



Low Emitting Materials Technical Brief

Green Guide for Health Care Environmental Quality Credits 4.1, 4.2, 4.3, 4.4, 4.5, 4.6

Overview

A preponderance of common building materials emit chemicals during and after installation, that can compromise indoor air quality (IAQ). The smell commonly associated with new paint and new carpet can be hazardous to the health of occupants, leading to acute reactions and chronic illnesses inside the building as well as causing smog formation outside. These effects may be manifested by obvious impacts on large numbers of occupants (as with “Sick Building Syndrome” symptoms and “Building Related Illnesses”). Or, they may be more subtle, contributing to a slow rise in illnesses and sick days. Advances in both testing technologies and understanding the health impacts of some of these chemicals have led to increasingly powerful health-based standards to screen materials based on their affect on healthy indoor air quality.

Volatile Organic Compounds (VOCs) – Sources of Exposure and Outcomes

Volatile organic compounds (VOCs), such as formaldehyde, acetaldehyde, toluene, and benzene, off-gas readily into the air and are associated with a range of health effects. Short-term effects of exposure include dizziness, headaches, and eye, nose and throat irritation (“Sick Building Syndrome”). Longer term exposure can also lead to cancer, damage to the liver, kidney, and nervous system (“Building Related Illnesses”) and is suspected of stimulating higher sensitivity to other chemicals (“Multiple Chemical Sensitivity”). Many regulatory restrictions of VOCs were initiated due to the fact that many VOCs react with nitrogen oxides (NOx) in sunlight to create ozone, a key component of smog. Ozone, in turn, can react with VOCs to produce aldehydes and other newly formed compounds that also can cause eye and bronchial irritation indoors and out.

VOCs are typically emitted at peak levels when a product is first installed, with diminished emission levels over time. Wet applied products, like paints and adhesives, typically emit VOCs very intensely for the first few days or weeks, then taper off rapidly. VOC emissions from solid materials, on the other hand, such as flooring and furniture, may have initial emissions that are relatively low, but will taper off much more slowly than wet applied products and may contribute to a long-term air quality problem. It is important that VOC mitigation strategies are tailored to the emission profile of a specific building material.

Other Chemicals of Concern (COC)

VOCs are the most studied category of chemicals released by building materials, and are most frequently addressed by IAQ programs. However, chemicals of concern (COC) in building materials, other than VOCs, can also affect building occupants. Some COCs, such as phthalates and halogenated flame retardants (HFRs), are semi-volatile organic compounds (SVOCs). These evaporate from products much more slowly than VOCs, or, like heavy metals, are not volatile at all. But all of these can also migrate into the breathing space by attaching to dust particles. Particulate matter, therefore, can be a concern both for its own direct effect on lungs and for the chemicals that may hitch a ride on it. Phthalates, a plasticizer used primarily in PVC to give flexibility, are developmental toxicants and linked to bronchial irritation and asthma. HFRs, used in fabrics, foams and various other plastics to reduce flammability, can disrupt thyroid and estrogen hormones, which can cause developmental effects, including brain and reproductive system damage. Similarly perfluorochemicals (PFCs) used in stain and wrinkle resistance treatments and other coatings for fabrics, furnishings and other building materials, are linked to testicular, breast, liver and prostate cancer, hypothyroidism and a range of developmental damage and other adverse effects.

Green Guide for Health Care™ Technical Brief

Low Emitting Materials

Many of these COCs are classified as persistent bioaccumulative toxicants (PBTs) meaning that they do not break down rapidly and concentrate as they move up the food chain. This class of chemical is of particular concern as PBTs are appearing in increasing concentrations in human blood and tissue samples of people and other species across the U.S. and internationally (even in remote, non-industrialized ecoregions), raising concerns about their growing potential for causing cancer and endocrine disruption.

GGHC v2.2 Environmental Quality Credit 4 – Consistent with its health-based approach to green building, the *Green Guide for Health Care's* Environmental Quality Credit 4 references the most stringent available standards and materials, such as ceiling finishes and exterior products. The six-credit series evaluates low emitting materials through the following categories: Interior Adhesives and Sealants (GGHC v2.2 Environmental Quality Credit 4.1), Wall and Ceiling Finishes (GGHC v2.2 Environmental Quality Credit 4.2), Flooring Systems (GGHC v2.2 Environmental Quality Credit 4.3), Composite Wood and Insulation (GGHC v2.2 Environmental Quality Credit 4.4), Furniture and Medical Furnishings (GGHC v2.2 Environmental Quality Credit 4.5), and Exterior Applied Products (GGHC v2.2 Environmental Quality Credit 4.6).

