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Ship Noise Level Analysis Based on the International Regulations

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***Abstract* – The target of analyse was to determine the exposure levels to the staff on the vessel and ensure adequate measures are in place to minimize the exposure when necessary. Noise levels through the vessel will be compared to the noise code detailed in section 2 of this report. The measurement data results obtained at this survey will be analysed against the codes, as shown below. In addition, the measurement result table has the readings from 2007 during sea trials at the shipyard, Brodogradilište d.o.o. – Split. The analyse is to measure the exposure levels, through the accommodation and machinery spaces to determine the risk to staff working in these areas as well as making recommendations that could reduce the exposure levels.**

***Keywords* – Accommodation, exposure, machinery, noise, protection.**

I. Introduction

Continuous noise onboard ships can have an adverse impact on human health [1]. The measurements obtained indicated the levels of noise throughout the accommodation and machinery spaces areas are below the noise level limits stated in the applicable codes [2], in areas that exceed the exposure action value of 80dB, suitable protective measures were in place.

Vessel was loading a cargo of fuel oil in New Orleans then on sea passage to Jamaica while the readings were obtained from 6th to 10th December 2018.

Exposure levels for noise were calculated to a daily exposure of 8 hours [2], however reports also record prolonged exposure over and above the accepted 8-hour exposure period and in all cases, this prolonged period was within the acceptable limits of exposure for the areas being surveyed.

Engine Room Workshop was recorded at 90 dB(A) with limit of 85 dB(A) according to the standards, at the time of the trial this was explained as being due to a door not closing.

Wheelhouse was recorded at 62 dB(A) with a limit of 60 dB(A), this is an error in the space designated limit as the standard allows for 65 dB(A) for the wheelhouse of a vessel.

II. Noise Code Information

The expectation and human tolerance of noise in different transport media is very different between aeroplanes; land-based transport such as cars, buses and trains; and ships. Indeed, the acceptable noise level is a function of variables like exposure time and the individuals' perception of the transport media [3].

IMO adopted, in 2012, a regulation in the International Convention for the Safety of Life at Sea (SOLAS) to require ships to be constructed to reduce on-board noise and to protect personnel from noise, in accordance with the Code on noise levels on board ships. The latest regulation – International Maritime Organization (IMO) noise level code on board ships, which became mandatory for new ships on July 1st, 2014 – is to protect seafarers against hearing loss, improve comfort levels and make aware the need to communicate with colleagues and hear alarms. All ship-owners have to meet these regulations for vessels with a gross tonnage of 1 600 and over [4].

The Code sets out mandatory maximum noise level limits for machinery spaces, control rooms, workshops, accommodation and other spaces on board ships.

The International Labour Organization's Maritime Labour Convention (MLC 2006) also has requirements with respect to preventing the risk of exposure to hazardous levels of noise on board ships.

The codes and regulations for noise exposure are found in the [2] Merchant Shipping & Fishing Vessels 'Control of Noise at Work Regulations: 2007', published 2009 and revised 2010.

This code [5] meets the requirements of [6] MLC 2006, Regulation 3.1: Accommodation and Recreational Facilities. Additional reference is taken from [7] IMO Resolution A.468(XII) "code on Noise levels on board Ship", 1981 and Maritime and Coastguard Agency Code of Safe Working Practices for Merchant Seamen, Chapter 34 – Noise, Vibration and other Physical Agents, Consolidated Edition 2007 [8].

- Machinery Spaces (not continuously manned) 110 dB (A)
- Machinery Control Rooms / CCR 75 dB (A)
- Workshops 85 dB (A)
- Cargo or Vehicle Decks 85 dB (A)
- Navigation Bridge & Chart Rooms 65 dB (A)
- Cabins 60 dB (A)
- Mess Rooms, Recreation Rooms & Offices 65 dB (A)
- Galley, Pantries & Laundry 75 dB (A)

Noise levels listed above [7] are designed to ensure that, if they are complied with, staff will not be exposed to an Leq(24) exceeding 80 dB(A). Spaces exceeding 85 dB(A) will require staff to use suitable ear protection [7].

Regardless of protection [7] no staff should be exposed to levels exceeding 120 dB(A) or to an Leq(24) exceeding 105 dB(A) (see Fig. 1).

