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CONTROLLING RISK DUE TO NOISE ON FERRYBOATS

ABSTRACT

Environmental and occupational noise is a common nuisance that affects the health of employees. Performed health checks of employees engaged by the Company "Pomorski Saobraćaj" showed that 5% of examined sailors had hearing loss. The results were a trigger for starting experiment on noise risk assessment with the objective of discovering the possibilities of noise pollution presence, precise significant noise sources and describing solutions for eliminating negative effects. Several measurements on five positions were performed on the ferryboat "KAMENARI", according to EC Physical Agents Directive and Merchant Shipping and Fishing Vessels Regulations 2007. Noise on the selected positions exceeded the limit by about 1-5 dB. The noise exposure level was 84.5 dB. Diesel engine, exhaust system and structural noise were the main sources of excessive noise. The experiment shows noise presence as nuisance that affects sailors. Noise presents a serious threat for the sailors' health. It interferes with crew communication and jeopardizes navigation safety. Technical measures, crew health checks and noise monitoring could prevent all the negative effects.

KEY WORDS

noise, sailor health, hearing loss, navigation safety

1. INTRODUCTION

All negative effects brought by the increase in noise can be observed through physiological and psychological effects of noise on human health and living nature around us. It is extremely important to take timely and preventive action in order to eliminate or at least mitigate the negative effects that increased noise has on the quality of life of modern human being and overall health of a human being [1].

As increased level of noise is directly related to places with extremely frequent traffic, it is evident that all traffic participants, whether they are passengers, passers-by or employees who work in management

or maintenance of transport means, will be exposed to increased level of noise [2]. A typical example are employees who perform their work activities as sailors on ferryboats for transport of people and vehicles. In this particular case, it is about employees who work as "sailors" on ferryboats owned by the company A.D. Pomorski saobraćaj - Kotor. Damage to hearing organs of employees who have been working as sailors for more than four years has been noticed through regular medical examinations of employees. Statistically speaking, the level of 5% of employees with reduced ability to detect sound signals does not represent a significant value and alarming data, but suggests the fact that it is necessary to do a risk analysis of increased noise exposure on a particular work position. An experiment has been conducted for this purpose, in which noise risk assessment has been carried out for sailors who work on "KAMENARI" ferryboat, which runs on Kamenari - Lepetane route. The ferry "Kamenari" was originally used as a navy artillery assault raft that in 1966 was adjusted for ferry service in the military shipyard "Arsenal". Regardless of the age of almost five decades, thanks to very good maintenance, this ferry is still being actively used (Figure 1).



Figure 1 - Ferryboat "KAMENARI"

The aim of the experiment is to define noise exposure levels for sailors on a daily and weekly basis, determine the causes of excessive noise and define ways of eliminating or reducing noise in accordance with the directives of the European Commission [3] and Statutory Rules for Great Britain [4]. Using EU norms and regulations of Great Britain is caused by the fact that national legislation does not prescribe instructions in this particular case, and therefore does not provide the possibility of a detailed analysis.

2. METHODS

Article 6 of Merchant Shipping and Fishing Vessels Regulations 2007 [4] (hereinafter referred to as "Regulation 2007") has defined the obligation of employer to carry out noise risk assessment process for crew members on the boat. The aim of this process is to determine whether the crew on the boat has been exposed to excessive noise during regular work activities on the boat, as well as to define measures to eliminate or reduce negative effects of noise on the crew. Using risk assessment, the employer shall: determine which crew members are exposed to excessive noise, define levels of noise exposure and compare them with the values defined by the applicable regulation (permitted limit values and values that indicate the immediate need for activities related to elimination of noise danger), define instruments for risk control and methods for their implementation. The process itself consists of a relatively brief assessment of noise presence followed by a set of measurements, in order to quantify the noise exposure and qualify the noise as a possible source of danger.

In the initial phase, the assessor is informed about work tasks of crew and visits all positions on which work activities are performed. Afterwards, it is necessary to talk with all crew members and get basic information about work activities and abilities of uninterrupted communication among the crew. It is necessary to pay particular attention to the ability of communication among crew members during work activities, when they are located at a distance of 2 m. If there is a necessity to communicate by shouting and gesticulations, then it is certainly necessary to check the noise exposure level at a given location. The reason for measuring the noise level on certain work positions can be the presence of buzzing in the ears after leaving the position, places that are directly exposed to noise, because of means of air conditioning and ventilation, mechanical department, positions next to electricity generators, places right beside the exhaust systems of boat engines and generators.

