Healthy Interiors, Materials Efficiency, Waste Management and Renewable Energy

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Healthy Interiors

Healthy Indoor Air Quality

- News reports and scientific inquiries have brought attention to the symptoms and causes of poor indoor air quality.
- Indoor pollutant concentrations can be 2-5 times higher than outdoors and Americans spend about 90% of their time indoors (U.S. EPA).
- Indoor pollutants can create significant health risks.
- Indoor pollutants can affect learning.

Symptoms and Health Effects

- Health problems are typically classified as:
  - Sick Building Syndrome (SBS).
  - Building-Related Illness (BRI).
  - Multiple Chemical Sensitivity (MCS).
- Symptoms range from:
  - Mild discomfort and perception of bothersome odors.
  - Severe illness and permanent injury.
- Health effects
  - Increased rates of infectious diseases (influenza,common cold, etc).
  - Eye and respiratory irritation, Chronic sinusitis.
  - Allergies and asthma.
  - Headaches.
- Environmental factors such as light quality and acoustics may also effect occupant health.

Children are More Vulnerable

- Relative to their size, their breathing rates and metabolic rates are significantly greater than adults.
- Because children's bodies are actively growing, they absorb and retain more toxins.
- Children have less effective immune systems.
- Exposures to common molds and damp environments can cause childhood respiratory illnesses:
  - Persistent wheezing.
  - Shortness of breath.
  - Bronchitis.
- Students and staff have increasingly sensitized respiratory systems.

Indoor Air Quality Has an Effect on Learning

- Exposures to VOCs and other indoor pollutants can cause a range of acute symptoms at relatively low concentrations:
  - Eye and respiratory irritation (most common complaint).
  - Headaches.
  - Behavioral problems.
  - Fatigue.
- A recent LBNL report found:
  - Increase in recurring symptoms (headaches, fatigue, memory problems, eye irritation, and cough) in schools with complaints relative to schools without complaints.
  - Similar symptoms in office buildings have been associated with reduced worker productivity, suggesting that school IEQ problems can be severe and persistent enough to affect the learning ability of students.

