PBT Elimination from Building Materials Technical Brief

Green Guide for Health Care **Materials & Resources Credit 4.1, 4.3**
Green Guide for Health Care **Environmental Quality Credit 4.5**

Overview

Persistent bioaccumulative toxicants (PBTs) are toxic chemicals that do not break down rapidly in the environment (persistent), accumulate in living tissues and concentrate as they move up the food chain – for example, from algae to fish to humans (bioaccumulative) – and are hazardous to human and environmental health (toxic). Some PBTs that contaminate the general environment are mobile and can have toxic effects thousands of miles from where they are released. PBTs include by-product chemicals associated with materials manufacture, such as dioxin, naturally occurring elements like mercury, and some substances intentionally added to materials – for example, some polybrominated flame retardants. PBTs are associated with a range of known or highly probable serious human health effects, including cancer, endocrine disruption, immune system disorders, impaired brain development, and birth defects. A variety of PBTs are used in building materials or are a byproduct of the material life cycle, produced in manufacture or at disposal.

Joining an international consensus reflected in an international treaty, the U.S. Environmental Protection Agency (U.S. EPA) has prioritized reducing PBT exposure. Over the past ten years, many hospital systems, manufacturers and local governments have established programs to reduce or eliminate the use of products and materials that lead to PBT release through their life cycle. In 1998, a Memorandum of Understanding between the American Hospital Association and the U.S. EPA set goals for hospital pollution prevention, including a goal for the virtual elimination of mercury and mercury-containing devices from the hospital waste stream by the year 2005, and identified hazardous substances such as PBTs for pollution prevention and waste reduction opportunities. The MOU's stated purpose is to "provide the health care industry with enhanced tools for minimizing the production of persistent, bioaccumulative and toxic ("PBT") pollutants and reducing the volumes of waste generated. Such reductions are beneficial to the environment and will reduce the waste disposal costs incurred by the health care industry."[1]

The PBT Elimination credits (GGHC v2.2 Materials & Resources Prerequisite 2, GGHC v2.2 Materials & Resources Credits 4.1, 4.2, and 4.3, and GGHC v2.2 Environmental Quality Credit 4.5) broaden the definition of a facility's Ecological Footprint to emphasize the connection between green building practices and human health.

GGHC v2.2 Materials & Resources Credit 4.1 encourages dioxin minimization through avoidance of building materials made with chlorinated compounds.

GGHC v2.2 Materials & Resources Credit 4.3 addresses building materials that commonly contain lead or cadmium: these include solder, roofing, wiring and paint.

GGHC v2.2 Materials & Resources Prerequisite 2 and Credit 4.2 reward projects that virtually eliminate mercury from building materials, products, equipment, and devices. Additional information on mercury elimination can be found in the *Green Guide for Health Care* Mercury Elimination Technical Brief.

[1] 1998 Memorandum of Understanding Between the American Hospital Association and the U.S. Environmental Protection Agency, http://www.h2e-online.org/pubs/Memorandum.pdf.

Green Guide for Health Care™ is a project of the Center for Maximum Potential Building Systems (CMPBS) and Health Care Without Harm.
The *Green Guide* Technical Briefs were funded through grants form the Merck Family Fund and New York State Energy and Development Authority.

GGHC v2.2 Environmental Quality Credit 4.5 excludes polybrominated diphenyl ethers (PBDE), a flame retardant; perfluorooctanoic acid (PFOA or C8); urea formaldehyde; and, phthalate plasticizers from furniture and furnishings specifications.

Types of PBTs, Sources of Exposure, and Outcomes

Heavy Metals

Lead, used to stabilize PVC, is a potent neurotoxin, particularly damaging to the developing brains of fetuses, infants, and children. Cadmium, used in paints and electronics and to stabilize PVC, is a carcinogen and is toxic to the kidney, lung, and placenta. Mercury, used in thermostats and other control and measurement devices, is a potent neurotoxin and increases the risk of cardiovascular disease. For details on health effects associated with mercury, refer to the *Green Guide for Health Care* Mercury Elimination Technical Brief. These heavy metal PBTs are used as additives or components in some building materials and products. They can migrate out of the product during use, directly exposing the building occupants, and at disposal, directly exposing the surrounding community. Additionally, workers involved with the manufacture of lead-, cadmium-, or mercury-containing products and materials are at risk of exposure.

