

BEYOND

SMART CITIES

INDOOR ENVIRONMENTAL QUALITY - GREEN BUILDING TECHNOLOGY TRAINING PROGRAM

FOR GREEN BUILDING AND SUSTAINABILITY SPECIALISTS

KRISHNAJI PAWAR, LEED AP BD+C, GSAS CGP, ISO 14001:2015, GCP

GREEN BUILDING SPECIALIST CURRICULUM

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ACOUSTIC PERFORMANCE - CREDIT

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LEARNING OBJECTIVES



Intent of Acoustic Performance - Credit

Behind the Intent

Step by Step Guidance

Requirements

Required Documentation

Connection to Ongoing Performance

Terms and Definitions

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IEQ- CR(1) - DESIGN

INTENT

To provide workspaces and classrooms that promote occupants' well-being, productivity, and communications through effective acoustic design.

POTENTIAL TECHNOLOGIES & STRATEGIES

This credit challenges project teams to address best practices in acoustic design as an indoor environmental quality imperative that complements other green building practices. Research by the Center for the Built Environment (CBE) of 34,000 building inhabitants 2, showed that LEED buildings outperform standard design in all areas of indoor environmental quality except acoustics (Figure 1). Acoustic performance typically is considered during the design process, the study found, yet teams are just beginning to understand the trade-offs with other green building practices, such as open floor planning, highly efficient HVAC systems, and efficient lighting strategies.

ACOUSTIC PERFORMANCE

REQUIREMENTS

HVAC background noise, Sound Transmission, and/or Reverberation time. Meet all three for an exemplary performance point. Confirm compliance via calculations or measurements in representative rooms, and/or design documentation from a person experienced in the field of acoustics.

IMPLEMENTATION

New Construction, Data Centers, Warehouses and Distribution Centers, Hospitality	All projects
HVAC background noise	Occupied spaces' sound level values
	Calculation, measurement narrative, or manufacturers' data
	Noise reduction narrative
Sound isolation	STC ratings for space adjacencies
	Calculation, measurement narrative, or manufacturers' data
Reverberation time	Reverberation time criteria for each room
	Calculation, measurement narrative, or manufacturers' data
	List of all large conference rooms and auditoriums
Sound reinforcement and masking systems	Explanation of sound reinforcement methodology (if installed)
	Explanation of sound reinforcement system components and specifications (if installed)
	Explanation of masking system components and specifications narrative (if installed)

BEHIND THE INTENT

This credit challenges project teams to address best practices in acoustic design as an indoor environmental quality imperative that complements other green building practices. Research by the Center for the Built Environment (CBE) of 34,000 building inhabitants showed that LEED buildings outperform standard design in all areas of indoor environmental quality except acoustics (Figure 1). Acoustic performance typically is considered during the design process, the study found, yet teams are just beginning to understand the trade-offs with other green building practices, such as open floor planning, highly efficient HVAC systems, and efficient lighting strategies.

Figure 1: Occupants' evaluation of environmental quality of LEED-certified buildings. Used with permission from the Center for the Built Environment, UC Berkeley.

LEED score correlated positively to the following building rating systems, partly because it indirectly affects building acoustics performance. However, acoustics could be a valuable and cost-effective strategy for reducing noise transmission between adjacent design strategies with consideration for lighting, thermal comfort, and other performance areas that may be considered when planning green buildings. All projects teams will design acoustics into building design for environmental quality of the space by building communication, increasing occupant satisfaction, and well-being and productivity.

The benefits of open collaboration spaces should be balanced with acoustic design. In schools, where communication between students and teachers affects the learning process, acoustic performance is essential (see EQ Prerequisite Minimum Acoustic Performance). In healthcare projects, the acoustic environment affects patients' privacy and recuperation. Careful sound isolation supports confidential personal health discussions among patients, their families, and caregivers. It also allows health care workers to communicate more effectively with each other. Better acoustics do matter: research links poor acoustic performance to sleep disturbances, increased blood pressure and heart rates, and stress.*

STEP-BY-STEP GUIDANCE

NEW CONSTRUCTION, DATA CENTERS, WAREHOUSES AND DISTRIBUTION CENTERS, HOSPITALITY

STEP 1. DEFINE ACOUSTIC NEEDS FOR EACH SPACE

Identify occupied spaces and determine the following:

- Activities or user groups within each space and adjacencies
- Privacy or sound sensitivity requirements

STEP 2. REVIEW ACOUSTIC CRITERIA

Evaluate how the four performance areas addressed by this credit affect each applicable space:

- HVAC background noise levels.** Engineers or acoustic experts will need to analyze background noise levels coming from HVAC equipment.
- Sound isolation.** Designers will need to specify materials to meet sound transmission class ratings.
- Reverberation time.** Designers will need to specify sound-absorbing treatments and/or sound room size to address reverberation time.
- Sound reinforcement and masking systems.** Designers will need to analyze STI or C50, sound level and sound-level coverage for spaces with sound reinforcement systems. Designers will also need to analyze sound level, loudspeaker coverage, and speech spectra for spaces with masking systems.

