eMARINA
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The Hong Kong Joint Branch of The Royal Institution of Naval Architects
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and The Hong Kong Institute of Marine Technology
皇家造船師學會暨輪機工程及海事科技學會香港聯合分會
及香港海事科技學會季刊
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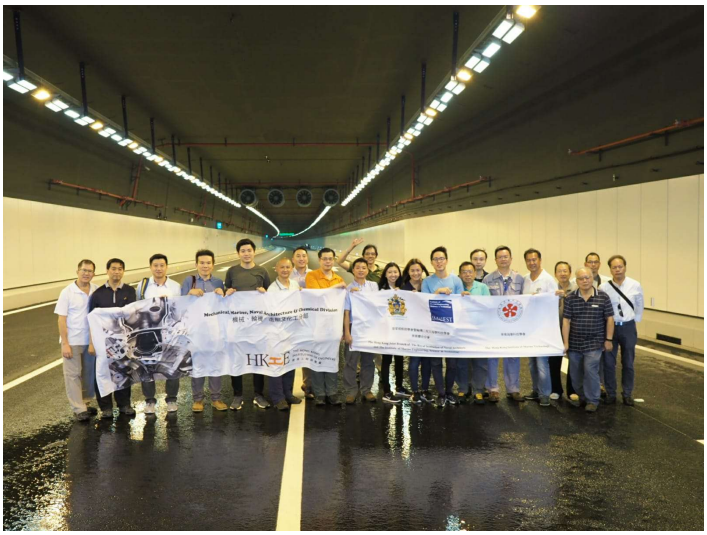
HKJB & HKIMT Activities

Joint Technical Visit to Hong Kong-Zhuhai-Macao Bridge

A joint technical visit to Hong Kong-Zhuhai-Macao Bridge (HZMB) was held on 1 September 2018. This event was jointly organized by HKIE-MC Division, Institution of Mechanical Engineers (IMechE), the Hong Kong Institute of Marine Technology (HKIMT), and Hong Kong Joint Branch of The Royal Institution of Naval Architects and The Institute of Marine Engineering, Science and Technology (HKJB). We were very honoured to be able to visit this magnificent architectural achievement before its official opening on 23 October 2018. More than 20 members participated in this activity.



The HZMB is a long and magnificent road linkage system that connects the Hong Kong Special Administrative Region (HKSAR), Zhuhai City of Guangdong Province and Macao Special Administrative Region. It consists of a long bridge section that runs across the mouth of the Pearl River Delta (PRD) and a tunnel section at Lingding Channel to ensure sea traffic in and out of the PRD Region. An artificial island at the end of the bridge in Zhuhai and an artificial island at the start of the bridge in Hong Kong house the boundary crossing facilities. Link roads on these islands are used to divert the incoming and outgoing traffic from the bridge.

We started the visit from the Zhuhai end, travelled along the main bridge and stopped before entering the Hong Kong border.

An informative presentation on the background and design of HZMB was given in the visitors' centre before our journey began. We were informed that the bridge is 29.6 km long and has a dual 3-lane carriageway and the tunnel section has a length of about 6.7 km long. We all marveled at the ingenuity in the construction process of the bridge, the tunnel and the artificial islands and also the daunting tasks to management such a huge and complex project. Undoubtedly, its successful completion required the detailed planning and close co-operation of all parties involved at different stages of construction. We were told as an example that before

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putting up the towers of the cable-stayed bridge of the main bridge, hundreds of rehearsals were carried out to ensure and check that all possible circumstances that might be encountered during installation could be dealt with properly beforehand.

We visited the tunnel section first. The ventilation and emergency measures were explained. Our discussion continued while we were on the shuttle bus that took us along the bridge section. We were also given the opportunity to set foot on the bridge and marvel at the grand views.

This was a valuable experience for us to visit the HZMB before operation. All participants were very impressed and proud to witness such a marvelous engineering wonder at close quarters.

