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MARINE ENVIRONMENT PROTECTION COMMITTEE
62nd session
Agenda item 19

MEPC 62/19/1
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NOISE FROM COMMERCIAL SHIPPING AND ITS ADVERSE IMPACTS ON MARINE LIFE

Information on the propeller as the main source for ship generated underwater noise

Submitted by Germany

SUMMARY

Executive summary:	This document makes reference to the work of the Correspondence Group on "Noise from commercial shipping and its adverse impact on marine life" and provides information to narrow the focus of global shipping noise towards the most important noise contributor. It will be shown that the screw-propeller, as the dominating propulsion type of ships, is the main source and, therefore, any activities should be directed to reducing the underwater noise level produced by these propeller types
Strategic direction:	7.1
High-level action:	7.1.2
Planned output:	7.1.2.4
Action to be taken:	Paragraph 14
Related documents:	MEPC 61/19, MEPC 61/24

Introduction

1 MEPC 58 approved the inclusion of a new high priority item in the work program of the Committee on "Noise from commercial shipping and its adverse impact on marine life." The Correspondence Group continued its work on this issue between MEPC 59 and 60. Two rounds of comments were exchanged and a report was provided for and discussed at MEPC 61. The Committee re-established the Correspondence Group under the coordination of the United States.

Discussion

2 MEPC 61 agreed that the propeller is the main source for ship generated underwater noise and that future research programmes should focus on the propeller and the relationship between cavitation and the cause of underwater sonic energy.

3 In response to the discussion of the Committee, this document provides further information that may serve as a rationale as well as incitement for corresponding research activities.

Background

4 In a symposium held in Hamburg in April 2008 on Underwater Radiated Noise of Ocean-Going Merchant Ships the frequency range below 300 Hz has been identified as the most critical one. There are several reasons for this:

.1 ships are noisiest in this frequency range;

.2 there is virtually no attenuation of noise in water at low frequencies;

.3 the communication frequencies of baleen whales are in this frequency range; and

.4 background noise due to shipping effectively masks received levels of whale calls, as can be seen from Figure 1, below.

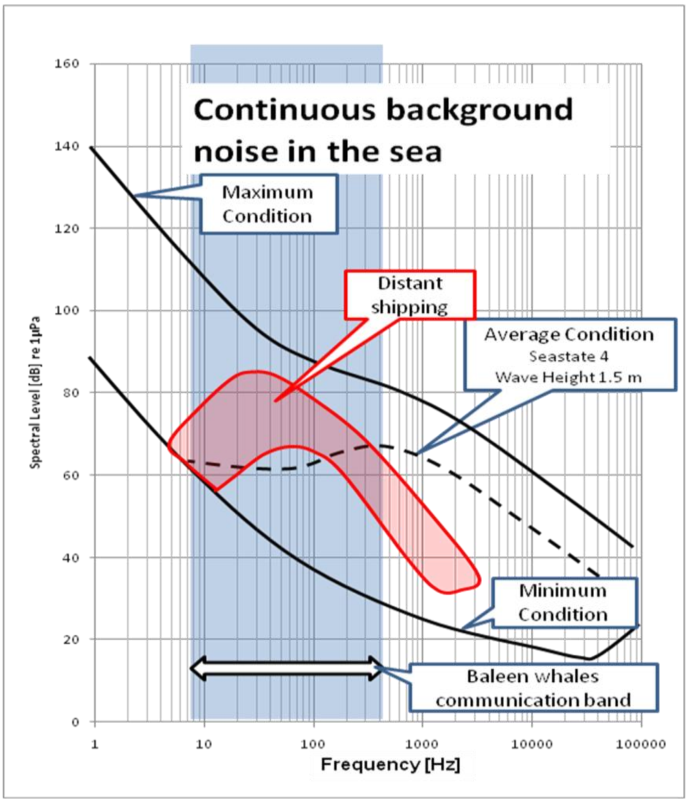

Figure 1: The contribution of distant shipping interferes with the communication frequency band of whales. Shipping noise levels exceed natural levels by up to more than 20 dB most of the time (Figure adapted from Ocean Noise and Marine Mammals, Nat'l Acad. Sci., 2003)

5 Shipping noise is described in standard curves (Urik) similar to seastate. These standard curves are characterized by a maximum in the 50 Hz range. The characteristic shape of this contribution can be attributed entirely to an effect of propeller cavitation. This is shown in Figure 2, below.

