ACUSTICA

SHAPING SOUND THROUGH ARCHITECTURE

To: Tayloe Harding – University of South Carolina School of Music
From: Shimby McCreery – Acustica
Date: 29 April, 2022
Re: **Acoustical Consulting Proposal**
Band Rehearsal 016 Assessment

Dear Tayloe,

Thank you for contacting Acustica to perform an acoustical analysis of Band Rehearsal Room 016 and Music Rooms 201/220 at the University of South Carolina's School of Music. This document summarizes my findings from my onsite testing on 4/20/22 as well as recommendations for improving upon the existing conditions. For the purposes of this report, treatments are described in narrative form with approximate square footages and costs included. Recommendations that are approved for construction will need to be further refined in conjunction with a contractor. Please do not hesitate to let me know if you have any questions or need any further information.

1) Band Rehearsal 016

Band Rehearsal 016 is an existing large rehearsal room that hosts a variety of ensembles within the School of Music. These include but are not limited to concert band and jazz ensembles. Presently, the room functions well, but sound levels within the space are too loud when hosting larger bands and jazz ensembles. Excessive loudness during rehearsal conditions is a serious concern as it can lead to long-term hearing loss in students and faculty. Ensuring appropriate listening conditions within rehearsal facilities is also a key component in the evaluation and accreditation process for the School of Music.

a) Evaluation

On 4/20/22 I visited the USC Music Building to perform an insitu evaluation of the interior acoustics of Band Rehearsal 016. During this visit, I observed a rehearsal by the concert band and performed sound pressure level and reverberation time measurements to document the existing conditions. Room 016 includes a large number of absorptive curtains that largely cover the side and rear walls of the space. Due to existing loudness concerns these curtains are left permanently exposed in the space. The room also includes a large number of permanently exposed absorptive wall panels that further assist with loudness and reverberation control in the space. The floor is an acoustically reflective VCT tile finish. The ceiling is comprised of a ceiling grid with a mix of acoustically diffusive/reflective panels and perforated metal tiles that allow sound to access the volume above the finish ceiling.

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Band Rehearsal 016

A reverberation time (RT) measurement was taken with the sound source in the approximate center of the room and the measurement microphone positioned near the conductor's stand. The results are displayed in the table below:

Frequency (Hz)	63	125	250	500	1000	2000	4000	8000
RT (s)	1.05	1.02	.88	.83	.74	.76	.69	.57

These values align with typical recommendations for a large Band Rehearsal Room. With the curtains retracted, the reverberation would increase to levels more attuned to Orchestral rehearsal. Despite the well-controlled reverberation, the users still experience elevated loudness levels that lead to discomfort and potential hearing loss from extended exposure.

In order to document typical rehearsal sound levels, a sound level meter was positioned at several locations throughout the Band ensemble and sound levels were registered as the band performed several passages from an upcoming performance. Measurements were taken with a Type 1 sound level meter for 1-minute intervals. Levels were not recorded when musicians were not playing but it is fair to assume that at a minimum, 50% of the rehearsals will be active playing by the band. Consequently, we would estimate the exposure of band students and faculty as a minimum of 30 minutes per 1 hour rehearsal. For the purposes of compliance and comparison with NIOSH standards, sound pressure levels are reported as A-Weighted values (dBA). Measurement positions included:

- Conductor's stand
- Middle of Brass section
- Equidistant from Brass, Drums and Piano

The following table summarizes average levels measured for each of the documented conditions. I was not able to capture identical passages for each measurement so levels inherently vary as a function of both location and the passage that was recorded. Multiple measurements were taken at the Conductor position during different selections as it was subjectively the loudest location in the room.

Measurement Position	Average Level (dBA)	Max Level (dBA)
Conductor Passage #1	97.1	104.6
Conductor Passage #2	97.2	106.5
Conductor Passage #3	98.1	107.6
Brass Section	97.3	106.6
Brass/Drums/Piano	96.5	104.7

Appendix A at the end of this document includes background information on industry standards and relevant considerations for loudness levels and hearing loss in music rehearsal environments. Based on a comparison of the insitu measurements taken in Band Rehearsal 016 and references cited in Appendix A, it can be concluded that the **levels produced in the concert band rehearsals approach levels that would lead to both temporary and long-term hearing loss for students and faculty.** This assessment is based on a combination of average noise exposure of 97+ dBA combined with frequent passages that exceed 105 dBA.

