Indoor/Outdoor Chemical & Pollutant Source Control Technical Brief

***Green Guide for Health Care*™ Environmental Quality Credit 5.1, 5.2**

Overview

Americans typically spend 90% of their day indoors.[1] In health care facilities, the need for highly controlled interior environments can result in sealed buildings that re-circulate contaminants through the mechanical system. Staff, visitors, and patients track in particulates and other pollutants through entryways. Airborne pollutants can be introduced to the indoor air supply through improperly placed air intakes located near areas designated for idling vehicles, such as the ambulance bay and the receiving dock. Facilities operations and clinical activities such as environmental services, laboratory work, anesthesia, sterilization, and laundry can impair indoor air quality by emitting a variety of chemicals. Finally, interior finishes, furniture, and furnishings can introduce volatile and semi-volatile organic compounds to the indoor environment as a result of material content, adhesives and sealants, and, in some cases, the products used to clean these surfaces. See *Green Guide for Health Care ("Green Guide")* technical briefs on Low-Emitting Materials and Furniture and Medical Furnishings for more information.

Additionally, health care organizations rely on a spectrum of chemicals for clinical and research purposes that release indoor air contaminants. Types and frequency of use vary from department to department. These chemicals mix with indoor air contaminants in the facility, potentially affecting the respiratory health of patients, staff, and visitors. Health impacts can include skin, ear, nose, and throat irritations and increased symptoms of asthma.[2] Compromised air quality can lead to decreased health and longer hospital stays for patient populations and increased sick days and lower productivity for staff populations. Prolonged chemical exposure may lead to increased chemical sensitivity and increased use of medications for both populations.

Contaminants that originate outside of the health care facility should be reduced or eliminated at their point of entry. Contaminants released in the interior of the facility should be properly stored and contained in negatively pressurized rooms when in use. The *Green Guide* encourages facilities to install entryway systems; to avoid placing exterior sources of pollution near entries or air intakes; and to provide a sealed, negatively pressurized space for chemical mixing in the facility. Due to the vulnerability of immuno-compromised patients and the sheer number of potential emissions sources on many health care facility campuses, the *Green Guide* offers two credits for chemical and pollutant source control: GGHC v2.2 Environmental Quality Credit 5.1: Outdoor and GGHC v2.2 Environmental Quality Credit 5.2: Indoor.

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[1] *The Inside Story: A Guide to Indoor Air Quality*, U.S. EPA and the U.S. Consumer Product Safety Commission Office of Radiation and Indoor Air (6609J). EPA Document # 402-K-93-007, April 1995. http://www.epa.gov/iaq/pubs/insidest.html.

[2] For more information on the relationship between the health care environment and asthma, see "Risks to Asthma Posed by Indoor Health Care Environments: A Guide to Identifying and Reducing Problematic Exposures," Health Care Without Harm, 2006, http://www.noharm.org.

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The Challenges

In many cases, the pollutants generated both in the exterior and interior of health care facilities are fundamental to health care delivery and, therefore, are not easily relocated or eliminated. Unless properly shielded, toxic emissions generated outside the facility by idling ambulances and helicopters can infiltrate entryways and intake grilles, compromising indoor air quality. Concerns related to critical adjacencies can pose obstacles to moving this kind of point source pollution sufficiently far from the building to reduce exposure to safe levels. On the interior of the facility, the need to sterilize medical devices quickly and efficiently to maximize delivery of care often supercedes safety controls required to prevent exposure to toxic sterilants such as gluteraldehyde. A systemic approach to minimizing sources of contamination is required to overcome these programmatic and operational challenges.

Best Practices

Outdoor Pollutant Source Control (GGHC v2.2 Environmental Quality Credit 5.1)

The *Green Guide* recommends that health care facilities evaluate the following prioritized options when establishing a strategy for outdoor pollutant source control:

1. Eliminate the Source of Contamination

Eliminating the source of contamination is the most effective pollution control method. On-site air contamination can take many forms, from wet-applied building materials to pesticide use in landscaping. The first step in containing outdoor sources of pollution is to eliminate them in favor of less toxic alternatives.

