

Indoor Air Quality/HVAC Issues

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Public Health – Always Working for a Safer and Healthier Washington

Washington State Department of Health School Environmental Health & Safety Program

Our Mission

To protect and improve the
Environmental Health and Safety
condition of schools in Washington state.



DOH School Environmental Health & Safety Program

Provide technical support & training

- Local Health Jurisdictions (LHJs)
- Schools

Authority

- **RCW 43.20.050(2)(c)** Adopt rules controlling public health related to environmental conditions including but not limited to heating, lighting, ventilation, sanitary facilities, cleanliness and space in all types of public facilities including but not limited to food service establishments, **schools**, institutions, ...
- **WAC 246-366**
- **DOH / OSPI K12 Health & Safety Guide**

School Environmental Health and Safety

- ▶ **Animals**
- ▶ **Control of Communicable & Zoonotic Diseases**
 - Disinfection and Green Cleaning
- ▶ **Hazardous Chemicals**
 - Arts, Science Labs, CTE
- ▶ **Indoor Air Quality**
 - Asthma, Mold, Ventilation, Filtration
- ▶ **Injury Prevention**
 - Athletics, Playgrounds, Fall Protection
- ▶ **Integrated Pest Management**
- ▶ **Lighting**
- ▶ **Noise**



Indoor Air Quality Principals

- ▶ Source Control
- ▶ Ventilation
- ▶ “If there is a pile of manure in the room, do not try to remove the odor by ventilation. Remove the pile of manure.”

Max Joseph Von Pettenkofer, 1818–1901



Temperature and School Work Performance

- ▶ In a high quality experimental study, the average speed of completing academic work, based on monitoring of performance of eight simulated school work tasks, decreased by approximately 1.1% per each 1 °F as temperatures increased from 68 °F to 77 °F. The number of errors in school work was not significantly affected by temperature changes in this temperature range.
- ▶ [Lawrence Berkeley National Labs Indoor Air Quality Scientific Finding Resource Bank](https://www.iaqscience.lbl.gov/performance-summary)
<https://www.iaqscience.lbl.gov/performance-summary>

IAQ Research

Indoor air quality, ventilation and health symptoms in schools:

An analysis of existing information (Daisey, JM, Angell, WJ, Apte, MG, Indoor Air 2003;13;53–64.

Reported ventilation and CO2 data strongly indicate that ventilation is inadequate in many classrooms, possibly leading to health symptoms. Adequate ventilation should be a major focus of design or remediation efforts.

There is evidence that low ventilation rates and other building characteristics can lead to increased incidence of respiratory diseases caused by viruses (Brundage et al., 1988; Fisk, 2001).

Ventilation and School Performance

- ▶ Increases in classroom ventilation rates up to approximately 20 cfm per student are associated with improvements in student performance of a few to several percent, with the magnitude of improvement depending on the initial ventilation rate. Increases of ventilation rates up to approximately 15 cfm per student are associated with a higher proportion of students passing standardized reading and math tests. However, data relating ventilation rate with school work performance are not extensive.
- ▶ [Lawrence Berkeley National Labs Indoor Air Quality Scientific Finding Resource Bank](https://www.iaqscience.lbl.gov/performance-summary)
<https://www.iaqscience.lbl.gov/performance-summary>

Good Ventilation is Essential for a Healthy and Efficient Building

Our Mission

To advance environmental and economic well-being by providing unmatched energy services, products, education and information based on world-class research.

About Us

Our staff of over 100 people (energy engineers, energy specialists, technical experts, software developers, energy research librarians, and more) work out of our Olympia, Spokane and satellite offices. Operating similar to a consulting firm, the WSU Energy Program is a self-supported department within the University.

Within WSU

We are part of the College of Agricultural, Human and Natural Resource Sciences. We report directly to the WSU Vice President of Agriculture and Extension.

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Most of us spend about half of our waking hours in office or school buildings. It follows that the quality of air in these buildings can affect the health, productivity and comfort of the occupants. Measures that protect air quality, such as adequate ventilation, should be taken seriously.

Indoor air quality (IAQ) is determined by:

- Concentrations of contaminants in the air, and
- How effectively the ventilation system brings in appropriate volumes of

fresh air and distributes it to people throughout the building.

The information presented here is designed to:

- Help facility managers understand the importance of continually monitoring a building's ventilation rate to ensure adequate IAQ is maintained as the number of people in each area of a building (or zone) changes throughout the day.

Symptoms of ventilation problems

- Stuffy or stale conditions
- Noticeable odors from outdoors or other areas in the building
- Very low or high relative humidity, dampness or window condensation
- Pressure imbalances between the inside and outside, which can make it difficult to open or close doors
- Noise or drafts from air delivery vents
- Spillage or back-drafting of combustion equipment
- Dust and dirt accumulation
- Reports of comfort or health issues
- Unusually high utility costs

Outside Air

- ▶ Increased Ventilation – Increased Achievement
- ▶ Work performance may be improved from a few percent to possibly as much as 10% by providing superior indoor environmental quality (IEQ).
- ▶ The economic benefits of the work performance improvements will often far outweigh the costs of providing better IEQ.

- ▶ Lawrence Berkeley National Laboratories
- ▶ <https://www.iaqscience.lbl.gov/performance-summary>

Ventilation in the Codes

- 2012 International Mechanical Code (WAC 51-52)
- IMC ventilation requirements are based on ASHRAE 62.1
- Codes are minimum.

- Classrooms/computer labs: $10 \text{ cfm/person} + 0.12 \times \text{occupancy}$
 - Default: 15 cfm/person
- Science, art, wood/metal shops: $10 \text{ cfm/person} + 0.18 \times \text{occupancy}$
 - Default: 17 cfm/person for science labs,
19 cfm/person for art and wood/metal shops.

Air from these rooms may not be recirculated to other parts of the building.

- Exhaust airflow rate:
 - sports locker rooms: 0.5 cfm/ft^2
 - art classrooms: 0.7 cfm/ft^2
 - science laboratories: 1.0 cfm/ft^2
 - wood/metal shops: 0.5 cfm/ft^2

Filtration

- ▶ ASHRAE Filter Rating of MERV 8–13
 - prefilter
- ▶ Deepest pleat possible – less resistance
- ▶ Tight fit
- ▶ Change as needed (3 months)
- ▶ Not jut to protect the unit!
- ▶ Reduce classroom clutter/furnishings
- ▶ Entry mats – cleaned
- ▶ Vacuums



Measuring Carbon Dioxide Inside Buildings – Why is it Important?

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The quality of air inside a building depends on the concentrations of contaminants – such as gases and particles – and how much fresh air is brought into the building through its ventilation system to dilute and remove these pollutants. It is essential to monitor indoor air quality (IAQ) to provide for occupant health, productivity and comfort.

