Where Green Turns into Gold
Improving Indoor Environmental Quality with LEED®

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Indoor Environmental Quality

Why the focus on IEQ?

- Americans spend 80-90% of their time indoors
- The quality of the indoor environment has a significant impact on health, productivity, and quality of life.
- In this case, an ounce of prevention is worth a pound of cure.
Indoor Environmental Quality

The overall quality of the indoor environment can be measured by evaluating multiple attributes:

- Indoor Air Quality (IAQ)
- System Controllability
- Thermal Comfort
- Lighting and Daylighting
- Views
- Acoustics
- Cleanliness
- Aesthetics …and more
Indoor Environmental Quality

Today we’ll be focusing on just one aspect of IEQ:

• Indoor Air Quality (IAQ)
Indoor Air Quality

IAQ is influenced by the design, construction, and maintenance of many complex building elements including:

- Heating, Ventilation, and Air conditioning (HVAC)
- HVAC System Controls
- HVAC System Maintenance
- Finish Material Selections
- Cleaning Policy and Procedures
- Purchasing Policy
- Occupant Behavior
Indoor Air Quality

Why the focus on IAQ?

• The Environmental Protection Agency (EPA) reports pollutant levels of indoor environments may run 2 to 5 times higher than outdoor levels.

• The World Health Organization (WHO) reports that most of an individual’s exposure to air pollutants comes through inhalation of indoor air.

• In 1987 and 1990 the EPA designated indoor air pollution as the top environmental risk to public health.
Indoor Air Quality

Why the focus on IAQ?

• Major health risks of poor indoor air quality:
  - Asthma and allergy
  - Infectious disease: flu, cold, pneumonia (Legionnaires' Disease, Pontiac fever),
  - Cancer, other genetic toxicity, teratogenicity - (Ecotoxicity)
  - CNS, skin, GI, respiratory, circulatory, musculoskeletal, and other systemic effects
  - SBS (Sick Building Syndrome)
IAQ Best Practice Concepts

Relationships between indoor air pollution sources, ventilation, and concentrations are the key.

Pollutant sources:

- Outdoor Air, Soil, Water / Building Envelope
- Building Equipment / Finishes and Furnishings
- Machines and Appliances / Occupants
- Occupant Activities / Maintenance and Cleaning
IAQ Best Practice Concepts

Source control options and strategies:
- Isolation from outdoors
- Outdoor air cleaning and filtration
- Outdoor air ventilation rates and schedules

Pollutant removal mechanisms:
- Sinks
- Ventilation
- Air Cleaning and Filtration
- Chemical Transformation
IAQ Best Practice Concepts

Ventilation system design and operation:

- Local exhaust for point sources.
- Air distribution strategy and ventilation effectiveness.
- Outdoor air ventilation rates.
- Assembly of all system components.
- Operator training.
- Commissioning.
IAQ Best Practice Concepts

Material Selection and Specification:

• Quantify major materials and identify important sources.
• Identify major material selection criteria and alternatives.
• Obtain maintenance, durability, and expected service life for candidate materials.
• Determine indoor air implications of installation, removal, and replacement processes.
• Specify construction practices.
IAQ Best Practice Concepts

Construction:

• Review submittals to ensure conformance to IAQ performance specifications.
• Specify and observe construction site practices.
IAQ Best Practice Concepts

Maintenance and Operation:

• Design and operation must be consistent.
• Need to follow-through the whole process.
• Design should provide for access to all components of HVAC systems for inspection, repair, and cleaning. Cleaning of surfaces is essential.
IAQ Best Practice Concepts
Change of Use, Renovation, Adaptive Re-use, and De-mounting:

• Modification and Renovation:

*During construction activities, construction dust, fumes, and vapors must be contained and not allowed to contaminant building surfaces or the air in occupied spaces.*

*Temporary ventilation and isolation barriers should be employed.*
IAQ Best Practice Concepts

• Adaptive Reuse:

*When the use of a space or building is significantly changed, it is essential to determine whether the building systems and layout can support the new activities and occupancy loads.*

*Review record drawings and other documents. If such documents are not available, an engineering assessment should be conducted.*

• Demolition:

*Avoid contamination of occupied spaces or of surfaces that will remain in use or be re-used.*
Where does LEED come in?