- Prohibit smoking on-site or designate an area at least 50 feet away from entryways and air intake grilles. (GGHC v2.2 Environmental Quality Prerequisite 2: Environmental Tobacco Smoke Control (ETS))
- Eliminate the use of highly volatile wet-applied building materials. (GGHC v2.2 Environmental Quality Credit 4.6: Low-Emitting Materials: Exterior Applied Products)
- Reduce the amount of air pollution generated on-site by encouraging staff to take advantage of alternative transportation options such as public transportation, cycling, and carpooling. (GGHC v2.2 Sustainable Sites Credit 4.1, 4.2, and 4.4: Alternative Transportation: Public Transportation Access, Bicycle Storage & Changing Rooms, and Parking Capacity)
- Initiate alternative fuel fleet vehicles (e.g., ambulances, campus shuttles) using technologies such as bio-diesel and hybrid-electric. (GGHC v2.2 Sustainable Sites Credit 4.3: Alternative Transportation: Low-Emitting & Fuel Efficient Vehicles)
- Establish a low impact site and green building exterior management plan that eliminates use of toxic pesticides and herbicides. (GGHC v2.2 Environmental Services Credit 1: Outdoor Grounds & Building Exterior Management)
- Do not incinerate waste on-site. Only use incineration for the fraction of the medical waste stream that is required by regulations to be incinerated. (GGHC v2.2 Waste Management Credit 2: Regulated Medical Waste Reduction)
- Use alternatives to salt for de-icing. (GGHC v2.2 Environmental Services Credit 1: Outdoor Grounds & Building Exterior Management)
- Select plants that minimize organic matter tracked into the facility. For example, move deciduous trees and/or fruit bearing trees or bushes away from sidewalks and entrance paths.
- Select native plants to mitigate chemical inputs near sidewalks and entrance paths. (GGHC v2.2 Water Efficiency Credit 1: Water Efficient Landscaping and Environmental Services Credit 1: Outdoor Grounds & Building Exterior Management)

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- Implement an integrated pest management (IPM) program. (GGHC v2.2 Environmental Services Credit 2: Indoor Integrated Pest Management)

2. Move the Source of Contamination

Several essential health care-related services are pollutant sources that cannot be eliminated from the site. In those cases, the alternative is to relocate them to a safe distance (minimum 50 feet) away from points of entry.

- Locate the ambulance bay 50 feet from the entry to the emergency room (ER).
- Locate the helipad on top of the parking garage, rather than the hospital. At existing facilities, mitigate helipad emissions through operational modifications such as shielding air intakes and shutting down the intakes while the helicopter is in operation.
- Prohibit idling within 50 feet of the building.
- Place the central plant downwind from the hospital and/or in a location where it is buffered from occupied buildings by a structure such as the parking garage.

3. Move/Protect Points of Entry

Design building entrances and fresh air intake grilles to minimize exposure to on-site point sources of pollution.

- Use MERV 13 filters at all HVAC air intakes to the building.
- Locate air intakes at least 50 feet away from sources of contaminants such as loading docks, ambulance bays, and drop-off entrances.
- Locate building entrances at least 50 feet away from sources of contaminants. For entries located in areas with high emissions (such as the entrance from the ambulance bay to the ER), provide pressurized entryway vestibules.
- Carefully coordinate HVAC air intakes when using vegetative roof systems. The spores of aspergillus bacterium are present in high quantities in decaying plant material. Until studies prove otherwise, avoid placing air intakes near any composting locations or vegetative roof systems.
- Evaluate the effectiveness of air intake protection by running a mathematical (e.g., computational fluid dynamic [CFD]) and/or physical (e.g., wind tunnel) model. Air passing through the intake must meet the National Ambient Air Quality Standard to comply with Credit Goals.

Indoor Pollutant Source Control (GGHC Environmental Quality Credit 5.2)

Spaces where chemicals are stored and mixed should be exhausted directly to the exterior to create a negatively pressurized room. *Green Guide* v2.2 Environmental Quality Credit 5.2 requires an exhaust rate of 6 air changes/hour for mild chemicals and 12 air changes/hour for rooms containing disinfectant and sterilant applications. Self-closing doors and deck-to-deck partitions combined with a pressure differential of 5 Pa (0.02 inches of water gauge) on average and 1 Pa (0.004 inches of water) when the doors are closed will effectively seal off the room from surrounding areas.

