NEXA ACOUSTIC ENGINEERING

TECHNICAL REPORT

Acoustic Analysis & Noise Control

Engineering Report

Environmental Noise Impact & Mitigation Design for the Synapse Laboratory Complex

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Abstract

This engineering report presents the environmental acoustic analysis and noise control design for the proposed Phase II expansion of the Synapse Laboratory Complex. Baseline ambient noise surveys were conducted at the project boundary, showing exceedances of local municipal bylaws by up to 12 dBA during peak night-time operations. To address this, we present design specifications for high-performance sound transmission loss partitions and customized acoustic absorption treatments. Sound transmission class (STC) ratings were calculated for proposed wall assemblies, and reverberation times (T_{60}) in the main testing hall were modeled. Our designs reduce boundary noise levels to compliant thresholds and optimize internal speech intelligibility, ensuring a safe and productive environment.

Contents

List of Tables

List of Figures

1 Introduction

As industrial facilities, commercial centers, and residential developments expand in close proximity, the control of environmental noise is critical for personnel health, regulatory compliance, and precision engineering operations. In laboratory environments, acoustic design presents unique challenges due to the co-existence of high-amplitude mechanical plant noise (e.g., HVAC chillers, exhaust fans) and vibration-sensitive precision instrumentation [2].

This acoustic analysis report documents the noise impact assessment and subsequent noise control design for Phase II of the Synapse Laboratory Complex located in the Meridian Industrial Park.

1.1 Project Objectives

The primary objectives of this noise control engineering report are:

1. **Environmental Assessment:** Evaluate current ambient noise levels at the property boundaries of the Synapse Laboratory Complex under representative daytime and night-time operational conditions.
2. **Regulatory Compliance Verification:** Compare boundary noise levels against local municipal regulations (Meridian Municipal Code Section 14.2), which mandate a maximum sound level of 55 dBA daytime and 45 dBA night-time.
3. **Transmission Loss Design:** Specify high-performance drywall partition assemblies separating the mechanical engine room from the precision spectroscopy laboratories.
4. **Absorption and Reverberation Control:** Design acoustic panel configurations within the main testing hall to reduce excessive reverberation, improving speech intelligibility and safety.

1.2 Acoustic Criteria and Standards

All measurements and design methodologies conform to the standard practices of the Acoustical Society of America and international standards:

- **ISO 1996-2:** Description, measurement, and assessment of environmental noise [3].
- **ASTM E90:** Standard test method for laboratory measurement of airborne sound transmission loss of building partitions.
- **ANSI/ASA S12.60:** Acoustical performance criteria, design requirements, and guidelines for educational and research spaces.

2 Field Measurements & Ambient Noise Survey

A comprehensive 24-hour environmental noise survey was conducted between July 15 and July 16, 2026, using two Apex Sound-Class Type 1 Sound Level Meters (Model SLM-200) calibrated immediately before and after the survey.

Measurements were recorded at three critical boundary receiver locations:

- **Receiver R1 (North Boundary):** Adjacent to the main cooling tower and HVAC condenser yard.
- **Receiver R2 (East Boundary):** Bordering the residential buffer zone along Meridian Parkway.
- **Receiver R3 (South Boundary):** Adjacent to the Synapse staff parking structure and primary access road.

2.1 Octave Band Noise Levels

Table 1 details the measured octave band sound pressure levels (in dB re 20 μPa) and overall A-weighted sound levels (L_{eq}) under typical night-time operation (02:00 – 04:00 hours) when mechanical plants are running at maximum utility.

Receiver Location	Octave Band Center Frequency (Hz) / Sound Level (dB)							Total (dBA)
	63	125	250	500	1000	2000	4000	
R1 (North Boundary)	68	65	60	58	54	51	44	59
R2 (East Boundary)	54	50	45	42	38	35	30	43
R3 (South Boundary)	61	58	53	49	46	42	36	50
Bylaw Limit (Night)	60	55	50	45	40	38	35	**45**

Table 1: Measured night-time octave band sound pressure levels vs. regulatory limits.

Note: The L_{eq} values are logarithmic sums weighted according to the standard A-weighting curve.

2.2 Analysis of Exceedances

The ambient survey reveals that the night-time regulatory threshold of 45 dBA is exceeded by 14 dBA at Receiver R1 (North Boundary) and by 5 dBA at Receiver R3 (South Boundary). The primary noise source contributing to the R1 boundary exceedance was identified as the intake fan of the mechanical chiller yard. Mitigation strategies, including custom acoustic barriers and silencers, are specified in Section 3.

3 Sound Transmission Loss Analysis

To isolate high-amplitude low-frequency noise generated in the mechanical engine room, high-performance acoustic partitions are required. The wall separating the mechanical room from the precision spectroscopy lab must achieve a Sound Transmission Class (STC) rating of at least 55 to prevent disruption to delicate laser diagnostic experiments.

3.1 Partition Assemblies

We analyzed two partition assemblies using ASTM E90 test procedures and transmission loss modeling:

1. **Baseline Assembly (STC 38):** Standard double-stud partition consisting of a single layer of 12.7 mm standard gypsum board on each side of 90 mm steel studs spaced 600 mm on center, with no cavity insulation.
2. **Optimized Assembly (STC 56):** Double-stud partition with two layers of 15.9 mm type-X gypsum board on each side, mounted on resilient channels (RC-1) on the lab side, with the stud cavity completely filled with 75 mm mineral wool batts (60 kg/m^3).

