

THE Quiet Zone

Building a Quiet Classroom

Quieting a class of students can be a challenge, but quieting a classroom built for students is even more challenging when some of the companies that build schools don't want to do it.

Classrooms are either quiet or noisy by design. New standards just adopted by the American National Standards Institute provide important guidance for schools in order to enhance learning environments with what should not be a radical idea: that students ought to be able to hear the teacher. Unfortunately, the Air-Conditioning and Refrigeration Institute, the School Facilities Manufacturers' Association, and the Modular Building Institute have appealed the new standards or asked that they be withdrawn, claiming that they are not in the public interest.

Help us spread the word that building quiet, effective learning environments is in the public interest by returning the letter between pages 4 and 5. And help get the accompanying article on "Classroom Design for Good Hearing" on page 2, the booklet *Classroom Acoustics* on our website, and the new ANSI standards into the hands of your

continued on page 2

FROM THE DIRECTOR

On September 11, 2002, President Bush led the nation in a moment of silence. Even today, the highest tribute we can pay is with quiet.

In this edition of the Quiet Zone, we celebrate a victory for quiet: SONY corporation, the target of last edition's letter-writing campaign, has stopped using the trademark "Disturb the Peace" to sell incivility and dangerously loud car stereos.

Also in this edition, we initiate another writing campaign, that with your help, we will also win. This time the letter is positive, supporting newly adopted standards for classroom noise from transportation, mechanical equipment, and reverberation. The new standards are being challenged by some industry and trade associations that don't want to build schools to standards that ensure students can hear their teachers.

Please share this edition with educators, return the postcard supporting quiet classrooms, and help our nation and communities choose a future that is quiet.

Peace and Quiet,



Les Blomberg,
Executive Director



In a small victory for Peace and Quiet, and a larger one for civility, SONY corporation has stopped using its trademarked slogan "Disturb the Peace" to sell its dangerously loud car stereos, amplifiers, and speakers. In addition, a number of communities have adopted boom car standards.

Thank you very much for your overwhelming help in this campaign. Your letters to SONY chairman and CEO Howard Stringer helped reign in corporate misbehavior.

We still have a long way to go. Boom cars still shake windows and walls, wake neighbors, cause car accidents, and injure the hearing of car occupants, but one less corporate giant is encouraging bullies to break the law and disturb the peace.

BUILDING A QUIET CLASSROOM

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students' teachers, principal, and school board (see page 4).

Now, we finally have a standard by which to measure the acoustical performance of classrooms. Make sure your child's education and your school property taxes are not being wasted in the din of traffic noise, the roar of jet airplanes, or the rumble of poorly designed heating and air-conditioning systems.

The Quiet Zone

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The Quiet Zone is published twice a year by the Noise Pollution Clearinghouse, a non-profit organization dedicated to creating more livable cities and more natural rural and wilderness areas by reducing noise pollution at the source.

Classroom Design for Good Hearing

Ewart A. Wetherill

*Classrooms may be noisy...
simply because of the way
they are constructed and finished.
It is a shocking fault, for the need to hear well
is basic in education.*

McQuade, *Schoolhouse*, 1958

In the summer of 2002, the American National Standards Institute published Standard 12.60, a totally new standard that provides acoustical performance criteria, design requirements and design guidelines for new classrooms and renovation of existing classrooms. The goal is to ensure a high degree of speech intelligibility in learning spaces. In order to achieve this, the noise level in an empty classroom should be kept to less than 35 decibels, and reverberation or echoes controlled.

While the impetus for the standard began initially as an effort to improve schools for children with impaired hearing or other learning disabilities, children with normal hearing will also benefit greatly from these standards.

The good news for architects and builders is that compliance with the acoustical standards need not be costly if they are incorporated early into the planning and design process, although remodeling existing facilities could be expensive depending on the actual situation. The requirements for good hearing were first presented formally to the American Institute of Architects in 1898 and have been successfully applied to many schools. However, in the absence of enforceable standards far too many schools have been built with little or no concern for good hearing. **Since acoustical problems are created by the design they can just as easily be avoided by the design.**

EXISTING CONDITIONS IN U.S. SCHOOLS

Elementary and secondary education, the nation's largest public enterprise, is conducted in more than 80,000 schools in about 15,000 districts. America's public schools serve more than 42 million students.

