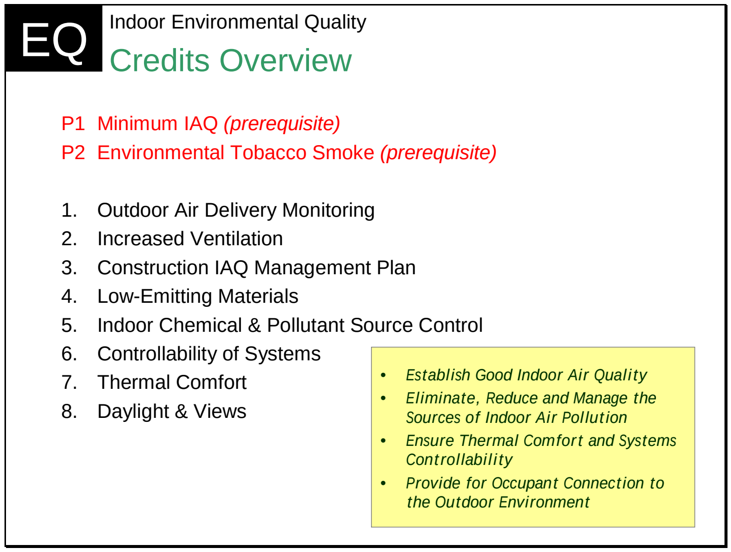
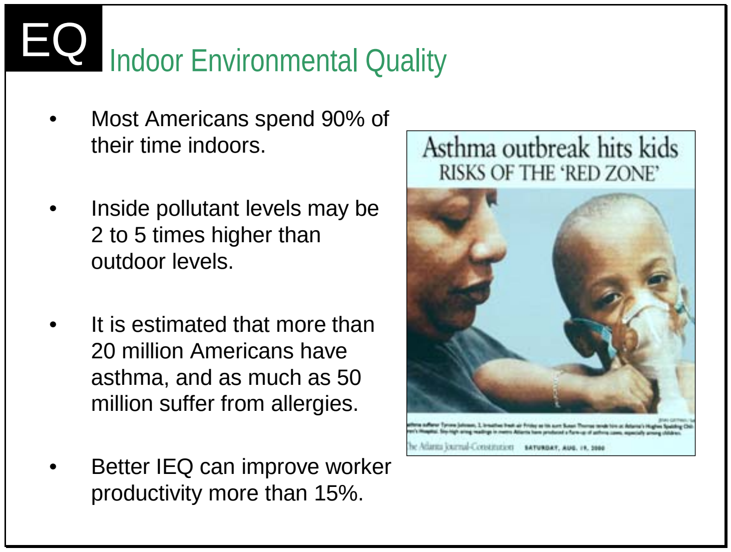
Slide 1



There are 2 prerequisites for indoor environmental quality. They represent the very minimum EQ efforts that must be addressed in order to proceed with attaining credits for certification. There are 8 LEED credits available in this area and are designed to address all aspects of indoor environmental quality, including pollutant source control, increased ventilation, daylighting, and thermal comfort. In order to achieve an optimum work environment, with reduced illness and increased productivity, efforts should be made to include as many of these credits as possible in the design and construction of a new or remodeled buildings.

Slide 2



Indoor pollutant levels are often 2-5 times higher than the levels allowed for outdoor pollutants, and in some cases even more concentrated due to the nature of the building and its function. Because Americans spend so much time indoors, it is important to consider all sources of pollutants and eliminate as much occupant exposure as possible.

According to the Environmental Protection Agency (EPA) and Center for Disease Control (CDC), there are now estimates of over 20 million Americans suffering from asthma related illness, and between 40 and 50 million suffering from sensitivity to allergens. By improving the indoor environment, not only do symptoms improve, medical costs and absenteeism due to illness decrease; resulting in an overall increase in productivity. While eliminating exposure to pollutants is an important area of concern, this section addresses environmental quality with a more comprehensive approach. It addresses other areas where productivity may be compromised due to lack of thermal comfort and poor lighting.

Several studies have been conducted to measure the effects of improving Indoor Environmental Quality, here a few of those presented by the U.S. Green Building Council (USGBC) and Building Operation Management (BOM):

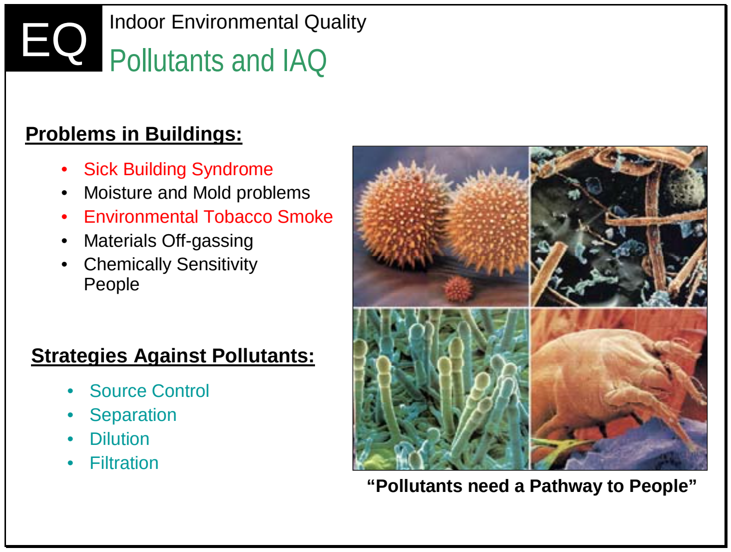
Study #1: A survey of 100 U.S. office buildings revealed that 23 percent of office workers experienced frequent symptoms of Sick Building Syndrome (SBS). Symptoms such as respiratory ailments, allergies and asthma resulted in an estimated decrease in productivity of around 2 percent nationwide, due to lower productivity and increased medical cost. The economic impact is enormous, providing an annual cost to the United States of approximately $60 billion.

Study #2: A recent study by Bjarne Olsen, chairperson for the International Center for Indoor Environment and Energy (ICIEE) in Denmark, indicated that improved thermal comfort, reduction in indoor pollutants, and enhanced ventilation rates and effectiveness can increase productivity by 5 to 10 percent. Conversely, the research also indicates that a 10 percent decrease in tenant satisfaction with IAQ results in a 1 percent drop in productivity.