Where possible, store chemicals in an enclosed, centralized room that is sealed in accordance with *Green Guide* Credit Goals for negative pressure, deck-to-deck partitions, and external exhaust or eliminate them altogether by employing green janitorial and least toxic sterilization procedures.

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Centralized Janitor Closets and Chemical Mixing Areas

- Eliminate the need for an eyewash station in soiled utility rooms by storing all hazardous chemicals, such as Formalin, in centralized locations that comply with Credit Goals.
- In the event that corrosive chemicals must be stored in soiled utility rooms, provide local exhaust ventilation (LEV) and comply with Credit Goals for negative pressure, deck-to-deck partitions, and external exhaust. Corrosive chemicals may include:
- Floor stripping and polishing products.
- Scented cleaners.
- Disinfectant chemicals: Diethylene glycol ethyl ether, aliphatic petroleum distillates and nonyl-phenol ethoxylate, ethariolamine, butoxyethanol, and sodium hydroxide.
- Antimicrobial pesticides: Quaternary ammonium compounds, phenols, and bleach.
- Eliminate the sink base cabinet when installing counter-mounted sinks to deter storing cleaning products under the sink.
- Locate centralized recycling collection points for dirty plastics, metals, and glass in rooms that comply with Credit Goals for negative pressure, deck-to-deck partitions, and external exhaust .

Non-Toxic Cleaners

- Replace spray bottles and aerosol cans where possible with pour-and-wipe applications.
- Use no- and low-VOC (volatile organic compound) cleaning products that comply with *Green Guide* v2.2 Environmental Services Credit 3: Environmentally Preferable Cleaning Policy and Environmental Services Credit 4: Sustainable Cleaning Products & Materials. Properly mix and store non-compliant housekeeping products in a negatively pressurized room or closet with direct venting to the exterior.
- Perform an air quality test to establish baseline indoor air quality (IAQ) as a first step towards implementing a cleaning program in compliance with U.S. EPA's IAQ housekeeping procedures for large buildings.[3] Establish a schedule for periodic air quality testing to track the program's success.
- Ensure that regular cleaning procedures and entryway systems minimize dirt tracked into the building.
- Use maximum extraction, minimum polluting housekeeping equipment and methods.
- Thoroughly dry porous materials such as wet carpet after spills or cleaning.
- Establish a policy for housekeeping personnel outlining the cleaning process. Refer to *Green Guide* v2.2 Integrated Operations Prerequisite 1: Integrated Operations and Maintenance Process for additional information. Provide regular staff education meetings to review the Environmentally Preferable Cleaning Policy.
- Include requirements for IAQ housekeeping procedures in contracts with outside environmental services contractors.
- Monitor the results of the IAQ housekeeping program and hold responsible parties accountable for deviations from the policy.

[3] US EPA I-BEAM Maintenance and Housekeeping Programs for protecting healthy indoor air quality, http://www.epa.gov/iaq/largebldgs/i-beam_html/ch3-pm.htm#PM2.4.

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- Steam clean carpets and partitions on a regular basis, followed by a high-efficiency particulate air filter vacuum.
- Install filters on mechanical cleaning equipment to capture chemical vapors and particulates.

HVAC Strategies to Control Indoor Pollutants

- Clean, balance, and maintain the HVAC system regularly.
- Maintain a low level of carbon dioxide (CO2) in the facility. If a space measures ≥ 1,000 parts per million CO2, increase ventilation to that area (a CO2 monitoring system is recommended). Consider achieving *Green Guide* v2.2 Environmental Quality Credit 1: Outdoor Air Delivery Monitoring.
- Maintain relative humidity between 30% and 60%, in accordance with the 2006 *AIA Guidelines for Design and Construction of Health Care Facilities*.
- At Nurse Stations, place high-volume office equipment, such as high volume photocopy machines, under an exhaust vent, if applicable. Most printers and fax machines in standard nurse stations do not have the volume that would warrant physical separation.

