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ANSI/ASA S12.60-2009/PART 2

American National Standard Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools, Part 2: Relocatable Classroom Factors

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AMERICAN NATIONAL STANDARD

Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools, Part 2: Relocatable Classroom Factors

ANSI/ASA S12.60-2009/Part 2

Accredited Standards Committee S12, Noise

Standards Secretariat
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AMERICAN NATIONAL STANDARD

Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools, Part 2: Relocatable Classroom Factors

Secretariat:

Acoustical Society of America

Approved September 2, 2009 by:

American National Standards Institute, Inc.

Abstract

This document is Part 2 of the ANSI/ASA S12.60 series. This part is applicable to relocatable classrooms and other relocatable modular core learning spaces of small to moderate size. This standard includes siting requirements, acoustical performance criteria, and design requirements for relocatable classrooms. Annex A (informative) provides commentary information on this standard, and Annex B (normative) provides procedures for determining compliance with the background sound requirements. This standard seeks to provide design flexibility without compromising the goal of obtaining adequate speech intelligibility for all students and teachers in classrooms and learning spaces within the scope of this standard.

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Foreword

[*This Foreword is for information only and is not a part of the American National Standard ANSI/ASA S12.60-2009/Part 2 American National Standard Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools, Part 2: Relocatable Classroom Factors.*]

This standard comprises a part of a group of definitions, standards, and specifications for use in noise. It was developed and approved by Accredited Standards Committee S12, Noise, under its approved operating procedures. Those procedures have been accredited by the American National Standards Institute (ANSI). The Scope of Accredited Standards Committee S12 is as follows:

> *Standards, specifications, and terminology in the field of acoustical noise pertaining to methods of measurement, evaluation, and control, including biological safety, tolerance, and comfort, and physical acoustics as related to environmental and occupational noise.*

At the time of publication of this document, the ANSI/ASA S12.60 series of standards includes the following American National Standards:

- ANSI/ASA S12.60-2002 (R 2009) *American National Standard Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools.*
- ANSI/ASA S12.60-2009/Part 2 *American National Standard Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools, Part 2: Relocatable Classroom Factors.*

However, at the time of this publication, ANSI/ASA S12.60-2002 (R 2009) is under revision and is expected to be re-designated as "Part 1." Work is also underway on a new part, ANSI/ASA S12.60/Part 3, *American National Standard Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools, Part 3: Information Technology Equipment in Classrooms.*

This standard is not comparable to any existing ISO Standard.

At the time this standard was submitted to Accredited Standards Committee S12, Noise, for approval, the membership was as follows:

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Introduction

Good acoustical qualities are essential in classrooms and other learning spaces in which speech communication is an important part of the learning process. Excessive background noise or reverberation in such spaces interferes with speech communication and thus presents an acoustical barrier to learning. With good classroom acoustics, learning is easier, deeper, more sustained, and less fatiguing. Teaching should be more effective and less stressful with good acoustical characteristics in a classroom. There can be more verbal interaction and less repetition between teacher and students when spoken words are clearly understood. Although all those in a classroom, including teachers and adult learners, will benefit, special beneficiaries are young children and persons with hearing, language, speech, attention deficit, or learning disabilities. Conformance to this standard will improve the quality of education by eliminating acoustical barriers for all students and teachers, including those with communication disabilities. Good design and attention to detail throughout the construction or renovation process can ensure conformance to the requirements of this standard.

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American National Standard

Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools, Part 2: Relocatable Classroom Factors

1 Scope and purpose

1.1 Scope

1.1.1 This part of ANSI/ASA S12.60 is applicable to relocatable classrooms and other relocatable modular core learning spaces of small to moderate size. This standard includes siting requirements, acoustical performance criteria, and design requirements for relocatable classrooms. Annex A (informative) provides commentary information on this standard, and Annex B (normative) provides procedures for determining compliance with the background sound requirements. This standard seeks to provide design flexibility without compromising the goal of obtaining adequate speech intelligibility for all students and teachers in classrooms and learning spaces within the scope of this standard.

1.1.2 Acoustical performance criteria are specified in this standard by limits on maximum one-hour A-weighted and C-weighted background noise levels and limits on maximum reverberation times.

1.1.3 The control of background noise levels in this standard is achieved, in part, by specifying the minimum outdoor-to-indoor level reduction for noise that intrudes into the classroom or learning space from sources outside of the school building envelope, and noise isolation for school building elements for noise that originates within the school building and intrudes into the classroom through classroom walls and partitions, floor-ceiling assemblies, and ventilation systems.

1.1.4 This standard does not apply to noise generated within a classroom by its occupants. Occupant-generated noise sources include voices and the sounds of classroom activities such as the moving of chairs. Furthermore, this standard does not apply to the noise from portable or permanent built-in equipment used during the course of instruction, such as audiovisual equipment and computers.

1.1.5 The following annexes are provided to support this standard.

• Annex A: Commentary: Additional information, discussion, and explanation of various provisions of the standard (informative).

• Annex B: Determining compliance with the background sound requirements (normative).

1.2 Purpose

This standard, in conjunction with the information provided in the commentary and annexes, is intended to help school planners and designers provide the acoustical qualities necessary for good speech communication between students and teachers in classrooms and other learning spaces without the use of electronic amplification systems. This standard is also intended to provide a minimum set of requirements that can be adopted by reference to this standard and enforced by an authority having jurisdiction.

