

Upper Darby High School Auditorium

ROOM ACOUSTICS REPORT

June 30, 2023



PREPARED FOR
Damion Spahr
VP Development & Preconstruction
SiteLogIQ



PREPARED BY
Ethan Savage
Associate Consultant

Scott Hulteen
Senior Consultant
Metropolitan Acoustics

June 30, 2023

Damion Spahr
VP of Development & Preconstruction
SiteLogIQ
3300 North 3rd Street
Harrisburg, PA 17110

Re: Upper Darby High School Auditorium
Room Acoustics Report

Dear Mr. Spahr:

Metropolitan Acoustics has completed a room acoustics analysis for the Upper Darby High School Auditorium in Drexel Hill, PA. The project entails the renovation of an auditorium, including replacing seating, floor finishes, and removing existing baffles. This report addresses interior room acoustics.

The information in this report is intended to be used as a guide for architectural disciplines so appropriate acoustical performance can be achieved. These recommendations are based on existing drawings received May 16, 2023, renovation drawings dated September 9, 2023, a site survey conducted on May 18, 2023, and correspondence with Schrader Group.

Please let us know if you have any questions regarding this information.

Best regards,

metropolitan acoustics, llc



Ethan Savage
Associate Consultant
e.savage@metro-acoustics.com
MA#230227



Scott Hulteen
Senior Consultant
s.hulteen@metro-acoustics.com

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ACOUSTIC TERMINOLOGY

Sound Level

Background sound levels in unoccupied rooms from mechanical and exterior sources are typically specified in terms of Noise Criteria (NC) ratings. The NC is a single-number rating derived from octave band sound pressure levels from 63 to 8000 Hz. A higher number corresponds to louder sound levels. For reference, a 3 dB difference in ratings represents a just-noticeable difference, a change of 5-6 dB is clearly noticeable, and a sound level that is 10 dB higher is perceived to be twice as loud.

Reflection

A reflection is the redirection of sound energy. Reflected sound can be either beneficial or detrimental to room acoustics depending on the magnitude, direction, arrival time, and the intended function of the room under design. For example, reflective surfaces can be used to project sound toward the audience in the rear of a lecture hall, and lateral reflections can enhance the sense of envelopment in a performance venue. On the other hand, reflections from a hard ceiling can degrade speech privacy in an open office, and reflections from a nearby surface in a crowded room can lead to excessive sound buildup.

Echoes

An echo is a reflection of direct sound that is discernible above reverberant decay in a room. There are several types of echoes including flutter echoes, slap echoes, and focusing. Flutter echoes are repeated reflections typically between hard, parallel surfaces. A slap echo is an excessively delayed reflection from a surface back to the source location. Focusing is a type of echo caused by concave surfaces that converges sound energy to a single point. Creep echo is also caused by concave surfaces where a series of reflections along the curvature is clearly audible on the opposite side.

Reverberation

Reverberation is the persistence of reflected sound after direct sound is produced. The reverberation time (RT), which is defined as the time it takes a sound to decay 60 decibels, is frequency-dependent where some frequencies decay faster than others depending on the finishes in a room. The RT is proportional to the volume of a room and inversely proportional to the amount of acoustically absorptive materials.

Unless otherwise noted, when a reverberation time is reported as a single number, it is the mid-frequency time: the average of the 500 and 1000 Hz octave bands.

EXISTING CONDITIONS

During a site survey conducted on May 18, 2023, the following finishes were observed in the auditorium:

- Ceiling: metal deck, suspended plywood baffles
- Walls: acoustic CMU, gypsum board (GWB), CMU
- Floor: carpet, wood stage
- Seating:
 - Center seating section: fabric upholstered seats
 - Wing seating sections: vinyl covered seats

The auditorium consists of 3 seating wings and a center stage, the side seating wings are perpendicular to the stage. We understand that the auditorium is used as a multipurpose space. The following are typical events and performances that are held in the auditorium:

- Music performances as follows:
 - School choir performances with approximately 200 performing members
 - School band/orchestra performances with approximately 60 performing members
 - ♦ School band and choir performances are sometimes held simultaneously
 - Professional orchestra performances with approximately 75 performing members
- Theater performances
- School assemblies and meetings

Musical performances in the existing space do not currently utilize a stage shell. A sound system is used for multiple performance types; however, many musical performances are unamplified. The existing seating area contains approximately 1800 seats; 1120 of these seats are rented out for theater performances.

