are not among the specific contaminants addressed by *WPN 11-6*, and most existing state H&S Plans and policies are silent on PCBs in caulk and other building materials. However, the federal guidance does not prohibit or restrict use of DOE funds to address PCBs in caulk. In addressing "formaldehyde, VOCs, and other air pollutants," *WPN 11-6* provides that removal of air pollutants is allowed, and is indeed required if the pollutants pose a risk to workers.

Dampness and Mold. The key element in preventing or addressing an indoor dampness or mold contamination problem is correcting the underlying source of moisture. Defects involving the building envelope, such as leaks and condensation, are common sources of moisture problems. *WPN 11-6* requires a visual assessment of moisture problems prior to weatherization and recommends additional diagnostic tools, such as moisture meters. Mold testing, which public health officials generally do not consider necessary or useful in order to undertake mold remediation, may not be performed with weatherization funds. State H&S plans can affirm and clarify the requirement that all dwelling units be inspected for moisture problems prior to weatherization activities and can specify methods for detecting mold and moisture issues. Several states, including Texas, set forth a detailed Mold and Moisture

[356] U.S. EPA, PCBs in Building Materials – Questions and Answers at 4 (2015), https://www.epa.gov/pcbs/questions-and-answers-about-polychlorinated-biphenyls-pcbs-building-materials. *See also* ATSDR, ToxFAQsTM for Polychlorinated Biphenyls (PCBs) (2014), http://www.atsdr.cdc.gov/toxfaqs/tf.asp?id=140&tid=26.
[357] See 40 C.F.R. 761.20, 761.50 et seq., 761.202 et seq. Materials containing PCB at concentrations below 50 ppm are not regulated by EPA, and more stringent requirements are triggered under the regulations when PCB concentrations exceed 500 ppm. *See* Disposal of Polychlorinated Biphenyls (PCBs), 63 Fed. Reg. 35384, 35387 (Jun. 29, 1998).
[358] U.S. EPA, Practical Actions for Reducing Exposure to PCBs in Schools and Other Buildings: Guidance for school administrators and other building owners and managers (2015), https://www.epa.gov/sites/production/files/2016-03/documents/practical_actions_for_reducing_exposure_to_pcbs_in_schools_and_other_buildings.pdf.
[359] U.S. EPA, Energy Savings Plus Health: Indoor Air Quality Guidelines for Multifamily Building Upgrades, *supra*, at 24.

Checklist in their Plans, which must be followed by all weatherization crews and contractors when conducting the mandatory moisture assessment.[360]

Mold abatement may not be performed with DOE weatherization funds. However, *WPN 11-6* provides that "limited water damage repairs" can be addressed by weatherization workers, and that "correction of moisture and mold creating conditions are allowed when necessary in order to weatherize the home and ensure the long-term stability and durability of the weatherization measures." States can encourage weatherization crews and contractors to address a wider range of moisture issues by defining "limited" repairs broadly in their H&S Plans. Some states establish a maximum area of existing mold and moisture issues that can be addressed by weatherization workers (and beyond which weatherization must be deferred). For example, Ohio uses a 10-square-foot limit, while Arizona authorizes corrective action up to 16 square feet.[361] Texas regulations establish a detailed procedure for when limited repairs should be used to address "mold-like substances," authorizing weatherization projects to proceed without deferral – and use WAP funds to correct the condition – as long as the mold-like substance covers less than 25 contiguous square feet.[362]

Combustion Safety and Carbon Monoxide Abatement. If the vent system for an appliance is not properly installed and maintained, combustion byproducts such as carbon monoxide (CO), nitrogen dioxide, particulate, and water vapor can leak into the building envelope. If vents become blocked, or if there is insufficient makeup air to replace the air used for combustion, exhaust may be forced back into the living space. Combustion byproducts can pose serious health risks when they accumulate indoors. For example, exposure to carbon monoxide can affect memory and cognition, and at very high levels can cause loss of consciousness and death. Nitrogen dioxide and particulates have adverse impacts on respiratory health over time.[363]

Before weatherization work may begin, *WPN 11-6* requires auditors to inspect vent systems and perform combustion safety testing, including ambient CO monitoring.[364] If inspections or testing reveal a problem, limited corrective measures may be implemented with H&S funds, including: correction of venting; repair and cleaning of combustion appliances; replacement of red-tagged heating equipment; and replacement of water heaters. *WPN 11-6* also allows WAP providers to install CO alarms in homes with combustion appliances.