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2 Normative references

The following referenced documents are indispensable for the application of this standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ANSI S1.1-1994 (R2004), American National Standard Acoustical Terminology

ANSI S1.4-1983 (R2006), American National Standard Specification for Sound Level Meters

ANSI S1.13-2005, American National Standard Measurement of Sound Pressure Levels in Air

ANSI/ASA S12.9-1992/Part 2 (R2008), American National Standard Quantities and Procedures for Description and Measurement of Environmental Sound, Part 2: Measurement of Long-term, Wide-area Sound

ANSI/ASA S12.9-1993/Part 3 (R2008), American National Standard Quantities and Procedures for Description and Measurement of Environmental Sound, Part 3: Short-term Measurements with an Observer Present

ASTM E90-09, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements

ASTM E336-08, Standard Test Method for Measurement of Airborne Sound Attenuation between Rooms in Buildings

ASTM E966-04, Standard Guide for Field Measurements of Airborne Sound Insulation of Building Façades and Façade Elements

ASTM E1007-04e1, Standard Test Method for Field Measurement of Tapping Machine Impact Sound Transmission Through Floor-Ceiling Assemblies and Associated Support Structures

ASTM E1332-90(2003), Standard Classification for Determination of Outdoor-Indoor Transmission Class

IEC 61672-1:2002, Electroacoustics — Sound level meters — Part 1: Specifications

3 Definitions

For the purposes of this standard, the terms and definitions given in ANSI S1.1 and the following apply. The definitions of acoustical terms given here are consistent with those given in ANSI S1.1 but may be simplified for the purposes of this document.

3.1 General terms

3.1.1 classrooms and other learning spaces. Locations within buildings where students assemble for educational purposes.

3.1.1.1 core learning spaces. Spaces for educational activities where the primary functions are teaching and learning and where good speech communication is critical to a student's academic achievement. These spaces include, but are not limited to, classrooms (enclosed or open plan),

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instructional pods or activity areas, group instruction rooms, libraries, and offices used for educational purposes.

3.1.1.2 ancillary learning spaces. Spaces where good communication is important to a student's educational progress but for which the primary educational functions are informal learning, social interaction, or similar activity other than formal instruction. These areas include, but are not limited to, corridors, cafeterias, gymnasia, and indoor swimming pools.

3.1.1.3 relocatable classroom. Educational classroom structure that utilizes factory-built modular construction methods that can be efficiently, repeatedly transported over public roads without the removal of the floor, roof, or other significant structural modification, and that typically consists of one or two modules (units, boxes, floors), but can consist of multiple units. Frequently called portable classrooms, temporary classrooms, mobile classrooms, or learning cottages.

3.1.1.4 special-purpose classrooms. Teaching areas designed for specific activities where the finishes and building systems including lighting and HVAC systems are specifically designed to support the unique activities occurring in the spaces they serve. Examples could include art studios, kitchens, chemistry labs, metal shops, wood shops, and classrooms used primarily for instruction of children with special hearing problems or other learning disabilities.

3.1.2 acoustical privacy. Pertains to the acoustical attenuation between spaces that is needed to prevent conversation in one space from being understood in an adjacent space.

3.2 Terms relating to acoustical performance and design

3.2.1 noise level or sound level. Generic terms employed interchangeably throughout this standard to represent the frequency-weighted sound pressure level of an airborne sound. This descriptor is used to express the magnitude of a sound in a manner related to how the ear perceives this magnitude. Noise level or sound level is expressed in decibels, unit symbol dB.

3.2.1.1 A-weighted sound level. Sound pressure level measured with a conventional frequency weighting that roughly approximates how the human ear hears different frequency components of sounds at typical listening levels for speech. The A-weighting (see ANSI S1.4 or IEC 61672-1) attenuates the low-frequency (or low-pitch) content of a sound. A-weighted sound level is expressed in decibels, unit symbol dB.

3.2.1.2 C-weighted sound level. Sound pressure level measured with a conventional frequency weighting (see ANSI S1.4 or IEC 61672-1) that does not significantly attenuate the low-frequency (or low-pitch) content of a sound. C-weighted sound level is expressed in decibels, unit symbol dB.

3.2.1.3 one-hour average A-weighted or C-weighted sound level. Level of the time-mean-square A-weighted or C-weighted sound pressure energy averaged over a one-hour period. One-hour average sound level is expressed in decibels, unit symbol dB.

3.2.2 background noise level. Sound in a furnished, unoccupied learning space, including sounds from outdoors, building services, and utilities. For the purposes of this standard, this excludes sound generated by people within the building or sound generated by temporary or permanent instructional equipment.

3.2.2.1 interior-source background noise. Noise from building services and utilities.

3.2.2.2 exterior-source background noise. Noise from transportation sources, such as aircraft, vehicle traffic, or from other outdoor noise sources (e.g., industrial sources).

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3.2.3 reverberation. An acoustical phenomenon that occurs in an enclosed space, such as a classroom, when sound persists in that space as a result of repeated reflection or scattering from surfaces enclosing the space or objects in the space, such as chairs or cabinets.

3.2.3.1 reverberation time. A measure of the amount of reverberation in a space and equal to the time required for the level of a steady sound to decay by 60 dB after it has been turned off. Reverberation time is expressed in seconds, unit symbol s.

NOTE For measurement of reverberation time see ASTM E2235.

3.2.4 sound absorption and reflection. Acoustical phenomena that occur whenever sound strikes a surface. For purposes of the calculation or measurement of reverberation time, absorbed sound is the portion of the sound energy striking the surface that is not returned as sound energy. Reflected sound is the remaining portion that bounces off the surface.

3.2.4.1 sound absorption coefficient. A measure of the ability of a material to absorb sound and equal to the ratio of the intensity of the absorbed sound to the intensity of the incident sound.

3.2.5 attenuation of airborne sound. A measure of the decrease in sound level when sound passes through structures between spaces within a building, or from outside to inside.

3.2.5.1 sound transmission class (STC). A one-number rating of the sound blocking ability of a partition, door, window, etc., calculated in accordance with ASTM E413 from one-third-octave band measurements made in a laboratory in accordance with ASTM E90.