The easiest solution to this problem would, of course, be to provide students and faculty with hearing protection. However, in a musical education and rehearsal setting, blocking out full frequency sound dramatically reduces the quality of the educational and performance experience. Hearing oneself and other members of the ensemble is a crucial part of the learning and performance experience. **Consequently, Acustica strongly recommend that steps be taken to alleviate the excessive sound pressure levels to which students and faculty are being subjected.**

b) <u>Recommendations</u>

Two key factors that affect loudness in an enclosed space are the room volume and finishes. In its current configuration, Band Rehearsal 016 has ample volume to handle the sound levels being introduced by the instruments (although it is not uncommon for comparable rehearsal rooms to have a higher ceiling). Consequently, these recommendations focus on changes to interior finishes to help further control loudness. It should be noted that many band instruments alone are capable of producing sound pressure levels on par with those documented by the measurements. Room acoustics solutions cannot affect the sound power of a source, but can address the role of an enclosed space in reflecting and consequently sustaining sound levels in a cumulative fashion.

In order to control loudness, additional absorptive materials should be introduced into the space. Based on the large quantity of absorptive wall finishes already present in the room, the floor and ceiling are the areas of the room that present the greatest opportunity to reduce loudness for students and faculty. There is limited wall area behind the conductor that could conceivably receive additional wall applied panels.

Band rooms often have a hard, acoustically reflective floor for several reasons. The sound of this material more closely resembles performance conditions on a typical stage. Hard floors are also easier to clean and maintain. **If acceptable to the school of music, a change to carpet flooring in Band 016 will help reduce loudness by intercepting and absorbing high frequency energy from first order reflections that are closest to students and faculty.** This change will not have a significant impact on low frequency energy, but it is typically frequencies in the 1kHz to 8 kHz range that are most associated with the experience of harsh loudness. This is also the range of human hearing that is most severely impacted by hearing loss due to exposure to loud sounds.

The current ceiling does not appear to have explicitly absorptive tiles in the ceiling grid. The perforated metal panels allow sound to travel up into the ceiling cavity effectively enlarging the acoustic volume of the space. This "enlargement" can be beneficial in that it provides a pressure release for the sound to escape the main room volume before reentering at a reduced level. However, this also tends to extend the effective reverberation time of the room. The diffusive ceiling tiles do little to absorb sound and primarily scatter the sound by sending reflections in multiple directions at somewhat reduced sound levels. **Switching out diffusive and perforated panels for acoustically absorptive ceiling tiles will help to reduce loudness levels and reverberation time in the space.**

It should be noted that these measures targeting loudness and reverberation time are primarily beneficial for issues affecting the concert band. These changes have a subjectively negative impact on the functionality of the space for quieter ensembles like orchestral or chamber groups that benefit from a livelier space. If the above changes are implemented, the school of music should make use of the operable curtains to tune the space for ensembles that prefer a more reverberant room.

c) <u>Summary and Cost</u>

Exact room dimensions were not taken, but the footprint of the space is estimated to be approximately 70' x 46' x 21'. Consequently, the quantities and associated costs cited below are preliminary and will need to be refined for actual implementation. Acustica is not a cost estimator and has limited access to information regarding current market pricing for construction materials and labor. Estimates cited below are based on available information from recent comparable projects.

i) Change flooring to carpet: It is recommended that the existing flooring be covered with a continuous carpet finish. There are many options and specific models are not part of this evaluation and report. In general, thicker carpet and options that include a pad will be more effective at absorbing sound.
   - **(1) Approx. 3220 s.f. of carpet tile at $5.20/s.f. = $16,744 to install new carpet tile over the entire flooring.**

ii) Change ceiling tile to absorptive acoustical ceiling tile: To maximize absorption, ceiling tiles should have a minimum noise reduction coefficient (NRC) of .9. Two tiers of performance could be considered: switch out all ceiling tiles for absorptive ACT or switch out 50% to maintain a mix of absorptive, diffusive and transparent tiles. The latter approach would be more amenable to a multipurpose rehearsal room, while the former will be more effective at reducing loudness and reverberation.

(1) Approx. 3220 s.f. at $5.40/s.f. = $17,388 to completely replace the ceiling tiles with nigh NRC tile. This pricing is based on installing a new grid, so the actual cost could be significantly lower to simply switch out tiles.