[360] Texas H&S Plan 2015-2016 at 36, https://www.tdhca.state.tx.us/board/docs/books/150312-Item1d-Draft-2015-DOE-WAP-State-Plan-150309.pdf.
[361] Arizona H&S Plan 2016 at 14, https://housing.az.gov/weatherization-health-and-safety-plan; Ohio H&S Plan 2016 at 15, https://development.ohio.gov/files/is/PY2016%20HWAP%20State%20Plan%20Composite%20File.pdf.
[362] 10 Tx. Admin. Code 5.523; Ohio H&S Plan 2016 at 15, https://development.ohio.gov/files/is/PY2016%20HWAP%20State%20Plan%20Composite%20File.pdf; Arizona H&S Plan 2016 at 14, https://housing.az.gov/weatherization-health-and-safety-plan.
[363] *See* U.S. EPA, Sources of Combustion Products: An Introduction to Indoor Air Quality, https://www.epa.gov/indoor-air-quality-iaq/sources-combustion-products-introduction-indoor-air-quality; WAPTAC, Technical Tools: Combustion Appliances and Gases, http://www.waptac.org/Health-and-Safety-Issues/Combustion-Appliances-and-Gases.aspx; CDC, Morbidity and Mortality Weekly Report (Oct. 20, 1995), https://www.cdc.gov/mmwr/preview/mmwrhtml/00039315.htm.
[364] *See* U.S. DOE, Standard Work Specifications, *supra*, at 2.0100.1e; WAPTAC, Combustion Appliances and Gases, http://www.waptac.org/Health-and-Safety-Issues/Combustion-Appliances-and-Gases.aspx.

Most state plans require WAP crews to install CO alarms in homes with combustion appliances where no operable alarm is present, and some go further by including specific installation standards.[365] Many states require that CO alarms be certified by Underwriters' Laboratory (UL); Kentucky's H&S Plan goes further, specifying that CO alarms must be UL listed and "have the capability to accurately detect and display low levels of carbon monoxide to 10 ppm."[366] A few states specify in their H&S Plans the level(s) of CO that require corrective action before weatherization may proceed.[367] States may find additional opportunities to specify best practices for addressing CO in their technical operations manuals. In New York, the H&S Plan and the WAP Policies and Procedures Manual require daily evaluations of CO sources, combustion appliance zone (CAZ) air pressure, and chimney draft.[368]

Apart from policies governing WAP activities, many states have enacted laws that require existing homes to have carbon monoxide alarms. (See Text Box.)

Radon. Radon gas can move from the ground into the air inside a building through cracks and other holes in the foundation or basement walls, and indoor exposure to radon is the second leading cause of lung cancer in the United States.[369] The only way to know the radon level in a particular building is to test the building for radon. EPA has established a radon "action level" of 4.0 picoCuries per liter of air (pCi/L); however, because there is no known safe level of exposure to radon, EPA also recommends that people consider fixing their home when radon levels are between 2.0 pCi/L and 4.0 pCi/L.[370]

EPA's *Healthy Indoor Environment Protocols for Home Energy Upgrades* guidance recommends that radon testing be performed by trained or certified professionals, and that precautionary foundation air sealing strategies should be implemented when pre-work radon levels are 2 pCi/L or higher. These strategies, recommended as "Minimum Actions," include: cover exposed dirt floors in basements and crawlspaces; air seal sumps; install airtight drain fittings in foundation floor drains; and seal/caulk openings or cracks in below-grade walls and floors that contact the ground. The EPA Protocols also

[365] New Hampshire is an example of a state where CO alarms also are required in dwellings with an attached garage. New Hampshire State Plan 2013 at 12, https://www.nh.gov/oep/news-events/2013/documents/wap-health-safety.pdf. Utah is one of several states specifying that CO alarms be installed on all levels and in the immediate vicinity of each sleeping area. *See* Utah Weatherization Assistance Program Guidelines, *supra*, at 130.

