

Title: Underwater acoustic calibration standards for frequencies below 1 kHz

Abstract

Concerns about the environmental impact of human activity, together with the needs of industry and oceanographic science, are driving an increased need for absolute measurements of sound in the ocean. The noise sources of greatest interest are the high amplitude, low frequency anthropogenic sources which radiate most of their sound energy in the frequency range between 10 Hz and 1 kHz. Currently, only one NMI within Europe has the capability to offer calibration services below 1 kHz; cooperation is required to develop a traceable infrastructure across Europe which will underpin regulation in support of EU Directives such as the Marine Strategy Framework Directive, where absolute acoustic measurements are made in support of environmental impact assessments for anthropogenic noise.

Keywords

Underwater acoustics, hydrophone calibration, low frequency pressure calibration, marine environmental noise assessment, Marine Strategy Framework Directive

Background to the Metrological Challenges

Recent years have seen an increasing influence of noise from human activities, which pose unprecedented risks for the sustainability of key marine species, biodiversity, ecosystems and the overall health of our seas. The noise sources of greatest concern are the high amplitude, low frequency sources such as airgun arrays for geophysical surveying, marine impact piling for offshore construction, explosive decommissioning, and particularly noise from shipping traffic. All of these sources radiate most of their sound energy in the frequency range between 10 Hz and 1 kHz.

In the EU, the Marine Strategy Framework Directive (MSFD, Directive 2008/56/EC) requires Member States to achieve or maintain Good Environmental Status (GES) by the year 2020. GES has 11 Descriptors, of which one requires that: "Introduction of energy (including underwater noise) does not adversely affect the ecosystem". Member States must monitor trends in 'continuous low frequency sound', and they must do so at a regional level. However, international collaboration on standardisation of monitoring methods and calibration of instrumentation must be accomplished so that the measurement programmes of Member States are underpinned with robust metrology and traceable standards. This was recognised as an urgent need by the EU TG Noise expert committee in 2014 [1].

Underwater acoustics is a relatively immature field for metrology. Calibration of hydrophones for frequencies from 0.01 Hz to 1 MHz is currently covered by the international standard IEC 60565:2006 that still draws much of its contents from the previous 1977 edition. Of the entire frequency span, most of the demand in support of active acoustic systems lies within the 1 kHz to 500 kHz range, which is the common range of operation for most sonar systems. For such a restricted range, the standard method of calibration which gives best accuracy is the free-field, three-transducer spherical wave reciprocity. However, current primary free-field standards are frequently limited to frequencies above 1 kHz in test tanks, due to the finite size of the tank.

Currently, there is only one mature NMI within Europe which has extensive expertise and experience in underwater acoustic metrology, for the entire frequency interval from tens of Hz up to the MHz range. In this field, other institutes are present in European Countries possessing calibration capabilities which are currently restricted to frequencies above about 1 kHz. These institutes are either already established within EURAMET as DI or have applied to obtain DI status. As a result, the current capability gap in European

metrology does not allow to properly and efficiently address the requirements for reliable low frequency noise measurements in the marine environment, as stated by EU regulations.

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 protocol.

The JRP shall focus on the development of metrological capacity in underwater acoustic calibration for frequencies below 1 kHz.

The specific objectives are

1. To develop traceable measurement capabilities to meet the need for calibration of hydrophones in the 63 Hz and 125 Hz third-octave bands, as required by the guidelines for monitoring undersea noise within the EU Marine Strategy Framework Directive.
2. To develop traceable measurement capabilities to meet the need for calibration of acoustic noise recorders and systems used for long-term ocean acoustic monitoring for NMIs and DIs seeking to establish a research capability in this field.
3. For each participant, to develop an individual strategy for the long-term operation of the capacity developed, including regulatory support, research collaborations, quality schemes and accreditation. They should also develop a strategy for offering calibration services from the established facilities to their own country and neighbouring countries. The individual strategies should be discussed within the consortium and with other EURAMET NMIs/DIs, to ensure that a coordinated and optimised approach to the development of traceability in this field is developed for Europe as a whole.

Joint Research Proposals submitted against this SRT should identify

- the particular metrology needs of stakeholders in the region,
- the research capabilities that should be developed (as clear technical objectives),
- the impact this will have on the industrial competitiveness and societal needs of the region,
- how the research capability will be sustained and further developed after the project ends.

The development of the research potential should be to a level that would enable participation in other TPs.

Proposers should note that the programme funds the activity of researchers to develop the capability, not the required infrastructure and capital equipment, which must be provided from other sources.

EURAMET has defined an upper limit of 500 k€ for the EU Contribution to any project in this TP, and a minimum of 100 k€.

EURAMET also expects the EU Contribution to the external funded partners to not exceed 10 % of the total EU Contribution to the project. Any deviation from this must be justified.

Potential Impact

Proposals must demonstrate adequate and appropriate participation/links to the “end user” community, describing how the project partners will engage with relevant communities during the project to facilitate knowledge transfer and accelerate the uptake of project outputs. Evidence of support from the “end user” community (e.g. letters of support) is also encouraged.

You should detail how your JRP results are going to:

- Address the SRT objectives and deliver solutions to the documented needs,
- Provide a lasting improvement in the European metrological capability and infrastructure beyond the lifetime of the project,
- Facilitate improved industrial capability or improved quality of life for European citizens in terms of personal health or protection of the environment,
- Transfer knowledge to acoustic measurement device manufacturers, the marine environment sector and the metrology community.

You should detail other impacts of your proposed JRP as specified in the document “Guide 4: Writing Joint Research Projects (JRPs)”.

You should also detail how your approach to realising the objectives will further the aim of EMPIR to develop a coherent approach at the European level in the field of metrology and include 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 EURAMET Member States whose metrology programmes are at an early stage of development to be increased
- 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] *Monitoring Guidance for Underwater Noise in European Seas*, Parts 1, 2 and 3, European Commission JRC Scientific and Policy Reports EUR 26555, 26556, and 26557 EN, Publications Office of the European Union, Luxembourg, 2014. Available from: <http://publications.jrc.ec.europa.eu/repository>.