Figure 1 through Figure 3 show the existing conditions in the auditorium, including the plywood baffles and acoustic CMU.

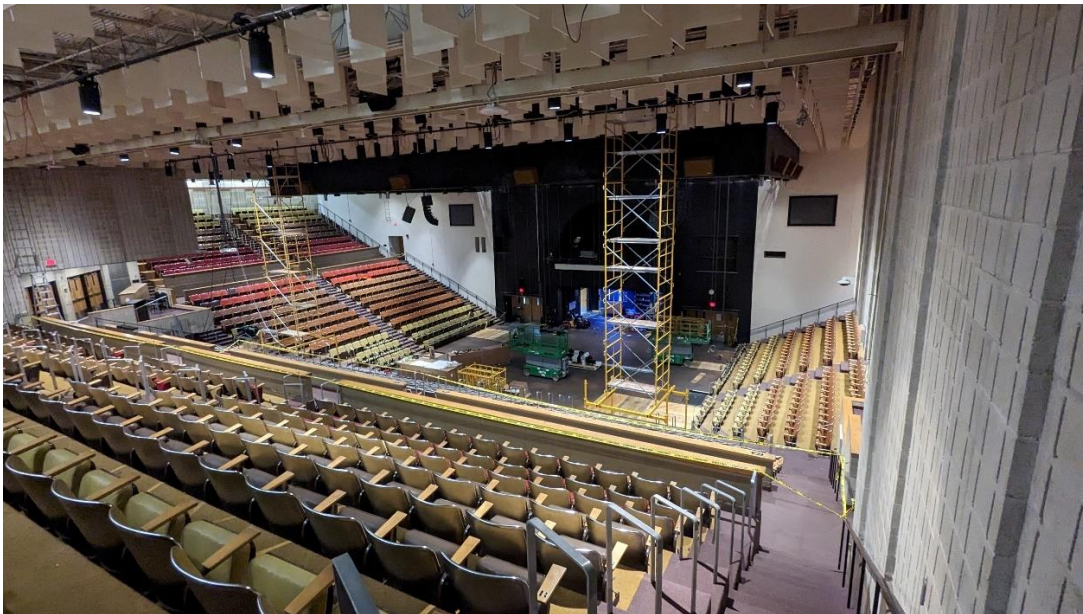


Figure 1. Existing conditions in auditorium



Figure 2. Existing acoustic CMU

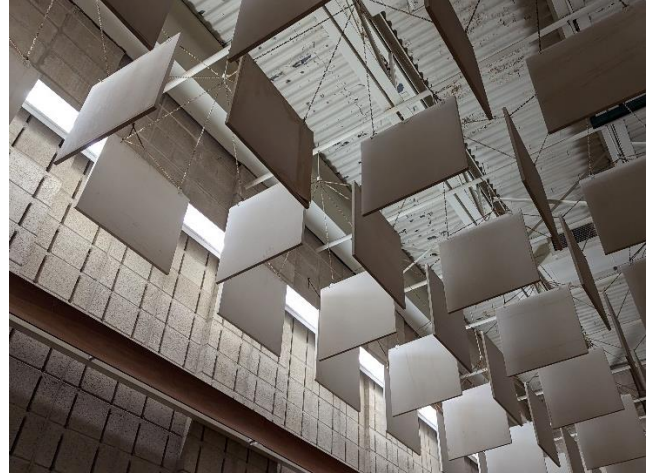


Figure 3. Existing plywood baffles

We observed the space for undesirable echoes. No slap or flutter echo was observed during the time of our testing.

We also measured the background sound level within the space due to the mechanical system. The background sound level ranged from NC 33-39, depending on the location. For an auditorium, the industry standard design goal for mechanical noise is NC 20-25. The existing mechanical system exceeds this design goal.

TEST PROCEDURES AND RESULTS

RTs were measured in octave bands from 125 to 4,000 Hz using an NTi Audio XL2 Sound Level Meter, which meets ANSI S1.4 criteria for a Type 1 sound level meter. Interrupted amplified broadband noise using a JBL PRX710 loudspeaker and pink noise generated by an NTi MR-PRO was used as the sound source. Measurements were conducted at multiple locations in each space, which was unoccupied at the time of testing. Table 1 below show the results of our testing.