LEED addresses the complete lifecycle of buildings:

- **Homes**
- **Neighborhood Development (in pilot)**
- **Commercial Interiors**
- **Core and Shell**
- **New Construction**
- **Schools, Retail, LEED for Healthcare**
- **Existing Buildings**
For today we’ll focus on:

LEED addresses the complete lifecycle of buildings:

- Homes
- Neighborhood Development (in pilot)
- Commercial Interiors
- Core and Shell
- New Construction
- Schools, Retail, LEED for Healthcare

LEED NC-2009
LEED NC 2009

Regional Priority

8 Prerequisites & 110 Possible Points

4 Possible Points

2 Prerequisites
15 Possible Points

1 Prerequisite
14 Possible Points

Innovation In Design

6 Possible Points

Site Planning

1 Prerequisite
26 Possible Points

2 Prerequisites
15 Possible Points

Material Use

1 Prerequisite
10 Possible Points

Energy

3 Prerequisites
35 Possible Points

Water Management

Indoor Environmental Quality

1 Prerequisite
14 Possible Points
LEED NC 2009
IEQ

2 Prerequisites
15 Possible Points
IEQ & IAQ in LEED

LEED addresses Indoor Air Quality (IAQ) within the Indoor Environmental Quality (IEQ) section.

Today we’ll focus on those LEED IEQ Pre-requisites and Credits related to IAQ.
IEQ & IAQ in LEED NC 2009

IEQ Prerequisite 1:
Minimum IAQ Performance

**INTENT:** Establish minimum indoor air quality (IAQ) performance to enhance indoor air quality in buildings, thus contributing to the comfort and well-being of the occupants.

**REQUIREMENTS:** Meet the minimum requirements of Sections 4 through 7 of ASHRAE 62.1-2007, Ventilation for Acceptable Indoor Air Quality. Mechanical ventilation systems shall be designed using the ventilation rate procedure or the applicable local code, whichever is more stringent.

Naturally ventilated buildings shall comply with ASHRAE 62.1-2007, paragraph 5.1.
IEQ Prerequisite 1: Minimum IAQ Performance

TECHNOLOGIES/STRATEGIES:

• Design ventilation systems to meet or exceed the minimum outdoor air ventilation rates as described in the ASHRAE 62.1 Standard.

• Balance the impacts of ventilation rates on energy use and indoor air quality to optimize for energy efficiency and occupant health.

• Use the ASHRAE 62.1 Users Manual for detailed guidance on meeting the referenced requirements.
IEQ Prerequisite 1: Minimum IAQ Performance


SECTION 4: OUTDOOR AIR QUALITY - The standard now requires a documented assessment of outdoor air quality. The manual explains the requirements for assessing both regional and local outdoor air quality. It details the criteria pollutants used to establish regional air quality in terms of “attainment” or “non-attainment” with NAAQS. It also describes the elements of a site survey for local assessment.
IEQ Prerequisite 1: Minimum IAQ Performance


SECTION 5: SYSTEMS & EQUIPMENT – This section covers general requirements for natural ventilation and for ventilation systems and equipment. The user’s manual addresses all of them. Required:

• The air distribution system be designed so that it can deliver the ventilation airflow rates required by Section 6.
• Must maintain the minimum outdoor airflows in CV & VAV systems.
• Avoid airstream surface materials that support mold or bacteria growth.
• Minimum separation distance between outdoor contaminant sources and the outdoor air intake opening.
• Dehumidifying systems must maintain space relative humidity to 65% or less when analyzed at design dew-point conditions.
• Dehumidifying systems to be designed to manage condensate properly to reduce microbial growth in liquid water and on wetted surfaces.
IEQ Prerequisite 1:  
Minimum IAQ Performance  

SECTION 6: PROCEDURES - This section covers specific ventilation requirements. Required:
- When following the prescriptive Ventilation Rate Procedure (VRP), the standard requires that breathing zone outdoor airflow be found using prescribed outdoor air rate per person times the zone population, plus prescribed outdoor air rate per unit area times the zone floor area. The standard provides a table of Minimum Ventilation Rates in Breathing Zone.
- The manual explains how to find system ventilation efficiency using either a default value from a table or a more accurate value calculated using an equation.
- The standard includes many additional requirements, such as installation, startup, operation and maintenance.
IEQ Prerequisite 1:  
Minimum IAQ Performance 

SECTION 7: CONSTRUCTION & STARTUP - This section covers construction practices and startup issues: 

- Filters 
- Protection of materials 
- Protection of occupied areas 
- Balancing 
- Testing 
- Documentation
IEQ Prerequisite 1:
Minimum IAQ Performance

Design Strategy: Displacement Ventilation

- Displacement ventilation is typically used in offices, public spaces, classrooms, and industrial plants. Most effective way to insure proper air changes.
- The temperature of incoming air must not be much lower than room temperature in order to avoid chilling the occupants. This factor has positive implications for building energy use.