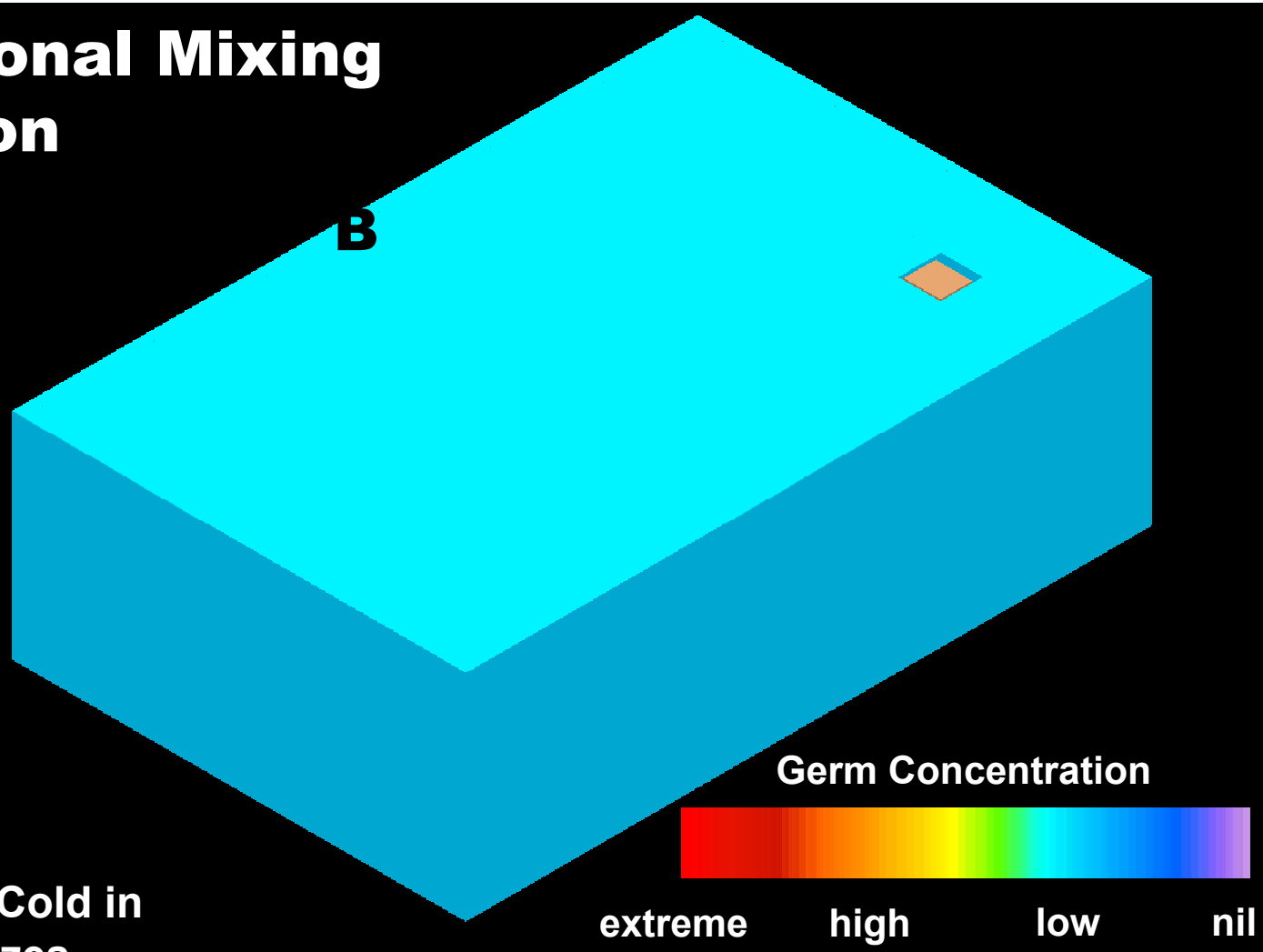
Four Design Strategies

- Source Control
- Ventilation Control
- Building Commissioning
- Building Maintenance

Ventilation Control

- Displacement Ventilation

Conventional Mixing Ventilation



Occupant with Cold in Cubicle B Sneezes

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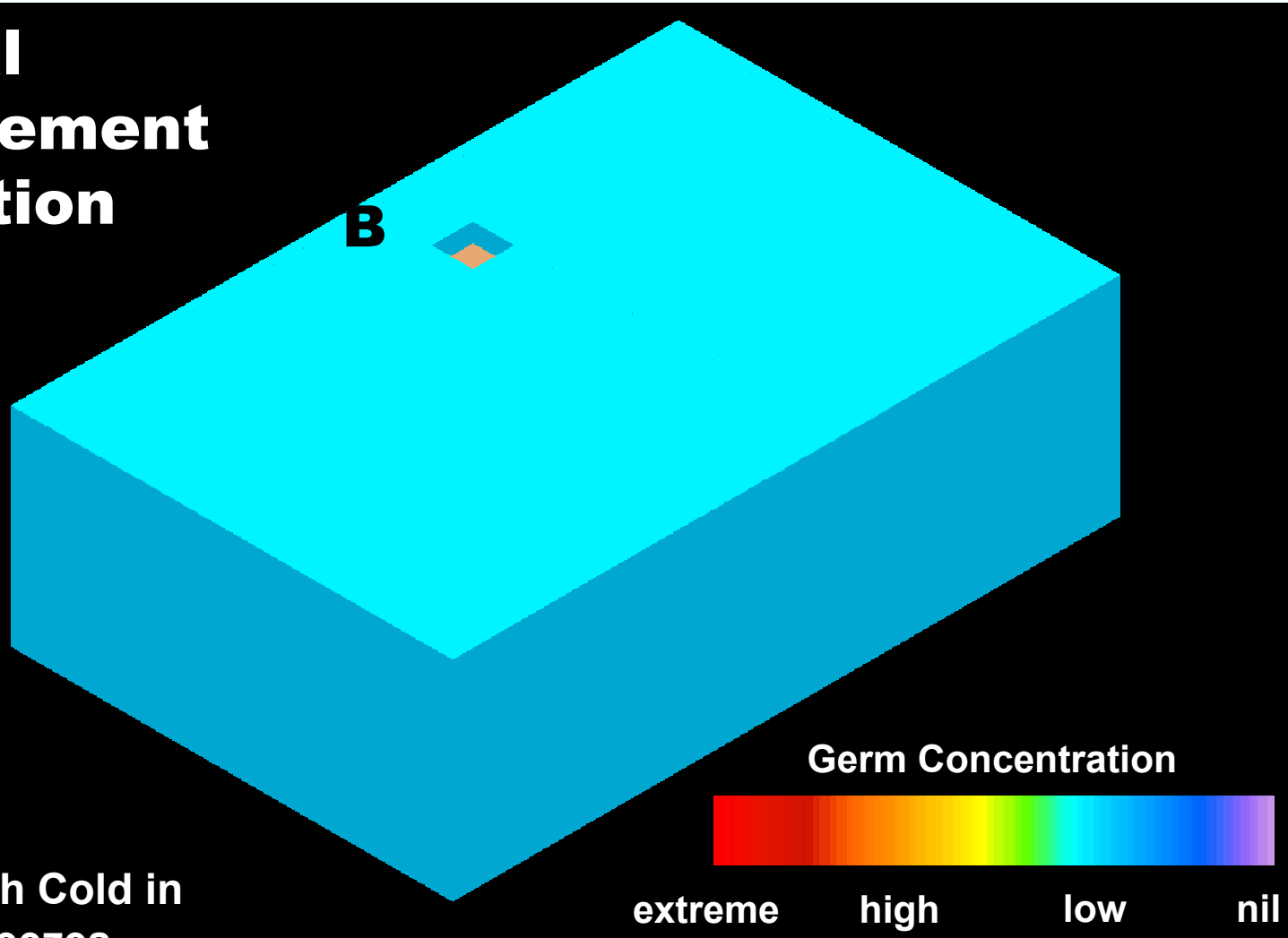
Thermal Displacement Ventilation