Halogenated Flame Retardants (HFRs) and Perfluorochemicals (PFCs)

Halogenated flame retardants are another class of problematic PBT additives in building materials. Formulated in fabrics, foams and various other plastics to reduce flammability, HFRs disrupt thyroid and estrogen hormones, which can cause developmental disorders, including brain and reproductive system damage.

Similarly, perfluorochemicals 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. PFCs enter the environment during the manufacturing process and also can become evident in building products as contaminants of stain and wrinkle resistance treatments.

Dioxins and Dioxin-like Compounds

Dioxins and dioxin-like compounds are a family of chemicals with variable toxicity. The most potent among them is considered by the U.S. EPA to be carcinogenic at extremely low levels of exposure. Other potential health problems associated with exposure to dioxin-like compounds include birth defects, neurodevelopmental problems, endometriosis, infertility, and abnormal immune system function. In animal tests, doses as small as nanograms (one thousandth of one millionth of a gram) per kilogram of body weight can cause harm. Exposure to fractions of a microgram of dioxin on a single day during pregnancy can cause developmental damage to the fetus.

Some dioxins and other PBTs are byproducts of the oil and gas refining process, the origin of all petrochemical plastics. Particularly problematic are chlorinated plastics, such as polyvinyl chloride (PVC) and neoprene. Production of chlorinated plastics leads inevitably to the production of hazardous dioxins and other priority PBTs, such as polychlorinated biphenyls (PCBs). When chlorine-containing plastic is burned – such as in a structural fire, an incinerator or landfill fire, it produces dioxins and dioxin-like compounds. Cement manufactured in kilns fired with hazardous and medical waste is also associated with release of dioxins and heavy metals.[2]

Dioxin and PCBs are not manufactured intentionally nor do they act as feedstocks for the manufacture of new building materials. Instead, they are produced as unintentional byproducts associated with the manufacture of certain materials, and associated with intentional or unintentional combustion (as with an incinerator or accidental structural or landfill fire, respectively). In either case, PBTs have a particularly

[2] For more information on the health impacts of dioxin, see the Healthy Building Network's Dioxin article on the Pharos Wiki at http://www.pharosproject.net/wiki/index.php?title=Dioxin and Health Care Without Harm "Dioxin, PVC, and Health Care Institutions" 2002, http://www.noharm.org/library/docs/Going_Green_3-1_Dioxin_PVC_and_Health_Care.pdf

Green Guide for Health Care™ is a project of the Center for Maximum Potential Building Systems (CMPBS) and Health Care Without Harm.
The *Green Guide* Technical Briefs were funded through grants form the Merck Family Fund and New York State Energy and Development Authority.

strong impact on fence line communities located near manufacturing plants and disposal facilities and have emerged as significant environmental justice concerns. However, because many PBTs tend to travel widely and concentrate in the food chain, they ultimately affect everyone. Average levels of dioxin exposure in the U.S. population already meet or exceed federal and international "safe" or tolerable daily dose.[3]

The Challenges

Eliminating life cycle PBTs from building specifications can seem a daunting task. They have been all but eliminated from some building materials, such as lead in paint. Other products, such as vinyl wallcovering and flooring, are still widely used due to their performance characteristics and low cost. Many high performance alternatives to vinyl finish materials exist, but as newly introduced products to the marketplace they sometimes have higher costs. As their use in health care settings expands, concerns about potential risks should be alleviated, while growing demand should result in leveling costs. An additional challenge to implementing PBT avoidance strategies may be presented by products such as window gaskets, which often do not identify PBTs in their material composition. Misleading labeling conventions can also present a challenge. For example, a solder product labeled “lead-free” may actually contain as much as 0.2% lead.

As signaled by the *Green Guide* credits, a manageable approach to PBT avoidance is to focus on large quantity applications, such as flooring, where the return for effort will be substantial rather than on small quantity applications such as gaskets.

