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NOISE ASSESSMENT ON HYDROACOUSTIC POSITION REFERENCE SYSTEMS

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INTRODUCTION

Today the offshore activities move to deeper and deeper water. This involves dynamic positioning of the operation vessel and in most cases a hydroacoustic positioning reference system in order to keep the vessel at its right position.

The D.P. system normally use heavy duty thrusters to keep the position. The thrusters are noise sources very close to the hydroacoustic system and may reduce the performance of this. In this work we describe a general method to assess the noise on hydroacoustic position reference systems due to cavitation noise from positioning thrusters. The work includes the following activities:

- Cavitation testing of the thruster in a cavitation tunnel giving the model noise spectrum and directivity function.
- Scaling of the model noise to full scale.
- Assessment of the noise field by experiments and theoretical considerations.
- Estimation of the performance of hydroacoustic equipment.

As an example for the method we have studied a rig which is equipped with several turnable and tunnel thrusters. When operated these are directive noise sources.

DESCRIPTION OF THE MEASUREMENTS.

The cavitation testing and the noise measurements are performed in the cavitation tunnel at the Norwegian Hydrodynamic Laboratories. The noise measurements are done by using a ring with 44 separate hydrophones. By suitable calibration for the effect of the tunnel the direction of radiation from the thruster is found.

The noise field at the positions of the H.P.R. hydrophones is estimated theoretically and a pilot study is performed in the towing tank. The towing tank noise measurements is formed on a model of the pontoon. In this model the propellers are simulated by known noise sources and the hydrophones are scaled versions of the transducers used in the positioning reference system.

SCALING.

In this investigation a number of different scaling procedures are needed. We have to make proper scaling of

- The cavitation process.
- The transmitted noise.
- The thruster nozzels and the pontoon.
- The plate thickness in the pontoon.
- The transducer used in the hydroacoustic positioning reference system.

The scaling of the cavitation is governed by demanding equal advance and cavitation numbers in model and full scale.

The pontoon is scaled with the geometrical ratio. If we assume that the reflections of the acoustics waves by the plates are described by longitudenal and shearwaves and not by bending modes the plate thickness should be scaled by the same ratio. The material inside the pontoon should have similar acoustic properties in model and full scale.

Scaling of the HPR-system requires a maintenance of a constant beamwidth and similar reflection properties at the boundaries of the pontoon. The propagation losses should also be properly scaled. The first two restrictions imply a linear scaling in frequency. The second has a factor due to absorption which scales as the square of the frequency.

RESULTS.

In this section the experimental results will be given and then some theoretical estimates of the signal to noise ratio of the HPR-system are presented.

Experimental results

The measured noise levels at three frequencies 20 25 and 40 kHz are shown in Fig.1. The levels are scaled to full scale.

In the figure the measured noise levels shown as bars are compared with ambient noise levels. The vertical bar give an indication of the variation in the level due to the directivity of the thruster. This specific unit is design for both pusher and tractor operation.

In the towing tank we have used a pontoon model with four thrusters, two in each end of the pont. .n.

It was found that the thrusters at the near end of the pontoon make the greatest contribution to the noise level. The noise level also varied as a function of the depth of the transducer as shown in Fig.2.

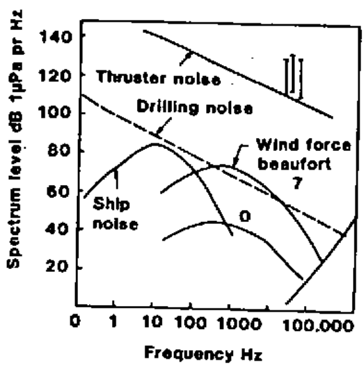

Fig. 1. Estimated full scale noise level.

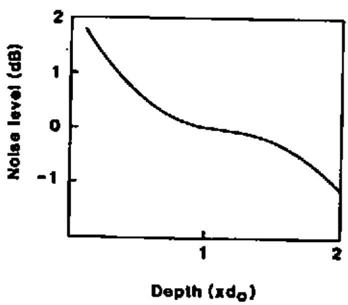

Fig. 2. Noiselevel as function of transducer depth.

The depth is given relative to the construction depth d_0. Fig. 2 shows that the noise level received increases with a reduced depth under the pontoon. This is what we should expect using a slightly directive receiver in a non-isotropic noisefield.

Theoretical estimates

On the basis of the measured model noise levels and the directivity function of the thrusters, full scale received noise levels on the HPR hydrophones may be found. The result of the analysis is an estimate of the signal to noise ratio S/N of the HPR. The theoretical signal to noise levels are shown in Fig. 3 as a function of the water depth.

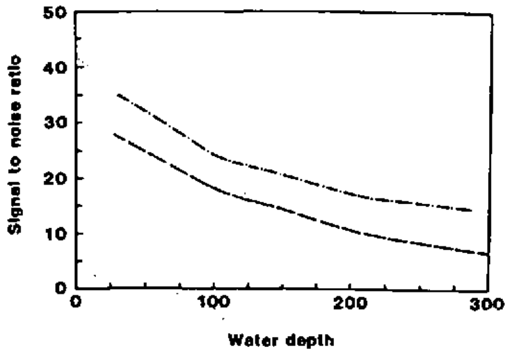

Fig. 3. Signal to noise ratio as a function of depth.

At shallow water the noise level is given by the semireverberant noise field while at deeper water the direct path dominates. In order to operate the HPR safely the signal to noise ratio should be in the order of 20 DB.

CONCLUDING DISCUSSION

In this paper we have shown that it is possible by an experimental procedure to compute the full scale noise and directivity pattern from thrusters and to predict the signal to noise ratio of hydroacoustic positioning reference-system used on a drilling rig or a vessel. This procedure as described is capable of finding

- Thruster noise level and directivety function.
- Reliable estimates of the received noise level on hydroacoustic equipment.
- Optimal positions of a transducers.
- Recomended modes of a thruster operation.