The Challenges

With emissions representing a potential problem in any building material, the challenge becomes knowing where to start. Eliminating emissions from building materials is both assisted and complicated by a range of rating systems and eco-labels that apply to different materials and products. In addition, emission rating programs have yet to rate products on many SVOCs of concern, including phthalates, HFRs and PFCs. Selecting low emitting materials can also be complicated by cost premiums, reduced product selection, infection control concerns, and/or the functional requirements for wear and tear in a health care environment.

Best Practices

Materials can be screened based upon both content and actual measured emissions. *VOC content* refers to the amount of chemicals in the product that are VOCs and, as such, can potentially off gas from the product during installation or use. *VOC emissions* refers to the gases released by the product during installation or use.

California-based air quality boards have established rules for total VOC (TVOC) content of various wet applied materials, like paints and adhesives, to reduce smog formation. Manufacturers generally list VOC content on the MSDS (Material Safety Data Sheet), the technical specification sheet, and/or product data sheet. These TVOC content measures represent an important first step; however, they are very crude tools for evaluating indoor air quality. Different individual VOCs have different potencies. Some are not accounted for on the TVOC scale because they do not contribute to smog formation, even though they have a negative health impact.

Several standards-setting programs are beginning to use lab tests to calculate VOC emissions. These programs use lab testing to measure the rate at which individual VOCs are emitted from a material. They then calculate the concentration of these VOCs that can be predicted to accumulate in a typical building, given the amount of the product in the building, the volume of the building and the ventilation rate. Finally they apply health-based research to determine whether the resulting predicted levels are problematic. A variety of standards and certification programs, including the California 01350 standard, Collaborative for High Performance Schools (CHPS), Scientific Certification Systems (SCS) Indoor Advantage™, GREENGUARD®, Carpet and Rug Institute (CRI) GreenLabel Plus™, and others, are beginning to use this approach to better rate materials relative to health-based standards.

In addition to manufacturers' promotional listings, several third-party programs maintain web-based lists of materials that have passed their laboratory tests. The Resources section below lists several databases for finding the manufacturers of materials that meet the *Green Guide's* credit requirements.

Green Guide for Health Care™ Technical Brief

Low Emitting Materials

To date, these ratings programs have been based primarily on VOC emissions. A few are beginning to look at some other chemicals of concern. With serious debate about the applicability of emissions tests for other chemicals of concern, screening by content is currently the most reliable way to avoid problematic exposures. None of the broadly recognized standards, however, currently rate products based on content of some of the key SVOCs of concern, including phthalates, halogenated flame retardants (HFRs), and perfluorochemicals (PFCs). Project teams should communicate directly with manufacturers' representatives to obtain information about these chemicals of concern.

Interior Adhesives & Sealants (GGHC v2.2 Environmental Quality Credit 4.1)

Currently, adhesives and sealants are primarily screened for TVOC content, with the exception of some flooring systems where the adhesive is rated in assembly with the carpet or resilient flooring. Currently, the limiting regulation for most adhesive types is the South Coast Air Quality Management District (SCAQMD) Rule #1168, which limits architectural adhesives to 50 g/l VOC content (grams VOCs per liter, not including water). Only some special purpose cements are allowed higher limits. Aerosol adhesives are limited by Green Seal GC-36, which restricts VOC content by weight.

California 01350-based standards and GREENGUARD have both developed testing protocols and threshold standards for VOC emissions from wet-applied products, but controversy about the appropriate measurement techniques and standards continues to slow progress in this area. Most work to date has been done to determine safe VOC concentrations for long-term exposures; more work needs to be done to determine the safe VOC concentrations for short-term exposures.

In addition to requiring abidance by the SCAQMD rule, the *Green Guide for Health Care* credit encourages screening adhesives and sealants for carcinogenic and reproductive toxicant components at 1% or more of total mass, as defined by the California OEHHA, Safe Drinking Water and Toxic Enforcement Act. In reality, this may be a difficult task for individual specifiers because of the inadequacy of MSDS sheets. However, those materials that have gone through a certification program like the 01350-based programs will have been screened for modeled concentrations of the potentially harmful chemicals outlined in the *Green Guide*.