This factsheet:

- Explains how carbon dioxide (CO₂) levels in a building can be used to monitor IAQ and the ventilation rate.
- Provides guidance about accurately measuring CO₂ levels.

See the companion factsheet, *"Good Ventilation is Essential for a Healthy and Efficient Building,"** to learn about how much fresh air should be brought into a building to keep the environment healthy and comfortable without using excessive energy.

Using CO₂ levels as an indicator of IAQ

The complex mixture of gases and particles in indoor spaces is difficult to measure. However, CO₂ levels, which are easy to measure, can be used in place of other measurements to indicate IAQ.

* Available on the Washington State University Energy Program website: <http://www.energy.wsu.edu/PublicFacilitiesSupport/ResourceConservation.aspx>.

CO₂ and Performance

- ▶ [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](#) Allen, et al, EPH October 2015
- ▶ **Methods:** Twenty-four (24) participants spent 6 full work days (9 a.m. – 5 p.m.) in an environmentally controlled office space, blinded to test conditions. On different days, they were exposed to IEQ conditions representative of Conventional (high volatile organic compound (VOC) concentration) and Green (low VOC concentration) office buildings in the U.S. Additional conditions simulated a Green building with a high outdoor air ventilation rate (labeled Green+) and artificially elevated carbon dioxide (CO₂) levels independent of ventilation.
- ▶ **Results:** On average, cognitive scores were 61% higher on the Green building day and 101% higher on the two Green+ building days than on the Conventional building day ($p < 0.0001$). VOCs and CO₂ were independently associated with cognitive scores.
- ▶ **Conclusions:** Cognitive function scores were significantly better in Green+ building conditions compared to the Conventional building conditions for all nine functional domains. These findings have wide ranging implications because this study was designed to reflect conditions that are commonly encountered every day in many indoor environments.

Carbon Dioxide and Performance

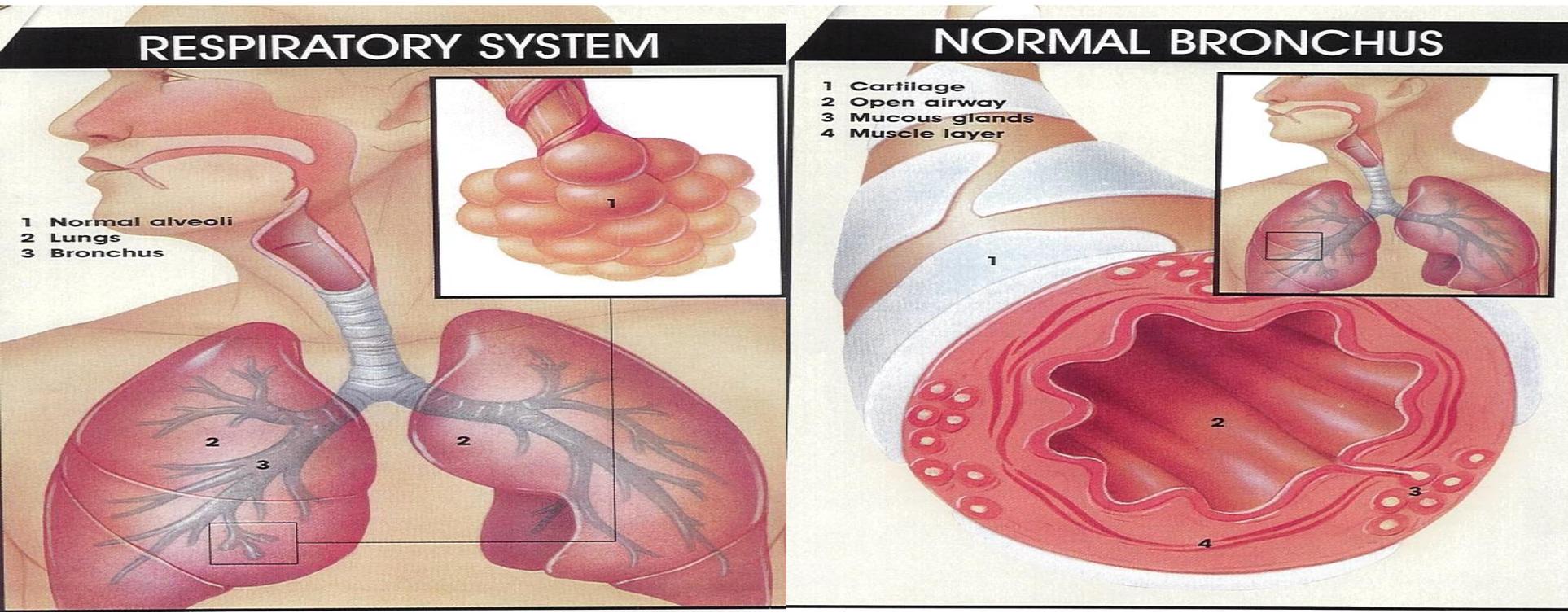
- ▶ Is CO₂ an Indoor Pollutant? Direct Effects of Low-to-Moderate CO₂ Concentrations on Human Decision-Making Performance

Satish, et al. EHP September 2012

- ▶ Results: Relative to 600 ppm, at 1,000 ppm CO₂, moderate and statistically significant decrements occurred in six of nine scales of decision-making performance. At 2,500 ppm, large and statistically significant reductions occurred in seven scales of decision-making performance
- ▶ Epidemiologic and intervention research has shown that higher levels of CO₂ within the range found in normal indoor settings are associated with perceptions of poor air quality, increased prevalence of acute health symptoms (e.g., headache, mucosal irritation), slower work performance, and increased absence (Erdmann and Apte 2004; Federspiel et al. 2004; Milton et al. 2000; Seppanen et al. 1999; Shendell et al. 2004; Wargocki et al. 2000).