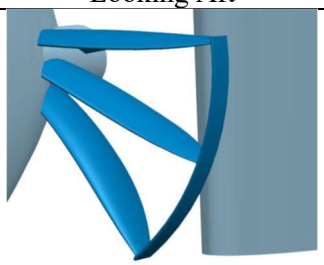
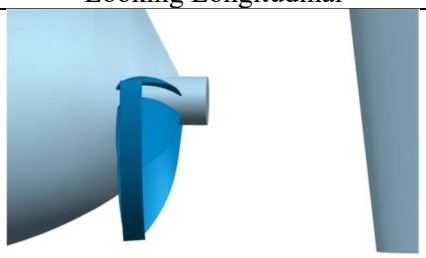
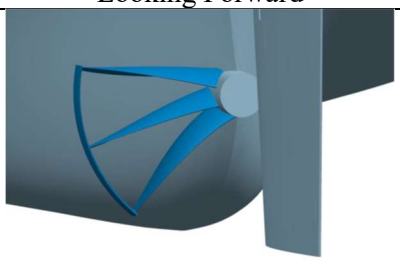
(Reported by Lillian Kwan)

PROPULSION EFFICIENCY & ENERGY SAVING DEVICES

The Hong Kong Shipowners Association and Wartsila organized a joint seminar on Wartsila Technology on 6 September 2018. The seminar covered various topics, one of which was on “Propulsion Efficiency & Energy Saving devices”. There are several methods of improving propulsion efficiency and/or saving fuel consumption in the market, and this presentation touched on some of the options available.

A straightforward explanation on “heavy running propellers” was of interest to many participants. Symptoms of main engine being overloaded could be high exhaust temperatures, increased wear of pistons, liners and valves, loss of vessel speed and/or higher fuel consumption etc. However, as there could be other reasons that may also cause engine overloading, a proper analysis of the engine and propeller should be carried out before arriving at this conclusion. Then calculations should be made for the propeller blades trailing edge modification (TEM) prior to the modification on the propeller. An example of TEM carried out on a twin-screw LNG carrier to improve the light running margin was shown. Besides the elimination of the engine problems, the change in the mean pitch of the propellers also allowed a higher speed in service resulting in the ability for two additional cargo deliveries per year.

Other presentations covered propeller optimization for slow steaming and also the use of propeller finned caps to weaken the propeller hub vortex and thus improve propeller efficiency. However, a notable solution of interest was the introduction of ENERGOFLOW to improve propeller efficiency. This is a device which provides a favorable inflow to the propeller. The device is attached to the hull, and is eye catching due to its asymmetrical design. It can be described as a pre-swirl stator which guides one side of the stern flow in the opposite direction to the propeller rotation, thereby generating pre-swirl for the propeller and increasing the propulsive efficiency up to 10%.

Looking Aft	Looking Longitudinal	Looking Forward
		

Extensive model tests for the device had been performed in regular and irregular waves, extreme conditions with wave height up to 10 meters, and slamming loads. For this device, the power savings achieved depend on the ship's Block Coefficient and propeller's thrust loading. Hence, it will benefit full form vessels such as tankers and bulk carriers most and provides them with a higher percentage of savings. This device can be retrofitted to existing vessels or applied to a newbuild. The first device will be fitted on a newbuilding shortly. Given that this device has no moving parts and hence attracts no additional maintenance costs and has an indirectly reduction in NO_x and CO_2 emissions, this is another tool that Owners may choose in their quest for efficiency and lower fuel consumption.

(Reported by Richard Dias)

DIGITALIZATION OF SHIPS - DATA DRIVEN ANALYTICS

As every seafarer will tell you, the introduction of the International Safety Management Code (ISM Code), resulted in more paper work, but it also lay the foundation for proper record keeping, and data collection. Fast forward to today, and we have more automation, digitalization and quicker cost-effective communication between ship and shore. The European Union requirement for monitoring, recording, verification (MRV) of carbon dioxide emission, and the International Maritime Organization's data collection system (DCS) for fuel oil consumption, all show the trend in this direction. Quite appropriately, Eniram (a Wartsila company) recently made a presentation at a Hong Kong Shipowners Association and Wartsila co-organized seminar on 06 September 2018 on "How Data Driven Analytics can Improve Performance and Save Cost".