Benefits

Health

Indoor air pollution often begins with unintended outdoor pollutants penetrating the building envelope. Once inside, contaminants can permeate the building, mixing with indoor air multiple times before finally filtering out of the system. The Joint Commission on the Accreditation of Health Care Organizations (JCAHO) has expressed increasing concern over growing respiratory issues among health care workers. JCAHO has identified sources of indoor chemical pollutants as contributing factors to indoor air quality issues, including: photocopiers, glutaraldehyde and ethylene oxide sterilants, xylene, aerosolized medication distribution systems, anesthetic gases, chemotherapeutic agents, latex, cleaners, and floor finishes. The health impact of the myriad of outdoor and indoor contaminants varies depending on the type of pollutant, its concentration, and the length of time it remains in the building. Health impacts vary from short-term to chronic and severe, contributing to diseases like asthma and some cancers. While the full range of health impacts associated with combined airborne contaminant exposure is uncertain, the precautionary principle suggests reducing exposure to chemicals of concern to avoid possible harmful health effects.

Ecologic

The ecologic damage associated with on-site pollution emissions and indoor chemical use can be avoided by switching to least toxic alternatives that meet or exceed performance requirements. Emissions released outside the facility are generally attributable to the central plant and on-site vehicles (e.g., idling ambulances, helicopters, and cars driving on and off the site). These emissions contribute to smog formation and global climate change. The use of chemicals inside the facility and the disposal of these chemicals through air exhausts and the wastewater system can pollute the municipal water supply and, ultimately, affect the viability of local, regional, and global ecosystems.

Economics

Research findings indicate that healthy indoor environmental quality could translate into $37 to $108 billion per year of increased productivity in the U.S. through reduced respiratory illnesses, reduced cases of allergies and asthma, reduced cases of sick building syndrome, and improved thermal and lighting

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controls.[4] In addition, switching to non-toxic cleaning products and operational processes (such as non-toxic disinfectants) can improve operational efficiency by reducing oversight for toxic processes and reducing facility "down time" for maintenance activities. Regulated medical waste disposal costs up to 10 times more than non-regulated solid waste disposal. Replacing disinfectants such as glutaraldehyde and ethelyne oxide -- shown to cause negative health impacts and requiring collection and disposal as licensed hazardous waste -- with safer alternatives can reduce a health care facility's annual waste disposal budget. Green cleaning products certified by third party certification organizations such as Green Seal are increasingly available at competitive prices.

Case Studies

Alternative Fuel Fleets, Pitt County Memorial Hospital, Greenville, NC
(Source: http://www.biodiesel.org/resources/pressreleases/fle/20050523_Hospital_Biodiesel_Pump.pdf)

In 2005, Pitt County Memorial Hospital (PCMH) in Greenville, NC, switched its fleet of diesel vehicles to B20 biodiesel (20% biodiesel and 80% diesel). To ensure accessibility to the alternative fuel, PCMH installed a biodiesel pump on the medical campus. The American Lung Association supported the health care provider's move to reduce its contribution to emissions that pose a serious health risk to the hospital occupants and the surrounding community. According to the AHA, vehicle emissions cause 60,000 premature deaths a year in the US.

PCMH's health system, University Health Systems of Eastern Carolina, heralded the multiple benefits of converting to biodiesel. Its lower emissions and regional extraction reinforce the hospital's commitment to community stewardship.

According to the National Biodiesel Board, biodiesel is the fastest growing alternative fuel in the U.S., running hundreds of major fleets. Its particulate emissions are 47% lower than petroleum diesel. It also reduces the emissions of polycyclic aromatic hydrocarbons (PAH), nitrated PAH, unburned hydrocarbon (a pollutant that contributes to smog formation and ozone depletion), and carbon monoxide.