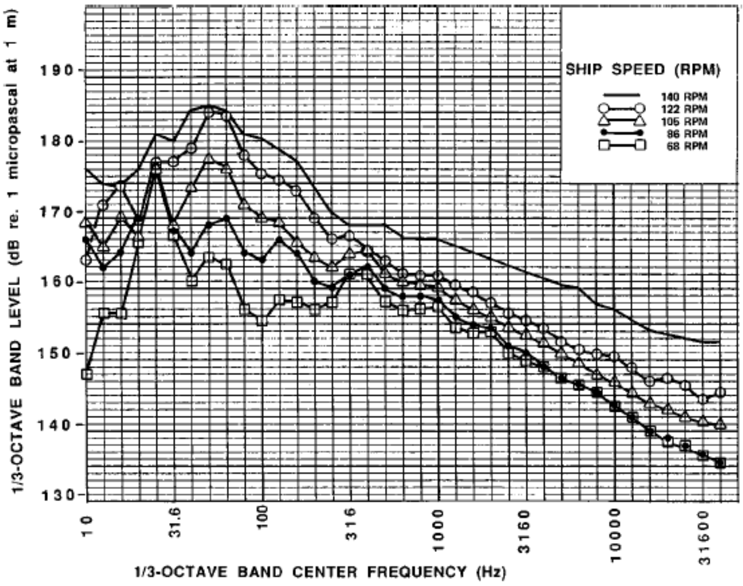

Figure 2: Radiated noise of a bulk carrier. The spectral maximum at 50 Hz develops with increasing speed and characterizes increasing propeller cavitation (from Arvesson, P. and Venditis, D. (2000). Radiated noise characteristics of a modern cargo ship, Journal of the Acoustical Society of America, 107 (1), 118-129.)

6 Today, this particular contribution is not subject to consideration in ship and propeller design, but it can be observed easily during model testing and onboard measurements. The frequency range below 300 Hz is considered for compliance with vibration requirements up to 80 Hz only. A typical display is shown in Figure 3, below.

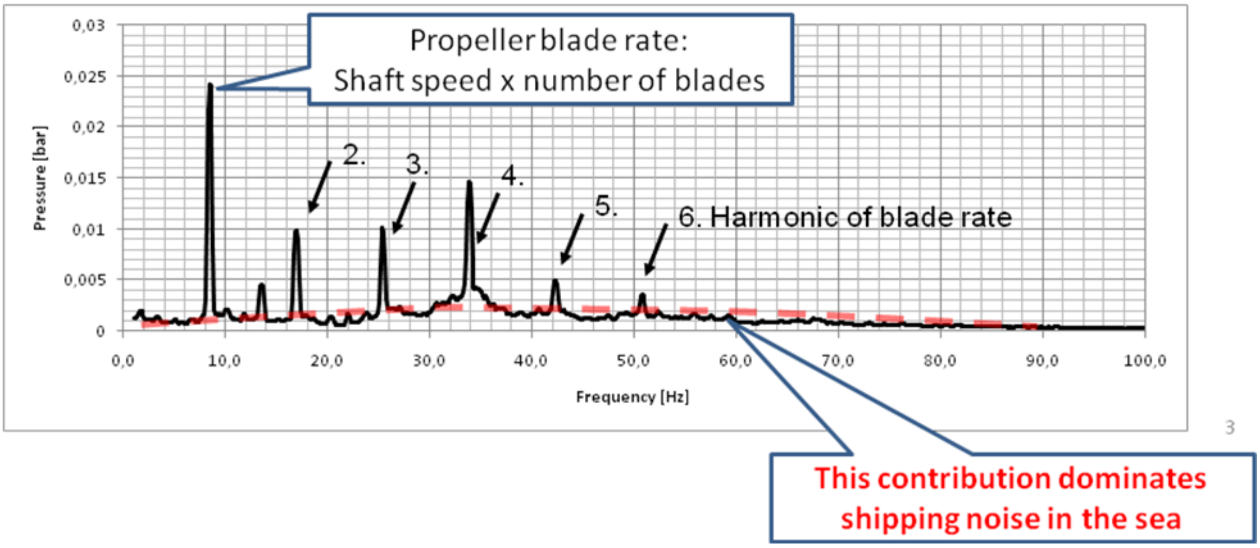

Figure 3: This a typical display of pressure fluctuations measured at the ship's hull above the propeller at maximum continuous rating. It serves as a basis to judge vibration levels on board. Obvious main feature is the tonal pattern of blade rate harmonics. Underlying broadband noise is not considered because of its low influence on vibration levels. For acoustic criteria frequency is too low to contribute to audible noise. The dotted line indicates the part of the spectrum important for underwater radiated noise.

7 However, if the display in Figure 3 is converted to logarithmic scales the importance of the broadband contribution becomes evident.

