ELECTROACOUSTICAL RESEARCH AND ACOUSTICAL CALIBRATIONS AT INMS

George S. K. Wong,
Institute for National Measurement Standards
National Research Council Canada, Ottawa, Ontario, K1A 0R6.

1. INTRODUCTION

Since the formation of the Institute for National Measurement Standards (INMS) at the National Research Council to replace programs in the previous Division of Physics and Division of Electrical Engineering, substantial changes have been made to the operational structure of NRC. INMS has the responsibility over a wide spectrum of Primary Standards that are maintained in Canada, and has a leadership role in national and international standards activities. The Institute also provides calibration services that are traceable to the Primary Standards. The aim here is to present a concise picture on the current research on electro-acoustics and the acoustical calibration and standards activities within INMS. The Acoustical Standards Group which is one of the ten groups in INMS, is responsible for the maintenance of the Primary Acoustical Standards and has been given a new mandate to develop Ultrasound Standards.

2. ELECTROACOUSTICAL RESEARCH

Electroacoustical research is a continuing activity of the Acoustical Standards Group. It includes up dating the semi-automatic acoustical instrument calibration system when new acoustical measuring instruments are submitted for calibration, low-frequency high sound pressure microphone calibration, phase match of microphones (for sound intensity measurements and research), new measuring techniques and instrument development. In view of a limited human resource, the current activities are selected to satisfy immediate needs :

(A) Coupler methods for phase match of microphones :

The design and development of a new three-port coupler [1] has enable NRC to have the capability to phase match microphones precisely. Current research indicates that the phase match uncertainty is less than $\pm$ 0.05 deg.; and depending on the type of microphones, the operating frequency range of the coupler can be extended to beyond 6.3 kHz. There are three variations of the coupler method :

With the Direct Method, the phase match arrangement requires two independent electronic channels i.e. two preamplifiers and two measuring amplifiers. The measurement is based on a microphone interchange procedure [1]. With the Substitution Method, only one electronic channel is required; whereas with the Comparison Method, two preamplifiers and one measuring amplifier are needed. The Direct Method has been automated with the operation under the control of a computer.

(B) Precision measuring amplifier :

The precision measuring amplifier [2] developed at NRC has been redesigned to incorporate new programmable features such as high pass and low pass filters; linear, A, B and C weightings; input and output gain stage selection, or with auto range; direct and preamplifier inputs; various response time constants; peak and hold, and data averaging.

3. CALIBRATION ACTIVITIES

Apart from routine calibrations, the Acoustical Standards Group is constantly upgrading and improving the capability of their calibration facilities.

(A) Primary acoustical standard :

The Canadian primary acoustical standards arrangement has been moved to a more spacious location. The reciprocity calibration system, including all the environmental controls for temperature, humidity and pressure, is being automated. The final arrangement will enable NRC to investigate into the effects of the environment on microphone sensitivity and frequency response.

(B) Accelerometer calibration :

A system for the absolute calibration of accelerometers is under development. The system consists of an electro-dynamic shaker to which the test accelerometer is attached, an interferometer to measure the movements of the accelerometer, together with an electronic counter to register the phase transition of the interference fringes, and a precision AC voltmeter to record the rms voltage from the accelerometer. Current investigation is focused on the shaker head movement orthogonality that contributes to nearly 40 % of the uncertainties in the calibration of an accelerometer.

(C) Ultrasound standards :

With the mandate to develop ultrasound standards to satisfy Canadian needs, the Acoustical Standards Group is making arrangements to implement initially, a high power ultrasound standard to cover the power range from approximately 0.5 W to 30 W ; and then a low power ultrasound standard to cover the range below 0.5 W.

The ultrasound standard consists of a tethered float suspended in water. The ultrasound beam from the test transducer displaces the hollowed cone shaped float from its initial position. By measuring the vertical displacement that has been calibrated with known weights applied to the float, the ultrasound power generated by the test transducer can be deduced from the product of the force acting on the float and the wave velocity.

4. CALIBRATION SERVICES

The acoustical calibration service is under review. New calibration services will include microphone phase match, filter sets, accelerometers, and partial check of sound level meters. INMS has recognised that the total cost for a relatively comprehensive calibration of a sound level meter may be out of reach for some smaller organizations, and consultants. Therefore, to provide a partial check that includes only attenuators or weighting net works together with sound pressure level sensitivity at a reference frequency, at a much lower cost can be more attractive. The above partial check rationale is based on the fact that some sound level meter features may not require annual calibration.

Calibration of commercial and special acoustical instruments pertaining to national and international standards are some of the on-going activities; and advice and information pertaining to acoustical standards, and technical aspects of noise measurement are usually available from the Acoustical Standards Group.

5. REFERENCES

[1] G. S. K. Wong, "Precision method for phase match of microphones," J. Acoust. Soc. Am. 90, September (1991).

[2] G. S. K. Wong, "Precision ac-voltage-level measuring system for acoustics," J. Acoust. Soc. Am. 65, 830-837 (1979).