ACOUSTICAL DESIGN STANDARD
Design Standard

Purpose:

Acoustic quality is often cited as a major factor influencing productivity and level of satisfaction in institutional and commercial facilities, and is central to the effectiveness of educational facilities. Appropriate acoustical characteristics enhance the utility of audio/visual systems, and are central to the proper functioning of certain kinds of spaces, such as classrooms, recording studios and post-production spaces, and music facilities. The performance standards cited herein are intended to establish and maintain a minimum level of acoustical quality in the educational and work facilities of San Mateo County Community College District buildings.

Design Standard:

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A. Related Acoustical Standards

1. ANSI S12.60-Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools
2. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
3. ASTM E336 - Standard Test Method for Measurement of Airborne Sound Attenuation between Rooms in Buildings

4. ASTM E413 - Classification for Rating Sound Insulation
5. ASTM E477 - Standard Test Method for Laboratory Measurements of Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers
6. ASTM E492 - Standard Test Method for Laboratory Measurement of Impact Sound Transmission Through Floor-Ceiling Assemblies Using the Tapping Machine
7. ASTM E557 - Standard Guide for Architectural Design and Installation Practices for Sound Isolation between Spaces Separated by Operable Partitions
8. ASTM E989 - Standard Classification for Determination of Impact Insulation Class (IIC)
9. ASTM E1007 - Standard Test Method for Field Measurement of Tapping Machine Impact Sound Transmission through Floor-Ceiling Assemblies and Associated Support Structures.
10. ASTM E1130 – Standard Test Method for Objective Measurement of Speech Privacy in Open Plan Spaces Using Articulation Index
11. ANSI S1.13 - Measurement of Sound Pressure Levels in Air
12. ISO 3382, Acoustics – Measurement of Room Acoustics Parameters
13. SMCCCD – Administrative Space Design Standard
14. SMCCCD – Instructional Space Design Standard
15. SMCCCD – Section 09 51 23 Acoustical Panel Ceilings Design Standard
16. SMCCCD – Section 14 20 00 Elevators Design Standard
17. SMCCCD – Division 22 Mechanical Design Standards

B. Acoustical Terminology

A-weighting (A) – A spectral weighting filter applied to sound pressure levels to account for the varying sensitivity that humans have to different frequencies. In general, humans are less sensitive to low frequencies than mid-range and high frequencies. Low frequency sounds can be played at significantly louder sound pressure levels and be perceived as being equally loud to mid-range and high frequencies.

Articulation Index (AI) – A measure of the intelligibility of voice signals, expressed as a percentage of speech units that are understood by the listener when heard out of context. An articulation index of 100 means that all speech can be understood, 0 means that no speech can be understood.

Decibel (dB) – A quantitative unit typically used to express the perceived loudness of sound. The decibel level of a sound or sounds is equal to 20 times the base ten logarithm of the measured sound pressure level (SPL) in Pascals (Pa) to a reference SPL of 20 µPa.

Fast-weighting (F) – A time window of 250 milliseconds sometimes applied to a measurement or set of measurements to determine acoustical parameters, such as L_{max}.

Field Impact Insulation Class (FIIC) – A field-measured IIC rating used to quantify the level of impact noise reduction provided by an existing demising floor/ceiling assembly. As FIIC ratings increase, the better impact noise attenuation is achieved. FIIC ratings will generally be lower (3-8 points) than IIC ratings as they will encompass in-situ conditions such as flanking paths and construction quality which can have significant effects.

Heating Ventilation and Air-Conditioning (HVAC) – An acronym often used when discussing mechanical building services that specifically pertain to the heating, ventilation and air-conditioning systems. HVAC systems are comprised of a variety of components and equipment such as air handling units, duct work, exhaust fans, variable air volume boxes, fan-powered boxes, diffusers, grilles and many other pieces providing these critical services to occupied spaces.

Impact Insulation Class (IIC) – A laboratory-measured single number parameter used to quantify the level of impact noise reduction provided by a mock-up demising floor/ceiling assembly. Higher IIC ratings indicate better impact noise attenuation. IIC ratings encompass third-octave frequency band measurements from 100 Hz to 3,150 Hz. IIC ratings will generally be higher (3-8 points) than FIIC ratings as they are more carefully constructed with minimal flanking noise paths in a controlled environment.

Equivalent Sound Pressure Level (L_{Aeq}) – Steady state sound pressure level which, over the measurement time period, contains the same amount of sound energy as the constantly fluctuating instantaneous levels measured during the period under scrutiny. This is a commonly used parameter to assess and compare varying sound sources and environments.

Maximum Sound Pressure Level (L_{Amax}) – Greatest A-weighted sound pressure level within the measurement period under scrutiny.

Noise Criterion (NC) – A single number rating system used to assess the loudness and properties of a noise spectrum. Typically these ratings are used to quantify and categorize noise from mechanical systems; however, it can be used to rate or provide design target levels for any noise spectrum. The rating considers sound levels measured in octave bands from 63 Hz to 8,000 Hz and range from NC 15 to NC 60. Higher NC ratings correspond to louder environments while lower NC ratings correspond to quieter environments.

Noise Isolation Class (NIC) – Single number rating system used to quantify the field-measured airborne sound isolation performance of a demising assembly (typically a partition or floor/ceiling). Ratings encompass third-octave frequency bands from 125 Hz to 4,000 Hz. As NIC ratings increase, so does the sound isolation performance of the demising assembly. NIC ratings will typically be lower (3-8 points) than laboratory-measured STC ratings typically due to in-situ conditions such as flanking paths and construction quality which can have significant effects.

Noise Reduction Coefficient (NRC) – Single number parameter commonly used to rate the absorptive characteristics and effectiveness of interior acoustical treatments. NRC is an arithmetic average of the absorption coefficients of a material at octave band center frequencies 250 Hz, 500 Hz, 1000 Hz and 2000 Hz. NRC ratings range from 0 (perfectly reflective, absorbing no sound) to 1 (perfectly absorptive, reflecting no sound).

