BCIT

Acoustical Guidelines

April, 2022

Facilities & Campus Development

1.0 GENERAL

.1 Introduction

.1 Consultants are to provide high-quality acoustical design and construction practices for good speech intelligibility within learning and meeting spaces, adequate speech privacy in offices and conference rooms, adequate sound isolation between rooms, and the control of ambient noise in cafeterias, workshops, and other open areas.

.2 Definitions

.1 **Noise Isolation Class** (NIC): a metric to indicate the actual difference between the sound level in the source room and the sound level in the receiving room.

.2 **Sound Transmission Class** (STC): a lab rating of how well a partition attenuates airborne sound in the absence of any acoustic flanking transmission.

.3 **Noise Reduction Coefficient** (NRC): often used to describe the effectiveness of sound-absorbing materials with a scale of 0 (perfectly reflective) to 1.0 (perfectly absorptive). (Acoustic ceiling systems use this reference).

.4 **Ceiling Attenuation Class** (CAC): represents the amount of sound attenuation from one room, up through the ceiling tile, over the top of the wall, and down through the ceiling tile in the adjacent room.

.5 **Speech Privacy Class** (SPC): a metric to indicate the degree to which conversation in a typical office or meeting room will be intelligible to listeners in an adjacent space. SPC is determined by adding the noise isolation between spaces (NIC) to the background noise level at the receiving location. The simple calculation is: SPC = NIC + dBA (dBA is the A-weighted background noise level).

.6 **Equivalent Sound Level** (Leq): an energy average of sound levels over a given period of time. For example, the Leq24 is averaged over a 24-hour period.

.7 **Reverberation Time** (RT): a measure of the time in seconds it takes for an impulse of sound such as a loud hard clap to decay by 60 dB (become inaudible) in a space. Lower reverberation time yields better speech intelligibility by minimizing the audible blurring of individual speech sounds.

.3 References / Resources

.1 BC Building Code (or Vancouver Building Bylaw), Fire and Sound Resistance Tables, Division B, Part 9.

.2 ASA (2010) Acoustical Society of America, Classroom Acoustics for Architects (free guide) https://acousticalsociety.org/classroom-acoustics-booklets-and-standards.

.3 ANSI/ASA standard S12.60-2010, Acoustical Guidelines for Schools.

.4 ASHRAE 2019 Applications Handbook (HVAC noise levels).

.5 ASTM E557-12 (2020) (for installation of operable walls).

.6 LEED v4.1 (2020) Building Design and Construction: U.S. Green Building Council.

.7 US Gypsum (2006), Acoustical Assemblies
http://www.usg.com/content/dam/USG_Marketing_Communications/united_states/product_promotional_materials/finished_assets/acoustical-assemblies-en-SA200.pdf

2.0 PROJECT PARAMETERS

.1 New Construction and Large Projects

.1 New construction and larger renovation and addition projects shall include an acoustic consultant on the design team.

.2 Acoustical consultants are required on the design team for projects with:

.1 Spaces with ceilings higher than 4.6m.

.2 Large lecture halls and auditoriums.

.3 Large open plan learning areas.

.4 Open office areas and offices and meeting rooms where speech confidentiality is required.

.5 Spaces where acoustics have historically been problematic, for example trades shops; confirm with BCIT.

.6 Outdoor unenclosed, trades and research work areas.

.7 Residences (minimum scope to confirm compliance with current adopted edition of the BC Building Code).

.2 Small to Medium Projects

.1 Consultants are to provide for the following basic considerations in the designs and may include an acoustic consultant on the design team to achieve optimum results. Considerations include:

.1 Sound isolation between spaces.

.2 Control of background noise from building services.

.3 Control of reverberation, echoes, and other acoustical defects in classrooms, meeting rooms and open areas to permit good intelligibility.

.4 Control of reverberant noise buildup in trade shops, service spaces, cafeterias, gyms and other noisy areas.

.5 Level of acoustic privacy needed in terms of room usage – private offices, open offices, meeting rooms, conference spaces, study areas, libraries, etc.