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Investing in data has value! Besides the decrease in fuel costs Eniram customers also reported better charter rates and better vessel re-sale prices. Onboard decisions were supported by: a) Real-time automated onboard guidance of dynamic trim adjustments so the vessel could use its propulsion power optimally; b) Real-time automated guidance of RPM to optimize arriving just in time; c) Real-time automated onboard guidance of engine load so engines could always be run at their optimal load. Onshore management can also use real-time data to assess ship performance, fleet performance, manager performance, identify any issues or trends early on, measure supplier performance which can then be useful in negotiations. This data can also be used by Charterers or Operators or Insurers, and ultimately whoever is the user, it results in more transparency in the industry. It eliminates the tedious tasks of manually analyzing noon reports, checking and verifying speed, fuel, routing instructions, and MRV, DCS can also be integrated for convenience.

So how is it done? Data is continuously collected from vessels and external data sources. They are automatically analyzed and enriched by statistical modelling and predictive simulations. The resulting insight is transformed into actions by easy-to-use user interfaces. This has been further developed so that information including notifications or alerts can also be available on mobile phones.

In conclusion, it is very interesting and encouraging to see all the data collected can be put into good use in the real-time to enable efficient operations, reduce operational costs, optimize energy efficiency, ensure proactive safety management, reduce emissions, allow better insurance risk evaluation, and ensure regulatory compliance.

(Reported by Richard Dias)

Members' Corner

Beryllium Found in Coal Slag

On Monday, January 9th, OSHA (Occupational Safety and Health Administration, U.S. Department of Labor) finalized new beryllium standards for professions commonly exposed to Beryllium. Several are affected including workers in the marine and construction industries. OSHA's new ruling on Beryllium confirms that at trace levels, beryllium can be harmful. Long-term beryllium exposure can lead to berylliosis, as well as cancer and heart failure.

OSHA notes, "There is no safe level of asbestos exposure for any type of asbestos fiber.".

This comes within a year of OSHA's ruling on Beryllium, another known carcinogen present in coal slag. In January 2017, OSHA released their final rule on Beryllium. Much like Chrysotile, Beryllium is directly responsible for lung disease and lung cancer. Coal slag is a waste, generated by coal-fired power plants and sold as an inexpensive, yet toxic abrasive.

Nontoxic abrasives have been on the market for several years. OSHA has outlined several of the risks of abrasive blasting in this OSHA Fact Sheet. Sponge abrasives (also known as Recyclable Encapsulated

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Abrasive Media), Dry Ice, Plastic bead media, Sodium bicarbonate (baking soda), are the only media listed as “less toxic”.

In the long run, the liability from using toxic abrasives make then a risky and expensive option. Non-Toxic abrasives are a better long-term value.

Beryllium and Abrasive Blasting

The OSHA held its permissible exposure limit (PEL) to 2.0 micrograms per cubic meter of air since the 1940s. After extensive studies and a push by worker safety advocates, OSHA dropped the PEL for beryllium to 0.2 micrograms per cubic meter - a 1000% percent reduction.

OSHA estimates that nearly 62,000 workers are potentially exposed to beryllium in approximately 7,300 establishments in the United States. This ruling is raising awareness for those that blast with coal slag. While basters wear PPE, surrounding workers and trades do not always use the same precautions.

OSHA states, “While the highest exposures occur in the workplace, family members of workers who work with beryllium also have potential exposure from contaminated work clothing and vehicles.”2 Same as second/third hand smoke, workers who contact beryllium would bring the risk of die, permanently disabled from berylliosis to their friend or family.

OSHA identifies individuals working as primary beryllium production workers, workers processing beryllium metal/alloys/composites, foundry workers, furnace tenders, machine operators, machinists, metal fabricators, welders, dental technicians, and abrasive blasters using slags (copper slag and coal slag) to be at the highest risk of beryllium exposure.