[366] Kentucky State Plan 2015 at 22, http://www.kyhousing.org/Development/Single-Family/Documents/DRAFT%20PY%202015%20Master%20File.pdf. The Kentucky plan also includes specific occupant education measures, requiring WAP agencies to provide occupants with verbal and written information on dangers of CO, how to read the CO alarm, how to respond to CO levels above 10 ppm, and how to change the batteries.

[367] In Maine, for example, homes with CO levels above 50 ppm in the flue of combustion appliances cannot be weatherized until the system has been evaluated by a licensed technician; cooking burners and ovens producing greater than 15 ppm must be cleaned or serviced; and homes with ambient CO levels above 9 ppm cannot be weatherized until the source of CO is mitigated. By comparison, the SWS for carbon monoxide require action when ambient levels exceed 35 ppm. Maine Annual Plan, *supra*, at V.7.

[368] New York also incorporates by reference best practices from the Building Performance Institute, with respect to combustion safety testing procedures, depressurization limits, and action levels. NYS Weatherization Assistance Program Policy and Procedure Manual at 151 (2015), http://www.nyshcr.org/publications/weatherizationmanual/wap_manual.pdf.

[369] U.S. EPA, Radon Health Risks, http://www.epa.gov/radon/healthrisks.html. Among non-smokers, indoor radon exposure is the leading cause of lung cancer.

[370] U.S. EPA, Why is Radon the Public Health Risk that it is?, http://epa.gov/radon/aboutus.html; U.S. EPA, Radon Publications and Resources, http://www.epa.gov/radon/pubs/index.html.

recommend educating the client about test results and the radon reduction measures that were followed to ensure that energy upgrade work would not introduce new radon problems.[371]

While DOE guidance does not allow WAP funds to be used for radon mitigation, radon testing is allowed (not required) in areas of the country with high radon potential. *WPN 11-6* includes required and allowed measures to help ensure that weatherization does not create or exacerbate existing radon issues. The guidance requires states to include as an H&S measure that "[w]henever site conditions permit, exposed dirt must be covered with a vapor barrier," and provides that "where radon may be present, precautions should be taken to reduce the likeliness of making radon issues worse."[372] States can specify the types of "precautions" that should be taken in addition to the vapor barrier, including strategies recommended in the EPA Protocols. The Delaware H&S Plan, for example, explains that precautionary measures include sealing sump pump cracks, air sealing between crawl and conditioned space, and air balancing strategies.[373] Additionally, states can recommend or require that WAP providers refer clients with existing radon problems in need of mitigation to other programs. Delaware's H&S Plan states that in addition to giving clients EPA's consumer's guide to radon, clients may also be referred to the Delaware Healthy Homes program.

Ventilation is one of the most significant IAQ considerations during a home energy efficiency upgrade.

Ventilation. In addition to control of individual pollutants, ventilation is one of the most important IAQ considerations when a home is weatherized. As noted earlier, tighter homes may not provide sufficient air exchange to dilute indoor pollutants to acceptable levels, and lower ventilation rates may have negative effects on pressurization and moisture.[374] The minimum ventilation standard for homes weatherized using WAP funds is set forth in *WPN 11-6*: "ASHRAE 62.2 is required to be met to the fullest extent possible, when performing weatherization activity," except that ASHRAE 62.2 need not be implemented "where acceptable air quality already exists as defined by ASHRAE 62.2."[375] The Guidance Table setting forth required and allowable actions also provides that existing fans and blower systems should be updated if they are not adequate.