Paints & Other Coatings (GGHC v2.2 Environmental Quality Credit 4.2)

Like adhesives, paints and other coatings are also still primarily screened by TVOC content. Currently, the limiting regulation for most paint and coating types is the South Coast Air Quality Management District (SCAQMD) Rule #1113.

Any product sold in southern California is required to meet the SCAQMD limits, so manufacturers of products in every category of paint and coating are steadily lowering VOC content levels in their products – with the notable exception of shellacs. Because of their very high VOC content levels, it is recommended to avoid shellac use where possible. When it is necessary for furnishings, it is preferable to shop apply vs. field apply on site, to allow for better control of emissions.

Note that even though the SCAQMD VOC limit for paints is 50 g/l, a large and growing number of paints are available at less than 20 g/l VOCs. It should be noted, however, that this VOC level is calculated based on the white base paint before tinting. Tinting additives for deep colors can significantly increase VOC content levels and therefore VOC emissions. Watch for new low and no VOC content tints beginning to be offered by some paint manufacturers.

Note, too, that Green Seal has certified paints based upon TVOC (50 g/l for flat and 150 g/l for non flat) and screening for a range of chemicals of concern.

Lab studies have shown that low VOC paints generally result in significantly lower VOC emissions. However, aldehydes, including formaldehyde, are still released in significant quantities from some low VOC paints, contributed by biocides and other additives; these chemicals can continue to be emitted for a month or more. Ethylene glycol can continue to be emitted from paints for over three years. 01350-based standards and GREENGUARD both have testing protocols for wet applied products. However, few

Green Guide for Health Care™ Technical Brief

Low Emitting Materials

products have been certified and there is significant disagreement on how to establish an industry standard for appropriate measurement techniques and standards.

Flooring, wall covering, trim, and ceiling materials (GGHC v2.2 Environmental Quality Credit 4.2 & 4.3)

For solid finishes – e.g., flooring systems, ceiling tiles and wall coverings – screening by emissions testing under a 01350-based system is becoming well established. Check the Resources section for listings of products meeting 01350-based standards. Note that the products listed as complying with CA 01350-based standards have not been screened for phthalates, HFR content or PFC-related materials. You will have to screen for those directly in consultation with manufacturer representatives.

The *Green Guide* credit also encourages screening adhesives and sealants used in flooring systems for carcinogenic and reproductive toxicant components at 1% or more of total mass. Specify materials that have been certified by a 01350-based screening process to avoid screening individual products on a project-by-project basis.

Composite Wood & Insulation (GGHC v2.2 Environmental Quality Credit 4.4)

Urea-formaldehyde is frequently used as the binder in composite wood products (e.g., particleboard, MDF, veneers, plywood) that are widely used for casework, furniture, and wall and floor assemblies. Urea-formaldehyde is also a common ingredient in acoustic and thermally insulating fiberglass insulation products. This known carcinogen is avoidable by specifying composite wood products and insulation that contain no added urea formaldehyde. The most prevalent replacements are phenol formaldehyde and isocyanurate-based binders. Even better are the soy-based binders just emerging in the composite wood market. Some insulation products, such as cotton, are manufactured without binders.

Furniture & Medical Furnishings (GGHC v2.2 Environmental Quality Credit 4.5)

Furnishings are an area of particular concern, not only for formaldehyde (in wood and finishes) and other VOCs, but also for other chemicals of concern that are used in various foam and fabric treatments, including halogenated flame retardants (HFRs) and perfluorochemicals (PFCs). Few of these chemicals are ever listed on either MSDS or specification sheets.