In February 1995, the U.S. Government Accounting Office (GAO) presented a report to the U.S. Senate on the results of a survey of school officials across the country on the physical condition of their facilities.

The report comprised hard facts concluding that more than \$100 billion would be needed to restore all of the schools to good condition. The most frequently mentioned of all the “unsatisfactory environmental conditions” was “acoustics for noise control.”

One outstanding example of acoustical inadequacy can be found in the standards set by the Los Angeles Unified School District, one of the largest in the country. These allow the use of classroom ventilation/air conditioning units that are up to 20 decibels noisier than would be permitted by Swedish standards. The inevitable conclusion is that school children cannot hear much of what is said, while teachers must shout to be heard at all. A second example that should be familiar to many was the disastrous trend in the late 1960s to open-plan schools. These created a situation in which some school children could hear the teacher of an adjacent class more clearly than their own teacher.

Thus, a combination of outdated facilities and unfortunate design or construction decisions leave us with an inheritance that will be a burden for decades to come. This legacy of past policies will consume a very significant part of the limited funds that many communities seem currently willing to allot to school construction or renovation; so skillful planning and site selection will be essential to attain the new goals.

CHILDREN AT RISK

In December 1997, representatives of eleven national groups joined the Acoustical Society of America in a workshop on Eliminating Acoustical Barriers to Learning in Classrooms. From this workshop has developed a coalition that worked actively to further improved hearing conditions in schools. Leaders in the field of audiology and a wide range of disciplines related to design and construction of educational facilities presented the results of surveys and research on the prevalence of hearing disorders and substandard facilities, and their effects on hearing. The truly alarming statistics clearly show the disadvantage resulting from poor hearing conditions for both normal and hearing-impaired school children.

Studies of speech recognition confirm that an adult listener hearing words in the context of a sentence can fill in words or syllables that are not heard clearly, depending on the size of the listener’s vocabulary. Since children have smaller vocabularies, they are less able to fill in the words not heard clearly. Similarly, someone using English as a second language or someone who suffers from an attention deficit disorder are at a significant disadvantage in a noisy classroom. In addition, many children with usually normal hearing have temporary hearing losses from illness. *Otitis Media*, a

bacterial infection of the middle ear that is the most frequently-occurring childhood medical complaint, has more than doubled in the last decade.

Compounding the learning disadvantages that confront children in noisy classrooms or with impaired hearing are the constant discouragement and frustration that can inhibit the motivation of even the most talented to learn and to excel.

The importance of clearly hearing the teacher seems self-evident, but this has not been a design criteria of many schools in the past.

REQUIREMENTS FOR GOOD HEARING

Two basic criteria must be satisfied to meet the requirements for good hearing:

1. A quiet background (e.g. noise from intruding traffic, adjacent classes, ventilation systems etc.)
2. Control of reverberation and self-noise

SPEECH TO NOISE RATIO

Speech in the classroom must be heard over the prevailing background noise level, be it intruding noise from traffic, adjacent classes, or a noisy ventilation system. A convenient and easily measured descriptor is the Speech to Noise ratio (S/N). There is general agreement that desired S/N ratios for speech recognition are:

Normal-hearing:

Adults: at least 6 decibels

Children: greater than for adults, at least 10 decibels

Hard-of-hearing listeners

Adults: at least 15 decibels,

Children: greater than for adults

By contrast, a survey of actual classroom conditions taken between 1965 and 1968 indicated a Speech to Noise ratio range from +5 decibels to -7 decibels. This information alone adds support to the growing concern both for children’s understanding and for teachers’ voice strain.

Reverberation (commonly known as an echo) is defined as the persistence of sound in a room after the source has stopped. In a reverberant space, successive syllables blend into a continuous sound, through which it is necessary to distinguish the orderly progression of speech. The level at which this sound persists is determined by the size of the space, the speech level and the interior finish materials. Reverberation time (the time it takes for a sound to die off) is measured in seconds, with a low value—around 0.5 seconds or less—being

continued on page 6

What you can do to make classrooms quieter and better learning environments

Extra Credit Purchase the ANSI standard and the booklet "Classroom Acoustics" for your children's school

- \$40 for standard and booklet from the Noise Pollution Clearinghouse, (these are being resold at cost by NPC and purchases are not tax deductible)
- OR \$35 for an electronic PDF version of the standard available at <http://asastore.org>; the booklet can be downloaded for free from our website <http://www.nonoise.org/quietnet/qc/>

Extra Credit Get a friend to send the second postcard to ANSI.