Reverberation Time (RT_{60}) – The amount of time, in seconds, that it takes for an impulse, or initial sound, to decay or reduce in loudness by 60 dB. Longer RT_{60}s equate to "live" environments with the potential for reduced speech intelligibility and acoustical comfort. Shorter RT60s equate to "dry" or controlled environments with fewer sound reflections and improved speech quality than a live, reflective environment. The optimal RT_{60} varies from space to space depending upon desired functionality and is determined by the volume, shape and interior finishes in a room. RT_{60} varies with frequency as materials do not reflect, absorb or diffuse sound across all frequencies equally.

Slow-weighting (S) – A time window of 1000 milliseconds applied to a measurement or set of measurements to determine acoustical parameters, such as L_{max}.

Sound Pressure Level (SPL) – A quantitative parameter used to gauge the loudness, in decibels (dB), of a sound source or combined sound sources. A typical human with healthy hearing can perceive sounds between 0 dB which represents the threshold of detection to 130 dB which represents the threshold of pain.

Sound Transmission Class (STC) – Single number rating used to quantify the laboratory-measured airborne sound isolation performance of a demising assembly (typically a partition or floor/ceiling). Ratings encompass third-octave frequency bands from 125 Hz to 4,000 Hz. As STC ratings increase, so does the sound isolation performance of the demising assembly. STC ratings will typically be higher (3-8 points) than field-measured NIC ratings typically due to more carefully constructed assemblies with minimal flanking noise paths.

C. Quality Assurance

Acoustical requirements and testing criteria to be as stated below:

Renovations: Unless otherwise specified by the Vice Chancellor of Facilities, acoustical measurements are to be taken in spaces to be renovated to establish baseline data and to establish project goals. The costs/benefits for achieving the criteria published herein should be reviewed with SMCCCD. Where appropriate, review the acoustical program in conjunction with the classroom instructional technology program so that all acoustic criteria are considered. Since renovation projects are generally limited in scope, provide alternate recommendations for acoustical treatment to achieve best cost/benefit performance using surface applied materials.

New Programs/Spaces: Unless otherwise specified by the Vice Chancellor of Facilities, measurements are to be taken to verify that the project meets the acoustical requirements and criteria at a substantial stage of completion which is representative of anticipated occupied conditions. Measurements are to include the following:

- Noise criteria (NC) in all instructional, office, and meeting spaces with the HVAC system operating at full load (ANSI S1.13)
- Fifteen-minute L_{Aeq} and L_{ASmax} measurements in all instructional, office, and meeting spaces (ANSI S1.13). These measurements should be conducted with the Heating Ventilation and Air Conditioning (HVAC) systems off as the stated noise limits are applicable to exterior noise intrusion
- Noise Isolation Class (NIC) for a random sample representative of typical wall conditions (ASTM E336)
- Noise Isolation Class and Field Impact Insulation Class (FIIC) for a random sample representative of typical floor/ceilings (ASTM E336 and E1007)
- NIC of all operable walls (ASTM E336)
- Reverberation time in a random sample representative of typical classrooms and other instructional spaces (ISO 3382)
- Articulation Index (AI) in open office areas, at the discretion of the owner (ASTM E1130)

D. Environmental Noise

Interior noise levels attributable to exterior noise sources shall comply with the following limits:

Space Type	Maximum 15-Minute L_{Aeq} (operational hours)	Maximum L_{ASmax} (operational hours)
Creative Arts Space • Media Program Arts Space (see Appendix A)	Per acoustical consultant recommendations	
Assembly Hall • Classrooms • Computer Lab • Editing Room • Event Space • Executive Office • Followspot Booth • Gallery • Group Study Room • Meeting Room • Music Library • News Room • One-on-one Counseling • Testing Room • Pre-Production Lab • Staging Area • Studio Art Digital Lab • Speech Communication Lab	35 dBA	50 dBA
Announcer Area • Art Gallery • Ceramics Studio • Classroom (large) • Dark Room • Dental Lab • Digital Photo Production Lab • Dining (faculty/staff) • Drawing Studio • Dry Lab • Editor Space • Faculty Office • Flex Studio • Exam Room • Green Room • Group Critique • Nursing Skills Lab • Painting Studio • Panorex Room • Pilates/Yoga Studio • Print Making Studio • Private Office • Radiology Operatory • Sculpture Studio • Semi-Private Office • Show-Go Computer Classroom • Simulation Lab • Team Room • Touchdown Room • Treatment Area • Wet Lab (w/o fume hoods) • Workroom • Wet Room	40 dBA	55 dBA
Aerobics Studio • Adaptive PE Area • Box Office • Break Room • Changing/Dressing Room • Concessions • Café • Circulation Space • Copy Center • Costume Room • Corridor • Dining (student) • Group X Room • Indoor Pools • Kiln Room • Lobby • Lounge • Open Computer Labs • Open Office • Reception • Scene Shop • Student Recreation Center • Student Support Lab • Welding Space • Wellness Pool • Wet Lab (w/ fume hoods)	45 dBA	60 dBA
Dimmer/Amp Room • Fitness/Weight Room • Food Prep/Main Kitchen • Gymnasium • Indoor Pool • Laundry Room • Locker Room • Restroom • Set Fabrication • Support Space	50 dBA	65 dBA

Note: The interior noise levels experienced in a space will depend on the sound pressure levels of exterior sources, the exterior façade constructions, ratio of exterior opaque wall to glazing elements as well as the interior finishes of a space. An acoustical consultant should review specific project conditions to assist in designing exterior shells capable of achieving project design target interior noise levels.