Prepare a log or spreadsheet to record pertinent acoustic information for each space.

Determine how the acoustic requirements fit into the design process so that each can be addressed by the responsible party at the appropriate time.

STEP 3. ADDRESS HVAC BACKGROUND NOISE

Identify equipment and air distribution elements that could contribute to HVAC background noise in occupied spaces. The following steps refer to the referenced standard, 2011 HVAC Applications ASHRAE Handbook, Chapter 48, Noise and Vibration Control (Chapter 48):

- When selecting and designing HVAC systems, consider basic acoustic design techniques (e.g., Chapter 48, page 48-8).
- Consider specific source design considerations (e.g., Chapter 48, pages 48-148-14 and 48-148-30).
- Compile acoustic performance data at specific operating points from the HVAC equipment manufacturer's data. This information may inform the HVAC background noise criteria used for compliance.
- Consider source-receiver paths when locating occupied spaces, and HVAC equipment. For example, noise-generating HVAC equipment could be placed above a corridor rather than above a conference room. Review Chapter 48, Table 6, and address each applicable transmission path.

STEP-BY-STEP GUIDANCE +

STEP 4. VERIFY HVAC BACKGROUND NOISE

Determine noise impact (NC) from existing or C-weighted sound pressure levels for each occupied space through one or more of the following methods (see Further Explanation, Identifying a Sound Rating Method). Consider sound pressure levels from HVAC equipment only, including lighting, and electrical may be excluded. 

- Calculate sound pressure levels per Chapter 48 and follow the steps outlined in the HVAC Noise Reduction Design Procedure section of the handbook. Calculations may be done in the design phase.
- Calculate sound pressure levels per ANSI Standard S84-2008, Procedure for Estimating Occupant Sound Levels in the presence of air terminals and air outlets, under the conditions in Section 6, Calculation Procedure for Estimating Sound Levels in Occupied Spaces. Calculations may be done in the design phase.
- Measure sound pressure levels per Chapter 48. Follow field measurement guidelines from the Determining Compliance section. Prior to testing from the Room Noise Measurements section, the measurements must be performed in quiet conditions and should be done in furnished spaces with HVAC systems operating in typical conditions and noise-to-occupants are present. Noise from sources other than HVAC systems should be measured or turned off during testing.

A local standard, procedure, or handbook that is equivalent to one of the above methods may also be used.Prepare a narrative that describes the methods followed and a summary report with measurements or calculations.- Demonstrate compliance with the overall sound pressure levels listed in Chapter 48, page 48.3, Table 1, or ANSI Standard S84-2008, Table 6, for applicable spaces.

STEP 5. VERIFY NOISE REDUCTION METHODS FOR SOUND TRANSMISSION RATING

In a narrative and associated drawings or details, highlight each transmission class from Chapter 48, Table 6, that is applicable to the project and the specific noise reduction measures selected.

STEP 6. IDENTIFY ADJACENCIES FOR SOUND ISOLATION REQUIREMENTS

Identify occupied spaces and their adjacency combinations. Review Table 1 from the credit requirements and the local building code to determine the applicable composite sound transmission class (STC) rating.

Identify all assemblies (e.g., wall, floor-ceiling, roof-ceiling, door, window) that serve to acoustically isolate each occupied space.

STEP 7. VERIFY SOUND ISOLATION

Verify that the assemblies for each occupied space meet the sound isolation requirements. Demonstrate compliance through published data, calculation, or measurement, as follows:

- Published data:** Select walls, doors, and windows with published manufacturer's data.
- Calculation:** Perform averaging calculations that allow a trade-off between higher STC of walls and lower STC ratings of doors, windows, and penetrations (see Further Explanation, Determining Composite Sound Transmission Class). Calculations may be done in the design phase. 
- Measurement:** Measure noise isolation class (NOC) for all assemblies per Annex A.3 of ANSI S12.60-2010 and compare the results with the sound isolation requirements. A NC rating within 3 points of the specified STC rating may be considered compliant. Measurements cannot be performed until after the substantial completion of construction.

Assemblies with similar construction details may be grouped together. Any significant variance in opening areas, such as window or door ratios, should be evaluated separately.- Complete a list of each occupied space. For each space, list the maximum STC rating, the design STC rating or measured results, and data or calculations to support the values.