3.0 ACHIEVING STC REQUIREMENTS

.1 Typical STC Requirements for Acoustically Sensitive Spaces

TABLE 1 – Typical STC Requirements for Acoustically Sensitive Spaces	
Classrooms, lecture halls, and labs to any adjacent rooms	STC 50-55 walls*
Shops, mechanical, music, theatres to noise-sensitive rooms	STC 60 walls*
Between standard offices	STC 45 walls*
Standard offices to corridors or common areas	STC 45 walls*, standard door, 6mm glazing
Confidential offices to adjacent offices	STC 50 walls*
Confidential offices to corridors or common areas	STC 45 walls*, STC 30-40 door, STC 39 glazing
Standard meeting rooms to any adjacent rooms	STC 50 walls*
Standard meeting rooms to corridors or common areas	STC 45 walls*, STC 30 doors
Confidential meeting rooms and video conferencing rooms to any adjacent rooms	STC 55 walls*
Confidential meeting, video conferencing rooms to corridors	STC 50 walls*, STC 40 doors, STC 39 glazing
*In all cases, floor and ceiling assemblies should have similar or higher STC ratings than those listed for walls.	

.2 Interior Walls and Floor / Ceilings

.1 STC ratings for a wide variety of wall and floor/ceiling systems are readily available from many sources. Two of the most complete references are the BC Building Code (Fire and Sound Resistance Tables in Division B, part 9) and the US Gypsum booklet Acoustical Assemblies, which can be downloaded from the US Gypsum website.

.2 To achieve the desired STC ratings, include acoustical sealant below the plates in stud walls, between the bottom of gypsum board and the structure behind, around all penetrations for services, and wherever there is a crack, hole, or the possibility of one developing.

.3 Where high levels of low-frequency sounds must be attenuated (for example, deep bass sounds from equipment or music), consider strategies such as provision of masonry walls or double-stud walls with multiple layers of gypsum board and large air cavities.

.3 Interior Glazing

.1 Wherever sound isolation is a concern, BCIT prefers the use of single-pane laminated glass because it also provides safety benefits in the event of breakage. The minimum thickness should be 6 mm but a thickness of up to 12 mm may be required to achieve higher STC ratings. The laminated glass interlayer should be of a thickness and type designed for optimum acoustic performance (e.g., Saflex Acoustic PVB). Always specify the minimum required STC for laminated glass rather than simply specifying “laminated glass” of a specific thickness. Refer to Table 2 for representative STC ratings.

.2 TABLE 2 – Design Guidelines for Typical STC Ratings of Glazed Assemblies:

STC Ratings of Glazed Assemblies	
Glass Thickness (mm)	**STC**
Non-Laminated Glass	
3	29
6	31
8	34

12	37
Laminated Glass	
6	36
10	38
12	39
16	41

.3 Where exceptionally good sound isolation is required, consider minimizing the area of glazing and/or utilizing a double-glazed unit with one or both panes laminated. Confirm STC ratings with manufacturer (e.g., https://www.saflex.com).

.4 Carefully consider and confirm with BCIT the amount of glazing to be used in rooms where speech security is required, as glazing typically reduces the room's overall STC rating.

.4 Interior Doors

.1 Carefully consider and confirm with BCIT the quantity and location of doors accessing rooms requiring high levels of speech privacy, as each door reduces the room's overall STC rating and speech privacy. For design guidelines:

.1 Any door with a large undercut will generally have an STC rating of less than 20.

.2 Metal or solid-core wood doors without perimeter seals typically provide STC 20.

.3 Metal or solid-core wood doors with effective perimeter seals and automatic door bottom typically provide STC 30.

.4 Commercial sound-rated door sets (door, frame, and seals) are available with a wide range of STC ratings in the STC 30 to 46 range.

.2 To achieve STC 30 with standard doors:

.1 Provide smooth-topped threshold saddles where the floor finish is carpet or the floor finish beneath the door is not flat and smooth.

.2 Provide perimeter sound seals and automatic door bottoms (e.g., Pemko, Zero, Draft Seal).

.3 Provide airtight astragal seals on double doors.

.4 Ensure that all sound seals are accurately fitted and adjusted to eliminate leaks.