E. Sound Isolation

1. Airborne Sound Isolation Guidelines for Partitions

A. Recommended partition performances range from STC 35 to STC 60 in increments of 5 rating points. Examples of partition assemblies that should achieve the recommended sound isolation performance targets are outlined below. Appendix A contains tables of sound isolation performance guidelines for partitions based on the horizontal adjacencies of a space.

i. **STC 35**– 3-5/8" 20-ga metal studs at 16" o.c., batt insulation, one layer of 5/8" gypsum board each side (Figure 1)

ii. **STC 40** – 3-5/8" 20-ga metal studs at 16" o.c., batt insulation, two layers of 5/8" gypsum board on one side, and one on the other (Figure 2)

iii. **STC 45** – 3-5/8" 20-ga metal studs at 16" o.c., batt insulation, and two layers of 5/8" gypsum board on each side (Figure 3)

iv. **STC 50** – 6" 20-ga metal studs at 24" o.c., batt insulation, and two layers of 1/2" gypsum board on each side (Figure 4a).

v. **STC 50** – 3-5/8" 20-ga metal studs at 16" o.c., batt insulation, two layers of 5/8" gypsum board on one side, and one layer of 5/8" gypsum board suspended on resilient clips (Pac Int'l RSIC clips or Kinetics IsoMax clips) on the other (Figure 4b).

vi. **STC 55** – 3-5/8" 20-ga metal studs at 16" o.c., batt insulation, two layers of 5/8" gypsum board on one side, and two layers of 5/8" gypsum board suspended on resilient clips (PAC Int'l RSIC clips or Kinetics IsoMax clips or equivalent) on the other (Figure 5). Resilient channels should not be used.

vii. **STC 60** – Two independent metal stud rows separated by a minimum 1" airspace, batt insulation in both sets of stud cavities, two layers of gypsum board on the outside stud faces, studs braced without bridging or rigid connections between stud rows per UL assembly U493 (Figure 6). Total cavity space of double stud partition should be 7" or greater.

It is important to note that the example STC rated assemblies *i* thorugh *vii* explicitly state stud type, gauge and spacing. If the stud type, gauge or spacing is altered, the predicted STC performance will be effected. Any alternate construction assemblies should be assessed by an acoustical consultant in order to assess the ramifications of construction alterations.

B. Sound-rated partitions should adhere to the following guidelines:

i. Offset gypsum board layer seams by 24". Mud and tape all joints between gypsum board layers.

ii. Provide full depth insulation in all stud cavities; do not compress insulation.

iii. Hold back the face layer of gypsum board ¼" from intersecting surfaces and caulk airtight with non-hardening resilient acoustical sealant.

iv. Minimize the number of penetrations in sound-rated partitions.

v. Oversize full perimeter of penetrations (maximum ¼" gap) to avoid direct contact between the penetrating element and partition framing elements and layers. Seal all penetrations with closed cell foam backer rod, if necessary, and non-hardening, resilient acoustical sealant.

vi. Rough-in boxes should be fully backed with putty pads (minimum ¼"-thick intumescent clay pads).

vii. Rough-in boxes should not be placed back-to-back; offset boxes by a minimum of 24" horizontally.

viii. Seal gaps airtight where full height walls meet structural decks above. Details should be developed to address specific conditions.

ix. Doors installed in sound rated partitions should adhere to the following recommendations:

a. STC 40 or lower partition – Hollow metal or 1-3/4" solid core wood door with double row of bulb seals at head and jambs, such as the Pemko S-88 or equivalent.

b. STC 45 to STC 50 partitions – Hollow metal or 1-3/4" solid core wood door with double row of bulb seals at head and jambs, such as the Pemko S-88 or equivalent, and an automatic drop bottom seal, such as the Pemko 412-PKL or equivalent. (Drop bottom needs to seal at a hard, flat material like tile or wood in order to provide an effective airtight seal.)

c. STC 50+ partitions – Acoustically rated door with an STC 45+ rating, such as the Overly 4511251 Wood Door or equivalent.

Frameless glass doors should be avoided in all acoustically sensitive spaces; doors with glass lite elements will provide reduced sound isolation performance but are acoustically acceptable.

x. Mullions are often the weakest acoustical point in a demising assembly due to the low mass and flanking conditions. Mullion conditions should be bolstered to the furthest extent possible in order to maintain the composite sound isolation performance of demising assemblies terminating at mullions. An airtight neoprene seal and a minimum of one layer of gypsum board on each side of the mullion condition is recommended for noise sensitive areas. (See Figure 10).

Note: Acoustically critical spaces require consideration beyond adherence to this standard. Examples of acoustically critical spaces can be found in the Media Program and Creative Arts areas (see Tables A-5 and A-7). An acoustical consultant should review the specific conditions of such spaces and provide additional recommendations.

2. Airborne and Impact Sound Isolation Guidelines for Floor/Ceiling Assemblies

A. Airborne sound isolation (STC) ratings for floor/ceilings shall be equal to or greater than those for partitions at similar adjacencies. Below are examples of floor/ceiling assemblies that should achieve the recommended sound isolation performance targets:

i. STC 45 or less – 4" normal weight concrete slab

ii. STC 55 or less – 6" normal weight concrete slab

iii. STC 60 or less – 8" normal weight concrete slab

iv. Wood-framed assemblies should be reviewed by an acoustical consultant to determine an STC rating.

B. Impact Insulation Class (IIC) ratings for floor/ceiling assemblies separating occupied spaces shall be as follows:

i. IIC 45 – Any space located over classrooms, offices, labs, event spaces, or other instructional spaces of normal sensitivity. Below are examples of floor/ceiling assemblies that should achieve an IIC 45 rating:

¢ 4" or 6" normal weight concrete with vinyl, tile, or wood on minimum ¼" acoustical underlayment (confirm assembly IIC rating with underlayment manufacturer) OR

¢ 4" or 6" normal weight concrete with carpet on thick pad

ii. IIC 70 or higher – Post Production Rooms, Midi Labs, Recording Studios and Booths, or other acoustically critical spaces as identified in the room data sheets.

- 6" or 8" normal weight concrete with a structurally decoupled ceiling, such as a gypsum board suspended via resilient clips or spring isolators (confirm assembly IIC rating with decoupling hardware manufacturer)

b. The following vertical adjacencies can present significant difficulties in obtaining adequate impact insulation and should be avoided wherever possible or evaluated on a case-by-case basis by an acoustical consultant:

i. Any wood-framed assemblies.

ii. Fitness/Weight/Yoga/Pilates/Aerobics areas over Classrooms, Offices, Meeting Rooms, or other acoustically sensitive spaces.

iii. Any space over acoustically sensitive spaces such as those in Media Program or Creative Arts areas (see Tables A-5 and A-7).

Note: All field measured sound isolation performance ratings (NIC and FIIC) should be within 5 points of the laboratory rating (STC and IIC) design guidelines.

