EMRP Call 2012 – Open Excellence, Industry and SI Broader Scope

Selected Research Topic number: **SRT-s01**
Version: 1.0

Title: Realisation, dissemination and application of the unit watt in airborne sound

Abstract

The sound emission of machines and household appliances is described in terms of sound power or sound power level (SWL) and is the subject of regulation. The experimental determination of this is currently based on the measurement of field quantities like sound pressure or sound pressure level (SPL). Acoustic power can be calculated from the field quantities only in very well controlled acoustic environments and this results in uncertainties of up to several dB. The JRP should develop an alternative route for traceability of sound power in airborne sound that can offer significant reductions in uncertainty and greater robustness in the measurement of noise sources.

Conformity with the Work Programme

This Call for JRPs conforms to the EMRP Outline 2008, section on “Grand Challenges” related to Industry & Fundamental Metrology on pages 28 and 33.

Keywords

Acoustic product properties, sound power, sound power level, airborne sound, traceability, uncertainty

Background to the Metrological Challenges

The Outdoor Directive [1] concerns the noise emission into the environment by equipment for use outdoors. Sound power levels from such equipment must be determined and declared. For some machines, e.g. lawnmowers and earth moving machinery, permissible sound power levels are defined. Manufacturers are not allowed to market their products in Europe if they do not meet these requirements. Therefore, manufacturers as well as notified bodies which carry out or supervise the conformity assessment procedures require traceable results with small uncertainties and a transparent uncertainty budget. At present, “Measurement uncertainties are not taken into account in the framework of conformity assessment procedures in the design phase.” (Annex III of the Outdoor Directive) and measurement results of the sound power level are not traceable at all. This reflects the difficulties to establish an approved uncertainty budget for the sound power level and clearly indicates the need for improved measurement methods ensuring traceability of the results.

The Machinery Directive [2] supports the free movement of goods in the European internal market. As a Directive under Article 114 of the Treaty on the Functioning of the European Union, prepared to avoid trade barriers, it poses essential requirements on safety issues which have to be observed by all machinery manufacturers and machine importers in Europe. As noise is one of the important hazards addressed by the Machinery Directive essential requirements on noise are included. Most important is the minimisation requirement that postulates a noise control at source by design with the aim of reaching lowest noise emission levels. As a consequence it is necessary to assess whether the applied noise reduction measures are sufficient with regard to the state of the art of noise reduction. The emission values must be given in the instruction manual of the respective machine and in the sales literature describing the machinery. The intention is to allow potential purchasers of machines to compare machines of the same type but of different brand in order to choose the quietest machine on the market. As a result, the noise exposure of workers will be reduced by applying rather quiet machines at work places, thus leading to less people with hearing impairment. The whole concept of the Machinery Directive is closely linked to the measurand sound power.

EURAMET, EMRP-MSU
National Physical Laboratory
Hampton Road, Teddington,
Middlesex, TW11 0LW, UK

Phone: +44 20 8943 6666
emrpA169@npl.co.uk
www.euramet.org

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Programme of EURAMET

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The implementation of the Machinery Directive will thus benefit considerably from the establishment of a sound power standard resulting in traceable sound emission measurements with a clear uncertainty budget.

The European Labelling Directive [3] establishes a framework for the harmonisation of national measures on end-user information, particularly by means of labelling and standard product information, on the consumption of energy and where relevant of other essential resources during use, and supplementary information concerning energy-related products, thereby allowing end-users to choose more efficient products. It is supplemented by Commission delegated regulations with regard to several household appliances. Such regulations exist e.g. for dishwashers, washing machines and refrigerators. The label of the mentioned household appliances must contain the “airborne acoustical noise emissions expressed in dB(A) re 1 pW and rounded to the nearest integer”. It is expected that future regulations for further household appliances will also contain the noise emission which is quantified by the sound power level. Manufacturers as well as consumers are therefore interested in traceable sound power measurements with small uncertainties.