STEP 8. IDENTIFY SPACE REVERBERATION TIME REQUIREMENTS

List Table 2 in the credit requirements to determine reverberation time requirements for each occupied space in the project. For spaces that vary by application or are not listed in the table, use criteria from referenced standards, or use values for the space type with the closest functional use.

STEP 9. IMPLEMENT REVERBERATION TIME MITIGATION STRATEGIES

Use sound-absorptive materials or other strategies to limit the reverberation times for each occupied space as appropriate for the room type.

STEP-BY-STEP GUIDANCE +

Consider the following surfaces when specifying materials:

- Sound absorptive materials can be applied to any planar surface in the space. Although absorbing treatment to the walls is typically effective, a sound absorptive ceiling is generally more cost effective. Absorptive wall surfaces or vertical acoustic panels in rooms that require hard surfaces, such as laboratories.
- Soft or upholstered furniture and seats for spaces with seating.
- Window curtains, ceiling baffles, or other acoustic finishes.

Determine sound absorber coefficients for absorptive materials. Use manufacturer's documentation or Table 3 for common materials.

TABLE 3. Sound absorber coefficients for common materials

Material	Coefficient α			Material	Coefficient α		
	1 kHz	500 Hz	125 Hz		1 kHz	500 Hz	125 Hz
Walls							
Brick, unplastered	0.05	0.04	0.05	Concrete or masonry	0.05	0.03	0.02
Wet, water-plastered	0.02	0.02	0.02	Concrete, water-saturated or wet	0.05	0.03	0.03
Wetted surfaces in rooms, smooth finish on the dry side	0.02	0.03	0.04	Wood	0.10	0.07	0.05
Wetted surfaces in rooms, rough or smooth finish on wet side	0.05	0.05	0.04	Wet, impervious to liquid or concrete	0.07	0.05	0.05
Concrete block, light plaster	0.10	0.09	0.09	Ceramic, heavy, on concrete	0.10	0.07	0.05
Concrete block, white plaster	0.05	0.07	0.09	Glaze, oil or varnish on hard surface	0.07	0.05	0.05
Asbestos ceiling, 10 inch, metal furring, 1/2 inch, 1/2 inch, 1/2 inch	0.05	0.04	0.07	Glaze, oil or varnish on hard surface	0.07	0.05	0.05
Expanded polystyrene, 1/2 inch thick	0.07	0.09	0.10	Plaster or gypsum tile	0.05	0.03	0.02
Large panels of fibrous glass	0.04	0.05	0.02	Floors			
Ordinary window glass	0.10	0.07	0.07	Light rubber, 1/2 inch or less, felt, heavy, 1/2 inch or less, felt	0.10	0.07	0.05
Roof							
Thin, metal or wood deck, with insulation	0.02	0.03	0.03	Medium rubber, 1/2 inch or less, felt, heavy, 1/2 inch or less, felt	0.10	0.07	0.05
				Heavy rubber, 1/2 inch or less, felt, heavy, 1/2 inch or less, felt	0.10	0.07	0.05

STEP-BY-STEP GUIDANCE +

- For each space using sound reinforcement, select sound reinforcement strategies that meet the speech intelligibility, sound level, and sound level coverage credit requirements (see Further Explanation, Hearing Sound Reinforcement Credit Requirements). 
- For each space using masking systems, select a system that meets the credit requirements for sound level and system uniformity (see Further Explanation, Identifying a Sound Rating Method). 
- Document the means that are addressed through a sound reinforcement or masking system, or the rationale for not including these systems.

SCHOOLS

STEP 1. IDENTIFY ALL CLASSROOMS AND OTHER CORE LEARNING SPACES

See EQ Prerequisite Minimum Acoustic Performance. Spaces addressed for this credit should be consistent with those addressed for the prerequisite.

STEP 2. REVIEW ACOUSTIC CRITERIA

Review the acoustic design documentation developed for EQ Prerequisite Minimum Acoustic Performance and append it as necessary for the HVAC background noise and sound isolation requirements of this credit.

- HVAC Background noise:** Using the results from Step 4 of the HVAC background noise section in the prerequisite, confirm that all classrooms and core learning spaces comply with a 35 dBA maximum.
- Sound Isolation:** Designers must specify materials to meet sound transmission class ratings.

Prepare a log or spreadsheet to record the pertinent acoustic information for each space.- Determine how the acoustic requirements will be integrated into the design process so that they can be addressed by the responsible party at the appropriate time.