NOTE: In some conditions, additional air volume must be circulated in order to capture internal sensible heat gains and in order to cool air for dehumidification purposes.
IEQ & IAQ in LEED NC 2009

IEQ Prerequisite 2: Environmental Tobacco Smoke (ETS) Control

**INTENT:** Minimize exposure of building occupants, indoor surfaces, and ventilation air distribution systems to Environmental Tobacco Smoke (ETS).

**REQUIREMENTS:**

**OPTION 1**

- Prohibit smoking in the building.
- Locate any exterior designated smoking areas at least 25 feet away from entries, outdoor air intakes and operable windows.
IEQ Prerequisite 2: Environmental Tobacco Smoke (ETS) Control

OPTION 2

- Prohibit smoking in the building except in designated smoking areas.
- Locate any exterior designated smoking areas at least 25 feet away from entries, outdoor air intakes and operable windows.
- Locate designated smoking rooms to effectively contain, capture and remove ETS from the building:
  - Directly exhaust to the outdoors with no re-circulation.
  - Impermeable deck-to-deck partitions.
  - Operate exhaust sufficient to create a negative pressure (specified in rating system).
- Performance of the smoking room differential air pressures shall be verified by . . . (testing specified in rating system).
IEQ Prerequisite 2: Environmental Tobacco Smoke (ETS) Control

OPTION 3 (For residential buildings only)

• Prohibit smoking in all common areas of the building.
• Locate any exterior designated smoking areas at least 25 feet away from entries, outdoor air intakes and operable windows opening to common areas.
• Minimize uncontrolled pathways for ETS transfer:
  Seal penetrations in walls, ceilings and floors in the residential units.
  Seal vertical chases adjacent to the units.
  Weather-strip doors to hallways.
• If the common hallways are pressurized with respect to the residential units then doors in the residential units leading to the common hallways need not be weather-stripped. (Testing criteria in rating system).
IEQ Prerequisite 2: Environmental Tobacco Smoke (ETS) Control

TECHNOLOGIES/STRATEGIES:

• Prohibit smoking in commercial buildings or effectively control the ventilation air in smoking rooms.

• For residential buildings, prohibit smoking in common areas, design building envelope and systems to minimize ETS transfer among dwelling units.
IEQ & IAQ in LEED NC 2009

IEQ Credit 1: Outdoor Air Delivery Monitoring

**INTENT:** Provide capacity for ventilation system monitoring to help sustain occupant health and comfort.

**REQUIREMENTS:** (1 point) - Install permanent monitoring systems that provide feedback on ventilation system performance to ensure that ventilation systems maintain design minimum ventilation requirements. Configure all monitoring equipment to generate an alarm when the conditions vary by 10% or more from setpoint, via either a building automation system alarm to the building operator or via a visual or audible alert to the building occupants.
IEQ Credit 1: Outdoor Air Delivery Monitoring

REQUIREMENTS (cont.)

FOR MECHANICALLY VENTILATED SPACES

• Monitor carbon dioxide (CO\textsuperscript{2}) concentrations within all densely occupied spaces (those with a design occupant density greater than or equal to 25 people per 1000 sf). CO\textsuperscript{2} monitoring locations shall be between 3 feet and 6 feet above the floor.

• For each mechanical ventilation system serving non-densely occupied spaces, provide a direct outdoor airflow measurement device capable of measuring the minimum outdoor airflow rate with an accuracy of plus or minus 15% of the design minimum outdoor air rate, as defined by ASHRAE 62.1-2007.
IEQ Credit 1: Outdoor Air Delivery Monitoring

REQUIREMENTS (cont.)

FOR NATURALLY VENTILATED SPACES

• Monitor CO² concentrations within all naturally ventilated spaces. CO² monitoring shall be located within the room between 3 feet and 6 feet above the floor.

• One CO² sensor may be used to represent multiple spaces if the natural ventilation design uses passive stack(s) or other means to induce airflow through those spaces equally and simultaneously without intervention by building occupants.
IEQ Credit 1: Outdoor Air Delivery Monitoring

TECHNOLOGIES/STRATEGIES:

• Install carbon dioxide and airflow measurement equipment and feed the information to the HVAC system and/or Building Automation System (BAS) to trigger corrective action, if applicable.