Study #3: In Finland, researcher Olli Seppanon, from the Helsinki University of Technology, developed a conceptual model to estimate cost effectiveness based on improved indoor environment. The model shows a decrease in performance by 2 percent for each degree increase of space temperature between 77^{o} F and 89.4^{o} F. Optimal productivity performance was found to occur when the space temperature was 72^{o} F.

Study #4: In a study conducted by Allan Hedge of Cornell University, low temperatures in work space also have a negative impact on productivity. His findings show that “chilly workers not only make more errors, but cooler space temperature could increase the hourly labor cost by 10 percent.”

Slide 3



Sick Building Syndrome (SBS) is a fast growing phenomenon. According to the EPA, the term "sick building syndrome" is used to describe situations in which building occupants experience acute health and comfort effects that appear to be linked to time spent in a building yet no specific illness or cause can be identified. Building occupants complain of flu-like symptoms, headaches, dizziness, nausea, dry cough, dry or itchy skin, difficulty in concentrating, fatigue, eye, nose, or throat irritation, and so on. Other symptoms, such as allergies or asthma may be exacerbated by building conditions.

Though the specific cause/effect relationship for one suffering from SBS is difficult to determine, there is sufficient evidence of the relationship between exposure to biological or chemical contaminants, combined with lack of proper ventilation to the symptoms of those suffering from SBS. Materials off-gassing from carpet and furniture, tobacco smoke, cleaning chemicals and mold spores are all possible contaminants that an occupant may be exposed to in their indoor environment. There are 4 strategic approaches in this section designed to reduce or eliminate pollutant exposure:

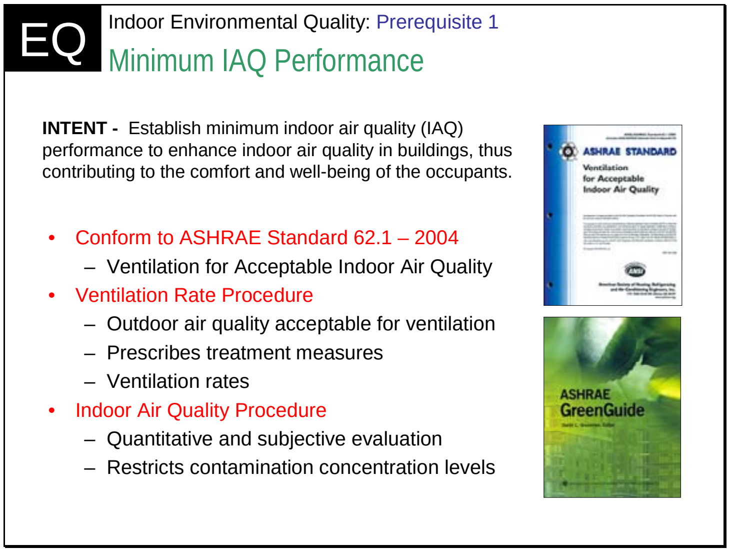
Source Control: The best way to eliminate pollutant exposure is to remove the source of the contaminant. Many credits in this section are aimed at eliminating the pollutant source altogether.

Separation: In cases where it is impossible to remove the source of contaminants, the second best approach is to remove the pathway of the exposure to the occupants.

Dilution: It is possible to reduce the potency of a contaminant with increased ventilation. It is always best to remove or separate contaminants when possible, and use dilution as an additional measure for insuring the cleanest, contaminant free air for the occupants.

Filtration: The least favored method of contaminant removal is filtration. Again, this should be considered an additional method applied to source removal or separation in order to achieve the highest level of air quality for building occupants.

Slide 4



Prerequisite 1 requires meeting or exceeding the minimum outdoor air ventilation rates as described in sections 4-7 of ASHRAE 62.1 – 2004, Ventilation for Acceptable Indoor Air Quality. ASHRAE 62.1 is the most recent American Society of Heating, Refrigerating and Air-Conditioning Engineers standard addressing the ventilation aspects of HVAC systems. Unlike the previous ASHRAE standard (in 2001) which used a one-part outdoor air requirement, ASHRAE 62.1-2004 standard involves a two-part outdoor air requirement. The first part uses per-person criteria and addresses carbon dioxide (CO_2) as a means for determining needs for introducing outside air, as well as people-generated pollutants or odors. The second part uses a per-floor area to address pollutants generated by materials in the space such as carpeting, furnishings and other material source contaminants.

Mechanical ventilation systems shall be designed using the Ventilation Rate Procedure or applicable local code, whichever is more stringent. Naturally ventilated spaces shall comply with ASHRAE 62.1, paragraph 5.1.

Slide 5

EQ Indoor Environmental Quality: Prerequisite 1

Minimum IAQ Performance

- Locate Outside Air intakes a minimum 25 feet from possible contaminant sources.

Potential sources of contamination

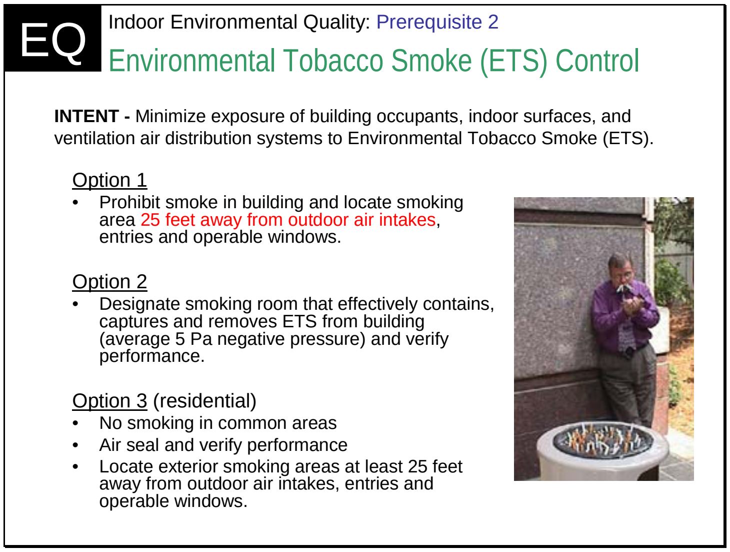
- Loading Areas
- Exhaust Fans
- Cooling Towers
- Street Traffic
- Idling Cars
- Standing Water
- Sanitary Vents
- Parking Garages
- Dumpsters
- Smoking Areas

Poor placement of Outdoor air intake next to loading dock & smoking area

* Avoid placing air intakes next to areas where contaminants are likely to be present, as in this photograph

Looking at all areas where pollutants can infiltrate is one way of avoiding pollutant pathways. Prerequisite 1 requires that outside air intakes be located at a minimum of 25 feet away from contaminant sources. For example, this photo demonstrates where the air intake is located just a few feet away from of a loading dock, and is a great example of how poor design and forethought created an easy pathway for vehicle exhaust to enter the occupant spaces of the building. Other areas where outside intakes should be avoided include: near exhaust fans, parking garages, dumpsters, designated smoking areas, and areas of standing water where mold spores may accumulate.