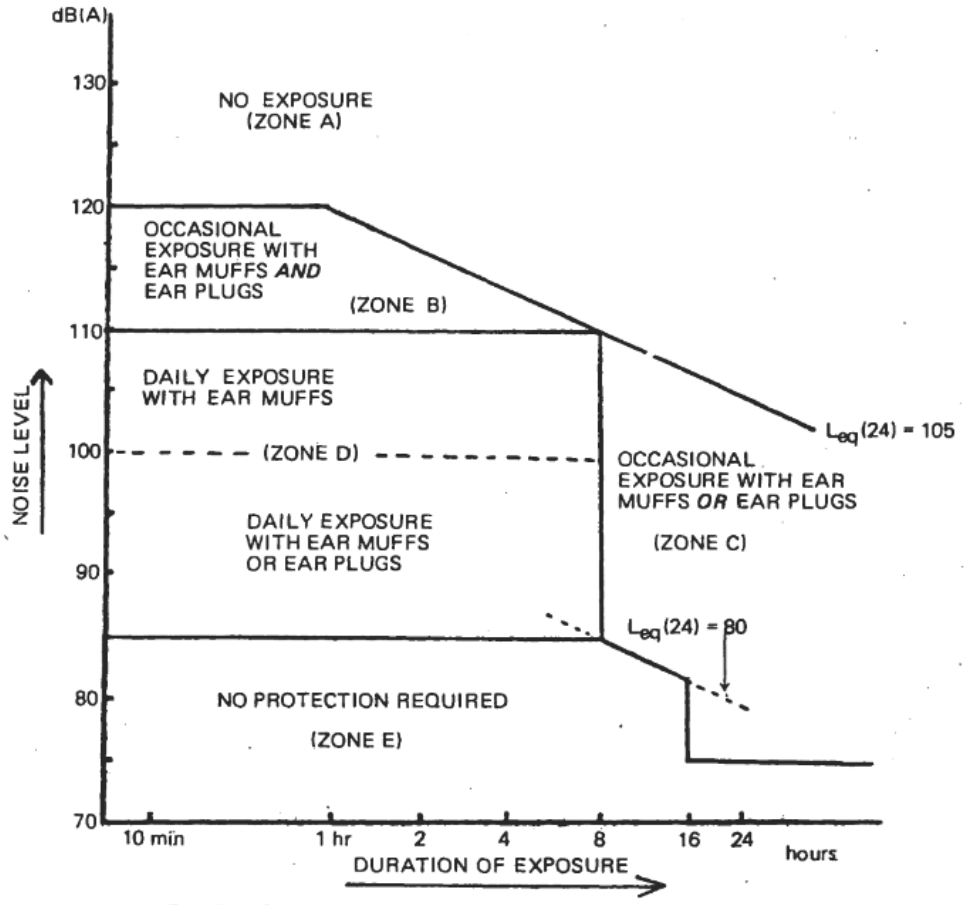

Fig. 1. Allowable daily and occasional noise exposure zones [7].

The ship, for her dimensions and characteristics, represents a very complex noise source [9]. The different plants present on board, devoted to propulsion and to the other operational functions of the ship, are all effective contributors to the noise field inside and outside the vessel. In addition to that, in the specific case of cruise or ferry ships, also the passengers on board and their activities can represent sources of noise and of annoyance for other passengers. In the following, the main sources of excitation on board will be briefly reviewed.

Ship Noise source analyse:

- consists of machinery noise (main engines, auxiliary machinery, gears, fans, etc.) and hydrodynamic noise (flow past the hull, appendages + cavities; blade rate tones; propeller singing; cavitation);
- all machinery on a ship radiates sound through the hull into the air and water;
- noise increases with ship size, power, load, and speed;
- ships with propellers are generally louder than ships with jet propulsion;
- propeller cavitation is the loudest component for speeds greater than the cavitation inception speed;
- tones at low frequencies correspond to propeller blade rate and harmonics: f [Hz] = number of blades x rpm/60;
- small vessels have small propellers turning at higher speeds resulting in higher frequency blade-rate tones;
- at low frequency (< a few 100 Hz), the ship spectrum also has tonal components from engines and gears; these spectral lines form the acoustic signature of the ship and allow acoustic identification;
- for f >100Hz the spectrum falls as −20log10f. [10]

III. Noise Methodology

Measurements of noise were made using a Class 2 precision grade sound level meter.

