LEED Building Design and Construction
Activity #8 – Indoor Environmental Quality (EQ)
Before completing this Activity Read: Reference Guide for Building Design and Construction v4 – Pages 596-775

Note the following abbreviations are used in this activity:

NC	LEED BD+C: New Construction and Major Renovation
CS	LEED BD+C: Core and Shell Development
S	LEED BD+C: Schools
R	LEED BD+C: Retail
DC	LEED BD+C: Data Centers
WDC	LEED BD+C: Warehouses and Distribution Centers
HOS	LEED BD+C: Hospitality
HC	LEED BD+C: Healthcare

Although the LEED BD+C reference guide does not number the LEED prerequisites and credits, for this exercise they have been numbered in the order presented in the credit category.

Fill-In, Multiple Choice, Matching

1. Test your knowledge of how well you know the names of the credits for the Indoor Environmental Quality (EQ) credit category:

LEED BD+C: NC, CS, S, R, DC, WDC, HOS, HC	
Credit	Name
P1	Minimum Indoor Air Quality Performance
P2	Environmental Tobacco Smoke Control
C1	Enhanced Indoor Air Quality Strategies
C2	Low-Emitting Materials
C3	Construction Indoor Air Quality Management Plan
C4	Indoor Air Quality Assessment
C5	Thermal Comfort
C6	Interior Lighting
C7	Daylight
C8	Quality Views
LEED BD+C: NC, S, DC, WDC, HOS, HC	
C9	Acoustic Performance
LEED BD+C: Schools	
P3	Minimum Acoustic Performance

2. Match the intent shown below to the prerequisite or credit:

LEED BD+C: NC, CS, S, R, DC, WDC, HOS, HC

Credit	ANS
EQ – P1	F
EQ – P2	K
EQ – C1	H
EQ – C2	B
EQ – C3	I
EQ – C4	A
EQ – C5	J
EQ – C6	D
EQ – C7	L
EQ – C8	G

LEED BD+C: NC, S, DC, WDC, HOS, HC

Credit	ANS
EQ – C9	E

LEED BD+C: Schools

Credit	ANS
EQ – P3	C

	INTENT
A	To establish better quality indoor air in the building after construction and during occupancy.
B	To reduce concentrations of chemical contaminants that can damage air quality, human health, productivity, and the environment.
C	To provide classrooms that facilitate teacher-to-student and student-to-student communication through effective acoustic design.
D	To promote occupants' productivity, comfort, and well-being by providing high-quality lighting.
E	To provide workspaces and classrooms that promote occupants' well-being, productivity, and communications through effective acoustic design.
F	To contribute to the comfort and well-being of building occupants by establishing minimum standards for indoor air quality (IAQ).
G	To give building occupants a connection to the natural outdoor environment by providing quality views.
H	To promote occupants' comfort, well-being, and productivity by improving indoor air quality.
I	To promote the well-being of construction workers and building occupants by minimizing indoor air quality problems associated with construction and renovation.
J	To promote occupants' productivity, comfort, and well-being by providing quality thermal comfort.
K	To prevent or minimize exposure of building occupants, indoor surfaces, and ventilation air distribution systems to environmental tobacco smoke.
L	To connect building occupants with the outdoors, reinforce circadian rhythms, and reduce the use of electrical lighting by introducing daylight into the space.

3. High-quality indoor environments also enhance productivity, decrease absenteeism, improve the building's value, and reduce liability for building designers and owners.

4. List the design strategies and environmental factors addressed by the Indoor Environmental Quality (EQ) credit category that influence the way people learn, work, and live:
   1. air quality
   2. lighting quality
   3. acoustic design
   4. control over one's surroundings

5. For many of the credits in the EQ category, compliance is based on the percentage of floor area that meets the credit requirements.

6. All spaces in a building must be categorized as either occupied or unoccupied.

7. List examples of spaces that are typically unoccupied:
   1. mechanical and electrical rooms
   2. Egress stairway or dedicated emergency exit corridor
   3. closets in a residence (walk-in closet is occupied)
   4. Data center floor, including a raised floor area
   5. Inactive storage area in a warehouse or distribution center

8. Occupied spaces are further classified as regularly occupied or nonregularly occupied, based on the duration of the occupancy.

9. Regularly occupied spaces are enclosed areas where people normally spend time, defined as more than one hour of continuous occupancy per person per day, on average; the occupants may be seated or standing as they work, study, or perform other activities.

10. Complete the table:

Space	Regularly occupied	nonregularly occupied
Gymnasium	X	
Hotel front desk	X	
School classroom	X	
Bank teller station	X	
Break room		X
Copy room		X
Restroom		X
Stairway		X
Locker room		X
Auditorium	X	
Study carrel	X	
Residential bathroom		X

11. Occupied spaces, or portions of an occupied space, are further categorized as individual or shared multioccupant, based on the number of occupants and their activities.

12. Occupied spaces can also be classified as densely or nondensely occupied, based on the concentration of occupants in the space.

13. A densely occupied space has a design occupant density of 25 people or more per 1000 square feet, or 40 square feet or less per person. Occupied spaces with a lower density are nondensely occupied.

14. Complete Table 1. Space types in EQ credits

Table 1. Space types in EQ credits

Space Category	Prerequisite or credit
Occupied space	• Minimum Indoor Air Quality Performance, ventilation rate procedure and natural ventilation procedure • Minimum Indoor Air Quality Performance, monitoring requirements • Enhanced Indoor Air Quality Strategies, Option 1 C • Enhanced Indoor Air Quality Strategies, Option 1 D • Enhanced Indoor Air Quality Strategies, Option 1 E • Enhanced Indoor Air Quality Strategies, Option 2 B • Enhanced Indoor Air Quality Strategies, Option 2 E • Indoor Air Quality Assessment, Option 2, Air Testing (sampling must be representative of all occupied spaces) • Thermal Comfort (New Construction, Schools, Retail, Hospitality), design requirements • Acoustic Performance (New Construction, Data Centers, Warehouses and Distribution Centers, Hospitality)
Regularly occupied space	• Thermal Comfort, design requirements (Data Centers) • Interior Lighting, Option 2, strategy A • Interior Lighting, Option 2, strategy D • Interior Lighting, Option 2, strategy E • Interior Lighting, Option 2, strategy G • Interior Lighting, Option 2, strategy H • Daylight • Quality Views
Individual occupant space	• Thermal Comfort, control requirements • Interior Lighting, Option 1
Shared multioccupant space	• Thermal Comfort, control requirements • Interior Lighting, Option 1
Densely Occupied space	• Enhanced Indoor Air Quality Strategies, Option 2 C

15. Complete Table 2. Rating-system-specific space classifications

Table 2. Rating-system-specific space classifications

Rating system	Space type	Prerequisite or credit
S	Classroom and core learning spaces	• Minimum Acoustic Performance • Acoustic Performance (Schools)
HOS	Guest rooms	• Interior Lighting* • Thermal Comfort, control requirements*
HC	Patient rooms	• Thermal Comfort, control requirements • Interior Lighting, Option 2, Lighting Quality
HC	Staff areas	• Interior Lighting, Option 2, Lighting Quality
HC	Perimeter area	• Daylight • Quality Views
HC	Inpatient units	• Quality Views
WDC	Office areas	• Thermal Comfort, design requirements • Quality Views
WDC	Areas of bulk storage, sorting, and distribution	• Thermal Comfort, design requirements • Quality Views
R	Office and administrative areas	• Thermal Comfort, control requirements • Interior Lighting, Option 2, Lighting Quality
R	Sales areas	• Interior Lighting, Option 2, Lighting Quality

*Hotel guest rooms are excluded from the credit requirements.

16. EQ Prerequisite Minimum Indoor Air Quality Performance requirements:
NC, CS, S, R, DC, WDC, HOS
Meet the requirements for both ventilation and monitoring.

Ventilation

Ventilation Mode	Required Standard
Mechanically Ventilated Spaces	ASHRAE Standard 62.1-2010
Naturally Ventilated Spaces	ASHRAE Standard 62.1-2010

What ASHRAE Standard 62.1-2010 procedure must be used to determine the minimum outdoor air intake flow for mechanical systems or a local equivalent, whichever is more stringent?

Ventilation Rate Procedure

What ASHRAE Standard 62.1-2010 procedure must be used to determine the minimum outdoor air opening and space configuration requirements flow for natural ventilation or a local equivalent, whichever is more stringent?

Natural Ventilation Procedure

What flow diagram must be followed to confirm that natural ventilation is an effective strategy for the project?