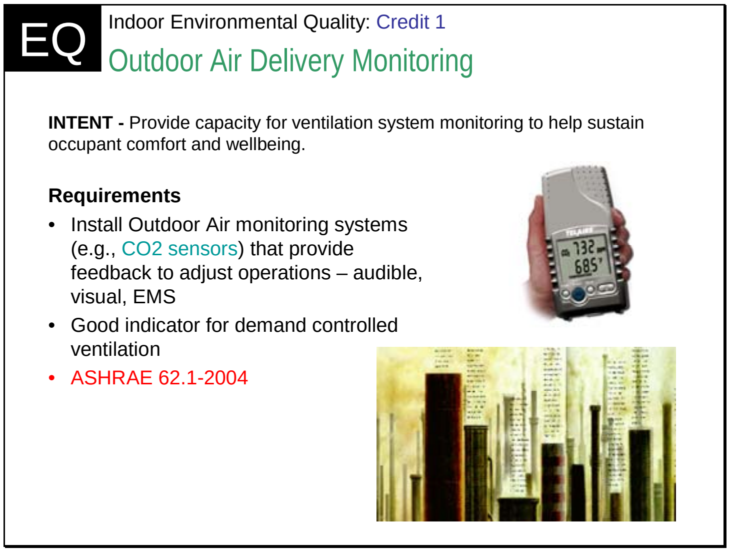
Slide 6



Many recent studies have involved the research of adverse health effects due to environmental tobacco smoke (ETS) exposure. For the purpose of this credit, ETS refers to the involuntary inhaling of tobacco smoke due to the location of the exposure source in relationship to the building occupants' paths of susceptibility. Prerequisite 2 requires that exposure to ETS is minimized by choosing one of the three options in order to eliminate the source pathway.

For commercial buildings, one or two options are available. The easiest, less expensive and most effective approach is to prohibit smoking in commercial buildings completely. The second option is to effectively control the ventilation air in smoking rooms, where the exhaust system is designed to directly ventilate to the outside of the building, doors to the room are closed and exhaust operation is sufficient to create a negative pressure with respect to the adjacent spaces. For residential buildings, Option 3 prohibits smoking in common areas, and requires the design of the building envelope and systems to minimize ETS transfer among dwelling units.

Slide 7



For this credit, the installation of permanent monitoring systems of building ventilation is required. By monitoring the ventilation systems' performance, the building operator will be able to stay informed of the deficiencies in the system. The monitoring system should be designed to generate an alarm when the conditions vary by at least 10% from the setpoint. One way to achieve this is by installing carbon dioxide (CO2) and airflow measurement equipment. The equipment should feed the information to the HVAC system, Building Automation System or building operator to signal for adjustment when varying beyond the setpoint.

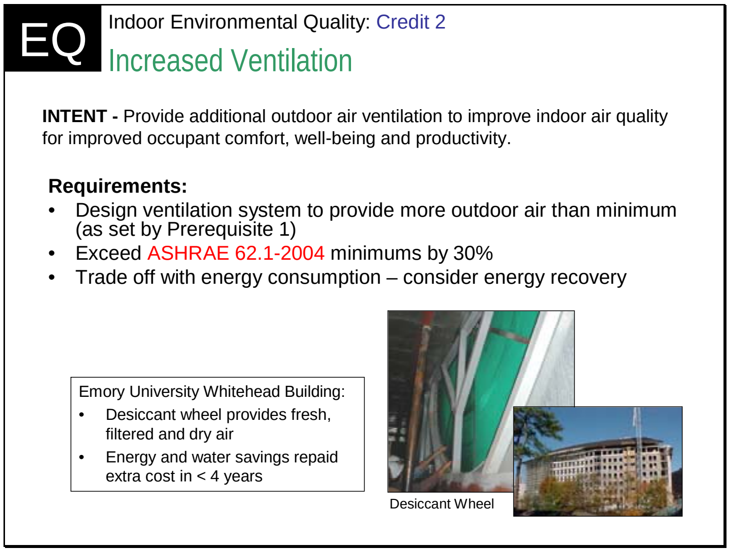
Mechanical ventilation spaces

Monitor CO_2 concentrations within all densely occupied spaces ($\geq$ 25 people per 1000 square feet). The CO_2 monitoring locations should be placed between 3 and 6 feet above the floor. For non-densely occupied areas, there should be a direct outdoor airflow measurement device capable of measuring minimum outdoor airflow rate with an accuracy of $\pm$ 15% of the design minimum outdoor air rate, as defined by ASHRAE 62.1-2004.

Naturally ventilated spaces

CO_2 monitoring locations should be placed between 3 and 6 feet above the floor.
If the building design uses passive stack(s) or other means to induce airflow through multiple spaces equally and simultaneously (without occupants intervention), then a single CO_2 sensor may be used to represent those multiple spaces.

