

# Proceedings of the Institute of Acoustics

## CURRENT NORTH AMERICAN CONCERNS ON SCHOOLROOM ACOUSTICS FOR CHILDREN WITH HEARING DISABILITIES

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### INTRODUCTION

The USA Architectural and Transportation Barriers Compliance Board has received a petition for rule-making from a parent of a child with a hearing loss, requesting that the accessibility guidelines of the Americans with Disabilities Act (ADA) of 1990 be amended to include new provisions for acoustical accessibility in schools for children who are hard of hearing.

The Architectural and Transportation Compliance Board (Access Board) is responsible for developing accessibility guidelines under the ADA and to ensure that new constructions and alterations in facilities covered by the law are made accessible and usable for individuals with disabilities. The guidelines under the ADA contain a number of provisions relating to communications, for example text telephones, assisted learning systems and visible alarms. It does not include provision for acoustical design or performance of spaces within buildings.

### CURRENT MOVES

In April 1997 the Access Board received a petition from a parent with a hearing impaired child, requesting that the Board consider architectural acoustics in schools and develop new provisions for children who are hard of hearing (1). It is argued that children who have hearing and other disabilities including learning, auditory processing, speech and language and developmental disabilities face numerous communication barriers in schools because of poor acoustics and that these barriers may prevent them from developing their full educational potential. The petition requests that the Board develop "acoustical guidelines....[to] ensure adequately low noise and reverberation so that the speech to noise ratio and speech to reverberation ratio allow satisfactory communication and learning".

The background to the petition relies heavily on work by the American Speech and

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Hearing Association (ASHA), which had previously produced a position paper on acoustics in educational settings, claiming that there was an increasing level of hearing loss, particularly amongst children and young adults. Children with mild hearing losses are more at risk for general psychosocial dysfunction and lags in academic progress than are children with normal hearing. A relationship has been claimed between poor room acoustics and low speech comprehension in children with hearing, learning and developmental disabilities.

ASHA studies have shown that 13% of a representative sample of children between the ages of 6 and 19 had a high frequency hearing loss and 7% a low frequency hearing loss of 60dB or more. This could affect perception and understanding of words. Increasing numbers of young children experience a mild temporary, but recurring, hearing loss caused by otitis media. It has been estimated that 25 - 30% of children in a typical kindergarten and first grade classrooms will not hear normally on a given day.

Effective speech reception is the main issue for people with impaired hearing. Excessive classroom noise impedes the development of language and cognitive skills for all children. It is thought that the failure to acquire effective language skills by the age of six cannot be fully compensated later on. Excessive noise levels impair a young child's speech perception, reading and spelling ability, behaviour, attention and overall academic performance. The ability to understand speech does not mature fully in children before the age 15, so that children are less effective listeners than are adults and children also have less experience in deriving meaning from context. A representative sample of children without hearing loss or other audiological disabilities, even when tested in above average listening environment could make out only 71% of a teacher's words. Those in the worst environments perceived only 30%. The listening abilities of children with hearing impairments are even worse than these figures. The populations mainly at risk are younger children, say below 14 years of age, those with a history of otitis media, those for whom English is a second language and those with auditory disabilities of any kind.

The Access Board requested information on a number of topics related to the acoustical performance of classrooms and similar spaces used by children in order to assist it to respond to the petition which it had received.

Amongst the information returned were statements from individuals and organisations including the Acoustical Society of America, American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) and a "coalition" of "concerned professionals, consumers and parents" with an interest in the auditory learning

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environment. These organisations supported the petition and encouraged the Access Board to proceed with new regulations.

### ACOUSTICAL SOCIETY OF AMERICA

The response from the Acoustical Society of America included the following technical points:

Children require signal to noise (S/N) ratios 2-3dB higher than adults to achieve the same level of communication in background noise.

The hearing-impaired child with hearing aids or the child with otitis media may require 10-30dB higher speech levels than the child without impairment. The use of a hearing aid does not reduce the S/N requirements of these children.

Children with mild to moderate hearing impairments require S/N ratios 3-5dB higher than the unimpaired.

Reverberation affects hearing impaired children more than it affects the unimpaired. Reverberation times should be less than 0.4 seconds to minimise the effects.

Children with limited proficiency in English, especially those for whom it is a second language, require S/N ratios 2-5dB higher than children who are proficient in English.

The recommended goal for speech levels throughout a classroom is 65dBA. The recommended goal for classroom S/N ratios is 15dB for voice use.

Background noise levels should be below 35dBA in unoccupied classrooms.

The recommended goal for reverberation is RT60 values of 0.4 -0.6 seconds or less in occupied classrooms.

The combined effects of noise and reverberation are greater than the effects of either alone.

Hearing aids will also amplify background noise and reverberation, whilst personal amplification FM systems, transmitting speech directly to the ear of

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the child, can improve S/N ratios by up to 15dB.

The cost of new classroom construction is of the order of \$100 per square foot. It is estimated that the cost of adding a suspended ceiling to an existing classroom would be up to \$1.5 per square foot, reducing the reverberation time to 0.5 seconds.

The cost of HVAC for schools is typically 10% of the total cost, typically leading to a 45dBA background noise level. Upgraded HVAC systems could achieve 35dBA for 15% of the total cost.

### ASHRAE

The response from ASHRAE came from the Noise Technical Committee TC2.6. It gives similar information to the ASA on requirements of S/N ratio. Although using A-weighted levels, ASHRAE also drew attention to excessive low frequency rumble, which leads to a spectral imbalance causing annoyance and distraction. Use of the dBC - dBA difference was suggested where a difference of up to 25dB indicates an acceptably balanced spectrum, whilst differences above 30dB indicate excess rumble. The 25 - 30dB difference range is a transition region. ASHRAE's recommendations are as follows

Rooms with listeners with unimpaired hearing - maximum sound level 45dBA.

Rooms with hearing impaired listeners - maximum sound level 35dBA.

The C-weighted levels should be less than 25dB greater than these.

The noise insulation coefficient rating between rooms should be at least NIC-55, which will require attention to be given to basic wall construction, building fixtures and components that penetrate walls, such as electrical boxes, conduits, duct work etc.

A reverberation time of less than 0.5 seconds is recommended.

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### "COALITION"

The response of the coalition included the following points

Poor classroom communication is a barrier both to learning and the development of a child's full potential. However, the acoustic properties of the classrooms are often overlooked in accessibility planning.

The current practice of including children with all types of learning difficulties in regular classrooms has magnified the problems of these children.

The neurological system of children under the age of 13 is not fully developed. In addition to the totality of children under the age of 13, 8-10% of students of all ages may have significant learning problems, which will be exacerbated by poor classroom acoustics.

A typical classroom may have 30-35 pupils and excess noise and reverberation in these classrooms are the main obstacles to verbal communication.

### CONCLUSIONS

The level of professional and other support for the petition makes it likely that the Access Board will, in due course, make the requested ruling. This could have wider implications than just for classrooms and might lead to rethinking the acoustic design of all spaces where hearing impaired people of any age might be present.

#### Reference.

1. Architectural and Transportation Barriers Compliance Board. 36 CFR Chapter XI [Docket No. 98-4], Petition For Rule Making. Request for information on acoustics. Published in Federal Register, June 1st 1998.

The document has also been available on:

<http://www.access-board.gov/rules/acoustic.htm>



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