Chartered Institution of Building Services Engineers (CIBSE) Application Manual AM 10, 2005

Monitoring

Mechanically Ventilated Spaces

Variable Air Volume (VAV)	**Constant-volume**
Provide a direct outdoor airflow measurement device capable of measuring the minimum outdoor air intake flow.	Balance outdoor airflow to the design minimum outdoor airflow rate
Measure with +/- 10% accuracy	Install a current transducer on the supply fan, an airflow switch, or similar monitoring device.
Alarm if varies by 15%	

Naturally Ventilated Spaces

Meet one of the following strategies:

Strategy 1	**Strategy 2**	**Strategy 3**
Direct exhaust airflow measurement device	automatic indication devices on all natural ventilation openings	Monitor carbon dioxide (CO_2) concentrations within each thermal zone.
Accuracy of +/- 10%	An alarm must indicate when any one of the openings is closed during occupied hours.	CO_2 monitors must be between 3 and 6 feet above the floor and within the thermal zone.
Alarm if varies by 15%		Audible or visual or alert BAS if CO_2 concentration exceeds setpoint by more than 10%

Core and Shell Only

Mechanical ventilation systems installed during core and shell construction must be capable of meeting projected ventilation levels and monitoring based on the requirements of anticipated future tenants.

Residential Only

In addition to the requirements above, if the project building contains residential units, each dwelling unit must meet all of the following requirements.

Unvented combustion appliances (e.g., decorative logs) are not allowed.

Carbon monoxide monitors must be installed on each floor of each unit.

All indoor fireplaces and woodstoves must have solid glass enclosures or doors that seal when closed.

Any indoor fireplaces and woodstoves that are not closed combustion or power -vented must pass a backdraft potential test to ensure that depressurization of the combustion appliance zone is less than 5 Pa.

Space- and water-heating equipment that involves combustion must be designed and installed with closed combustion (i.e., sealed supply air and exhaust ducting) or with power-vented exhaust, or located in a detached utility building or open -air facility.

For projects in high-risk areas for radon, EPA Radon Zone 1 (or local equivalent for projects outside the U.S.), design and construct any dwelling unit on levels one through four above grade with radon-resistant construction techniques. Follow the techniques prescribed in EPA Building Radon Out; NFPA 5000, Chapter 49; International Residential Code, Appendix F; CABO, Appendix F; ASTM E1465; or a local equivalent, whichever is most stringent.

Healthcare

Meet the following requirements for both ventilation and monitoring.

Ventilation

Ventilation Mode	Required Standard
Mechanically Ventilated Spaces	ASHRAE Standard 170-2008; 2010 FGI Areas not covered by 170 or FGI use: ASHRAE Standard 62.1-2010
Naturally Ventilated Spaces	ASHRAE Standard 62.1-2010

What flow diagram must be followed to confirm that natural ventilation is an effective strategy for the project?

CIBSE AM 10, 2005

Monitoring

Mechanically Ventilated Spaces

direct outdoor airflow measurement device capable of measuring the minimum outdoor air intake flow
Measure with +/- 10% accuracy
Alarm if varies by 15%

Naturally Ventilated Spaces

Meet one of the following strategies:

Strategy 1	**Strategy 2**	**Strategy 3**
Direct exhaust airflow measurement device	automatic indication devices on all natural ventilation openings	Monitor carbon dioxide (CO_2) concentrations within each thermal zone.
Accuracy of +/- 10%	An alarm must indicate when any one of the openings is closed during occupied hours.	CO_2 monitors must be between 3 and 6 feet above the floor and within the thermal zone.
Alarm if varies by 15%		Audible or visual or alert BAS if CO_2 concentration exceeds setpoint by more than 10%

17. List the factors that contribute to maintaining good indoor air quality (IAQ):
    1. controlling pollutant sources
    2. removing contaminates from outdoor air
    3. supplying at least some outdoor air

18. The standards for EQ Prerequisite Minimum Indoor Air Quality Performance were chosen because they strike a balance between providing fresh air and maintaining energy efficiency.

19. List the three methods that can be used to provide ventilation to building spaces:
    1. Mechanical (active)
    2. Natural (Passive)
    3. Mixed-Mode

20. To help in determining whether natural ventilation is feasible for a building or space what should the project team reference?
    CIBSE AM 10, 2005 (Flow chart)

21. To determine the minimum amount of outdoor air that must be supplied by each mechanical ventilation system what must be completed in ASHRAE Standard 62.1-2010?
    Ventilation Rate Procedure

22. In what mode does the worst-case condition occur? Why?
    Heating mode when supply airflows are lowest or supply air temperature is highest

23. Variables required for the ventilation rate procedure:

Abbreviation	Name
E_z	zone air distribution effectiveness
D_s	total design airflow rate at condition analyzed
E_p	primary air fraction of supply air at condition analyzed
E_v	system ventilation efficiency
E_r	fraction of local recirculated air that is representative of system return air

24. List the zones that the ventilation rate procedure differs for:
    1. single-zone
    2. 100% outdoor air
    3. multiple-zone

25. For single-zone systems or 100% outdoor air systems, use the calculator provided by USGBC or a user-generated spreadsheet. The 62MZCALC spreadsheet is not applicable to these systems and should not be used to perform the ventilation calculations.

26. For multiple-zone systems, use the 62MZCALC spreadsheet.

27. Energy modeling software may also be used to perform ventilation rate procedure calculations for all three system types.

28. Abbreviation MERV Name Minimum Efficiency Reporting Values

29. For a mechanically ventilated building or space, if the project is in a nonattainment area (not meeting the EPA air quality standard) for fine particulate matter (PM2.5) what is the filters minimum efficiency reporting values (MERV) that must be installed?

MERV 11 or higher

30. For a mechanically ventilated building or space, if the project is in an area where ozone exceeds the most recent three-year average, annual fourth-highest daily maximum eight-hour average ozone concentration of 0.107 ppm, what must be installed?

air-cleaning device of ozone

31. For VAV systems a direct outdoor airflow measurement device must measure the intake flow rate.

32. For constant volume (CV) systems, balancing ensures that the correct amount of outdoor air is being supplied to the building.

33. List the information required for each naturally ventilated space:
    1. minimum ceiling height
    2. location of natural ventilation openings
    3. size of the natural ventilation openings (openable area)

34. CO_2 sensors must be located in the breathing zone which is 3 to 6 feet above finished floor.

35. ASHRAE Standard 62.1–2010, Section 6.4, requires naturally ventilated spaces to include a mechanical ventilation system unless one of the following exceptions applies:
    Ventilation openings comply with Section 6.4 and are permanently open.
    Ventilation openings comply with Section 6.4 and have controls that prevent them from being closed during times of expected occupancy.
    The naturally ventilated zone is not served by heating or cooling equipment.
    The system is an engineered natural ventilation system approved by the authority having jurisdiction

36. List the three main types of mechanical ventilation systems:
    1. single-zone
    2. 100% outdoor air
    3. multiple-zone recirculating

37. Because of the complexity of the calculations for multiple-zone recirculating systems, project teams must use the 62MZCALC spreadsheet, or energy modeling software to perform the ventilation rate procedure calculations and determine the amount of outdoor air required at the system level.

38. EQ Prerequisite Environmental Tobacco Smoke Control requirements:
NC, CS, R, DC, WDC, HOS, HC

Prohibit smoking inside the building.

Prohibit smoking outside the building except in designated smoking areas located at least 25 feet from all:

1. entries
2. outdoor air intakes
3. operable windows

Also prohibit smoking outside the property line in spaces used for business purposes.

Signage must be posted within 10 feet of all building entrances indicating the no-smoking policy.

Residential Only
Option 1. No Smoking
Meet the requirements above.

OR

Option 2. Compartmentalization of Smoking Areas

Prohibit smoking inside all common areas of the building.

The prohibition must be communicated in building rental or lease agreements or condo or coop association covenants and restrictions. Make provisions for enforcement.

Prohibit smoking outside the building except in designated smoking areas located at least 25 feet from all entries, outdoor air intakes, and operable windows. The no-smoking policy also applies to spaces outside the property line used for business purposes.

If the requirement to prohibit smoking within 25 feet cannot be implemented because of code, provide documentation of these regulations.

Signage must be posted within 10 feet of all building entrances indicating the no-smoking policy.

Each unit must be compartmentalized to prevent excessive leakage between units:

Weather-strip all exterior doors and operable windows in the residential units to minimize leakage from outdoors.

Weather-strip all doors leading from residential units into common hallways.

Minimize uncontrolled pathways for the transfer of smoke and other indoor air pollutants between residential units by sealing penetrations in the walls, ceilings, and floors and by sealing vertical chases (including utility chases, garbage chutes, mail drops, and elevator shafts) adjacent to the units.

Demonstrate a maximum leakage of 0.23 cubic feet per minute per square foot at 50 Pa of enclosure (i.e., all surfaces enclosing the apartment, including exterior and party walls, floors, and ceilings).

Schools

Prohibit smoking on site.

Signage must be posted at the property line indicating the no-smoking policy.

39. EQ Prerequisite Minimum Acoustic Performance applies to: Schools

40. EQ Prerequisite Minimum Acoustic Performance requirements:

HVAC Background Noise

Area	Maximum noise level from HVAC (dBA)
Classrooms and core learning spaces	40

List the acceptable standards for recommended methodologies and best practices:

1. ANSI Standard S12.60-2010
2. 2011 HVAC Applications ASHRAE Handbook
3. AHRI Standard 885-2008

Exterior Noise

For high-noise sites (peak-hour Leq above 60 dBA during school hours), implement acoustic treatment and other measures to minimize noise intrusion from exterior sources and control sound transmission between classrooms and other core learning spaces. Projects at least one-half mile from any significant noise source (e.g., aircraft overflights, highways, trains, industry) are exempt.