.5 Consider provision of cam-lift hinges, which improve the sealing effectiveness by lifting and lowering the door as it swings.

.5 Interior Operable Walls

.1 Use of operable walls should be avoided where possible due to poor acoustic performance and potential maintenance issues. Note that sound isolation provided by operable walls, once installed, is often well below their published STC ratings.

.2 There are three types of operable walls:

.1 Accordion Fold Flexible Partitions (STC 35-44) – not recommended and accepted only with approval from BCIT.

.2 Panel Walls with Fixed Seals (up to STC 44) – not recommended and accepted only with approval from BCIT.

.3 Panel Walls with Retractable Mechanical Seals (up to STC 55) – preferred solution and to be used where acoustical performance is paramount.

.3 Accordion Fold Flexible Partitions and Panel Walls with Fixed Seals are best avoided as they rely on drag seals that don't provide a sufficient seal for acoustic performance, and are subject to damage by friction and tearing, especially over carpet. Use these types only where sound isolation is not important.

.4 Where acoustical performance is paramount, use panel walls with retractable mechanical seals. These partitions have superior acoustical performance, are easier to operate, and are generally reasonably robust (including the seals). It is preferable to have operable seals along both top and bottom. Partitions with fixed top seals are harder to operate and are prone to damage and wear of the seals, with a corresponding degradation of the acoustical performance.

.5 For good performance of the operable wall, the floor and supporting ceiling bulkhead must be flat, smooth, plumb, and rigid in order to permit airtight seals. This should be emphasized on construction drawings. The supporting bulkhead above the operable wall should be designed to provide an STC rating which is at least as high as the STC rating for the operable wall. ASTM Standard E557-12 provides best practice installation guidance.

.6 In carpeted rooms, the carpet should be interrupted and a smooth threshold installed for the bottom seal to act against.

.7 Once the moveable wall is installed, the completed installation is to be tested by the owner's acoustical consultant with an agreed upon Noise Isolation Class (NIC) value specified and agreed upon as a condition of acceptance.

.6 Acoustical Flanking Paths

.1 Minimize flanking paths around acoustically rated walls.

.1 For walls with ratings of STC 45 or higher, the preference is to continue the walls up to the underside of the structure above them.

.2 For walls with ratings of less than STC 45, full height installation is still preferable but alternatively, only one (1) layer of gypsum board on the studs above the acoustic ceiling tile level or use of proprietary ceiling plenum barriers may be acceptable if suspended ceilings on both sides of the wall are gypsum board or ceiling tiles with a Ceiling Attenuation Class (CAC) rating of at least 35.

.3 Ensure all penetrations through plenum barriers by ducts, pipes, or conduits are sealed.

.4 The preferred arrangement is to return air from each office into the adjacent corridor or open area but if return air must pass through plenum barriers, provide acoustically lined elbows or transfer silencers.

.2 To minimize flanking, ventilation branch ducts, especially unlined ducts, should be routed from each room to a main duct running above the corridor.

4.0 SPEECH PRIVACY

.1 Speech Privacy Requirements

.1 Provide adequate speech privacy for enclosed offices and meeting rooms. The level of speech privacy required depends upon the use of the space. Various categories of speech privacy are defined in ASTM Standard E2638-10 (2017) in terms of the Speech Privacy Class (SPC). A SPC of 75 represents “Standard Speech Privacy” and this is generally considered to be appropriate for most BCIT facilities. Any areas requiring more confidential privacy should be designed to provide SPC 80.

.2 Speech Privacy Design Guidance

.1 Consultant to confirm desired speech privacy (SPC) levels with BCIT and provide designs accordingly. Speech privacy depends not only on the STC of the separating partition but also on the background noise level in the receiving space. For design purposes, the SPC can be estimated using the formula SPC = STC + dBA. Refer to Table 1 (above) for appropriate STC ratings. For background noise levels in the receiving space, assume recommended values (refer to Section 6.1).

.3 Room Acoustics

.1 Small and medium sized classrooms: ceiling treatment to provide NRC of at least 0.70 (exclusive of ventilation and lighting).

.2 Large classrooms, lecture halls and auditoriums: engage the services of an acoustical consultant.

