Hydro acoustical range facilities in Germany

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Introduction

Military requirements demand special properties of their equipment. Therefore the navy works out operational scenarios to derive the possibly threat of their mission and ships and the required own capabilities of the performance of the sonar equipment.

In respect to this prerequisite we define feasible maximum signature levels of naval ships and boats placed in contracts agreed by the ship yard.

WTD 71 provides hydro acoustical ranges to perform measurements for investigating the acoustical behavior of naval ships and boats and to control the fulfillment of the contracts.

Ranges

According to the different propagation properties and operational modes WTD 71 employs a shallow water and deep water facilities.

Shallow water range

In 20m water depth two sites with 8 hydrofones are installed on different sea bottoms within the Eckernförder Bucht. The distances of these sensors to the course is accepted to a optimal signal to noise ratio due to our purposes. Measurements are done up to 20 kn in keel and beam aspects simultaneously. The accuracy of tracking is based on DGPS and optical bearing. Besides the dynamic ranging stationary measurements are performed on site 2. For the new German submarine a new site was built according to the requirements of stationary ranging.

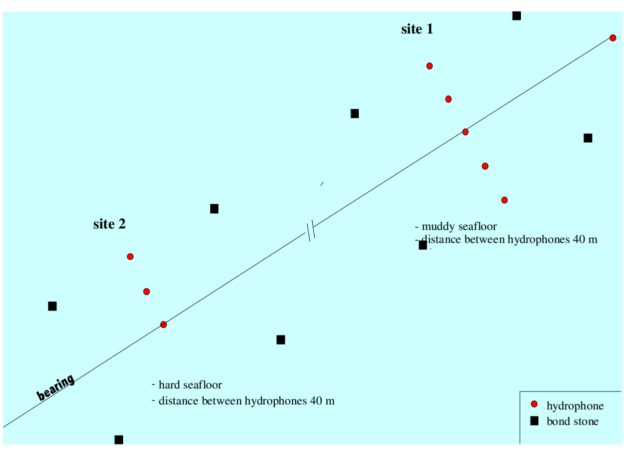

Figure 1: Shallow water range sketch. Two sites in 20 m water depth and 1500m distance.

Besides ranging Navy vessels WTD 71 also performs acoustical measurement of civil or research vessels as well.

Deep water range

In cooperation with Norway and the Netherlands WTD 71 runs a deep water range in Norway in the Herdle Fjord. Measurements are performed in a 400 m deep area up to maximum speed of the vessel.

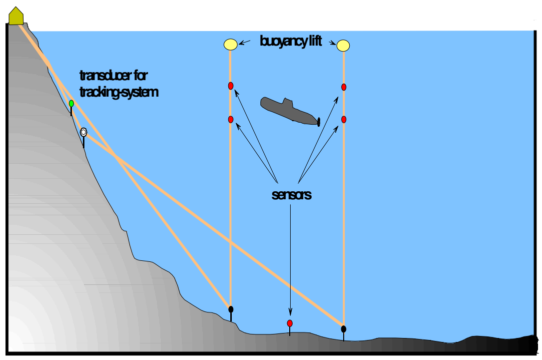

Figure 2: Sketch of the deep water range in Norway. Water depth 400m. 4 sensors are arranged in a winch system.

The 4 hydrofones are arranged in pairs forming a gate with a spreading of 216 m. The distance between the upper and lower sensor is fixed with 65 m.

Especially ranging of a submarine in a submerge mode is possible. Respectively to keep the same glance angel the sensors are variable in the depth as a set by operating a winch system. The variation of submerged sensors starts from 20 to 300m.

The submarine is being tracked by a transmitter-transponder-hydrofon system. Just before starting the measurement the active signal must be switched off.

Technical equipment

In a frequency range from 4 – 100kHz analysis are done at both facilities. The sound emission received by the hydrofones will be preamplified transmit over the sea cable to the range house. Adapted to an optimum dynamic resolution the analogue data will be stored and distributed to the different analysers.

The best overview in the required frequency band is to illustrate the data in 1/ 3 octave band. The relative band width describes the acoustical condition of the vessel. Hence of this properties the 1/3 octave analysis is used as a base line for the determination of the target level.

Especially the broad band noises like e. g. cavitation can be shown in this curves.