Many contractors in the abrasive blasting industry continue to use hard, cheap substances as media for their sandblasting systems. Coal slag, which is otherwise a hazardous waste byproduct of coal power plants is a very inexpensive media. Beryllium in coal slag makes it toxic and deadly. This follows the same pattern that blasting operations went through with sand, the original sandblasting media. Silica was known to be a carcinogen for many years before its use was discontinued in the US. Hong Kong Labour Department began banning silica sandblasting as early as 1978.

Alternative (non-beryllium, silica free) abrasives used for sandblasting include Sponge Media, garnet, and steel grit. These “non-beryllium and non-silica” abrasives preform at comparable rates for the removal of industrial coatings, rust, and profiling metal. Nontoxic abrasives have been on the market for several years. OSHA has outlined several of the risks of abrasive blasting in this OSHA Fact Sheet. Sponge abrasives are the only media listed as “less toxic” while still profiling metal for coating.

(Submitted by Warners Suen)

(Excerpts reprinted with permission from Sponge-Jet, Inc. Source: https://blog.spongejet.com/beryllium-and-abrasive-blasting)

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The Right Way to Carry Out Noise Tests

Synopsis

Neptune Marine Ltd. was entrusted with the duty to witness and certify the results of the airborne sound emitted by a recreational craft engine built by Tohatsu Corporation Japan. I was the surveyor appointed by my company to witness the type tests to see whether this engine complied with the international standard ISO 14509-1:2008. As testing of airborne sound emitted by engines was rare, I would like to take this opportunity to share my experiences with my fellow professionals in this paper.

Applicable Standards for the Tests

Before I began, I would like to outline those international standards that are applicable to the testing of airborne sound emitted by recreational craft engine. The most important standard is ISO 14509-1:2008 - Measurement of airborne sound emitted by powered recreational craft. This standard provides a standard for the measurement of airborne sound emitted by inboards, stern drives, personal watercraft and outboard motors for recreational craft up to 24 m in length.

The others standards that are relevant to the tests include inter alia: IEC 61672-1:2013 specifies sound level meter functionality and performances; ISO/IEC Guide 98-3; Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement (GUM:1995); ISO 2922; Acoustics — Measurement airborne sound emitted by vessels on inland waterways and harbours; ISO 3744, Acoustics — Determination of sound power levels of noise sources using sound pressure — Engineering method in an essentially free field over a reflecting plane; ISO 8178-4, Reciprocating internal combustion engines — Exhaust emission measurement — Part 4: Test cycles for different engine applications and ISO 8666 Small craft — Principal data.

The Pre-tests Preparations

The tests were carried out on 19th July, 2018. After my arrival to Tohatsu Corporation Japan in Tokyo, we had a short briefing on the test procedures. We began by reviewing and verifying all the conditions of the equipments used in these tests.

The equipments required to complete the tests included a **sound level meter, anemometer, engine, tachometer and standard craft**.

The **sound level meter** and its components included the microphones, cables and windscreen. They were checked, verified, calibrated and tested for their conformity with the manufacturer's recommendations and the IEC 61672-1 as class 1 instruments. The sound level meter we used for the tests had the "maximum hold" capability for convenience and accuracy in taking readings.

As the sound level meter is the most important instrument used in the tests, it should undergo laboratory verification for compliance with IEC 60651 at no longer than two years intervals and carry laboratory verification every year using national standards. Laboratory verifying the instrument should keep traceable records for inspection by relevant parties. The date of the last verification of the compliance with IEC 61672-1 should be checked before use.

To ensure the accuracy of the meter during the tests, a class 1 sound calibrator which met the requirements of IEC 60942 should be used. The overall acoustic performance of the measurement equipment should be checked with the sound calibrator according to the instructions of the manufacturer prior to the tests. At the beginning and at the end of each series of measurements and at least every four hours during the tests and at the beginning and end of each measurement day, the meter should also be calibrated for its accuracy.