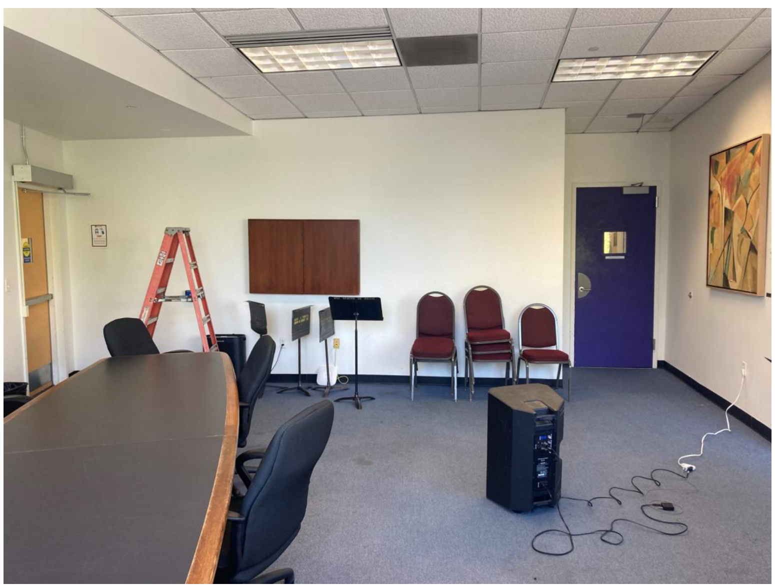
(2) If an intermediate level of intervention is preferred, the layout and placement of the various ceiling tiles would be adjusted and optimized for loudness control. In this case, there would be material cost savings but the labor cost associated would likely remain similar.

iii) Add absorptive wall panels behind Instructor: While there is limited available wall area, adding wall treatment directly behind the conductor could help to reduce 1st order reflections back to room occupants.

(1) Approx. 150 s.f. of 2" fabric wrapped absorptive wall panels at $22/s.f. = $3300

2) <u>Music Rooms 201 and 220</u>

Music Rooms 201 and 220 are horizontally adjacent spaces used by the School of Music for chamber music rehearsal. Room 220 was not designed for music rehearsal and is consequently not enclosed by typical acoustical isolation partitions. Currently, there is excessive sound bleed between 201 and 220, which limits the school's ability to use them for simultaneous rehearsal.



Music Room 201

a) <u>Evaluation</u>

In order to assess the existing sound isolation between these rooms a Noise Isolation Class (NIC) measurement was performed. This is intended to document the transmission loss across the assembly using a metric akin to Sound Transmission Class (STC) which is typically reserved for laboratory settings. A visual inspection of the assembly separating the spaces was also conducted to identify any obvious weak points.

The NIC measurement was performed with a sound source in 201 playing pink noise and the resulting levels were documented in 220. The measurement was normalized using the reverberation time in the receiving room, 201. The measurements produced a Normalized Noise Isolation Class

(NNIC) of 42. This value is consistent with a metal stud wall with batt insulation in the cavity and one layer of gypsum board on either side. **It is significantly underrated for separation of adjacent music ensemble rehearsal rooms where an NNIC of 65-70 would be considered appropriate.**

While the test signal was playing, I listened and scanned the wall separating the spaces. Aside from the obvious weakness of the assembly which allowed significant energy to pass through the lightweight wall, several other weak points were identified:

- Return air transfer duct above ceiling
- Unsealed baseboards
- Unsealed penetrations
- Electrical backboxes

b) Recommendations and Cost

In order to provide adequate sound separation between Music 201 and 220 all of the issues outlined should be addressed. The following section outlines steps that should be taken in order to allow for simultaneous rehearsal in these rooms. They are listed in order of decreasing impact to the overall assembly performance.

Pricing these items is difficult in the context of a small intervention as cost estimates from larger projects do not necessarily translate to this smaller scope. Materials and labor may be more expensive per unit area as economies of scale will not apply. Preliminary cost estimates for each item are included below as a general starting point for budgetary discussions.