Best Practices

Dioxin-Related Materials (GGHC v2.2 Materials & Resources Credit 4.1)

Materials that May Result in the Production of Dioxin

Cement

Roughly half of the cement kilns in the United States use hazardous waste for fuel. The challenge of avoiding cement from kilns fired with hazardous waste will vary depending on location. Discuss the issue with the project’s cement and/or concrete supplier to determine availability of cement from kilns fired without hazardous waste. Note that a variety of recycled content cement substitutes exist that can be used to reduce both the dioxin and global warming burden of Portland cement. Be sure to use fly ash that was itself not generated from a process fired with hazardous waste.

Chlorinated Plastics

The polymers listed below are manufactured with chlorine. As such, they are associated with life cycle dioxin releases resulting from manufacturing practices and intentional or unintentional combustion. Cost competitive substitute materials with equal or superior performance attributes are available for most of these applications.

Chlorinated polyethylene (CPE also brand name Tyrin)	Used in buildings primarily as an additive to PVC in windows, pipes and cables.
Chlorinated polyvinyl chloride (CPVC)	Primarily used for hot water pipe.
Chlorosulfonated polyethylene (CSPE, also brand name Hypalon)	Used in buildings primarily for single ply roofing membranes, geomembranes and other coated fabrics.

[3] Center for Health, Environment and Justice, “The American People's Dioxin Report, Technical Support Document”, November 1999 Table 4-5 http://www.besafenet.com/report.html

Green Guide for Health Care™ is a project of the Center for Maximum Potential Building Systems (CMPBS) and Health Care Without Harm.
The *Green Guide* Technical Briefs were funded through grants form the Merck Family Fund and New York State Energy and Development Authority.

Polychloroprene (CR or chloroprene rubber, also brand name Neoprene)	Used in adhesives, gaskets, hot tar flashings, expansion joint filler, geomembranes and coatings.
Polyvinyl chloride (PVC)	By far the largest bulk of chlorinated plastics found in building materials. PVC is used in piping, roof membranes, window frames, siding, carpet backing, resilient flooring, ceiling tiles, window treatments, wall coverings and wall protection.

Alternative Materials

Exterior Materials

- Roof membranes – TPO (thermoplastic polyolefin) and EPDM fulfill performance criteria for single-ply membrane roofs (including cool roof criteria), are readily available and cost competitive.
- Geomembranes – Polypropylene, polyolefin and high-density polyethylene (HDPE) are commonly available alternatives to Hypalon, neoprene and PVC.
- PVC is not widely used in health care for window- & door-frames, siding or exterior finishes.

Interior Finishes

- Carpet, flooring and base (minimum of 50% of total floor area) – Health care grade carpet backings are available in polyvinyl butyral (PVB), polyolefins, polypropylene, urethane and jute. Resilient floor options include linoleum, rubber, polyolefin, polyethylene, terrazzo and cork. Finished concrete can avoid the need for installing a flooring finish material.
- Ceiling Tiles – Ceiling tiles sometimes utilize PVC for the scrubbable surface. Polyesters, such as Mylar®, offer a chlorine-free alternative plastic film surface. Other tiles such as those made from inorganic perlite are inherently scrubbable and mold resistant.
- Wall coverings and protection – Polyethylenes, polyesters and cellulose are just a few of the scrubbable surfaces offered for flexible wall coverings. Note that PVC wall coverings have the additional problem of trapping moisture in walls, leading to mold growth. The wall protection industry is beginning to roll out a variety of products using bio-based polymers, HDPE, ABS, aluminum, wood and other materials. Consider removing wall coverings altogether in favor of paint.
- Window treatments – Window treatments are available in TPO, fiberglass and polyesters.

Plumbing/Electrical Systems

Due to code and other concerns, most health care facilities contain little PVC or CPVC piping. Neoprene may be used in small specialty applications. Most PVC piping will likely be outdoors in irrigation and in conduit and junction boxes. The GGHC v2.2 Materials & Resources Credit 4.1 Resources section lists several databases for finding manufacturers of materials that meet these credit requirements.

- Piping – Most PVC piping in health care facilities is found below grade or in the irrigation system. Polyethylene irrigation pipe comes in long flexible rolls offering installation advantages over rigid PVC and more protection against shovel damage.
- Conduit – Conduit is available in HDPE, polypropylene, steel, fiberglass, aluminum and nylon.
- Electrical cable – Jacketing is often made of PVC with lead additives. Alternatives include low smoke, zero halogenated (LSZH) wire and cable products. Avoid jacketing manufactured with perfluorochemical compounds, commonly sold as Teflon®, which also are persistent and toxic. See the *Green Guide for Health Care* Low Emitting Materials Technical Brief for additional information
- Junction boxes – Junction boxes are available in HDPE, polypropylene, steel, fiberglass, aluminum and nylon.