An **anemometer** with an accuracy of less than ± 10 % should be used to measure the wind speed of the location in which the tests were carried out.

The **engine** subjected to the tests was a Tohatsu engine model number MFS60A. This is four-stroke outboard engine with a power rating of 44 kw (60 hp). A **tachometer** which had an accuracy of less than ± 2 % was already mounted on the engine panel.

The **standard craft** used to mount the outboard engine is not an arbitrary selection. ISO 14509-1:2008 has specific requirements on the length and mass of the standard craft. Clause 13 of the standard specifies such requirements in Table 4. It is reproduced below for reference.

Craft selected for the test is to be governed by the outboard engine power. The associated length and mass of the craft are then taken from Table 4 for the tests. In the real world, unless a craft is specially built for the tests, it is unlikely that a craft can be found to meet the length and mass specified in the standard. The standard, therefore permits a variation of ± 20 % in length and ± 25 % for mass when trying to find such a craft.

In addition, the standard also specifies that the craft shall have no covers over the outboard motor or unusual extensions behind the transom that may affect the sound level.

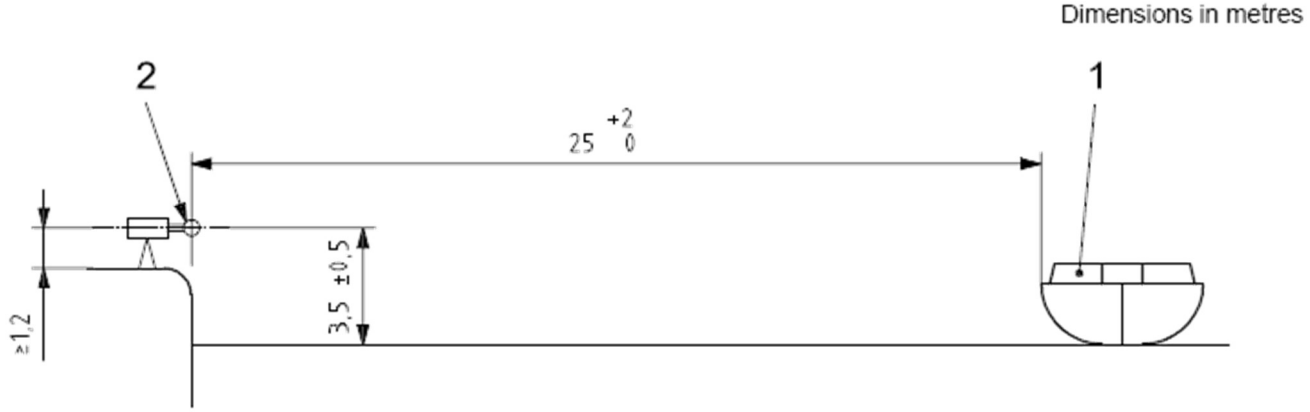
Table 4 - Standard craft specifications

Declared propeller shaft power of outboard motor under test (determined according to ISO 8665**)** kW	**Length of hull (measured according to ISO 8666) m**	**Mass without engine (mLCC measured according to ISO 8666:2002, 6.3, minus mass of heaviest engine) kg**
P < 6	3.8	135
6 ≤ P < 25	4.2	220
25 ≤ P < 55	4.7	400
55 ≤ P < 115	5.5	800
115 ≤ P < 150	6.2	1100
P ≥ 150	7.5	1650

Given that the Tohatsu MFS60A has an output power of 44 kw. The row marked in yellow in Table 4 appears to fit the description. The standard craft required for the tests should then be 4.7m± 20 % (i.e. length of craft is between 3.76m and 5.64m) in length and 400 kg ± 25 % (i.e. mass of craft is between 300 kg and 500 kg) in mass. An existing craft - Yamaha EK8 which is 4.51 meter in length and has a displacement of 327 kg appears to meet the specification requirements and is therefore chosen as the standard craft for the tests.

