



Health Considerations When Choosing School Flooring

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This fact sheet is intended to help schools make good floor purchasing decisions. There are a number of issues that need to be taken into consideration when choosing flooring, including how different materials may impact indoor air quality, up-front and long-term costs (including maintenance requirements and product durability), and the environment. The emphasis will be on health effects.

Carpet and vinyl are the most commonly purchased school flooring products, primarily because of their low “first” costs. However, it may be time to reconsider these choices because their lifetime and health costs may be higher than desired. For instance, both carpet and vinyl may need frequent replacement. And carpeting, when not scrupulously maintained, may be associated with health problems. A number of pollutants that are associated with respiratory illnesses, including dusts, mold and mildew, are captured and can grow in carpets and then get released into the air. Vinyl is also subject to mold and mildew when water pools below it. Vinyl is also the most toxic flooring material to manufacture and to dispose of. Below are some better options.

Major considerations at a glance (see comparison table at the end of the fact sheet for more detail)

Area***	Common Flooring Choices	Better*
Halls and entry	Vinyl tile or sheet	<i>Better:</i> linoleum; <i>Much better:</i> terrazzo, ceramic tile or concrete with non-skid texture and walk-off mats
Classrooms	Carpet	<i>A little better:</i> VCTT carpet **; <i>Better:</i> linoleum; <i>Much better:</i> Terrazzo, ceramic tile or concrete, with washable rugs, mats or cushions as needed
Libraries	Carpet	<i>A little better:</i> VCTT carpet; <i>Better:</i> linoleum; <i>Much better:</i> Terrazzo, ceramic tile or concrete, with washable rugs and non-flooring noise abatement measures
Cafeteria and restrooms	Vinyl tile or sheet	<i>Better:</i> linoleum; <i>Much better:</i> Terrazzo, ceramic tile or concrete
Kitchen	Quarry tile (which we recommend) and resinous epoxy	Rubber, or hard flooring (terrazzo, quarry or ceramic tile, or concrete) with anti-fatigue mats

*Better for health, lower maintenance, higher durability, and less environmental impact, though up front costs are much higher for hard flooring (terrazzo, tile and concrete).

**VCTT is vinyl compound tufted textile, a form of carpet with a thin top fuzzy layer and an impermeable backing, designed to reduce water problems, and limit trapped pollutants. See text for detailed discussion.

***Note, there is not enough information to include gym floors in the table. There is a special section in the text about gyms.

In choosing flooring, next in importance to choice of material is proper maintenance, including training of custodians. A detailed discussion of each flooring choice follows this summary page. A menu of flooring characteristics is also available. School personnel should be alert to new materials that maximize desired traits discussed below, and minimize undesirable ones.

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Major health impacts of flooring. Because people in schools have experienced a variety of health problems linked to poor indoor air quality, the impact on air is one of the most important health factors to consider when choosing flooring.

Among the main air components associated with flooring are:

- allergens (substances and organisms that can cause allergy and asthma);
- irritants (substances that can trigger asthma and cause other respiratory problems);
- toxic chemicals, as in some adhesives and maintenance compounds.

Air quality may be affected by emissions from the flooring material itself, as well as by the adhesives used to attach the floor, surface coatings and maintenance materials, such as waxes and strippers. These emissions of *volatile organic compounds*, or VOCs, are a major concern. VOC's may contribute to any of a full range of health effects, including triggering an asthma attack in someone who already has asthma, gradually leading to the development of asthma in someone who doesn't have it, or contributing to health effects ranging from minor irritation to cancer. In choosing floor materials and associated products, schools should look for low-VOC products and flooring surfaces less likely to exacerbate moisture/mold and allergens issues. Low VOC products are now widely available.ⁱ The Carpet and Rug Institute rates flooring and associated products, using a Green Label for products it considers acceptable.ⁱⁱ

Air quality can be affected by water trapped in or under floors, which may support mold and mildew, associated with asthma and other serious respiratory hazards. This is of particular importance with carpets, which have a fuzzy surface that can hold moisture and support growth. Carpets also collect pesticides and dirt tracked in from outside, and release it into the air when people walk on the carpet.

Other health considerations in choosing flooring include surface qualities related to slips and falls (slipperiness and hardness), glare and seating comfort.