The core requirements of ASHRAE 62.2 relate to (1) whole-house ventilation rate; and (2) local ventilation of kitchens and bathrooms. As DOE guidance explains, mechanical ventilation typically is

[371] *See* U.S. EPA, Home Energy Upgrade Protocols, *supra*, at 12-13.
[372] WPN 11-6, *supra*, at 8.
[373] Delaware H&S Plan, *supra*, at 13.
[374] *See* Institute of Medicine, Climate Change, the Indoor Environment, and Health, *supra*, at 226; U.S. EPA, Energy, Weatherization, and Indoor Air Quality, https://www.epa.gov/indoor-air-quality-iaq/energy-weatherization-and-indoor-air-quality; U.S. DOE, Energy Saver: Ventilation, http://energy.gov/energysaver/ventilation.
[375] The Guidance Table in WPN 11-6 requires compliance with ASHRAE 62.2-2010 or the latest version of ASHRAE 62.2. ASHRAE 62.2 is updated every three years, though addenda are typically added in between "full" versions. According to WAPTAC, after a new full standard is published, state programs are not required to adopt it until it has been incorporated in the state's H&S Plan, which typically takes a full program year. WAPTAC, ASHRAE 62.2 Facts, http://waptac.org/Additional-Pages/FAQ-ASHRAE-62002E2.aspx

needed to achieve the required rate in a tight home.[376] All states are required to include ASHRAE 62.2 compliance in their H&S Plans. However, ASHRAE 62.2 is the minimum standard, and states may incorporate additional ventilation requirements based on local conditions and priorities.[377] The New Jersey H&S Plan includes an express authorization to this effect: "ASHRAE 62.2 is a minimum standard and additional ventilation may be necessary and is allowed to address higher concentrations of humidity or pollutants."[378]

States may also have opportunities to guide their sub-grantees in selecting the most appropriate *type* of ventilation system for a home. WAP guidance does not specify among the types of systems allowed under ASHRAE 62.2. Most of the mechanical ventilation systems installed by the weatherization program in heating climates are exhaust-only systems, which have a lower cost.[379] However, DOE's Oak Ridge National Laboratory has concluded that "this type of ventilation is generally considered to be inappropriate in hot-humid climates, where the potential for mold growth from pulling moist air through building cavities is high, and balanced or supply-only ventilation is the preferred approach."[380] EPA's *Healthy Indoor Environment Protocols for Home Energy Upgrades* include installation of a "balanced, whole-house ventilation system (e.g., heat recovery ventilator [HRV])" as an Expanded Action to address whole-house ventilation.[381]

States can consider including provisions in their WAP plans, policies, and guidance that facilitate the use of a ventilation system that will best protect IAQ in the weatherized home.[382] The Wisconsin Weatherization Field Guide, for example, provides, "Ventilation systems must be matched to the home. A home may require only simple exhaust fans in bathroom and/or kitchen. Very tight homes may require a balanced central ventilation system."[383] States also have an opportunity to clarify how the exception provided in *WPN 11-6*, for dwellings "where acceptable air quality already exists as defined by ASHRAE 62.2," should be applied. States can include in their H&S Plan factors for assessing whether air quality is acceptable – e.g., location in a radon Zone 1 or Zone 2 area, presence of indoor pets or smokers, suspected mold problem, gas range without operable range hood.[384]