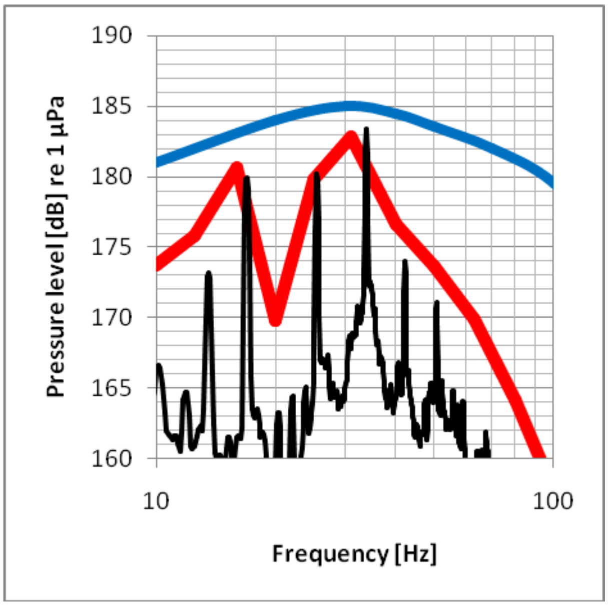

Figure 4: Same spectrum as in Figure 3 with a 1/3 octave presentation and compared to the shipping curve (Urik, R. (1983), Principles of underwater sound, 3rd edition, Peninsula Publishing). It shows that the characteristics of the global shipping noise contribution is present already in this particular ship

8 The maximum of the broadband spectrum is observed to be around the 5 harmonic of blade rate, typically around 40 to 60 Hz depending on shaft speed and blade number. This noise characteristic is not only a feature of most ships with cavitating propellers but it can also be observed in cavitation tunnels. The prediction quality of frequency and noise level from model scale to full scale is quite good, as can be seen from, e.g. (Bark), Figure 5. It is not observed that the noise contribution in question is limited to certain types of ships.

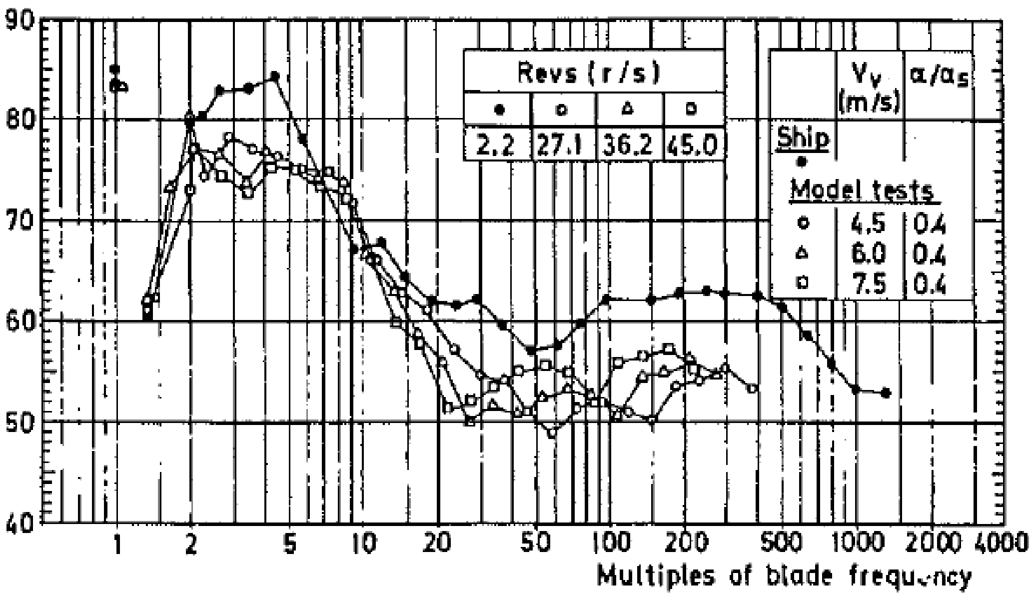

Figure 5: Comparison of model scale and full scale noise levels of a propeller behind a ship (Bark, G., Prediction of propeller cavitation noise from model test and its comparison with full scale data, Journal of Fluids Engineering, 3/1985, Vol. 107)

Conclusion

9 Propeller cavitation is by far (at least by 10 dB) the dominating source for global shipping noise level in the most important frequency range below 300 Hz. The characteristics of this noise contribution is known and can be observed also in model scale. The level for a full scale ship can be predicted with good accuracy.

10 However, the exact reason for this noise contribution and its features have never been investigated because it is not subject to any other criteria be it safety, annoyance, comfort or any technical reason.

11 If the noise making mechanism could be described, measures may be developed to reduce noise levels. This could be done by changes in propeller design, secondary measures (like partial ventilation with air) or any other measure to be developed after the physics are understood.

Proposal

12 IMO activities on noise from commercial shipping and its adverse impacts on marine life should focus on propeller noise and encourage relevant research.

13 Further steps may include:

.1 a survey on publications which may deal with the issue;

.2 prepare funding for tests in model scale to systematically relate propeller noise in the frequency range below 300 Hz to cavitation types and mechanisms; and

.3 develop measures to reduce noise levels for new builds and existing ships.

Action requested of the Committee

14 The Committee is invited to consider the information provided and take action as appropriate.

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