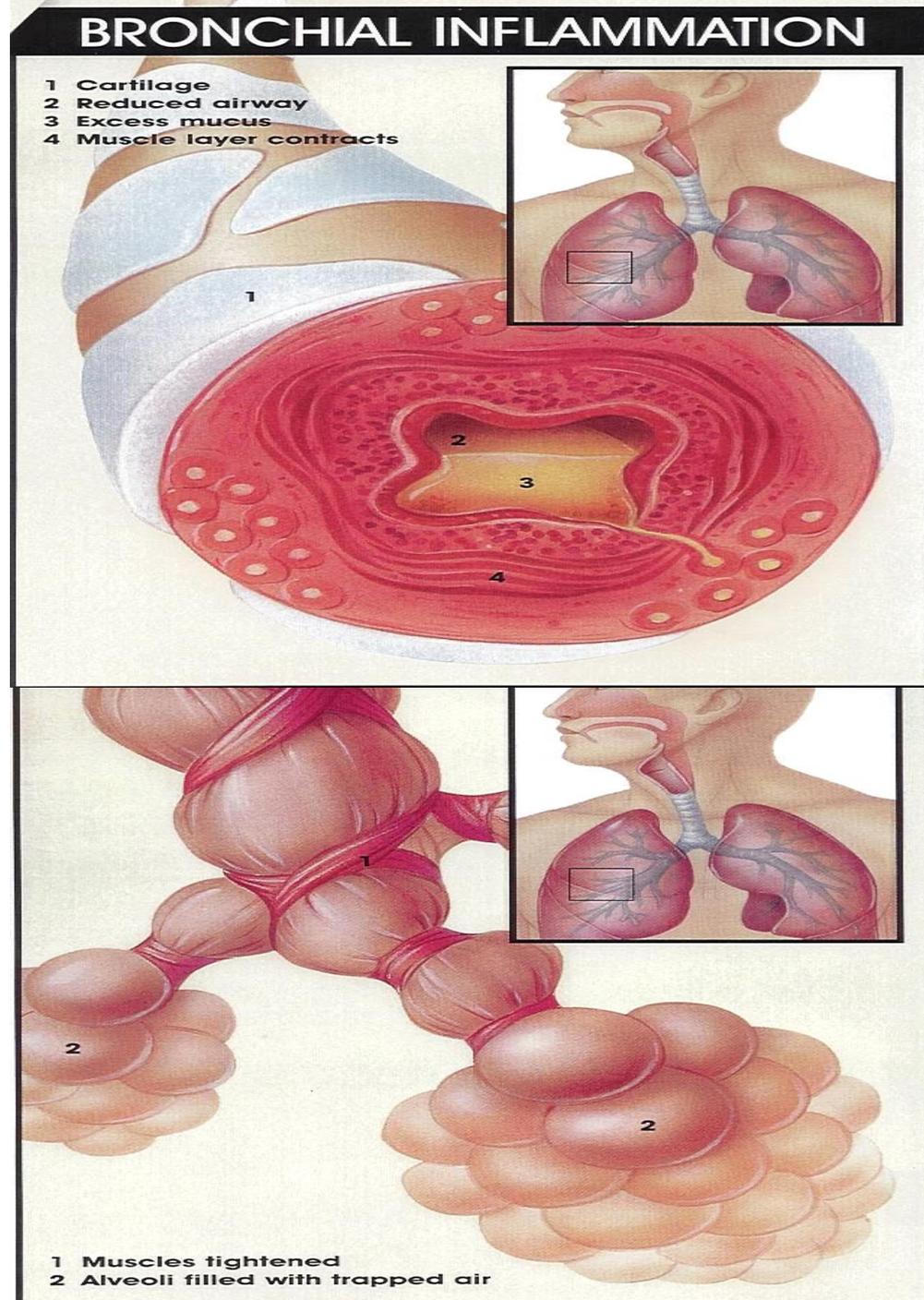
Asthma

- ▶ Asthma is a chronic disease that intermittently inflames and narrows the airways.
- ▶ Wheezing, breathlessness, chest tightness and coughing.
- ▶ Managed – not cured
 - Medication
 - Trigger Control
- ▶ Missed school/work – ~8–10%



Asthma Triggers

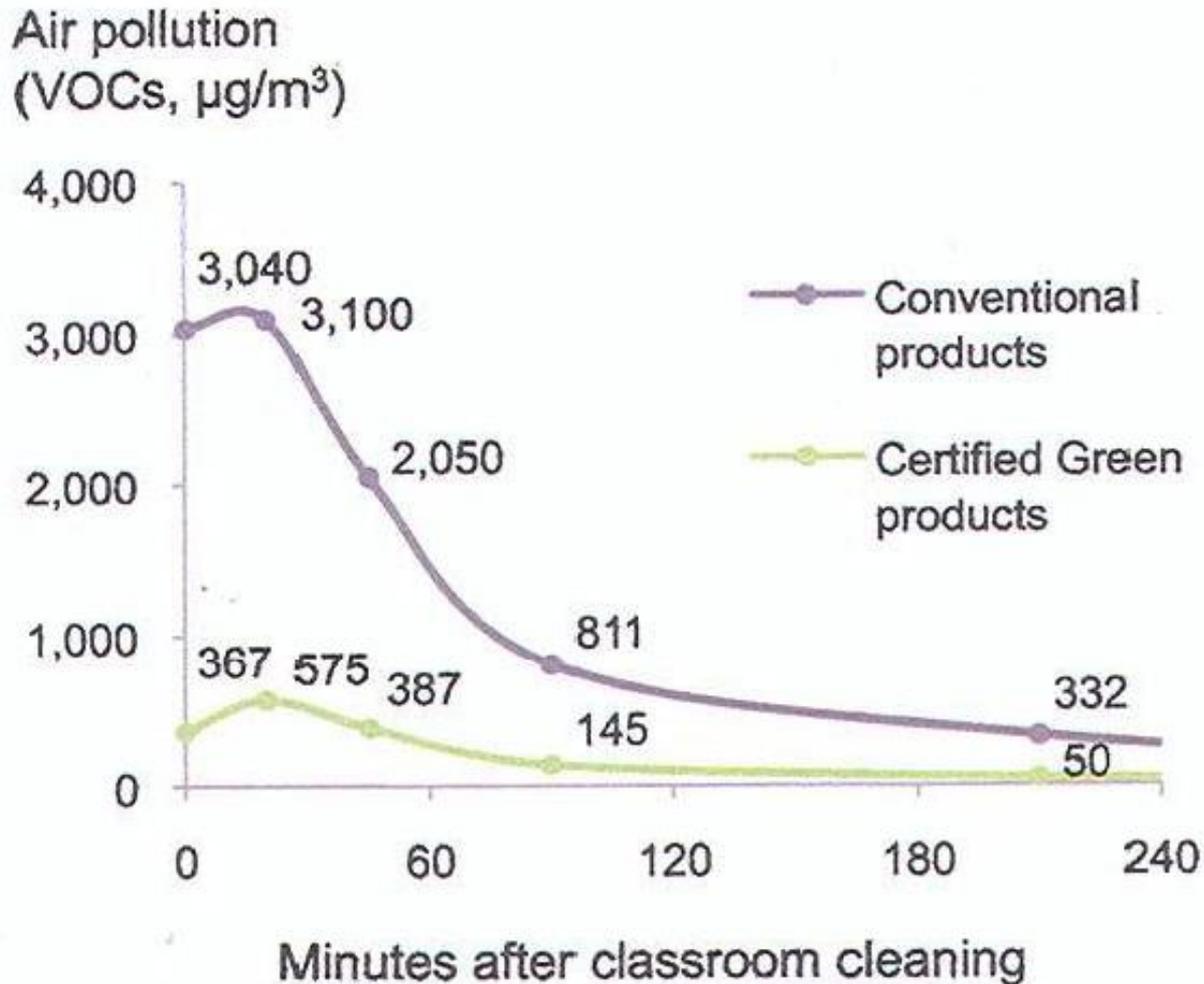
- ▶ Outdoor Air Pollution
 - Pollen
 - Smoke
- ▶ Indoor Air Pollution
 - Rodents
 - Cockroaches
 - Dust mites / Dust
 - Chemicals
 - Mold
 - Smoke
- ▶ Infections
- ▶ Stress/athletics
- ▶ Pool chemistry