[376] U.S. DOE, Energy Saver: Ventilation, http://energy.gov/energysaver/ventilation.
[377] *See* WAPTAC, ASHRAE 62.2 Facts, http://waptac.org/Additional-Pages/FAQ-ASHRAE-62002E2.aspx.
[378] New Jersey H&S Plan 2012 at 22, http://www.state.nj.us/dca/divisions/dhcr/offices/docs/wap/wap_nj_health_sfty_plan.pdf.
[379] Oak Ridge Nat'l. Laboratory, National Weatherization Assistance Program Impact Evaluation (2014), http://weatherization.ornl.gov/Retrospectivepdfs/ORNL_TM-2014_367.pdf.
[380] *Id.*
[381] U.S. EPA, Home Energy Upgrade Protocols, *supra*, at 22.
[382] A 2010 report prepared for the U.S. EPA noted that "adapting to continuous [climate] change may require new institutional, more 'forward looking' framework, and a willingness to invest in increased envelope protection and greater adaptability of systems (e.g., balanced ventilation systems tend to be more adaptable, but also cost more)." David Mudarri, The Cadmus Group, Public Health Consequences and Cost of Climate Change Impacts on Indoor Environments, https://www.epa.gov/sites/production/files/2014-08/documents/mudarri.pdf.
[383] Wisconsin Weatherization Field Guide 5-19 (2016), http://homeenergyplus.wi.gov/docview.asp?docid=27554. *See also*, Saturn Resource Mgmt., Northeast Weatherization Field Guide ("The best home-ventilation strategy for very airtight [dwellings] is balanced ventilation using a ventilator powered by one or two fans….The less expensive mixing-box type ventilator (no heat recovery) is the best choice to complement low-income weatherization."), https://www.mainehousing.org/docs/default-source/energy/energy-ne-wxstds.pdf?sfvrsn=2.
[384] *See* WAPTAC, ASHRAE 62.2 Facts, (noting also that demonstrating acceptable IAQ involves "an objective assessment that holds up to questioning and must be approved as part of the State Plan review process"), http://waptac.org/Additional-Pages/FAQ-ASHRAE-62002E2.aspx.

State Requirements for Carbon Monoxide Alarms in Homes

Indoor carbon monoxide exposure is an important health and safety issue for home energy retrofits, and state energy efficiency programs can help prevent CO poisoning by checking that fuel-burning appliances are operating properly. Because symptoms of acute CO exposure mimic the flu and may culminate in loss of consciousness, energy efficiency programs may also include installation of a CO alarm to help ensure occupants are alerted to a problem in time to take action. Another important cause of CO poisoning is the improper use of portable generators inside or close to homes – e.g., during power outages in the aftermath of severe storms.

The past several years have seen a significant increase in the number of state laws and regulations requiring CO alarms in homes.

State Fire Codes. In many states, CO alarm requirements can be found in the statewide fire code. A few states have authored their own fire codes to include CO alarm requirements. A commonly adopted model fire code, the International Fire Code (IFC), requires CO alarms in existing "residential buildings" (Group R), starting with the 2012 edition. Nearly half of all states have adopted the 2012 or 2015 edition of the IFC, including the requirement for CO alarms in existing residential buildings. The IFC does not apply to one- and two-family detached dwellings; however, a small number of states have amended the model language to extend the CO alarm requirement to existing one- and two-family homes as well.

Some states base their fire codes on model standards issued by the National Fire Protection Association (NFPA). While *NFPA 1: Fire Code* and *NFPA 101: Life Safety Code* require CO alarms in new dwellings only, a few states have amended the provisions to require alarms in certain existing buildings. *NFPA 720: Standard for the Installation of Carbon Monoxide Detection and Warning Equipment* sets forth a standard for *how* to install, operate, and maintain CO alarms, including where alarms should be located and how often devices should be tested and inspected. The IFC and many of the other state laws and regulations requiring CO alarms specify that alarms must be installed and maintained in accordance with NFPA 720.

Other Areas of State Law. States have also adopted CO alarm requirements in other areas of law. For example, a small number of states have amended their landlord-tenant or public health laws to require CO alarms in covered rental dwellings. Several states have incorporated CO alarm requirements into their property laws, where the requirement is triggered upon change of occupancy of a home – e.g., by sale and/or lease transaction. Many states also require CO alarms to be installed in dwellings used for special purposes (e.g., child care, foster care), typically including the requirement in the licensing rules for those home care facilities.

Sources: ICC, International Fire Code 2015, http://codes.iccsafe.org/app/book/toc/2015/I-Codes/2015_IFC_HTML/index.html;
NFPA, NFPA 1: Fire Code (2015 ed.), http://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards?mode=code&code=1;
NFPA, NFPA 101: Life Safety Code (2015 ed.), http://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards?mode=code&code=101;
NFPA, NFPA 720: Standard for the Installation of Carbon Monoxide (CO) Detection and Warning Equipment (2015 ed.), http://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards?mode=code&code=720;
CDC, Carbon Monoxide Poisoning: Frequently Asked Questions, http://www.cdc.gov/co/faqs.htm.