STEP 3. ADDRESS HVAC BACKGROUND NOISE

Follow the step-by-step guidance for HVAC background noise in EQ Prerequisite Minimum Acoustic Performance, and verify that background noise does not exceed 35 dBA in any applicable space. The credit threshold will likely require the adoption of a layered strategy that combines several best practices for low-noise mechanical design. Teams are encouraged to engage mechanical designers or acoustic experts familiar with the referenced standards who can calculate HVAC background noise levels during design development.

STEP 4. IDENTIFY ADJACENCIES

Identify the types of spaces that are adjacent to each core learning space. Review ANSI S12.60-2010, Section 5.4.2, Table 4, to understand the types of adjacent spaces and determine the applicable required STC ratings.

- Review ANSI S12.60-2010, Section 5.4.2, to determine which assemblies require composite wall STC ratings (which account for doors, windows, and other penetrations).
- Review Section 5.4.2 to identify the STC ratings for interior door assemblies and their associated window glazing.
- Windows in core learning spaces must have a minimum STC rating of 25 in lieu of the ratings in Section 5.4.2.

STEP 5. DESIGN FOR MAXIMIZING SOUND ISOLATION

Identify all assemblies (e.g., wall, floor-ceiling, roof-ceiling, door, window) that serve to acoustically isolate each core learning space.

STEP 6. VERIFY SOUND ISOLATION

Verify that the assemblies for each core learning space meet the sound isolation requirements listed in ANSI S12.60-2010, Part 1, Section 5.4.2, under the heading Attenuation of Airborne Sound and Table 4. Demonstrate compliance through published data, calculation, or measurement, as follows:

- Published data:** Select walls, doors, and windows with published manufacturer's data.
- Calculation:** If necessary, perform averaging calculations according to Sections 5.4.2 and 5.4.2.4 of the ANSI standard (see Further Explanation, Determining Composite Sound Transmission Class). Calculations may be done in the design phase. 

STEP-BY-STEP GUIDANCE +



- **Measurement.** Measure noise isolation class (NIC) for all assemblies per Annex A.3 of ANSI S32.6-2010 and compare with the sound isolation requirements. A NIC rating within 5 points of the specified STC rating may be considered compliant. Measurements cannot be performed until after the substantial completion of construction.
- Assemblies may be grouped together based on similar construction details. Any significant variance in opening areas, such as window or door ratios, should be evaluated separately.
- Compile a list of each noise-bearing space. For each space, list the maximum STC rating, the design STC rating or measured results, and data or calculations to support the values.

HEADLINE

STEP 1. IDENTIFY OCCUPIED SPACES

Create a table of all occupied spaces in the project and the function of each space.

STEP 2. SELECT OPTION

Determine whether the project will pursue one or both options.

- Option 1 includes requirements related to exterior spaces and partitions.
- Option 2 has requirements for interior finishes, the building envelope, and exterior noise sources.

Both options 1 and 2 may involve multiple design strategies.

- Separating patient rooms from treatment areas, media areas, and staff areas.
- Including buffer spaces in the building program.
- Using partition-height barriers in open-plan areas and isolating partitions in closed-plan areas.
- Installing sound-absorptive finishes.
- Addressing mechanical system noise and medical equipment noise.
- Installing ambient background noise or electronic masking systems.
- Installing interior vision panels.
- Installing glass fit doors with gaskets where appropriate.

Both options reference the 2010 FGI Guidelines for Design and Construction of Health Care Facilities (2010 FGI Guidelines) and the Sound and Vibration Design Guidelines for Health Care Facilities (2010 SV Guidelines) (see Further Exploration, Using 2010 FGI Guidelines and 2010 SV Guidelines) ➔

Option 1. Speech Privacy, Sound Isolation, and Background Noise

STEP 1. IDENTIFY ADJACENCIES AND ISOLATION REQUIREMENTS

In the table of occupied spaces and functions, note adjacencies. Review the 2010 FGI Guidelines, Table 12.2.3, to determine the applicable composite sound transmission class (STC) ratings. Consider adjacencies for interior spaces only; exterior adjacency is addressed elsewhere.

STEP 2. DESIGN FOR SOUND ISOLATION

Identify all separating wall assemblies and floor-ceiling assemblies that acoustically separate each applicable occupied space, including patient rooms, intensive-care units, examination rooms, treatment rooms, toilet rooms, consultation rooms, HRV rooms, corridors, and public space.

For all applicable assemblies, use products with sound isolation properties that meet the STC ratings in the 2010 FGI Guidelines, Table 12.2.3.