• If such automatic controls are not feasible with the building systems, use the measurement equipment to trigger alarms that inform building operators or occupants of a possible deficiency in outdoor air delivery.
IEQ & IAQ in LEED NC 2009

IEQ Credit 2: Increased Ventilation

**INTENT:** Provide for the effective delivery and mixing of fresh air to support the health, safety, and comfort of building occupants.

**REQUIREMENTS:** (1 point) –

**CASE 1. MECHANICALLY VENTILATED SPACES**

- Increase breathing zone outdoor air ventilation rates to all occupied spaces by at least 30% above the minimum rates required by ASHRAE Standard 62.1-2007 as determined by IEQ Prerequisite 1.
IEQ Credit 2: Increased Ventilation

REQUIREMENTS (cont.)

CASE 2. NATURALLY VENTILATED SPACES

• Design natural ventilation systems for occupied spaces to meet the recommendations set forth in the Carbon Trust Good Practice Guide 237 [1998]. Use flow diagram process specified to show compliance.

AND

• Option 1: Use diagrams and calculations to show that the design of the natural ventilation systems meets the recommendations set forth in the CIBSE Applications Manual 10: 2005, Natural Ventilation in Non-domestic Buildings.

OR

• Option 2: Use a macroscopic, multi-zone, analytic model to predict that room-by-room airflows will effectively naturally ventilate, defined as providing the minimum ventilation rates required by ASHRAE 62.1-2007 Ch. 6, for at least 90% of occupied spaces.
IEQ Credit 2: Increased Ventilation

TECHNOLOGIES/STRATEGIES:

• For Mechanically ventilated Spaces: Use heat recovery, where appropriate, to minimize the additional energy consumption associated with higher ventilation rates.

• For Naturally ventilated Spaces: Follow the eight design steps described in the Carbon Trust Good Practice Guide 237:
  1) Develop design requirements,
  2) Plan airflow paths,
  3) Identify building uses and features that might require special attention,
  4) Determine ventilation requirements,
  5) Estimate external driving pressures,
  6) Select types of ventilation devices,
  7) Size ventilation devices,
  8) Analyze the design.

• Use public domain software such as NIST’s CONTAM, Multizone Modeling Software, along with LoopDA, Natural Ventilation Sizing Tool, to analytically predict room-by-room airflows.
IEQ & IAQ in LEED NC 2009

IEQ Credit 3.1: Construction IAQ Management Plan - During Construction

**INTENT:** Reduce indoor air quality problems resulting from the construction or renovation process and promote the comfort and well-being of construction workers and building occupants.
IEQ Credit 3.1: Construction IAQ Management Plan - During Construction

REQUIREMENTS (1 Point):
Develop and implement an Indoor Air Quality (IAQ) Management Plan for the construction and pre-occupancy phases of the building as follows:

• During construction meet or exceed the recommended Control Measures of the Sheet Metal and Air Conditioning National Contractors Association (SMACNA) IAQ Guidelines for Occupied Buildings under Construction, 1995, Chapter 3.

• Protect stored on-site or installed absorptive materials from moisture damage.

• If permanently installed air handlers are used during construction, filtration media with a Minimum Efficiency Reporting Value (MERV) of 8 shall be used at each return air grille, as determined by ASHRAE 52.2-1999. Replace all filtration media immediately prior to occupancy.
IEQ Credit 3.1: Construction IAQ Management Plan - During Construction

TECHNOLOGIES/STRATEGIES:

• Adopt an IAQ management plan to protect the HVAC system during construction, control pollutant sources and interrupt contamination pathways. Sequence the installation of materials to avoid contamination of absorptive materials such as insulation, carpeting, ceiling tile and gypsum wallboard. Coordinate with Indoor Environmental Quality Credits 3.2 and 5 to determine the appropriate specifications and schedules for filtration media.

• If possible, avoid using permanently installed air handlers for temporary heating/cooling during construction. Consult the LEED-NC 2009 Reference Guide for more detailed information on how to ensure the well-being of construction workers and building occupants if permanently installed air handlers must be used during construction.
IEQ Credit 3.1: Construction IAQ Management Plan - During Construction

TECHNOLOGIES/STRATEGIES:
(cont.)

