Indoor Air Quality Issues for Hotels

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DEA 670
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# Thermal Control

## Hotel Indoor Air Quality

<table>
<thead>
<tr>
<th>Relative Humidity</th>
<th>Winter Temperature</th>
<th>Summer Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>30%</td>
<td>68.5°F - 76.0°F</td>
<td>74.0°F - 80.0°F</td>
</tr>
<tr>
<td>40%</td>
<td>68.5°F - 75.5°F</td>
<td>73.5°F - 79.5°F</td>
</tr>
<tr>
<td>50%</td>
<td>68.5°F - 74.5°F</td>
<td>73.0°F - 79.0°F</td>
</tr>
<tr>
<td>60%</td>
<td>68.0°F - 74.0°F</td>
<td>72.5°F - 78.0°F</td>
</tr>
</tbody>
</table>

*(ASHRAE Standard 55-1992)*
Hotel Indoor Air Quality

Fungi-Mold & Mildew

70 million replacing items have been damaged by mold and mildew. (American Gas, Jul 1999)

(Mold on the bath curtain)
Hotel Indoor Air Quality

**Conditions to Thrive**

Temperature range above 40°F and below 100°F
Mold spores
Nutrient base (most surfaces contain nutrients)
Moisture RH>70%
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Health Impact

• Allergies
• Asthmatic reactions
• Skin Disease
• Parasite in lungs
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Controls

• Reduce the moisture content (vapor pressure) of the air
• Increase air movement at the surface
• Increase the air temperature (either the general space temperature or the temperature at building surfaces).
• Wash mold off hard surfaces and dry completely.
• Absorbent materials, such as ceiling tiles and carpet, with mold may need to be replaced.

(EPA, Moisture, Mold and Mildew141 Appendix C)
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Carpet

Interior products in the home have the potential to impact the indoor air because they emit volatile organic compounds (VOCs) into the air.
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Health Impact

• Eye and respiratory tract irritation
• Headache
• Dizziness
• Memory impairment
• Neurotoxicity
• Cancer
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Controls

• Look for and purchase a carpet, cushion, or floor-covering adhesive that displays the Carpet and Rug Institute (CRI) Indoor Air Quality Testing label.

• Tests indicated that carpet emissions that are released upon installation, with proper ventilation, will dissipate within 48-72 hours.
Hotel Indoor Air Quality

(CRI/IAQ Carpet Testing Label)
The current criteria for the program are based on a maximum emission factor measured in mg/m$^2$ hr as follows:

<table>
<thead>
<tr>
<th>Compound</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Volatile Organic Compounds</td>
<td>0.5</td>
</tr>
<tr>
<td>4-PC (4-Phenylcyclohexene)</td>
<td>0.05</td>
</tr>
<tr>
<td>Formaldehyde (to prove that none is used)</td>
<td>0.05</td>
</tr>
<tr>
<td>Styrene</td>
<td>0.4</td>
</tr>
</tbody>
</table>

*(CRI/IAQ Carpet Testing Program, 1992)*
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Vacuum cleaner
Hotel Indoor Air Quality

• Use portable HEPA (high efficiency particulate arrestance) vacuums instead of low-efficiency paper-bag collectors.
• True HEPA exhaust filter captures 99.99% of all particles down to 0.3 microns.

(Plant Engineering; Feb 1998)
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HEPA Vacuum Cleaner V.S. Non-HEPA Vacuum Cleaner
Hotel Indoor Air Quality

Dishwasher
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Waterborne pollutants from tap water enter the air when water is heated. Within a minute or 2, the first cycle in the dishwasher stripped the water of 96 to 100 percent of **toluene, ethylbenzene, and cyclohexane**. It continuously vent some 5 to 7 liters of air per minute into the kitchen, the volatilized pollutants almost immediately begin circulating within the house.