Reverberation Time

Classrooms and Core Learning Spaces < 20,000 cubic feet

Compliance with ANSI Standard S12.60-2010, Part 1, Acoustical Performance Criteria Design Requirements and Guidelines for Schools

Option 1

For each room

Total surface area of acoustic:

1. wall panels
2. ceiling finishes
3. sound-absorbent finishes

= or exceeds

Total ceiling area of the room (excluding lights, diffusers, and grilles).

Materials must have an NRC of 0.70 or higher to be included in the calculation.

OR

Option 2

Confirm through calculations described in ANSI Standard S12.60-2010 that rooms are designed to meet reverberation time requirements as specified in that standard.

Classrooms and Core Learning Spaces ≥ 20,000 cubic feet

Meet the recommended reverberation times for classrooms and core learning spaces described in the NRC-CNRC Construction Technology Update No. 51, Acoustical Design of Rooms for Speech (2002), or a local equivalent for projects outside the U.S.

Exceptions

Exceptions to the requirements because of a limited scope of work or to observe historic preservation requirements will be considered.

41. List sources of noise that impinge of concentration in core learning spaces:
    1. Exterior noise
    2. Reverberation
    3. Sound transmission
    4. HVAC Equipment
    5. Crosstalk between rooms via ductwork

42. List the acoustic performance areas addressed by EQ Prerequisite Minimum Acoustic Performance:
    1. HVAC background noise
    2. Exterior noise
    3. Reverberation time

43. List examples of significant noise sources (within ½ mile of the face of the building):
    1. major transit corridors
    2. industrial or manufacturing facilities
    3. outdoor concert or sports venues
    4. rail lines
    5. air traffic lanes

44. If peak-hour L_{eq} measurements exceed 60 dBA, the project is considered a high-noise site and the team must implement noise reduction measures.

45. List the frequencies that sound absorptive coefficients must be used to determine the sound absorption properties of absorptive materials and reverberation times:
    1. 500 Hz
    2. 1000 Hz
    3. 2000 Hz

46. Use the room volume to determine whether the reverberation time requirements are defined by the ANSI or NRC-CNRC standard.

47. EQ Enhanced Indoor Air Quality Strategies requirements:
    Option 1. Enhanced IAQ Strategies (1 point)
    Comply with the following requirements, as applicable.

    Mechanically ventilated spaces:
    A. entryway systems;
    B. interior cross-contamination prevention; and
    C. filtration

    Naturally ventilated spaces:
    A. entryway systems; and
    B. natural ventilation design calculations.

    Mixed-mode systems:
    A. entryway systems;
    B. interior cross-contamination prevention; and
    C. filtration
    D. natural ventilation design calculations.
    E. mixed-mode design calculations.

A. Entryway Systems

Install permanent entryway systems at least 10 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:

1. grates
2. grilles
3. slotted systems

that allow for cleaning underneath, rollout mats, and any other materials manufactured as entryway systems with equivalent or better performance. Maintain all on a weekly basis.

Warehouses and Distribution Centers only

Entryway systems are not required at doors leading from the exterior to the loading dock or garage but must be installed between these spaces and adjacent office areas.

Healthcare only

In addition to the entryway system, provide pressorized entryway vestibules at high-volume building entrances.

B. Interior Cross-Contamination Prevention

Exhaust areas where hazardous gases or chemicals may be present

Exhaust rates:

Determined in EQ Prerequisite Minimum Indoor Air Quality Performance or
A minimum of 0.50 cfm per square foot,
to create negative pressure, when doors to the room are closed.

Each Space:

self -closing doors
deck -to-deck partitions or Hard -lid ceiling

C. Filtration

Each ventilation system that supplies outdoor air to occupied spaces must have particle filters or air-cleaning devices that meet one of the following filtration media requirements:
MERV of 13 or higher, in accordance with ASHRAE Standard 52.2-2007;
Or
Class F7 or higher as defined by CEN Standard EN 779-2001

Replace all air filtration media after completion of construction and before occupancy.

D. Natural Ventilation Design Calculations

Demonstrate that the system design for occupied spaces employs the appropriate strategies in CIBSE Applications Manual AM 10, March 2005, Natural Ventilation in Non-Domestic Buildings, Section 2.4

E. Mixed-Mode Design Calculations

Demonstrate that the system design for occupied spaces complies with CIBSE Applications Manual 13 –2000, Mixed Mode Ventilation.

Option 2. Additional Enhanced IAQ Strategies (1 point)

Comply with the following requirements, as applicable.

Mechanically ventilated spaces (select one):	Naturally ventilated spaces (select one):	Mixed-mode systems (select one):
A. exterior contamination prevention; B. increased ventilation; C. carbon dioxide monitoring; or D. additional source control and monitoring.	A. exterior contamination prevention; D. additional source control and monitoring; or E. natural ventilation room by room calculations.	A. exterior contamination prevention; B. increased ventilation; D. additional source control and monitoring; or E. natural ventilation room-by-room calculations.

A. Exterior Contamination Prevention

Design the project to minimize and control the entry of pollutants into the building. Ensure through the results of computational fluid dynamics modeling, Gaussian dispersion analyses, wind tunnel modeling, or tracer gas modeling that outdoor air contaminant concentrations at outdoor air intakes are below the thresholds listed in Table 1.

Table 1. Maximum concentrations of pollutants at outdoor air intakes

Pollutants	Maximum concentration	Standard
Those regulated by National Ambient Air Quality Standards (NAAQS)	Allowable annual average OR 8-hour or 24-hour average where an annual standard does not exist OR Rolling 3-month average	National Ambient Air Quality Standards (NAAQS)

B. Increased Ventilation

Increase breathing zone outdoor air ventilation rates to all occupied spaces by at least 30% above the minimum rates as determined in EQ Prerequisite Minimum Indoor Air Quality Performance.

C. Carbon Dioxide Monitoring

Monitor CO_2 concentrations within all densely occupied spaces. CO_2 monitors must be between 3 and 6 feet above the floor. CO_2 monitors must have an audible or visual indicator or alert the building automation system if the sensed CO_2 concentration exceeds the setpoint by more than 10%. Calculate appropriate CO_2 setpoints using methods in ASHRAE 62.1–2010, Appendix C.

D. Additional Source Control and Monitoring

For spaces where air contaminants are likely, evaluate potential sources of additional air contaminants besides CO_2. Develop and implement a materials-handling plan to reduce the likelihood of contaminant release. Install monitoring systems with sensors designed to detect the specific contaminants. An alarm must indicate any unusual or unsafe conditions.

E. Natural Ventilation Room-by-Room Calculations

Follow CIBSE AM 10, Section 4, Design Calculations, to predict that room-by-room airflows will provide effective natural ventilation.

48. EQ Credit Low-Emitting Materials requirements:
This credit includes requirements for product manufacturing as well as project teams. It covers volatile organic compounds (VOC) emissions into indoor air and the VOC content of materials, as well as the testing methods by which indoor VOC emissions are determined.

Different materials must meet different requirements to be considered compliant for this credit. The building interior and exterior are organized in seven categories, each with different thresholds of compliance.

The building interior is defined as everything within the waterproofing membrane.

The building exterior is defined as everything outside and inclusive of the primary and secondary weatherproofing system, such as waterproofing membranes and air- and water-resistive barrier materials.

Option 1. Product Category Calculations
Achieve the threshold level of compliance with emissions and content standards for the number of product categories listed in Table 2.

Complete Table 1. Thresholds of compliance with emissions and content standards for 7 categories of materials

Table 1. Thresholds of compliance with emissions and content standards for 7 categories of materials

Category	Threshold	Emissions and content requirements
Interior paints and coatings applied on site	At least 90%, by volume, for emissions; 100% for VOC content	General Emissions Evaluation for paints and coatings applied to walls, floors, and ceilings VOC content requirements for wet applied products
Interior adhesives and sealants applied on site (including flooring adhesive)	At least 90%, by volume, for emissions; 100% for VOC content	General Emissions Evaluation VOC content requirements for wet applied products
Flooring	100%	General Emissions Evaluation
Composite wood	100% not covered by other categories	Composite Wood Evaluation
Ceilings, walls, thermal, and acoustic insulation	100%	General Emissions Evaluation **Healthcare, Schools** only Additional insulation requirements
Furniture (include in calculations if part of scope of work)	At least 90%, by cost	Furniture Evaluation
Healthcare and Schools Projects only: Exterior applied products	At least 90%, by volume	Exterior Applied Products

Complete Table 2. Points for number of compliant categories of products

Table 2. Points for number of compliant categories of products	
Compliant categories	**Points**
New Construction, Core and Shell, Retail, Data Centers, Warehouses and Distribution Centers, Hospitality projects without furniture	
2	1
4	2
5	3
New Construction, Core and Shell, Retail, Data Centers, Warehouses and Distribution Centers, Hospitality projects with furniture	
3	1
5	2
6	3
Schools, Healthcare without furniture	
3	1
5	2
6	3
Schools, Healthcare with furniture	
4	1
6	2
7	3

Option 2. Budget Calculation Method
If some products in a category do not meet the criteria, project teams may use the budget calculation method (Table 3).