3.2.5.2 noise isolation class (NIC). A one-number rating of the attenuation of airborne sound between enclosed spaces calculated in accordance with ASTM E413 from one-third octave band measurements made in accordance with ASTM E336.

3.2.5.3 outdoor-indoor level reduction (OILR). A measure of the decrease in sound level (attenuation) in one-third octave bands when airborne sound passes from outdoors to indoors.

3.2.5.4 outdoor-indoor noise isolation class (OINIC). A one-number rating of the decrease in sound level (attenuation) when airborne sound passes from outdoors to indoors calculated in accordance with ASTM E1332 using values of outdoor-indoor level reduction instead of transmission loss.

3.2.6 structure-borne impact sound. The acoustical phenomenon of sound transmission due to impacts or other interaction of objects with a structure, the most common being footsteps on a floor.

3.2.6.1 impact insulation class (IIC). Single number rating of structureborne noise radiated below by a floor or floor-ceiling assembly when tested in a laboratory in accordance with ASTM E492 and calculated in accordance with ASTM E989; abbreviation IIC.

NOTE 1 The rating is derived from the sound levels measured in the receiving room when a standard tapping machine is operating on the floor assembly above, adjusted to what they would be for a specific amount of absorption in the receiving space below

NOTE 2 The higher the FIIC rating, the lower the impact sound levels.

3.2.6.2 field impact insulation class (FIIC). Single number rating of the structureborne noise radiated below by a floor or floor-ceiling assembly when tested in the field in accordance with ASTM E1007 and calculated in accordance with ASTM E989; abbreviation FIIC.

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NOTE 1 The rating is derived from the sound levels measured in the receiving room when a standard tapping machine is operating on the floor assembly above, adjusted to what they would be for a specific amount of absorption in the receiving space below.

NOTE 2 The higher the FIIC rating, the lower the impact sound levels.

NOTE 3 FIIC is also known as apparent impact insulation class, AIIC.

3.3 major renovation. Any reconstruction, rehabilitation, addition, or capital improvement of a structure, the cost of which equals or exceeds fifty percent of the market value of the structure itself before the start of construction of the improvement.

4 Applications

4.1 This standard applies to relocatable classrooms and other relocatable modular core learning spaces of small to moderate size with volumes not exceeding 566 m^3 (20 000 ft^3) and to relocatable ancillary learning spaces of any volume. Learning spaces larger than the above volume limit shall be considered ancillary spaces for purposes of this standard. The standard does not apply to special-purpose classrooms such as music rooms, teleconferencing rooms, special-education rooms such as those for severely acoustically challenged students, or other spaces such as large auditoria that have unique or more stringent acoustical requirements.

4.2 The acoustical performance criteria and design requirements of this standard apply during the design and construction of all new relocatable classrooms or learning spaces of small to moderate size as specified in 4.1.

4.3 The acoustical performance criteria and design requirements of this standard apply during major renovation as defined in 3.3 of all relocatable classrooms or learning spaces of small to moderate size as specified in 4.1.

4.4 Relocation of a classroom shall not constitute new construction or major renovation. However, a relocated classroom shall continue to meet all the requirements of Clause 5 that were applicable to it before the relocation.

4.5 No renovations shall be allowed that diminish the acoustical performance of existing relocatable classrooms.

4.6 Sound reinforcement systems shall not be used as a substitute for meeting acoustical design requirements.

5 Acoustical performance criteria and noise isolation design requirements and guidelines

5.1 Introduction

Acoustical performance criteria and design requirements are contained in the following sub-clauses and are designed to ensure an appropriate acoustical learning environment. The performance criteria shall apply to relocatable classrooms and other relocatable modular core learning spaces and to ancillary learning spaces. For purposes of this standard it shall be assumed that the learning spaces are furnished consistent with their use and the building is unoccupied with doors and windows closed.

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Acoustical design requirements for minimum noise isolation apply only to fully enclosed classrooms and learning spaces.

5.2 Performance criteria for background noise

5.2.1 Exterior-source background noise

5.2.1.1 The one-hour average A-weighted exterior-source background noise level within the enclosed space for the noisiest continuous one-hour period during times when learning activities take place shall not exceed the limits specified in Table 1. The limits for the exterior-source background noise shall apply for the following conditions:

1) for the noisiest continuous one-hour period during times when learning activities take place;

2) portable and permanent (built-in) instructional equipment, such as computers and audiovisual equipment, are turned off.

Table 1 — A-weighted sound levels of background noise and reverberation times in unoccupied, furnished learning spaces

Learning space [a]	One-hour average A-weighted sound level of interior-source background noise[b] (dB)	One-hour average A-weighted sound level of exterior-source background noise (dB)	Maximum reverberation time for sound pressure levels in octave bands with midband frequencies of 500, 1000, and 2000 Hz (s)
Core learning space with enclosed volume ≤ 283 m^3 (≤ 10 000 ft^3)	41 dBA upon adoption; 38 dBA in 2013; 35 dBA in 2017	35	0.5
Core learning space with enclosed volume > 283 m^3 and ≤ 566 m^3 (> 10 000 ft^3 and ≤ 20 000 ft^3)	41 dBA upon adoption; 38 dBA in 2013; 35 dBA in 2017	35	0.6
All ancillary learning spaces	40 [c]	40 [c]	No requirement

a) See 3.1.1.1 and 3.1.1.2 for definitions of core and ancillary learning spaces.

b) See 5.2.2.2 -5.2.2.4 for other limits on interior-source background noise.

c) See 5.2.3 for limits in corridors adjacent to classrooms.