Environmental Conditions for the Tests

The tests were carried out Arakawa which was 45 minutes' drive from Tokyo. The environmental conditions were checked against the requirements in ISO 14509-1. The requirements specify that within 30 m around the craft under test and the microphone, there shall be no large surfaces such as retaining walls, building façades, rocks, bridges etc. where sound can be reflected back to the



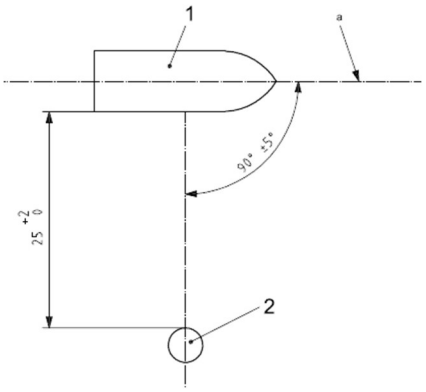
Key: 1. Craft 2. Microphone

microphone. There should be no sound absorbing or sound reflecting objects between the standard craft and microphone.

Setting Up the Test Course and the Microphone

After measurement, the distance is 25.8 meters for this test. The intended course line also been indicated with five marker buoys.

The test course to be followed shall be a straight line such that the distance between the microphone and the side of the craft nearest to the microphone when passing it shall be 25m ± 2 m. It is the standard requirements that the microphone shall be positioned at 3.5 m ± 0.5 m above the water surface. If the mounting is on a solid surface, it shall be positioned at least 1.2 m above that surface.



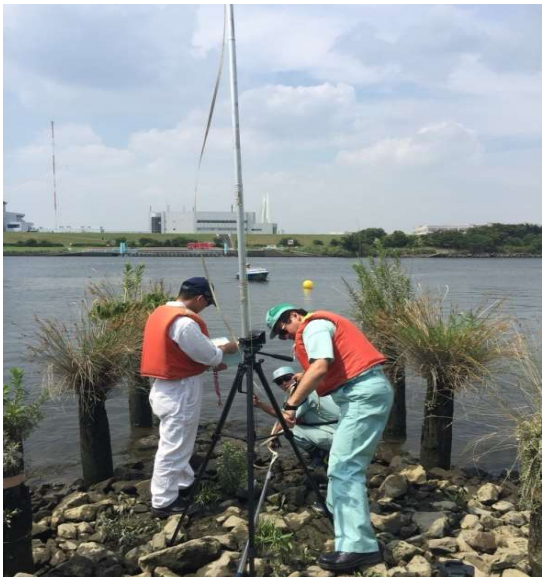
Key (Dimensions in meter)
1. Craft,
2. Microphone
a. Craft course line

On 19th July 2018, it was a calm and sunny day. Wave height was less than 0.05 meter and the wind speed less than 3 m/s which met the standard requirements of less than 0.1 m and 7 m/s respectively.

The Tests

Prior to the tests, risk assessments were made on the vessels and the nearby objects. All parties were made aware of other nearby crafts and objects so as to ensured that they would not interfere and affect the results of the tests. No person should stand between the microphone and the sound source to avoid interfering with the meter reading.

Before starting the tests, the sound level meter was calibrated with the sound calibrator according to the instructions of the manufacturer before taking measurements.



After measurement, the height of the microphone above the water surface is 3.55 meters for this test.

The craft was operated by two persons with the weight 68kg +76kg = 144kg, which met the requirement that any person chosen to man the craft should be 75 kg ± 20 kg (i.e. between 55 kg and 95 kg).

The AS-weighted background sound pressure levels, L_p should be measured immediately before and immediately after each run.