**Solution**

Use exhaust fans or open windows in kitchens and bathrooms when showering, cooking, or using the dishwasher.
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Bacteria

Legionnaire’s Disease can be infected via the mist of cooling towers
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Conditions

• Ubiquitous
• Many bacteria are $\sim 1 \mu m$
• Ventilation duct dust can contain up to 50,000 bacteria per gram of dust.
• Dirty HVAC filters can contain up to 6,700 bacteria per gram of dust.
• Bacteria need 95% RH to survive.
Hotel Indoor Air Quality

Health Impact

Legionnaire’s Disease

- *Legionella pneumophila* can thrive in cooling towers and the cooling tower mist can be re-entrained into the HVAC system.
- Symptoms - malaise, headache, high fever, gastro-intestinal symptoms, respiratory failure, death.
- Legionnaire’s disease mainly fatal for elderly and immune-suppressed (e.g. AIDS patients).
- > 600 deaths per year.
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Controls

- Lower water temperature by installing cooling towers. Optimal growth temperature ~35°C in water (~95°F).
  (Issues on Prevention of Nosocomial Pneumonia, 1994)
- Bacterium killed in 8 minutes at 58°C (136°F).
- Bacterium killed in 4 minutes at 60°C (140°F).
- Killed by chlorination.
- Killed by UV light.
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Schematic of a Typical Cooling Tower
(after MILLER, 1979)
Hotel Indoor Air Quality

**Suggested Legionella Risk Assessment Levels**

<table>
<thead>
<tr>
<th>Legionella Per ml.</th>
<th>Cooling Towers</th>
<th>Hot Water Systems</th>
<th>Humidifiers fogger</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1</td>
<td>Low</td>
<td>Low</td>
<td>Low but increasing</td>
</tr>
<tr>
<td>1 to 9</td>
<td>Low</td>
<td>Low but increasing</td>
<td>Moderate</td>
</tr>
<tr>
<td>10 to 99</td>
<td>Low but increasing</td>
<td>Moderate</td>
<td>High</td>
</tr>
<tr>
<td>100 to 999</td>
<td>Moderate</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>&gt;1000</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
</tbody>
</table>

*(Occupational Hazard, 1999)*
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HVAC

Room HEPA filter unit (*Isolate, INC.*)
Hotel Indoor Air Quality

Contaminant

• Dust or dirt in ductwork or other components
• Microbiological growth in drip pans, humidifiers, ductwork, and coil
• Improper use of biocides, sealants, and cleaning compounds
• Improper venting of combustible products
• Refrigerant leakage
# Hotel Indoor Air Quality

Filter efficiency suggested by ASHRAE:

<table>
<thead>
<tr>
<th>Location</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hotel/Motel</td>
<td>20%-30%</td>
</tr>
<tr>
<td>Bedrooms</td>
<td>20%-30%</td>
</tr>
<tr>
<td>Suites</td>
<td>20%-30%</td>
</tr>
<tr>
<td>Lobbies</td>
<td>20%-30%</td>
</tr>
<tr>
<td>Conference</td>
<td>20%-30%</td>
</tr>
<tr>
<td>Assembly Hall</td>
<td>20%-30%</td>
</tr>
<tr>
<td>Restaurant/Nite-club</td>
<td>35%-40%</td>
</tr>
<tr>
<td>Smoking Room</td>
<td>80%</td>
</tr>
</tbody>
</table>

HEPA filters
Hotel Indoor Air Quality

Relationship between CO$_2$ levels in a space and ventilation

(Telaire Systems, Inc)
EPA concluded that ETS (Environmental Tobacco Smoke) is a human lung carcinogen, responsible for approximately 3,000 lung cancer deaths annually in U.S. nonsmokers.

(IFMA, 1994)
Hotel Indoor Air Quality

**Health Impact**

- Eye, nose and throat irritation
- Headaches
- Lung cancer
- Heart disease.

**Control**

- Do not smoke in your home or permit others to do so.
- Do not smoke if children are present, particularly infants and toddlers.
- Increase ventilation in the area where smoking takes place. Open windows or use exhaust fans.