A+

Get a teacher to send a letter on his or her own stationary to:

Ms. Ann Caldas
Board of Standards Review
American National Standards Institute
25 West 43th Street, NY NY 10036

Tell the Board of Standards Review that the classroom acoustics standard is in the public interest. See page 5 for a list of points teachers should cover.

A

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Send the postcard to ANSI with about 500 to 1,000 others!

Need to do some homework on classroom noise? Go to the Classroom Acoustics library at <http://www.nonoise.org/quietnet/qc/>

Writing Your Own Letter?

Here's What You Need to Know

The noisy school industry wants people to think that creating quiet classrooms is:

1. Radical and unrealistic
2. Too costly
3. Not in the “public interest”

HERE'S WHAT YOU SHOULD SAY:

The 35 decibel level is recommended by the World Health Organization.

To be able to hear and understand spoken messages in class rooms, the noise level should not exceed 35 dB LAeq during teaching sessions. For hearing impaired children, a still lower sound pressure level may be needed. The reverberation time in the class room should be about 0.6 seconds, and preferably lower for hearing impaired children.

World Health Organization, 1995

We can't afford not to build good learning environments when we build schools. For each noisy classroom, hundreds of students over the next 20 to 50 years will miss what their teacher is saying. Public school tax dollars will be wasted and students will be held back in their learning.

In most classrooms the dominant background noise source, and the main obstacle to achieving the recommended background noise level is the heating, ventilating and air conditioning (HVAC) system. Individual experts, members of the American Society for Heating Refrigerating and Air Conditioning Engineers (ASHRAE), have estimated HVAC costs to be 10% of the total costs to build classrooms with approximately 45 dB(A) background noise levels.

“The school was established to promote learning, which is acquired largely by word of mouth and listening. Therefore, acoustics is one of the most important physical properties that determine how well the school building can serve its primary function. Thus the exclusion of noise and the reduction of reverberation are indispensable in adapting classrooms to the function of oral instruction”

Vern Knudsen and Cyril Harris, *Acoustical Designing in Architecture* (1950)

These experts also estimate that upgraded HVAC systems could achieve 35 dB(A) background noise levels for 14.5% of total costs. Thus, the incremental cost to achieve the ASA acoustic performance goal for HVAC background noise is 4.5%, or \$4.56 per square foot. This estimate is based on the median costs per square foot for new classroom construction in high schools, which typically have the highest construction costs per square foot. The median incremental cost per high school classroom is approximately \$5000—an annual cost of about \$250 per classroom, or \$8.40 per student in a 30-student classroom over the estimated 20-year lifetime of the materials. When the ceiling tile and HVAC costs are combined, the total annual cost per student of achieving the recommended acoustic goals is slightly over \$11, a small price to pay for the removal of acoustic barriers in the classroom.

Acoustical Society of America, 1998

Effective public education is in the public interest. The National Center for Educational Statistics reports that 18% of schools suffer from poor acoustics or noise control. In these classrooms, students listen to jet planes, trucks, or the drone of an air conditioner or fan instead of the teacher. The cost to retrofit and fix problems after they are built is orders of magnitude greater than the cost of good original design. We are already saddled with these schools, and it will be years (and thousands of students) before they are fixed. We don't need to build more bad schools. 18% is already too high. We should not build any more schools that fail to meet reasonable acoustical standards.

“When it comes to the education of our children... failure is not an option.”