Control Asthma Triggers

- ▶ Door mats
- ▶ Avoid clutter / cleanable surfaces
- ▶ Limit hanging items / T-bar clips
- ▶ Premixed clay
- ▶ Vinyl/leather furniture
- ▶ No pets
- ▶ Food storage
- ▶ Wash stuffed toys in hot water every 2 weeks
- ▶ Markers
- ▶ No fragranced products
- ▶ No chemicals from home
- ▶ Carpet cleaning

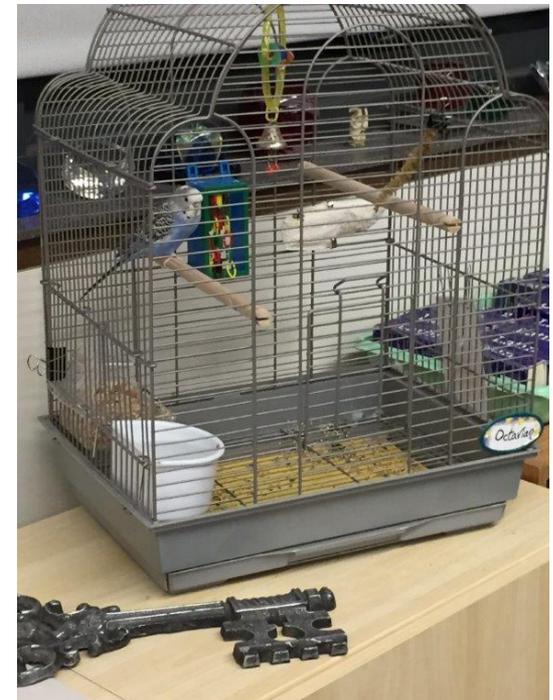
Cleaning a classroom with green products releases one-sixth the overall air pollution.



Source: <http://www.ewg.org/files/2009/10/school-cleaners/EWGschoolcleaningsupplies.pdf>

Animals

- ▶ DOH recommends that animals be visitors for educational purposes, not residents at school.
- ▶ It is a safety issue, an indoor air quality issue, to control allergens and asthma triggers, and for the welfare of the animals.
- ▶ K12 Health & Safety Guide Section O and Appendix F
 - ▶ Dogs in training
 - ▶ Service animals
 - ▶ Therapy animals



Control/Remove Chemicals/Particulates

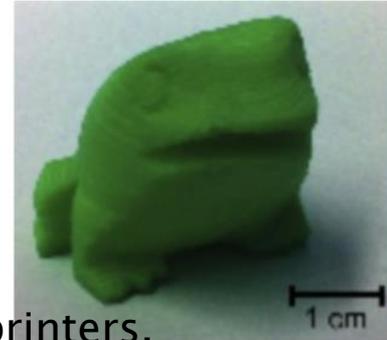
- ▶ PCBs
- ▶ Lead
- ▶ Science
- ▶ Art
- ▶ Shops
- ▶ Integrated Pest Management



- ▶ “All sources producing air contaminants of public health importance shall be controlled by the provision and maintenance of local mechanical exhaust ventilation systems as approved by the health officer.” WAC 246-366-080(2)

3D Printers

- ▶ Heated thermoplastic extrusion/deposition
- ▶ Significant aerosol emission potential
 - “High emitters” of ultrafine particles
 - Gases/fumes
- ▶ Provide exhaust ventilation
- ▶ Stephens, B et.al. Ultrafine particle emissions from desktop 3D printers, *Atmospheric Environment* 79 (2013) 334–339
- ▶ “caution should be used when operating many printer and filament combinations in enclosed or poorly ventilated spaces or without the aid of gas and particle filtration systems” Azimi, P et. al. [Emissions of Ultrafine Particles and Volatile Organic Compounds from Commercially Available Desktop Three-Dimensional Printers with Multiple Filaments](#), *Environmental Science and Technology*, 2016, 50(3), 1260–1268



Electronic Cigarettes and Vaping

- ▶ Children and teens should not use E-cigarettes
- ▶ There are safety concerns associated with E-cigarettes, especially for children
- ▶ Pregnant or breastfeeding women should not use E-cigarettes
- ▶ “Vaping” may not be safer than smoking traditional cigarettes
- ▶ E-cigarettes may not be helpful to quit smoking
- ▶ ASHRAE 62.1 – include in “ETS”

<http://www.doh.wa.gov/YouandYourFamily/Tobacco/OtherTobaccoProducts/ECigarettes>

Perfumed, Fragranced, & Scented

- ▶ Added fragrances can trigger asthma attacks, allergies, sensitization.
- ▶ Eye, skin, and respiratory irritation.
- ▶ “Fragrance” – a thousand components.
- ▶ Limonene, pinenes, acetone, ethanol, camphor, benzyl alcohol, ethyl acetate, limonene, benzene, formaldehyde, 1,4-dioxane, methylene chloride, acetaldehyde, synthetic musks, phthalates, etc.
- ▶ Natural oils – lavender, lemon, etc.
- ▶ Look for “fragrance-free,” not “unscented”.

Essential Oils / Natural Air Fresheners

- ▶ Anne Steinenmann – “all air fresheners tested – even those advertised as “natural,” “green,” “organic,” or with essential oils – emitted chemicals classified as toxic or hazardous, including some with no safe exposure level.”

Hidden Hazards in Air Fresheners and Deodorizers

<http://www.drsteinemann.com/Resources/Air%20Freshener%20Fact%20Sheet.pdf>

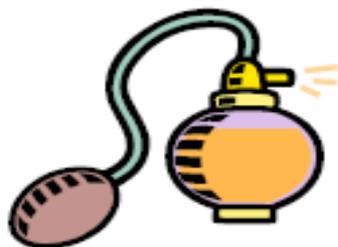
- ▶ Not okay in schools/public places
- ▶ Sensitization reactions/asthma
- ▶ Respiratory, eye, skin irritation, headaches
- ▶ No diffusers, plug-ins, Sensei, candles, etc.
- ▶ Particulates/oils spread through room

Sample Fragrance-free Sign

Staff and Visitors:

In order to protect fragrance-sensitive employees, please do not use or apply scented products, including perfume, cologne, deodorant, hair products, aftershave, nail polish and removers, air fresheners, cleaners, and clothing with residue fragrance while on these premises.