Green Guide for Health Care™ is a project of the Center for Maximum Potential Building Systems (CMPBS) and Health Care Without Harm.
The *Green Guide* Technical Briefs were funded through grants form the Merck Family Fund and New York State Energy and Development Authority.

Mercury Elimination (GGHC v2.2 Materials & Resources Prerequisite 2 and Credit 4.2)

Best practices for mercury elimination are outlined in the *Green Guide for Health Care* Mercury Elimination Technical Brief.

Lead (GGHC v2.2 Materials & Resources Credit 4.3)

Lead is used in solder, roofing, gutter and flashing products, radiation shielding, and batteries and as a stabilizer in PVC products. In the past, it was used in paints and pipes and is a hazard in older buildings and demolition projects.

- Specify 100% lead-free solders. (Note that solder marketed as 'lead-free' can still legally contain ≤0.2% lead.)
- Avoid terne and copper roofing, flashing and gutter products.
- A major use of lead in PVC products is in the insulation jacketing for wiring. Specify lead-free jacketing where available. (Also note that Teflon®-jacketing should be avoided – see the *Green Guide for Health Care* Low Emitting Materials Technical Brief for additional information.)
- Green Seal certified paints are assured to be free of cadmium and lead.

Cadmium (GGHC v2.2 Materials & Resources Credit 4.3)

Cadmium is used in paints, coatings, and batteries and as a stabilizer in PVC products. While lead has been largely eliminated from paints, cadmium remains a widely used pigment.

- Green Seal certified paints are assured to be free of cadmium and lead.
- Review material MSDS sheets if concerned that a material may contain cadmium.

Halogenated Flame Retardants & Perfluorocarbons (GGHC v2.2 Environmental Quality Credit 4.5)

Flame retardants are used in fabrics and foams in furniture and some other building material plastic applications.

- Avoid furniture that includes PBDEs (polybrominated diphenyl ether – already banned in some states) and other halogenated organic flame retardants (HFRs), including Tetrabromobisphenol-A (TBBPA), Hexabromocyclododecane (HBCD), Deca-BDE (Decabromodiphenyl ether), Tris(2-chloroisopropyl) phosphate (TCPP), Tris(2-chloroethyl)phosphate (TCEP), and Dechlorane Plus.
- Seek furniture designed to avoid the need for added flame retardants such as seating with mesh instead of foam.

PFC contamination results from the use of PVC in manufacturing fabric and other building material stain and non-stick treatments such as Krypton®, Scotchguard®, Stainmaster®, Scotchban®, Teflon®, Zonyl®.

Determining whether HFRs are in the product or PFCs were used in manufacturing will require discussion with your manufacturer's rep. HFRs are rarely listed on product data sheets. PFCs are most commonly used as a process chemical or are a break down product, so they are considered contaminants rather than a final ingredient.

Note that GGHC v2.2 Environmental Quality Credit 4.5 addresses a range of other indoor air quality issues as well, described in more detail in the *Green Guide for Health Care* Low Emitting Materials Tech Brief.

Green Guide for Health Care™ is a project of the Center for Maximum Potential Building Systems (CMPBS) and Health Care Without Harm.
The *Green Guide* Technical Briefs were funded through grants form the Merck Family Fund and New York State Energy and Development Authority.

Benefits

Health

PBT avoidance in building materials has a positive impact on the health of building occupants, the surrounding community and the global community. Many PBTs are used as additives, such as stabilizers and flame retardants in building materials. As the finished material ages, these additives can leach or flake out and be breathed in by patients, staff and visitors. Contact with even small amounts of PBTs can lead to health problems. The populations served by hospitals, particularly the very young and immuno-compromised, are potentially most susceptible to the negative health impacts of PBTs. Eliminating products containing PBTs from a building's interior improves the indoor air quality and associated general health of all its occupants.

