Publishable Summary for 15RPT02 UNAC-LOW
Underwater acoustic calibration standards for frequencies below 1 kHz

Overview

The goal of the project is to develop the European Metrological Capacity in underwater acoustic calibration for acoustic frequencies below 1 kHz by providing traceable measurement capabilities to meet the need for calibration of hydrophones and autonomous underwater acoustic noise recording systems. The project will develop the scientific and technical research capabilities in the field within Europe, and provide an improved metrology framework to underpin the absolute measurement of sound in the ocean in support of regulation and EU Directives (such as the Marine Strategy Framework Directive) for which traceability is currently lacking.

Need

There is an increased need for absolute measurements of sound in the ocean driven by ongoing concerns about the environmental impact of human activity, together with the emerging needs of industry and oceanographic science. In order to be meaningful, such absolute measurements require traceability to agreed standards, but traceability is not widely available for acoustic frequencies below 1 kHz. With regard to marine environmental protection, the expansion of offshore activities has led to concern about the environmental impact of man-made sound upon marine fauna. The effect on marine fauna of high amplitude sources may include physiological effects (e.g. damage to hearing) or behavioural effects (e.g. flight response or displacement from habitats). An increase in background noise level may also have chronic effects (e.g. masking of biologically produced sound vital for communication and foraging).

The anthropogenic sources of most environmental concern radiate most of their sound energy in the frequency range between 20 Hz and 1 kHz. However, in this frequency range there is a lack of availability of traceable measurement standards, with much of the historic demand being for testing of active systems at kilohertz frequencies. There is a direct and urgent need for traceable calibration of the hydrophone instrumentation used for measurements driven by the increased demand for measurement generated by regulation. However, there is also a technology push provided by the development and increasing commercial availability of new instrumentation, specifically autonomous recorders which combine hydrophones and acquisition and data storage capabilities.
Currently, no standards exist to calibrate these instruments; therefore there is an urgent need to develop traceable measurement capabilities for calibration of hydrophones and autonomous underwater acoustic noise recording systems at frequencies between 20 Hz and 1 kHz, including the 63 Hz and 125 Hz third-octave bands required by the EU MSFD. This must include research to develop new traceable calibration methods for autonomous noise recorders for which there are no established calibration methods. Underwater acoustics is a relatively immature field for metrology, and in addition to establishing a European calibration capability, a strategy must be developed for the long-term operation of the developed capabilities, contributing to a coherent metrology strategy for Europe within this field, providing significant improvement of the use of the available resources to better meet metrological needs and assure the traceability of national standards, and to develop a research capability within the metrology community.

Objectives

The overall objective of this project is to develop an absolute measurement technique for making the calibration of hydrophones and autonomous underwater acoustic noise recording systems at frequencies between 20 Hz and 1 kHz and dissemination of the calibration capability in order to fulfil the related directive which is stated in the Marine Strategy Framework Directive (MSFD, Directive 2008/56/EC)

This project addresses the following scientific and technical objectives;

1. To develop traceable measurement capabilities to meet the need for calibration of hydrophones at frequencies between 20 Hz and 1 kHz, and covering 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 calibration methods which provide traceable measurement capabilities to meet the need for calibration of autonomous underwater acoustic noise recording systems used for long-term ocean acoustic monitoring at frequencies between 20 Hz and 1 kHz, including the 63 Hz and 125 Hz third-octave bands for NMIs and DIs seeking to establish a research capability in this field.
3. To develop an individual strategy for each participant for long-term operation of the developed measurement capabilities including regulatory support, research collaborations, quality schemes and accreditation, contributing to development of a coherent metrology strategy for Europe within this field (discussed and agreed within the EURAMET community via the EURAMET TC-AUV), and significantly increasing the research capacity in the field.

Progress beyond the state of the art

The project will develop and validate appropriate measurement methods for the calibration of hydrophones in the frequency range from 20 Hz to 1 kHz. At the conclusion of the project, at least two of the hydrophone calibration methods selected from those described in the scientific literature or the related international standards will be implemented into new calibration systems. These will be validated by comparison measurements between the project partners. Through this work, traceability for absolute measurement of sound in the ocean using hydrophones will be provided across the EU countries, with project partners offering calibration services from their established facilities to their neighbouring countries.

The calibration methods developed in this project will provide the ability to determine the key acoustic performance characteristics of the recorders, including the self-noise of the hydrophone and system, the hydrophone and system sensitivities. The newly established methods to calibrate autonomous noise recorders will be implemented by the project partners and services offered to stakeholders in neighbouring countries, with recommendations given to technical standards committees including ISO TC43 SC3 and IEC TC87 for preparation of related standards. This will be facilitated by members of the project consortium who are active in the standards committees (the consortium contains the Convenor of several key Working Groups). The manufacturers and end users of noise monitoring systems will be informed of the developments so that the improvements can be incorporated into their own work.

Establishing traceable calibration facilities for the hydrophones and noise recorders by the project partners will sufficiently extend the capability of each related stakeholder. Also these calibration facilities shall be used for providing calibration services by NMIs/DIs and guides for end users working in the field on underwater acoustic measurement and monitoring including the design and production of corresponding systems.