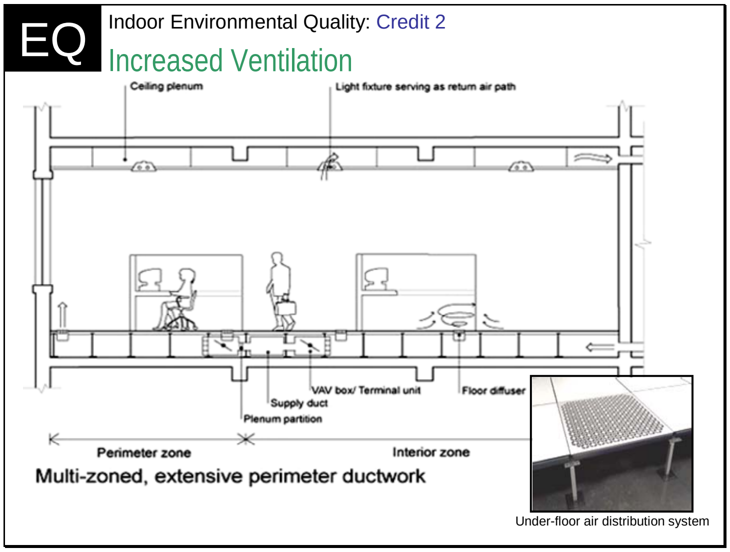
Slide 8



In order to achieve this credit for mechanically vented spaces, the outdoor ventilation rates to all occupied spaces must be increased by 30% above the minimum rates required by ASHRAE Standard 62.1-2004. One approach is to use heat recovery in order to minimize the additional energy consumption associated with higher ventilation rates.

For naturally ventilated spaces, first determine if natural ventilation is an effective strategy for the project, then follow the design recommendations set forth in the Carbon Trust Good Practice Guide 237 [1998]. Use diagrams and calculations to show that the design of the natural ventilation systems meets the recommendations outlined in the Chartered Institution of Building Services Engineers (CIBSE) Applications Manual 10:2005. Another option is to use a macroscopic, multi-zone analytic model to predict room-by-room airflows that will effectively naturally ventilate, providing the minimum ventilation rates required by ASHRAE 62.1- 2004 for at least 90% of the occupied spaces. Public domain software such as NIST's CONTAM, Multizone Modeling Software, along with LoopDA, Natural Ventilation Sizing Tool, are good resources for analytically predicting room-by-room airflows.

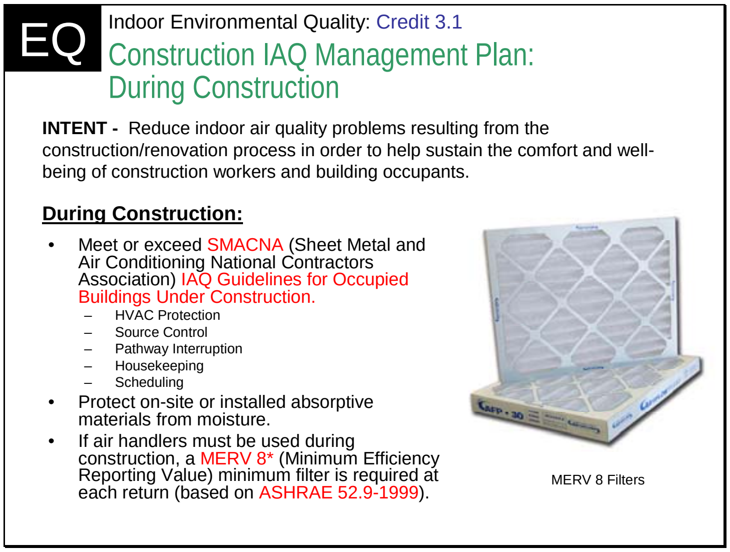
Slide 9



Many newly constructed office buildings are incorporating raised floor systems in order to house the amount of wiring needed to accommodate the electronic equipment needs of its occupants. An Under-Floor Air Distribution (UFAD) is one method of making use of this space by also using it to supply the ventilation needs. The above diagram is an example of a UFAD system, still considered by some to be in the experimental phase. Under-floor air systems are designed to maximize airflow, while providing thermal comfort for the occupants by allowing individual controls at plenum partitions in the floor. Other features highlighted in this diagram are ceiling plenums and return air paths located at the light fixtures that allow for heat recovery; a strategy at lowering overall energy costs.

* The Southface Eco Office is currently highlighting this technology in its third floor offices in order to quantify the effects of the system.

Slide 10



The intention of the credit is to reduce indoor air quality problems by eliminating as many avenues for contaminants to enter the HVAC system as early in the construction phase as possible. Follow SMACNA IAQ Guidelines for Occupied Buildings Under Construction and coordinate installation of absorptive materials, such as insulation, carpeting, ceiling tile and gypsum (wallboard) to protect them from moisture damage. If permanently installed air handlers are used during construction, use a filtration media with a Minimum Efficiency Reporting Value of 8 at each return and replace all filtration prior to occupancy. Refer to LEED- NC v2.2 Reference Guide for more detailed information if planning to use permanently installed air handlers during construction.

* Please note that if your project is pursuing IEQ Credit 5, Indoor Chemical and Pollution Source control, you will need to size racks to fit a MERV 13 filter.

Slide 11

EQ

Indoor Environmental Quality: Credit 3.1

Construction IAQ Management Plan: During Construction

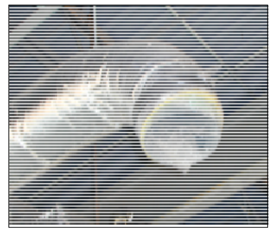
Option 1

- Submit 18 photographs (6 each at 3 different times) to show adherence to SMACNA Guidelines.

Option 2

- Declare the 5 Design Approaches from SMACNA Guidelines, Chapter 3, with a brief description of important design approaches used:

1. HVAC Protection
2. Source Control
3. Pathway Interruption
4. Housekeeping
5. Scheduling



Duct protected from outside contamination using plastic

In order to document the construction IAQ Management Plan, there are two options available. The first is to take at least 18 photographs of the construction area to demonstrate adherence to the SMACNA (Sheet Metal and Air Conditioning National Contractors Association) IAQ Guidelines for Occupied Buildings Under Construction. The second option is to write a brief description of important design approaches used from the SMACNA Guidelines.

Slide 12

The above photographs demonstrate the efforts of careful planning and implementation of a construction IAQ management plan. Under Option 1, 18 are required for this credit.

Slide 13

EQ

Indoor Environmental Quality: Credit 3.2

Construction IAQ Management Plan: Before Occupancy

INTENT - Reduce indoor air quality problems resulting from the construction/renovation process in order to help sustain the comfort and well-being of construction workers and building occupants.

After Construction / Before Occupancy

Option 1

- Conduct a building flush-out with 14,000 cu.ft outside air per square foot, minimum 25% (3,500 cfm) prior to occupancy.

Option 2

- Conduct a baseline IAQ test procedure consistent with EPA Protocol for Determination of Air Pollutants in Indoor Air.