Ecologic

PBTs released into the environment during manufacture, disposal or other stages of the building materials' life cycle can negatively impact human and wildlife health globally, causing endocrine disruption, infertility, birth defects, cancer and other health effects. Local, regional and global ecologies are threatened by PBT emissions. Many PBTs are effective at very small doses, making emission control difficult and clean up challenging to contain after they have entered the biosphere. Eliminating the sources is therefore the most effective way to reduce further ecologic contamination.

Economic

High performance, cost-competitive alternatives to PBT-containing building materials are available for most applications. Cost-neutral alternatives to PVC products are becoming increasingly available as awareness of the associated hazards grows among architects, contractors, owners, and the general public, thereby accelerating demand. Because the health care industry is dominated by owner-occupied facilities, it is uniquely poised to take advantage of the life-cycle cost benefits associated with the low-maintenance properties of many PVC-free products, such as flooring and wall covering.

Case Study

The Kaiser Permanente health care system has established and is implementing a policy to avoid materials that contribute to PBT releases. As part of a larger effort to reduce the environmental burdens associated with its construction and operations, Kaiser Permanente has taken aggressive steps to eliminate materials and products containing PVC. Finding that comparative information on products for the health care market was not readily available, Kaiser Permanente undertook a focused study including pilot-testing materials in projects. As a result of that effort, Kaiser Permanente changed its standards from PVC piping and conduit to HDPE, and from vinyl flooring to rubber and polyolefin options. Roofing standards are shifting to PVC-free cool roof membranes. Finding that the options in the marketplace did not meet all of Kaiser Permanente's design, performance, and environmental requirements, the organization challenged the carpet and wall protection industries with offers of beta tests and contracts for those who joined into cooperative development agreements. Manufacturers responded by developing new products that increase PVC-free options for both product types.

Kaiser Permanente has a strong commitment to environmental health improvement, but with construction costs skyrocketing and profit margins slim, each change must be supported by a strong business case. For example, the switch from vinyl flooring to rubber and polyolefin options increased flooring first costs. However, Kaiser Permanente found that the combination of reduced maintenance costs (due to the elimination of waxing) and higher coefficient of friction (reducing slip-fall accidents that plague wet vinyl floors) associated with the substitute products offset the increased first cost. Kaiser Permanente has increasingly found that doing the right thing for the environment has bottom line payoffs.

Green Guide for Health Care™ is a project of the Center for Maximum Potential Building Systems (CMPBS) and Health Care Without Harm.
The *Green Guide* Technical Briefs were funded through grants form the Merck Family Fund and New York State Energy and Development Authority.

Resources

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

Kaiser Permanente case study and business case: sidebar "Kaiser Permanente Takes the Lead" in "Hospital, Heal Thyself: Greening the Design and Construction of Health care Facilities," Jessica Boehland, *Environmental Building News*, June 2005, http://www.buildinggreen.com

PBT-free building materials:

- GreenSpec Product Directory, http://www.buildinggreen.com
- Healthy Building Network, PVC free building materials chart, http://www.healthybuilding.net/pvc/alternatives.html
- Health Care Without Harm, Green Building: Alternatives to Polyvinyl Chloride (PVC) Building Materials for the Neonatal Intensive Care Unit (NICU) – includes information on PVC & HFR content http://www.noharm.org/details.cfm?ID=1339&type=document

PBT information: U.S. Environmental Protection Agency website for the Persistent Bioaccumulative and Toxic (PBT) Chemical Program, http://www.epa.gov/pbt

PVC, dioxin and health care activities to reduce dioxin exposure: Health Care Without Harm, http://www.noharm.org

Relationship between PVC and PBTs: Joe Thornton, PhD, *Environmental Impacts of Polyvinyl Chloride Building Materials*, Healthy Building Network, Washington, DC 20002, http://www.healthybuilding.net/pvc/Thornton_Enviro_Impacts_of_PVC.pdf

Tech brief authored by Tom Lent of Healthy Building Network. Reviewed by Dr. Ted Schettler, MD, MPH, Science and Environmental Health Network.

Last update 6/29/2007.

Green Guide for Health Care™ is a project of the Center for Maximum Potential Building Systems (CMPBS) and Health Care Without Harm.
The *Green Guide* Technical Briefs were funded through grants form the Merck Family Fund and New York State Energy and Development Authority.