STEP 3. VERIFY SOUND ISOLATION

Verify that the assemblies for each occupied space meet the sound isolation requirements. Demonstrate compliance through published data, calculation, or measurement, as follows:

- **Published data.** Select walls, doors, and windows with published manufacturer's data.
- **Calculation.** Perform averaging calculations that allow a trade-off between higher STC of walls and lower STC ratings of doors, windows, and penetrations (see Further Exploration, Determining Composite Sound Transmission Class). Calculations may be done in the design phase. ➔

STEP-BY-STEP GUIDANCE +



- **Measurement.** Measure noise isolation class (NIC) for all assemblies per Annex A.3 of ANSI S32.6-2010 and compare with the sound isolation requirements. A NIC rating within five points of the specified STC rating may be considered compliant. Measurements cannot be performed until after the substantial completion of construction.
- Assemblies may be grouped together based on similar construction details. Any significant variance in opening areas, such as window or door ratios, should be evaluated separately.
- Compile a list of each occupied space. For each space, list the maximum STC rating, the design STC rating or measured results, and data or calculations to support the values.

STEP 4. IDENTIFY SPEECH-PRIVACY REQUIREMENTS

In the table developed for Step 1, identify whether each space is fully enclosed or open to other spaces, and work with the owner to determine the level of speech privacy needed in each space and required to comply with the Health Insurance Portability and Accountability Act (HIPAA) and other privacy protection statutes.

Clearly speech privacy goals as "normal," "confidential," or "secure" based on the sensitivity of essential conversations. Overlap spaces typically avoid limited opportunities for speech privacy, as within the speech privacy level is required to ensure essential speech.

Enclosed rooms that require confidential levels may include dentistry areas, laboratory and professional consulting and testing rooms, laboratory sets, clinical study, examination rooms, consultation rooms, and private offices where speech privacy is critical to the services performed. Secure speech privacy, the highest level, is generally achieved as the total readability of speech in adjacent spaces. This level of privacy may be required in special clinical areas, such as hearing test booths, speech therapy rooms, and special diagnostic rooms.

Design for noise barrier and speech privacy to avoid the speech privacy area material list will be used to evaluate compliance and to provide design assistance. Refer to the 2010 FGI Guidelines, page 21, Appendix A.2.6.2.1. For further discussion of the four methods (privacy noise, articulation index, speech transmission index, and speech intelligibility index).

STEP 5. DESIGN FOR SPEECH PRIVACY

Two approaches to providing adequate speech privacy are common. The first is to reduce sound transmission between spaces by installing improved partition assemblies (for enclosed rooms) and partial-height partitions and sound-absorptive room finishes (for open-plan spaces). The second is to provide an adequate level of continuous background sound.

STEP 6. VERIFY SPEECH-PRIVACY PERFORMANCE

Evaluate each occupied space for speech privacy and compare to the speech privacy goals in the 2010 FGI Guidelines, Table 12.4 for the selected method. Seek expert guidance on the appropriate calculation or site measurement methodology, or review the standards referenced in 2010 FGI Guidelines, page 27, Appendix A.2.6.1.5.1.

Retain copies of testing or calculation procedures for documentation.

STEP 7. ADDRESS BACKGROUND NOISE

Identify all equipment that could contribute to background noise in occupied spaces.

Requirements of this credit apply to all elements within the project scope that have the potential to generate audible noise in occupied rooms. Examples include all building mechanical, electrical, plumbing systems, and air distribution elements.

Consider source-receiver paths when locating occupied spaces and HVAC equipment. For example, an air-handling unit could be placed above a corridor rather than above a patient's room. Control ambient noise, including mechanical system noise, by selecting quiet fans that rotate at slow speeds, changing filters on a regular basis, locating sound attenuators at variable or volume terminal losses where needed, installing vibration isolators on rotating and vibrating equipment, providing duct attenuation, designing ductwork to minimize "cross-talk" from one room to another, and controlling airflow velocity in the ductwork to minimize turbulence noise.

- Correlate acoustic performance data at the specific operating points from the equipment manufacturers' data. This information may inform the background noise criteria used for compliance (see Further Exploration, Selecting a Sound Rating Method) ➔
- Because of the sensitive nature of these projects' occupants, electrical, lighting, and plumbing noise sources are considered in the background noise requirements for healthcare but not for the other BDC rating systems.

STEP-BY-STEP GUIDANCE +



STEP 6. SELECT ROOM NOISE RATING METHOD

Review the 2010 FGI Guidelines, Table 12-2, to determine the applicable background noise criteria for each space. The referenced standard lists four measures for background noise criteria (NIC), room criteria (RC), room criteria musical (RCM), and A-weighted decibel (dBA). To demonstrate achievement of the credit, project teams must verify compliance for one metric for each space. For space types not listed in the table, refer to 2011 HVAC Applications ASHRAE Handbook, Chapter 46, Table 11.0 (see Further Exploration, Selecting a Sound Rating Method) ➔

STEP 6. VERIFY HVAC BACKGROUND NOISE

Determine sound pressure levels for each occupied space and verify compliance for each applicable room type using the 2010 FGI Guidelines, Table 12-2. Consider sound pressure levels from HVAC, plumbing, lighting, and electrical equipment. Demonstrate compliance through calculation or measurement, as follows:

- Engage an acoustics expert to complete the necessary calculations manually or through computer simulation. Early calculations, during design, may allow teams to iteratively evaluate alternative or revised strategies.
- Consider measuring sound levels if the mechanical designer or acoustics expert on the project team is familiar with best practice acoustic design and construction strategies. Ensure that the meter used conforms to credit requirements.