As result of the first phase of noise risk assessment, there are work positions on which measurements of noise levels should be carried out. It is im-

portant to distinguish and define two basic terms that are crucial in further noise risk assessment. These are the noise exposure level (depending on noise level and time of exposure) and the maximum measured noise level. Regulation 2007 prescribes that the lower limit of noise exposure level (which indicates the need for action in order to reduce noise) on a weekly basis is $L_{EP,w} = 80$ dB(A) and that the peak sound pressure level is $L_{C,peak} = 135$ dB. The upper limit of noise exposure level (indicates an urgent need to implement measures to reduce noise) on a weekly basis is $L_{EP,w} = 85$ dB dB(A) and peak sound pressure level is $L_{C,peak} = 137$ dB [4].

In the second phase of risk assessment, the noise level is measured on the selected positions. In this particular case, noise was measured by Brüel&Kjaer modular precise analyzer, model 2250, which met the prescribed IEC60804 standard. The set frequency range from 6.3 Hz to 20 kHz corresponded to the frequency range for tertiary noise analysis. A-weighting curve was set for frequency weighting with the rapid response time of 0.125 s. Dynamic range of the instrument for tone signal at the frequency of 1 kHz was set for the maximum value of 140 dB. Before and after the completion of the measurement, the device was calibrated using the sound calibrator, model Brüel&Kjaer 4230, which produced the sound level of 94 dB at the frequency of 1,000 Hz, with accuracy of ± 0.25 dB. The "free-field" microphone, size 0.5 inches, working range of 2.6 Hz to 20 KHz, was used during the measurement. During the measurements, the weather was good (cloudy and quiet weather) with sea condition of 0-1. The measurements were performed in real conditions, the ferryboat "KAMENARI" regularly operated on route Kamenari - Lepetane, i.e. it transported passengers and vehicles. Given the work activities of sailors, five work positions were defined, on which measurements have been performed, and these were the following: position right beside the movable ramp on the boat stern (Pos. 1), position next to the movable ramp on the boat bow (Pos. 2), position for accommodation of crew while sailing (Pos. 3), position on the movable ramp on the boat bow during loading/discharging (Pos. 4) and the position on the movable ramp on the boat stern during loading/discharging (Pos. 5). In order not to interfere with normal work activities of sailors, the assessor performed the measurement process by himself, i.e. he had set up the measuring instrument so that it was located at shoulder height, at a distance of 20 cm compared to the left ear, that is, the right ear, depending on where the source of sound (noise) was located. Care was taken that the instrument was located at a distance of a minimum of 1 m compared to the surrounding obstacles, in order to avoid the effect of reflection of sound waves, which could have threatened the reality of obtained results. From the present noise sources, exhausts of boat engines on the boat

stern, openings for entrance and ventilation of mechanical department, movable ramps on the boat bow and boat stern, as well as heavy trucks and buses at moments of loading/discharging, which the ferryboat was transporting, were singled out.

The period, that is, the duration of measurement on the selected positions is determined in accordance with the regulation [4]. The minimum duration of the measurement period is 60 seconds, and it is long enough to enable the instrument measurement of the equivalent noise level L_{eq} , so that its value is stable and the deviation does not exceed 0.2 dB. If different sound events rotate in the measurement interval, it is necessary for the measurement period to last long enough to include all significant sound events. The analysis of the work process has defined the measure-

ment periods, separately for each measurement position. So, the measurement time for the positions next to the movable ramp on the boat bow and boat stern was set for the period of 2 minutes (that is the time required for approaching/departure of the ferryboat and lowering/lifting the movable ramp). The measurements period on the positions on movable ramps during loading/discharging on the boat stern and boat bow was set for the period of 5 minutes, while the time on position for accommodation of sailors while sailing was specified to 7 minutes. During a period of eight working hours, a sailor spends time on measurement points, so he spends: 32 minutes on the position next to the ramp on the boat stern, 32 minutes next to the ramp on the boat bow, 1 hour and 20 minutes at the stern ramp during loading/discharging, 1 hour and 20

