MINIMIZING NOISE LEVELS SO FUTURE ENGINEERS CAN FOCUS

CLASSROOM ACOUSTIC TECHNICAL REFERENCE GUIDE

Airedale by MODINE

ARE YOU GETTING THE CORRECT INFORMATION WHEN IT COMES TO CLASSROOM SOUND?

There are many reasons why it is important to minimize HVAC noise in the classroom. First and foremost, it can inhibit learning. Second, minimizing noise from all sources is essential for projects that want to gain LEED certification. But are you really getting all the information needed to select the quietest HVAC unit for your classroom? Modine provides comprehensive sound test data.

Modine's industry-leading testing facilities were designed and built to provide complete testing data. At Modine's state-of-the-art sound lab, engineers provide an unparalleled level of testing both in the design process and in pre-installation simulation. This ensures that a Modine HVAC unit is not only the quietest on the market, but also the quietest product once it is installed in a classroom.

MODINE SEMI-ANECHOIC SOUND CHAMBER

- Capable of testing both sound pressure and sound intensity
- Room Size: 31' x 21' x 14'
- Door Size: 8' x 9'
- Non-conditioned airspace
- 2-tons cooling water supply for test unit
- Power Supply: 480 Vac 3 Phase, 280 Vac 3 Phase, 120 Vac Single Phase (other voltages available upon request)
- Tachometer: 0 to 30,000 RPM
- Room cutoff frequency: 100 Hz
- Background noise: 20 dBA
- 15 dBA above background for full certainty
- Data Acquisition: 8 Channels OctoBox+ with two pulse input channels
- Sampling rate: up to 48 kHz
- 146 dB re. 20 µPa. with 3% distortion

SOUND PERFORMANCE ACROSS ALL STANDARDS

Modine is dedicated to providing engineers with advanced data to help with the design process.

LEED 2009

IEQ Prerequisite 3: Minimum Acoustical Performance

Achieve a maximum background noise level from HVAC systems in classrooms and other core learning spaces of 45 dBA.

Applicable to Modine School Systems product. References methodologies and best practices in Annex B of ANSI S12.60-2002 and 2007 ASHRAE Handbook Chapter 47.

ANSI S12.60-2002

Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools

Much of this standard is discussing the acoustic properties of the finished space, and the maximum reverberation time for sound in that space.

Annex B references guidelines for design of HVAC systems, and has Table 1 for maximum one-hour A-weighted steady background noise level limit at 35 dB.

Annex E – E3.7 Measuring Background Noise Find the "key" location **(different in every classroom)** where the background noise level is the highest.

2007 ASHRAE Handbook Chapter 47

Sound and Vibration Control

This chapter reviews the fundamentals of sound and vibration control. It addresses noise reduction methods for specific transmission paths, and provides recommendations to keep in mind to reduce the sound of airflow through ductwork and into space, the transmission of vibration from equipment through walls and other surfaces, and many more examples.

This chapter is very focused on reducing the specific noises from equipment, but does not establish minimum requirements for HVAC equipment installed within a space.

ANSI S12.60-2010 – Part 1 (Permanent Schools)

Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools

Table 1 has more information with regards to the Greatest one-hour average A-weighted sound level of interior background noise (limit at 35 dB). Note F references measurement location definition in A.1.3 which indicates a "key" location **(different in every classroom)** that the A-weighted requirement must be met. Measurements to comply must be taken after complete installation.

5.2.2.1 – Limits on interior-source A- or C-weighted background noise levels from building services and utilities and calculation of HVAC noise levels
Multi-stage types of HVAC equipment shall not exceed limits in Table 1, when calculated using the duty cycles defined in Table 2. This table defines the sound level limit of 37 dB.

These standards do not define a sound measurement procedure to easily determine if a piece of equipment will meet the LEED prerequisite. The sound pressure at a given point changes with its surroundings.

ANSI S12.60-2009 – Part 2 (Relocatable Classroom Factors)

Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools

Table 1 is similar to Part 1 but has a published A-weighted sound level of interior-source background noise of 38 dBA.

