INTERNATIONAL MARITIME ORGANIZATION

E

MARINE ENVIRONMENT PROTECTION COMMITTEE
83rd session
Agenda item 9

MEPC 83/INF.16
26 January 2025
ENGLISH ONLY
Pre-session public release: ☐

EXPERIENCE-BUILDING PHASE FOR THE REDUCTION OF UNDERWATER RADIATED NOISE FROM SHIPPING

Measures to reduce underwater noise of merchant ships and noise reduction prospects of energy-saving measures

Submitted by China

SUMMARY

Executive summary:	This proposal summarizes a series of potential commercial vessel noise reduction measures and the noise reduction prospects of energy-saving measures, and analyses the relationship between these measures and ship energy efficiency.
Strategic direction, if applicable:	1
Output:	1.16
Action to be taken:	Paragraph 8
Related documents:	MEPC.1/Circ.906; SDC 8/14/3; SDC 10/INF.3 and SDC 11/15

Background

1 MEPC 82 approved the *Action Plan for the Reduction of Underwater Noise from Commercial Shipping* and agreed to change the title of output 1.16 to "Experience-building phase (EBP) for the reduction of underwater radiated noise (URN) from shipping" and extend its target completion year to 2026 (MEPC 82/17, paragraph 9.16).

2 MEPC 82 also agreed to amendments to the Revised URN Guidelines (MEPC.1/Circ.906), consisting of the inclusion of a fourth appendix containing a URN management planning reference chart and a new paragraph 5.5, referencing the chart, and subsequently approved MEPC.1/Circ.906/Rev.1 on *Revised guidelines for the reduction of underwater radiated noise from shipping to address adverse impacts on marine life* (MEPC 82/17, paragraphs 9.6 and 9.7). MEPC 82 further approved the *Guidance on the Experience-Building Phase (EBP) for the Revised guidelines for the reduction of underwater radiated noise from shipping to address adverse impacts on marine life (MEPC.1/Circ.906/Rev.1)* (EBP Guidance) (MEPC 82/17/Add.1, annex 9) and invited interested Member States and international organizations to follow the EBP guidance when gathering, preparing, and sharing experience, data, and research during the EBP (MEPC 82/17, paragraph 9.22).

3 Furthermore, MEPC 82 requested the Secretariat to inform the SDC Sub-Committee of any outcomes of its work concerning energy efficiency measures that might be relevant to the work on URN, as well as the outcome of the Second IMO Expert Workshop on URN and energy efficiency due to be organized in 2025, in accordance with objective B.2 of the URN Action Plan (MEPC 82/17, paragraph 9.18).

4 Annexes 3 and 4 to document MEPC 70/INF.12 provide information on energy-saving technologies such as design improvements, recovery of propeller energy, engine energy recovery, hull coating, alternative fuels and energy. There are three main types of greenhouse gas emission reduction technologies available: alternative fuels and green power plants; energy-saving technologies such as wind power assisted devices, air lubrication, hydrodynamic energy-saving devices, low friction anti fouling paints, hull form optimization, route optimization, propeller optimization, and waste heat recovery; exhaust gas treatment technologies.

China's experience based on model-scale and full-scale ship tests

5 China has actively carried out the implementation and application of the Revised Guidelines on the reduction of adverse effects of underwater radiated noise on marine life caused by shipping, and is willing to share some results and information obtained at this stage. China has summarized a series of potential merchant vessel noise reduction measures and the prospect of energy saving measures based on the model-scale and full-scale ship tests, and analysed the relationship between these measures and ship energy efficiency.

6 China has carried out model-scale and full-scale ship tests on a series of potential noise reduction measures and energy saving measures for merchant ships. The results of the model-scale and full-scale ship tests show that:

.1 the propeller optimization design for a container ship increases the propulsion efficiency from 72% to 73%, and reduces the total level of radiated noise by about 2.7dB;

.2 using propeller blade perforation technology, the propulsion efficiency is reduced by about 1.5% to 2%, the radiated noise can be reduced by 4dB in low frequency band, and increased by more than 10dB in high frequency band, and the total noise level is reduced by about 2dB;

.3 using air injection technology, the noise can be reduced by 2dB to 7dB, but the working point propulsion efficiency is reduced by about 2%;

.4 wind boost technology can reduce energy consumption by 5% to 10%, and reduce the propeller rotation speed and load in the case of maintaining the same speed, which is beneficial to reduce noise; and

.5 the use of pre-shrouded vanes technology is conducive to improving the propeller pushing efficiency and reducing energy consumption, but it will increase noise by about 1.5dB.