Table 1 - Exposure Points for various levels and durations

L_{eq} dB(A)	Exposure points for durations (full or partial)								total EP	$L_{EP,d}$
	1/4 hour	1/2 hour	1 hour	2 hours	4 hours	8 hours	10 hours	12 hours		
110	1,000	2,000	4,000	8,000	16,000				32,000	110
109	800	1,600	3,200	6,300	13,000				25,000	109
108	630	1,300	2,500	5,000	10,000				20,000	108
107	500	1,000	2,000	4,000	8,000	16,000			16,000	107
106	400	800	1,600	3,200	6,300	13,000			13,000	106
105	320	630	1,300	2,500	5,000	10,000	13,000		10,000	105
104	250	500	1,000	2,000	4,000	8,000	10,000	13,000	8,000	104
103	200	400	800	1,600	3,200	6,300	8,000	10,000	6,300	103
102	160	320	630	1,300	2,500	5,000	6,300	8,000	5,000	102
101	130	250	500	1,000	2,000	4,000	5,000	6,300	4,000	101
100	100	200	400	800	1,600	3,200	4,000	5,000	3,200	100
99	80	160	320	630	1,300	2,500	3,200	4,000	2,500	99
98	63	130	250	500	1,000	2,000	2,500	3,200	2,000	98
97	50	100	200	400	800	1,600	2,000	2,500	1,600	97
96	40	80	160	320	630	1,300	1,600	2,000	1,300	96
95	32	63	130	250	500	1,000	1,300	1,600	1,000	95
94	25	50	100	200	400	800	1,000	1,300	800	94
93	20	40	80	160	320	630	800	1,000	630	93
92	16	32	63	130	250	500	630	800	500	92
91	13	25	50	100	200	400	500	630	400	91
90	10	20	40	80	160	320	400	500	320	90
89	8	16	32	63	130	250	320	400	250	89
88	6	13	25	50	100	200	250	320	200	88
87	5	10	20	40	80	160	200	250	160	87
86	4	8	16	32	63	130	160	200	130	86
85	3	6	13	25	50	100	130	160	100	85
84		5	10	20	40	80	100	130	80	84
83		4	8	16	32	63	80	100	63	83
82		3	6	13	25	50	63	80	50	82
81			5	10	20	40	50	63	40	81

Table 2 – Noise level measurement results for Pos. 1

LAeq [dB]	LAF10.0 [dB]	LAF50.0 [dB]	LAF90.0 [dB]	LAF5.0 [dB]	LAF1.0 [dB]	LAFmax [dB]	LAI _{max} [dB]	LC _{peak} [dB]
83.9	85	83.9	82	85.6	86.6	89.3	90.1	116.4

Table 3 – Noise level measurement results for Pos. 2

LAeq [dB]	LAF10.0 [dB]	LAF50.0 [dB]	LAF90.0 [dB]	LAF5.0 [dB]	LAF1.0 [dB]	LAFmax [dB]	LAI _{max} [dB]	LC _{peak} [dB]
86.3	87.9	85.9	84.5	88.2	88.7	89.3	90.6	118.1

minutes at the ramp on the bow during loading/discharging and 3 hours and 42 minutes in the place for sailors while sailing. The total time that a sailor spends on the measurement positions is very important for calculating the noise exposure, also representing the final phase of noise risk assessment.

Measurement values obtained for each measurement position are entered into a table that represents the summarized results of the performed risk assessment, in the form of obtained values of total noise exposure during daily, that is, weekly period and peak sound pressure values during the period of noise exposure. Work activities, position on ship, time of day, measured equivalent level, total time of exposure during 8 hours of work and measured $L_{C,peak}$, are shown for the defined work position. It is necessary to calculate the number of exposure points and the total exposure level. The calculation is performed using the "Health and Safety Executive Ready Reckoner", which is shown in the table (Table 1). The procedure for determining the exposure points is very simple. Based on the measured equivalent noise level, the right type is found in Table 1. Afterwards, based on the total time of exposure, a column in Table 1 is found. At the point of crossing of the selected column and the selected type, we read the value that refers to a particular number of exposure points. Based on the number of obtained exposure points, the noise exposure level $L_{EP,d}$, is determined by reading the value for $L_{ep,d}$ for the given number of exposure points from the right separate column shown in Table 1.

The procedure has to be repeated in order to obtain the values for each measurement position. Finally, the obtained values for noise exposure points for each measurement position are summed up and the total value (Total EP) is obtained. Total noise exposure level for the period of 8 hours is read from the right part of Table 2 (two separate columns), based on the total value of exposure points. The procedure for determining the weekly exposure level is such that the daily exposure points for a period of five days are summed up and divided by 5. Then, the corresponding level that represents the weekly exposure level ($L_{EP,w}$) is read (from the right part of Table 1), based on the obtained value.