WE SHARE THE AIR



**No
Scents is
Good
Sense!**



Scented products contain hazardous chemicals which can cause serious problems for many people, especially those with asthma, allergies or sensitivities to chemicals.

EFFECTS OF SCENTED PRODUCTS FACTS:

- Scented products can cause a variety of health problems such as, but not limited to, sore throat, runny nose, sinus congestion, wheezing, shortness of breath, headache, mental confusion, inability to concentrate, flushing, irritability, nausea, or muscle pain.

The PSESD strives to ensure the safety and comfort of staff and visitors by encouraging a fragrance-controlled environment. We support a healthful environment for our staff members, clients and visitors. For the comfort and health of all, the PSESD discourages the use by employees and visitors of scents and fragrant products.

School Environmental Health and Safety

www.doh.wa.gov/schoolenvironment

Air Quality

- ▶ [Air Pollution and School Activities Guide \(PDF\)](#)
- ▶ [Asthma and Schools](#)
- ▶ [Good Ventilation is Essential for a Healthy and Efficient Building, WSU \(PDF\)](#)
- ▶ [Healthy Air Quality in Schools – Tips for Administrators, Custodians, and Teachers](#)
- ▶ [Improving Indoor Air Quality in King County Schools, Local Hazardous Waste Management Program in King County](#)
- ▶ [Improving Ventilation during Wildfire Smoke Events \(PDF\)](#)
- ▶ [Indoor Air Quality Tools for Schools, EPA](#)
- ▶ [Indoor Air Quality Topics](#)
- ▶ [Measuring Carbon Dioxide Inside Buildings, WSU \(PDF\)](#)
- ▶ [Responding to Indoor Air Quality Concerns in our Schools, 2005 \(PDF\)](#)
- ▶ [School Indoor Air Quality Best Management Practices Manual, 2003 \(PDF\)](#)

Air Pollution and School Activities

Public Health Recommendations for Schools on Fine Particle Air Pollution



Air Quality Conditions

First, check local air conditions at <https://fortress.wa.gov/ecy/enviwa/> and then use this chart.

	Good	Moderate	Unhealthy for Sensitive Groups	Unhealthy	Very Unhealthy/ Hazardous
Recess (15 minutes)	No restrictions.	Allow students with asthma, respiratory infection, lung or heart disease to stay indoors.	Keep students with asthma, respiratory infection, and lung or heart disease indoors.	Keep all students indoors and keep activity levels light.	Keep all students indoors and keep activity levels light.
P.E. (1 hour)	No restrictions.	Monitor students with asthma, respiratory infection, lung or heart disease. Increase rest periods or substitutions for these students as needed.	Limit to light outdoor activities. Allow any student to stay indoors if they don't want to go outside. Keep students with asthma, respiratory infection, lung or heart disease, and diabetes indoors. Limit these students to moderate activities. Students with asthma should follow their Asthma Action Plan.	Conduct P.E. indoors. Limit students to light indoor activities. Students with asthma should be following their Asthma Action Plan.	Keep all students indoors and keep activity levels light. Students with asthma should be following their Asthma Action Plan.
Athletic Events and Practices (Vigorous activity 2-3 hours)	No restrictions.	Monitor students with asthma, respiratory infection, lung or heart disease. Increase rest periods and substitutions for these students as needed. Students with asthma should follow their Asthma Action Plan.	Consider moving event indoors. If event is not cancelled, increase rest periods and substitutions to allow for lower breathing rates. Students with asthma, respiratory infection, lung and heart disease, or conditions like diabetes shouldn't play outdoors. Students with asthma should follow their Asthma Action Plan.	Cancel the event. Or move the event to an area with "Good" air quality — if this can be done without much time spent in transit through areas with poor air quality.	Cancel the event. Or move the event to an area with "Good" air quality — if this can be done without much time spent in transit through areas with poor air quality.

Light Activities: Playing board games, throwing and catching while standing, and cup stacking.

Moderate Activities: Yoga, shooting basketballs, dance instruction, and ping pong.

Vigorous Activities: Running, jogging, basketball, football, soccer, swimming, cheerleading, and jumping rope.

<http://www.doh.wa.gov/Portals/1/Documents/Pubs/334-332.pdf>

Healthy Air Quality in Schools

Achieving healthy air quality in schools takes administrators, custodians, and teachers working together. Good ventilation and source control of pollutants means healthy indoor air quality.

General Tips

- Teachers and staff need to know who to contact for indoor air quality concerns in the school.
- There should be a written school or district indoor environmental quality plan that includes indoor air quality and integrated pest management.
- Notify school or district indoor air quality contact or maintenance staff if you detect odors or dust from locations such as shops, copy rooms, science labs, laminators, locker rooms, graphic arts, custodial supply rooms, storage areas, combustion equipment, kitchens, or bus exhaust. Document your concerns.
- Immediately report any water leaks, water stains, damp materials, or unusual odors (such as musty or moldy smells) to maintenance staff.
- Maintenance staff should respond to water leaks and moisture problems within 24 hours.
- Relative humidity levels between 30 and 50 percent are better for health. Low relative humidity leads to dry eyes and respiratory irritation. High relative humidity allows dust mites to grow and promotes condensation.
- Dispose of food wastes promptly in covered containers.

Ventilation

- Operate the ventilation system continually when the school is in use, including during custodial work. Supply at least 15 cubic feet per minute per person of fresh outside air whenever the school is in use. See [WSU Energy Program's Good Ventilation is Essential for a Healthy and Efficient Building \(PDF\)](#).
- An occupied room is considered to be receiving the minimum amount of fresh air when indoor carbon dioxide levels are at or below approximately 1030 parts per million (ppm). See [WSU Energy Program's Measuring Carbon Dioxide Inside Buildings \(PDF\)](#).
- Maintain three feet of clearance around unit ventilators.
- Change ventilation filters regularly. Use the highest rated, deepest pleat filters the system can accommodate.
- Check to make sure that air supply, exhaust, and return grills are not blocked. They should be clean and dry.
- Don't turn off unit ventilators – ask maintenance staff to repair noisy units, control temperatures, and control drafts.
- Monitor windows – they should not show condensation except on the very coldest of days.
- Don't allow vehicle idling on school property.
- Maintenance staff should follow integrated pest management strategies. Don't use pesticides in the building.