President George W. Bush

CLASSROOM DESIGN

continued from page 3

figure A

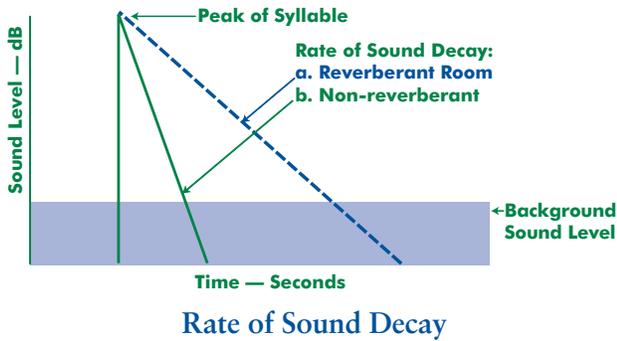


figure B

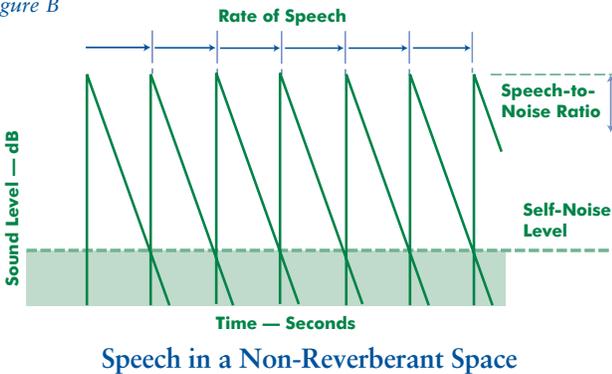
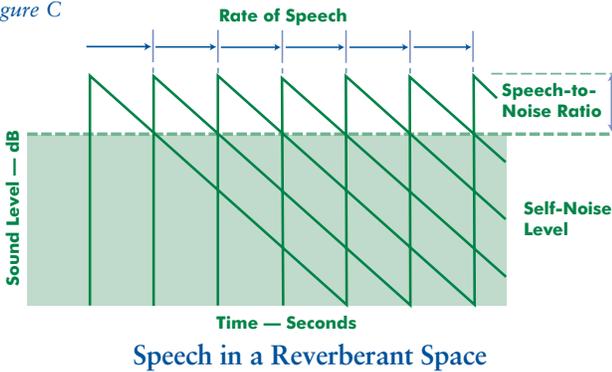


figure C



In a reverberant room, teachers must compete with their own echo (self-noise) which raises the overall noise level in the room.

optimum for a classroom seating about 30 children. Reverberation can be controlled by the use of readily-available sound-absorbing wall and ceiling materials that comply with building code requirements.

EFFECTS OF NOISE AND REVERBERATION ON SPEECH RECOGNITION

Mean speech-recognition scores (the percent of words correctly recognized) of adults with normal hearing for various S/N ratios clearly demonstrate the connection between good acoustics and effective hearing.

S/N ratio	Word Recognition
+12 decibels (low-background noise)	95.3%
+6 decibels	80.7%
0 decibels (high-background noise)	46.0%

Mean speech-recognition scores (in percent correct) of children for monosyllabic words with various reverberation times (RT) show a similar correlation.

RT - Seconds	Normal Hearing	Hearing Impaired
0.0 (no echo)	94.5 %	87.5%
0.4	82.8%	69.0%
1.2 (persistent echo)	76.5%	61.8%

The combined effects of poor Speech to Noise and long reverberation time for children, which is the actual situation encountered daily in many of the nation's schools, are predictably a substantial handicap to entire classes. The following scores are for monosyllabic words.

Test Condition	Normal Hearing	Hearing Impaired
FOR REVERBERATION TIMES OF 0.0 SECONDS:		
+12 decibels	89.2%	70.0%
0 decibels	60.2%	39.0%
FOR REVERBERATION TIMES OF 1.2 SECONDS:		
+ 12 decibels	68.8%	41.2%
0 decibels	29.7%	11.2%

The following conclusions can be drawn from these test results and from corroborating evidence compiled from other test situations.

1. Understanding of children with normal hearing can be seriously affected by a combination of excessive background noise and reverberation.
2. Hearing impaired children are always at a disadvantage compared to those with normal hearing but the difference can be minimized by acoustical controls.
3. Comprehension levels for multisyllabic and unfamiliar words can be expected to be worse than indicated by monosyllabic testing.
4. Decrease in intelligibility with distance from the teacher can be minimized by acoustical treatment and shaping of the space.

EFFECT ON TEACHERS

In addition to children's hearing concerns, the effect of trying to compete with an acoustically-difficult environment creates a problem of severe strain on the vocal

chords for many teachers. While not as well-known or studied as the listener's ability to understand, voice strain is belatedly being recognized as a serious and potentially incapacitating problem for teachers. However, effective acoustical treatment of a classroom can create significant benefits here also.