3. RESULTS

3.1 Noise level measurement results on selected positions

3.1.1 Measurement results for the position next to the ramp on the boat bow (Pos. 1)

Noise level measurement results on the position next to the ramp on the boat bow (Pos. 1), where a sailor spends a total of 32 minutes during 8 working hours, are shown in the table (Table 2).

From data necessary to assess noise exposure, the following is pointed out: $L_{A,eq} = 84$ dB, $L_{C,peak} = 116$ dB.

3.1.2 Measurement results for the position next to the ramp on the boat stern (Pos. 2)

Noise level measurement results on the position next to the ramp on the boat stern (Pos. 2), where a sailor spends a total of 32 minutes during 8 working hours, are shown in the table (Table 3).

From the data necessary to assess noise exposure, the following is pointed out: $L_{A,eq} = 86$ dB, $L_{C,peak} = 118$ dB.

Due to exceeded noise level value that, according to standards, represents the first level for reacting, it is also necessary to perform a frequency analysis (Figure 2).

It can be seen in Figure 2 that the maximum noise level is present in the frequency interval from 63-500 Hz. The noise level decreases in the range from 2 KHz to 16 KHz.

3.1.3 Measurement results for the position for accommodation of sailors while sailing (Pos. 3)

Noise level measurement results on the position for accommodation of sailors while sailing, where a sailor spends a total of 3 hours and 42 minutes during 8 working hours, are shown in Table 4.

Necessary data are: $L_{A,eq} = 81$ dB, $L_{C,peak} = 120$ dB.

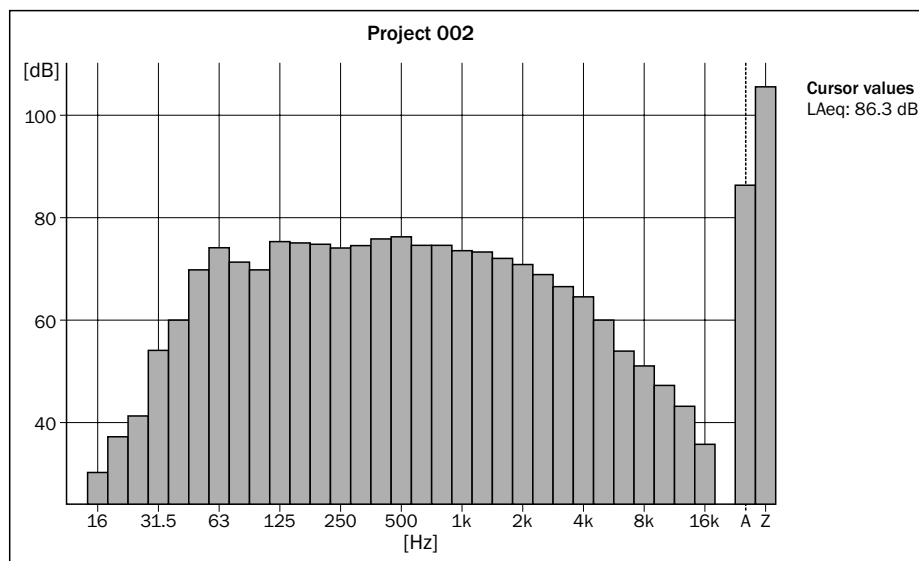


Figure 2 – Frequency analysis results for the position next to the ramp on the boat stern

Table 4 – Noise level measurement results for Pos. 3

LAeq [dB]	LAF10.0 [dB]	LAF50.0 [dB]	LAF90.0 [dB]	LAF5.0 [dB]	LAF1.0 [dB]	LAFmax [dB]	LAlmax [dB]	LCpeak [dB]
80.8	82.2	79.3	74.2	82.4	83	84.6	87.3	119.9

Table 5 – Noise level measurement results for Pos. 4

LAeq [dB]	LAF10.0 [dB]	LAF50.0 [dB]	LAF90.0 [dB]	LAF5.0 [dB]	LAF1.0 [dB]	LAFmax [dB]	LAlmax [dB]	LCpeak [dB]
86.3	87.9	85.9	84.5	88.2	88.7	89.3	90.6	118.1

Table 6 – Noise level measurement results for Pos. 5

LAeq [dB]	LAF10.0 [dB]	LAF50.0 [dB]	LAF90.0 [dB]	LAF5.0 [dB]	LAF1.0 [dB]	LAFmax [dB]	LAlmax [dB]	LCpeak [dB]
83.9	85	83.9	82	85.6	86.6	89.3	90.1	116.5

3.1.4 Measurement results for the position at the ramp on the boat stern during loading/ discharging (Pos. 4)

Noise level measurement results on the position at the ramp on the boat stern during loading/ discharging, where a sailor spends a total of 1 hour and 20 minutes during 8 working hours, are shown in Table 5.