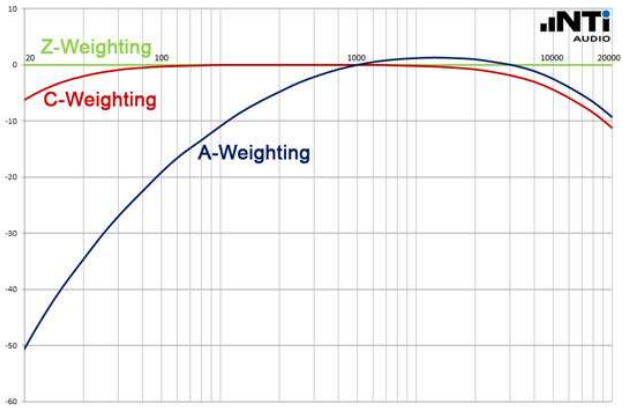
The engine should operate at full throttle for all tests but the craft speed should not exceed 70 km/h (37.8 knots). When the craft passed through the measuring point (the microphone), its direction and the maximum AS-weighted sound pressure level and L_{pASmax} were taken and recorded.

Each cycle of the tests consisted of two runs. The record showed that the craft runs from the right to left direction when passing the measurement point and vice versa to complete the testing cycle. The L_{pASmax} taken from each run should not normally be more than 1 dB. Test record shown below was the results of the tests:

Run	Side	File #	Craft Speed	Engine Speed	Measurement Distance	L'_{pASmax}	L''_{pAS}	Background noise correction	Distance correction	L_{pASmax}
No.	Port/Starboard	ID-1	[km/h]	[min^{-1}]	[m]	[dB]	[dB]	[dB]	[dB]	[dB]
1	Port		57.4	5,462	25	69.2	53.9 / 51.4	0.0	0.0	69.2
2	Starboarc		58.5	5,466	25	68.0	50.3 / 51.3	0.0	0.0	68.0
3	Port		57.5	5,469	25	69.4	51.5 / 50.3	0.0	0.0	69.4
4	Starboarc		58.5	5,468	25	68.1	52.2 / 50.4	0.0	0.0	68.1
5	Port		57.6	5,472	25	69.6	52.2 / 50.9	0.0	0.0	69.6
6	Starboarc		58.7	5,464	25	67.9	52.8 / 52.8	0.0	0.0	67.9
7										
8										

The Supporting Theories

Sound is transmitted in the form of a wave by varying the pressure of air as it travels. Therefore, the intensity of sound can be measured by the changing air pressure acting on the diaphragm of a microphone. The SI unit of sound pressure is in pascal (Pa). However, because the unit of sound was historically described in decibel (dB), the sound pressure level (L_p) is converted into decibels. A sound level meter is used to measure the sound pressure level in decibels.



Sound level meters normally offered noise measurements with **A**, **C** and **Z** frequency weighting. Frequency weighting is to cut out or reduce the unwanted frequencies by filters. Sound with **Z**-Weighting means that the sound has not been filtered. All sound frequencies are included in the sound. It is represented by the green line on the graph.

A-Weighting curve represents what human can hear. This is the most important curve in the study of noise pollution. Acoustic sound contains more lower and higher frequencies than humans can hear. The **C**-Weighting curve tunes up the lower frequencies and make them audible to humans. For the assessment of compliance with ISO 14509-1:2008, the **A**-Weighting is more meaningful in describing the frequency response of the human ear in the real world. Therefore, the abbreviation of sound pressure level after filter becomes L_{pA}.

Time weighting, Fast (**F**), Slow(**S**) or Impulse(**I**) represents a time-based measurement on sound. The time weighting is to dampen sudden changes in sound levels, thus creating a smoother reading on a sound pressure meter.

If a sound pressure meter is set to Slow (**S**) measurement, it will take approximately 5 seconds to reach 80 dB and around 6 seconds (decay time) to drop back down to 50 dB. **S** is appropriate when measuring a signal that fluctuates a lot but is continuous. A Fast (**F**) measurement is quicker to react to air pressure changes. It will take approximately 0.6 seconds to reach 80 dB and just under 1 second to drop back down to 50 dB. **F** may be more suitable where the sound is less impulsive but dies down quickly. An Impulse (**I**) measurement will take approximately 0.3 seconds to reach 80 dB and over 9 seconds to drop back down to 50 dB. **I** can be used in situations where there are sharp impulsive noises e.g. fireworks, gunshots. ISO 14509-1:2008 has chosen time weighting **S** for the tests of sound levels on recreational craft. Therefore, the abbreviation of sound pressure level after filter and response time adjustment becomes L_{pAS}.