- SMACNA focuses on sheet metal ducting.
- Moisture is a big issue, not to be neglected.
  - Proper phasing of materials.
  - Installing wet materials.
  - Design of drainage plains.
- Failure to cover ducts.
IEQ & IAQ in LEED NC 2009

IEQ Credit 3.2: Construction IAQ Management Plan - Before Occupancy

**INTENT:** Reduce indoor air quality problems resulting from the construction or renovation to promote the comfort and well-being of construction workers and building occupants.
IEQ Credit 3.2: Construction IAQ Management Plan - Before Occupancy

REQUIREMENTS (1 Point):

Develop and implement an Indoor Air Quality (IAQ) management plan for the pre-occupancy phase—*after all finishes have been installed and the building has been completely cleaned*—as follows:

**OPTION 1 — Flush-Out**

**Path 1:** After construction ends, prior to occupancy, perform a building flush-out by supplying a total air volume of 14,000 cf of outdoor air per square foot of floor area while maintaining an internal temperature of at least 60° F and relative humidity no higher than 60%.

OR…
IEQ Credit 3.2: Construction IAQ Management Plan - Before Occupancy

REQUIREMENTS (cont):

OPTION 1 — Flush-Out (cont.)

Path 2: If occupancy is desired prior to completion of the flush-out, the space may be occupied following delivery of a minimum of 3,500 cf of outdoor air per sf of floor area to the space. Once a space is occupied, it shall be ventilated at a minimum rate of 0.30 cfm/sf of outside air or the design minimum outside air rate determined in EQ Prerequisite 1, whichever is greater. During each day of the flush-out period, ventilation shall begin a minimum of three hours prior to occupancy and continue during occupancy. These conditions shall be maintained until a total of 14,000 cf/sf of outside air has been delivered to the space.
IEQ Credit 3.2: Construction IAQ Management Plan - Before Occupancy

REQUIREMENTS (cont):

OR...

OPTION 2 — Air Testing

Conduct baseline IAQ testing, after construction ends and prior to occupancy, using testing protocols consistent with the United States Environmental Protection Agency Compendium of Methods for the Determination of Air Pollutants in Indoor Air and as additionally detailed in the Reference Guide.
IEQ Credit 3.2: Construction IAQ
Management Plan - Before Occupancy

REQUIREMENTS (cont):

**OPTION 2 (cont.)**
Demonstrate that the contaminant maximum concentrations listed below are not exceeded.

<table>
<thead>
<tr>
<th>CONTAMINANT</th>
<th>MAX. CONCENTRATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formaldehyde</td>
<td>27 parts per billion</td>
</tr>
<tr>
<td>Particulates (PM10)</td>
<td>50 micrograms per cubic meter</td>
</tr>
<tr>
<td>Total Volatile Organic Compounds (TVOC)</td>
<td>500 micrograms per cubic meter</td>
</tr>
<tr>
<td>* 4-Phenylcyclohexene (4-PCH)</td>
<td>6.5 micrograms per cubic meter</td>
</tr>
<tr>
<td>Carbon Monoxide (CO)</td>
<td>9 part per million and no greater than 2 parts per million above outdoor levels</td>
</tr>
</tbody>
</table>

* This test is only required if carpets and fabrics with styrene butadiene rubber (SBR) latex backing material are installed as part of the base building systems.
IEQ Credit 3.2: Construction IAQ Management Plan - Before Occupancy

REQUIREMENTS (cont):

OPTION 2 (cont.)

For each sampling point where the maximum concentration limits are exceeded conduct additional flush-out with outside air and retest the specific parameter exceeded. Repeat procedure until all requirements have been met.

Conduct air sample testing per the requirements in the rating system:

1) All measurements shall be conducted prior to occupancy with normal system ops,
2) The building shall have all interior finishes installed,
3) Sample point per rating systems requirements,
4) Air samples shall be collected between 3 and 6 feet over a minimum 4-hour period.
IEQ Credit 3.2: Construction IAQ Management Plan - Before Occupancy

TECHNOLOGIES/STRATEGIES:

• Prior to occupancy, perform a building flush-out – OR – test the air contaminant levels in the building.

• The flush-out is often used where occupancy is not required immediately upon substantial completion of construction.

• IAQ testing can minimize schedule impacts but may be more costly.