Necessary data are: $L_{A,eq} = 86$ dB, $L_{C,peak} = 118$ dB.

3.1.5 Measurement results for the position at the ramp on the boat bow during loading/ discharging (Pos. 5)

Noise level measurement results on the position at the ramp on the boat bow during loading/ discharging, where a sailor spends a total of 1 hour and 20 minutes during 8 working hours, are shown in Table 6.

Necessary data are: $L_{A,eq} = 84$ dB, $L_{C,peak} = 117$ dB.

3.2 Noise risk assessment table

Based on the obtained noise level measurement results for the defined measurement positions and based on the rules defined in Regulations 2007, a table for noise risk assessment for a “sailor” job on a ferryboat is formed (Table 7). Using “Health and Safety Executive Ready Reckoner”, the number of exposure points for each position is obtained.

After summing up the number of exposure points for each position, we get that the total sum of all exposure points is TOTAL EP = 72.

The value for LEP,d from Table 1 is read, based on TOTAL EP, which is approximately:

$$LEP,d = 83.5 \text{ dB}$$

Since there are no deviations in the operating mode during the work week, it is clear that the exposure level on a weekly basis equals the exposure level on a daily basis, i.e.

$$LEP,w = 83.5 \text{ dB.}$$

Table 7 – Noise risk assessment table

Job	Location	Position on ship plan	Time of day	Sample duration	$L_{a,eq}$ [Db]	Expo. Duration	Expo. Points	$L_{c,peak}$ [Db]
Sailor	Pos. 1	Bow	Morn.	2 min.	84	32 min.	5	116
	Pos. 2	Stern	Morn.	2 min.	86	32 min.	8	118
	Pos. 3	Open deck	Morn.	7 min.	81	3h 42 min.	20	120
	Pos. 4	Stern	Morn.	5 min.	86	1h 20min.	24	118
	Pos. 5	Bow	Morn.	5 min.	84	1h 20min.	15	117

By comparing the obtained exposure level on a daily basis with the permitted limit values ($80 \text{ dB} < L_{EP,w} < 85 \text{ dB}$), it is clear that the lower level of noise exposure on a weekly basis has been exceeded, which indicates the need for implementation of activities to reduce the noise level. Measured peak sound pressure level for C-weighting is $L_{C,PEAK} = 120 \text{ dB}$, and it is lower than the maximum permitted value ($L_{C,PEAK} = 137 \text{ dB}$).

4. DISCUSSION

The results of the conducted experiment indicate the fact that the noise that is present at the sailor's workplace exceeds the permitted limit values, which has a negative effect on their life and health.

The impact of sound volume and the nature of noise have been determined by complex factors, one of which is that the human ear is not equally sensitive to all frequencies of sound. It is most sensitive to those between 2 kHz and 5 kHz, and less sensitive to lower and higher frequencies than those. The level of sound disturbance does not only depend on the sound quality but also on our attitude towards that. (For example, the sound of a new jet can be music to the ears of a designer, but a nightmare for residents living near the airport). This is why today special attention is paid to the so-called "annoyance" factor (noise annoyance factor) and assessment of population that is very disturbed by noise, whether it comes to noise in the environment or in the work environment [6].

One should not lose track of subjective sensitivity to noise, which has the highest correlation with the term "endangerment-sensitivity" to noise. This basically means that the sound does not necessarily (only) has to be loud in order to disturb the population. Higher cerebral processes affect the body's response to noise, and to explore the non-auditive effects of noise, the subjective sense-perception of noise must be taken into consideration [5]. There are several degrees of noise regarding intensity. The noise of 30-60 dB is generally well tolerated and only bothers sensitive people. The intensity of 65-90 dB harms the body in general, but also causes disturbances of hearing. Higher intensities of noise cause impairment of hearing and mental health. Generally, the higher the intensity of noise, less time is required for it to