A windshield was fitted to the sound level meter. Measurements were made at each of the locations identified in the deck plan results section of this report.

In addition, noise dose badges were used which were worn by staff to provide noise level exposure over an extended period.

IV. Analyse Equipment Details

INSTRUMENT TYPE		Sound Level Meter
MANUFACTURER		Cirrus Research plc
MODEL NUMBER		RC:162C / Class 2
SERIAL NUMBER		G078236
CALIBRATION DATE		Calibrating before and after measurement period
DATES OF USE		6th to 10th December 2018 on the Stena Perros

INSTRUMENT TYPE		Dose badge Reader
MANUFACTURER		Cirrus Research plc
MODEL NUMBER		Class 2 Level 114 dB @ 1 kHz
SERIAL NUMBER		RC:110A SN 77672
CALIBRATION DATE		23rd November 2017 by shore
DATES OF USE		6th to 10th December 2018 on the Stena Perros

INSTRUMENT TYPE		Noise Dose badge
MANUFACTURER		Cirrus Research plc / Year of manufacture 2016
MODEL NUMBER		CR: 110AIS / Class I zone 0 / AEx ia IIC T4
SERIAL NUMBER		YF 850 / YF 848 / YF 846 / YF 845
CALIBRATION DATE		Calibrating before and after measurement period
DATES OF USE		6th to 10th December 2018 on the Stena Perros

V. RESULTS

The measurement result in Table I presents readings during sea trials at the shipyard of the vessel Stena Perros (see Fig. 2).