Summary

7 The optimal design of propeller with tip configuration optimization and increasing side inclination can not only reduce the noise, but also improve the propulsion efficiency. While propeller blade perforation and air injection technologies (used to improve cavitation) are beneficial for reducing noise, they also reduce propulsion efficiency and thus energy

efficiency. Wind boost technology is beneficial to reduce the load of the propeller, which is also beneficial to noise reduction. For PSV technology, although it is helpful to improve the quality of the propeller flow field and improve the propulsion efficiency, it has a negative effect on reducing the propeller noise. In terms of reducing noise and reducing energy consumption, a balance needs to be struck.

Action requested of the Committee

8 The Committee is invited to note the information provided above and more detailed information provided in the annex.

***

ANNEX

MODEL-SCALE AND FULL-SCALE SHIP TEST RESULTS OF POTENTIAL COMMERCIAL VESSEL NOISE REDUCTION MEASURES AND THE NOISE REDUCTION PROSPECTS OF ENERGY-SAVING MEASURES

Propeller optimization design technology

1 The optimization of propeller design includes the optimization of tip configuration and increasing of blade slope under the premise of improving incoming flow. Two propeller models were designed for a container ship. The previous design of the 5-blade propeller (Pro.C) had poor hydrodynamic performance, and the propeller propulsion efficiency was 72%. The 6-blade propeller (Pro.D) was designed by optimizing the tip configuration and increasing the blade rake, and its propulsion efficiency increased to 73%. The model test results show that the propulsive efficiency is improved and the overall level of radiated noise reduced by 2.7dB. For the current commercial propeller, there is potential to design a high-efficiency propeller with low noise performance.

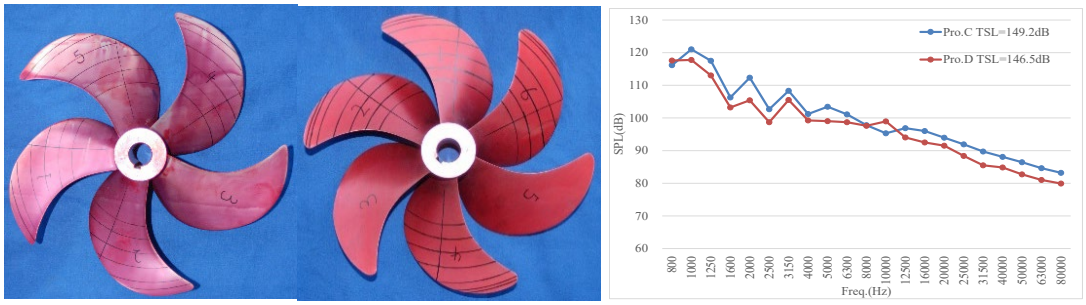


Figure 1: Propeller model (Pro.C and Pro.D) and noise test results

Propeller blade perforation technique

2 The blade perforation technology uses the pressure difference between the blade and the suction surface to form a micro-jet, which destroys the macroscopic structure of the cavity, so as to improve the stability of the cavity and control the noise of the cavity. The micro-perforation technology has certain potential in controlling the low-frequency cavitation noise in the propeller, and has a reverse effect on reducing the noise in the high frequency band, while bringing the loss of hydrodynamic performance. The effect of perforation technology on propeller efficiency and noise is studied experimentally. The test models are a pair of four-blade propellers. The first propeller (Pro.A) had 9 microholes drilled at 0.8R/0.9R/0.95R, distributed nearly evenly along the chord length, with a diamenter of about 1mm. The second propeller (Pro.B) drilled 13 microholes at the tip and the guide edge at 0.85R/0.9R/0.95R/0.975R for relieving cavitation of the guide edge piece and tip vortex.