Housekeeping – final cleaning prior to flushout October 28, 2004

There are 2 options for achieving this credit. The first is to conduct a building flush-out prior to building occupancy by supplying a total volume of 14,000 cubic feet of outdoor air per square foot of floor area, while maintaining an internal temperature of 60 degrees Fahrenheit and up to 60% relative humidity. The flush-out is often used where occupancy is not required immediately upon substantial completion of construction. The second option is to conduct baseline IAQ testing after construction ends, but prior to occupancy to demonstrate that the contaminant maximum concentrations are not exceeded. IAQ testing can minimize schedule impacts but may be more costly. Refer to the U.S. Environmental Protection Agency Compendium of Methods for the Determination of Air Pollutants in Indoor Air, as well as the LEED Reference guide for detailed protocols for IAQ testing.

**Coordinate with Indoor Environmental Quality Credits 3.1 and 5 to determine the appropriate specifications and schedules for filtration media.

Slide 14

EQ

Indoor Environmental Quality: Credit 4

Low-Emitting Materials

4.1 Adhesives & Sealants
4.2 Paints & Coatings
4.3 Carpet Systems
4.4 Composite Wood & Agrifiber Products

Low VOC paints and sealers


Interface Showroom, Atlanta. LEED CI Platinum

There are four opportunities to receive points toward LEED certification with the use of low-emitting materials. Each of the four points addresses a specific class of material which the following slides will cover in more detail.

Slide 15

EQ

Indoor Environmental Quality: Credit 4.1

Low-Emitting Materials: Adhesives & Sealants

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.

VOCs: Volatile Organic Compounds

- VOC content of adhesives and sealants must be less than the limit set by South Coast Air Quality Management District (SCAQMD) Rule # 1168.

AND

- Aerosol Adhesives must meet or exceed Green Seal GS #36.

Substrate VOC Limits

Substrates	VOC Limit (g/L)
Metal to metal	30
Plastic foams	120
Porous material except wood	120
Wood	30
Fiberglass	200

South Coast Rule #1168 VOC Limits

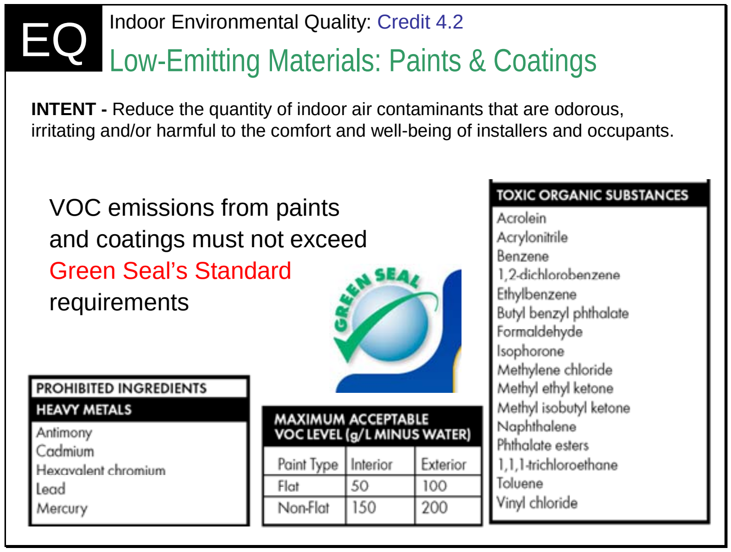
Welding & Installation	VOC Limit (g/L)	Welding & Installation	VOC Limit (g/L)
Non-vinyl backed installation	150	PVC welding	510
Carpet pad installation	150	CPVC welding	490
Wood flooring installation	150	ABS welding	400
Ceramic tile installation	130	Plastic cement welding	350
Dry wall & panel installation	200	Cove base installation	150
Subfloor installation	200	Adhesive primer for plastic	650
Rubber floor installation	150	All others	250
VCT & asphalt tile installation	150		

Many conventional adhesives and sealants contain volatile organic compounds (VOC's) that can have potentially irritating or harmful effects due to chemical off-gassing. Occupant exposure to VOC's can trigger existing health conditions, such as asthma or allergies and cause short-term effects such as headaches, dizziness, coughing, or eye irritation. Certain VOC's have also been known to cause more serious long-term effects, such as cancer and developmental problems. Harmful chemical off-gassing has often been blamed for poor productivity, increase in sick leave, and worker/student absences. Many low-emitting alternatives are now available.

In order to achieve this credit all adhesives, sealants and sealant primers used in the building interior must be less than the limits set by the South Coast Air Quality Management District (Rule # 1168) and Green Seal #36 for aerosol adhesives. Low-VOC materials must be specified in the construction documents and VOC limits should be clearly stated in each section of the specifications where adhesives and sealants are addressed.

**Common products to evaluate include: general construction adhesives, flooring adhesives, fire-stopping sealants, caulking, duct sealants, plumbing adhesives, and cove base adhesives.

Slide 16



As with adhesives and sealants, conventional paints and coatings also have limitations on the VOC content in order to qualify for LEED credit. Low-VOC paints and coatings that fall within Green Seal's Standards must be specified in the construction documents. Green Seal Standards include VOC limits for interior paints and coatings, wood finishes, floor coatings, stains and shellac. Be sure that VOC limits are clearly stated in each section of the specifications, where paints and coatings are addressed and track the VOC content of all interior paints and coatings during construction.

For example, the following are VOC limits per the Green Seal's Standard for interior paints:
GS – 11: Architectural paints, coatings and primers applied to interior walls and ceilings are required to not exceed 50g/L VOC Content for Flats 150 g/L for Non-Flats.
GS – 03: Anti-corrosive and anti-rust paints applied to interior ferrous metal are required to not exceed 250 g/L VOC content.

Slide 17

EQ

Indoor Environmental Quality: Credit 4.3

Low-Emitting Materials: Carpet Systems

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.