Option 2. Acoustic Finishes and Site Exterior Noise

STEP 1. IDENTIFY SOUND ABSORPTION REQUIREMENTS

Review the 2010 FGI Guidelines, Table 12.2, to determine the applicable sound absorption criteria for each space listed in the table created for Step 1.

STEP 2. IDENTIFY SURFACES FOR ACOUSTIC TREATMENT

Calculating the area of planar surfaces in each space and identify locations where absorptive finishes can be applied:

- **Acoustic.**
- Acoustically absorptive finishes are typically applied to floors, ceilings, or walls as soft or perforated materials. Fabric-covered furniture or partition systems may be considered part of the permanent room sound.
- For spaces with noisy plantum equipment, sound transmission paths that travel through the ceiling elements or partitions that do not extend to the underside of the deck above, consider incorporating ceiling materials with ceiling attenuation class (CAC) ratings of 35 or greater.
- Customized flooring materials may reduce footfall and controlling noise.

Additional acoustic finishes may be applied as window curtains, ceiling baffles, or other elements. Balance the application of acoustic treatments with other performance criteria. For example, criteria for daylighting penetration may affect how acoustic ceilings are applied. Areas with divergent orientation needs may also restrict the placement of acoustically absorptive materials on the floor or down walls.

STEP 3. SELECT ACOUSTIC TREATMENTS

Specify and install finish materials with a high noise reduction coefficient (NRC) rating to satisfy the credit requirements. Typically, acoustically absorptive materials have NRC ratings of 0.75 or higher. Consult manufacturer's documentation to verify the NRC of each acoustic finish material. Record the area of each acoustic finish material for credit documentation.

STEP 4. VERIFY SOUND ABSORPTION COEFFICIENT

Calculate the average sound absorption coefficient (a) for each space type, using Equation 1, and confirm that each room complies with the applicable sound absorption.

Account for all room surfaces (walls, floors, and ceilings) in the calculation.

Early in the design process, assess the project site for exterior noise sources, both on- and off-site. Off-site sources may include major transit corridors, industry or manufacturing facilities, outdoor venues, rail lines, and air traffic lanes. On-site sources may include heliports, emergency power generators, and outdoor mechanical and building services equipment.

Predicted noise sources may also be identified through neighborhood maps or aerial photographs that show adjacent site uses. Consider marking existing off-site and anticipated on-site noise sources on a map, where adjacencies to project buildings or residential neighbors can be identified. These zones can then be highlighted for special consideration for noise mitigation.

Ensure that the design meets the 2010 SV Guidelines acoustic requirements for heliports, generators, mechanical equipment, and building services, as described in the credit requirements. Several reference sections affect programmatic functions of the project; therefore, teams are encouraged to evaluate criteria early in planning and design. Other sections define criteria for equipment specification and adjacency limits that must be resolved during design development and construction.

Evaluate each section and define how a combination of architectural and engineering strategies will be used to satisfy the requirements.

Through observation or measurement, determine the project's exterior noise exposure category per 2010 FGI Guidelines, Table A12-2 or the 2010 SV Guidelines, Table 13-1. For additional information on exterior noise exposure categories, see 2010 FGI Guidelines, Section A12.2-6.1.2, and 2010 SV Guidelines, Section 13.

- On a site visit, identify development patterns around the project, their approximate sound levels, and adjacency to major transportation corridors (e.g., rail, highway).

Most teams will be able to classify their sites based on observation. However, teams that wish to claim a site classification lower than the default category should analyze measured site noise levels.

STEP 8. DESIGN ENVELOPE USING STC PERFORMANCE CRITERIA
Based on the site's exterior noise exposure category identified in Step 7, determine the required STC rating for exterior building envelope assemblies according to the 2010 FGI Guidelines, Table A1.2a. To meet the STC exterior performance criteria, consider the following strategies:

- Select exterior envelope assemblies based on STC ratings provided by manufacturers.
- Noisy sites may require thicker wall materials and highly insulated fenestration.
- Wall assembly STC ratings should exceed the STC rating requirement if any low-STC rated assemblies or elements are used for fenestrations, doors, or other openings.
- Balance the use of low-STC-rated assemblies and elements with the need to provide daylighting and views to occupied perimeter spaces.