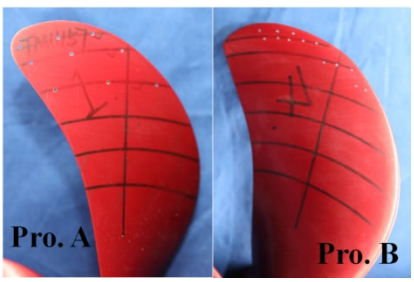


Figure 2: Two propellers with perforated blades (Pro.A and Pro.B)

3 The test results show that for the first propeller (Pro.A), after perforation, the propeller propulsion efficiency reduced by about 1.5%, the cavitation area became smaller, the noise level around 1kHz become significantly lower, the noise in the frequency band above 3kHz increased significantly, and the total noise level (TSL) has no change; For the second propeller (Pro.B), after perforation, the efficiency is reduced by about 2%, the cavitation area became smaller, the noise level around 1kHz become more than 4dB smaller, and the noise level above 3kHz increases significantly, the total noise level reduces by 2dB.

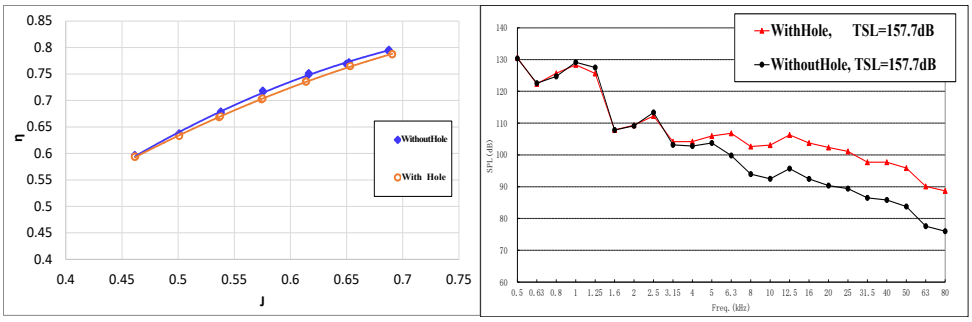


Figure 3: Propulsive efficiency and noise performance of the first propeller(Pro.A)

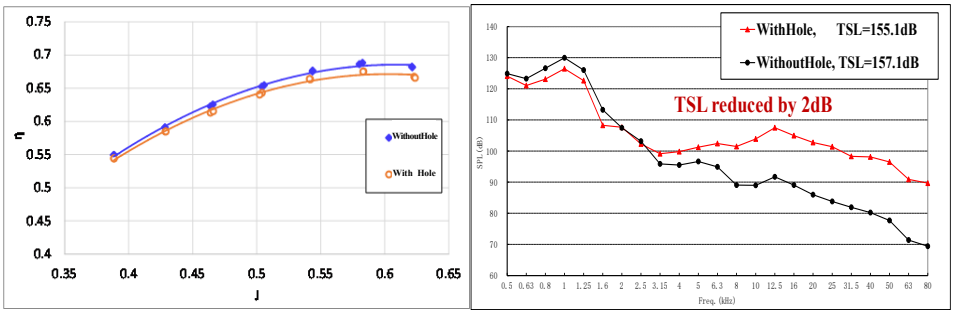


Figure 4: Propulsive efficiency and noise performance of the second propeller (Pro.B)

4 The effects of air injection methods on propeller efficiency and noise were studied experimentally. In cavitation tunnel, air injection is realized by placing a ring perforated gas pipe in front of the propeller, and the perforation size is variable. The test results show that when the porosity is 0.5mm and 1mm, the propeller noise is reduced by about 2dB and 7dB respectively. When the hole diameter is 0.5mm, the efficiency has no change, and when the hole diameter is 1mm, the efficiency reduce about 2%.