Complete Table 3. Points for percentage compliance, under budget calculation method

Table 3. Points for percentage compliance, under budget calculation method	
Percentage of total	**Points**
≥ 50% and < 70%	1
≥ 70% and < 90%	2
≥ 90%	3

Complete the table. The budget method organizes the building interior into six assemblies:

Flooring	thermal and acoustic insulation
ceilings	furniture
walls	Healthcare, Schools: exterior applied products

Include furniture in the calculations if it is part of the scope of work. Walls, ceilings, and flooring are defined as building interior products; each layer of the assembly, including paints, coatings, adhesives, and sealants, must be evaluated for compliance. Insulation is tracked separately.

Determine the total percentage of compliant materials according to Equation 1.

Equation 1. Total percentage compliance

$$\text{Total \% compliant for projects without furniture} = \frac{(\text{\% compliant walls} + \text{\% compliant ceilings} + \text{\% compliant flooring} + \text{\% compliant insulation})}{4}$$

$$\text{Total \% compliant for projects with furniture} = \frac{(\text{\% compliant walls} + \text{\% compliant ceilings} + \text{\% compliant flooring} + \text{\% compliant insulation}) + (\text{\% compliant furniture})}{5}$$

Equation 2. System percentage compliant

$$\text{Flooring, walls, ceilings, insulation \% compliant} = \frac{(\text{compliant surface area layer 1} + \text{compliant surface area layer 2} + \text{compliant surface area layer 3} + \ldots)}{\text{total surface area of layer 1} + \text{total surface area of layer 2} + \text{total surface area of layer 3} + \ldots} \times 100$$

Equation 3. Furniture systems compliant, using ANSI/BIFMA evaluation

$$\text{\% compliant for furniture} = \frac{0.5 \times \text{cost compliant with §7.6.1 of ANSI/BIFMA e3-2011} + \text{cost compliant with §7.6.2 of ANSI/BIFMA e3-2011}}{\text{total furniture cost}} \times 100$$

Calculate surface area of assembly layers based on the manufacturer's documentation for application.

If 90% of an assembly meets the criteria, the system counts as 100% compliant.

If less than 50% of an assembly meets the criteria, the assembly counts as 0% compliant.

Manufacturers' claims. Both first-party and third-party statements of product compliance must follow the guidelines in CDPH SM V1.1-2010, Section 8. Organizations that certify manufacturers' claims must be accredited under ISO Guide 65.

Laboratory requirements. Laboratories that conduct the tests specified in this credit must be accredited under ISO/IEC 17025 for the test methods they use.

Emissions and Content Requirements

To demonstrate compliance, a product or layer must meet all of the following requirements, as applicable.

Inherently nonemitting sources.

List examples of products that are inherently nonemitting sources of VOCs:

1. Stone
2. ceramic
3. powder-coated metals
4. plated or anodized metals
5. glass
6. concrete
7. clay brick
8. unfinished/untreated solid wood

These products are considered fully compliant without any VOC emissions testing if they do not include integral organic based surface coatings, binders, or sealants.

General emissions evaluation. Building products must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.1–2010, using the applicable exposure scenario.

The default scenario is the private office scenario.

The manufacturers or third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area.

Manufacturers' claims of compliance with the above requirements must also state the range of total VOCs after 14 days (336 hours), measured as specified in the CDPH Standard Method v1.1:
0.5 mg/m3 or less;
between 0.5 and 5.0 mg/m3; or
5.0 mg/m3 or more.

Additional VOC content requirements for wet-applied products.

Product	Standard(s)
Paints and coatings wet-applied on site	California Air Resources Board (CARB) 2007, Suggested Control Measures (SCM) for Architectural Coatings OR
	SCAQMD Rule 1113
Adhesives and sealants wet-applied on site	SCAQMD Rule 1168

For projects in North America, methylene chloride and perchloroethylene may not be intentionally added in paints, coatings, adhesives, or sealants.

Composite Wood Evaluation. Composite wood, as defined by the California Air Resources Board, Airborne Toxic Measure to Reduce Formaldehyde Emissions from Composite Wood Products Regulation, must be documented to have low formaldehyde emissions that meet the California Air Resources Board ATCM for formaldehyde requirements for ultra-low-emitting formaldehyde (ULEF) resins or no added formaldehyde resins.

Salvaged and reused architectural millwork more than one year old at the time of occupancy is considered compliant, provided it meets the requirements for any site-applied paints, coatings, adhesives, and sealants.

Furniture evaluation. New furniture and furnishing items must be tested in accordance with ANSI/ BIFMA Standard Method M7.1–2011. Comply with ANSI/ BIFMA e3-2011 Furniture Sustainability Standard, Sections 7.6.1 and 7.6.2, using either the concentration modeling approach or the emissions factor approach.

Model the test results using the open plan, private office, or Seating scenario in ANSI/ BIFMA M7.1, as appropriate.

USGBC -approved equivalent testing methodologies and contaminant thresholds are also acceptable.

For classroom furniture, use the standard school classroom model in CDPH Standard Method v1.1. Documentation submitted for furniture must indicate the modeling scenario used to determine compliance.

Salvaged and reused furniture more than one year old at the time of use is considered compliant, provided it meets the requirements for any site-applied paints, coatings, adhesives, and sealants.

Healthcare, Schools only
Additional insulation requirements. Batt insulation products may contain no added formaldehyde, including urea formaldehyde, phenol formaldehyde, and urea-extended phenol formaldehyde.

Exterior applied products. Adhesives, sealants, coatings, roofing, and waterproofing materials applied on site must meet the VOC limits of BOTH:

1. CARB 2007 SCM
2. SCAQMD 1168

Small containers of adhesives and sealants subject to State or federal consumer product VOC regulations are exempt.

Two materials are prohibited and do not count toward total percentage compliance:
hot -mopped asphalt for roofing, and
coal tar sealants for parking lots and other paved surfaces.

49. EA Credit Low-Emitting Materials uses a holistic systems approach that rewards teams for partial compliance, recognizing compliance of product assemblies even if some of their elements do not meet the applicable standard.

50. Specifying only compliant products is the easiest way to ensure that the credit requirements are met and the building will have the lowest possible emissions.

51. EA Credit Low-Emitting Materials, Option 2 allows project teams to substitute a noncompliant product if necessary.

52. List the interior materials that must be specified, as applicable to the project's scope of work:

1. paints
2. coatings
3. adhesives
4. sealants
5. flooring
6. composite wood
7. ceilings
8. walls
9. thermal and acoustic insulation
10. furniture

Complete Table 4. Determine if the two products meet the VOC budget requirement:

Table 4. SCAQMD Rule 1113							
Regulation	Product type	General emissions criteria met?	Volume installed (L)	Allowable VOC content	Actual VOC content	VOC budget	
						Baseline case (g)	Design case (g)
SCAQMD Rule 1113	Faux finishing coatings—trowel-applied coatings	YES	50	350	450	17,500	22,500
SCAQMD Rule 1113	Clear wood finishes—sanding sealers	YES	55	275	150	15,125	8,250
					VOC budget baseline case total (g)		32,625
					VOC budget design case total (g)		30,750

Yes, meets VOC Budget

53. EA Credit Low-Emitting Materials Exemplary Performance:

Option 1. Earn all points and reach 100% of products.

Option 2. Reach 100% of products.

54. EQ Credit Construction Indoor Air Quality Management Plan requirements:
Develop and implement an indoor air quality (IAQ) management plan for the construction and preoccupancy phases of the building.

The plan must address all of the following.
During construction, meet or exceed all applicable recommended control measures of the Sheet Metal and Air Conditioning National Contractors Association (SMACNA) IAQ Guidelines for Occupied Buildings under Construction, 2nd edition, 2007, ANSI/SMACNA 008–2008, Chapter 3.

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

Do not operate permanently installed air-handling equipment during construction unless filtration media with a minimum efficiency reporting value (MERV) of 8, as determined by ASHRAE 52.2-2007, with errata (or equivalent filtration media class of F5 or higher, as defined by CEN Standard EN 779–2002, Particulate Air Filters for General Ventilation, Determination of the Filtration Performance), are installed at each return air grille and return or transfer duct inlet opening such that there is no bypass around the filtration media.

Immediately before occupancy, replace all filtration media with the final design filtration media, installed in accordance with the manufacturer's recommendations.

Prohibit the use of tobacco products inside the building and within 25 feet (7.5 meters) of the building entrance during construction.

Healthcare

Moisture. Develop and implement a moisture control plan to protect stored on-site and installed absorptive materials from moisture damage.

Immediately remove from site and properly dispose of any materials susceptible to microbial growth and replace with new, undamaged materials. Also include strategies for protecting the building from moisture intrusion and preventing occupants' exposure to mold spores.