Control Asthma Triggers

Control Dust

- All outside doors should have large entry mat barriers (walk-off mats) outside and just inside the door. The mats should provide at least four to seven footfalls.
- Maintain cleanable surfaces and avoid clutter. Put loose items into plastic boxes with lids that can be wet-wiped.
- Damp-wipe surfaces weekly with a micro-fiber cloth.
- Don't hang items from the ceiling T-bars without special clips to prevent fraying fiberglass. Remove or clean items when dusty.
- Discourage clutter by removing as many unnecessary dust-collecting items as possible.
- Use pre-mixed art supplies whenever possible to avoid dusts.
- Replace fabric upholstered furniture with furniture easily dusted.
- Remove area rugs that cannot be regularly cleaned and that trap dirt and moisture.

Reduce Animal Allergens, including Dust Mites

- Animals shouldn't be classroom residents and should only come to school for educational purposes.
- Use integrated pest management practices to prevent cockroach and rodent infestations.
- Store food in tightly sealed containers.
- Seal all cracks and crevices.
- Grate all foundation and roof ventilation.
- Use barriers to discourage birds roosting.
- Wash stuffed animals and blankets in hot water every two weeks, or remove them.

Reduce Chemicals

- Don't use permanent, solvent based or scented pens, markers, and board cleaners. Use water based, unscented, crayon based, or low-odor items.
- Don't use room deodorizing sprays, plug-ins, scented candle warmers, scented reeds, candles, incense, therapeutic oils, or potpourris.
- Don't use urinal cakes in bathrooms.
- Avoid spray adhesives, contact cement, and volatile paints. If spray adhesives are necessary, use hexane and toluene-free products. Wear solvent-resistant gloves. Spray in an area with local exhaust ventilation and away from children. See [King County's Selecting Safer Art Adhesives](#).
- Don't bring chemicals, cleaners, or disinfectants from home. Use only those provided by the school or district.
- Never use air-cleaning devices that generate ozone. Ozone is a respiratory irritant.
- Discourage the use of perfumes, colognes, body sprays and other strongly scented personal care products.
- Hazardous chemicals in laboratories, chemical storages, shops, art rooms, and any other areas need to be properly stored and managed to prevent air contamination.

Carpet Care

- Whenever possible, don't allow food or beverages in classrooms. If possible, vacuum daily (when children are not present). Use a vacuum with a HEPA (high efficiency particulate air) filter – or use HEPA vacuum bags. Having both is even better.
- Clean carpets thoroughly with truck-mounted hot water and steam extraction once or twice per year.
 - Spot treat carpet as needed first.
 - Use the minimum amount necessary of low-odor and low-sudsing carpet shampoo.
 - All shampoo and cleaner needs to be thoroughly extracted until the water runs clean.
 - Carpet should dry thoroughly within 24 to 48 hours after cleaning.

More Resources

- [Printer-friendly version of this webpage \(PDF\)](#)
- [School Indoor Air Quality Best Management Practices Manual, 2003 \(PDF\)](#)
- [Integrated Pest Management for Schools, WSU](#)
- [Creating Healthy Indoor Environments in Schools, EPA](#)
- [Taking Asthma Care To School, Washington Asthma Initiative \(PDF\)](#)
- [Art Hazards, King County Local Hazardous Waste Management Program](#)

Content Source: [School Environmental Health and Safety Program](#)

Improving Ventilation and Indoor Air Quality during Wildfire Smoke Events



Recommendations for Schools and Buildings with Mechanical Ventilation

Overview

- Smoke is a complex mixture of carbon dioxide (CO₂), water vapor, carbon monoxide (CO), hydrocarbons, other organic chemicals, nitrogen oxides (NO_x), trace minerals, and particulate matter.
 - Particulate matter consists of solid particles and liquid droplets suspended in the air. Particles with diameters less than 10 microns (PM₁₀) are upper respiratory tract and eye irritants.
 - Smaller particles (PM_{2.5}) are the greatest health concern – they can be inhaled deep into the lungs, and can affect respiratory and heart health.
 - Carbon monoxide, a colorless, odorless gas produced by incomplete combustion, is a particular health concern and levels are highest during the smoldering stages of a fire.
- Outdoor (ambient) air pollutants, including smoke, enter and leave buildings in three primary ways:
 1. Mechanical ventilation systems, which actively draw in outdoor air through intake vents and distribute it throughout the building.
 2. Natural ventilation (opening of doors or windows).
 3. Infiltration, the passive entry of unfiltered outdoor air through small cracks and gaps in the building shell.
- Tightly closed buildings reduce exposure to outdoor air pollution. Upgrading the filter efficiency of the heating, ventilating, and air-conditioning (HVAC) system and changing filters frequently during smoke events greatly improves indoor air quality. Supplementing with HEPA filters, particularly those with activated charcoal or other adsorbents, improves air quality even more.
- During long-term smoke events, take advantage of periods of improved air quality (such as during rain or shifts in wind) to use natural ventilation to flush-out the building.
- To reduce smoke particles in the building and their off-gassing, damp mop with microfiber cloths and use high efficiency (HEPA) vacuums or vacuums with high efficiency filter bags.
- Reduce all sources of indoor air pollutants, including use of aerosols, fragrances, gas, propane or wood-burning stoves, smoking, etc.

Maximizing a Building's Capacity to Improve Indoor Air Quality

- When outside air is in the hazardous category (see the [Department of Ecology Washington Air Quality Advisory Map](#)), close all windows and minimize use of outside doors.
- Under normal operations, mechanical ventilation air intake systems can supply approximately 15 -20 cubic feet per minute of outside air per person to flush out pollutants and keep CO₂ levels below about 1000 - 1100 parts per million (ppm).
- Close air intakes when outside air is in the unhealthy category. Indoor CO₂ levels will probably rise.
- If possible, monitor CO₂ levels. The eight-hour Washington Division of Occupational Safety and Health permissible limit for CO₂ is 5000 ppm ([WAC 296-841-20025](#)). If CO₂ reaches this level, the building will be uncomfortable. At about 4000 ppm, open air intakes to bring in outside air, preferably filtered.
- If recommended by public health officials, use CO monitors with meters that can detect CO at levels as low as 1 ppm. Most hardware store CO alarms only detect potentially life-threatening levels of CO, not long-term, low-level exposures that still affect health.
 - California considered children when they set the current ambient air CO standard of 9 ppm CO averaged over 8 hours, and 20 ppm averaged over 1 hour. See [California's Evaluation of Air Quality Standards and Protection of Children \(PDF\)](#). Low levels of CO can cause headache, dizziness, fatigue, weakness, confusion, and nausea.

