INSTRUMENTATION FOR MEASUREMENTS IN BUILDING ACOUSTICS

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1. INTRODUCTION

The basic measurements in building acoustics are measurements of sound levels. The measured sound levels can be broadband or band-limited, frequency-weighted, and time-averaged or time-weighted. The measurements can take place in free-field, diffuse-field, or some other acoustic conditions. The sound levels can be steady or decaying. The measured quantities are usually used to determine quantities such as transmission loss or reverberation time.

One of the many factors involved in making good building acoustics measurements is the performance of the instruments that are used. Measurement systems can take many different configurations, from a simple single-channel hand-held stand-alone instrument to a complex multi-channel distributed system.

While many manufacturers provide comprehensive documentation of the performance of their products and refer to publicly-available test results, others may provide only limited and unverified information. It is rare for manufacturers to state how their products will perform when integrated with products from other manufacturers. The user needs to know whether unverified performance claims are sufficient to give confidence in the results of measurements, or whether the performance of the measurement systems should be tested.

Measurement practitioners should be able to call upon a comprehensive but practicable reference for both the specification and testing of the performance of the instruments. At present, all ASTM E33 (Building and Environmental Acoustics) measurement standards include a brief statement of requirements for microphones, but the statements are inconsistent and do not give requirements for the whole measurement system.

There is a draft ASTM Standard Specification that will attempt to address these issues[1]. The Specification is intended to be cited by ASTM measurement standards. This paper suggests how the goals can be achieved within such a Specification document, based on well-established standards for acoustical measurement instruments.

2. EXISTING SPECIFICATIONS

Comprehensive and agreed specifications and test methods for the various components of measurement systems already exist in international standards.

2.1 IEC 61672 – sound level meters

IEC 61672 is the international standard for sound level meters. The standard covers any measurement system that transduces sound pressure and displays sound level, and is not required to be a hand-held instrument. (This paper uses 'measurement system' because this term may be more familiar when referring to the diverse configurations of sound level meters that are in use.) IEC 61672 allows instruments to be defined in terms of their free-field or random-incidence response.

The performance specifications are given in the first part of the standard: IEC 61672-1[2]. For a measurement system to conform to IEC 61672, all the following conditions must apply:

a) the manufacturer has designed the measurement system to conform to the specifications for the various performance characteristics that are given in IEC 61672-1,

b) evidence is publicly available that examples of the model of measurement system have successfully passed the rigorous pattern evaluation (type-testing) that is specified in IEC 61672-2[3],

c) the individual example of the measurement system has successfully passed the simple periodic test specified in IEC 61672-3[4].

The periodic tests use an acoustical signal source (such as a multi-frequency sound calibrator or an electrostatic actuator) and an electrical signal source to test the response of the instrument to specified input signals. The periodic tests were designed to cover only the most essential characteristics and those where experience has shown that many instruments exhibit problems.

The manufacturer of a sophisticated modular measurement system could claim conformance to the specifications of IEC 61672-1 for some configurations (for example, using particular microphone models) but not for other configurations. The former configurations could meet the three conditions listed above, but the latter configurations would not meet the first two of the three conditions, however good the individual components.

IEC 61672-1 was recommended for use in Canada by the Canadian Standards Association in CSA Z107.10 in 2006[5]. Note that the ANSI S1.4-1983 and ANSI S1.43-1997

standards for sound level meters contain outdated specifications and impracticable test methods and are thus effectively obsolete[6,7].

2.2 IEC 61260 – band-pass filters

IEC 61260 is the international standard for fractional-octave band-pass filter sets[8]. The requirements of ANSI/ASA S1.11-2004 are almost identical to those of the international standard[9]. Both documents give specifications and test methods.

3. PRACTICAL IMPLEMENTATION

Measurement systems can be divided into two categories: a) those that *as a system* have been designed to conform to the requirements of IEC 61672, and b) those that have not been designed to conform to the requirements of IEC 61672, perhaps because they are not intended for professional use or they pre-date IEC 61672 or they have been assembled by the user from various available components.

3.1 Systems designed to conform to standards

Requirements for this category are straightforward - a measurement system for which conformance to standardized specifications (such as IEC 61672-1 and IEC 61260) is claimed should be tested using the relevant methods (IEC 61672-3 and IEC 61260).

3.2 Systems *not* designed to conform to standards

A measurement system that was not designed to conform to the specifications can still be tested using the relevant methods of IEC 61672-3 if the owner specifies the basic set-up information for the measurement system. The owner can specify the configuration of the system that is to be tested; for example, it may not be practicable to include in the configuration to be tested long signal cables that have little influence on the performance of the system.

The tests need only be performed for the characteristics that are necessary for the measurement of non-impulsive sound levels for building acoustics:

- response to a suitable calibrated sound calibrator
- self-generated noise
- frequency weightings
- level linearity on the reference level range
- level linearity when changing the level range
- overload indication

The owner of the measurement system might be required to look at the nominal frequency response chart for the model of microphone that is used, or to state the starting point for the tests of level linearity (preferably at the nominal level of the associated sound calibrator), or to state the limits of the ranges of sound levels that the system is expected to measure. This approach has already been tried for some sound level meters that were manufactured before the publication of IEC 61672 and was found to be practicable[10].

An instrumentation standard for building acoustics should therefore include some instructions or guidance on supplying the necessary set-up information to the test laboratory. The testing can be performed by the owner of the measurement system if they have access to the acoustical and electrical signal sources described in 2.1 above.

4. CONCLUSIONS

The need for agreed test methods for instrumentation for building acoustics can be addressed by reference to existing specification standards for acoustical instruments. Even for complex measurement systems that are not designed to conform to particular specification standards, it is possible to perform consistent tests of performance if the basic set-up information is specified by the user. The approach has been shown to be practicable and is recommended for adoption by standards organizations.

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ACKNOWLEDGEMENTS

The authors gratefully acknowledge discussions with Robert A. Hallman and Rich Peppin regarding the requirements for instrumentation for building acoustics.