Case Studies Illustrating IEQ Challenges in Sustainably Constructed Buildings

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Overview

- Key factors and challenges for success
- LEED – brief background re IEQ
- 2 case studies to illustrate
  (pre-occupancy IAQ testing)
IEQ Initiatives in Construction

- Green building programs
- Design specifications
- Selection of low-emitting materials and furnishings
- Scheduling / sequencing
- Flush-out
- Pre-occupancy clearance criteria
- Education (awareness)!
Green Building Programs
# Product Ranking by Loading (top 10)

<table>
<thead>
<tr>
<th>Rank</th>
<th>Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Workstations</td>
</tr>
<tr>
<td>2</td>
<td>Seating</td>
</tr>
<tr>
<td>3</td>
<td>Duct liner</td>
</tr>
<tr>
<td>4</td>
<td>Fireproofing</td>
</tr>
<tr>
<td>5</td>
<td>Access floor</td>
</tr>
<tr>
<td>6</td>
<td>Ceiling tile</td>
</tr>
<tr>
<td>7</td>
<td>Carpet tile</td>
</tr>
<tr>
<td>8</td>
<td>Carpet tile adhesive</td>
</tr>
<tr>
<td>9</td>
<td>Broadloom carpet</td>
</tr>
<tr>
<td>10</td>
<td>Broadloom adhesive</td>
</tr>
</tbody>
</table>
Common Threads

- Selection & use of low-emitting, non-toxic construction / furnishing materials
- Construction practices that minimize intro of high solvent / odorous materials
- Good building ventilation
- Building commissioning incl pre- and/or post-occupancy testing to determine acceptable indoor pollutant levels
Leadership in Energy & Environmental Design

• Initiated 1998 (USGBC), various revisions
• “Credit” point system (performance-based rating system)
• Growth of “Green”
LEED: Brief Overview

15 / 64 possible points for IEQ (+ innovation credit=69)

Content and graphic courtesy of the USGBC
LEED for New Construction v2.2 – EQ Credits

- Prereqs for minimum IAQ performance and ETS control
- Outdoor air delivery monitoring
- Increased ventilation
- Construction IAQ Mgt Plan
- Low-emitting materials
- Source control
- Lighting, controllability of systems, thermal comfort, daylighting & views
LEED IAQ Clearance Criteria

Which to choose?
Flush-out OR IAQ testing

• Issues:
  – Cost
  – Geography / Climate / Seasonal
  – “Evidence”
LEED IAQ Clearance Criteria (cont’d)

- All criteria, all samples
- Requires good management: construction schedules & sampling schedules
- Fail ... Retest...first flush building
Case Studies
TVOC: Initial Testing Results
TVOC Comparison: Initial and Retest
Formaldehyde: Initial Testing Results

![Box plot showing HCHO (ppb)]
Case Study #1

- Newly constructed hotel / conference center
- 5 stories + basement; 100,000 ft²
- Importance of completing construction / major finishing processes early (especially wet products)
Guess what?

- Construction schedules slipped
- Building acceptance in a matter of days
- We walked in ~ everything from painting to vinyl wallcovering installation to deep cleaning of entire building…
## What Did We Find?

<table>
<thead>
<tr>
<th>Floor</th>
<th>HCHO, ppb</th>
<th>TVOC, µg/m³</th>
<th>4-PCH, µg/m³</th>
<th>Airborne Particles, µg/m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st floor</td>
<td>7.2</td>
<td>591</td>
<td>3.8</td>
<td>44</td>
</tr>
<tr>
<td>2nd floor</td>
<td>26.7</td>
<td>1,824</td>
<td>2.8</td>
<td>48</td>
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<tr>
<td>3rd floor</td>
<td>46.2</td>
<td>1,562</td>
<td>6.7</td>
<td>20</td>
</tr>
<tr>
<td>4th floor</td>
<td>19.1</td>
<td>314</td>
<td>2.4</td>
<td>24</td>
</tr>
<tr>
<td>5th floor</td>
<td>21.9</td>
<td>856</td>
<td>2.8</td>
<td>31</td>
</tr>
<tr>
<td>MCL</td>
<td>50</td>
<td>500</td>
<td>6.5</td>
<td>150</td>
</tr>
</tbody>
</table>

Case study #1, cont’d
## Retest Successful

<table>
<thead>
<tr>
<th></th>
<th>HCHO, ppb</th>
<th>TVOC, µg/m³</th>
<th>4-PCH, µg/m³</th>
<th>Airborne Particles, µg/m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st floor</td>
<td>-</td>
<td>106</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2nd floor</td>
<td>-</td>
<td>163</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3rd floor</td>
<td>-</td>
<td>198</td>
<td>0.5</td>
<td>-</td>
</tr>
<tr>
<td>4th floor</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>5th floor</td>
<td>-</td>
<td>30.1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>MCL</strong></td>
<td><strong>50</strong></td>
<td><strong>500</strong></td>
<td><strong>6.5</strong></td>
<td><strong>150</strong></td>
</tr>
</tbody>
</table>

Case study #1, cont’d
“Marriott’s Green Hotels” * …proud that the Inn & Conference Center … has been designated the first environmentally-friendly hotel and conference center in the U.S. by acquiring the U.S. Green Building Council's LEED certification … blends environmental responsible design with beauty … focusing on four key areas:

– Use of environment-friendly building materials
– Recycling
– Water conservation
– Smoke-free environment

* [www.marriott.com](http://www.marriott.com)
Case Study #2

- GA DNR – Suwanee River Visitor Center
- A little background...
More About Suwanee River site

• 7,000 SF, $1.7 million
• Extensive use of local / regional materials
• Substantial energy savings realized

Case study #2, cont’d
IAQ Pre-occupancy Testing

Timing good...
- Construction completed
- Finishing work completed
- TVOC = 255 ug/m³

But...

Case study #2, cont’d
Challenges re: Materials

- Not a lot of high VOC emitting materials, but formaldehyde = 67.7 ppb

Case study #2, cont’d
Biggest challenge

Case study #2, cont’d
Achieved LEED Gold Certification

9 / 15 EQ points:

- CO$_2$ monitoring
- Low-emitting materials
- Indoor chemical & pollutant source control
- Thermal comfort
- Daylight & views

Case study #2, cont’d
Summary: Lessons Learned

• Timing is (almost) everything
• Low-emitting materials important

Beware of alligators!