Upgrading Filters on HVAC Units

Upgrading the filters on existing HVAC systems helps improve indoor air quality and allows air intakes to stay open during moderate pollution events. The filters chosen depend on the fan, which has to be able to move enough air through it. Most public HVAC systems should accommodate at least Minimum Efficiency Reporting Value (MERV) 8 filters. Selecting a filter with the deepest pleat your system can accommodate (two inches or more) reduces the air resistance across the filter and improves filtration. Research shows even medium efficiency filters can improve indoor air quality; have your HVAC technician evaluate if a higher MERV filter can be used. Filters need to be checked and replaced more often during prolonged smoke events.

Proper installation, operation, and maintenance are critical for effective use of air filters:

- Make sure the filter fits tightly in its seat to prevent air from bypassing the filter.
- Check filter for dust and debris buildup at least every month during heavy use – more often in heavy smoke conditions. Clean or replace the filter as necessary.
- To prolong the life of a high-efficiency filter, discuss with your HVAC technician installing a low-efficiency pre-filter upstream to prevent rapid overloading of the filter.

Portable Air Cleaners

Portable high efficiency HEPA air cleaners can supplement the work of the HVAC system by removing fine particulates. HEPA filters with activated charcoal or alumina, especially those impregnated with potassium permanganate or zeolite will adsorb gases in the smoke, including NO_x and some of the volatile organic compounds (VOCs) such as benzene. These filters are more expensive and need more frequent replacement.

Do not use ozone generators, personal air purifiers, or electrostatic precipitators and ionizers that produce ozone. Ozone is a respiratory irritant that can aggravate asthma and other lung diseases. Consult the [California Air Resources Board Consumers' Air Cleaner Portal](#) for information on devices certified to avoid ozone exposures.

Proper size, installation, and maintenance are critical for portable air cleaners to be effective.

- Air cleaners should filter at least two or three times the room volume per hour.
- The package should indicate the unit's airflow rate, the room size it is suitable for, its particle removal efficiency, and perhaps its Clean Air Delivery Rate (CADR), a rating that combines efficiency and airflow.
- The [Association of Home Appliance Manufacturers \(AHAM\)](#) maintains a certification program for air cleaners. The AHAM seal on the box lists three CADR numbers; the higher the numbers, the faster the unit filters the air. Choose a unit with the highest number.
- [Consumer Reports](#) has evaluated air cleaning devices and produced a buying guide.
- Put the unit(s) away from doors, windows, and foot traffic; but not close to walls or corners, so the air can easily reach the unit.

More Resources

- [Wildfire Smoke, Washington State Department of Health](#)
- [Wildfire Smoke Guide for Public Health Officials \(PDF\)](#)
- [Indoor Air Quality: Air Cleaners, EPA](#)

Contact for School Environment and Indoor Air Quality Issues

- www.doh.wa.gov/SchoolEnvironmentContact - Washington State Department of Health

Schools and Pesticides

<http://www.doh.wa.gov/CommunityandEnvironment/Schools/EnvironmentalHealth/Pesticides>

Agricultural Pesticide Drift

Illnesses at schools from exposure to pesticide drift (drifting spray and dust from pesticide applications) from neighboring farmlands have also occurred. There are more than 100 public schools in Washington located within 200 feet of agricultural operations and more than 200 within one-quarter mile. The proximity of schools and agricultural operations presents a risk of unintended exposure of students and staff to pesticides through drift.

To prevent illness, follow [WSU School IPM-Guidelines for Schools Next to Agricultural Operations](#) on how to communicate with agriculturalists about practices to reduce the risk of pesticide drift and on what emergency procedures to take if a drift occurs.



In 2014, three teachers reported illness when pesticides drifted from apple orchards that surround their school. What to do in a [pesticide drift emergency](#).

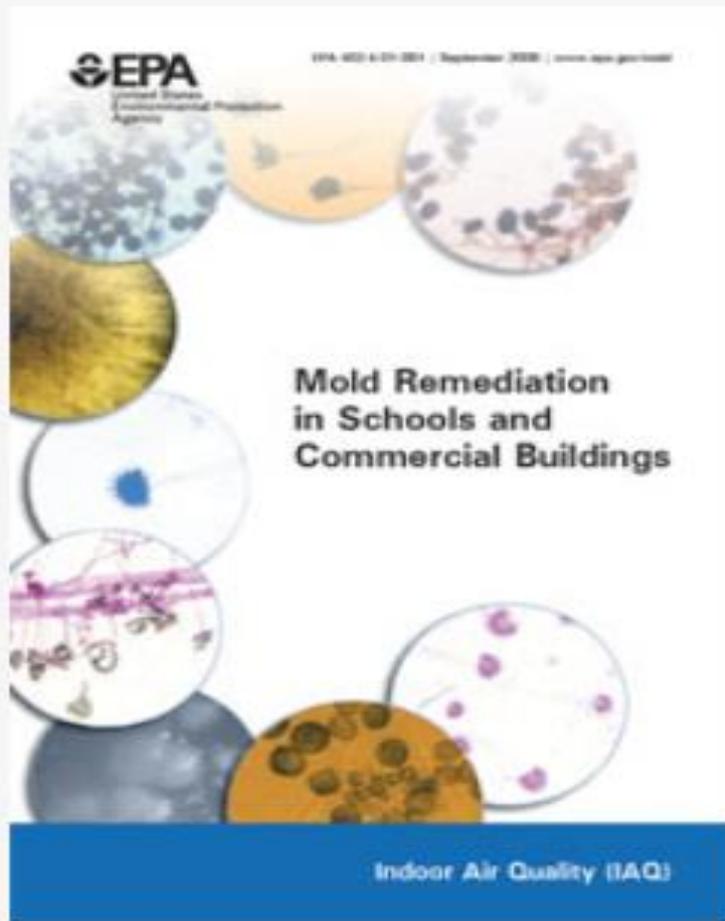
What to do if a pesticide drift occurs

- ▶ Close up the building
- ▶ Turn off the ventilation
- ▶ Keep people indoors
- ▶ Stop the application
- ▶ Address health concerns
- ▶ Report immediately to the WSDA
 - 1-877-485-7316
- ▶ Notify parents/users
- ▶ Consult/prepare for post event clean up.
 - Open windows/ventilate thoroughly
 - Clean contaminated surfaces – soap and water
 - Monitor for health symptoms
 - Replace all air filters