5.2.2.1 – Limits on interior-source A- or C-weighted background noise levels from building services and utilities and calculation of HVAC noise levels
Multi-stage types of HVAC equipment shall not exceed limits in Table 1, when calculated using the duty cycles defined in Table 2. This section also defines Type 3 as a system that as two stages of cooling or heating with an additional ventilation-only mode.

These standards do not define a sound measurement procedure to easily determine if a piece of equipment will meet the LEED prerequisite. The sound pressure at a given point changes with its surroundings.

RAISING THE BAR IN THE SCIENCE OF SOUND

It is easier to understand how a unit will perform in the classroom with comprehensive data. While sound pressure is the measurement used for LEED certification, translating it from a lab to a classroom requires a precise measurement. At Modine, products are evaluated by additional standards, such as sound power, because that is a measurable value that does not change based on installation. Sound power can also be used to calculate or simulate the sound pressure at different points in the classroom before the unit is installed.

SOUND PRESSURE

Sound pressure is the force of sound on a surface area. It is different at every point in a room due to the directionality of the sound and the characteristics of the room along with every object in it. Because sound pressure is so dependent upon its surroundings, the pressure ratings are different in a sound chamber than in an actual classroom.

ANSI/AHRI STANDARD 575-2017

Method of Measuring Machinery Sound within an Equipment Space

Purpose: To establish a uniform method of measuring and recording the Sound Pressure Level of machinery installed in a mechanical equipment space. It is not the intent of this standard to be used for the sound rating of equipment.

Defines:

- Data to be taken
- Valid measurement points
- Sound averaging equation
- Many other required procedures and calculations

Results: Define how to publish
(what information is required to be identified)

Sound Pressure is dependent on the acoustic properties of the space and distance from the source. It is not a valid method of comparing manufacturers for a specific condition.

SOUND POWER

Sound power is the energy of sound per unit of time. It is dependent on the sound source alone, meaning it is not dependent on room construction or location of installation within the room. The value to understanding sound power within a space is the ability to calculate sound pressure at any point within that space.

ANSI/AHRI STANDARD 260–2017

Sound Rating of Ducted Air Moving and Conditioning Equipment

Sound Power Standard for testing using either a reverberation room or to follow ISO 9614 procedure for intensity measurements

Figure 1a – Typical Ducted Product Application

- The unit is installed outside of the room that requires conditioning
- This results in two separate sound results

Figure 1b – Concept Reverberation Room Ducted Discharge Test Set-Up

- The unit is installed outside of the test space
- This test results in the "$LW_{discharge}$" test point

Figure 1c – Concept Reverberation Room Free Discharge (or Inlet) Combined with Casing Radiated Test Set-Up

- Supply air is ducted to another space
- This test results in the "$LW_{radiated}$" test point

This standard is NOT typically applicable to unit ventilator or single packaged vertical unit installations

AHRI STANDARD 350 – 2015

Sound Performance Rating of Non-Ducted Indoor Air-Conditioning and Heat Pump Equipment

Sound power standard for testing using either a reverberation room or to follow ISO 9614 procedure for intensity measurements

Figure 2 – Location of Equipment in the Test Room

- The unit is installed in the same space it is conditioning

All unit ventilators and single packaged vertical units should be rated in accordance with this standard