If the project is located on a B, C, or D site, provide calculations or measurements to verify that assembly STC ratings meet the applicable 2010 FGI Guidelines requirements. Sites categorized as A or Minimal have limited exterior noise and can skip this step.

For all occupied spaces, meet two of the following: HVAC background noise, Sound Transmission, and/or Reverberation Time. Meet all three for an exemplary performance point.

Confirm compliance via calculations or measurements in representative rooms, and/or design documentation from a person experienced in the field of acoustics.

systems per 2015 ASHRAE Handbook—HVAC Applications, Chapter 43, Table 1; ASHRAE Standard 62-2008, Table 15; or a local equivalent.

If confirming compliance via measurements, use a sound level meter that conforms to ANSI S1.4 or IEC 61671 or type 2 (general purpose) sound measurement instrumentation, the International Electrotechnical Commission (2013) IEC 6872-2:2013 Electroacoustics - Sound Level Meters - Part 2: Specifications, or a local equivalent.

2015 ASHRAE Handbook—HVAC Applications, Chapter 48, Table 6, or a local equivalent.

Meet the composite sound transmission class (STC) ratings or noise isolation class (NIC) listed in

Table 1. Minimum composite sound transmission class ratings or noise isolation class for adjacent

species	Adjacency combinations	STC _c ^{aa}	NIC ^{aa}
Retail	Retail	50	45
Collaborative / multi-use	Highway, stairway	25	20
Private	Highway, stairway	25	20
Confidential	Highway, stairway	40	35
Collaborative / multi-use	Collaborative / multi-use	35	30
Collaborative / multi-use	Private	45	40
Collaborative / multi-use	Confidential	50	45
Private	Private	45	40

Private	Confidential	90	45
Confidential	Confidential	90	45
Confidence room	Confidence room	90	45
Mechanical equipment room ^a	Hallway, Stairway	90	45
Mechanical equipment room ^a	Occupied area	90	50

^aMaximum STC or IAC, but to be met only to prove that the equipment noise in conjunction with the actual sound power level of the partitions and doors will not exceed the maximum background noise requirements of the adjacent space.

• If a sound masking system is implemented in a minimum noise of 40-45 dBA, the STC 100/STC90 of NC, values in Table 1 may be lowered by 5 points. This applies to all space types except mechanical equipment rooms. The sound masking system must be designed by an acoustical professional and meet the following criteria:

- The overall level for sound masking must be set by an acoustical professional and must not exceed 45 dBA in open offices, libraries, cafeterias, corridors/hallways, 45-50 dBA in enclosed offices, and 40 dBA in conference rooms and wellness rooms. The combined level of masking

➤ The sound making spectrum must conform to the National Research Council of Canada (NRC) Optimum Making Spectrum or an alternate spectrum if specified by an acoustical engineer.

Meet the regeneration line requirements in Table 2 (adapted from Table 6.1 in the Performance Measurement Protocol for Commercial Buildings).

Office building	Executive or private office	+ 1.5
	Conference room	+ 0.5

	Teleconference room	+ 0.6
	Open-plan office without sound masking	+ 0.6
	Open-plan office with sound masking	0.0
Courtyards	Unplanned speech	+ 0.3
	Planned speech	- 0.3
Performing arts space	Drama theater, concert and rock hall	Varies by application
Laboratories	Teaching or research with planned speech (e.g. lecture)	+ 1.0
	Conversative phone use and speech unaccompanied	- 0.6
Church, mosque, synagogue	General assembly with or without music programs	Varies by application

	Large-capacity space with speech amplification	< 18
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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.

Sound Transmission
Design classrooms and other core learning spaces to meet the sound transmission class (STC) requirements of ASHRAE 92.40-2010 Part 1, or a local equivalent. Exterior windows must have an STC

Option 1: Speech Privacy, Sound Isolation, and Background Noise (7 point)

Speech Privacy and Sound Isolation
Design sound isolation to achieve speech privacy, acoustical comfort, and minimal annoyance from external activities on-site. Consider sound levels at both source and receiver locations, the background

- 2018 FGI Guidelines for Design and Construction of Outpatient Facilities—Section 12-516 and Section 12-516.2

- Background Issue:**
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 criteria outlined in the following sections, as applicable:**
- 2028-FG Guidelines for Design and Construction of Hospital/Healthcare 2.9.6.1.4 (Table 2.9.3)
 - 2028-FG Guidelines for Design and Construction of Outpatient Facilities—Section 12.3.1.1 (Table 12.3.1)
 - 2028-FG Guidelines for Design and Construction of Residential Health, Care, and Support Facilities—Section 2.9.6.1.4 (Table 2.9.3)

Calculate or measure sound levels in representative rooms and spaces of each type to confirm compliance with criteria in this subchapter and other rules under chapter 103, Wis. Stats.