Non-health issues in selecting a floor. These other considerations need to be addressed:

- **Activities in the area.** In libraries and sometimes classrooms, for example, keeping noise levels down may be important; in hallways and other areas with high foot traffic, strength and durability are critical; in the cafeteria, strength, durability, and resistance to water stains matter most.
- **Ergonomic issues.** Slips and falls are affected by how slippery a surface is, and the impact of a fall by how hard a surface is. For young children, who often sit on the floor, it may be important to have a comfortable surface to sit on.
- **Cost.** It is important to consider not only the up-front cost of materials and installation, but the lifetime cost, which includes durability and frequency of replacement, and the cost of maintenance. Carpet, for example, typically has the lowest purchase price of any option, but expensive maintenance and low durability make its life span cost highest of all options considered here.

- **Environmental impact.** More and more schools are looking at cradle to grave environmental impact of flooring materials. In addition to promoting good indoor air quality, the concerns include: hazardous exposure to workers in manufacturing, whether the product is made from renewable resources, contains recycled material, can be recycled, contributes to hazardous waste, and how much energy is used in manufacturing it. A list of materials for school construction that are environmentally sound has been prepared by the Collaborative for High Performance Schools (CHPS), used in California and Massachusetts.ⁱⁱⁱ

Since carpet is widely associated with indoor air problems, the next section will address carpet in detail.

THE CARPET ISSUE

Before the 1950s, most schools used Terrazzo, which lasts forever, later linoleum (which then contained asbestos) and then vinyl flooring (which did not). In the 1960s carpeting became popular, as a low-cost alternative that also controlled noise and reflected light, was comfortable to sit on and attractive. But the trend in recent years is back to harder floors, because of the indoor air problems associated with carpets. Many carpet adhesives give off VOCs. They may continue to emit them long after the 48 hours or so the building is commonly recommended to be unoccupied following installation. Some data shows they stop emitting after a couple of weeks. Porous backing allows water from cleaning, spills, leaky pipes or floods to penetrate to the backing and subfloor, where it remains, favoring growth of mold and mildew. These micro-organisms then get stirred up into the air and can cause respiratory problems. The fuzzy (top) part of the carpet also retains dirt and dust, as well as pesticides and other pollutants from shoes or other sources. The carpet industry sometimes says this is a good thing--the carpet can hold pollutants out of the air until they are vacuumed up. But pollutants are kicked up by walking and become airborne. To minimize these pollutants, carpets need to be vacuumed and washed frequently (see section 5). Finally, carpets are often warranted for only five years, but may need repair or replacement earlier than that.

VCTT, a special carpet. A relatively new type of carpet may solve the worst air problems caused by conventional (broadloom) carpet. It's called vinyl composition tufted textile, or VCTT. This carpet is made from a very dense low-tufted textile that will gather less dirt than conventional carpet. Most importantly, it has a backing that is impermeable to water and allows for impermeable welded seams. It is more thoroughly cleaned by vacuuming than broadloom, because of the thinner fuzzy layer. It can even be cleaned and dried easily following a flood. Another advantage is that VCTT is applied with a non-wet "peel-and-stick" adhesive that is unlikely to emit VOCs. VCTT retains the broadloom characteristics of noise and glare control, and seating comfort.

Concerns about VCTT. It is important to realize, that although VCTT is an improvement over broadloom, it is still carpet: its surface will retain some dirt, and when it gets wet (floods, leaks, spills) the surface can harbor mold and mildew within 24 hours. Also its impermeability can be a problem if there is water coming from the slab. In that situation, carpet of any kind is a poor choice (see the section below, **Water and the slab**). When VCTT is used under humid conditions, it is worth considering adding air

conditioning to dehumidify the air. However, air conditioning, if improperly installed, may actually cause water problems (from condensate dripping from improperly insulated ducts). Finally, it is vinyl, and like vinyl resilient flooring (see next section), it presents an environmental concern. Vinyl manufacture can expose workers to carcinogenic materials, and when discarded vinyl is burned it gives off toxic dioxin unless burned at very high temperatures.

Other ways to abate noise. Carpet is actually one of the least effective ways to reduce noise. In rooms needing noise abatement, such as libraries, consider that noise can be better reduced by:

- Putting sound reducing materials in ducts, walls and ceilings. Be sure to choose non-porous materials that do not give off formaldehyde or other VOCs; acoustic ceiling tiles are among the best measures, but it is important to replace wet tiles, and to store replacement tiles well sealed or in a completely dry environment.
- Building the libraries or classrooms with walls at angles other than perpendicular, or moving bookshelves to achieve room spaces that are not rectangular or square;
- Putting pads on chair and table leg bottoms.