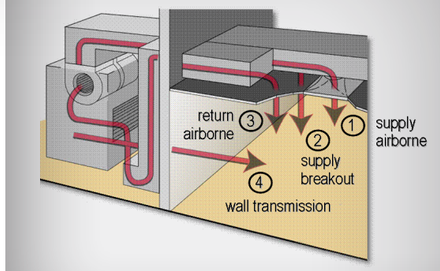


FIGURE 1a

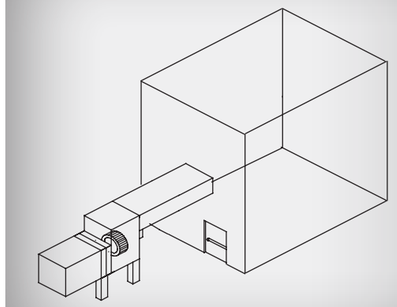


FIGURE 1b

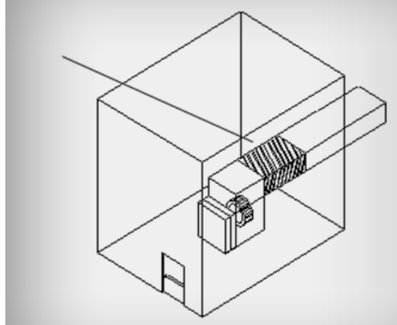


FIGURE 1c

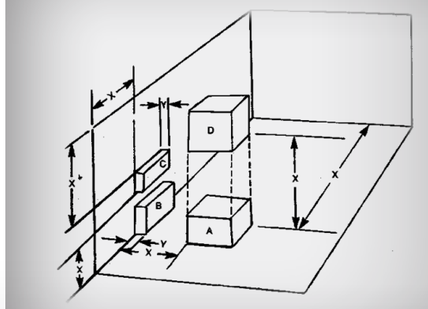


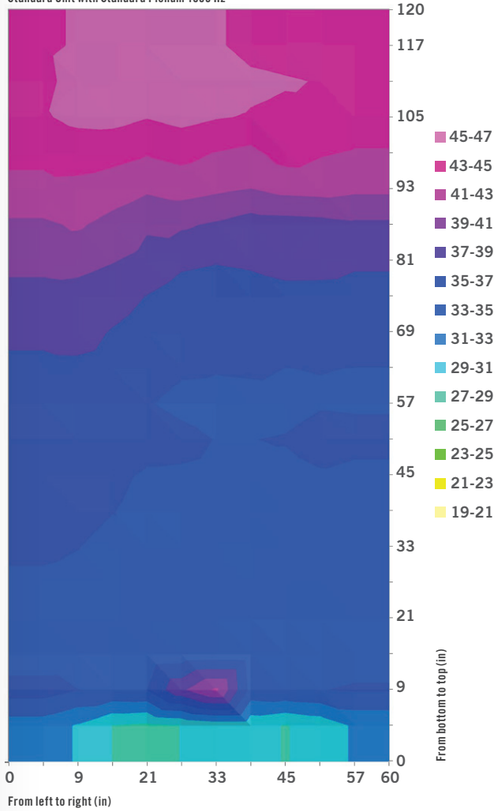
FIGURE 2

MODINE ENGINEERED ACOUSTIC SOLUTIONS

After sound testing was complete, Modine used the sound intensity mapping to improve the sound performance of our unit.

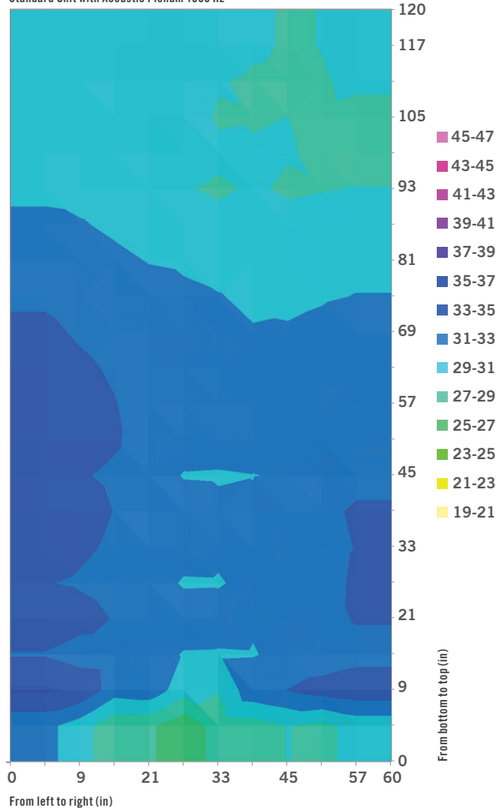
48MBH CAPACITY
HIGH FAN SPEED 1500CFM | SOUND INTENSITY MAPPING – FRONT (DB)