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Source Control

- VOC Emissions
- Mold and Mildew
- During Construction
- Outside Contaminants

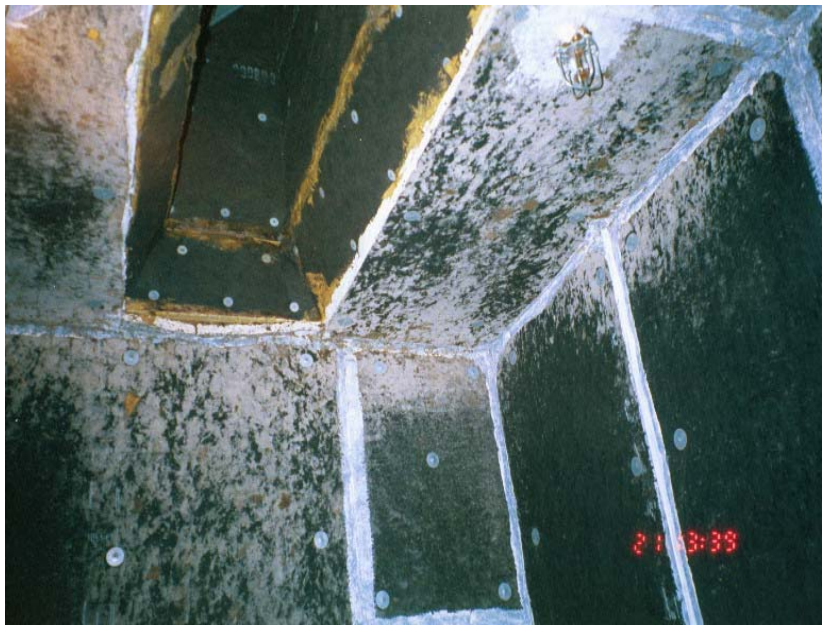
http://windom.cybox.com/logs/2001/07.31.html

Volatile Organic Compound Pollutants

- Hazardous ingredients can degrade the natural environment during production and after disposal.
- May be hazardous to installers and manufacturers.
- May cause health problems for building occupants.

Source Control: Mold and Mildew

- Design the ventilation system to maintain the indoor relative humidity between 30% and 50%.
- Minimize water vapor condensation, especially on walls, the underside of roof decks, and around pipes or ducts. Irrigation systems should not spray buildings.
- Keep precipitation out of the building.



Source Control: During Construction

- Temporary Construction Ventilation
  - Ventilate when installing materials emitting VOCs.
- Dust protection
  - Turn ventilation system off, and protect HVAC supply and return openings.
- Preconditioning
  - Allow products to off-gas in dry, well-ventilated space prior to delivery to site.
- Mold protection
  - Immediately remove and properly dispose materials showing signs of mold and mildew.
- Sequencing
  - Install odorous and/or high VOC emitting products before porous and fibrous materials.
- Filters
  - Replace all filtration media immediately prior to occupancy.