i) Install a new single sided wall in Music 220 along the length of the entire party wall. This assembly shall consist of 2 layers of 5/8" Type C gyp. board and 1 layer of Quietrock 530 at the room interior on metal studs spaced 24" on center with batt insulation in the cavity. Framing for the wall shall be spaced 2" from the existing party wall and shall not make contact with any part of that assembly. The new wall shall be sealed airtight around the full perimeter to the side walls, floor and deck above the finish ceiling. Gyp. should be kerfed to continuously seal to the metal deck. **Approx. cost: $4500-6000**

ii) Add a layer of Quietrock 530 5/8" gypsum board to the Music 201 side of the wall. The board shall be installed continuously from floor to deck above the ceiling and sealed airtight around the full perimeter. Gyp. should be kerfed to continuously seal to the metal deck. **Approx. cost: $1500-2000**

iii) The return air transfer above the ceiling should be extended by a minimum of 8' of internally lined rigid metal duct work that incorporates two 90-degree elbows. Ideally the transfer would be extended on both sides of the wall with at least one lined elbow above each room. **Approx. cost: $1000-1500**

iv) Prior to installation of new wall materials the existing vinyl base should be removed from both sides of the wall and a continuous bead of 100% silicone sealant should be used to seal the gap between gyp. board and flooring airtight. **Approx. cost: $100**

v) Any electrical backboxes that are adjusted or moved as part of the new construction should be back wrapped with firestop putty so they are sealed airtight. **Approx. cost: $500-2000 depending on the extent of electrical reworking that is required.**

vi) Any penetrations through the wall should be inspected and caulked airtight with a silicone sealant. **Approx. cost: $100**

3) Product References

The following section includes information on specialty materials that are included in the recommendations above. This is by no means an exhaustive list, but included as a basis of design for pricing.

- Acoustical Ceiling Tile (NRC .9+)
  - Armstrong models Optima PB, Lyra PB, Calla High NRC
  - USG model Halcyon

- 2" Fabric Wrapped Wall Panels
  - Kinetics High Impact Hardside
  - AVL Acoustech High Impact

- Quietrock 530 Gyp. Board

- 2" Duct Liner
  - Owens Corning
  - Johns Manville

- Backbox Firestop Putty
  - Hilti CP 617
  - 3M MPP+

Please let me know if you have any questions on the contents of this report. I look forward to discussing these findings and recommendations with you further.

Sincerely,

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Principal

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Appendix A – Background

There are numerous resources covering recommended noise levels in both industrial and musical environments. The National Association of Schools of Music (NASM) provides ample information with multiple references on this topic that can be found here:

https://nasm.arts-accredit.org/publications/brochures-advisories/nasm-pama-hearing-health/

We recommend that faculty and students familiarize themselves with these resources as they include information on long-term hearing protection under potentially damaging circumstances. The most common references for allowable levels in a workplace are summarized in the table below:

Recommended Maximum Daily Exposure Times to Instances of
Continuous Noise at Various Decibel Levels*

Decibel Level	NIOSH	OSHA
85 dB	8 hours	16 hours
88 dB	4 hours	10.6 hours
91 dB	2 hours	7 hours
94 dB	1 hour	4.6 hours
97 dB	30 minutes	3 hours
100 dB	15 minutes	2 hours
110 dB	2 minutes	30 minutes
120 dB (close-range)	almost immediate	almost immediate

*NIOSH and OSHA maintain that the risk for hearing loss is increased
when continuous exposure time exceeds these recommended maximums.

Based on this table one can determine if someone is at risk for hearing loss depending on the loudness and duration of their exposure to sound levels. As average sound levels go up, the allowable time exposure decreases. At a level of 120dB no amount of time is short enough to prevent hearing loss.

The NASM published a document titled "Information and Recommendations for Administrators and Faculty in Schools of Music" which includes useful information on factors that influence the degree of hearing loss for students and faculty. A brief excerpt is included below:

"**Sound-level variation** - In some musical situations, decibel levels are essentially constant. However, in most, decibel levels rise and fall. A rock concert may constantly expose performers and audiences to dangerously high noise levels. A classical string quartet performance is usually characterized by fluctuations between soft and loud, with relatively few moments at peak volume.

Settings - Rehearsals and performances may take place in spaces that are right-sized and shaped for the size and volume levels of the individual performer or ensemble. Such spaces have adequate cubic volume. Other spaces may be too small, thus concentrating noise levels. Such spaces do not have adequate cubic volume. Some have proper acoustical treatment for their musical purposes. Others may not. Some settings feature electronic amplification; others do not. Placement of individual musicians in ensembles is also a factor in sound-level exposure. Settings have a significant effect on sound levels.

Distance - The distances between individual musicians and between performers and audience members influence a person's sound-level exposure. Generally, the closer a person is to the source of music or source of amplification, the greater the sound level. This obvious point has applications in many decisions about hearing health.

Length of Exposure - The amount of loud sound varies by type of music, by composition, style, and setting, and by artistic and personal choice. Length of exposure is critical in calculating whether over exposure is occurring and hearing loss is a consideration."

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