

Underwater Sound Reference Division, United States/ Underwater Acoustic Metrology

Introduction

The Underwater Sound Reference Division (USRD) has been establishing Navy Local Calibration Procedures (LCPs) and primarily focused in reducing overall measurement uncertainty throughout the acoustic calibration facilities. USRD continues to provide underwater acoustic calibration (over 300 transducer or hydrophone calibrations over the past two years) and maintains transducer standards for the navy, universities, and private industry to support both the United States and international activities. To support this critical mission, USRD maintains several World-class facilities including the Acoustic Pressure Tank Facility, Open Tank Facility, Low Frequency and the Leesburg Facility. Additionally, the USRD maintains the United States only Transducer Standard Program and this activity continues to develop/manufacture new standards for the acoustic community.

Historically, the USRD was established in Orlando, Florida at the beginning of WWII as the Underwater Sound Reference Laboratory for the purpose of performing quantifiable underwater acoustic measurements in support of the United States Navy. Today's role is to perform research and development to advance the state of the art in underwater acoustic measurement methodology and to design and develop underwater electroacoustic devices to both receive and transmit acoustic energy within respected uncertainty budgets under varying environmental conditions.

USRD continues to provide the following capabilities:

- Maintains a large pool of standard active or passive acoustical transducers or hydrophones (over 800) with traceable, historical, data through the Transducer Standards Program supporting Navy, industry and academic communities
- Provides acoustic transducer calibration services to Navy, industry and academia.

CURRENT USRD UNDERWATER ACOUSTIC METROLOGY

Status of the USRD underwater acoustic metrology activities are summarized below:

- Round Robin transducer calibration among the different calibration facilities continue to be conducted every six months (more often if required), which effectively provides a reference base among the different facilities within the USRD. There are four USRD Round Robin transducers covering various frequency ranges with quantifiable acoustic calibration under extreme environmental conditions. Regarding International Round Robins, the USRD represented the United States in the Key Comparison for underwater acoustics performed under the auspices of the International Bureau of Weights and Measures (BIPM) and plans on participating again in CY12.

- The USRD Electroacoustic Calibration Simulator (ECS) box continues to be circulated among the different calibration facilities on a quarterly basis. The ECS provides a useful tool to maintain the same levels of the simulated transducer driving conditions across the test facilities and employs a critical tool to separate calibration equipment uncertainties from those by the transducers themselves.
- USRD continues to develop U.S. Navy MetCal Local Calibration Procedures (LCPs). Previous LCP covered the USRD H52 Hydrophone under the Low Frequency calibration facility over the band up of 2 kHz. Two more LCSs have been developed this year which were submitted to the Navy MetCal covering frequencies from 1 kHz to 200 kHz and 10 Hz to 2 kHz for the USRD H52 Hydrophone by Reciprocal Calibration, and for the USRD H64 Hydrophone respectively. Establishing measurement uncertainty budgets are key with active uncertainty analyses taking place throughout the facilities. Plan will be to have another five LCPs generated and submitted this year to the Navy MetCal Corona Division for approval which follows standard Navy MetCal protocols.
- USRD and The Office of Technology Evaluation, Bureau of Industry and Security, U.S. Department of Commerce are working closely in the development of a national survey for the assessment of all underwater acoustic and transduction related facilities. The assessment includes US government, academia, and industrial base operations and address past, current, and future acoustic metrology related capabilities and available national assets.

Papers/publications/chaired committees from the USRD in the fields of AUV

NAVSEA LCP-NRA-010, Local Calibration Procedure, H52 Hydrophone (Reciprocity Calibration), NUWCDIVNPT USRD, March 2012.

NAVSEA LCP-NRA-011, Local Calibration Procedure, H64 Hydrophone, NUWCDIVNPT USRD, April 2012.

ANSI/ASA S1.20-2012 American National Standard Procedures for Calibration of Underwater Electroacoustic Transducers: Establishes measurement procedures for calibrating electroacoustic transducers and describes forms for presenting and assessing the resultant data (WG Chair R.M. Drake 2012).

The Science of Measurement Uncertainty as Applied to Underwater Acoustic Measurements, Dr. Dehua Huang, sponsored efforts at the Underwater Sound Reference Division (2011-2012)

Dehua Huang and Anthony Paolero, "Low frequency acoustic sensor or array calibration waveguides of finite length," J. Acoust. Soc. Am. 129, 2643 (2011).

**Papers/publications/chaired committees from the USRD in the fields of AUV
(Continued)**

Dehua Huang, "Non-uniform array synthesis concept and theory," J. Acoust. Soc. Am. 127, 1981 (2010).

Non-uniform Array Synthesis Concept and Theory, Dehua Huang, Journal of the Acoustical Society of America, vol. 127, p1981 (2010)

Breazeale Legacy in Gaussian Acoustics, Dehua Huang, Journal of the Acoustical Society of America, vol. 127, p1844 (2010)

Dehua Huang and Anthony Paolero, "Analysis models for the Underwater Sound Reference Division low-frequency acoustic calibration systems," J. Acoust. Soc. Am. 126, 2196 (2010).