

INTERNATIONAL COMPARISONS ON ACOUSTICAL CALIBRATIONS AND MEASUREMENTS

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1.0 INTRODUCTION

The mutual acceptance of acoustical calibrations and measurements between industrial countries is essential for international trade and will also remove non-tariff trade barriers. In order to gain international acceptance of Canadian calibrations and measurements, INMS participates in international comparisons in acoustical calibrations and measurements. The Comité international des poids et mesures (CIPM), under the general umbrella of the Bureau International des Poids et Mesures (BIPM), has formed a Consultative Committee on Acoustics, Ultrasound and Vibration (CCAUV) to formalise international comparisons on Acoustics (primary calibrations of laboratory standard microphones), Ultrasound (ultrasound power measurements and hydrophone calibrations) and Vibration (accelerometer calibrations).

2.0 NORTH AND SOUTH AMERICA

In North America, under the North American Cooperation in Metrology (NORAMET), NRC (Canada), NIST (USA) and CENAM (Mexico) have completed comparisons of microphone and accelerometer calibrations. With the inclusion of countries from South America, such as Brazil and Argentina, comparisons with five countries, are under the supervision of SIM (Sistema Interamericano de Metrología). The SIM comparison for accelerometers has been completed, and it is expected that the comparison for microphones will be completed by the end of 1999.

3.0 INTERNATIONAL COMPARISONS

The current CCAUV international comparisons involve more than twelve countries. The participants are responsible for hand carrying of the artefacts and returning them to the pilot laboratories: NPL, UK for the microphone comparisons, and PTB, Germany for the comparisons of ultrasound power measurements and accelerometer calibrations. For hydrophone comparisons, both NIST, USA and PTB, Germany will act as pilot laboratories. It is hoped to complete these comparisons by the year 2002.

3.1 PARTICIPATION IN INTERNATIONAL COMPARISONS

The participants in Consultative Committee (CC) comparisons are restricted to members. However, there are three major requirements in order to become a full member of a CC: (a) to be a national laboratory charged with establishing national standards in the field, (b) to be active in research and have a record of publications in research journals of international repute, and (c) to have demonstrated competence by a record of participation on international comparisons organised either by the Consultative Committee, the BIPM or a regional metrology organization. Requirements (b) above, will most likely restrict some national laboratories to observer status.

4.0 MEASUREMENT TRACEABILITY

For international trade, it is essential to have mutual recognition of measurements made by both the exporting and the importing country. For example, the noise level emitted by a machine measured at the factory with certified instruments and methods in accordance to international standards, should be acceptable to the importing country without the requirement to duplicate the measurements. To achieve this mutual recognition, it is necessary for the exporting country to have proven capabilities in international comparisons and an unbroken chain of traceability from the respective national laboratories to the machine shop level.

5.0 BENEFICIARY OF INTERNATIONAL COMPARISONS

"Who benefits from International comparisons?" This question is often asked by many organizations and governments. From the above, one may conclude that it is the consumer that reaps the benefits. Apart from mutual recognition to avoid non-tariff trade barriers, there are other aspects that benefit the consumers. For example, in connection to being active in research and development pertaining to acoustical calibrations, INMS developed an economically attractive interchange microphone method for microphone calibrations by comparison [1, 2]. The method enables the users of microphones to have their microphones calibrated at regular intervals without the relatively higher cost of an absolute calibration by the reciprocity technique. The above interchange microphone method of microphone calibrations by comparison has been accepted by the International Electrotechnical Commission (IEC) as an international standard IEC/61904-5 in the stage of a second committee draft.

6.0 SOME RELATED CURRENT ACOUSTICAL RESEARCH AT INMS

6.1 MICROPHONE CALIBRATIONS

The sensitivity of condenser microphones is affected by a change in barometric pressure. As an example, when the barometric pressure changes from 94 to 106 kPa, the sensitivity of a Brüel and Kjær 4160 laboratory standard microphone changes by approximately 0.2 dB and 0.35 dB at 1 kHz and 10 kHz, respectively [3]. A pressure coefficient curve has been obtained for this microphone so that users can correct their results to reduce their measurement uncertainties. All that is necessary is to measure the barometric pressure during the acoustical measurements.

To obtain the above pressure coefficient data, the Acoustical Standards Program at INMS designed and developed a calibration chamber with a controlled environment such that the pressure coefficients of microphones can be measured accurately. The chamber is currently being used for the SIM microphone calibration comparison for which INMS is the pilot laboratory, and will be used for

participation in the coming CCAUV comparison.

6.2 ULTRASOUND POWER MEASUREMENTS

At the request of Health Canada, INMS has developed a high-power ultrasound standard. A large absorbing or reflecting target submerged in a water tank is suspended with thin wires from a small hook at the bottom of an electronic balance. The test transducer with its active surface submerged in water is positioned coaxially above the target. The radiation force generated by the transducer and impinging on the target is measured by the electronic balance. Within a range of approximately 0.1 to 10 watts, and depending on the frequency of measurement, the uncertainty of the measured ultrasound power is between 5 and 10 percent at a confidence level of approximately 95%.

6.3 ACCELEROMETER CALIBRATIONS

To satisfy industrial needs, and possible future low frequency calibration requirements, a test rig has been built to enable accelerometer calibrations by comparison to frequencies as low as 2 Hz. A thin beam is excited with a shaker. One end of the beam is clamped with the shaker located at a short distance from the clamp. A reference accelerometer is mounted back-to-back with the test accelerometer at the far end of the beam. Under excitation, a sinusoidal motion is generated at the free end of the beam. The uncer-

tainty of the comparison is estimated to be 3% at a confidence level of approximately 95%.

7.0 CONCLUSIONS

International comparisons on acoustical calibrations and measurements are essential for international trade. The research and development that support the international comparisons benefit the consumers

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