5.2.1.2 When transportation or military sources are the dominant noise source(s), the one-hour average A-weighted sound level shall, where practical, be predicted using the methods and computer programs developed by the U.S. Department of Transportation or U.S. Department of Defense. These include Integrated Noise Model (INM) and Noisemap for aircraft noise, Traffic Noise Model (TNM) for road noise, and the Federal Transit Administration procedures for rail noise. These calculated levels shall be used in lieu of measured values to determine the exterior noise level.

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5.2.1.3 The one-hour average A-weighted sound level for exterior source background noise, if measured, shall be measured in accordance with the procedures of Annex B based on guidance in ANSI/ASA S12.9 Part 2 or ANSI/ASA S12.9 Part 3 as applicable.

5.2.2 Interior-source background noise

5.2.2.1 Limits on interior-source A-weighted background noise levels from building services and utilities and calculation of HVAC noise

The one-hour average A-weighted level of interior-source background noise shall not exceed the limits specified in Table 1 when calculated as follows. The one-hour average A-weighted sound level for the HVAC shall be calculated using the duty cycles in Table 2 for 1-, 2-, and 3-stage HVAC systems. The noise level of the different stages, if measured, shall be measured in accordance with the procedures of Annex B. The one-hour average A-weighted sound level of any other building system noises (e.g., lighting) shall be added on an energy basis to the calculated one-hour average A-weighted sound level of the HVAC noise. Specifically, these “Integration Factors” shall be applied as indicated by the following example.

For a Type 3 unit, if the sound levels for the Maximum Capacity Heating, Low Capacity Heating, and Ventilation modes are 40, 35, and 32 dB, respectively, the energy average sound level for one-hour operation at the respective relative times of 17%, 25%, and 58%, will be:

$$10 \times \text{Log}_{10}[0.17\times10^{(40/10)} + 0.25\times10^{(35/10)} + 0.58\times10^{(32/10)}] = 35.3 \text{ dB.}$$

Table 2 — HVAC system duty cycles

	HVAC system operational modes integration factors[a), b)]		
	Single mode Type 1	**Dual mode Type 2**	**Triple mode Type 3**
Max. capacity heating or cooling	100%	34%	17%
Low capacity [c)] heating or cooling	Not applicable	Not applicable	25%
Ventilation [d)]	Not applicable	66%	58%

Type 1 - represents systems that have a single stage and operational mode of performance.

Type 2 - represents systems that have a single stage of cooling or heating and a ventilation-only mode.

Type 3 - represents systems that have two stages of cooling or heating with an additional ventilation-only mode.

a) See clause 5.2.2.1 for a worked example.

b) These duty cycles are based on testing done over a one-year period with classrooms sited in Modesto and Fontana, California. The buildings sited in Modesto were selected because of their cold winters and hot summers, and the Fontana units were selected because of their high cooling demand and long cooling season. Both of these are inland locations and, thus, they represent a more challenging HVAC environment than do temperate coastal areas. This study was conducted by Lawrence Berkeley National Laboratory with support from the DOE and the California Energy Commission.

c) Low capacity shall be no lower than 60% of maximum capacity for the given time weight values to apply. If other values are used for low capacity they shall be accompanied by appropriate time weighting and sufficient information to substantiate the values chosen.

d) Ventilation shall be at least at the rate required by applicable code.

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5.2.2.2 Limits on interior-source C-weighted background noise levels from building services and utilities

The maximum one-hour average C-weighted steady background noise levels from the combination of HVAC systems, lighting, and other building services and utilities operating simultaneously shall not exceed the limits on A-weighted interior-source background noise levels in Table 1 by more than 20 dB.

5.2.2.3 Limits on disturbing sounds from building services and utilities

Disturbing sounds, such as rumble, or the tones from hums, buzzes, whines, or whistles generated by HVAC systems and other building services and utilities shall be controlled so as to not interfere with speech communication or be distracting or annoying to the occupants of the learning spaces. Rumble can be quantified using the methods in ANSI/ASA S12.2 and there shall be no "clearly perceptible vibration and rattles" as required in Clause 6 of ANSI/ASA S12.2. Also, the prominence of any tones shall be quantified using the methods in ANSI S1.13 and there shall be no "prominent discrete tones" as defined in ANSI S1.13.

5.2.2.4 Limits on time-varying noise levels from building services and utilities

The A-frequency-weighted and SLOW time-weighted noise level at any usable location in a room from HVAC systems and other building services shall not vary by more than 3 dB during any 5 s period, except during transition between operating modes of the HVAC system.

5.2.3 Background noise in corridors

When corridors adjacent to classrooms are used solely for conveyance of occupants within the school building and structured learning activities do not occur there, the one-hour A-weighted steady background noise level for such corridors shall not exceed 45 dB.

5.2.4 Computers and audio-visual equipment

The limits on background noise do not apply to portable or permanent (built-in) instructional equipment such as computers and audiovisual equipment. Calculations of background noise shall not include such equipment and all measurements shall be made with such equipment turned off.

5.3 Performance criteria for reverberation times

The reverberation times shall not exceed the limits specified in Table 1.

5.4 Noise isolation design requirements

5.4.1 Outdoor to indoor attenuation of airborne sound

5.4.1.1 The exterior-source background noise is a function of two independent factors: (1) the exterior noise environment, and (2) the reduction of the exterior noise from outdoors to indoors by the building shell. It shall be the responsibility of the user, e.g., the school board, to determine and specify the site exterior noise environment, L_{site}, which is the one-hour average A-weighted sound level for the noisiest hour on the average (school) day during school hours. To this end, the user shall conduct a site assessment to determine the maximum outdoor one-hour average A-weighted sound level at the proposed location of the relocatable classroom. It shall be the responsibility of the user to specify, and

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the supplier to provide, a modular classroom with an Outdoor-Indoor Noise Isolation Class (OINIC) greater than:

$$\mathrm{OINIC}_{min} = L_{site} - 35.$$

5.4.1.2 All newly constructed relocatable classrooms shall be designed to meet a minimum OINIC of 20 dB. For an OINIC of 20 dB, selected sites shall not exceed a one-hour average A-weighted sound level of 55 dB for the noisiest hour during the time of day that school is normally in session. For sites with a one-hour average A-weighted sound level exceeding 55 dB, schools shall follow the requirements in Table 3.