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

Specify materials, products systems, installation details, and other design features to meet the following:

2015 FGI Guidelines for Design and Construction of Hospitals—Section 1.2-5.1.3 (Table 1.2-4)
2015 FGI Guidelines for Design and Construction of Outpatient Facilities—Section 1.2-5.1.3 (Table 1.2-1)

Exterior Noise

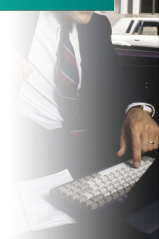
noise the effect on building occupants of site exterior noise produced by road traffic, aircraft, rail, railroad, on-site transports, emergency power generators during maintenance testing, outdoor MEP and building services equipment, etc. Also minimizes effects on the surrounding community.

mechanical equipment, 25-8233 and
building services, 822-65

- Design and analyze data to determine the exterior noise classification (A, B, C, or D) of the facility site by using the building envelope to determine the following, as applicable:
- 2008 FGI Guidelines for Design and Construction of Hospital Facilities—Table 12-1
 - 2008 FGI Guidelines for Design and Construction of Outpatient Facilities—Table 12-2
 - 2008 FGI Guidelines for Design and Construction of Residential Health Care, and Support Facilities—Table 23-3
- Exterior site exposure categories B, C, or D, calculate or measure the sound outside performance of sensitive elements of the exterior building envelope to determine the composite sound level (L₅₀) resulting from measurement of facade elements. Measurements should generally comply to ASTM E905 B, Standard Guide for Field Measurements of Airborne Sound Isolation of Facades and Façade Elements

CONNECTION TO ONGOING PERFORMANCE

LEED Q+M EQ prerequisite Indoor Environmental Quality Performance: Strategies to minimize HVAC background noise, exterior noise, reverberation time etc. in newly constructed buildings can help contribute to better indoor environmental quality and overall occupant satisfaction during operations phase.



REQUIRED DOCUMENTATION

Item Contribution, Data Center, Warehouse and Distribution Center, Hospitality	All projects
HVAC background noise	
Occupied space sound level values	X
Calculation, measurement narrative, or manufacturer data	X
Noise reduction strategy	X
STC ratings for space separation	X
Sound isolation	
Calculation, measurement narrative, or manufacturer data	X
Reverberation time criteria for each room	X
Reverberation time	
Calculation, measurement narrative, or manufacturer data	X
List of all single conference rooms and auditoriums	X
Sound reinforcement and masking system	
Explanation of sound reinforcement methodology (if installed)	X
Explanation of sound reinforcement system components and specifications (if installed)	X
Explanation of masking system components and specifications narrative (if installed)	X
Other	
Background noise	
See EQ Prerequisite Minimum Acoustic Performance	X
STC calculation or measurement method	X
Sound isolation	
List of STC ratings	X
STC rating assembly source data	X

Requirement	Option 1	Option 2
Speech privacy and sound isolation		
List of spaces, adjacency, STC ratings	X	
List of spaces, adjacency, privacy values	X	
Calculation or simulation results, or report of field measurements	X	
Room noise levels		
List of spaces, design criteria, values	X	
List of field reports and installation results, or report of field measurements	X	
Acoustical Profiles		
Documentation of wall, ceiling, and floor finishes with associated NRC values		X
Calculated average sound absorption coefficients for representative room types		X
Reference building average STC ratings		X
Site noise exposure category narrative		X
Mitigation narrative for each 2000 Hz guideline		X
Special neighborhood considerations narrative		X



REFERENCED STANDARDS

ASHRAE 2011, HVAC Applications Handbook

Chapter 48, Noise and Vibration Control: ashrae.org AHRI Standard 885-2008: ahrinet.org

ANSI S1.4, Performance Measurement Protocols for Commercial Buildings: ashrae.org



TERMS AND DEFINITIONS

Occupied space is an enclosed space intended for human activities, excluding those spaces that are intended primarily for other purposes, such as storage rooms and equipment rooms, and that are only occupied occasionally and for short periods of time. Occupied spaces are further classified as regularly occupied or non regularly occupied based on the duration of the occupancy, individual or multi occupant based on the quantity of occupants, and densely or non densely occupied spaces based on the concentration of occupants in the space.

classroom or "core learning space," a space that is regularly occupied and used for educational activities. In such a space, the primary functions are teaching and learning, and good speech communication is critical to students' academic achievement. (Adapted from ANSI S12.60)



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