Other ways to provide seating comfort. In elementary classrooms, alternatives to carpet include hard floors with washable rugs or mats, or cushions with washable covers.

Recommendation. Fleecy materials (carpet and VCTT) should only be used when essential for acoustic or comfort purposes, and only if the school has the budget for adequate maintenance.^{iv} In such areas, VCTT may be the best alternative.^v Carpet should at minimum meet the VOC testing standards of the Carpet and Rug Institute.ⁱⁱ For carpet care, see the section, **FLOOR CARE WITH AIR QUALITY IN MIND** on page 7. For other school areas, it is best to go with the most durable non-porous hard materials, such as terrazzo, concrete or tile (see attached chart). With any option, the ability to budget for appropriate maintenance, repair and replacement should always be considered. Also it is important to train maintenance personnel in the best methods to maintain good indoor air quality as well as preserve the floor.

RESILIENT VS. HARD FLOORING

Resilient flooring (vinyl or linoleum tiles or sheets) is popular because of its initial low cost and ease in cleaning. However it has several disadvantages, including: a) potential VOC problems from adhesives, sealers, waxes and strippers, and from the materials themselves. There are now a range of products with low VOCs, reducing that problem. Whether the vinyl itself emits VOCs is a subject of debate. Linoleum is an all natural product, but emits vapors of linseed oil, which bother some people. b) high cost of maintenance; c) linoleum is subject to mold and mildew if the subfloor gets wet. Vinyl is completely impermeable to water and is not breathable, which can cause it to pop up from water pressure if there is a lot of water under the floor. d) vinyl also is environmentally unfriendly: it is a synthetic, non-recyclable material that can be carcinogenic to the workers who make it, and a problem in landfills. When burned it gives off toxic dioxin, unless burning takes place at very high temperatures.

Hard mineral floors are all expensive--several times more than the most common flooring, vinyl composition tile--but because of their easy maintenance and very long durability, they have the lowest lifetime cost of any flooring. All three are hard surfaces to fall on and do not reduce noise. Slips and falls can be reduced in the case of ceramic tile by having grit baked in the surface during manufacture, or with concrete by having a texture stamped into the floor.

If budgets do not allow hard flooring, linoleum is acceptable, provided attention is paid to water below the floor and maintenance issues.

WATER AND THE SLAB

All schools are built on a concrete slab. If the slab is on the ground it is likely to conduct water to its upper surface. Vapor barriers below or above it are not foolproof (though some manufacturers of concrete sealers claim they can resist very high moisture levels by coating the upper surface of the slab). Water from the slab can pool beneath the floor and cause several problems:

- It may undermine a flooring adhesive. The adhesive may then become an ongoing VOC problem. In new construction it is important to allow the slab to cure completely before applying any adhesive;
- The water is a potential respiratory issue if the floor contains organic materials that support mold and mildew. Organic materials include carpet, vinyl products and adhesives.
- If the floor is completely impermeable, the water may pool and ultimately pop the flooring. Impermeable floors include vinyl, VCTT, and hard-fired tile.

It is important to address water problems before installing a floor. Seek to prevent leaks of outside water into the building. Controlling rainwater through site grading is key. In addition, it is important to provide a pathway for water to drain from the slab.

Mineral floors (terrazzo, ceramic tile and concrete) can become wet on the underside without contributing to indoor air problems; all of them, except porcelain and some high-fired tile, are "breathable", which means they allow water *vapor* to evaporate from the slab, though they absorb little or no *liquid* water.

GENERAL CONSIDERATIONS FOR EACH AREA (EXCEPT GYMS)

A table to aid in making a flooring selection follows the text. Before consulting the table, it would be helpful to review these general considerations for each school area:

Classrooms. Classrooms may require a trade-off between the noise control, comfort and safety of VCTT on the one hand, and the good air quality characteristics, durability and immunity to water of hard floors on the other. Young children often sit on the floor
Recommendation: *Use hard floors (first choice) or linoleum (second choice) and provide washable rugs or mats, or cushions with washable covers for children to sit on.*

Libraries. The issue of carpet and noise abatement is addressed above in the section on **Carpet**. Note another problem with carpet in libraries is that books are a major source of dust, dirt and possibly mold, which can accumulate in carpet.