• Coordinate with IEQ Credits 3.1 and 5 to determine the appropriate specifications and schedules for filtration media.
IEQ & IAQ in LEED NC 2009

IEQ Credit 4: Low Emitting Materials

**INTENT:** Reduce the quantity of indoor air contaminants that are odorous, irritating and/or harmful to the comfort and well-being of installers and occupants.
IEQ Credit 4.1: Low Emitting Materials - Adhesives and Sealants

REQUIREMENTS (1 Point):

All adhesives and sealants used on the interior of the building (defined as inside of the weatherproofing system and applied on-site) must comply with the requirements of the following reference standards:

Adhesives, Sealants and Sealant Primers: South Coast Air Quality Management District (SCAQMD) Rule #1168. Volatile Organic Compound (VOC) limits are listed in the table below and correspond to an effective date of July 1, 2005 and rule amendment date of January 7, 2005.
<table>
<thead>
<tr>
<th>Architectural Applications</th>
<th>VOC Limit [g/L less water]</th>
<th>Specialty Applications</th>
<th>VOC Limit [g/L less water]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indoor Carpet Adhesives</td>
<td>50</td>
<td>PVC Welding</td>
<td>510</td>
</tr>
<tr>
<td>Carpet Pad Adhesives</td>
<td>50</td>
<td>CPVC Welding</td>
<td>490</td>
</tr>
<tr>
<td>Wood Flooring Adhesives</td>
<td>100</td>
<td>ABS Welding</td>
<td>325</td>
</tr>
<tr>
<td>Rubber Floor Adhesives</td>
<td>60</td>
<td>Plastic Cement Welding</td>
<td>250</td>
</tr>
<tr>
<td>Subfloor Adhesives</td>
<td>50</td>
<td>Adhesive Primer for Plastic</td>
<td>550</td>
</tr>
<tr>
<td>Ceramic Tile Adhesives</td>
<td>65</td>
<td>Contact Adhesive</td>
<td>80</td>
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<tr>
<td>VCT &amp; Asphalt Adhesives</td>
<td>50</td>
<td>Special Purpose Contact Adhesive</td>
<td>250</td>
</tr>
<tr>
<td>Drywall &amp; Panel Adhesives</td>
<td>50</td>
<td>Structural Wood Member Adhesive</td>
<td>140</td>
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<tr>
<td>Cove Base Adhesives</td>
<td>50</td>
<td>Sheet Applied Rubber Lining Operations</td>
<td>850</td>
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<tr>
<td>Multipurpose Construction Adhesives</td>
<td>70</td>
<td>Top &amp; Trim Adhesive</td>
<td>250</td>
</tr>
<tr>
<td>Structural Glazing Adhesives</td>
<td>100</td>
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<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Substrate Specific Applications</th>
<th>VOC Limit [g/L less water]</th>
<th>Sealants</th>
<th>VOC Limit [g/L less water]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metal to Metal</td>
<td>30</td>
<td>Architectural</td>
<td>250</td>
</tr>
<tr>
<td>Plastic Foams</td>
<td>50</td>
<td>Nonmembrane Roof</td>
<td>300</td>
</tr>
<tr>
<td>Porous Material (except wood)</td>
<td>50</td>
<td>Roadway</td>
<td>250</td>
</tr>
<tr>
<td>Wood</td>
<td>30</td>
<td>Single-Ply Roof Membrane</td>
<td>450</td>
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<tr>
<td>Fiberglass</td>
<td>80</td>
<td>Other</td>
<td>420</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sealant Primers</th>
<th>VOC Limit [g/L less water]</th>
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</thead>
<tbody>
<tr>
<td>Architectural Non Porous</td>
<td>250</td>
</tr>
<tr>
<td>Architectural Porous</td>
<td>775</td>
</tr>
<tr>
<td>Other</td>
<td>750</td>
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</tbody>
</table>
IEQ Credit 4.1: Low Emitting Materials - Adhesives and Sealants

REQUIREMENTS (cont.)

<table>
<thead>
<tr>
<th>Aerosol Adhesives:</th>
<th>VOC weight [g/L minus water]</th>
</tr>
</thead>
<tbody>
<tr>
<td>General purpose mist spray</td>
<td>65% VOCs by weight</td>
</tr>
<tr>
<td>General purpose web spray</td>
<td>55% VOCs by weight</td>
</tr>
<tr>
<td>Special purpose aerosol adhesives (all types)</td>
<td>70% VOCs by weight</td>
</tr>
</tbody>
</table>
IEQ Credit 4.1: Low Emitting Materials - Adhesives and Sealants

TECHNOLOGIES/STRATEGIES:

• Specify low-VOC materials in construction documents.