3. Acceptable sources for predicting airborne and impact sound isolation ratings include the following:

   a. *Architectural Acoustics Design Data for Acoustics*, United States Gypsum

   The Gypsum Association *Fire Resistance Design Manual* is NOT a reliable reference for determining sound isolation ratings.

4. Operable Partitions

   Operable partitions shall be used where specifically approved by SMCCCD. While acceptable for certain uses, operable partition generally should not be relied upon to provide sound isolation on a regular basis as they are designed for specialty applications which do not justify the financial investment where fixed partitions will be adequate.

   Operable partitions should be rated for a minimum STC 50 performance and a minimum field measured sound isolation performance rating of NIC 45. The installing contractor shall have final installations tested and report the acoustical performance results (ASTM E 336).

   Operable partition selections should take into account the following additional variables:

   - Storage area for panels which should be coordinated early in the design process (vertical pocket versus ceiling soffit).
   - Details of seal conditions and partition storage area should be provided by the manufacturer then reviewed and approved by an acoustical consultant to ensure that the sound isolation performance will be maintained.
   - Deployment method (manual versus mechanical) should be considered; manual deployment can be time-consuming which should be accounted for when scheduling room usage and should be done by personnel trained in operation of the partition as incorrect deployment can result in poor sound isolation performance or damage.
   - The finish material is often customizable and absorptive material can be selected to improve room acoustics or achieve the acoustical design targets.

5. Speech Privacy in Open Plan Offices – The acoustical treatment of open office spaces shall be designed with the intent of achieving a maximum Articulation Index (AI) of 0.40 which may be verified by means of pre-occupancy testing at the discretion of the owner.

   Acoustical design strategies for improved speech privacy, where necessary, may include some combination of ceiling tiles with high acoustical absorption characteristics (minimum NRC 0.8), selecting cubicle partitions that are ideally 60" tall (minimum 48") with acoustically absorptive surfaces such as fabric-wrapped panels or cork and internal septa with a minimum STC 25 rating, as well as use of an electronic sound masking system.

F. Room Acoustics

1. Reverberation Times (RT_{60}s) in the 500 Hz octave band shall not exceed the limits outlined in the following table.

Space Type	Reverberation Time (RT_{60})
Learning Space+ (room volume Š 10,000 ft^3)	0.6 seconds
Exam Room • Executive Office • Learning Space+ (10,000 ft^3 < room volume Š 20,000 ft^3) • Office • One-on-one Counseling • Semi-Private Office • Touchdown Room	0.7 seconds
Assembly Hall • Break Room • Café • Dining (faculty/staff and student) • Event Space • Learning Space+ (20,000 ft^3 < room volume) • Lounge • Meeting Room • Open Office* • Team Room	1.0 second
Fitness/Weight Room • Gymnasia • Indoor Pool • Lobby • Wellness Pool	1.5 seconds
Creative Arts Space • Media Program Arts Space (see Appendix A)	Per acoustical consultant recommendations
+ The term *Learning Space* refers to a classroom, group study area, lab, studio, workroom or similar area. * RT_{60} target refers to local RT_{60} measured at a workstation when fully furnished, treated and occupied.	

   Acoustically reflective surfaces such as glass, concrete, gypsum board and other hard materials will increase the RT_{60}. Acoustically absorptive surfaces such as fiberglass panels, heavy fabrics, and other soft fibrous materials will decrease the RT_{60}. Therefore, the RT_{60} of a space can be optimized to achieve the desired acoustical result by selecting interior finishes with appropriate acoustical properties. See the Preferred Product Criteria section below for potential treatment materials.

2. Additional Design Considerations

   a. Concave surfaces should be treated with acoustically absorptive or diffusive materials to minimize acoustical focusing (or "hot spot") effects. See the Preferred Product Criteria section below for potential focusing treatment materials.

   b. Flutter echoes should be minimized by canting or acoustically treating at least one surface in each pair of hard, flat parallel surfaces, especially in the seated to

standing ear height range (3'to 7'). See the Preferred Product Criteria section below for potential treatment materials to minimize flutter echoes.

c. In order to optimize speech intelligibility and minimize distractions or acoustical fatigue, rooms should be designed or treated to control late reflections, especially from the lectern or typical speaker position. Late reflections can be controlled by canting or treating reflective surfaces. See the Preferred Product Criteria section below for potential treatment materials to control late reflections.

For classrooms, labs and other learning spaces, late reflections are considered to be any strong reflection occurring 50ms or later than the initial sound. An acoustical consultant should be retained for performance, rehearsal or music instruction spaces since late reflections can play a large role in achieving the desired timbre.

3. Preferred Product Criteria

a. Maintainable Surfaces

SMCCCD prefers acoustic treatments that are cleanable and replaceable over the duration of time the products will be in place – thirty or more years. If the design professionals wish to propose a product other than those listed in the approved products list below, the design professional may submit product literature to the Executive Director of Construction Planning for approval of the proposal acoustic product prior to designing the product into the project.

Spray-on acoustic treatments are specifically prohibited for SMCCCD applications. SMCCCD's prior experience with spray-on acoustic treatments has resulted in ceilings and walls that are dirty in appearance, difficult to clean, and not locally repairable. Spray-on acoustic treatments do not meet SMCCCD's criteria for acoustic treatments.

b. Existing SMCCCD Approved Acoustical Treatment Materials

Treatment Manufacturer and Product Type	Surface	NRC
Armstrong Cirrus, 12"x12" mineral fiber tile	Flat or sloped ceiling	0.60
Armstrong Optima, 4'x8' 1"-thick glass fiberboard	Flat or sloped ceiling	0.90
Armstrong Painted Nubby, 4'x8' 1"-thick glass fiberboard	Flat or sloped ceiling	0.95
USG Millenia ClimaPlus Illusion Two/24 panels	Lay-in tile grid ceiling	0.70
USG Radar Panels, 2'x4' panels	Lay-in tile grid ceiling	0.55
USG Clean Room ClimaPlus Class, 2'x4' perforated panels	Lay-in tile grid ceiling	0.55
Illbruck Basix 1, 1-3/4" foam ceiling tiles	Coffered ceiling	0.65
Illbruck Basix 2, 2-3/8" foam ceiling tiles	Coffered ceiling	1.00
Armstrong Optima, 1"-thick smooth faced with 3 pcf unfinished glass fiberboard	Coffered ceiling	0.90