Other Energy Efficiency Programs and Policies

In addition to the Weatherization Assistance Program, a wide variety of other funding programs and financing mechanisms help homeowners overcome financial barriers to implementing energy upgrades in existing homes. At the federal level, examples include residential energy efficiency tax credits and energy-efficient mortgage programs.[385] Additionally, a 2010 report noted that there are "over 600 government and utility energy audit, rebate, loan, and grant programs" at the state and local levels.[386] The laws and regulations governing these funding programs do not typically address the consideration of IAQ issues directly; however, states can build on the WAP laws, regulations, plans, and guidance discussed above in establishing policies to incorporate IAQ measures. Following are examples of policy provisions that can help facilitate the integration of IAQ goals in home energy upgrades that are funded in whole or part by a state, local government, or utility.

Regulatory Requirements for Specific IAQ Pollutants. Energy efficiency retrofit projects, including weatherization activities, must be carried out in accordance with applicable federal and state laws and regulations governing specific pollutants. As discussed above, a wide range of indoor pollutants may be affected by energy retrofit activities, including asbestos, lead paint, radon, and carbon monoxide. States can adopt laws and regulations of general applicability to address these and other indoor exposures in homes. They can also develop policy guidance on these issues for individual energy efficiency funding programs. While it is beyond the scope of this chapter to discuss state policies on all of these potential IAQ exposures, the text box below describes one policy strategy that has been widely adopted to reduce exposure to carbon monoxide in homes – an issue that is important not only in connection with energy efficiency retrofits, but also in relation to the use of portable generators following severe storms.

Designating IAQ Measures as Eligible Activities for Energy Funding Programs. By designing funding and financing programs to allow some portion of project funds to be used for health and safety measures, states can help ensure that energy efficiency measures will not create or exacerbate IAQ problems. In Oregon, for example, state policy establishing a low-interest loan program for residential energy conservation measures (available to homes using fuel oil or wood heating systems) defines "Energy Conservation Measures" as items that are primarily designed to improve the energy efficiency of a dwelling, including "[v]apor barrier material, exhaust fans and venting to provide spot ventilation in

[385] For example, the Residential Energy Efficiency Tax Credit allows owners of existing homes to claim a tax credit worth 10% of the cost of upgrading the efficiency of the building's envelope, up to $500. *See* U.S. DOE, *Residential Energy Efficiency Tax Credit*, http://www.energy.gov/savings/residential-energy-efficiency-tax-credit. The U.S. Department of Agriculture's Rural Economic Development Energy Efficiency initiative provides guaranteed loan financing and grant funding to rural homes for energy efficiency retrofits. *See* USDA, *Rural Energy for America Program Renewable Energy Systems & Energy Efficiency Improvement Loans and Grants*, https://www.rd.usda.gov/programs-services/rural-energy-america-program-renewable-energy-systems-energy-efficiency. Energy-efficient mortgage programs run by the Veterans' Administration are available to military personnel and veterans for energy improvements when purchasing an existing home, and the Federal Housing Administration enables homeowners to finance energy efficient improvements by making higher payments on their FHA insured mortgage, including up to $3,500 to pay for basic weatherization measures, such as thermostats and insulation. *See* Energy Star, Energy Efficient Mortgages, https://www.energystar.gov/newhomes/mortgage_lending_programs/energy_efficient_mortgages.

[386] *See, e.g.*, National Safe and Healthy Housing Coalition, Integrating Energy Efficiency and Healthy Housing at 1 (rev. 2010), http://www.nchh.org/Portals/0/Contents/Coalition_briefing_paper_energy.pdf.

kitchens, bathrooms, utility rooms, or other areas where as the result of installing recommended energy conservation measures moisture problems could be created or worsened."[387] The *EmPower New York* program, which is primarily intended to supplement WAP funding by providing low-income households with additional energy efficiency services, addresses energy-related health and safety measures, including checks of combustion appliances and installation of carbon monoxide alarms.[388]

Valuing Non-Energy Benefits in the Prioritization and Selection of State-funded Projects. States typically establish cost-effectiveness criteria for energy efficiency activities supported by state-funded programs and utility rate-payer funded programs. These criteria may pose a practical obstacle to including IAQ-related measures as part of the energy efficiency project, because such measures provide health and productivity benefits that are difficult to quantify.