- Perfluorochemicals (PFCs) are most commonly used as process chemicals or breakdown products. As a result, they often appear as a contaminant rather than listed as a final ingredient. Until better rating systems are available, screening for these products in furniture will generally require direct inquiry to the manufacturer regarding material content. The *Green Guide* credit recognizes the difficulty of obtaining this information by requiring that only 40% of all furniture and medical furnishings avoid three of four materials (PBDE, PFOA, urea-formaldehyde and phthalate plasticizers).
- When possible, avoid all halogenated flame retardants (HFRs), including polybrominated diphenyl ether (PBDE), TBBPA, HBCD, and others. Avoid HFRs by specifying seating with mesh and no foam.
- PFCs can be avoided by screening for common stain and non-stick treatments, including Scotchguard®, Teflon®, Stainmaster®, Scotchban®, and Zonyl®.
- Phthalate plasticizers are generally only found in flexible PVC (vinyl) parts. Avoid phthalates by avoiding furnishings with PVC (vinyl) fabrics and parts.

Meeting the requirements of one of the California 01350-based emissions measurement standards is another important issue recognized by the *Green Guide* credit. However, as of this writing, no 01350 standard is used widely to certify furniture. For more information on materials selection for these products, refer to the *Green Guide for Health Care* Furniture & Medical Furnishings Technical Brief.

Green Guide for Health Care™ Technical Brief

Low Emitting Materials

Exterior Applied Products (GGHC v2.2 Environmental Quality Credit 4.6)

Coatings, roofing and waterproofing materials installed outdoors can be harmful to installers and to the occupants of nearby buildings and can also contribute to the formation of ground-level ozone, a precursor of smog. As a result, it is important to select materials that minimize fumes. Prioritize avoiding hot tar built-up roofing (BUR), and select materials that meet the emission levels listed in the *Green Guide for Health Care*.

In addition to avoiding the use of high fume materials, it is important to manage the fumes that are released by closing windows and fresh air intakes near the work area. If you must install or repair a hot tar roof, follow the guidelines in the NIOSH Publication on Asphalt Fume Exposures listed in the reference section to minimize exposure.

Benefits

Health

VOCs and other carcinogens and reproductive toxicants emitted by building materials represent a serious health risk to installers, building occupants, and the general public. While the science of environmental health is still in its early development, more robust screening processes and environmental quality standards are developed each year. Project teams that use a precautionary approach to materials selection by avoiding products that have been shown to contain or emit potentially harmful substances reduce the possibility that vulnerable populations in the facility will be exposed to chemicals of concern.

Ecological

Low emitting building materials are often made with chemicals that do not carry significant health risks. As a result, low emitting materials often pose a lesser ecological burden than their conventional counterparts throughout their life: from manufacturing to disposal. Exterior applied products that off-gas can pose health risks to workers and contribute to air, water, and soil pollution. Where possible, consider the extraction and manufacturing processes associated with low emitting materials during the specification process to minimize the product's overall ecological impacts.

Economic

The significant increase over the past few years in the availability of low emitting building materials is, in large part, due to growing demand in the design and construction industry. As more designers began to question the chemical content and emissions of the materials they specify on their projects, more and more manufacturers began to release low emitting products. The result has been that the price premium has all but disappeared for most low emitting indoor finishes.

Case Study

Kaiser Permanente, the State of California, and other major buyers have increasingly been insisting on attainment of California 01350-based VOC emission standards by interior finish product manufacturers for several years, starting with flooring and carpet and expanding to fabrics, furniture and other interior finish products. The result is a rapid wholesale change in the industry, driving down emissions from building materials. The California 01350 emissions standards were originally developed by the State of California Department of General Services for specifying materials for its Capitol Area East End Office complex, block 225 in Sacramento, California. After losing the contract because its product failed to pass the test due to formaldehyde emissions, a major ceiling tile manufacturer researched the source of the formaldehyde and reformulated their product to eliminate these emissions.

Green Guide for Health Care™ Technical Brief

Low Emitting Materials

Since the time of that project, dozens of carpet, flooring and other interior finish product manufacturers have had their products tested against these standards and worked to reformulate their products to meet the requirements. Hundreds of products are now listed that have passed independent third party laboratory testing to prove that they do not release VOCs in excess of the 01350 standards. See the web sites in the Resources section below for lists of compliant products.

Resources

In addition to the resources noted in the Green Guide for Health Care, the following may offer additional guidance:

Product lists:

(Note that the products listed as passing a California 01350 based test have not been screened for phthalate, HFR content or PFC related materials. You will have to screen for those directly with manufacturer representatives.)