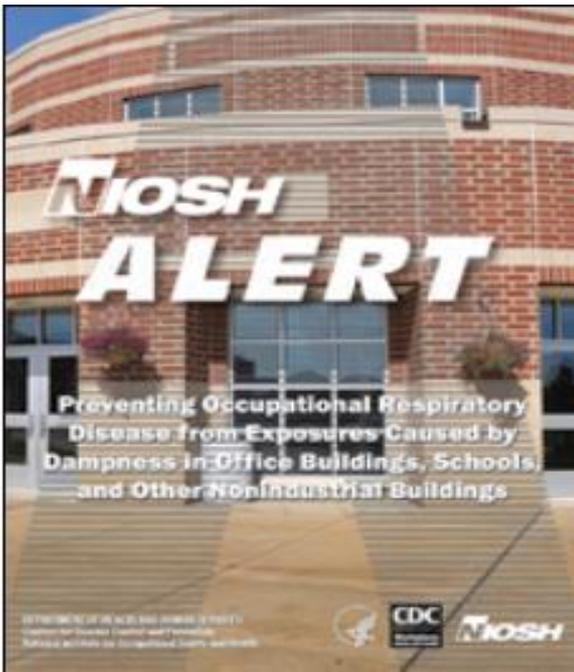
Mold Remediation in Schools and Commercial Buildings

EPA 402-K-01-001, Reprinted
September 2008



http://www.epa.gov/mold/mold_remediation.html

NIOSH Alert: Preventing Occupational Respiratory Disease from Exposures Caused by Dampness in Office Buildings, Schools, and Other Nonindustrial Buildings



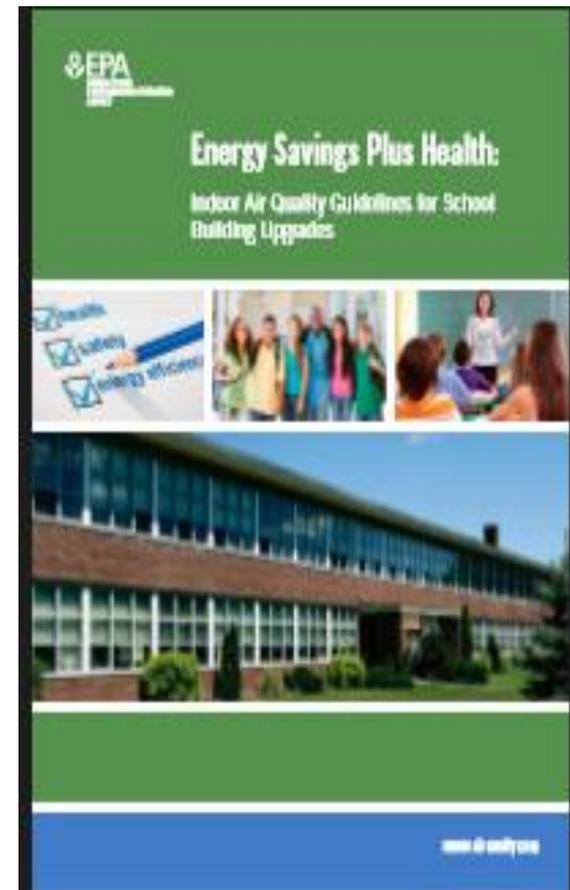
<http://www.cdc.gov/niosh/docs/2013-102/>

Energy Savings Plus Health: IAQ Guidelines for School Building Upgrades New EPA Resource

Assessment Protocols and Recommended Actions

- Integrated Process
- Moisture and Mold
- Hazardous Materials
- Outdoor Contaminants and Sources
- Indoor Contaminants and Sources
- Heating, Ventilation, and
Air Conditioning (HVAC)
- Safety

http://www.epa.gov/iaq/schools/pdfs/Energy_Savings_Plus_Health_Guideline.pdf



Moisture Control Guidance for Building Design, Construction and Maintenance, December 2013, USEPA



<http://www.epa.gov/iaq/pdfs/moisture-control.pdf>

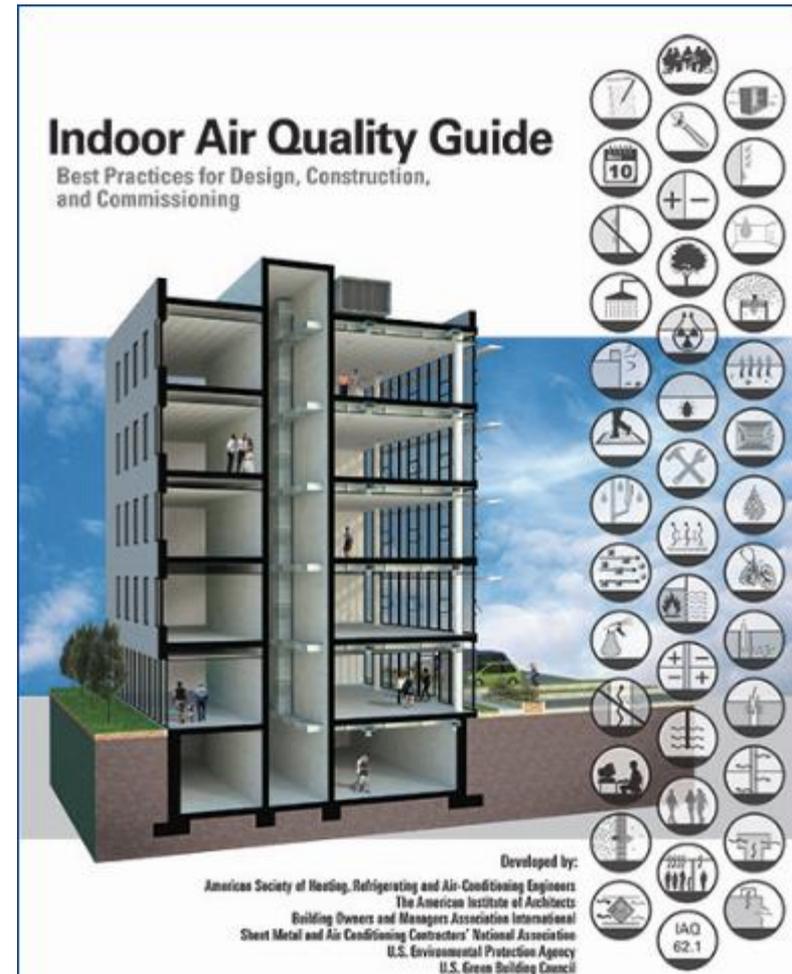
Indoor Air Quality Guide

Best Practices for Design, Construction, and Commissioning

Free ASHRAE download:

<https://www.ashrae.org/resources--publications/bookstore/indoor-air-quality-guide>

Developed in cooperation with the American Institute of Architects, The U.S. Green Building Council, the Builders and Owners Management Association International, the Sheet Metal and Air Conditioning Contractors of North America, and the U.S. Environmental Protection Agency.



Thank You

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Resources available on my web site:
www.doh.wa.gov/schoolenvironment
Join my list serve for timely information!



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