Table 3 — OINIC rating for relocatable classroom

A-weighted outdoor noise level	OINIC rating for relocatable classroom
≤ 55	20 dB
>55 dB and ≤ 60 dB	25 dB
>60 dB and ≤ 65 dB	30 dB

5.4.1.3 Sites with an outdoor one-hour average A-weighted sound level that exceeds 65 dB shall be acceptable only if the requisite sound reduction can be achieved.

5.4.1.4 Verification measurements, if required, shall be performed in accordance with Annex B.

5.4.2 Indoor to indoor attenuation of airborne sound

5.4.2.1 Wall and floor-ceiling assemblies that separate enclosed or open-plan core learning spaces from adjacent spaces shall be designed to achieve the minimum STC ratings specified in Table 4 when tested in accordance with ASTM E90 in a laboratory. The STC rating requirements of Table 4 also shall apply to the design of temporary partitions that subdivide a learning space.

5.4.2.2 All penetrations in sound-rated partitions shall be sealed and treated to maintain the required ratings. Attention shall be given to flanking paths that would reduce the isolation between spaces so as to achieve an overall isolation between two core learning spaces of at least NIC 45 if tested.

Table 4 — Minimum STC ratings required for single or composite interior wall and floor-ceiling assemblies that separate an enclosed core learning space from an adjacent space

Adjacent space			
Other core learning space, speech clinic, health care room	Common use and public use toilet room and bathing room[a)]	Corridor, staircase, office or conference room[b)]	Music room
50	53	45[c)]	60

a) This requirement does not apply to a toilet that opens only to a single core learning space.

b) For corridor, staircase, office or conference room walls containing doors, the basic wall exclusive of the door shall meet the STC rating shown. The door shall meet the requirements of 5.4.2.4.

c) STC 50 for critical privacy conditions.

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5.4.2.3 Except for walls containing doors between the core learning spaces and corridors, staircases, offices, or conference rooms, when a partition contains a door or window or is not of consistent construction throughout, the required minimum STC ratings in Table 4 apply to the overall composite partition. Basic wall assemblies which contain doors or interior windows with STC ratings less than those given in Table 4 shall have higher STC ratings sufficient to conform to the required minimum STC ratings of the composite construction. For walls containing doors to corridors or staircases, or to offices, conference rooms or toilets that open only to the one core learning space, the minimum STC ratings of Table 4 apply to the wall exclusive of the door. See B.3.1.3 for the method to calculate the composite STC.

5.4.2.4 Interior doors into core learning spaces from corridors, stairways, offices, or conference rooms shall be capable of achieving STC 30 or higher in their operable condition. The STC rating for interior entry doors into music rooms from corridors or staircase areas shall be 40 or higher.

5.4.2. It shall be the responsibility of the user, e.g., the school board, to determine if and when the need for acoustical privacy around an office or conference room is critical. If so, then the minimum STC rating of the partitions around these specifically designated spaces shall be 50 or higher.

5.4.3 Structureborne impact sound isolation

The floor-ceiling assemblies of normally occupied rooms located above learning spaces shall be designed for an expected laboratory test rating of at least IIC 50 if above core learning spaces and IIC 45 if above ancillary learning spaces.

5.5 Compliance testing

This standard does not require compliance testing to demonstrate conformance. When optional tests are performed to verify conformance with the requirements of this standard, the procedures in Annex B shall be followed.

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Annex A

(Informative)

Commentary

Commentary-1.1.2 An objective of these performance criteria is to achieve a level of speech that is sufficiently high relative to the background noise level for listeners throughout the classroom or learning space. However, a requirement for the relative difference between speech levels and levels of background noise, usually referred to as the signal-to-noise ratio, is not within the scope of this standard.

Commentary-1.1.4 The background noise generated by occupants and instructional equipment can seriously degrade communication or speech intelligibility in learning spaces. This background noise should be evaluated in terms of the one-hour average A-weighted sound level.

Commentary-3.2.3.1 reverberation time. The decay rate depends on the amount of sound absorption in a room, the room geometry, and the frequency of the sound. In practice, the reverberation time is often measured by measuring a 20 or 30 dB decay and extrapolating that to the time required for a 60 dB decay.

Commentary-3.2.4 sound absorption and reflection. The magnitude of the reflected sound in a room is determined by the amount of sound absorption at the surfaces, the room geometry, and the frequency of the sound. As distance from a sound source in a classroom increases, the sound is increasingly dominated by reflected sound.

Commentary-3.2.4.1 sound absorption coefficient. The sound absorption coefficient of a material normally varies with frequency. It ranges from about 0.2 to about 1.0 for sound-absorbing materials, to less than 0.05 for a smooth, painted concrete floor. Sound absorption coefficients measured in a laboratory (that is, in a reverberation room) can be larger than 1.0 because of test method and sample size effects.

Commentary-3.2.5 attenuation of airborne sound. The attenuation of airborne sound depends on the sound reduction through these elements, on their size, on sound leakage around their periphery, on the sound absorption in the receiving space, and on the frequency of the sound.

Commentary-4.1 Conformance to the requirements of this standard should be considered to be a minimum goal for the acoustical qualities of such spaces, excluding auditoria. The standard does not provide recommendations for electronic aids for persons with hearing impairment.