- Carpet systems must meet or exceed the requirements of the Carpet and Rug Institute's Green Label Plus Indoor Air Quality Test Program

CARPET AND RUG INSTITUTE

The Carpet and Rug Institute (CRI) launched its Green Label program in 1992 to help identify carpets, cushions and adhesives with very low emissions of VOCs. For this credit, select products that are either certified under the Green Label Plus program or where testing has been done by qualified independent laboratories in accordance with the appropriate requirements. Clearly specify requirements for product testing and/or certification in the construction documents. For more information on testing methods and sample collection refer to Section 9, Acceptable Emissions Testing for Carpet, Department of Health Services Standard Practice CA/DHS/EHLB/R-174. This document is available at: www.dhs.ca.gov/ps/deodc/ehlb/iaq/VOCS/Section01350_7_15_2004_FINAL_PLUS_ADDENDUM-2004-01.pdf.

(also published as Section 01350 Section 9 [dated 2004] by the Collaborative for High Performance Schools [www.chps.net]).

Slide 18

Urea-formaldehyde resins have been known to off-gas formaldehyde during chemical degradation. This degradation can occur when the material is exposed to high humidity, or if saturated with water during flooding, or when leaks occur. Levels of off-gassing increase with increasing temperatures and relative humidity. Symptoms of exposure to formaldehyde can be acute, such as burning eyes, nose and throat, skin irritations, headache and nausea, including increased sensitivity in those with asthma. Formaldehyde has also been designated as a probable human carcinogen, and as a workplace carcinogen by the National Institute for Occupational Safety and Health (NIOSH).

This credit refers to composite wood and agrifiber products used in base building elements, such as particleboard, medium density fiberboard (MDF), plywood, panel substrates and door cores. Laminating and adhesives used to fabricate on-site and shop-applied composite wood and agrifiber assemblies must be specified that they contain no added urea-formaldehyde resins.

* Wheatboard is an example of an alternative building product that would meet this credit criteria. It is made of recycled wheat chaff and uses an isocyanate binder, rather than urea-formaldehyde.

Slide 19

EQ Indoor Environmental Quality: Credit 5

Indoor Chemical & Pollutant Source Control

INTENT- Minimize exposure of building occupants to potentially hazardous particulates and chemical pollutants.

To prevent cross contamination of areas:

- Employ permanent entryway systems to capture dirt.
- Separate and vent chemical usage areas (garages, housekeeping and copy centers).
- Replace all filtration media immediately prior to occupancy with minimum MERV 13.

Permanently installed walk-off mat

This credit is designed to minimize and control pollutant entry to the building. There are three areas that need to be addressed in order to qualify:

Install a permanent entryway system at each outdoor to indoor entry to prevent occupant-borne contaminants from entering the building. The system must be at least six feet long in the primary direction of travel in order to capture dirt and particulates before they can enter the building. Acceptable systems include: grates, grilles or slotted systems that allow for regular cleaning underneath. Roll-out mats are only acceptable if scheduled to have cleaning on a weekly basis by a contracted service.

Design facility cleaning and maintenance areas with isolated exhaust systems for contaminants, and exhaust each space sufficiently to create a negative pressure with respect to the adjacent spaces. This includes garages, housekeeping and laundry areas, as well as copying and printing room areas. Maintain physical isolation from the rest of the regularly occupied areas of the building.

In mechanically ventilated buildings, 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.

Slide 20

EQ Indoor Environmental Quality: Credit 6.1

Controllability of Systems: Lighting

INTENT- Provide a high level of lighting system control by individual occupants or by specific groups in multi-occupant spaces (i.e. classrooms or conference areas) to promote the productivity, comfort and well-being of building occupants.

- Provide individual lighting controls for at least 90% of occupants

AND

- Provide controllability for all shared multi-occupant spaces to adjust light levels for group needs

Task lighting

Design the building interior with a high level of lighting system control for the individual occupants, as well as lighting system controllability for multi-occupant spaces. Include integration of lighting systems controllability into the overall lighting design in order to provide both ambient and task lighting that will promote occupant comfort and productivity, while keeping energy use at a minimum.

Slide 21

EQ Indoor Environmental Quality: Credit 6.2

Controllability of Systems: Thermal Comfort

INTENT - Provide a high level of thermal comfort system control by individual occupants or by specific groups in multi-occupant spaces (i.e. classrooms or conference areas) to promote the productivity, comfort and well-being of building occupants.

- Provide individual controls for airflow and temperature for at least 50% of the occupants.

AND

- Provide comfort controls for all shared multi-occupant spaces to adjust levels for group needs.

Operable windows

Credit 6.2 requires that thermal comfort be controllable by the occupants. Building design should included individual comfort controls, as well as comfort controls for groups in multi-occupant spaces. Individual adjustments may involve individual thermostat controls, local diffusers at floor, desk or overhead levels, or control of individual radiant panels. There may also be other means of control integrated into overall thermal comfort and energy systems in the building design.

Thermal comfort systems may by strictly mechanical, or may integrate both mechanical and operable windows in order to provide the comfort criteria needed for this credit. ASHRAE Standard 55-2004 identifies the factors of thermal comfort and a process for developing building spaces that suit the needs of the occupants involved in their daily activities. For more detail on how operable windows can be used in lieu of comfort controls refer to the requirements of ASHRAE Standard 62.1-2004,paragraph 5.1 for Natural Ventilation requirements that must be met.

** Please note: designers should evaluate the close relationship between thermal comfort (as required by ASHRAE Standard 55-2004) and acceptable indoor air quality (as required by ASHRAE Standard 62.1-2004, whether natural or mechanical ventilation).

Slide 22

EQ

Indoor Environmental Quality: Credit 7.1

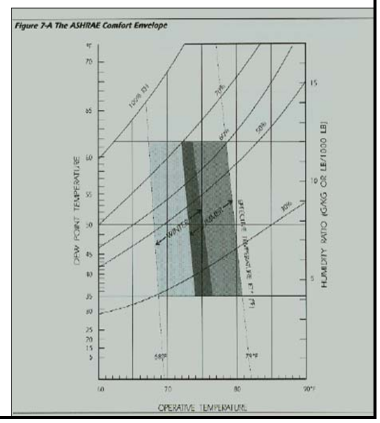
Thermal Comfort: Design

INTENT- Provide a comfortable thermal environment that supports the productivity and well-being of building occupants.

