Measurement of attenuation and sound speed.

The methods of measuring are under continuous development, towards increasing traceability and accuracy.

Equipment:

A casting mould measuring 6 * 6 * (N* 1cm +/- 0.01 cm).
A transmitter: Agilent 22500B programmable function generator.
A transducer: Optel 100 nS, 8mm Ø, unfocused.
A water bath 48 * 30 * 12 cm with slow circulation.
A hydrophone, Sonda Model HNR-1000 placed 120 mm from the transducer.
A preamplifier of my own construction. Specifications not relevant.
An oscilloscope: Tektronix TDS210, certified 15. June 2015
Vertical 8 bit resolution, accuracy +/- 3 % * reading,
Horizontal accuracy +/- 100 ppm.
A mercury thermometer +/- 0.1 °C, certified 31.01.2002.
A computer. Specifications not relevant.

Method:

Each time a phantom is cast, a test block is cast in the test mould from the same casting mass. This test block is used for testing sound speed and attenuation.

Sound speed:

The transducer is activated with a number of sine wave bursts of different frequencies. The received waveforms from the hydrophone are stored in the computer.
The sample is placed in the sound path close to the hydrophone. The transducer is then activated with the same frequencies and cross-correlations between the two sets of waveforms are calculated. From the cross-correlations the time differences are calculated. These time differences are used to calculate the speed of sound in the test block relative to water.
The sound speed in water v at the temperature t is calculated from the formula:
$v = 1403 + 5*t - 0.06*t^2 + 0.0003*t^3$.

Attenuation:

The transducer is activated with a number of sine wave bursts of different frequencies, all at the maximum duration that will not create interference with the re-reflections inside the test block but not more than 20 cycles. A FFT analysis is made, and the frequency with the maximum energy is found. These frequencies and their corresponding energies are stored. The test block is then placed in the sound path, close to the hydrophone and the measurements are repeated. From the differences in energy at different frequencies the attenuation is calculated.

Backscattering:

The backscattering from a sample compensated for transducer geometry and attenuation is compared with the echo from a steel block at focus.