Particulates. Do not operate permanently installed air-handling equipment during construction unless filtration media with a minimum efficiency reporting value (MERV) of 8, as determined by ASHRAE 52.2-2007, with errata (or equivalent filtration media class of F5 or higher, as defined by CEN Standard EN 779–2002, Particulate Air Filters for General Ventilation, Determination of the Filtration Performance), are installed at each return air grille and return or transfer duct inlet opening such that there is no bypass around the filtration media.

Immediately before occupancy, replace all filtration media with the final design filtration media, installed in accordance with the manufacturer's recommendations.

VOCs. Schedule construction procedures to minimize exposure of absorbent materials to VOC emissions. Complete painting and sealing before storing or installing "dry" materials, which may accumulate pollutants and release them over time. Store fuels, solvents, and other sources of VOCs separately from absorbent materials.

Outdoor emissions. For renovation projects involving waterproofing, repairing asphalt roofing, sealing parking lots, or other outdoor activities that generate high VOC emissions, develop a plan to manage fumes and avoid infiltration to occupied spaces. Comply with the procedures established by NIOSH, Asphalt Fume Exposures during the Application of Hot Asphalt to Roofs (Publication 2003–112).

Tobacco. Prohibit the use of tobacco products inside the building and within 25 feet (7.5 meters) of the building entrance during construction.

Noise and vibration. Develop a plan based on the British Standard (BS 5228) to reduce noise emissions and vibration from construction equipment and other nonroad engines by specifying low-noise emission design or the lowest decibel level available that meets performance requirements in the British Standard. Construction crews must wear ear protection in areas where sound levels exceed 85 dB for extended periods.

Infection control. For renovations and additions adjacent to occupied facilities or phased occupancy in new construction, follow the FGI 2010 Guidelines for Design and Construction of Health Care Facilities and the Joint Commission on Standards to establish an integrative infection control team comprising the owner, designer, and contractor to evaluate infection control risk and document the required precautions in a project-specific plan. Use the infection control risk assessment standard published by the American Society of Healthcare Engineering and the U.S. Centers for Disease Control and Prevention (CDC) as a guideline to assess risk and to select mitigation procedures for construction activities.

55. List the SMACNA guidelines that apply to EQ Credit Construction Indoor Air Quality Management Plan:

1. HVAC Protection
2. Source control
3. Pathway interruption
4. Housekeeping
5. Scheduling

56. Write the SMACNA Guideline next to each description:

Pathway interruption	Prevent circulation of contaminated air when cutting concrete or wood, sanding drywall, installing VOC-emitting materials, or performing other activities that affect IAQ in other work spaces.
Housekeeping	Maintaining a clean job site results in fewer IAQ contaminants to manage.
Source control	Keep sources of contaminants out of the building and have a plan to eliminate any that are introduced.
Scheduling	Sequence construction activities to reduce air quality problems in new construction projects. For major renovations, coordinate construction activities to minimize or eliminate disruption of operations in occupied areas.
HVAC Protection	Keep contaminants out of the HVAC system. Do not run permanently installed equipment if possible, or maintain proper filtration if it is used.

57. EQ Credit Indoor Air Quality Assessment requirements:
Select one of the following two options, to be implemented __after__ construction ends and the building has been completely __cleaned__. All interior __finishes__, such as millwork, doors, paint, carpet, acoustic tiles, and movable furnishings (e.g., workstations, partitions), must be installed, and major __VOC__ punch list items must be finished. The __options__ cannot be combined.

Option 1. Flush-Out (1 point)
Path 1. __Before__ Occupancy
Install __new__ filtration media and perform a building __flush-out__ by supplying a total air volume of __14,000__ cubic feet of outdoor air per __square foot__ of __gross__ floor area while maintaining an internal temperature of at least __60__ °F and no higher than __80__ °F and relative humidity no higher than __60%__.

OR

Path 2. __During__ Occupancy
If occupancy is desired before the flush-out is completed, the space may be occupied only after delivery of a minimum of __3,500__ cubic feet of outdoor air per square foot of gross floor area while maintaining an internal temperature of at least __60__ °F and no higher than __80__ °F and relative humidity no higher than __60%__. Once the space is occupied, it must be ventilated at a minimum rate

of 0.30 cubic foot per minute (cfm) per square foot of outdoor air or the design minimum outdoor air rate determined in EQ Prerequisite Minimum Indoor Air Quality Performance, whichever is greater. During each day of the flush-out period, ventilation must begin at least three hours before occupancy and continue during occupancy. These conditions must be maintained until a total of 14,000 cubic feet per square foot of outdoor has been delivered to the space.

Option 2. Air Testing (2 points)
After construction ends and before occupancy, but under ventilation conditions typical for occupancy, conduct baseline IAQ testing using protocols consistent with the methods listed in Table 1 for all occupied spaces.

Use current versions of ASTM standard methods, EPA compendium methods, or ISO methods, as indicated.

Laboratories that conduct the tests for chemical analysis of formaldehyde and volatile organic compounds must be accredited under ISO/IEC 17025 for the test methods they use. Retail projects may conduct the testing within 14 days of occupancy.

Demonstrate that contaminants do not exceed the concentration levels listed in Table 1.
Complete Table 1. Maximum concentration levels, by contaminant and testing method

Table 1. Maximum concentration levels, by contaminant and testing method

Contaminant	**Maximum concentration**	**Maximum concentration (Healthcare only)**	**ASTM and U.S. EPA methods**	**ISO method**
Formaldehyde	27 ppb	16.3 ppb	ASTM D5197; EPA TO-11 or EPA Compendium Method IP-6	ISO 16000-3
Particulates (PM10 for all buildings; PM2.5 for buildings in EPA nonattainment areas, or local equivalent)	PM10: 50 micrograms per cubic meter PM2.5: 15 micrograms per cubic meter	20 micrograms per cubic meter	EPA Compendium Method IP-10	ISO 7708
Ozone (for buildings in EPA nonattainment areas)	0.075 ppm	0.075 ppm	ASTM D5149 - 02	ISO 13964
Total volatile organic compounds (TVOCs)	500 micrograms per cubic meter	200 micrograms per cubic meter	EPA TO-1, TO-15, TO-17, or EPA Compendium Method IP-1	ISO 16000-6
Target chemicals listed in CDPH Standard Method v1.1, Table 4-1, except formaldehyde	CDPH Standard Method v1.1–2010, Allowable Concentrations, Table 4-1	CDPH Standard Method v1.1–2010, Allowable Concentrations, Table 4-1	ASTM D5197; EPA TO-1, TO-15, TO-17	ISO 16000-3, 16000-6
Carbon monoxide (CO)	9 ppm; no more than 2 ppm above outdoor levels	9 ppm; no more than 2 ppm above outdoor levels	EPA Compendium Method IP-3	ISO 4224

ppb = parts per billion; ppm = parts per million; µg/cm = micrograms per cubic meter

Conduct all measurements before occupancy but during normal occupied hours, with the building ventilation system started at the normal daily start time and operated at the minimum outdoor airflow rate for the occupied mode throughout the test.

For each sampling point where the concentration exceeds the limit, take corrective action and retest for the noncompliant contaminants at the same sampling points. Repeat until all requirements are met.

58. Commissioning can occur during the flush-out, provided none of the commissioning procedures introduce contaminants into the space and none of the flush-out procedures circumvent the commissioning process.

59. EQ Credit Indoor Air Quality Assessment, Option 1, uses the gross square footage of all space in the building to calculate the total cubic feet of air required.

60. Determine the total amount of Flush-out outdoor air volume required for EQ Credit Indoor Air Quality Assessment, Option 1, for a building that is 100' x 100'.

$$\text{CF Air needed} = 100' \times 100' \times 14{,}000 \frac{\text{CF}}{\text{SF}}$$

$$= 140{,}000{,}000 \text{ CF}$$

61. A project will be using two 5000 cfm air-handlers capable of delivering 100% outdoor air while maintaining 60–80ºF and 60% relative humidity 24 hours per day to perform a building flush-out. If the building is three floors with 12' between each floor and the building footprint is 80' x 120' how many days will it take to complete the flush-out?

$$\text{Duration (Days)} = \frac{(80' \times 120' \times 3) \times 14{,}000 \frac{\text{cf}}{\text{SF}}}{10{,}000 \text{ CFM}} \times \frac{1}{1440 \frac{\text{min}}{\text{day}}}$$

$$= \frac{40{,}320 \text{ min}}{1440 \text{ min/day}}$$

$$= 28 \text{ Days}$$

62. EQ Credit Thermal Comfort requirements:
Meet the requirements for both thermal comfort design and thermal comfort control.

Option 1. ASHRAE Standard 55-2010
Design heating, ventilating, and air-conditioning (HVAC) systems and the building envelope to meet the requirements of ASHRAE Standard 55-2010, Thermal Comfort Conditions for Human Occupancy, with errata or a local equivalent.

For natatoriums, demonstrate compliance with ASHRAE HVAC Applications Handbook, 2011 edition, Chapter 5, Places of Assembly, Typical Natatorium Design Conditions, with errata.