Compliance with ASHRAE 55-2004

- ASHRAE 55 defines the design temperature and humidity values required for the comfort of at least 80% of the building occupants

@50% RH, 30 fpm airflow	
Winter	68-74 °F
Summer	73-79 °F

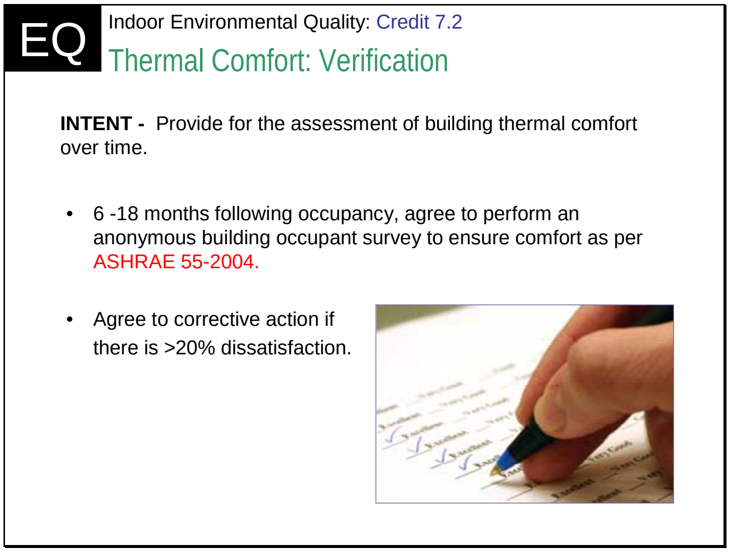


There are three variables that can affect thermal comfort of building occupants: activity, clothing, and environmental factors. Environmental factors include air temperature, thermal radiation (or radiant temperature), humidity and air speed. To qualify for this credit, the design of the building's HVAC system and building envelope must comply with ASHRAE 55 – 2004, Thermal Comfort Conditions for Human Occupancy, which supports the desired quality and occupant satisfaction with building performance. During the design and planning phase, the owner and designer should evaluate the buildings' needs based on the building size, type, location, and nature of the operations, as well as climate conditions. Once determined, use load calculations to determine size and selection of HVAC equipment to accomplish the thermal comfort goals and refer to the Chartered Institution of Building Services Engineers Application Manual 10 (CIBSE-AM10) for strategies involving natural ventilation.

The above diagram (The ASHRAE Comfort Envelope) illustrates the thermal environmental conditions for which most people are comfortable. The envelope distinguishes between summer and winter to demonstrate the seasonal shift in thermal comfort needs as relates to both dry bulb temperature and the amount of moisture in the air.

* Strategies: Use an integrated approach when evaluating air temperature, radiant temperature, air speed and relative humidity for this credit and coordinate with the credit requirements involved in EQ Prerequisite 1, EQ Credit 1, and EQ Credit 2.

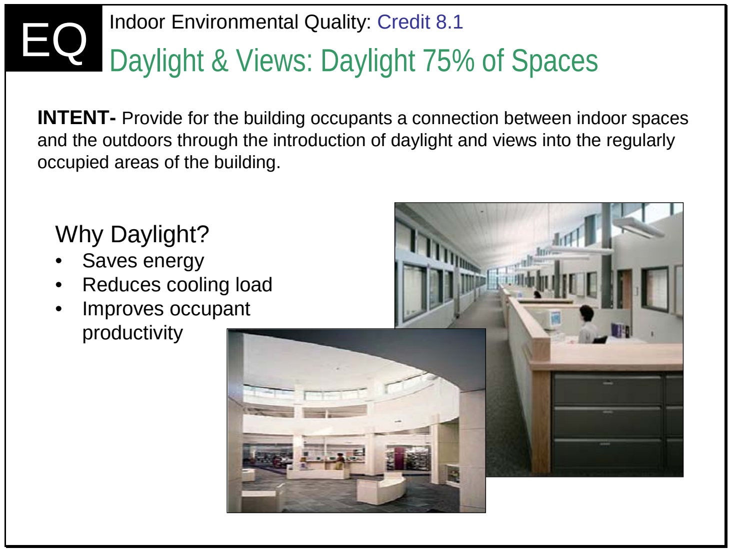
Slide 23



This is not a difficult credit to achieve providing the building system's performance follows the design intention. First, agree to have the occupants fill out a survey to ensure that their comfort level is being met. ASHRAE Standard 55-2004 provides guidance for establishing thermal comfort criteria and the documentation and validation of building performance to the criteria. Second, after the survey, agree to develop a plan for corrective action if greater than 20% of those surveyed are dissatisfied with the comfort level of the building. This plan should include relevant environmental variables for problem areas in accordance with ASHRAE Standard.

**The ASHRAE Standard is not intended for purposes of continuous monitoring and maintenance of the thermal environment, however, the principles expressed in the standard provide a basis for design of monitoring and corrective action systems.

Slide 24



The Lawrence Berkeley National Laboratory completed several studies on the effect of daylighting and student performance. One case study from a school located in southern California (San Juan Capistrano) indicated that students with the most daylighting in their classrooms progressed 20% faster on math comprehension and 26% faster on reading comprehension tests in one year than those with minimal exposure to natural light. Similarly, students in classrooms with the largest window surface areas were found to progress 15% faster in math and 23% faster in reading than those located in classrooms with a minimal window surface area. Also, students with well-designed skylights, providing additional daylight to the space, improved 20% faster than students without the skylights.

Studies involving worker productivity have also had similar results. The goal of this credit is to increase this connection that people have between indoor and outdoor spaces that results in increased comfort and productivity.

Slide 25

EQ Indoor Environmental Quality: Credit 8.1

Daylight & Views: Daylight 75% of Spaces

Strategies:

- Light Tubes & Light Shelves
  - Transmit light while reducing heat gain
- Clerestories & Light Monitors
  - Simulate natural sunlight by illuminating the ceiling and brightening the interior of the building
- Exterior Shading
  - Prevents direct sunlight from entering, while allowing indirect light into the building
- Low-Transmittance Glass
  - Prevents Glare
- Interior Shading / Blinds
  - Offer shading when necessary