States can facilitate the incorporation of IAQ goals in energy efficiency retrofits by reviewing and revising their laws, regulations, and program guidance to include mechanisms that account for IAQ benefits in determining eligible projects. One strategy implemented by a number of states is to establish an "adder," or flat percentage of the total project cost that may be counted as a benefit in the cost-effectiveness screening for a particular project, in order to account for non-energy benefits of the project.[389] Another approach is to apply cost-effectiveness criteria at the portfolio level, rather than applying those tests to programs or to individual measures.[390] States can also consider incorporating waivers into their cost-effectiveness requirements to allow programs to cover work in homes with significant IAQ-related issues that can be addressed as part of the larger funded project.[391]

Incorporating IAQ into Home Energy Audits. Many of the funding and financing programs that promote energy efficiency upgrades for existing buildings (including WAP) require a home energy audit as a first step. While the primary purpose of an energy audit is to evaluate a home's energy profile and identify potential energy efficiency improvements, it can also be an opportunity to describe existing IAQ problems and identify IAQ measures to be considered and addressed as part of the retrofit.

Industry standards for energy audits affirm the importance of including indoor environmental quality issues in the audit. For example, the Building Performance Institute, Inc. (BPI) has developed a home energy auditing standard that includes a section on health and safety designed to "ensure that home performance upgrade activities do not negatively affect indoor air quality or otherwise cause or

[387] Or. Admin. Code 330-060-0010.
[388] New York State Energy Research and Development Authority (NYSERDA), EmPower New York Program Guidelines and Procedures Manual (rev. 2011), http://on.ny.gov/2hHUVMI. *See also,* NYSERDA, EmPower New York, https://www.nyserda.ny.gov/All-Programs/Programs/EmPower-New-York.
[389] *See* I. Malmgren and L. Skumatz, Lessons from the Field: Practical Applications for Incorporating Non-Energy Benefits into Cost-Effectiveness Screening (2014), http://bit.ly/1O15PIb (reviewing programs in, e.g., Colorado (10 and 25% adders), Vermont (15% adder), and the District of Columbia (10% adder)). *See generally* Cal. Public Utilities Comm., Addressing Non-Energy Benefits in the Cost-Effectiveness Framework, http://www.cpuc.ca.gov/NR/rdonlyres/BA1A54CF-AA89-4B80-BD90-0A4D32D11238/0/AddressingNEBsFinal.pdf.
[390] *See generally* Energy Efficiency Screening Coalition, Recommendations for Reforming Energy Efficiency Cost-Effectiveness Screening in the United States at 21 (2013), http://bit.ly/2hHWr1A; The Cadmus Group, Picking a Standard: Implications of Differing TRC Requirements (2012), http://bit.ly/2dDaW6x.
[391] *Id.*

exacerbate an unsafe condition in the home."[392] BPI-certified auditors must identify health and safety hazards that may be caused or exacerbated by changes to the building envelope and systems, specify preventive measures to protect residents from known and potential hazards during work, and specify appropriate safe work practices in the scope of work.