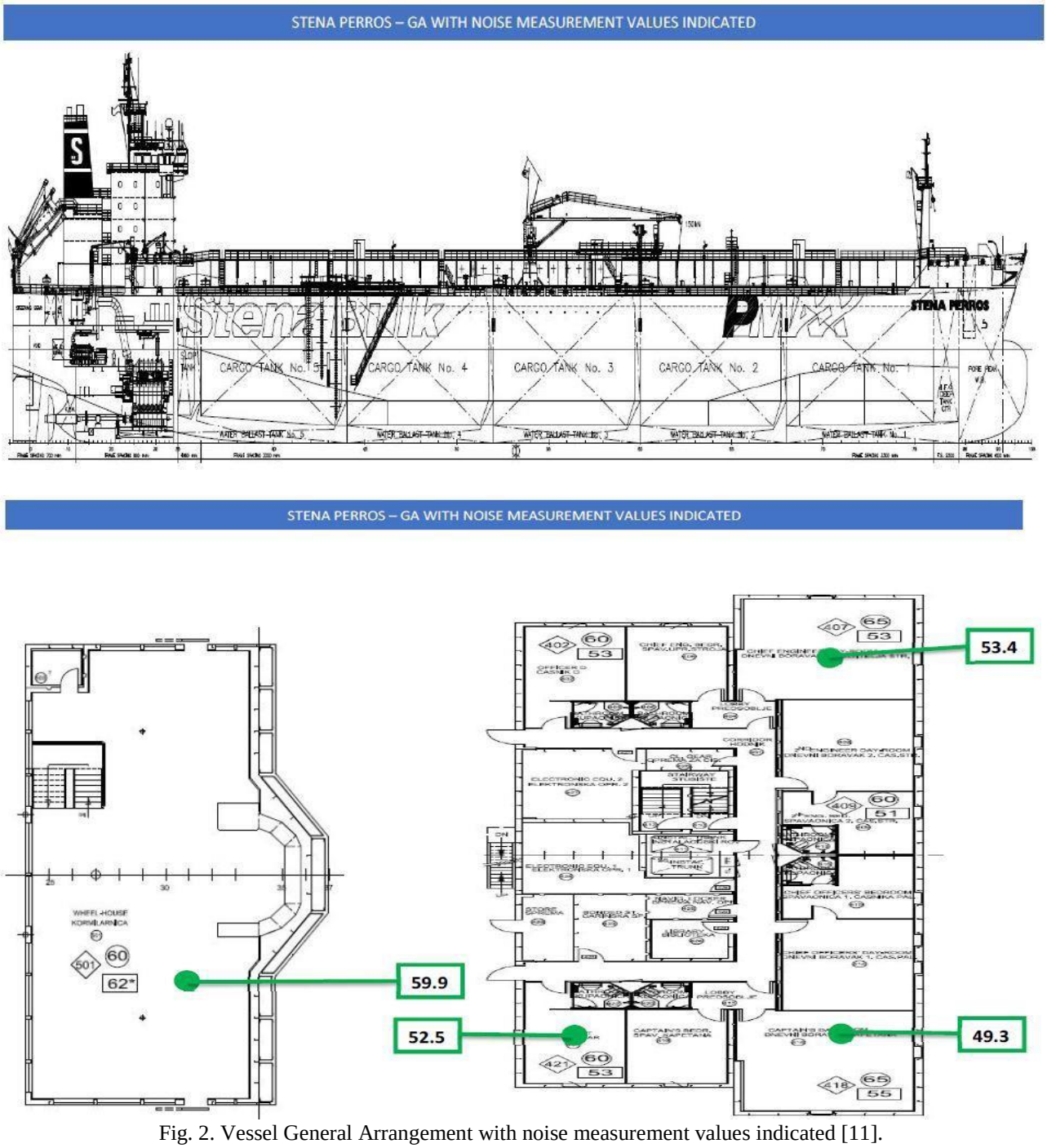

Fig. 2. Vessel General Arrangement with noise measurement values indicated [11].

TABLE I

NOISE SURVEY READINGS FULL SPEED PASSAGE (8-HOUR PROJECTED EXPOSURE)

Location Description	Design Limit dB(A)	Sea Trial Data dB(A)	In Port dB(A)	Full Sea Speed dB(A)
01 Wheelhouse (see Fig.2)	65	62.0	57.9	59.9
02 Masters Cabin (see Fig.2)	60	55.0	50.2	49.3
03 Chief Eng Cabin (see Fig.2)	60	53.0	53.1	53.4
04 Pilot Cabin (see Fig.2)	60	53.0		52.5
05 3rd Deck SB Fwd 2/O Cabin	60	50.0		50.7
06 3rd Deck SB Aft Cabin	60	56.0		54.7
07 3rd Deck Crew Cabin PS Fwd	60	54.0	56.3	57.6
08 3rd Deck PS Aft Cadet Cabin	60	54.0		60.2
09 2nd Deck Crew Cabin SB Fwd	60	53.0		53.8
10 2nd Deck Crew Cabin SB Aft	60	56.0	56.6	56.5
11 2nd Deck Fitter Cabin PS Fwd	60	53.0		59.1
12 2nd Deck Crew Cabin PS Aft	60	56.0		58.0
13 Officer TV Room	65	57.0	52.9	49.5
14 Officer Mess Room	65	65.0	60.1	60.2
15 Galley	75	63.0	69.3	73.4
16 Crew Mess Room	65	64.0	61.6	63.9
17 Crew TV Room	65	57.0	55.6	51.5
18 CCR	75	63.0	65.6	61.4
19 Ships Office	65			51.7
20 Gym	65	65.0	58.4	59.1
21 Hospital	65	59.0	52.6	57.8
22 Provision Stores	65			63.5
23 3rd Deck Outside Aft	N/A			95.2
24 2nd Deck Outside Aft	N/A			95.0
25 1st Deck Outside Aft	N/A			91.0
26 Upper Deck Outside Aft	N/A			85.8
27 ECR	75	68.0	72.0	66.2
28 IG Fan Flat	110			88.3
29 Boiler Burner Flat	110		96.9	88.6
30 Engine Room Workshop Doors Open	85	90.0	82.6	82.1
31 Engine Room Workshop Doors Closed	85			78.3
32 Incinerator Flat	110		84.3	94.8
33 PS Aux Engine Flat	110		100.2	96.5
34 PS Steering Gear Room	110			86.3
35 SB Aux Engine Flat	110		101.1	102.9
36 SB Steering Gear Room	110			81.4
37 Purifier Room	110			85.0
38 PS ME Cylinder Head Deck	110	104.0		99.2
39 SB ME Cylinder Head Deck	110			101.4
40 Cooler Rooms	110		88.8	93.0
41 SB ER Floor	110		87.2	98.8

Engine Room Workshop has noise levels close to action limits, given the watertight door is usually open when the machinery space is manned then it would be advisable to use ear protection in this area.