• Ensure that VOC limits are clearly stated in each section of the specifications where adhesives and sealants are addressed.

• Track the VOC content of all adhesives and sealants during construction.

• Common products to evaluate include:
  • general construction adhesives,
  • flooring adhesives,
  • fire-stopping sealants,
  • caulking,
  • duct sealants,
  • plumbing adhesives,
  • cove base adhesives.
IEQ Credit 4.2: Low Emitting Materials - Paints and Coatings

REQUIREMENTS (1 Point):

Paints and coatings used on the interior of the building (defined as inside of the weatherproofing system and applied on-site) shall comply with the following criteria:

Architectural paints, coatings and primers applied to interior walls and ceilings: Do not exceed the VOC content limits established in Green Seal Standard GS-11, Paints, First Edition, May 20, 1993. [Flats: 50 g/L Non-Flats: 150 g/L]

IEQ Credit 4.2: Low Emitting Materials - Paints and Coatings

REQUIREMENTS (cont):

...criteria (cont.)

Clear wood finishes, floor coatings, stains, and shellacs applied to interior elements must not exceed the VOC content limits established in South Coast Air Quality Management District (SCAQMD) Rule 1113, Architectural Coatings, rules in effect on January 1, 2004.

Some examples:
- Clear wood finishes: varnish, sanding, and lacquer 275 g/L
- Floor coatings: 50 g/L
- Sealers: waterproofing sealers 100 g/L; sanding sealers 275 g/L
- Shellacs: Clear 730 g/L; pigmented 550 g/L
- Stains: 100 g/L
IEQ Credit 4.2: Low Emitting Materials - Paints and Coatings

TECHNOLOGIES/STRATEGIES:

- Specify low-VOC materials in construction documents.
- Ensure that VOC limits are clearly stated in each section of the specifications where paints and coatings are addressed.
- Track the VOC content of all interior paints and coatings during construction.
IEQ Credit 4.3: Low Emitting Materials - Flooring Systems

REQUIREMENTS (1 Point):

All carpet installed in the building interior shall meet the testing and product requirements of the Carpet and Rug Institute’s Green Label Plus program.

All carpet cushion installed in the building interior shall meet the requirements of the Carpet and Rug Institute Green Label program.

All carpet adhesive shall meet the requirements of IEQ Credit 4.1: VOC limit of 50 g/L.

All hard surface flooring must be certified as compliant with the FloorScore standard by an independent third-party. Includes vinyl, linoleum, laminate flooring, wood flooring, ceramic flooring, rubber flooring and wall base.
IEQ Credit 4.3: Low Emitting Materials - Flooring Systems

REQUIREDMENTS (cont.):

An alternate compliance path using FloorScore is acceptable for credit achievement.

Concrete, wood, bamboo, and cork floor finishes such as sealer, stain, and finish must meet the requirement of the South Coast Air Quality Management District (SCAQMD) Rule 1113, Architectural Coatings, rules in effect on January 1, 2004.

Tile setting adhesives and grout must meet the SCAQMD rule 1168. VOC limits correspond to an effective date of July 1, 2005 and rule amendment date of January 7, 2005.
IEQ Credit 4.3: Low Emitting Materials - Flooring Systems

TECHNOLOGIES/STRATEGIES:

• Clearly specify requirements for product testing and/or certification in the construction documents.
• Select products that are either certified under the Green Label Plus or FloorScore programs, or for which testing has been done by qualified independent laboratories in accordance with the appropriate requirements.
IEQ Credit 4.4: Low Emitting Materials - Composite Wood & Agrifiber Products

REQUIREMENTS (1 Point):

Composite wood and agrifiber products used on the interior of the building (defined as inside of the weatherproofing system) must contain no added urea-formaldehyde resins. Laminating adhesives used to fabricate on-site and shop-applied composite wood and agrifiber assemblies must not contain added urea-formaldehyde resins.