States can establish home energy audit requirements that incorporate such industry standards, to help ensure that state-funded projects consider IAQ during the audit inspection and include relevant IAQ issues and recommendations in the audit report. Nevada's law governing the licensure of home energy auditors draws on the BPI standards in setting forth a number of IAQ-related items that all home energy audit evaluations must include, for example:

- A "health and safety test of the energy features of the entire home;"
- Documentation of "anticipated remediation issues, including, without limitation, moisture or combustion appliance problems;"
- An "assessment of the performance and efficiency of the building airflow and indoor air quality and ventilation, including, without limitation…[a]ny visible sources of indoor air pollution;" and
- An "assessment of the control of moisture in the home, including, without limitation…identification of any potential areas where mold may grow."[393]

The Nevada law also requires home energy auditors to prepare an audit report that includes a "prioritization of health and safety hazards in the home and recommendations for improvements according to their urgency and importance, in relation to any energy efficiency measures which have been installed."[394]

Summary

State programs that fund home energy retrofits can help reduce indoor pollutant exposures and improve indoor air quality, particularly in low-income households that may be more vulnerable to the health effects of substandard housing. In developing requirements and recommended best practices for home energy efficiency upgrades, state policymakers can build on the examples of the Weatherization Assistance Program and other state funding programs that integrate energy savings and health. Strategies that can help prevent degradation, and facilitate improvement, of indoor air quality during energy upgrades include:

- Requiring assessment of indoor air- and health-related conditions during home energy audits and after completion of retrofit projects;

[392] Building Performance Institute, ANSI/BPI-1100-T-2014 Home Energy Auditing Standard at 2 (2014), http://bpi.org/standards_approved.aspx. *See also* Residential Energy Services Network (RESNET), RESNET National Standard for Home Energy Audits (incorporating the "procedures adopted by the Building Performance Institute or the certified Building Analyst classification" into the RESNET Comprehensive Home Energy Audit), http://bit.ly/1IrDYQb.
[393] Nv. Rev. Stat. 645D.300.
[394] *Id.* at subd. 2(c).

- Allowing a portion of project funds to be used for health and safety measures to ensure that energy efficiency measures do not create or exacerbate IAQ problems;
- Allowing a portion of funds to be used to correct or improve existing IAQ problems;
- Structuring incentives and eligibility criteria to reflect a whole building approach to savings, and including non-energy (health) benefits in cost-effectiveness calculations;
- Providing for quality assurance measures (including assessments, work specifications, and training); and
- Providing residents with information about the links between energy efficiency, IAQ, and health.

CHAPTER 5

Conclusion

The U.S. Global Change Research Program has identified climate impacts on indoor air quality as an emerging issue: "Most of the air people breathe over their lifetimes will be indoors, since people spend the vast majority of their time in indoor environments. Thus, alterations in indoor air pollutant concentrations from climate change have important health implications."[395] Over the past few years, scientific reviews have described a broad range of indoor air pollutant exposures that can be expected to worsen as a result of climate change. For the most part, these are IAQ issues that are *already* significant problems.

States have an important role to play in addressing these problems now, and in so doing aid their efforts to prepare for increased risk in the future. This report discusses a variety of specific policy and program approaches for consideration by states in three areas – wildfire smoke, dampness and mold, and IAQ impacts of energy retrofits. While many states have already begun to address these issues, there is considerable room for further action.

There are good reasons for states to begin focusing greater attention on these and other indoor air quality issues that have significant, but often unacknowledged, consequences for human health and the economy. As the USGCRP report noted, "Public and environmental health professionals have known for decades that poor indoor air quality is associated with adverse respiratory and other health effects."[396] The economic costs of these health effects and substandard building conditions are considerable.

States can improve public health and productivity now and in a changing climate by considering broadly and strategically how to address IAQ in homes, schools, and other buildings, with a focus on the most vulnerable and underserved populations. Toward this end, states can:

- Infuse health and IAQ considerations into strategic state *planning* processes, such as planning for climate change and emergency preparedness;

- Strengthen key *policies* to institutionalize best practices for preventing and fixing priority IAQ problems; and

- Support state health, housing, and other *programs* that assist local agencies and communities in taking action to reduce exposures – e.g., by implementing and enforcing policies, and by providing technical guidance, outreach, education, and financial support.

[395] U.S. Global Change Research Program, The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment at 72 (2016), http://www.globalchange.gov/health-assessment.
[396] *Id*. at 79.

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Environmental Law Institute

1730 M Street NW, Suite 700

Washington, D.C. 20036

Telephone: (202) 939-3800

Fax: (202) 939-3868

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