Figure 5: Air injection in cavitation water tunnel and propulsion efficiency

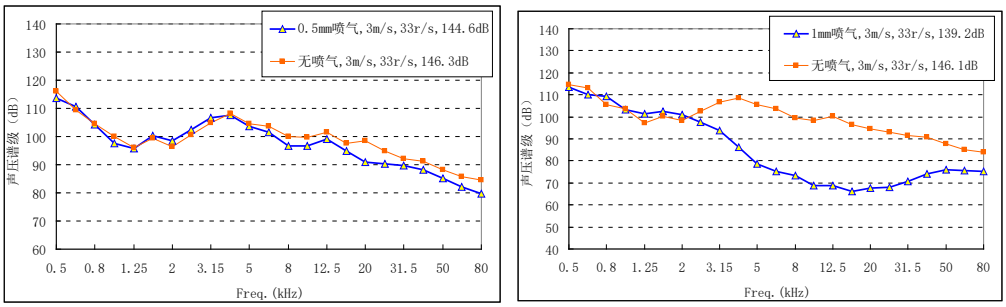


Figure 6: Radiation noise spectrum with or without air injection (left: diameter 0.5mm, right: 1mm)

Wind boost technology

5 China Ship Scientific Research Center has carried out a large number of model-scale and full-scale ship tests on wind-assisted energy-saving technology. The model tests show that the energy-saving effect of wind-assisted rotor is 6%~10%. The technology has been successfully applied to energy-saving 88000t bulk carrier; Penglong 50000t bulk carrier adopts wind wing boost technology to reduce the energy consumption by 5%~10%, "Kaili" 308000t super large oil carrier adopts sail boost technology to reduce energy consumption by 3%. Wind boost technology is conducive to reducing the load of the propeller, reducing the energy consumption of the ship, and is also beneficial to noise reduction. It should be noted that wind boost technology is not suitable for all ranges and all routes. According to the noise measurement results of a typical ship propeller model carried out in cavitation tunnel, to guarantee the sailing speed is stable, the rotation speed reduce by 7% and the noise level reduce by 2.3dB; When the rotation speed reduce by 14%, the noise level reduce by 3.2dB. After the application of wind boost technology, it is expected to bring 2-3dB noise reduction.

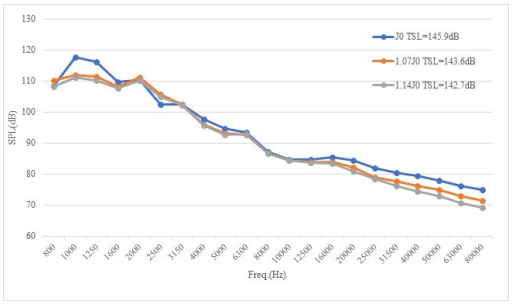


Figure 7: Model test results of radiated noise at different working points of a bulk carrier

Pre-shrouded vanes technology

6 The pre-shrouded vanes (PSV) is a kind of hydrodynamic energy-saving device composed of conduit and stator, which is installed on the hull in front of the propeller. At the cost of small resistance, the pre-rotor flow is generated to reduce the rotational energy loss of the propeller wake, improve the quality of the propeller flow and improve the propeller propulsion efficiency. The pre-shrouded vanes are well applied on ships. The model test shows that the propeller propulsion efficiency can be improved by installing the PSV. The total level of radiated noise increases by 1.6dB due to the addition of the rotating mechanism.

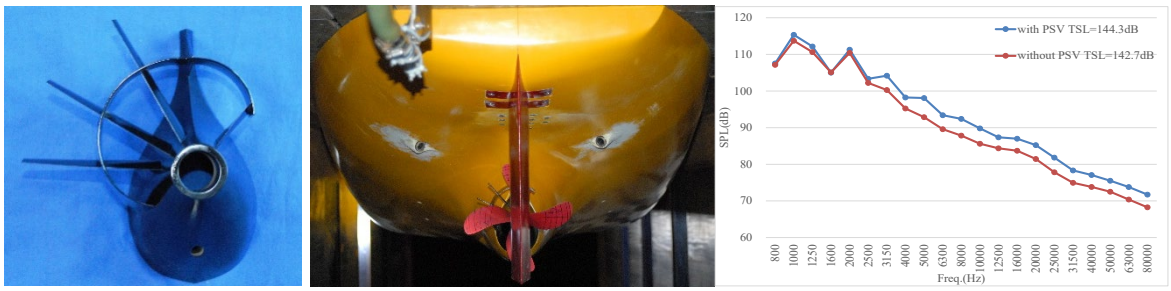


Figure 8: Comparison of the radiated noise of the PSV model