Commentary-Table 1 — Maximum A-weighted steady background noise levels and maximum reverberation times in unoccupied, furnished learning spaces. Regarding note c), the use of corridors for formal learning purposes should be avoided. Regarding reverberation in core learning spaces with enclosed volumes >566 m^3 (>20 000 ft^3) and all ancillary learning spaces, this standard does not specify a mandatory reverberation time for these spaces; however, spaces larger than 566 m^3 are not likely when using relocatable/modular construction.

Commentary-5.2.4 Background noise from instructional equipment. Control of such noise, especially from permanent built-in instructional equipment, should be carefully addressed in the planning stages for new and renovated schools.

Commentary-Table 2 Other situations may be substantially different in terms of percentages, but the decibel change is usually modest if the HVAC is one that was designed for that climate zone. For

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example, in the clause 5.2.2.1 example, if the percent time of Max Fan and Low Fan were each to increase by about 50% (with a corresponding decrease in ventilation) to the percentages for Max Fan, Low Fan, and Ventilate of 25%, 40%, 35%, respectively, then the computed level goes up by just over 1 dB.

Commentary-5.4 Noise isolation design requirements. The first and most cost-effective step in achieving good noise isolation between learning spaces and other spaces in a school is accomplished in the facility planning stage. This includes optimizing the location of noisy spaces and activities to protect sensitive learning spaces. Where this is not possible, adequate noise isolation is needed.

Need for noise isolation. The acoustical performance criteria for background noise levels in 5.2 apply to unoccupied facilities. However, in occupied facilities, activity noises generated in one space can be transmitted through walls, floors, ceilings, and doors to adjacent learning spaces, thus contributing to the overall background noise level in those spaces. Adequate sound isolation is required to limit noise transmission between core learning spaces and adjacent spaces in occupied facilities. The minimum STC ratings of Table 4 are intended to provide this noise isolation for normal activities in adjoining spaces. Certain educational styles (such as open plan and group learning) intentionally avoid the use of full enclosures between learning groups. Sometimes, partial height sound barriers or no barriers at all separate adjacent learning groups. Adequate noise isolation between adjacent learning groups cannot be assured unless each learning group is fully enclosed by ceiling-height sound barriers. Because of the inherent low noise isolation, partially enclosed or unenclosed learning spaces are not recommended when good speech communication is desired. In occupied multistory educational facilities, the transmission of impact noise through the floor of the room above to the learning space below also contributes to the overall background noise level. To limit impact noise disturbances in learning spaces, this standard also provides minimum impact insulation class (IIC) design requirements for the floor-ceiling assemblies above learning spaces for multi-story educational facilities.

Caution on variability of sound isolation test results. The same wall or floor-ceiling assembly design when tested in a laboratory can achieve results over a significantly wide range. With enough tests a typical expected result can be established. A single test result can be unrepresentative. Likewise, there is a variation when tests are conducted in the field. The apparent performance of the partition in the field when rated by the apparent STC or FIIC is virtually always less than the laboratory result due to flanking around the partition and possibly lesser quality construction. Flanking between adjacent classrooms in modular construction can be severe if details are not appropriately controlled. Specifically, the gypsum in side walls should not be continuous from one classroom to another. Floor flanking also can be a problem. On the other hand, the perceived overall isolation for airborne sound can be enhanced by strong absorption in the receiving room in comparison with the size of the partition. While this is factored into the NIC if measurements are done, the required STC values should not be reduced in anticipation of such absorption benefit still achieving the required NIC in a field test. Note that while a similar absorptive benefit can reduce the sound heard from impacts above, no credit for it is given in the required FIIC result if measurements are made.

Ancillary learning spaces. Recommendations are given in Table A.1 for STC ratings for partitions (that is, walls and floor-ceiling assemblies) that enclose an ancillary learning space or that separate two ancillary spaces. When the partition includes two or more elements, such as doors, windows, or penetrations of the partition for HVAC ducts or other services, the STC of this composite construction also should conform to the recommendations of Table A.1.

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Commentary-Table A.1 — Minimum STC ratings recommended for single or composite wall, floor-ceiling and roof-ceiling assemblies separating an ancillary space from an adjacent space.

Receiving ancillary learning space	Adjacent space			
	Corridor or staircase[a)], common use, and public use toilet and bathing room[b)]	Music room	Office or conference room[a)]	Mechanical equipment room[f)], cafeteria, gymnasium or indoor swimming pool
Corridor	45	60[c)]	45[d)]	55[c)]
Music room	45	60	60[e)]	60
Office or conference room	45	60	45[d)]	60

a) For corridor, staircase, office or conference room walls containing entrance doors to the ancillary learning space, the STC rating of the basic wall, exclusive of the door, should be 45. The entrance door should conform to the requirements of 5.4.2.4.

b) The STC rating for an ancillary space/toilet partition does not apply when the toilet is private and connected to a private office. An STC rating higher than 45 may be required for separating a quiet office or conference room from a common use or public use toilet or bathing room.

c) When the corridor will not be used as an ancillary learning space, the minimum STC rating may be reduced to not less than 45. Use of corridors as ancillary learning spaces should be avoided when they are located next to the noisy spaces indicated in the table by the high STC ratings.

d) When the need for acoustical privacy is critical, the STC rating should be increased to 50.

e) This is justified to prevent the music space from interfering with the office or conference room.

f) When the adjacent space is a mechanical equipment room containing fans circulating 140 m^3/min (5000 ft^3/min) or more, the minimum STC rating should be 60. When the fan circulation is less than this rate, the STC rating may be as low as 40 providing the maximum A-weighted steady background noise level in the adjacent ancillary learning space does not exceed 40 dB. The minimum STC rating includes the effect of any entry door(s) into the mechanical equipment room.