Armstrong Painted Nubby, 1”-thick smooth faced with 3 pcf unfinished glass fiberboard	Coffered ceiling	0.95
Armstrong Optima, 4’X8’ 1”-thick glass fiberboard on 1”-deep furring strips	Wall	0.95
Armstrong Painted Nubby, 4’X8’ 1”-thick glass fiberboard on 1”-deep furring strips	Wall	0.95

c. Potential SMCCCD Approved Acoustical Treatments
Alternative product selections to the SMCCCD approved lists are acceptable

Treatment Manufacturer and Product Type	Acoustical Purpose	NRC
ATS Acoustics Acoustical Wall Panel, 1”-thick	Absorption	0.85
ATS Acoustics Acoustical Wall Panel, 2”-thick	Absorption	1.00
Decoustics Acoustical Wall Panel, 1”-thick	Absorption	0.85
Decoustics Acoustical Wall Panel, 2”-thick	Absorption	1.00
Auralex Hemisphere	Diffusion	N/A
Auralex QuadFuso	Diffusion	N/A
RPG FlutterFree	Diffusion	N/A
RPG Omniffusor FRG	Diffusion	N/A

provided that the acoustical performance and installation requirements are commensurate with the product(s) being replaced and can be evidenced.

d. Surface-Mounted Products Application Preparation

i. Wall Panels: Any relatively smooth interior surface such as drywall or plaster is suitable. For block, brick or concrete, first apply a polyethylene film to the wall then apply horizontal furring strips.

ii. Ceiling Panels: Direct the installer to measure each ceiling area and establish layout of acoustical units to balance border widths at opposite edges of each ceiling. Avoid use of less than half width units at borders, and comply with reflected ceiling plans. Coordinate panel layout with mechanical and electrical fixtures.

a. Adhesive: Install ceiling tile by glue-up method to drywall using acoustical tile cement.

b. Wall moldings: Use slip-on molding with 15/16” flange as follows: ¾” thick, Item #7843.

c. Accessories: Use 1/16" thick fiber spline approximately 3" long at each corner to assist with leveling.

iii. Trim and Furring Strips

a. Specify the attachment of the "C" Channels that will carry the weight of the panels using mechanical fasteners appropriate for the wall structure or furring strips. Adhesive may be used in conjunction with the mechanical fasteners, but should not be used as the sole means of support at the base of the installation.

b. Furring strips, if used, should be should be horizontally spaced 12 inches on center when panels are installed below 5 feet from the finished floor; and 24 inches on center when installed above 5 feet from finished floor. Exposed edges of furring strips may be field painted.

c. Fasteners used to attach “C” and “H” channels should be installed no more than 2 feet on center. "H" Channels are used at locations where two panels butt against one another. "C" Channels are used at the perimeters of the installation and to frame any openings that may have to be cut through a panel.

iv. Fiberglass Ceiling and Waffle Panel Installation

a. Install fiberglass panels to ceiling on stick-clips with white protective caps and using 3-M 77N contact adhesive.

b. Direct Contractor to provide edge trim at perimeter of panels to fully conceal fiberglass core. Insulation must not be visible at joints between adjacent panels.

G. MEP Noise and Vibration Control

1. Indoor HVAC Noise Control

The primary background noise sources in occupied spaces are typically related to HVAC system components. The table below outlines the recommended maximum Noise Criterion (NC) ratings and ambient noise levels attributable to HVAC systems based on space type and intended functions. These recommendations are in accordance with industry best

practices and guidelines specified in the Noise and Vibration Control chapter of the ASHRAE Handbook.

Room Type	Maximum Noise Criterion (NC) Rating	Maximum Noise Level (15-minute L_{Aeq})
Audience Area • Film Editing • Control Room • Media Dry Studio • Recording Studio • Recording Booth • Sound Control Room	NC 20	25 dBA
Choral Room • Concert Band Room • Digital Music Lab • Mac Lab • MIDI Studio/Lab • Multi-Use Black Box/Small Recital Hall • Piano Lab • Post-Production Lab • Practice Room • Recording Control Room • Sound & Light Lock	NC 25	30 dBA
Assembly Hall • Classroom (small/medium and smart/lecture) • Computer Lab • Editing Room • Event Space • Executive Office • Followspot Booth • Gallery • Group Study Room • Meeting Room • Music Library • News Room • One-on-one Counseling • Testing Room • Pre-Production Lab • Staging Area • Studio Art Digital Lab • Speech Communication Lab	NC 30	35 dBA
Announcer Area • Art Gallery • Ceramics Studio • Classroom (large) • Dark Room • Dental Lab • Digital Photo Production Lab • Dining (faculty/staff) • Drawing Studio • Dry Lab • Editor Space • Faculty Office • Flex Studio • Exam Room • Green Room • Group Critique • Nursing Skills Lab • Painting Studio • Panorex Room • Pilates/Yoga Studio • Print Making Studio • Private Office • Radiology Operatory • Sculpture Studio • Semi-Private Office • Show-Go Computer Classroom • Simulation Lab • Team Room • Touchdown Room • Treatment Area • Wet Lab (w/o fume hoods) • Workroom • Wet Room	NC 35	40 dBA
Aerobics Studio • Adaptive PE Area • Box Office • Break Room • Changing/Dressing Room • Concessions • Café • Circulation Space • Copy Center • Costume Room • Corridor • Dining (student) • Group X Room • Indoor Pools • Kiln Room • Lobby • Lounge • Open Computer Labs • Open Office • Reception • Scene Shop • Student Recreation Center • Student Support Lab • Welding Space • Wellness Pool • Wet Lab (w/ fume hoods)	NC 40	45 dBA
Dimmer/Amp Room • Fitness/Weight Room • Food Prep/Main Kitchen • Gymnasium • Indoor Pool • Laundry Room • Locker Room • Restroom • Set Fabrication • Support Space	NC 45	50 dBA

In order to adhere to the maximum ambient noise level targets, it is important to consider all potential HVAC noise paths (ductborne, airborne, and structureborne). These noise paths are complex and can be difficult to mitigate if not considered and addressed early in the design or renovation process. The guidelines below are provided as general best practices for a mechanical designer or engineer to include.

a. General HVAC Design Guidelines

- Provide at least 25’ of ductwork and two 90° elbows internally lined with a minimum of 1”-thick acoustical duct liner between any AHU and first main tap. Where inclusion of these elements is not possible, hold a minimum of 5’ plus 6 equivalent duct diameters of straight ductwork for insertion of an acoustical silencer between any AHU and the main tap.

