# ACOUSTICS IN ALBERTA SCHOOLS - OVERVIEW AND CHALLENGES

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## 1 Introduction

The province of Alberta is presently embarked on a major modernization and new school building program of about 230 schools. Alberta Infrastructure has developed acoustical requirements and it is our mandate to implement these. The difficulty is that schools are the property of school boards and we cannot impose our requirements.
To achieve success, we need to ensure that our requirements are reasonable and also be able to answer questions on certain issues.

## 2 Alberta Infrastructure requirements

### 2.1 Comparison to ANSI/ASA S12.60-2010[1]

The "Standards and Guidelines for School Facilities"[2] was first published in 2000 as a result of years of involvement in various teaching facilities starting with a band room study in 1977. For the most part, the requirements are the same as S12.60. HVAC noise is specified as RC and not dBA as used in S12.60. This is typically the way a mechanical engineer designs for noise.
S12.60 specifies the STC for toilets and bathing rooms which we do not specify and also the coverage uniformity for Classroom audio distribution systems which is not included in our requirements.

### 2.2 Requirements not mentioned in S12.60

Gymnasia are required to have a reverberation time less than 2s and the HVAC noise RC 35.
Music rooms require a range of reverberation between 0.7s an 0.8s and well as door seals
Music practise room are required to have an NRC ≥0.8 on the walls and ceiling as well as door seals.
Corridors and lunchrooms require ceilings with NRC ≥0.55.
Student gathering areas and computer lab require ceilings with NRC ≥0.7
Drama theatres require advice from an acoustical consultant.

## 3 Challenges

### 3.1 Classroom Audio Distribution Systems

These were a very intensely studied area in early 2000. There were claims of significant academic improvement. However, in recent studies Dockrell [3] explains how difficult it is to obtain meaningful data and concludes "*academic attainments showed no benefits from the use of sound-field systems*". If these are to provide benefit they must be installed in classrooms that meet acoustical requirements. The question remains as to the benefit they provide in such a classroom.

### 3.2 Gymnasium reverberation

As we require the reverberation in the gymnasium to be less than 2 seconds, any difficulty in measuring this becomes a contractual issue. This is how the issue reported by Packer [4] came to Infrastructure's attention.
Since then, no further investigation has occurred but the use of plywood "diffusers" for testing is accepted by Alberta Infrastructure.
The challenge is still to explain the physics of the observed phenomenon and then, using this data, make the changes in the measurement standards bodies or redefine how to calculate reverberation time in such a space.

### 3.3 Movable partitions

The trend we are seeing is a rather indiscriminate use of movable partitions. The architects point to the STC values of the products (typically 54) and feel justified in using these. The more troubling trend is that of using mall style sliding glass partitions as these have a lab STC 42 rating or less.
There are unfortunately little published NIC values of installed movable partitions [5] but the manufacturers expect 8-12dB degradation from STC. This means that NIC of 46 is the best one can expect.
Few architects follow ASTM E557-12 which is very stringent. For example, the top track deflection must be less than l/1156 - much stiffer than the usual l/360.
A concern is also how these partitions perform over time. How does the NIC change over years of service?
The challenge is to educate the owners and architects as to how difficult it is to obtain acoustic separation with these and discourage their use.

### 3.4 Trade teaching areas

The existing don't address rooms where trades are taught in acoustically challenging environments. Ideally they should represent a typical working environment but this may not be acoustically reasonable teaching environment.

#### Cosmetology

The challenge of these spaces is that they typically emulate a high end salon. The floors are typically sheet goods and the walls must be easily washable and the ceiling is typically drywall. Because of the number of students in the space and the noise of the equipment it becomes difficult to communicate beyond a meter. Convincing the designer to use absorptive ceiling tiles or baffles has become easier with

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some newer micro-perforated metal look products and felted polyester products.

**Culinary Arts**

These are effectively large commercial kitchens. The flooring is hard and the walls typically a highly washable plastic finish. Ceiling tiles are typically vinyl faced drywall. The ventilation system is typically loud.
The only area that can easily be modified is the ceiling tile. Previously the only alternative was mylar faced ceiling tiles. Recently, newer FDA approved products, with good acoustic absorption have been introduced.
Abating the exhaust fan noise remains a challenge.

**Construction trades & Automotive Shops**

These include a variety of workshops: woodworking, fabrication, auto body, and automotive shops. They can be treated together because they require hard flooring, generate significant dust and have high ceilings. The wall construction tends to be massive for fire control. The activities are also very noisy.
The primary surface that can receive acoustical treatment is the ceiling. Convincing the designers and owners of this expense is somewhat difficult as the argument is given that it is not typically provided in the workplace.
The noise of the exhaust air or dust collection systems is rarely addressed.

**Modular classrooms**

The intent of Alberta's modular classrooms is that each structure is capable of being moved to accommodate varying demands from shifting demographics in the community. These structures connect to other modular classrooms and/or the core school. They must be designed to be able to be moved over three times during a thirty-year period and meet all the "standard" acoustical requirements. Over the last decade the province has introduced teachers and students to the new High Performance Modular Classroom, with approximately 80 m2 floor space, each with a dedicated HVAC system.
The most significant acoustical challenge for the builders is achieving RC 30 (N) background noise criterion. .
The acoustical environments in a particular builder's modular classroom prototypes has been accessed in 2005, 2007, 2009, 2010 and 2012. Background noise levels were found to be RC 48 (N), RC 32(R), RC 31, RC 20(R)/RC 26(MF) and RC 27(R)/RC 31(MF), respectively. These levels are non-compliant due to some of the following deficiencies:
1. Furnaces were oversized requiring a major balancing damper restriction to provide the required flow rate resulting in significant turbulence noise at mid and high frequencies.
2. Mechanical room doors opened into the classrooms compromising the mechanical room's envelope as was a recessed electrical panel in the mechanical room wall.
3. Exhaust fans were found to be another dominant noise source at low frequencies as were roof mounted exhaust fans not properly isolated from the structure.
4. A major path for low frequency fan energy resulted in fan vibration being transferred to the mechanical room floor, through the monolithic floor assembly, and then radiated out into the classroom.
5. No flex acoustic duct was installed between the balancing dampers and each diffuser or lined duct.

Based on this experience we relaxed the RC 30(N) spectrum requirement and introduced a new 1/3 octave band criteria that allows low frequency noise to be a bit higher for Modular Classrooms but is not objectionable even though ASHRAE would classify it with an (R) rating; this low frequency noise component does not interfere with speech.
In the 2015 assessment of a modular classroom prototype, the builder only had to implement some minor acoustical renovations by additional structural isolation of the mechanical room ductwork but the background noise was found to be compliant to the new criteria.

## 4 Conclusion

To achieve schools that provide good acoustics we have a task of educating the public and school administrators. Ideally we would like to show that there is a correlation between acoustics and student outcome.
However, we still have some pure acoustic work to be done:
1. Is sound reinforcement in a classroom necessary in a school with good acoustics?
2. How do we explain the difference in reverberation measurement in an empty gym and one with some diffusion?
3. Will movable walls ever provide hoped for isolation?
4. Can we define and agree on acoustic requirements for trades' education areas?

## Acknowledgements

We would like to acknowledge the contributions of our predecessors at Alberta Infrastructure: Kelly Kruger, Erwin Rebke and Martin Fayers.

## References

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[5] A.D. Lightstone Practical Aspects of operable wall isolation, *Canadian Acoustics / Acoustique Canadienne* vol.22 no.3(1994) 31