Source Control: Outside Contaminants

- Walk-off mats

http://windom.cybox.com/logs/2001/07.31.html

Materials Efficiency

Importance of Material Efficiency

Life Cycle of Building Materials:

- Source.
- Extraction.
- Processing.
- Installation.
- Useful Life.
- End of Use.

Each Stage of the Life Cycle:

- Uses Energy.
- Contributes to Environmental Impacts.

Materials Efficient Criteria

- Durable.
- Reused, salvaged, and refurbished material or structure.
- Relocatable, refinishable, and reusable.
- Made with recycled content.
- Recyclable.
- Made from or use resources that are sustainable.
- Locally manufactured (500 miles).
- Packaged in minimal, reusable, recycled content, and recyclable containers.
- Purchased from a manufacturing source that embraces sustainability as corporate policy.

Material Efficient Hierarchy

Reduce: Waste Prevention

- Specify durable materials.
- Apply dimensional planning to design.
- Avoid unneeded materials.
- Design for disassembly.

Reuse: Salvage and Refurbish

Deconstruction: building disassembly and material salvage.

- If 25% of buildings demolished every year were deconstructed, approximately 20 million tons of debris could be diverted from landfills.

Refurbishing includes:

- Renovating, repairing, restoring, or generally improving the appearance, performance, quality, functionality, or value of a product.

Recycle: Minimize Waste

- Implement areas in design to facilitate recycling.
  - Allocate space for storage and collection of recyclables.
- Close the loop and “buy recycled”.
  - Specify products that contain recycled content.
    - Use materials and assemblies with the highest available percentage of post-consumer recycled content.
- Ensure products are “recyclable” at the end of their “useful life”.

EPA Comprehensive Procurement Guidelines (CPG)

United States Environmental Protection Agency | Solid Waste and Emergency Response (5306W) | EPA530-F-00-009 April 2000 www.epa.gov/cpg

EPA

ECO PURCHASING

2000 Buy-Recycled Series
Construction Products

Construction project managers are learning what the U.S. Army and U.S. Navy already know—recycled construction products are cost-effective, reliable, easy to obtain, and environmentally friendly. Whether you're erecting a new building or constructing a new highway, high-quality recycled-content products can help you get your project

Material Recycling: Key Strategies

- Allocate Space
  - Common areas
    - 20-25 Gallon Containers Maximum Size, Wheeled Carts
  - Centralized collection point
    - Front-loader bins, Ramps
- Provide Easy Access for Collection.
  - Site recycling containers near waste receptacles.
- Design Considerations for Recycling Areas/Enclosures.
  - Signage to prevent contamination.
  - Access/Clearance.
  - Protection from the elements.
  - Security.

Materials and Indoor Air Quality

High Performance Flooring

- Durable.
- Light color to enhance daylighting.
- Recyclable & high recycled content.
- Contribute to a comfortable indoor environment.

High Performance Walls and Ceilings

- Durable.
- Light color to enhance daylighting.
- Recyclable & high recycled content.
- Do not contain asbestos, formaldehyde, or crystalline silica.
- Provide plenty of tackable wall space for displaying student projects.

High Performance Paints and Coatings

- Light colors should be specified to enhance daylighting.
- High quality, low-toxicity, and low-VOC coatings should be used.

High Performance Casework and Trim

- Avoid interior products made with urea-formaldehyde bonding agents.
- Preferable product alternatives include:
  - Exterior grade plywood with phenolic formaldehyde resign.
  - Formaldehyde-free medium density fiberboard (MDF).
  - Oriented strand board (OSB).
  - Engineered wood.

High Performance Adhesives and Sealants

- Specify the least toxic / lowest VOC product suitable for the application. Consider:
  - Yellow and white glues.
  - Silicone sealants in interior areas.
  - Acrylics and siliconized acrylics (typically the safest to handle and have the lowest solvent content).

Renewable Energy Systems

Passive Heating and Cooling

- Integrate passive solar heating with daylighting.
- Locate thermal mass to maximize low winter sun.
- Make use of natural ventilation/ evaporative cooling.
- Use more north-facing windows.
- Shade south-facing windows.