EXAMPLES OF EFFECTIVE CLASSROOM DESIGN

Designers and builders can improve hearing conditions in schools by incorporating the basic principles of acoustics into classroom design. For every new and remodeled school, the control of unwanted sounds and enhancement of wanted sounds, without the complications inherent in general amplification, should be placed high on the list of design goals. For new classrooms accommodating from 30 to 40 children these requirements should not add anything to the cost of either design or construction. However, correction of acoustical deficiencies in existing facilities could be costly, depending on the particular situation.

At least the following considerations must be addressed (see appended sketches):

Control of unwanted sounds

- locate schools away from highways, rail tracks, and flight paths
- minimize noise intrusion from outdoors (*figure D*)
- minimize interference between classrooms
- design quiet ventilation system (*figures E and F*)

figure D

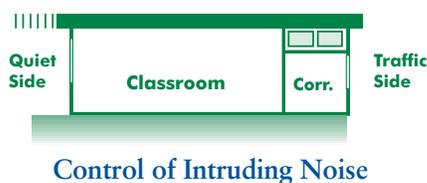


figure E

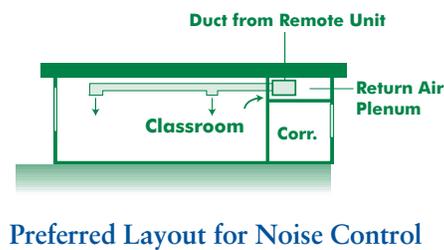
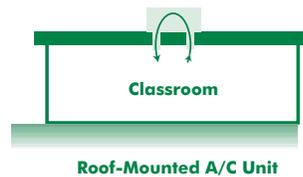
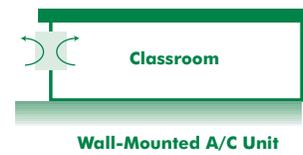


figure F



Built-in Noise Problems To Be Avoided

Enhancement of wanted sounds

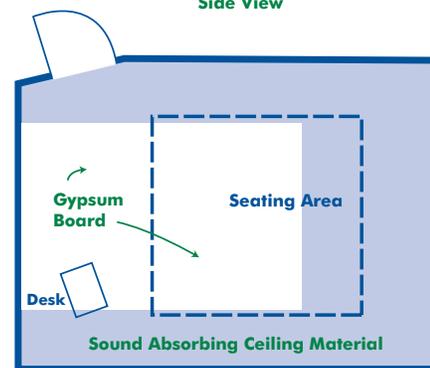
- control excessive reverberation by sound absorption
- minimize echoes from distant surfaces (such as the back wall)
- use hard materials for useful sound reflections (such as on surfaces beside and above the teacher)

Figure G shows a suitable acoustical treatment for a "traditional" classroom configuration. For other desired class uses, redistribution of the required sound absorption may be appropriate. The booklet *Classroom Acoustics*, available at NPC's website, www.nonoise.org/quietnet/qc/, and the ANSI Standard S12.60 are of help when working with teachers and administrators.

figure G



Side View



Top View

Acoustical Treatment for a Classroom

Leave a Legacy of Peace and Quiet

Many of the values that we hold dear, such as peace and quiet, remain important to our friends, families and communities long after we are no longer here ourselves. Including the Noise Pollution Clearinghouse in your will is one way to help sustain the quality of life you believe in for your community and loved ones.

Leaving a Legacy of Peace and Quiet is easy through a simple bequest. You should consult your lawyer or estate planner, but a basic bequest might read “I give and bequeath to Noise Pollution Clearinghouse (Montpelier, Vermont) the sum of \$xxx.” Bequests can also be made as a percentage of your total estate, or the remainder of your estate after all other bequests are fulfilled. Please contact us if you have decided to, or are thinking about, including NPC in your will.



WHAT NPC'S DOING NEXT YEAR

Starting next year, NPC is undertaking at least three major projects that will help urban cities, suburban neighborhoods, and rural and wilderness areas. Next year look for our efforts to quiet:

1. **Urban cities:** Motorcycle and Truck Noise Regulation—the laws are on the books but poorly enforced, and better regulations exist.
2. **Suburban neighborhoods:** Quiet Lawns—a *Consumer Reports*-like look at lawn equipment noise.
3. **Rural and wilderness areas:** Quiet Lakes—a series of projects aimed at jet skis, air boats, cigarette boats, state boating regulations (currently, no state's boat noise regulations are quieter than the federal standards for trucks, which also are too loud—see above), and creating quiet times, days, and lakes.

THE NOISE POLLUTION CLEARINGHOUSE

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