- All service connections (ducts, piping and conduit) should be resiliently isolated from oscillating units via flexible connections. Where flexible connections are not possible, structurally isolate service lines via resilient mounts for a minimum of 25’ downstream of each unit.
- Select seismic restraints compatible with the vibration isolation equipment. Seismic restraints should not create rigid connections between equipment and structural building elements.
- Do not locate terminal units (e.g., VAVs and FPBs) above noise sensitive spaces such as classrooms, conference rooms, offices, etc. Where such placements cannot be avoided, additional noise control measures may be required to minimize radiated noise levels.
- Diffusers and return grilles should be rated at least 5 NC points lower than the target maximum NC of the room in which they are to be located.
- Locate volume dampers at least 4’ upstream of diffusers or return grilles; locate farther upstream wherever possible.
- Transfer boots required in full height partitions should have a minimum of two 90° elbows separated by at least 4’ of straight ductwork and fully internally lined with 2”-thick acoustical duct liner.
- VAV units should be at least 8’ from diffusers and FPB inlets should be oriented away from diffusers wherever possible.
- Mechanical ductwork should be sized to adhere to the recommended airflow velocity limits as outlined in the Noise and Vibration Control chapter of the ASHRAE Handbook (Tables 8 and 9 in the 2011 edition).

Further analysis by an acoustical consultant during design stages is highly recommended to address any unique project constraints that might exist.

2. Outdoor HVAC Noise Control

   Exterior noise levels directly attributable to base building systems noise sources shall comply with the following limits:

Base Building System Noise Type	Maximum 15-Minute L_{Aeq} (during operational hours)
Balanced noise spectrum (no tonal characteristics)	50 dBA at 30 feet OR 5 dBA above ambient noise
Unbalanced noise spectrum (clear tonal characteristics)	45 dBA at 30 feet OR 3 dBA above ambient noise

   Measurements shall be taken with equipment running at full loads according to mechanical designer or engineer. Measurements should also have direct line of sight to equipment in order to account for worst-case scenarios.

3. Structureborne HVAC Noise Control

   Mechanical equipment should be structurally isolated from building structure per the guidelines in the Noise and Vibration Control chapter of the ASHRAE Handbook (Table 47 in the 2011 edition).

4. Plumbing Noise Control

   The guidelines below are provided as general best practices for a plumbing designer or engineer to include. (Refer to section G.1 of this document for room NC ratings.)

   a. General Plumbing Design Guidelines

      - NC 30 or lower rooms: Do not route plumbing through or near spaces.
      - NC 35 to NC 45 rooms: Active piping located above a hard cap ceiling should not require mitigation. Where active piping is located above a mineral fiber ceiling, wrap in one layer of mass-loaded vinyl with a minimum surface weight of 2.0 psf over 1”-thick fiberglass insulation.
      - NC 45+ rooms: Noise mitigation should not be required.
      - Plumbing fixtures should not exceed 60 PSI at fixtures.
      - All piping should be installed with a minimum 1” clearance between piping and building elements, such as partition studs or bracing.
      - Active piping should be structurally isolated using resilient mounts, such as Holdrite, Acousto-Plumb, Stoneman Trisolators or equivalents.
      - All practical measures to avoid water hammer noise should be taken; for example, installing VFD pumps, incorporating air chambers and water hammer arresters, using quick-open/slow-close valves and so on.

   Plumbing systems shall comply with the following limits, as outlined by ASHRAE:

Pipe Diameter (in.)	Maximum Water Flow Velocity (fps)	Maximum Flow Rate (gpm)
½	4	3
¾	4	6
1	4	10
1 ¼	4	15
1 ½	4	25
2	4	42
2 ½	5	74
3	6	138
4	7	277
6	8	720

5. Electrical Noise Control

   Electrical transformers should be structurally isolated via restrained spring isolators with a minimum static deflection of 2", such as the Mason Industries Type SLR or equivalent. Spring isolators should be mounted on minimum ¾"-thick neoprene pads, such as Mason Industries Type Super W or equivalent, secured with bolts and resilient washer bushings, such as Mason Industries Type HG or equivalent.

   If located near occupied areas, high sound isolation performance demising constructions may be required and an acoustical consultant should be engaged.

6. Elevator Noise Control

   a. Traction Elevator Design Guidelines

      The guidelines below are provided as general best practices for layout, design and installation of traction elevators and associated equipment. (Also refer to the SMCCCD Section 14 20 00 Elevators Design Standard.)

      - If possible, locate elevator machine rooms on unoccupied or service area floors. If a machine room must be located on occupied floors it should be displaced and structurally decoupled from the occupied deck areas.
      - Silicon controlled rectified drives should be mounted on the most robust components available from the elevator manufacturer for vibration isolation; isolators should not be less than ¾" thick neoprene pads.
      - Mount the electrical filter/reactor on minimum ¾"-thick neoprene pads.
      - Hoist and sheaves should be mounted to a single structural base or component which is resiliently mounted to the machine room floor. Resilient mounts should be the most robust components available from the elevator manufacturer for vibration isolation; isolators should not be less than 1"-thick neoprene pads of bridge bearing natural rubber.
      - Double roped systems should terminate on the resiliently mounted base.

- Where bolts are required to secure vibration isolation pads resilient washer bushings, such as Mason Industries Type HG should be used.
- Spring-loaded neoprene or rubber roller wheels with the largest possible diameter should be used.
- Align guide rails to achieve a tolerance of 0.06" or less per 100' of rails.
- Use flexible connectors for all service connections to any piece of elevator equipment.

b. Hydraulic Elevator Design Guidelines

The guidelines below are provided as general best practices for layout, design and installation of hydraulic elevators and associated equipment. (Also refer to the SMCCCD Section 14 20 00 Elevators Design Standard.)