Data Centers only
Meet the above requirements for regularly occupied spaces.

WAREHOUSES AND DISTRIBUTION CENTERS
Meet the above requirements for office portions of the building.

In regularly occupied areas of the building's bulk storage, sorting, and distribution areas, include one or more of the following design alternatives:
radiant flooring;
circulating fans;
passive systems, such as nighttime air, heat venting, or wind flow;
localized active cooling (refrigerant or evaporative-based systems) or heating systems; and
localized, hard-wired fans that provide air movement for occupants' comfort.
other equivalent thermal comfort strategy.

Thermal Comfort Control
Provide individual thermal comfort controls for at least 50% of individual occupant spaces.
Provide group thermal comfort controls for all shared multioccupant spaces.

Thermal comfort controls allow occupants, whether in individual spaces or shared multioccupant spaces, to adjust at least one of the following in their local environment:
List:
1. air temperature
2. radiant temperature
3. air speed
4. humidity

Hospitality only
Guest rooms are assumed to provide adequate thermal comfort controls and are therefore not included in the credit calculations.

Retail only
Meet the above requirements for at least 50% of the individual occupant spaces in office and administrative areas.

HEALTHCARE
Provide individual thermal comfort controls for every patient room and at least 50% of the remaining individual occupant spaces. Provide group thermal comfort controls for all shared multioccupant spaces.

Thermal comfort controls allow occupants, whether in individual spaces or shared multioccupant spaces, to adjust at least one of the following in their local environment:
List:
1. air temperature
2. radiant temperature
3. air speed
4. humidity

63. List the primary factors that affect human comfort:
    1. surface temperature
    2. air temperature
    3. humidity
    4. air movement
    5. Metabolic rate
    6. Clothing

64. List the factors of human comfort that thermal comfort controls should allow occupants to control:
    1. air temperature
    2. radiant temperature
    3. air speed
    4. humidity

65. List examples of eligible thermal comfort controls:
    1. thermostats
    2. ceiling fans
    3. adjustable underfloor diffusers
    4. task-mounted controls, plug-in desktop fan
    5. plug-in Humidifiers, or dehumidifiers
    6. operable window

66. List examples of ineligible thermal comfort controls:
    1. ceiling diffuser without an accessible Control
    2. Thermostat with a fixed setpoint

67. List examples of zero-energy strategies used for natural conditioning:
    1. cross or stack natural ventilation
    2. passive solar heating
    3. thermal mass, to moderate exterior conditions

68. EQ Credit Interior Lighting requirements:
    Select one or both of the following two options.

    Option 1. Lighting Control (1 point)

    For at least 90% of individual occupant spaces, provide individual lighting controls that enable occupants to adjust the lighting to suit their individual tasks and preferences, with at least three lighting levels or scenes (on, off, midlevel). Midlevel is 30% to 70% of the maximum illumination level (not including daylight contributions).

    For all shared multioccupant spaces, meet all of the following requirements.

Have in place multizone control systems that enable occupants to adjust the lighting to meet group needs and preferences, with at least three lighting levels or scenes (on, off, midlevel).

Lighting for any presentation or projection wall must be separately controlled.

Switches or manual controls must be located in the same space as the controlled luminaires. A person operating the controls must have a direct line of sight to the controlled luminaires.

Hospitality only
Guest rooms are assumed to provide adequate lighting controls and are therefore not included in the credit calculations

AND/OR
Option 2. Lighting Quality (1 point)

Choose four of the following strategies.

A. For all regularly occupied spaces, use light fixtures with a luminance of less than 2,500 cd/m2 between 45 and 90 degrees from nadir. Exceptions include wallwash fixtures properly aimed at walls, as specified by manufacturer's data, indirect uplighting fixtures, provided there is no view down into these uplights from a regularly occupied space above, and any other specific applications (i.e. adjustable fixtures).

B. For the entire project, use light sources with a CRI of 80 or higher. Exceptions include lamps or fixtures specifically designed to provide colored lighting for effect, site lighting, or other special use.

C. For at least 75% of the total connected lighting load, use light sources that have a rated life (or L70 for LED sources) of at least 24,000 hours (at 3-hour per start, if applicable).

D. Use direct-only overhead lighting for 25% or less of the total connected lighting load for all regularly occupied spaces.

E. For at least 90% of the regularly occupied floor area, meet or exceed the following thresholds for area weighted average surface reflectance: 85% for ceilings, 60% for walls, and 25% for floors.

F. If furniture is included in the scope of work, select furniture finishes to meet or exceed the following thresholds for area-weighted average surface reflectance: 45% for work surfaces, and 50% for movable partitions.

G. For at least 75% of the regularly occupied floor area, meet a ratio of average wall surface illuminance (excluding fenestration) to average work plane (or surface, if defined) illuminance that does not exceed 1:10. Must also meet strategy E, strategy F, or demonstrate area-weighted surface reflectance of at least 60% for walls.

H. For at least 75% of the regularly occupied floor area, meet a ratio of average ceiling illuminance (excluding fenestration) to work surface illuminance that does not exceed 1:10. Must also meet option E, option F, or demonstrate area-weighted surface reflectance of at least 85% for ceilings.

RETAIL

For at least 90% of the individual occupant spaces in office and administrative areas, provide individual lighting controls.

In Sales areas, provide controls that can reduce the ambient light levels to a midlevel (30% to 70% of the maximum illumination level not including daylight contributions).

HEALTHCARE

Provide individual lighting controls for at least 90% of individual occupant spaces in staff areas.

For at least 90% of patient positions, provide lighting controls that are readily accessible from the patient's bed.

In multioccupant patient spaces, the controls must be individual lighting controls.

In private rooms, also provide exterior window shades, blinds, or curtain controls that are readily accessible from the patient's bed. Exceptions include in-patient critical care, pediatric, and psychiatric patient rooms.

For all shared multioccupant spaces, provide multizone control systems that enable occupants to adjust the lighting to meet group needs and preferences, with at least three lighting levels or scenes (on, off, midlevel). Midlevel is 30% to 70% of the maximum illumination level (not including daylight contributions).

69. The credit encourages lighting quality in multiple ways.

Minimizing light fixture luminance (strategy A) helps reduce disability and discomfort glare; the threshold, 2,500 candela per square meter, was selected because research by the Light Right Consortium found that above that level, glare became objectionable.

Using light sources with a color rendering index above 80 (strategy B) helps approximate natural light.

Using light sources with long lamp life (strategy C) can lengthen the period over which the integrity of the lighting design is maintained; it also reduces maintenance costs and lowers material and resource inputs. A lamp life of 24,000 hours promotes the use of longer-life fluorescents.

Designing spaces with less direct-only overhead lighting (strategy D) helps minimize glare, reduces the perceived brightness of the direct luminaires, and reduces contrast between ceiling and luminaire.

Specifying surfaces with high reflectance (strategies E and F) helps make the space brighter through reflection, minimizing the difficulty of viewing light documents on dark surfaces; the specific surface reflectance values for ceilings, walls, and floors are above the standard industry assumptions of 80, 50, and 20, respectively, as recommended in the latest edition of the Illuminating Engineering Society (IES) Lighting Handbook.

Designing for an illuminance ratio less than 1:10 (strategies G and H) minimizes the amount of contrast that occupants experience between their work surface and the ceiling and wall surfaces around them; the 1:10 illuminance ratio represents one log scale difference in lighting levels (human eyes are logarithmic, but illuminance is linear).

70. Complete Table 1. Strategies for Option 2, Lighting Quality

Table 1. Strategies for Option 2, Lighting Quality

Strategy	Scope	Exceptions, exclusions
A. Light fixture luminance	All light fixtures located in regularly occupied spaces	• Wallwash fixtures properly aimed at walls, as specified by manufacturer • Indirect uplighting fixtures, provided there is no view down into these uplights from a regularly occupied space above • Any other specific applications (e.g., adjustable fixtures)
B. Color Rendering Index (CRI)	All light fixtures	• Lamps or fixtures specifically designed to provide colored lighting for effect • Site lighting • Any other special use
C. Lamp Life	75% connected lighting load	---
D. Direct overhead light	25% connected lighting load	---
E. Surface reflectance: ceilings, walls, floors	90% regularly occupied floor area	---
F. Surface reflectance: furnishings	All furniture used for work surfaces	---
G. Surface illuminance ratio: wall to work surface	75% regularly occupied floor area	---
H. Surface illuminance ratio: ceiling to work surface	75% regularly occupied floor area	---

71. For EQ Credit Interior Lighting, Option 1, residential units must have one lighting control for each individual occupant and multioccupant space. For example, a bedroom is listed as individual occupancy. A task light in the bedroom or an overhead light with manual dimmable control would be acceptable.

72. EQ Credit Daylight requirements:
Provide manual or automatic (with manual override) glare -control devices for all regularly occupied spaces.

Select one of the following three options.

Option 1. Simulation: Spatial Daylight Autonomy and Annual Sunlight Exposure (2–3 points, 1-2 points Healthcare)

Demonstrate through annual computer simulations that spatial daylight autonomy$_{300/50\%}$ (sDA$_{300/50\%}$) of at least 55%, 75%, or 90% is achieved. Use regularly occupied floor area.