Composite wood and agrifiber products are defined as: particleboard, medium density fiberboard (MDF), plywood, wheatboard, strawboard, panel substrates and door cores. Materials considered fit-out, furniture, and equipment (FF&E) are not considered base building elements and are not included.
IEQ Credit 4.4: Low Emitting Materials
- Composite Wood & Agrifiber Products

TECHNOLOGIES/STRATEGIES:

• Specify wood and agrifiber products that contain no added urea-formaldehyde resins.
• Specify laminating adhesives for field and shop applied assemblies that contain no added urea-formaldehyde resins.
IEQ Credit 4.5: Low Emitting Materials - Furniture and Furnishings

CREDIT AVAILABLE FOR SCHOOLS ONLY

(Schools may choose from IEQ Credits 4.1-4.6 for a maximum of 4 points)

REQUIREMENTS:

Classroom furniture including all student and teacher desks, tables and seats that were manufactured, refurbished or refinshed within 1 year prior to occupancy must meet 1 of the requirements specified. Salvaged and used furniture that is more than 1 year old at the time of occupancy is excluded.
IEQ Credit 4.6: Low Emitting Materials - Ceiling and Wall Systems

CREDIT AVAILABLE FOR SCHOOLS ONLY

(Schools may choose from IEQ Credits 4.1-4.6 for a maximum of 4 points)

REQUIREMENTS:

All gypsum board, insulation, acoustical ceiling systems and wall coverings installed in the building interior must meet the testing and product requirements of the California Department of Health Services Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers, including 2004 Addenda.
IEQ & IAQ in LEED NC 2009

IEQ Credit 5: Indoor Chemical and Pollutant Source Control

**INTENT:** Minimize exposure of building occupants to potentially hazardous particles and chemical pollutants.

**REQUIREMENTS (1 point):**

Design to minimize and control pollutant entry into buildings and later cross-contamination of regularly occupied areas through the following strategies:
IEQ Credit 5: Indoor Chemical and Pollutant Source Control

REQUIREMENTS (cont):

• Employ permanent entryway systems at least ten feet long in the primary direction of travel to capture dirt and particulates entering the building at regularly used exterior entrances. Acceptable entryway systems include permanently installed grates, grilles, or slotted systems that allow for cleaning underneath.
IEQ Credit 5: Indoor Chemical and Pollutant Source Control

REQUIREMENTS (cont.):

• Sufficiently exhaust each space where hazardous gases or chemicals may be present or used (e.g. garages, housekeeping and laundry areas, scientific laboratories, prep rooms, art rooms, shops of any kind, and copying and printing rooms), to create negative pressure with respect to adjacent spaces with the doors to the room closed. For each of these spaces, provide self-closing doors and deck-to-deck partitions or a hard lid ceiling. The exhaust rate must be at least 0.50 cfm/sq.ft., with no air recirculation. Follow pressure differential requirements in rating system.
IEQ Credit 5: Indoor Chemical and Pollutant Source Control

REQUIREMENTS (cont):

• In mechanically ventilated buildings, install new air filtration media in regularly occupied areas prior to occupancy; these filters must provide a Minimum Efficiency Reporting Value (MERV) of 13 or higher. Filtration should be applied to process both return and outside air that is to be delivered as supply air.

• Provide containment (i.e. closed container for storage for off-site disposal in a regulatory compliant storage area, preferably outside the building) for appropriate disposal of hazardous liquid wastes in places where water and chemical concentrate mixing occurs (e.g., housekeeping, janitorial and science laboratories).
IEQ Credit 5: Indoor Chemical and Pollutant Source Control

TECHNOLOGIES/STRATEGIES:

• Install permanent architectural entryway systems such as grills or grates to prevent occupant-borne contaminants from entering the building.

• Design facility cleaning and maintenance areas with isolated exhaust systems for contaminants. Maintain physical isolation from the rest of the regularly occupied areas of the building.

• Install high-level filtration systems in air handling units processing both return air and outside supply air. Ensure that air handling units can accommodate required filter sizes and pressure drops.
Indoor Environmental Quality (IEQ) - LEED NC 2009

OTHER IEQ PREREQUISITE & CREDITS:

• Prerequisite 3: Minimum Acoustic Performance (Schools Only)
• IEQ Credit 6.1: Controllability of Systems – Lighting
• IEQ Credit 6.2: Controllability of Systems - Thermal Comfort
• IEQ Credit 7.1: Thermal Comfort – Design
• IEQ Credit 7.2: Thermal Comfort – Verification
• IEQ Credit 8.1: Daylight and Views – Daylight
• IEQ Credit 8.2: Daylight and Views – Views
• IEQ Credit 9: Enhanced Acoustical Performance (Schools Only)
• IEQ Credit 10: Mold Prevention (Schools Only)
References and Resources

- www.epa.gov/iaq
- www.buildinggreen.com/elists/halpaper.html
- www.ashrae.org
- http://www.ashrae.org/technology/page/678
- http://www.bfrl.nist.gov/IAQanalysis/CONTAM/
Thank you!

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