Currently, there are different standardised measurement procedures for the determination of sound power levels. A method used very often is the enveloping surface method in which the sound pressure level is measured and the sound power level is calculated from the mean sound pressure level under the assumption of a free field (ISO 3745) or of an essentially free field (ISO 3744, ISO 3746). In another approach, the sound pressure level is used to approximate the energy density in a diffuse field (ISO 3741) or in a nearly diffuse field (ISO 3743). Integrating the energy density over the room volume then gives the sound power level. There is also a substitution method (ISO 3747) which requires the use of a calibrated reference sound source. The calibration of this device is carried out according to ISO 6926. All the above mentioned measurement procedures are based on sound pressure measurements. There is also the possibility to measure sound intensity on an enveloping surface either at discrete positions (ISO 9614-1) or by scanning (ISO 9614-2, -3). The basic problem with all the mentioned standards is that sound power results will be different for different methods. There is no “reference method” and no primary sound power standard. Therefore, systematic deviations between the sound power results cannot be accounted for. The measurand “sound power level” is thus defined by the prescribed procedures which are different for different methods. Hence the existing uncertainty budgets do not describe the measurement situations properly and there is no effective traceability for sound power levels.

Scientific and Technological Objectives

Proposers should address the objectives stated below, which are based on the PRT submissions. Proposers may identify amendments to the objectives or choose to address a subset of them in order to maximise the overall impact, or address budgetary or scientific / technical constraints, but the reasons for this should be clearly stated in the JRP-Protocol.

The JRP shall focus on the traceable measurement of acoustic power.

The specific objectives are

1. To develop a reference sound source with a calculable sound power based on measurements of vibration velocity, dimension and the environmental properties of air with an uncertainty of 0.5 dB. The device should be characterised by the traditional methods described in ISO 6926 and any deviations from the predicted behaviour explained.
2. To measure the output of this device with sound intensity instruments calibrated in accordance with IEC 61043 and explain any deviations from the predicted behaviour.
3. To develop methods for the calibration of non-calculable sound sources by comparison with this device.

These objectives will require large-scale approaches that are beyond the capabilities of single National Metrology Institutes and Designated Institutes. To enhance the impact of the research work, the involvement of the larger community of metrology R&D resources outside Europe is recommended. A strong industry involvement is expected in order to align the project with their needs and guarantee an efficient knowledge transfer into industry.

Proposers should establish the current state of the art, and explain how their proposed project goes beyond this.

The total eligible cost of any proposal received for this SRT is expected to be around the 2.7 M€ guideline for proposals in this call. The available budget for integral Research Excellence Grants is 42 months of effort.

Potential Impact

Proposals must demonstrate adequate and appropriate participation/links to the “end user” community. This may be through the inclusion of unfunded JRP partners or collaborators, or by including links to industrial/policy advisory committees, standards committees or other bodies. Evidence of support from the “end user” community (eg letters of support) is encouraged.

You should detail how your JRP results are going to:

- feed into the development of urgent documentary standards through appropriate standards bodies
- transfer knowledge to the acoustic instrumentation and product compliance sectors.

You should detail other impacts of your proposed JRP as detailed in the document “Guide 4: Writing a Joint Research Project”

You should also detail how your approach to realising the objectives will further the aim of the EMRP to develop a coherent approach at the European level in the field of metrology and includes the best available contributions from across the metrology community. Specifically the opportunities for:

- improvement of the efficiency of use of available resources to better meet metrological needs and to assure the traceability of national standards
- the metrology capacity of Member States and countries associated with the Seventh Framework Programme whose metrology programmes are at an early stage of development to be increased
- outside researchers & research organisations other than NMIs and DIs to be involved in the work

Time-scale

The project should be of up to 3 years duration.

Additional information

The references were provided by PRT submitters; proposers should therefore establish the relevance of any references.

[1] DIRECTIVE 2000/14/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 8 May 2000 on the approximation of the laws of the Member States relating to the noise emission in the environment by equipment for use outdoors.

[2] DIRECTIVE 2006/42/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 17 May 2006 on machinery, and amending Directive 95/16/EC

[3] DIRECTIVE 2010/30/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 19 May 2010 on the indication by labelling and standard product information of the consumption of energy and other resources by energy-related products