- If possible, locate motor and pump on grade. Locate equipment as far as possible from occupied areas. If equipment must be located near occupied areas, high sound isolation performance will be required of demising assemblies, acoustically absorptive treatments may be required and an acoustical consultant should be engaged.
- Ensure that inline muffler(s) are installed in the hydraulic line(s).
- Structurally isolate the motor and pump using spring isolators with a minimum 1" static deflection.
- Structurally isolate hydraulic lines from all building elements (partitions, floor/ceiling assemblies, etc.) using a minimum ¼"-thick neoprene pads.

c. Elevator Airborne Noise Limits

Elevator systems shall comply with the following limits during operation.

Location	Maximum L_{ASmax} (during elevator operation)
Elevator Machine Room	80 dBA
Inside Elevator (5' above floor during all operations)	50 dBA
Outside Elevator Doors (10' away and 5' above floor)	45 dBA

End of Document

(Appendix A follows)

Appendix A
Acoustical Design Standards
Demising Assemblies Sound Isolation Rating Tables

Appendix A
Table A-1 – Classroom BuildingslAreas

Classroom Areas Minimum Recommended Partition Sound Isolation Performance (STC Ratings)	Classroom+	Computer Lab	Corridor	Dry Lab	Faculty Office	Group Study Room	Mechanical Equipment Room	Restroom	Staff Break Room	Student Lounge/Lobby	Support Spaces	Wet Lab
Classroom+	50	50	50	50	50	50	N/A	50	50	50	45	50
Computer Lab		50	50	50	50	50	N/A	50	50	50	40	50
Corridor			-	50	45	45	60	45	40	40	-	50
Dry Lab				50	50	50	N/A	50	50	50	40	50
Faculty Office					45	45	N/A	50	45	45	40	50
Group Study Room						45	N/A	50	40	45	40	50
Mechanical Equipment Room							-	50	60	60	60	N/A
Restroom								40	45	45	35	50
Staff Break Room									35	40	35	45
Student Lounge/Lobby										40	35	50
Support Spaces											-	40
Wet Lab												50

+ A classroom with program audio loudspeakers and other low frequency (<125 Hz) sound sources should use demising partition assemblies with resilient clips (e.g., Figure 4b) to improve low frequency sound isolation.
- Sound isolation performance of the demising assembly is not critical; partition at the discretion of design team.
“N/A” Adjacency is acoustically incompatible and should be avoided unless addressed by an acoustical consultant.

Appendix A
Table A-2 – Office BuildingsIAreas

Office Areas Minimum Recommended Partition Sound Isolation Performance (STC Ratings)	Corridor	Copy Center	Executive Office	Lobby/Reception	Mechanical Equipment Room	Meeting Room	Open Office	Private Office	Restroom	Semi-Private Office	Workroom
Corridor	-	35	50	35	60	50	40	45	45	40	40
Copy Center		35	50	45	60	50	35	45	45	40	40
Executive Office			50	50	N/A	50	50	50	55	50	50
Lobby/Reception				-	60	50	40	50	50	45	40
Mechanical Equipment Room					-	N/A	60	N/A	50	N/A	60
Meeting Room						50	50	50	55	50	50
Open Office							-	45	50	40	40
Private Office								45	50	45	45
Restroom									40	50	50
Semi-Private Office										45	40
Workroom											40

- Sound isolation performance of the demising assembly is not critical; partition at the discretion of design team.
"N/A" Adjacency is acoustically incompatible and should be avoided unless addressed by an acoustical consultant.

Appendix A
Table A-3 – Student Services BuildingsIAreas

Student Services Areas Minimum Recommended Partition Sound Isolation Performance (STC Ratings)	Corridor	Health/Psych Exam Rooms Office	Lobby/Reception	Mechanical Equipment Room	Meeting Room	One-on-One Counseling/Testing	Open Office	Private Office	Restroom	Speech Communication Lab	Student Support Labs	Support Spaces
Corridor	-	50	35	60	50	50	40	45	45	50	50	35
Health/Psych Exam Rooms		50	50	N/A	50	50	50	50	50	50	50	45
Lobby/Reception			-	60	50	50	40	45	50	50	50	35
Mechanical Equipment Room				-	N/A	N/A	60	N/A	50	N/A	N/A	60
Meeting Room					50	50	50	50	50	50	50	45
One-on-One Counseling/Testin						50	50	50	50	50	50	45
Open Office							-	45	50	50	50	40
Private Office								45	50	50	50	40
Restroom									40	50	50	35
Speech Communication Lab										50	50	40
Student Support Labs											50	40
Support Spaces												-

- Sound isolation performance of the demising assembly is not critical; partition at the discretion of design team.
"N/A" Adjacency is acoustically incompatible and should be avoided unless addressed by an acoustical consultant.

Appendix A
Table A-4 – Cafeteria BuildingsIAreas

Cafeteria Areas Minimum Recommended Partition Sound Isolation Performance (STC Ratings)	Assembly Hall/Event Space	Café/Lounge	Corridor	Faculty/Staff Dining	Food Prep/Main Kitchen	Mechanical Equipment Room	Restroom	Student Dining	Support Spaces
Assembly Hall/Event Space	50	45	45	50	55	60	50	50	40
Café/Lounge		-	35	40	50	60	50	40	35
Corridor			-	45	45	60	45	40	-
Faculty/Staff Dining				-	50	60	50	45	35
Food Prep/Main Kitchen					-	60	40	50	-
Mechanical Equipment Room						-	50	60	60
Restroom							40	45	35
Student Dining								-	35
Support Spaces									-

- Sound isolation performance of the demising assembly is not critical; partition at the discretion of design team.
"N/A" Adjacency is acoustically incompatible and should be avoided unless addressed by an acoustical consultant.