Besides measuring the target level it is also mandatory to verify the generating noise source.

Narrow band analyzer

Analyses where the filter bandwidth is constant for all frequencies within the frequency range of interest are referred to as “narrow-band analyses”.

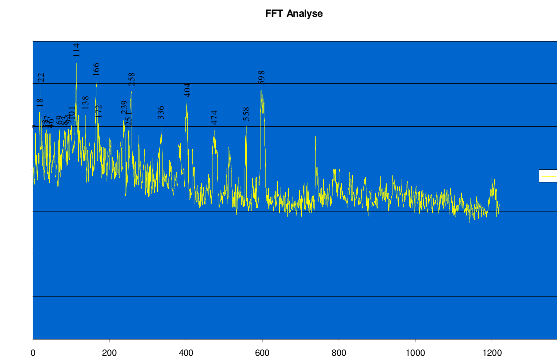

Figure 3: Narrow Band Spektrum compute as FFT with 1 HZ Resolution and a band width from 4 Hz to 1.2 KHz

Up to 2 kHz with a frequency resolution of 1 Hz the spectrum provides tonals of periodic turning devices. This indicates a correspondence to the source. For the most devices this method computed as FFT is sufficient.

LOFAR

LOFAR stands for Low Frequency Analysis and Recording and is a method for time-continuous narrow-band analysis and representation of measuring values. In practice, this representation is frequently referred to as waterfall diagram. It serves to examine line stabilities and transients and to divide discrete frequency noise portions into speed-dependent and speed-independent portions by measuring acceleration and deceleration maneuvers.

DEMON

DEMON stands for Demodulation of Envelope Modulation on Noise. This method is used whenever the noise or carrier frequency is modulated by rotating parts, and thus conclusions as to the noise source may be drawn. One typical application for this method is the demonstration of propeller cavitation. During operation, the propeller blades are subjected to a turbulent flow caused by the rotation of the propeller, which results in cavitation

Linear array

Another method to assign stochastic noises to their sources is the use of a directional sensor system. This method is based on the fact that the point of the ship where the noise source is located will also be the main radiation point. This method is often successfully employed in cases where the source cannot be determined by analytical methods

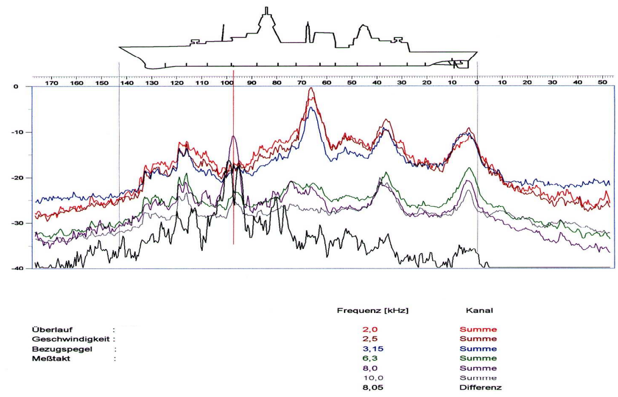

Figure 4: radiated noise sources referring to the hull measured by a linear array 30m aside the ship in 20 m depth. 1/ 3 octave results vers the time

The linear array system consists of two interleaved individual arrays, each using 11 individual sensors. The array spacing (spacing between individual sensors) is constant over the antenna aperture, i.e. 45 cm for the low-frequency receiver unit and 15 cm for the high-frequency receiver unit. The beam former is located directly within the metal structural support. It serves to add the individual sensor signals by shading, thus summarizing them in a sum channel. The broadband antenna operates within a frequency range of 2 kHz to 12 kHz. The side level is 30 dB. Subsequent signal processing is performed in third-octave bands without normalization to 1 Hz or 1 m distance.

Prospect

The range facilities are constantly being improved by the requirements of new projects. Detecting the noise sources and reducing their noise levels finally the contribution of to broad band noise of cavitation and flow appears.

Therefore in the R&D program of WTD 71 will emphasize the development of a linear array. Submerged submarine will be scanned by a 2 D Array at the deep water facility. The defined resolution provides “hot spots” on the hull of the boat/ship.

Also the transient noise is a detectable source especially with the increasing performance of the sonar equipment. Corresponding analysis tools are being established and improved.