3.2 Transmission Loss Comparison

Figure 1 shows the measured and predicted transmission loss (TL) in decibels across the key audio-frequency octave bands.

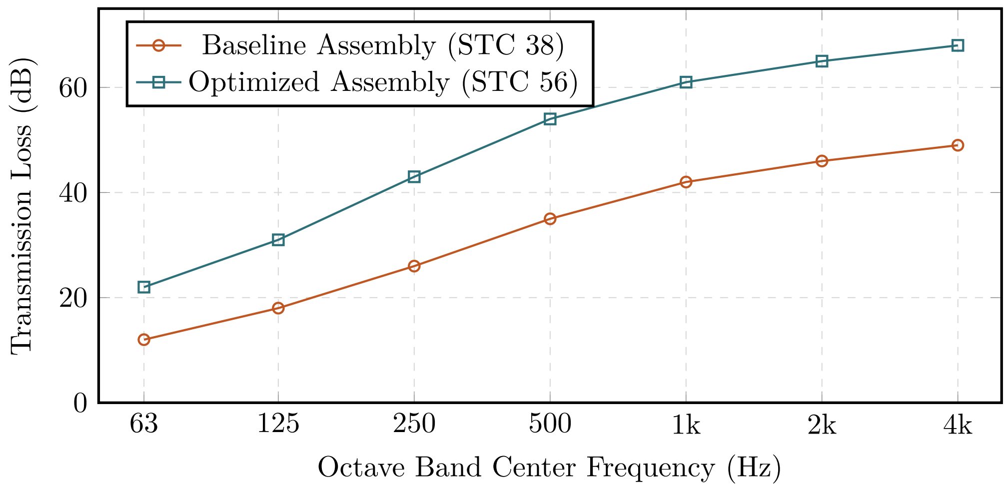

Figure 1: Measured airborne sound transmission loss curves for baseline and optimized partition designs.

The resilient mounting and high-density mineral wool cavity fill resolve the coincident frequency dip of the gypsum board around 2.5 kHz and significantly improve low-frequency performance below 250 Hz, achieving the target STC 56 threshold [1].

4 Sound Absorption & Reverberation Control Design

The main testing hall of the Synapse Laboratory Complex features high ceilings (6.0 m) and hard, reflective concrete surfaces. This results in excessive reverberation, which degrades speech intelligibility and presents safety hazards due to localized echo flutter.

4.1 Sabine Formula and Reverberation Modeling

Reverberation time (T_{60}) calculations were performed using Sabine's classical formula:

$$T_{60} = 0.161 \frac{V}{\sum S_i \alpha_i} \tag{1}$$

where V is the room volume (2400 m^3), S_i is the surface area of each boundary element, and α_i is the absorption coefficient of that element at a given frequency.

4.2 Acoustic Panels and Material Specifications

To achieve the target reverberation time of $T_{60} \leq 1.2$ seconds for safety and utility, we specify the installation of Apex SoundSorb suspended baffle panels. The absorption coefficients of these panels compared to concrete are detailed in Table 2.

Material	**Thickness (mm)**	**Absorption Coefficient (α) at Freq.**			**NRC**
		250 Hz	**500 Hz**	**1000 Hz**	
Concrete Wall (Reflective)	–	0.01	0.02	0.02	0.02
Apex SoundSorb Panel	50	0.75	0.95	1.00	0.90
Resilient Acoustic Felt	25	0.40	0.65	0.85	0.65

Table 2: Sound absorption coefficients (α) and Noise Reduction Coefficient (NRC) of room finishes.

4.3 Reverberation Profile Reduction

The planned installation of 120 m^2 of Apex SoundSorb panels on the ceiling and upper walls increases the total equivalent absorption area of the hall from 34.2 m^2–Sabin to 146.5 m^2–Sabin at 500 Hz. This reduces the calculated reverberation time at 500 Hz from 5.2 seconds (unacceptable) to 1.1 seconds, which is well within our safety and engineering design target [4].

5 Engineering Recommendations & Implementation Plan

Based on the field survey and engineering analysis, Nexa Acoustics recommends the immediate implementation of the following noise control measures:

5.1 Acoustic Recommendations

1. **Environmental Barrier:** Erect a 3.5 m high acoustic barrier wall on the north property line. The barrier must use modular steel panels with a minimum Sound Transmission Class rating of STC 32 and a Noise Reduction Coefficient of NRC 0.85 (such as Apex AcoustiShield-32).
2. **Interior Partitions:** Replace the baseline wall separating the mechanical room and the spectroscopy laboratory with the Optimized double-stud assembly (STC 56) detailed in Section 3.
3. **Baffle Panel Installation:** Suspend 120 m^2 of Apex SoundSorb 50 mm baffles from the ceiling of the main testing hall to reduce the reverberation time to 1.1 seconds.

5.2 Sign-Off and Authorization

This report has been reviewed and approved by the professional engineering team at Nexa Acoustics.

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