Finding Alternatives to Ethylene Oxide (EtO), Mary Hitchcock Memorial Hospital (MHMH), Lebanon, Nh
(Source: U.S. Environmental Protection Agency, 2002. "Environmental Best Practices for Health Care Facilities," November 2002, http://www.ciwmb.ca.gov/wpie/Healthcare/EPAEtOGlut.pdf)

Ethylene oxide (EtO) is a known human carcinogen, a potential reproductive hazard, an allergic sensitizer, and a potent neurotoxin. It is used in hospitals to sterilize heat- and moisture-sensitive medical supplies. In response to the growing body of knowledge regarding occupational health concerns associated with ethylene oxide and increasingly stringent regulations, Mary Hitchcock Memorial Hospital (MHMH) in Lebanon, New Hampshire, replaced EtO with safer alternatives: Sterrad, a plasma phase hydrogen peroxide-based sterilizing agent, and Steris, a peracetic acid-based technology. Some medical devices that are manufactured using mixed-media materials have not been approved for sterilization by EtO alternatives. In those cases, MHMH is seeking to replace their current devices with products manufactured out of a single material and approved for sterilization by EtO alternatives.

MHMH has found that the cost of purchasing EtO alternatives is $20,000 to $45,000 more expensive than the cost of EtO over a two-year period. However, operating sterilization processes using non-EtO alternatives saves $14,200 per year. Most significantly, the alternative products avoid the need for emissions control and, therefore, the health and safety concerns associated with exposure to a known carcinogen. The calculated savings listed above do not account for additional benefits such as faster

[4] William J. Fisk, P.E., "How IEQ Affects Health, Productivity," *ASHRAE Journal*, May 2002.

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average sterilization time, reduced labor, and better control over the sterilization process, e.g., improved infection control.

Resources

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

American Lung Association, "Occupational Hazards," 2000, p.3, www.lungusa.org

Anderson, Dr. Rosalind C. and Dr. Julius H Anderson, "Acute Toxic Effects of Fragranced Products". *Archives of Environmental Health* 53(2): 138-146 (1998).

Ashkin, Stephen, "Green & Clean: The Designer's Impact on Housekeeping and Maintenance," American Institute of Architects: *Environmental & Economic Balance: The 21st Century Outlook*, http://www.rochestermidland.com/division/institut/articles/greenandclean.pdf

Better Health Channel, "Aspergillus"
http://www.betterhealth.vic.gov.au/bhcv2/bhcarticles.nsf/pages/Aspergillus?open
California Office of Environmental Health Hazard Assessment Fact Sheet, "Health Effects of Diesel Exhaust," August, 2000, http://www.oehha.ca.gov

Fisk, William and Arthur Rosenfield. "Improved Productivity and Health from Better Indoor Environments," *Center for Building Science Newsletter* (Now *Environmental Energy Technologies Newsletter*). Lawrence Berkley Labs, Summer 1997. p.5. Available at http://eetd.lbl.gov

Fragranced Products Information Network, http://www.fpinva.org/

"Greener Hospitals: Improving Environmental Performance,"
http://www.bms.com/static/ehs/sideba/data/greenh.pdf

Green Seal, http://www.greenseal.org

Haz-Map: Information on Hazardous Chemicals and Occupational Diseases, http://hazmap.nlm.nih.gov/

Hospitals for a Healthy Environment, http://www.h2e-online.org. For information on chemical minimization plan, chemical waste, minimizing waste in hospital laboratories, persistent bioaccumulative toxins, pesticides and integrated pest management, sterilants and disinfectants.

OSHA Substance technical guidelines for formalin - 1910.1048 App A,
http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10076

Sustainable Hospitals case study on microfiber mops,
http://www.sustainablehospitals.org/PDF/MicrofiberMopCS.pdf

Western Regional Pollution Prevention Network, http://www.westp2net.org

US EPA

- http://www.epa.gov/iaq/pubs/hpguide.html (Report linking IAQ to productivity and medical expenses)
- http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=20797 (Database of dioxin sources)
- http://www.epa.gov/pbt/ (Persistent bioaccumulative and toxic (PBT) chemical program)
- http://www.epa.gov/iaq/largebldgs/i-beam_html/ch3-pm.htm#PM2.4 (I-BEAM Programs)

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Last update 6/29/2007.

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