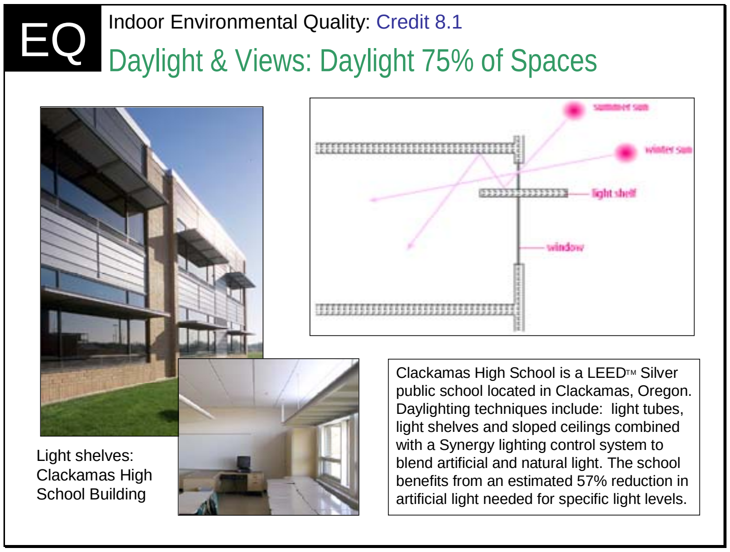
Daylighting

Light Tube

Light Monitor

There are several strategies that can be used to increase the amount of daylight entering a building. Many are designed to bring daylight into areas that would otherwise be inaccessible to window light, such as interior offices, classrooms, kitchens, and meeting areas. Others are designed to maximize the sunlight coming in, while preventing discomfort due to glare that can be caused by direct sunlight.

Slide 26



The diagram on the top right demonstrates how the light shelf is designed to block the summer sun from directly entering the building and instead, reflect it onto the ceiling of the interior in order to maximize the available light. In the winter, the sun's path is at a lower position in the Southern sky and is allowed to enter the building in order to provide light and an additional heat source for the cooler season.

Slide 27

EQ Indoor Environmental Quality: Credit 8.1

Daylight & Views: Daylight 75% of Spaces

There are 3 options for this credit:

Option 1

- Achieve a minimum Daylight Factor of 2% in 75% of regularly occupied areas.

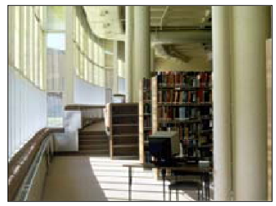
$$\text{Daylight Factor} = \frac{\text{Window Area [SF]}}{\text{Floor Area [SF]}} \times \text{Window Geometry} \times \frac{\text{Actual } T_{vis}}{\text{Minimum } T_{vis}} \times \text{Window Height Factor}$$

Option 2

- Use simulation to show 25 footcandles of daylight in 75% of regularly occupied areas.

Option 3

- Measure and verify 25 footcandles of daylight in 75% of regularly occupied areas.



For Option 1, calculate a daylighting factor of 2% in 75% of regularly occupied spaces using the glazing factor calculation; include the area of each type of glazing (sidelighting and toplighting), the square feet of occupied area, and the visible light transmittance (T_{vis}) for each glazing type.

For Option 2, use a computer simulation to demonstrate 25 footcandles under clear sky conditions, at 12:00pm, on the equinox, at 30 inches above the floor for at least 75% of all regularly occupied spaces. Provide copies of drawings showing the illumination simulation results.

For Option 3, verify 25 footcandles by taking light measurements on a 10-foot grid for all occupied spaces and record them on the building floor plans.

Slide 28

EQ Indoor Environmental Quality: Credit 8.2

Daylight & Views: Views for 90% of Spaces

INTENT - Provide for the building occupants a connection between indoor spaces and the outdoors through the introduction of daylight and views into the regularly occupied areas of the building.

- Provide direct line of sight to vision glazing for 90% of all regularly occupied spaces

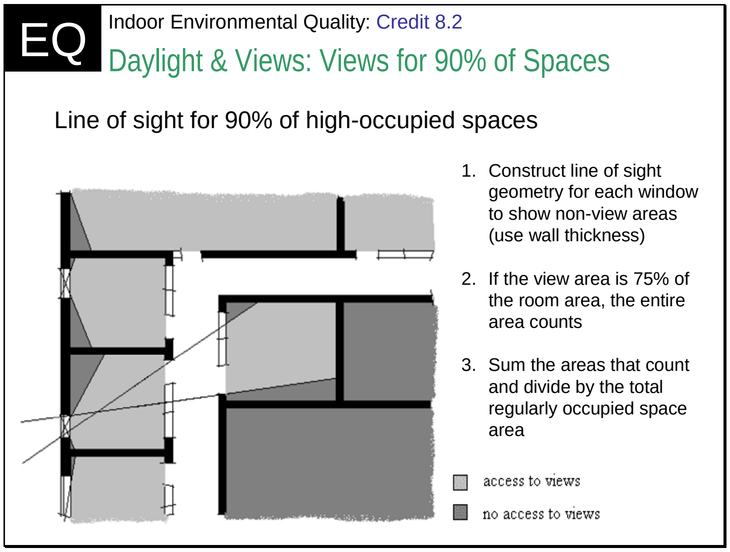
Vision glazing:

Only applies to windows placed between 2.5' and 7.5' of the wall space

(no high transoms, skylights, or roof monitors)

Credit 8.2 requires a direct line of sight for 90% of the occupants to view the outdoor environment through windows placed between 2'6" and 7'6" above the finished floor. While the amount of glazing needed to meet this credit criteria may add to the initial cost to the project, proper daylighting can significantly reduce the amount of artificial lighting needed. It is important to note that measures should be taken to insure proper design and energy modeling to avoid increased heat gain due to the lower insulating nature of glass compared to standard walls, while maximizing energy efficiency and reduced need for artificial lighting.

Slide 29



For private offices, the entire square footage of the office can be counted if at least 75 % or more area has a direct line of sight to perimeter vision glazing. For multi-occupant spaces, the actual square footage must be considered. Some strategies include placing interior glazing in line with exterior windows to draw views further into the building interior, and lowering partition heights to avoid blocking the direct line of sight to outdoor windows.

Slide 30

EQ Indoor Environmental Quality

Points Summary

P1 Minimum IAQ (prerequisite)
P2 Smoking (prerequisite)

1.	Outdoor Air Monitoring	1
2.	Increased Ventilation	1
3.	Construction IAQ	1-2
4.	Low-emitting Materials	1-4
5.	Indoor Pollutants	1
6.	Controllability of Systems	1-2
7.	Thermal Comfort	1-2
8.	Daylight and Views	1-2
	TOTAL	**15**