Passive Heating and Cooling

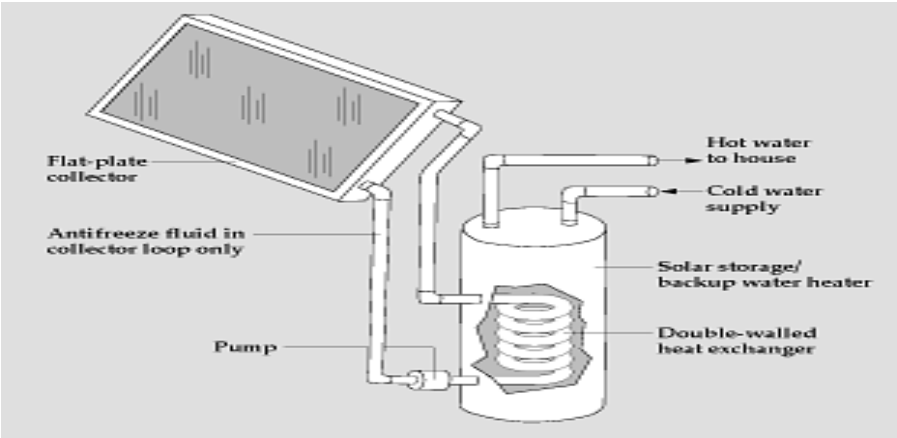
- **Direct gain** – sunlight penetrates and is stored in the room.
- **Indirect gain** – heat is trapped and distributed from storage material.
- **Isolated gain** – heat is collected in an area that can be closed or opened as needed.

Solar Thermal Hot Water Systems

- Use thermal hot water systems as primary heat sources or to augment boiler system efficiency
- Before sizing a system, consider water conservation strategies

Solar Thermal Hot Water Systems

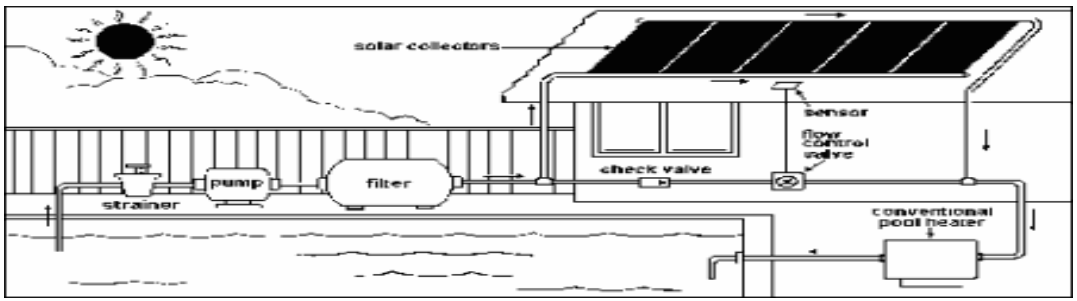
- **Direct system** – heats potable water in collector. Less expensive.
- **Indirect system** – heats working fluid, heat exchanger heats potable water. Can be used in any climate zone.



Graphic courtesy DOE

Solar Pool Heating

- Use an efficient pool cover to minimize heat loss
- Consider placement and orientation of collectors early
- Use roof-mounted panels to lower air conditioning costs



Solar Pool Heating

- Orient collectors due south, or within 15º
- Collector tilt angle ideally 30º to 32º, but varies based on latitude, climate, and usage
- Indoor pools used year round require glazed flat plate collectors, sloped 35º to 45º

Wind Power

Wind power is applicable to your school if….

- Wind resource is more than 14 mph average.
- State policies encourage wind: net billing, loan funds, tax credits, etc.
- No height restrictions.
- Space is available.

Geothermal Heat Pumps

- Concentrates naturally existing heat in the Earth for heating.
- Uses Earth as as heat sink in summer.
- Applicable to all interior school spaces.
- Used for space and water heating and cooling.

Photovoltaics

- Ideal for climates where sunlight is available most days.
- Suitable for remote facilities.
- Cost effective for providing power to exterior and parking lot lighting.
- Provides reliable power and teaching tool.
- Simple payback period for the average system is 25 to 30 years.

Photovoltaics

- Mount arrays on or above roof top for full sun (site with no shade from trees, etc).
- Consider net metering instead of battery system for lower costs.
- Use arrays as building components to economize materials and for unobtrusive design.