Standard Unit with Standard Plenum 1000 Hz



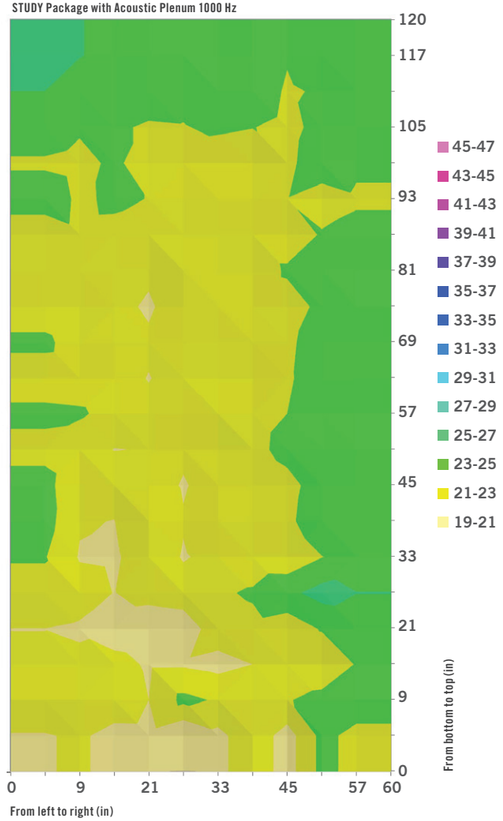
		Value
1 Meter	dB(A)	50
	NC	41
5' Avg Front	dB(A)	49
	NC	39
10' Avg Front	dB(A)	47
	NC	37

Standard Unit with Acoustic Plenum 1000 Hz



		Value
1 Meter	dB(A)	48
	NC	37
5' Avg Front	dB(A)	46
	NC	36
10' Avg Front	dB(A)	43
	NC	31

STUDY Package with Acoustic Plenum 1000 Hz



		Value
1 Meter	dB(A)	43
	NC	30
5' Avg Front	dB(A)	43
	NC	29
10' Avg Front	dB(A)	40
	NC	24

Reference AIR 2-300 for details on sound testing.

THE SOLUTION

These features, engineered for the toughest classrooms, result in the ClassMate® with STUDY Package achieving the highest standard for sound reduction in its class.

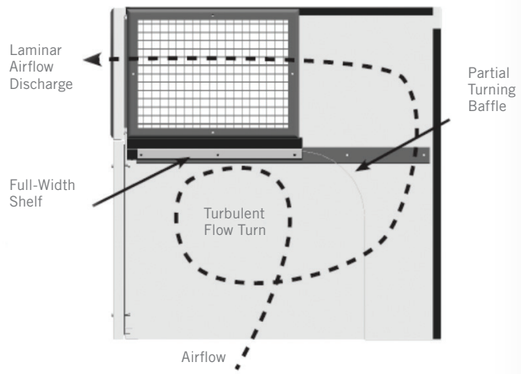
THE RESULTS

Redesigned cabinet to reduce air flow velocity

- Extensive sound intensity testing identified opportunities for sound reduction
- Sound intensity mapping allowed Modine to isolate components and frequency to engineer specific solutions
- Redirected air flow reduced velocity through side grills

Redesigned baffle for improved air flow path

- Patented baffle design adds significant value without sacrificing performance of the base unit
- Providing laminar airflow to a space without requiring additional ductwork



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INNOVATION BACKED BY EXPERIENCE

A.B. Modine's invention of the hydronic unit heater transformed Modine into an HVAC pioneer by 1922. Since acquiring Airedale, an industry leader in school applications, Modine has brought that same innovative, entrepreneurial spirit into the classroom HVAC market with industry-leading testing and engineering capabilities.

MODINE

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