Outside of accommodation at the aft end of 3rd, 2nd, 1st and Upper deck there are high noise levels due to the ventilation systems for the machinery spaces. Staff walking through these areas in transit, while experiencing annoying levels of noise is not at risk for the brief time in the area. However, if staff are to work in these areas for a period of time then ear protection is required. Vessel needs to place warning notices in these areas to inform staff of the need for ear protection.

VI. Conclusion

This paper has considered a number of aspects relating to the noise and vibration of ship.

The result Tables I above shows the measurements obtained to be generally in compliance with the resolutions.

From the results obtained there are some remedial actions required as follows:

1. Engine room workshop, the noise levels in the workshop are at the upper limit of the standards allowance and as such ear protection should be worn as it is in the general machinery spaces. This type of vessel has a workshop construction that leads to the access doors being open during working periods so noise from machinery has an effect on the levels measured in the workshop space.
2. The open decks aft of accommodation are exposed to noise levels requiring protective measures, except when staff is passing through without working in the area. Staff should be wearing ear protection of minimum SNR 30 dB and warning signs should be located in this area.

For further improvement sound insulation of ER fan casing to be replaced with more appropriate [12], [13].

Machinery spaces, excluding the ECR, however exceed the 80 dB (A) limit and ear protection must be worn in these areas with minimum SNR 30 dB protection.

The correct type of ear protection to be worn and in line with company guidelines these must exceed SNR 30 standard as per below three examples (see Fig. 3).

Scandia HL303 Ear Plug – SNR 33 dB offers suitably high standard of protection and is suitable for staff and visitors. Staff can use these daily, but care to be taken due to possible risk of ear infections if the plugs are not changed frequently.

ScanSilence ML3 (clip on helmet) – SNR 35 dB offers suitably high standard of protection and is advised for staff using ear protection in the machinery spaces.

ScanSilence L3 Ear Muff (Headband) – SNR 36 dB.

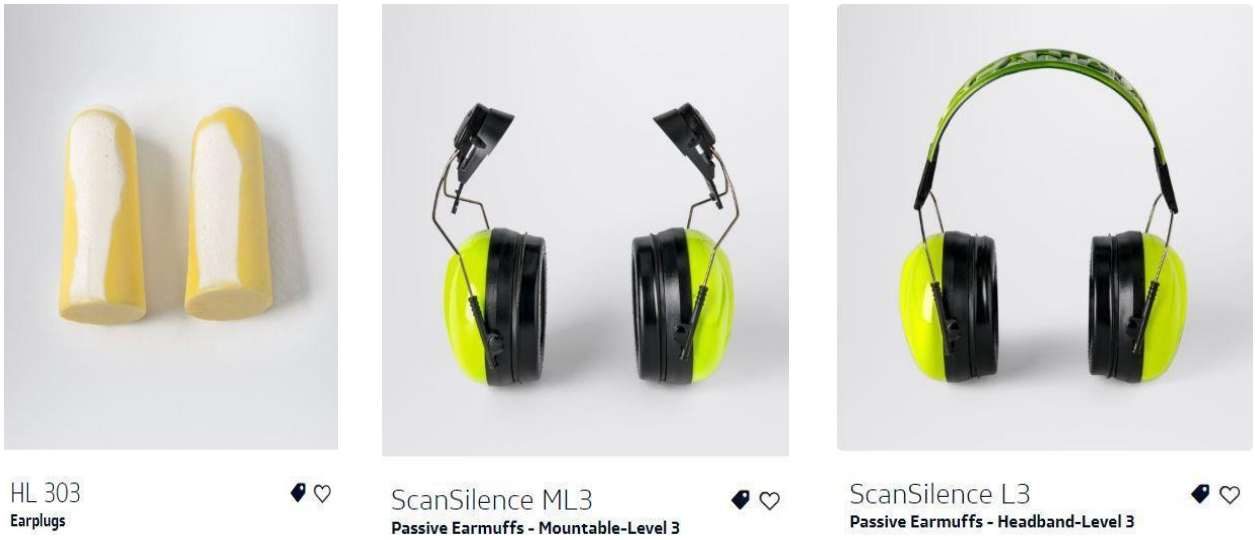

Fig. 3. Ear protection [14].

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