Recommendation: *Use hard floors (first choice) or linoleum (second choice) with architectural noise abatements and possibly washable rugs.*

Hallways and entries. See the section, **RESILIENT VS. HARD FLOORING** for detailed discussion. Whatever the floors, they will benefit from **walk-off mats** at entrances to scrape dirt from shoes. This dirt can carry in allergens and pesticide residues used outside. The mats should not be extra thick (these may never dry) or attached to the floor; they should be capable of being picked up, cleaned and replaced when needed. Rubber backing prevents them from slipping. Sometimes a sequence of walk-off mats is used. Some schools have found that keeping the outside paths well swept also reduces outside dirt tracked inside. Other strategies include using grates and other systems that help knock dirt off of shoes before people enter.

Recommendation: *Use durable non-porous, low-maintenance hard materials, such as terrazzo, ceramic tile and concrete, with textured surfaces, and walk-off mats. Second choice, linoleum with walk-off mats.*

Cafeteria and Restrooms. Because of the likelihood of food and liquid spills, the floor should be durable, waterproof and as non-slip as possible.

Recommendation: *Textured terrazzo, concrete and ceramic tile are the best choices. Linoleum and rubber are acceptable with the reservations under " **Hallways and entries.**"*

Kitchen. Here, the important qualities of flooring are resilience, so that the floor is easier on the legs of employees who stand for long periods, being waterproof, non-slip and easily cleaned.

Recommendation. *There are two satisfactory alternatives. First, resilient flooring (linoleum or rubber) is easier on the legs than harder floors. If rubber is used, be sure it does not have an odor. The second alternative is a hard flooring (terrazzo, concrete or tile). With hard flooring, anti-fatigue mats may be needed to reduce the impact of the hardness on employees who stand for long periods.*

A NOTE ON WOOD FLOORS

Wood flooring is not discussed in this factsheet only because it is prohibitively expensive for most schools. However, it is important to note that wood is an excellent floor. If a school already has wood flooring in reasonable condition, it would be unwise to cover it with another type of flooring with more potential problems, such as carpet or resilient flooring.

GYM FLOORING

Gym floors are either wood, or one of three categories of synthetics. Wood floors are still the most widely used in professional sports and high schools, though it is not certain whether this is a matter of tradition or quality. They are far more expensive than synthetic floors. Elementary and middle schools that use their gyms for multiple

purposes are better served by synthetic floors, which can be extremely hard and durable. There are three categories of synthetic floors: poured polyurethane, vinyl or rubber sheet, and injection molded polypropylene tiles. Limited information is available on these floors. What we know is discussed below.

Issues to consider include:

- a) *Athletic characteristics, including friction and resilience.* Too much friction, and a running athlete will stop too short and may fall; too little and the athlete may slip. Friction is determined by the top coating on the floor. Resilience, if too great, will cause fatigue; if too low, will be hard on the athletes' bodies. Resilience is determined by the floor materials, and to a greater degree, by what's under it. There is a large array of pads, foam strips, and other materials, that can cushion wood and synthetic floors.
- b) *Emissions of VOCs.* VOCs may be an issue during installation, from the product itself after installation, and from maintenance chemicals. It is extremely important to ventilate the area with maximum possible outside air during and after installation, and continue for at least as long as the manufacturer recommends, preferably longer.
- c) *Water problems.* As with all flooring, water from the slab or from floods or leaks, must have somewhere to go, so that it does not pool under the floor, damaging the floor and supporting mold and mildew.

Below are some of the *concerns* and *advantages* of each type of flooring, where known. Note there is not enough information available to make a recommendation.

Wood. *Concern:* There is debate as to whether water-based finishes are sufficiently durable, though they give off far fewer VOCs than oil-based finishes. A low-VOC alkyd-based finish was successful in Nova Scotia schools, but an 8-week period for offgassing was allowed before occupancy.

Poured polyurethane. *Concerns:* Urethanes contain isocyanates, which are extremely irritating to the skin and respiratory system, and which can lead to asthma in sensitive individuals after repeated low-level exposures. The VOCs will be hazardous while the product is drying. Polyurethane can contain small amounts of lead or mercury--ask manufacturer to guarantee it does not. During installation, polyurethane gives off significant VOCs. It needs to cure for several days with good ventilation. Sports lines are then painted on with a polyurethane paint, another VOC source. An additional concern: if there is no rubber base mat on the slab, the product may not self-level and the uneven surface can lead to trips and shin splints.

