ÉTS-IRSST COMMON INFRASTRUCTURE FOR RESEARCH IN ACOUSTICS - ICAR

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Abstract

This year, the ÉTS-IRSST common infrastructure for research in acoustics (ICAR) celebrates its 4^{th} year of activity. This is a joint laboratory between the École de technologie supérieure (ÉTS) and the Institut de recherche Robert-Sauvé en santé et en sécurité du travail (IRSST). When first created in 2011 at ÉTS, the lab included a semi-anechoic chamber coupled with a reverberation room. In 2014, an audiometric booth was added and a new laboratory for the characterization of acoustic materials, described in a companion paper [1], was added this year.

Keywords: laboratory, acoustics, vibrations, psychoacoustics, anechoic room, reverberant room, audiometric booth

Résumé

L' Infrastructure commune en acoustique pour la recherche ÉTS-IRSST (ICAR) célèbre aujourd'hui ses 4 ans d'activité. Il s'agit d'un laboratoire commun entre l'École de technologie supérieure (ÉTS) et l'Institut de recherche Robert-Sauvé en santé et en sécurité du travail (IRSST) qui est en activité depuis 2011. À l'origine, il comprenait une salle semi-anéchoïque couplée à une salle réverbérante. En 2014, une cabine audiométrique a été ajoutée et un nouveau laboratoire de caractérisation des matériaux acoustiques, décrit dans un article complémentaire [1], s'est tout récemment ajouté à l'infrastructure ICAR.

Mots clefs: laboratoire, acoustique, vibrations, psychoacoustique, salle anéchoïque, salle réverbérante, cabine audiométrique

1 Introduction

The exposure to high noise levels which can damage the auditory system in the long term is a present problematic with a strong impact on society. In order to (1) reduce the level of noise both at the source and during its propagation, and (2) improve technologies that can prevent hearing loss, a laboratory with the latest technology was needed. The École de technologie supérieure (ÉTS) and the Institut de recherche Robert-Sauvé en santé et en sécurité du travail (IRSST), with financial support from the Economic Development Agency of Canada, pooled their resources to create this unique research facility located within ÉTS's facilities at the heart of the Quartier de l'innovation, in downtown Montreal.

In collaboration with the industry and organizations concerned with occupational health and safety, the ÉTS-IRSST common infrastructure for research in acoustics (ICAR) is intended to further research in industrial acoustics, more specifically, in noise and vibration. ICAR addresses the problem of excessive noise from three possible solution-oriented angles: noise control at the source, control of the noise propagation paths, and individual protection devices. In other words, ICAR can test, improve and develop new and improved products or processes acoustically, be it industrial machinery, tools, transport vehicles, household appliances, acoustic materials, and products for the ear (hearing protection headphones, hearing aids, telecommunications / telephony devices, etc.). Its ultimate goals are to increase the comfort, health and safety of workers (and the public in general) through its facilities of advanced acoustic testing, to meet the needs of manufacturers and researchers, as well as train highly qualified professionals in this specialized field.

2 Equipment

Figure 1: Semi-anechoic room

The semi-anechoic room shown in figure 1 has a useful internal volume of 83 m^3. Removable wedges make it possible to render the room fully anechoic when such conditions are required for measurements. The cutoff frequency is then below 100 Hz. The room is also equipped with a pro-

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grammable rotary arm located in the center of the room with a 2.0 m spherical diameter range. The arm can be equipped with either a speaker, for example to measure the attenuation of hearing protectors in free field conditions or with a multi-microphone antenna, for example to quantify the sound field created by a noise source.

Figure 2: Reverberation room

The reverberation room shown in figure 2 has a useful internal volume of 211 m^3. It is equipped with 4 amplified power loudspeakers and has a reverberation time at 1000 Hz of about 3 s. The semi-anechoic and reverberation rooms are coupled with a measurement window 1.8 m high and 2.0 m wide and a niche depth of 0.3 m.

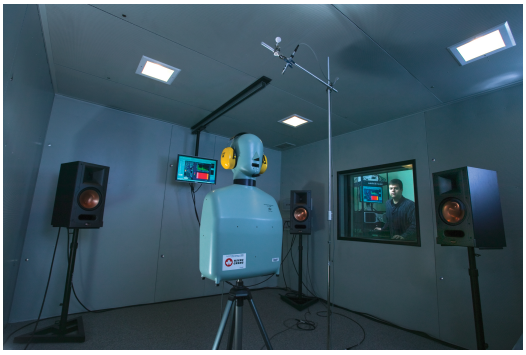

Figure 3: Double wall audiometric test booth

The audiometric test booth shown in figure 3 has double walls and a useful internal volume of 20 m^3.

The laboratory is also equipped with: a mobile intensity mapping system (I-Track, Soft dB); an intensity probe (B&K); a wheel array of 42 microphones (B&K); several multi-processing acquisition systems (Pulse B&K: 44 inputs including 2 high frequencies; National Instruments LabVIEW-PXI: 5-slot PXI Chassis including the following cards 1 NI PXI-4462 (4 AI), 1 NI PXI-4461 (2 AI and 2 AO) and 2 NI PXI-6221); an artificial head ISL; an artificial head G.R.A.S. 45CB Acoustic Test Fixture in compliance with ANSI S12.42 standard; Multi-voltage power supply for industrial equipment (120/240 and 347/600 Volts); an omni-directional sound source (BSWA); a "compression chamber" noise source type; a supply of compressed air for pneumatic tools up to 150 PSI.

3 The standard measures

ICAR offers a wide range of measurement capabilities, either for research or certification, such as measurements of: absorption coefficient of acoustic materials in a reverberation room according to ASTM C423-09a or ISO 354; sound power measurement in an anechoic or reverberation room according to ISO 3744; sound intensity mapping; source localization with acoustic holography and beamforming; intensity measures of wall sound insulation according to ISO 15186-1; directivity assessment of the attenuation of hearing protectors; source directivity, according to standard IEC 60268-5; attenuation of hearing protectors at different levels, ranging from auditory thresholds to typical industrial methods, and according to ANSI / ASA S12.6-2, ISO 4869 as well as AS / NZ1270 standards.

4 Examples of achievements

Various joint research projects between ÉTS and IRSST have already taken place and produced scientific and technological results, such as: the development of tools and methods to better assess and improve individual hearing protection for workers: acoustic and psychoacoustic measurements on human subjects [2]; experimental validation of finite element models of earplugs [3], earmuffs [4], and the occlusion effect due to earplugs [5]; the development of vibrational and acoustic diagnostic methods for portable pneumatic nailers: developing benchmarks for companies and experimental methods to measure noise and vibration emissions of this type of tool, identifying the mechanisms of noise propagation and proposing noise attenuation solutions; the localization of acoustic sound sources in the workplace with time-domain antenna methods [6].

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