CHPS Low-Emitting Materials Compliant Materials Table, based upon compliance with CA 01350, http://www.chps.net/manual/lem_table.htm

EPP Carpet Standard also including CA 01350 testing, <http://www.scscertified.com/carpet/>

FloorScore and Indoor Advantage Indoor Air Quality Performance Environmental Certification Program Scientific Certification Systems, both based upon CA 01350, http://www.scscertified.com/manufacturing/manufacture_certclients.html

Green Label Plus - Carpet Testing Program - Approved Products, based upon compliance with CA 01350, http://www.carpet-rug.com/News/040614_GLP.cfm

Green Seal Certified Products List, <http://www.greenseal.org> screen for Children & Schools certified products.

GreenSpec Product Directory, <http://www.buildinggreen.com>

Healthy Building Network, PVC free building materials charts (avoid phthalates), <http://www.healthybuilding.net/pvc/alternatives.html>

Health impact and testing information:

BFRs: Health Care Without Harm website, <http://www.noharm.org> (search for “BFR”) and in “Flame Retardants Under Fire” *Environmental Building News*, June 2004 available at <http://www.buildinggreen.com/auth/article.cfm?filename=130601a.xml> (requires subscription for access)

Bernheim, A, Levin, H and Alevantis, LE, “Special Environmental Requirements for a California State Office Building,” published in Proceedings: Indoor Air 2002, <http://www.dhs.ca.gov/iaq/VOC/>

Chang, John, “Capstone Report on the Development of a Standard Test Method for VOC Emissions from Interior Latex and Alkyd Paints,” US EPA EPA/600/SR-01/093, January 2002, <http://www.epa.gov/nrmrl/pubs/600r01093/600R01093.pdf>

NIOSH Publication No. 2003-112: “Asphalt Fume Exposures During the Application of Hot Asphalt to Roofs,” http://www.cdc.gov/niosh/docs/2003-112/2003-112_6.html

Perfluorochemicals (PFCs): U.S. Environmental Protection Agency website on Perfluorooctanoic Acid (PFOA) and Fluorinated Telomers at <http://www.epa.gov/opptintr/pfoa> and in “Wire and Cable: Untangling Complex Environmental Issues” in *Environmental Building News* March 2004 at <http://www.buildinggreen.com/auth/article.cfm?filename=130301a.xml> (requires subscription for access)

Green Guide for Health Care™ Technical Brief Low Emitting Materials

Phthalates: Health Care Without Harm website, <http://www.noharm.org> (search for “phthalates”)

VOCs and their health effects: U.S. Environmental Protection Agency website on Organic Gases
<http://www.epa.gov/iaq/voc.html>

Regulations and Rating Systems:

California 01350 based rating systems are defined by the “Standard Practice For The Testing Of Volatile Organic Emissions From Various Sources Using Small-Scale Environmental Chambers” published by the California Department of Health Services document CA/DHS/EHLB/R-174 available at <http://www.dhs.ca.gov/ps/deodc/ehlb/iaq/VOCS/>

More information on the use of the 01350 standard in healthcare can be found at the PharosWiki (http://www.pharosproject.net/wiki/index.php?title=Section_01350) and in “Improving Indoor Air Quality with the California 01350 Specification” by Tom Lent, Healthy Building Network website http://www.healthybuilding.net/healthcare/CHPS_1350_summary.pdf and

Floor Score & Indoor Advantage: Scientific Certification Systems Indoor Air Quality Performance Environmental Certification Programs SCS-EC10-2004, <http://www.scs-certified.com/iaq>

GREENGUARD Children & Schools Certification Standards for Low Emitting Products for the Indoor Environment, <http://www.greenguard.org>

Green Seal Commercial Adhesives (GS-36),
<http://www.green-seal.org/certification/standards/commercialadhesives.cfm>

Green Seal Paint Standard GS-11 & GS-03, <http://www.green-seal.org>

South Coast Air Quality Management District (SCAQMD) Rule 1113 (Architectural Coatings),
<http://www.aqmd.gov/rules/reg/reg11/r1113.pdf>

South Coast Air Quality Management District (SCAQMD) Rule 1168 (Adhesive and Sealant Applications),
<http://www.aqmd.gov/rules/reg/reg11/r1168.pdf>.

Tech brief authored by Tom Lent of Healthy Building Network. Reviewed by Anthony Bernheim, FAIA, HDR.

Last update 6/29/2007