Healthcare projects should use the perimeter area determined under EQ Credit Quality Views. Points are awarded according to Table 1.

Complete Table 1. Points for daylit floor area: Spatial daylight autonomy

Table 1. Points for daylit floor area: Spatial daylight autonomy			
C, CS, S, R, DC, WDC, HOS		**HC**	
sDA (regularly occupied floor area)	**Points**	**sDA (perimeter floor area)**	**Points**
55%	2	75%	1
75%	3	90%	2

AND
Demonstrate through annual computer simulations that annual sunlight exposure$_{1000,250}$ (ASE$_{1000,250}$) of no more than 10% is achieved. Use the regularly occupied floor area that is daylit per the sDA$_{300/50\%}$ simulations.

The sDA and ASE calculation grids should be no more than 2 feet square and laid out across the regularly occupied area at a work plane height of 30 inches above finished floor (unless otherwise defined). Use an hourly time-step analysis based on typical meteorological year data, or an equivalent, for the nearest available weather station. Include any permanent interior obstructions. Moveable furniture and partitions may be excluded.

Core and Shell only
If the finishes in the space will not be completed, use the following default surface reflectances: 80% for ceilings, 20% for floors, and 50% for walls. Assume that the entire floor plate, except for the core, will be regularly occupied space.

OR

Option 2. Simulation: Illuminance Calculations (1-2 points)
Demonstrate through computer modeling that illuminance levels will be between 300 lux and 3,000 lux for 9 a.m. and 3 p.m., both on a clear-sky day at the equinox, for the floor area indicated in Table 2. Use regularly occupied floor area. Healthcare projects should use the perimeter area determined under EQ Credit Quality Views.

Complete Table 2. Points for daylit floor area: Illuminance calculation

Table 2. Points for daylit floor area: Illuminance calculation			
C, CS, S, R, DC, WDC, HOS		**HC**	
Percentage of regularly occupied floor area	**Points**	**Percentage of perimeter floor area**	**Points**
75%	1	75%	1
90%	2	90%	2

Calculate illuminance intensity for sun (direct component) and sky (diffuse component) for clear-sky conditions as follows:
Use typical meteorological year data, or an equivalent, for the nearest available weather station. Select one day within 15 days of September 21 and one day within 15 days of March 21 that represent the clearest sky condition.

Use the average of the hourly value for the two selected days.

Exclude blinds or shades from the model. Include any permanent interior obstructions. Movable furniture and partitions may be excluded.

Core and Shell only
Assume the following default surface reflectances if the finishes in the space will not be completed: 80% for ceilings, 20% for floors, and 50% for walls. Assume that the entire floor plate, except for the core, will be regularly occupied space.

OR

Option 3. Measurement (2-3 points, 1-2 Healthcare)

Achieve illuminance levels between 300 lux and 3000 lux for the floor area indicated in Table 3.

Complete Table 3. Points for daylit floor area: Measurement

Table 2. Points for daylit floor area: Measurement

C, CS, S, R, DC, WDC, HOS		HC	
Percentage of regularly occupied floor area	**Points**	**Percentage of perimeter floor area**	**Points**
75%	2	75%	1
90%	3	90%	2

With furniture, fixtures, and equipment in place, measure illuminance levels as follows:
Measure at appropriate work plane height during any hour between 9 a.m. and 3 p.m.
Take one measurement in any regularly occupied month, and take a second as indicated in Table 4.
For spaces larger than 150 square feet, take measurements on a maximum 10 foot square grid.
For spaces 150 square feet or smaller, take measurements on a maximum 3 foot square grid.

Table 4. Timing of measurements for illuminance

If first measurement is taken in ...	Take second measurement in ...
January	May- September
February	June- October
March	June-July, November-December
April	August -December
May	September-January
June	October-February
July	November-March
August	December-April
September	December-January, May-June
October	February-June
November	March-July
December	April-August

73. List examples of passive solar design strategies that can improve daylight penetration and distribution:
    1. atria
    2. clerestories
    3. courtyards
    4. shallow floor plates

74. List the acceptable glare control devices:
    1. interior window blinds
    2. Shades
    3. curtains
    4. movable exterior louvers
    5. movable screens
    6. movable awnings

75. List the unacceptable glare control devices:
    1. Fixed exterior overhangs
    2. fixed fins
    3. Fixed louvers
    4. Dark color glazing
    5. Frit glazing treatment
    6. Additional glazing treatments

76. EQ Credit Quality Views requirements:
    New Construction, Core and Shell, schools, Retail, Data Centers, Hospitality

    Achieve a direct line of sight to the outdoors via vision glazing for 75% of all regularly occupied floor area. View glazing in the contributing area must provide a clear image of the exterior, not obstructed by frits, fibers, patterned glazing, or added tints that distort color balance.

    Additionally, 75% of all regularly occupied floor area must have at least two of the following four kinds of views:
    multiple lines of sight to vision glazing in different directions at least 90 degrees apart;
    views that include at least two of the following: (1) flora, fauna, or sky; (2) movement; and (3) objects at least 25 feet (7.5 meters) from the exterior of the glazing;
    unobstructed views located within the distance of three times the head height of the vision glazing; and
    views with a view factor of 3 or greater, as defined in "Windows and Offices; A Study of Office Worker Performance and the Indoor Environment."

    Include in the calculations any permanent interior obstructions. Movable furniture and partitions may be excluded.

    Views into interior atria may be used to meet up to 30% of the required area.

WAREHOUSES AND DISTRIBUTION CENTERS
For the office portion of the building, meet the requirements above.

For the bulk storage, sorting, and distribution portions of the building, meet the requirements above for 25% of the regularly occupied floor area.

HEALTHCARE
For inpatient units (IPUs), meet the requirements above (1 point).

For other areas, configure the building floor plates such that the floor area within 15 feet of the perimeter exceeds the perimeter area requirement (Table 1), and meet the requirements above for the perimeter area (1 point).

Complete Table 1. Minimum compliant perimeter area, by floor plate area

Table 1. Minimum compliant perimeter area, by floor plate area

Floor plate area		Perimeter area	
(square feet)	**(square meters)**	**(square feet)**	**(square meters)**
Up to 15,000	Up to 1400	7,348	682
20,000	1800	8,785	816
25,000	2300	10,087	937
30,000	2800	11,292	1049
35,000	3300	12,425	1154
40,000	3700	13,500	1254
45,000	4200	14,528	1349
50,000 and larger	4600 and larger	15,516	1441

77. Building occupants who can visually connect with outdoor environments while performing everyday tasks experience greater satisfaction, attentiveness, and productivity.

78. Designing for quality views involves consideration of building orientation and site design, facade, and interior layout.

79. Integrated design enables project teams to identify potential compromises.

80. List examples of elements that meet the view quality requirement:
    1. parks
    2. green roofs and walls
    3. nearby Buildings
    4. pedestrian and Vehicle movement

81. Movement (feature 2) includes such activities as people walking, cars driving on the street, and boats moving through the water. Movement of plants and trees from wind does not qualify.

82. What reference is used to determine the view factor?

Windows and offices: A study of office Worker Performance and the Indoor Environment

83. To perform calculations for EQ Credit Daylight and EQ Credit Quality Views see the daylight and quality views calculator provided by VSGBC.

84. List the spaces that can be excluded from the view requirements:

1. Auditoriums
2. Conference rooms dedicated to video conferencing
3. Gymnasiums
4. Incomplete Spaces, Core and shell

85. EQ Credit Quality Views Exemplary Performance
New Construction, Core and Shell, Schools, Retail, Data Centers, Hospitality
Meet the requirements for 90% of all regularly occupied area.

Warehouses and Distribution Centers
Meet the requirements for 90% of the regularly occupied floor area in the office portion of the building, and for 50% of the regularly occupied floor area in the bulk storage, sorting, and distribution portions of the building.

Healthcare
For inpatient areas, meet the requirements for 90% of the regularly occupied floor area.
For noninpatient areas, exceed the area requirements in Table 1 by 10% or more.

86. EQ Credit Acoustic Performance requirements:
NC, DC, WDC, HOS
For all occupied spaces, meet the following requirements, as applicable, for HVAC background noise, sound isolation, reverberation time, and sound reinforcement and masking.

HVAC Background Noise
Achieve maximum background noise levels from heating, ventilating, and air conditioning (HVAC) systems per 2011 ASHRAE Handbook, HVAC Applications, Chapter 48, Table 1; AHRI Standard 885-2008, Table 15; or a local equivalent. Calculate or measure sound levels.

For measurements, use a sound level meter that conforms to ANSI S1.4 for type 1 (precision) or type 2 (general purpose) sound measurement instrumentation, or a local equivalent.

Comply with design criteria for HVAC noise levels resulting from the sound transmission paths listed in ASHRAE 2011 Applications Handbook, Table 6; or a local equivalent.

Sound Transmission
Meet the composite sound transmission class (STC_c) ratings listed in Table 1, or local building code, whichever is more stringent.