.3 Meeting rooms, conference rooms: ceiling treatment to provide NRC of at least 0.70 plus some wall treatment on two adjacent walls where practicable, particularly for large rooms.

.4 Video conferencing rooms: In addition to ceiling treatment, provide sound absorbing panels on two adjacent walls. Preference is for sound absorbing panels on all four walls.

.5 Learning Commons Areas: Study areas (including libraries), lounges, atriums: Provide as much sound absorption as practicable, in the form of acoustic ceilings and/or alternative treatments. This will minimize ambient noise and maximize acoustic privacy.

.6 Active Learning Areas: Provide as much sound absorption as practicable to provide good localized speech intelligibility while minimizing sound transmission from one area to another, consider:

.1 Ceiling with high NRC.

.2 Sound absorbing wall panels.

.3 Carpeted floor.

.4 Soft furnishings.

.5 Moveable screens and furniture to act as sound barriers.

.6 Electronic sound masking to maximize acoustic privacy between areas.

.7 Advice from acoustical consultant may be warranted for large areas.

.7 Cafeterias: control ambient noise with ceiling treatment providing NRC of at least 0.70.

.8 Corridors: provide sound absorptive treatment on at least 50% of ceiling to control ambient noise within corridor and to minimize noise transmission into adjacent spaces.

.9 Trades Shops benefit from as much sound-absorptive treatment as practicable. Since suspended ceilings are not always practicable, consider:

.1 Acoustical spray.

.2 Suspended baffles.

.3 Panels on upper walls.

5.0 HVAC NOISE CONTROL

.1 General

.1 Refer to ANSI standard S12.60-2010, LEED v4.1, and the ASHRAE Applications Handbook for recommended maximum levels.

.2 Mechanical consultants to select equipment with relatively low sound power levels and specify maximum allowable sound power level in the mechanical specifications.

.3 Locate noise-generating components (e.g. VAV boxes, fan coils, dampers) over corridors or in non-sensitive spaces.

.4 Avoid excessive air velocities in ducts.

.5 Select grilles and diffusers such that their total noise contribution will be well under the noise criterion for the room. NC ratings published by manufacturers are for one unit only and assume ideal (i.e. non-turbulent) flow. Each time the number of diffusers is doubled, total diffuser noise increases by 3 dB. Flexible duct or sharp bends at the entry to diffusers can increase noise significantly relative to published data.

.6 Noise levels in sensitive spaces should be predicted using methods such as those recommended by ASHRAE.

.1 Silencers and/or acoustical duct lining should be provided as necessary to achieve the recommended noise criteria.

.2 Silencers are generally more effective than duct lining, particularly for low-frequency noise or where space is limited, but pressure drop and self-generated noise from silencers need to be considered.

.7 While round duct minimizes breakout noise, rectangular duct is generally more suitable where acoustic lining or silencers are required.

.8 Duct work should be laid out to avoid direct paths between adjacent noise-sensitive spaces.

.9 Do not rely upon open ceiling plenums for return air from noise-sensitive spaces.

.10 Mechanical equipment should be vibration isolated from the building structure in accordance with ASHRAE recommendations.

6.0 PLUMBING NOISE CONTROL

.1 Strategies to Employ

.1 Employ these strategies to avoid plumbing noise problems:

.1 Do not locate supply or waste lines near noise-sensitive spaces. If unavoidable, specify that they should be acoustically lagged using mass loaded vinyl with a decoupler layer between the vinyl and the piping.

.2 Do not locate washrooms adjacent to noise-sensitive spaces whenever possible. Avoid plumbing walls/chases that are shared with classrooms or other sensitive spaces.

.2 Alternate Strategies

.1 If the strategies outlined in 6.1.1. are not possible, consider using:

.1 Double stud walls with plumbing attached only to the washroom side.

.2 Vibration isolating pipe clamps or hangers.

.3 Acoustically wrapping pipes.

.4 A combination of the strategies listed above.