Commentary-5.4.2.3 Core learning spaces. Composite assemblies are walls, floor-ceiling and roof-ceiling constructions composed of more than one element (for example, a wall with a door, window, or penetrations by HVAC ducts or other services). This standard requires that walls between core learning spaces meet the composite STC requirement, which means that any door in such a wall will need to be acoustically rated. See 5.4.2.4 for special requirements for doors in corridor, office or conference room walls that are not required to meet the STC requirements for composite walls including the doors. Walls and floor-ceiling assemblies may not maintain their design STC rating if penetrations or openings for piping; electrical devices; recessed cabinets; soffits; or heating, ventilating or exhaust ducts are unsealed.

Commentary-5.4.2.4 Entry doors into classrooms and other core learning spaces. The intent of the STC 30 requirement is to require solid core wood doors or heavy-duty steel doors with good seals. The location of classroom entry doors across a corridor should be staggered to minimize noise transmission between these classrooms. Provisions should be made to ensure that the perimeter seals of sound rated doors are well maintained. Seals for entrance doors should be inspected and adjusted, as necessary, every six months. The gaskets of door seals should never be painted.

Commentary-5.4.3 Structureborne impact sound isolation. There is no way to mathematically predict what an IIC rating will be. Structures have to be tested. Very little if any test data is available

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for classroom-type structures. Almost all test data is for residential structures with gypsum ceilings. Achieving this rating with frame-type construction usually requires an isolated gypsum ceiling and a cushioning agent under a hard surface floor or the use of carpet. ANSI/ASA S12.60 currently requires the IIC requirements be met without carpet even if carpet is to be used.

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Annex B

(Normative)

Verifying Compliance with the Background Sound Level Requirements by Measurement

B.1 Verifying compliance with the interior source background noise requirement

B.1.1 Interior source background noise measurements shall be taken during time periods when the outdoor sound contribution to the indoor sound is minimal. Both background measurements and HVAC measurements shall be taken under nominally the same outdoor environment.

B.1.2 Identify the listening area within the classroom where direct teacher and student speech communication generally takes place. With the HVAC and other noise sources operating in their respective noisiest operational mode, perform a quick acoustical survey of the classroom within that listening area. This shall be done at the potentially noisiest locations within the room, including at the HVAC inlet or outlet air ducts, in the vicinity of the HVAC equipment, or at any other location that the observer feels could be a significant source of interior-generated noise. Identify the noisiest location within the listening area using a sound level meter that conforms to the requirements for Type 1 in ANSI S1.4 or Class 1 in IEC 61672. The location with the highest A-weighted sound level shall be termed the “key” location.

B.1.3 Measurements, including the above screening for the "key" location, shall be taken at any time such that outdoor noise contributes less than 0.5 dB to the measurement of the interior source background noise. The microphone shall be located at a height of 1.0 to 1.2 m (40 to 48 in.) above the floor; no closer than 1 m (40 in.) from a wall or fixed object such as HVAC plenum or bookshelves; and no closer than 0.5 m (20 in.) from a readily movable object such as a desk, chair, or table.

B.1.4 At the key location, first measure the sound with the HVAC equipment turned off. Then take five consecutive A- and C-weighted 60-second time-average sound level measurements with the HVAC operating. If the measured A- and C-weighted levels with HVAC equipment operating are at least 6 dB higher than the background A- and C-weighted levels, respectively, then the HVAC noise shall be considered to be the primary source of interior noise. If the HVAC sound is the primary source of interior generated noise, then measurements shall be repeated in each operational mode of the HVAC equipment as described in Table 2; otherwise, the method of clause B.1.8.2 shall be used.

B.1.5 For heat pump systems, the sound testing shall be performed in the cooling mode if the outdoor ambient temperature is 10 °C (50 °F) or above and in the heating mode if the outdoor ambient temperature is below 10 °C (50 °F). For fuel furnaces and compressor cooling systems, the sound testing shall be performed in the cooling mode.

B.1.6 The average of five consecutive 60-second measurements in each mode of operation shall be recorded. For each mode, it shall be determined if the background sound data are steady. The criterion for steady background sound data shall be that the difference between the highest and lowest data points of the five 60-second samples is not more that 3 dB.

B.1.7 These data, if steady, then shall be used to calculate an integrated single value sound level using the percent factors from Table 2.

B.1.8 If the background noise level is unsteady, then the source of the unsteadiness shall be determined—exterior or interior.

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B.1.8.1 If the source is exterior, then the interior-source background noise measurements shall be repeated at a time when the exterior noise is less. If no such time can be found, then it is likely that the outdoor sound is too great and it shall be measured.

B.1.8.2 If the source is interior, then one-hour average A-weighted sound level measurements shall be taken and reported. These measurements shall be used in lieu of the five 60-second averages to determine the interior-source background noise level for the room at the key location.

B.1.9 Measured results within 2 dB of the background noise criterion shall be reported as passing the test for meeting the background noise criterion.

B.2 Verifying compliance with the exterior source background noise requirement

B.2.1 Verifying compliance with the outdoor-to-indoor noise level reduction requirement

B.2.1.1 The OINIC shall be computed using the following 2-step process.

B.2.1.1.1 The OILR shall be measured in one-third octave bands from 80 to 4000 Hz following the guidance in ASTM E966.

B.2.1.1.2 The OINIC shall be calculated using the OILR data in accordance with the procedure described in ASTM E1332 using the values of OILR instead of transmission loss.

B.2.1.2 *In situ*, the source and geometry are defined. In this case, if present with sufficient intensity, the actual major outdoor noise source (e.g., aircraft, road or rail traffic, industrial noise) shall be used for the OILR measurements at a specific application site; otherwise, an artificial noise source(s) shall be used. The space shall be evaluated with the surfaces exposed that would be exposed to the exterior sound in the application. Results within 2 dB of the stipulated OINIC rating shall be reported as verifying the stipulated OINIC rating.