According to IEC 61672-1:2013, L_{pASmax} is the maximum sound pressure level attained during the sound measurement of the passage of craft under the specific operating conditions measured by the sound meter with frequency weighting **A** and with time weighting **S**.

Interpretation of the Results

From the test record, it can be seen that the maximum **AS**-weighted sound pressure level L_{pASmax} of the Tohatsu MFS60A engine is 69.6 dB.

Looking closer to the data entries in the record, when the standard craft was moving from right to left, the craft speed was 1.0~1.1 km/h lower than when the craft was moving in the opposite direction. This was a clear an indication that the current is moving from left to right. The engine needed more power to propel the craft forward from right to left, thus causing the craft speed to drop. The extra loading on the engine in this direction caused it to generate a louder sound (i.e.1.2~1.7 dB higher) than when the craft is moving from left to right.

The measured Maximum **AS**-weighted sound pressure level L_{pASmax} was at least 10 dB higher than the background noise (e.g. noise from waves splashing on the measuring craft or the shore, other craft or equipment, and wind effects etc.). Under this condition, there was no need to make any background noise correction for the tests.

The measurement was taken when the vessel passed at a distance of 25 meters in front of the microphone. This met the distance requirement of ISO 14509-1:2008. Therefore, there was no need to make correction as sound pressure decayed in accordance with the inverse square law of distance

as it travelled through air. Adjustment was only necessary if the craft passed the microphone at a distance more than or less than ± 2 m of 25 meters.

Reflections

Today, a lot of people around the world are working hard to reduce noise pollution to the environment and to reduce its harmful effects to human. There are many ISO and IEC standards governing the emission of sound power sources and equipments.

Hong Kong is a small place in which over 7 million people live and work. The harmful effects of noise pollution are far greater than most other places. Although the Environmental Department in Hong Kong enacts Chapter 400 on Control of Noise Pollution, it is a reactive ordinance which is difficult to implement and enforce. Yet many people are still complaining about being awaken by noisy boat and car engines in the middle of the night. Workers may be protected by noise reduction gears while working in work/construction sites but people working and living in the vicinity have to endure and suffer from the noise produced. This is a serious problem Hong Kong people faced every day.

The solution to our problem may lie in “Buy-Quiet” programs. “Buy-Quiet” programs were first developed at the INTER-NOISE 2011 Congress in Osaka, Japan. A technical study group on “Buy-Quiet” programs was approved by the International Institute of Noise Control Engineering. International standards were developed for controlling and measuring the specification of noise emissions. Manufacturers and buyers are now able to make, test and purchase according to these international standards.

The Hong Kong Government may take the initiative by including “Buy-Quiet” in their purchasing and construction contracts. Professionals in HKJB can also join-in to help by using and purchasing quieter products that meet the international standards to control noise pollution generated by their projects and in the equipments they intend to use. I am sure the cumulative effects of reducing noise pollution by all will pay off and make Hong Kong a better place to live!

(Written by Simon Chen)

HKJB & HKIMT Coming Activities

Date	Event
10-12 Oct. 2018	PAAMES/AMEC20 at Busan, Korea & Technical Visit
14-16 Nov. 2018	Sustainable Ocean Summit in Hong Kong
16 Nov. 2018	HKJB/HKIMT Joint Annual Ball
20 Nov. 2018	Asian Logistics Maritime Conference
21 Nov. 2018	Technical Seminar on “Cruise Ship Safety” by RINA
24 Nov. 2018	Technical Seminar on Marine Engineering & Technology
5-7 Dec. 2018	8th International Maritime Expo in Guangzhou, China

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