Results

The project will facilitate significantly improved capability within Europe for marine acoustic metrology at frequencies below 1 kHz, providing much-needed traceability for absolute measurement of sound in the ocean, and underpinning acoustic measurements for protection of the marine environment. In addition to the benefits for the metrology community itself, the improvements will also directly benefit the European marine acoustic community, with the main stakeholders being from:

- industry (manufacturers and suppliers of hydrophones and autonomous noise recorders),
- the end user community (scientific institutes and acoustic consultants undertaking in-situ measurement of sound in the ocean),
- and the relevant regulatory bodies and licensing authorities (both national and international) that require acoustic measurements to be undertaken to satisfy the requirements of EU Directives such as MSFD, offshore licences and environmental impact assessment.

Calibration of hydrophones

As a result of this project, the improved traceability for hydrophone calibration will provide manufacturers and users with vital confidence in the measurement result.

Calibration of autonomous underwater acoustic noise recording systems

The new methods for calibration of autonomous recorders will provide manufacturers with important feedback on key performance metrics for the first time, leading to development of improved system performance and validated calibration methods and better uncertainties. The new calibration guidance developed by the project will also be directly used by calibration laboratories, which will assure traceability of measurements performed by end users of recorder systems. This will enable results of in-situ measurements of ocean noise to be reported with a more robust associated uncertainty (1 dB for hydrophones and 1-1.5 dB for autonomous sound recorders), which will enable a transparent comparison of measurement results made in different environments and by different users. Moreover, a comparison of the performance of autonomous noise recorders will be possible either individually as a function of time to assess stability, or between differing designs of recorders. This will provide increased reliability and confidence in the performance of instruments for the end-user community.

Individual strategy for long-term operation of the developed measurement capabilities

Each partner will develop a strategy for the long-term operation of the calibration capability developed in the project. This will include establishing regulatory support and research collaborations, as well as appropriate quality schemes and accreditation.

Also, each partner will develop a strategy for offering calibration services from their established facilities, both to their own country, and to neighbouring countries. The individual strategies will form part of a coherent metrology strategy for Europe within this field, discussed and agreed within the EURAMET community of NMIs/DIs via the EURAMET TC-AUV.

Impact

As the regulatory requirement for measuring acoustic noise in the ocean has increased, the measurements which were once the province of scientific institutes are being increasingly provided by acoustic consultants, many of which more typically work in air acoustics. Although hydrophone and autonomous noise recorder instrumentation is commercially available, the availability of traceable calibration is significantly lacking, with only one European NMI (NPL) routinely providing calibration standard services.

Impact on industrial and other user communities

Harmonised and traceable calibration based on accreditation is a basic requirement for mutual recognition of calibration results, offering a cost saving to European manufacturers wishing to export throughout the world. The recognised traceability of calibration results will also provide an important contribution to environmental protection. Regulatory authorities need robust metrology to underpin decisions about environmental legislation, and the licensing of offshore operations where noise is a by-product of human activity (for example, construction noise for offshore structure such as oil and gas platforms and offshore wind farms). The requirements of the EU MSFD mandate that Member States undertake noise monitoring in one-third-octave bands centred at 63 Hz and 125 Hz to assess the influence and trends in noise from ship traffic. In response to the EU MSFD, Member States will be establishing monitoring programmes in the next few years (during the lifetime of the project) and there will be a direct and urgent need for traceable calibration of instrumentation. This project will provide the necessary metrology infrastructure for the national authorities responsible for implementation of policies in response to the EU MSFD.

Impact on relevant standards

Accreditation bodies and accredited laboratories working according to EN ISO/IEC 17025 for the calibration of hydrophones and laboratories calibrating recorders will benefit from the project's outcomes as the calibration methods developed will serve as the basis for future standardisation. The harmonised calibration procedures provided by this project will also provide consistency in methods for the calibration of the hydrophone and autonomous noise recorder and will support the harmonised accreditation of commercial calibration laboratories.

Impact on the metrology and scientific communities

Furthermore, a wide range of stakeholders will benefit from the new calibration standards and traceability. These include industrial manufacturers and suppliers of hydrophones and autonomous noise recorders, the end user community of scientific institutes and acoustic consultants undertaking in-situ measurements of

sound in the ocean, and the relevant regulatory bodies and licensing authorities (both national and international) that require acoustic measurements to be undertaken to satisfy the requirements of licences and environmental impact assessment. This is in addition to the metrology community of NMIs and DIs, where the benefits will flow through CCAUV and EURAMET TC-AUV, and the standards community within ISO and IEC. The partners will systematically disseminate the project results through presentations at international technical working group meetings, the project web page, workshops and meetings with local stakeholders and will present the project's results at conferences and in scientific publications and trade journals. The interaction with stakeholders through the project's Stakeholder Committee will also help to steer the project enabling it to adapt to stakeholders' needs.

Project start date and duration:	01 May 2016, 36 Months	
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