B.2.1.3 At a factory when a classroom is being rated for general use, the source and exposure situation are not well defined. The classroom shall be rated based on the greatest exposure likely to occur. A modular classroom shall be assumed to have one, two, or three exposed surfaces (wall or roof section that can be the whole roof) as given in the following three cases:

B.2.1.3.1 Case 1 – Three exposed surfaces. This case shall include two adjacent, (normally) perpendicular walls and the roof section adjacent to the two walls. This case occurs any time two or more adjacent walls of a classroom face the outdoors and the classroom is part of a single-story unit or on the top floor of a multi-story unit. Examples include a single, stand-alone classroom, a 2-classroom unit, or any corner unit that is either single story or occupies the top story.

B.2.1.3.2 Case 2 – Two exposed surfaces. This case shall include either two adjacent walls or one wall with its adjacent roof section. The one wall with its adjacent roof section situation occurs for classrooms that adjoin three other interior spaces and that are part of a single-story facility or occupy part of the top floor of a multi-story facility. The two-wall situation occurs for any corner unit in a multi-story facility that occupies any floor other than the top floor.

B.2.1.3.3 Case 3 – One exposed surface. This case shall include one wall. It occurs for classrooms in a multi-story unit that horizontally adjoin three other interior spaces and that occupy any floor other than the top floor.

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B.2.1.4 ASTM E966 describes methods to measure the OILR for single, **individual** partitions such as a wall alone or roof alone rather than a complete room with multiple surfaces exposed to the sound. When sound can enter the enclosed space through multiple surfaces, the sound through the various surfaces combines, and as a result the overall OILR and OINIC for the space will be less than (poorer than) that of the exposed surface that produces the lowest (poorest) OINIC.

B.2.1.4.1 If *N* multiple surfaces are sequentially exposed to sound and the OINIC determined for each without significant exposure of other surfaces, the overall OINIC for the room with all such surfaces exposed shall be computed from:

$$\mathrm{OINIC}_{\mathrm{Room}} = -10 \log \left(10^{-(\mathrm{OINIC}_1/10)} + 10^{-(\mathrm{OINIC}_2/10)} + \ldots + 10^{-(\mathrm{OINIC}_N/10)}\right) \qquad \text{(B.1)}$$

where *N* is the number of surfaces exposed.

B.2.1.4.2 If the OINIC is evaluated for one surface of a space exposed and it is assumed that additional surfaces that would be exposed have the same ability to block sound, then the OINIC shall be estimated by:

$$\mathrm{OINIC} = \mathrm{OINIC}_{\mathrm{meas}} - 10 \log \left(A / A_{\mathrm{meas}}\right) \qquad \text{(B.2)}$$

where $\mathrm{OINIC}_{\mathrm{meas}}$ is the OINIC for the surface that is evaluated, A_{meas} is the area of that surface, and A is the full area that would be exposed in the typical situation.

B.2.2 Determining or verifying the user-stipulated exterior-source, outdoor, free-field, loudest-hour environmental noise levels

B.2.2.1 The one-hour average A-weighted sound levels shall be measured in accordance with ANSI/ASA S12.9 Part 2 and ANSI/ASA S12.9 Part 3, as applicable, and in accordance with ANSI S1.13. Extraordinary sounds such as a vehicle crash, a loud plane where normally there are none, or siren where normally there are none, shall be excluded from the reported hourly environmental noise level.

B.2.2.2 Results within 2 dB of a previously estimated and stipulated one-hour average A-weighted sound level shall be considered as verifying the estimated and stipulated result.

B.3 Verifying inside-to-inside sound isolation

B.3.1 Verifying inside-to-inside airborne sound isolation

B.3.1.1 The noise isolation class (NIC) between rooms shall be measured in accordance with ASTM E336.

B.3.1.2 Where a requirement exists for a composite partition including floor-ceilings to meet a specified STC, an NIC within 5 points of the specified STC shall be considered as verifying the specified performance.

B.3.1.3 In some cases walls containing doors, such as corridor walls, are exempt from the composite STC requirement. However, a minimum expected STC of the composite wall can be calculated based on the areas of the door and wall and the minimum required STC of each. The approximate expected composite STC of the wall with the door can be estimated from:

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$$\text{Composite STC} = 10 \log (A_w + A_d) - 10 \log \{ A_w \times 10^{(-STC_w/10)} + A_d \times 10^{(-STC_d/10)} \} \qquad \text{(B.3)}$$

where

A_w is the area of the wall exclusive of the door;

A_d is the area of the door;

STC_w is the STC of the wall exclusive of the door;

STC_d is the STC of the door and its seals.

This result can then be compared to a measured NIC for evaluation. For a more accurate result, the above equation should be applied to the result at each of the one-third-octave bands included in the STC to get a composite result in each band, and the composite STC determined from those results in accordance with ASTM E413.

B.3.2 Verifying inside-to-inside impact sound isolation

B.3.2.1 The field impact insulation class (FIIC) shall be measured in accordance with ASTM E1007.

B.3.2.2 A resulting FIIC within 5 points of the specified IIC shall be considered as verifying specified performance.

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Bibliography

ANSI/ASA S12.2-2008, *American National Standard Criteria for Evaluating Room Noise*

ANSI/ASA S12.60-2002 (R 2009), *American National Standard Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools*

ASTM E413-04 (2009), *Standard Classification for Rating Sound Insulation*

ASTM E492-09, *Standard Test Method for Laboratory Measurement of Impact Sound Transmission through Floor-Ceiling Assemblies Using the Tapping Machine*

ASTM E989-06, *Standard Classification for Determination of Impact Insulation Class (IIC)*

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