



A BREATH OF FRESH AIR FOR A MINNESOTA SCHOOL DISTRICT

White Paper | QLCI Displacement Chilled Beams

BACKGROUND

In 2002, the American National Standards Institute (ANSI) published ANSI S12.60, Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools. In essence, this standard calls for a 35 dBA (approximately NC27) acoustical level in all core learning areas.

The Anoka-Hennepin School District is the largest school district in Minnesota; it comprises most of the suburbs on the north side of Minneapolis. In 2004, the district allocated monies for the retrofit of existing elementary and middle schools based on IAQ improvement within the classroom. Interestingly, the addition of air conditioning for the schools did not qualify for the monies although the implementation of the space humidity control was allowed under the allocation. The Planning and Management Team for the school district were particularly attracted to the QLCI displacement with induction terminals as a solution for the planned classroom retrofits as well as continuing new school designs.

As air conditioning of the classrooms did not qualify for the allocated funds, the heat transfer coils within the QLCI terminals were configured for heating only at this time. However, they were piped such that inclusion of a chilled water circuit could be easily accomplished in the future. While there was no cooling contribution from the coil, the delivery of 55°F air from the air handling unit (required to accomplish dehumidification of the space) achieved a minimal level of classroom cooling.

In May 2005, the district installed a mock-up of the QLCI system in a classroom in an elementary school where the first retrofit was to be performed. Among the performance parameters studied were the acoustics and the CO₂ concentration within the classroom. These were compared to those of an adjacent classroom served by a mixed air system (unit ventilators) under similar thermal loads and occupancy.

QLCI KEY BENEFITS:

- Improved removal of heat associated contaminants inherent to thermal displacement ventilation systems.
- Classroom acoustical levels compliant with ANSI S12.60
- Designed for direct integration with a DOAS system to allow delivery of primary air at the space minimum ventilation rate.
- Lower maintenance requirements than other available classroom HVAC terminals.

CLASSROOM ACOUSTICAL STUDIES

Subsequent to the issuance of this standard the Air Conditioning and Refrigeration Institute (ARI) commissioned ATS&R (a Minnesota based A/E firm which specializes in educational facility design and renovation) and Kvernstoen, Ronnholm & Associates (a Minneapolis area acoustical consultant) to perform a study of acoustical levels in area schools.

The primary objectives of the study were:

- 1.) Provide a survey of classroom acoustics in existing installations.
- 2.) Identify potential design solutions and estimated cost of achieving compliance in classrooms that did not meet the requirements of Standard S12.60.

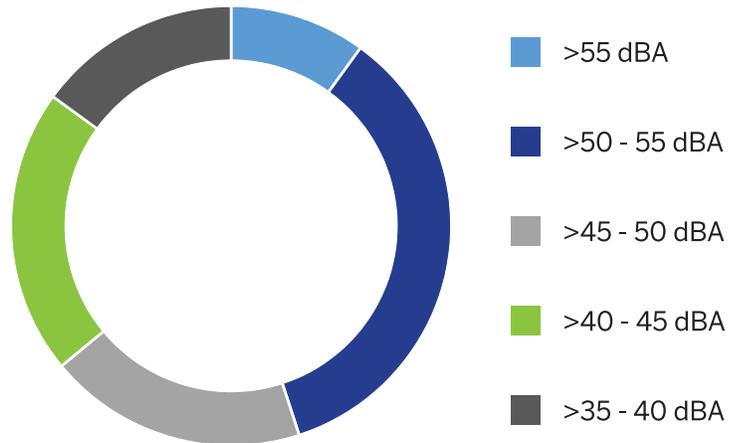


Figure 1: Classroom Acoustical Levels (ARI Study)

Sixteen schools (primarily located in Minnesota) and 48 classrooms were evaluated in the study, the results of which were published in October 2005. Ambient noise levels in the classrooms ranged from 36 to 58 dBA, resulting in only one (1) classroom complying with ANSI S12.60 requirements. The average classroom noise level was 47 dBA (approximately NC40). Figure 1 illustrates the summary of these acoustical tests.

ATS&R was contracted as the A/E consultant for the planned retrofit of the Anoka-Hennepin Schools. In June 2005, Kvernstoen, Ronnholm & Associates was commissioned to measure the combined acoustical performance of the three (3) QLCI displacement terminals installed in the mock-up at a combined primary airflow rate of 450 CFM (the minimum ventilation flow rate for the classroom). These tests were conducted during the late evening (approximately 10 PM) to minimize the effect of background noise. The results confirmed that the QLCI system produced noise levels compliant with Standard S12.60. A similar test of the unit ventilator in the adjacent classroom resulted in a noise level of 55 dBA.

CLASSROOM CONTAMINANT CONCENTRATIONS

In an effort to substantiate the contaminant removal efficiency superiority of the QLCI displacement terminals (versus the unit ventilator), a CO₂ sensor was hung at the center (6 foot height) of each of the aforementioned classrooms. Over a two week period, CO₂ levels were recorded in which the two classrooms were typically occupied.

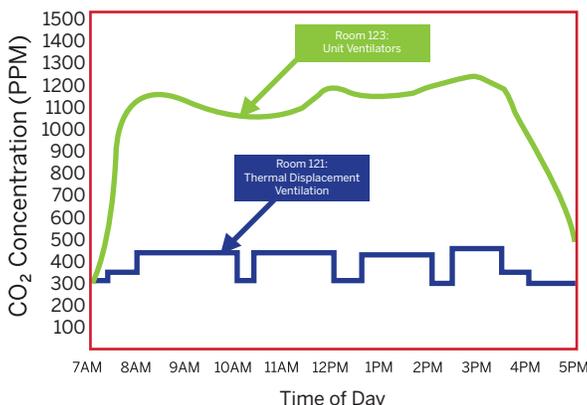


FIGURE 2: CLASSROOM CO₂ CONCENTRATIONS

CO₂ levels were considered the most important indicator as they are primarily the result of respiration and can logically be related to the airborne spread of disease. Figure 2 illustrates a typically daily plot of the CO₂ concentrations in the two classrooms. Note that the levels in the classroom served by the unit ventilator increase rapidly as the classroom becomes occupied and then remain relatively constant throughout the day. There were slight peaks and valleys that results from periods when the classroom was unoccupied (recess, lunch, etc.), but these

normally lagged the change in occupancy by half an hour or more. The overall average classroom CO₂ level was approximately 1100 PPM.

In contrast, the average CO₂ levels in the classroom served by the displacement (QLCI) system averaged 400 PPM, or 65% lower than those found in the original classroom. In addition, unoccupied periods were clearly evidenced by a sharp (and immediate) drop in the CO₂ levels. This should be expected as displacement systems remove airborne contaminants at the source, as opposed to simply diluting their concentration within the space. Therefore the odds of an occupant contracting a disease by airborne means were reduced by a similar 65% as well.

SUMMARY

Since the mock-up, the school district has retrofitted eleven schools with the QLCI system and has a number of other retrofits scheduled for 2007 and beyond. Citing the results of the District, several other districts in Minnesota have also used the QLCI system in both retrofit and new construction applications.

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