Appendix A
Table A-5 – Media Program BuildingslAreas

Media Program Areas Minimum Recommended Partition Sound Isolation Performance (STC Ratings)*	Corridor	Digital Photo Production	Editor	Lecture Room/Smart Classroom	Mechanical Equipment Room	Media Dry Studio	MIDI Studio/Lab	News Room	Office	Post-Production Lab	Pre-Production	Recording Control Room	Recording Studio/Booth	Restroom	Show-Go Computer Classroom
Corridor	-	50	45	50	60	60	60	45	45	60	60	60	60	45	50
Digital Photo Production		50	50	50	N/A	60	60	50	50	60	60	60	60	50	50
Editor			45	50	N/A	60	60	45	45	60	60	60	60	50	50
Lecture Room/Smart Classroom				50	N/A	60	60	50	50	60	60	60	60	50	50
Mechanical Equipment Room					-	N/A	N/A	60	N/A	N/A	N/A	N/A	N/A	50	N/A
Media Dry Studio						60	60	60	60	60	60	60	60	N/A	60
MIDI Studio/Lab							60	60	60	60	60	60	60	N/A	60
News Room								45	45	60	60	60	60	50	50
Office									45	60	60	60	60	50	50
Post-Production Lab										60	60	60	60	N/A	60
Pre-Production											60	60	60	N/A	60
Recording Control Room												60	60	N/A	60
Recording Studio/Booth													60	N/A	60
Restroom														40	50
Show-Go Computer Classroom															50

*STC ratings do not address sound below 125 Hz or above 4,000 Hz. Multiple spaces to be used for the Media Program Arts will have sound sources capable of generating high sound pressure levels outside of the frequency range encompassed in STC ratings. Therefore, it is highly recommended that an acoustical consultant be engaged during the design phases of Media Program areas to provide further design guidelines on a case-by-case basis. The table above provided minimum recommended constructions.

- Sound isolation performance of the demising assembly is not critical; partition at the discretion of design team.

“N/A” Adjacency is acoustically incompatible and should be avoided unless addressed by an acoustical consultant.

Appendix A
Table A-6 – Fitness & Athletics BuildingsIAreas

Fitness & Athletics Areas Minimum Recommended Partition Sound Isolation Performance (STC Ratings)*	Adaptive PE	Aerobics/Pilates/Yoga	Announcer Area	Classroom	Corridor	Fitness/Weight Room	Group X Room	Gymnasium	Indoor Pool	Laundry Room	Locker/Restroom	Mechanical Equipment Room	Office	Restroom	Team Room	Touchdown Room	Wellness Pool
Adaptive PE	50	55	45	55	45	55	55	60	55	55	50	60	50	50	50	40	55
Aerobics/Pilates/Yoga Studio		55	N/A	55	50	55	55	60	55	N/A	55	N/A	55	50	55	45	55
Announcer Area			-	50	40	50	50	50	50	50	50	60	45	50	50	40	50
Classroom				50	50	N/A	N/A	N/A	N/A	N/A	N/A	N/A	50	50	N/A	50	N/A
Corridor					-	50	50	45	45	45	45	60	45	45	45	40	50
Fitness/Weight Room						-	55	45	45	50	40	60	55	45	45	40	55
Group X Room							55	55	50	50	45	60	55	45	50	45	55
Gymnasium								-	55	50	50	60	60	45	50	45	50
Indoor Pool									-	50	45	60	55	45	50	45	-
Laundry Room										-	40	50	55	40	45	45	50
Locker/Restroom											45	60	50	35	50	45	50
Mechanical Equipment Room												60	N/A	50	60	60	60
Office													45	50	55	45	55
Restroom														40	50	50	45
Team Room															50	45	50
Touchdown Room																40	45
Wellness Pool																	-

*STC ratings do not address sound below 125 Hz or above 4,000 Hz. Spaces to be used for the Fitness & Athletics areas having sound sources capable of generating high sound pressure levels outside of the frequency range encompassed in STC ratings, such as loudspeakers in the Aerobics/Pilates/Yoga Studios, Fitness/Weight Rooms, Group X Rooms, Team Rooms and so on. Therefore, it is highly recommended that an acoustical consultant be engaged during the design phases of Fitness & Athletics areas to provide further design guidelines on a case-by-case basis. The table above provided minimum recommended constructions.

- Sound isolation performance of the demising assembly is not critical; partition at the discretion of design team.

"N/A" Adjacency is acoustically incompatible and should be avoided unless addressed by an acoustical consultant.

Creative Art Areas Minimum Recommended Partition Sound Isolation Performance (STC RatingS) *	Audience Area	Box Office/Lobby /Concessions	Ceramics/ Drawing/ Painting/Sculpture Studio	Changing/ Dressing Room	Choral Room/Concert Band Room	Classroom/ Lecture Room	Costume/Staging Area\ Set Fabrication	Dark Room and Lab Print Making Studio	Digital Music/ Mac/MIDI Lab	Dimmer/Amp Room	Film Editing/Record Control/ Sound Control Room	Flex Studio	Followspot Booth	Gallery	Green Room	Group Critique/Work Room	Kiln Room	Loading Dock	Mechanical Equipment Room	Multi-Use Black Box Space/Small Recital Hall	Music Library	Office	Piano Lab/ Practice Room	Restroom	Sound & Light Lock	Warming Kitchen	Welding Space	Wet Room
Audience Area																												
Box Office/Lobby/Concessions																												
Ceramics/Drawing/Painting/ Sculpture Studio																												
Changing/Dressing Room																												
Choral Room/Concert Band Room																												
Classroom/Lecture Room																												
Costume/Set Fabrication/ Staging Area																												
Dark Room and Lab Print Making Studio																												
Digital Music/Mac/MIDI Lab																												
Dimmer/Amp Room										-	N/A	50	55	55	50	55	50	45	5									
Film Editing/Recording Control/ Sound Control Room											N/A	N/A	55	N/A	N/A	N/A	60	N/A										
Flex Studio												60	N/ A	60	50	55	50	N/A										
Followspot Booth													-	55	55	55	55	N/A	6									
Gallery														50	50	50	50	60										
Green Room															45	50	50	60	6									
Group Critique/Work Room																50	50	60	6									
Kiln Room																	-	55	6									
Loading Dock																		-	5									
Mechanical Equipment Room																												
Multi-Use Black Box Space/Small Recital Hall																												
Music Library																												
Office																												
Piano Lab/Practice Room																												
Restroom																												
Sound & Light Lock																												
Warming Kitchen																												
Welding Space																												
Wet Room																												