Complete Table 1. Maximum composite sound transmission class ratings for adjacent spaces

Table 1. Maximum composite sound transmission class ratings for adjacent spaces		
Adjacency combinations		**STCc**
Residence (within a multifamily residence), hotel or motel room	Residence, hotel or motel room	55
Residence, hotel or motel room	Common hallway, stairway	50
Residence, hotel or motel room	Retail	60
Retail	Retail	50
Standard office	Standard office	45
Executive office	Executive office	50
Conference room	Conference room	50
Office, conference room	Hallway, stairway	50
Mechanical equipment room	Occupied area	60

Reverberation Time
Meet the reverberation time requirements in Table 2 (adapted from Table 9.1 in the Performance Measurement Protocols for Commercial Buildings).

Complete Table 2. Reverberation time requirements

Table 2. Reverberation time requirements		
Room type	**Application**	**T60, at 500 Hz, 1000 Hz, and 2000 Hz**
Apartment and condominium	–	<0.6
Hotel/motel	Individual room or suite	<0.6
	Meeting or banquet room	<0.8
Office building	Executive or private office	<0.6
	Conference room	<0.6
	Teleconference room	<0.6
	Open-plan office without sound masking	<0.8
	Open-plan office with sound masking	0.8
Courtroom	Unamplified speech	<0.7
	Amplified speech	<1.0
Performing arts space	Drama theaters, concert and recital halls	Varies by application
Laboratories	Testing or research with minimal speech communication	<1.0
	Extensive phone use and speech communication	<0.6

Church, mosque, synagogue	General assembly with critical music program	Varies by application
Library		<1.0
Indoor stadium, gymnasium	Gymnasium and natatorium	<2.0
	Large-capacity space with speech amplification	<1.5
Classroom	—	<0.6

Sound Reinforcement and Masking Systems
Sound Reinforcement
For all large conference rooms and auditoriums seating more than 50 persons, evaluate whether sound reinforcement and AV playback capabilities are needed.

If needed, the sound reinforcement systems must meet the following criteria:
Achieve a speech transmission index (STI) of at least 0.60 or common intelligibility scale (CIS) rating of at least 0.77 at representative points within the area of coverage to provide acceptable intelligibility.
Have a minimum sound level of 70 dBA.
Maintain sound-level coverage within +/– 3 dB at the 2000 Hz octave band throughout the space.

Masking Systems
For projects that use masking systems, the design levels must not exceed 48 dBA. Ensure that loudspeaker coverage provides uniformity of +/– 2 dBA and that speech spectra are effectively masked.

SCHOOLS
HVAC Background noise
Achieve a background noise level of 35 dBA or less from heating, ventilating, and air-conditioning (HVAC) systems in classrooms and other core learning spaces. Follow the recommended methodologies and best practices for mechanical system noise control in:
ANSI Standard S12.60–2010, Part 1, Annex A.1;
the 2011 HVAC Applications ASHRAE Handbook, Chapter 48, Sound and Vibration Control, with errata;
AHRI Standard 885–2008; or a
local equivalent.

Sound Transmission
Design classrooms and other core learning spaces to meet the sound transmission class (STC) requirements of ANSI S12.60–2010 Part 1, or a local equivalent. Exterior windows must have an STC rating of at least 35, unless outdoor and indoor noise levels can be verified to justify a lower rating.

HEALTHCARE
Design the facility to meet or exceed the sound and vibration criteria outlined below, which are adapted from the 2010 FGI Guidelines for Design and Construction of Health Care Facilities ("2010 FGI Guidelines") and the reference document on which it is based, Sound and Vibration Design Guidelines for Health Care Facilities ("2010 SV Guidelines").

Option 1. Speech Privacy, Sound Isolation, and Background Noise (1 point)
Speech Privacy and Sound Isolation
Design sound isolation to achieve speech privacy, acoustical comfort, and minimal annoyance from noise-producing sources. Consider sound levels at both source and receiver locations, the background sound at receiver locations, and the occupants' acoustical privacy and acoustical

comfort needs. Speech privacy is defined as "techniques...to render speech unintelligible to casual listeners" (ANSI T1.523-2001, Telecom Glossary 2007).

Design the facility to meet the criteria outlined in the sections of Table 1.2-3, Design Criteria for Minimum Sound Isolation Performance between Enclosed Rooms, and Table 1.2-4 Speech Privacy for Enclosed Room and Open-Plan Spaces (in the 2010 FGI Guidelines and 2010 SV Guidelines).

Calculate or measure sound isolation and speech privacy descriptors achieved for representative adjacencies as necessary to confirm compliance with the criteria in the 2010 FGI Guidelines, Sections1.2-6.1.5 and 1.2-6.1.6, and the 2010 SV Guidelines (including the appendix).

Background Noise
Consider background noise levels generated by all building mechanical-electrical-plumbing systems, air distribution systems and other facility noise sources under the purview of the project building design-construction team.

Design the facility to meet the 2010 FGI Guidelines, Table 1.2-2 Minimum-Maximum Design Criteria for Noise in representative interior rooms and spaces.

Calculate or measure sound levels in representative rooms and spaces of each type to confirm compliance with criteria in the above-referenced table using a sound level meter that conforms to ANSI S1.4 for type 1 (precision) or type 2 (general purpose) sound measurement instrumentation. For spaces not listed in Table 1.2-2, refer to ASHRAE 2011 Handbook, Chapter 48, Sound and Vibration Control, Table 1.

Option 2. Acoustical Finishes and Site Exterior Noise (1 point)
Meet the requirements for acoustical finishes and site exterior noise.

Acoustical Finishes
Specify materials, products systems installation details, and other design features to meet the 2010 FGI Guidelines, Table 1.2-1, Design Room Sound Absorption Coefficients (including associated sections of the appendix) and the 2010 SV Guidelines.

Calculate or measure the average sound absorption coefficients for representative unoccupied rooms of each type in the building to confirm conformance with the requirements.

Site Exterior Noise
Minimize the effect on building occupants of site exterior noise produced by road traffic, aircraft flyovers, railroads, on-site heliports, emergency power generators during maintenance testing, outdoor facility MEP and building services equipment, etc. Also minimize effects on the surrounding community from all facility MEP equipment and activities as required to meet (1) local applicable codes or (2) Table 1.2-1 of the 2010 FGI Guidelines, Table 1.2-1, and the 2010 SV Guidelines, Table 1.3-1, whichever is more stringent.

Comply with the 2010 FGI Guidelines for the following noise sources:

heliports, A1.3-3.6.2.2;
generator, 2.1-8.3.3.1;
Mechanical equipment, 2.1-8.2.1.1; and
Building services, A2.2-5.3

Measure and analyze data to determine the exterior noise classification (A, B, C, or D) of the facility site. See the 2010 FGI Guidelines, Categorization of Health Care Facility Sites by Exterior Ambient Sound, Table A1.2a, and the 2010 SV Guidelines, Table 1.3-1.

Design the building envelope composite STC rating based on the 2010 FGI Guidelines, Categorization of Health Care Facility Sites by Exterior Ambient Sound, and show conformance with requirements.

For exterior site exposure categories B, C, or D, calculate or measure the sound Isolation performance of representative elements of the exterior building envelope to determine the composite sound transmission class (STC_c) rating for representative facade sections. Measurements should generally conform to ASTM E966, Standard Guide for Field Measurements of Airborne Sound Insulation of Building Façades and Façade Elements, current edition.

87. List the performance areas addressed by EQ Credit Acoustic Performance for NC, DC, WDC, and HOS:
    1. HVAC background noise
    2. sound isolation
    3. reverberation time
    4. sound reinforcement and masking system

88. List the performance areas addressed by EQ Credit Acoustic Performance Schools:
    1. Background noise
    2. sound Isolation

89. List the performance areas addressed by EQ Credit Acoustic Performance Healthcare:
    1. Speech privacy and sound isolation
    2. Room noise level
    3. Acoustical finishes
    4. Site Exterior Noise

90.

Abbreviation	Name
STC	Sound Transmission class.
STI	speech Transmission Index
CIS	common intelligibility scale
NC	Noise criteria
RC	Room critereria
STCc	Composite sound Transmission class
NIC	Noise Isolation class

91. List how project teams can verify that the assemblies for each occupied space meet the sound isolation requirements:
    1. Published data
    2. Calculation
    3. Measurement

92. List the frequencies that reverberation time must be verified:

1. 500 Hz
2. 1000 Hz
3. 2000 Hz

93. An open-plan office with sound masking is 25' x 40' x 12' high walls. The total sound absorption in the room is A = 725 at 500 Hz. Determine the Reverberation time (RT). Does it meet the T60 credit requirement?

$$RT = 0.049 \times \frac{(25' \times 40' \times 12')}{725}$$

$$= 0.8$$

Yes, meets T60

94. Composite sound transmission class (STC) rating is a weighted value for the capacity of a partition to attenuate airborne sound. STC rating is calculated by averaging the transmission loss through an entire assembly.

95. Speech transmission index (STI) is measured from 0 (total unintelligible) to 1.0 (perfectly intelligible).