Table 1: Measured Reverberation Times (seconds) Upper Darby High School Auditorium							
Space	Octave Band Center Frequency						Mid Frequency Average
	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	
Auditorium	2.22	1.74	1.65	1.48	1.25	1.02	1.57

CLIENT-PROPOSED CHANGES

The proposed changes to the auditorium include the following:

- Removal of existing ceiling suspended plywood baffles.
- Existing vinyl seating to be replaced with new fabric upholstered seating.
- The existing carpet in the aisles is to be removed and replaced with a new carpet. VCT will be installed beneath the seating areas.
- The existing acoustical CMU is to be painted.
- New lighting and rigging will be suspended from the ceiling
 - This installation was in progress during our site survey on May 18, 2023

DESIGN GOALS

Based on the volume, use of the space, and discussion with SchraderGroup and Upper Darby High School personnel, we recommend the following design goals for the auditorium:

- RT: 1.6 seconds
- Provide diffusion/equal distribution of sound
- Direct beneficial reflections to audience
- Promote speech intelligibility and musicality
- Mitigate footfall noise
- 300 cu ft of volume per occupant
- Control reflections

ANALYSIS PROCEDURES

We built computer models to calculate reverberation times based on the location, amount, and absorptive characteristics of the interior surfaces and the volume of the rooms. The models of each space were calibrated to match the measured RT from our testing. A second set of models with the proposed changes was created, and a third set of models with modified finishes was created to achieve the design goals.

ANALYSIS RESULTS & RECOMMENDATIONS

Table 2 displays our design goals as well as the existing and predicted acoustical conditions for the auditorium both occupied and unoccupied.

Table 2. Reverberation Time Design Goals, Existing, and Predicted Conditions <i>Upper Darby High School Auditorium</i>		
<i>MA Design Goals</i>	<i>Existing Conditions</i>	<i>Predicted Conditions</i>
<ul style="list-style-type: none">• RT: 1.6 seconds	<ul style="list-style-type: none">• RT unoccupied (measured): 1.6 seconds• RT fully occupied (predicted): 1.4 seconds	<ul style="list-style-type: none">• RT unoccupied: 1.5 seconds• RT fully occupied: 1.5 seconds

As shown in Table 2, the predicted modifications will not change the RT significantly and the RT will remain slightly below the design goal. However, the existing conditions severely limit the achievable acoustical performance, as follows:

- Beneficial lateral reflections to the seating area are not achievable due to the shape of the space.
- Beneficial overhead reflections to the seating area are not achievable due to the stage location in relation to the wing seating areas, as well as the installation of new lighting and rigging that was being installed above the stage.
- Increasing the reverberation time to meet the design goal is not achievable due to the amount of acoustical CMU within the space.

To achieve these goals, drastic modifications to the space would be needed; the entire space would need to be demoed and rebuilt in a more typical auditorium layout, such as a shoebox or fan shaped space.

PROPOSED MODIFICATION DISCUSSION

As discussed above, multiple modifications will be made to the space. Each modification is discussed below with its effect on acoustics.

Removal of Plywood Baffles

The plywood baffles provide very little acoustical absorption; as a result, their removal will not drastically change the reverberation time. These baffles may provide some diffusion of sound, but we don't expect a drastic change in the performance after their removal. However, if there was a desire to replace these baffles with other diffusive acoustical treatment, it would be likely be cost prohibitive as acoustical diffusion products are costly and a large area of treatment needs to be replaced.

Painting of Acoustical CMU

After discussions with the acoustical CMU manufacturer, we understand that painting the acoustic CMU will not have a significant impact on its acoustical performance, as long as the slots in the acoustic CMU are not painted over or filled in.

Seat Modifications

The replacement of the vinyl seating will help reduce the change in RT between various audience sizes. A large portion of the existing seating is vinyl covered, which will be replaced with fabric upholstered seats. In contrast to a vinyl covered seat, the amount of absorption provided by an unoccupied fabric upholstered seat more closely resembles the absorption provided by an occupied fabric upholstered seat.

Carpet Flooring

Carpet has poor absorptive characteristics where it absorbs high frequency sound very well, but not low frequency sound. Therefore, too much carpet can cause the room to sound "boomy." Carpet will only be used in the aisles; this proposed modification is recommended as it controls footfall noise and reduces the overall amount of carpet within the space.