Advantages: has no seams to gather dirt. Lasts 15-30 years, according to manufacturers. Easy to repair. Comes with a variety of resiliencies.

Vinyl or rubber sheet. *Concerns:* The installer may add layers of polyurethane topcoat to reduce scuffing, a potential VOC problem. Floors must be periodically refinished. Rubber may be mixed with a binder containing isocyanates, which are extremely irritating to the skin and respiratory system, and which can lead to asthma in sensitive individuals after repeated low-level exposures. The hazard is most likely to affect

workers in manufacture. It is not clear if there is a hazard to the finished product. Seams can gather dirt. Rubber may have a lasting, but probably not harmful, odor.

Advantages: Some products require no coating for the lifetime of the floor. Rubber, for example, can last the life of building. A variety of colors that can be used to lay sports lines directly into floor, minimizing painting of floor. Easy to repair by patching. Easy maintenance--mop with neutral cleaner. They are about half the cost of wood.

Polypropylene tile. *Concerns:* We have no health problem information, but also no information as to how good the floors are for sports.

Advantages: They are snap-together tiles that do not require adhesive to the slab or rubber mat. They are absolutely immune to water damage. Repair requires only replacing affected tiles; the entire floor can be disassembled, moved or reinstalled over a different subfloor. They are the least expensive synthetic, at about one third the price of wood.

FLOOR CARE WITH AIR QUALITY IN MIND

Proper maintenance. Maintenance should be done with environmentally safe cleaners, which preserve both the floor and respiratory health. Here are some basics:

- Minimize stripping by having 6 to 12 coats of durable finish, walk-off mats, and good daily maintenance;
- Avoid high gloss finishes;
- Clean carpets with daily vacuuming with a high efficiency particulate (HEPA) filter, and monthly hot water extraction. Vacuuming with a non-HEPA filter can actually increase particulates in the air, as fine particles extracted from the carpet may be exhausted into the room. Do not use chemicals or soap if possible, as residues of these can be very irritating when airborne. It is important to observe two precautions with hot water extraction: ensure removal of all moisture, and don't close up rooms and areas after cleaning, particularly in the summer, so that humidity is minimized. Excess moisture can lead to lots of mold growth.
- Avoid excessive water when cleaning resilient flooring. It can get behind the base molding and saturate the paper facing of gypsum board walls, providing food for mold.

7. INDOOR AIR QUALITY PROGRAM

Obviously, choosing floors with indoor air quality in mind is not by itself sufficient to protect air quality. An Indoor Air Quality Committee should consider other building materials, as well as safe pest control, moisture control and the ventilation system. The program should include committee education about evaluating and solving indoor air problems. A helpful guide is the EPA's *Tools for Schools*.^{vi} For further information on flooring and other school design issues, the Collaborative for High Performance Schools (CHPS), under the Massachusetts Technology Collaborative, has created an exhaustive manual which can be found online.^{vii}

ⁱ To find information on the health effects of a product, one place to start is the product's Material Safety Data Sheet, or MSDS. Companies are required by OSHA to furnish MSDS's to all users. If the MSDS does not provide clear or adequate information, other sources can be consulted, including the local or state health departments, OSHA, or the internet.

ⁱⁱ The Green Product List of Carpet & Rug Institute (CRI) website, www.carpet-rug.com, which also provides information on selection, installation and maintenance.

ⁱⁱⁱ The list can be found at http://www.chps.net/manual/lem_table.htm.

^{iv} This is the recommendation of both the Massachusetts Department of Public Health and the Washington State Department of Health.

^v ***From the Ground UP: Floorcovering Recommendations from an IAQ Consortium***, a CEFPI Brief, Council of Educational Facility Planners, August 2002. Available on website of National Clearinghouse for Educational Facilities, or at the cefpi website, <http://www.cefpi.org/pdf/issue15.pdf>.

^{vi} ***Tools for Schools*** and ***IAQDesign Tools for Schools***, are kits with comprehensive instructions on how to convene a committee and initiate a process for evaluating and solving indoor air problems. It is available on the internet at the website of the Environmental Protection Agency, available at <http://www.epa.gov/iaq/schooldesign/>.

^{vii} <http://www.chps.net/manual>.

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