7.0 OUTDOOR TRADES SHOPS

.1 General

.1 Design outdoor trades shops to avoid excessive noise at or within BCIT property lines. This includes noise from HVAC equipment, machine tools and activities such as hammering:

.1 Ensure that noise emission to the outdoors complies with applicable municipal noise bylaws.

.2 Confirm with BCIT, locations of existing or proposed future noise sensitive outdoor areas such as campus walkways, outdoor cafés or seating areas. Limit noise at nearest point on walkways to 60 dBA and limit noise in outdoor seating areas to 55 dBA.

.2 Strategies to Employ

.1 Employ the following strategies to limit noise emissions from the outdoor shops:

.1 Provide efficient sound absorbing treatment over entire ceiling and any available upper wall surfaces (refer to Section 5.1).

.2 Provide partial or full-height walls to the extent practicable, particularly between the outdoor shop and BCIT property lines.

.3 Where viewing into the shops from outside is desired, consider the use of glazing between the shop and any noise sensitive viewing areas.

.4 Design ventilation systems, including dust collection systems to minimize both interior and exterior noise.

.5 Retaining an acoustical consultant is strongly advised.

8.0 STUDENT RESIDENCES

.1 General

.1 Engage the services of an acoustical consultant to confirm compliance of demising walls and floor with the Sound Transmission requirements of the current adopted edition of the BC Building Code (or Vancouver Building Bylaw where applicable).

.1 Perimeters of acoustically rated gypsum board walls should be caulked airtight with non-drying, non-hardening caulking compound prior to taping. The ceiling gypsum board should be isolated from the wall gypsum board with caulk, so that it is air tight prior to taping.

.2 Use 25-gauge steel studs in sound rated walls. If load bearing studs are required for structural reasons, attach gypsum board using resilient channels or check with an acoustical consultant for other options.

.3 Double frame wall assemblies should avoid any bracing across the air gap between the studs. If required for structural reasons, bracing should be limited to gypsum board braces (or 25-gauge studs) spaced at a minimum of 1200 mm apart (e.g., at mid height between floor and ceiling). The gypsum board brace (or the 25-gauge stud bracing) should only connect to the web of the stud and should be cut short so as not to contact the gypsum board sheets that are attached to the flange of the stud.

.4 Outlet boxes in party walls should be staggered at least one stud spacing from those on the opposite side so there are no back-to-back outlets. Where the density of building services does not permit off-setting of outlet boxes, then they should be sealed and insulated from the wall cavity by wrapping with dense putty pads (e.g., Hilti Putty Pads, Lowry #10 pads or the 3M Stix MP+). The openings in the drywall for the outlet boxes should be as small as possible and sealed around the perimeter with resilient caulking.

.5 Penetrations through party wall assemblies should be avoided where possible but where unavoidable (e.g. for plumbing connections), openings should be carefully cut to size, leaving a minimal oversize gap (e.g., 6 mm) which should be sealed with permanently flexible caulking or fire stop.

.6 Avoid installing recessed cabinets (e.g. medicine cabinets) in party walls.

.7 Plumbing (including rain water leaders) should not directly contact drywall or studs. Position risers/wastes in centre of wall chase to meet this requirement. Avoid plumbing within party walls. Provide chases as required to avoid this condition.

.2 Design floor/ceiling assemblies over acoustically sensitive spaces to achieve an Impact Insulation Class (IIC) rating of at least 55.

.1 Utilize acoustic underlayments by manufacturers that provide reliable IIC test data and which are intended for use beneath the specified finish floors.

.2 Provide shock absorbers or rubber bumpers on kitchen cupboards and drawers to minimize transmission of impact noise to neighbouring residential units.

.3 Where residential building facades are exposed to noise from road traffic or other sources of environmental noise, design exterior walls and windows to provide interior noise levels not exceeding the following 24-hour Equivalent Sound Levels (Leq):

.1 Bedrooms - 35 dBA.

.2 Living, dining, recreation rooms - 40 dBA.

.3 Kitchens, bathrooms, hallways - 45 dBA.

.4 Design HVAC systems which serve bedrooms to not exceed 35 dBA.

.5 Adhere to plumbing noise control guidelines in Section 6.0.

*** END OF **ACOUSTICAL GUIDELINES** ***