cause negative effects. If the noise lasts longer, lower intensities of noise can also cause health problems, through hyperreactivity, disorder of the hypothalamus-pituitary-adrenal gland system, resulting in stress with its negative consequences [7]. Pathophysiological, i.e. neurophysiological reaction to noise is based on the fact that ear receives sound impulses and transmits them to the nervous system which stimulates certain reactions in the body. Due to noise stimulation, a reflex arc is established within the syndrome of general adaptation to stress. Target organs are the visceral organs, i.e. heart, blood vessels, digestive tract (digestive organs), endocrine glands, which are innervated by the autonomic nervous system [8]. Preventive action in the form of regular medical controls, therapeutic treatment and careful monitoring will reduce or completely eliminate these effects. Since the noise exposure level is $L_{EP,w} = 83.5 \text{ dB}$, in this particular case, it is not necessary to give the crew members to use tools and equipment for personal protection [9]. In addition to directly affecting the quality of life and health of a sailor, excessive noise can threaten normal functioning of work activities on the boat, disable normal communication among crew members, and therefore bring into question the safety of sailing. In order to limit the negative effects on the boat's operability, International Maritime Organization (IMO) has defined the limit noise values depending on the Boat Layout Plan [10]. In relation to the disruption of work activities carried out by the majority of nautical staff, and in relation to the possibility of causing other extra-auditory effects of noise on the command bridge, the permitted limit values range from 55 to 65 dB. Permitted noise level on the open deck must not exceed 75 dB. The experiment results show that this level has been exceeded by the entire 11 dB. Eliminating the negative effects of excessive noise on the inability of normal communications among the ship's crew was carried out with the help of modern means of communication, a modern crew communication system providing freedom of movement, free hands, full communication and hearing protection. Headsets for speech communication are used in a wide range of applications. A communication headset usually consists of a pair of headphones and a microphone attached to the headset with an adjustable boom. Simple form headset has

an open construction with little or no attenuation of the environmental noise. Within headsets designed for noisy environments, the headphones are mounted in ear cups with cushions that provide some attenuation. Passive headsets produce good attenuation of noise, typically in the order of 40 dB above 500 Hz. Analogue active noise control headsets typically produce an attenuation of about 20 dB at 100 to 200 Hz, which falls to zero below approximately 30 Hz and above approximately 1 kHz [11]. Active noise control headsets have proven to be very successful in improving attenuation at frequencies below 1,000 Hz by up to 20 dB [12].

In order to discover the effects of excessive noise, it is very important to define the noise sources. The following have been identified as the largest noise sources on the boat: structural vibrations, turbochargers, diesel engines, turbo-generators, gearboxes, auxiliary equipment (for lighting, pumps, compressors, boilers), propellers, shaft lines, exhaust systems, ventilation systems, air conditioning systems, electronic devices, radar transformers and other navigation devices [13, 14]. As the ferryboat "KAMENARI", which is more than 30 years old, has been selected for conducting the experiment, noise from propulsion and auxiliary engines, exhaust system and structural vibrations can be singled out from the mentioned noise sources. Considering the measurement positions, the most significant noise sources are the exhaust system and noise created by the propulsion engines. Using detailed analysis it has been observed that the maximum noise levels have been recorded in the frequency range from 125 Hz to 500 Hz, which coincides with the data that some manufacturers of diesel engines display, and which are related to noise levels created by the engine in the frequency domain of 25 Hz – 8 KHz [15, 16]. The absence of excessive noise at higher frequencies indicates the fact that the exhaust system was built to eliminate higher frequency noise, indicating that an absorption type of purge muffler was installed at the exhaust system. Ageing of boats is one of the factors causing increased noise, as confirmed by the results of a research conducted in 1970s, which are very similar to the results obtained by the experiment [17].

In order to reduce the negative effects of excessive noise in this particular case, it is necessary to perform technical changes on the propulsion system of the ferryboat. The modification of the exhaust system through installation of additional reflective type of purge muffler is seen as the most economical solution, which would, combined with the already existing one, reduce noise levels at lower frequencies [18]. Due to the age of the ship and financial unprofitability, it is im-

possible to affect the structural noise that comes from high vibrations of propulsion and auxiliary systems on the boat.

6. CONCLUSION

The obtained experiment results indicate the presence of excessive noise as a factor that has negative effect on health of seafarers. Since the presence of increased noise interferes with work activities and threatens communication among crew members, the risk concerning security and safety of sailing is evident. Successful noise risk management on the boat, which is implemented through integration of technical solutions, modern boat management methods and constant monitoring of health of employees, can significantly influence the enhanced safety of sailing, better operational efficiency, higher work performance and a satisfactory level of health of the crew. In this particular case, it is possible to implement several measures that would minimize the negative effects of excessive noise recorded. A technical measure that might be implemented is the installation of additional reflective type of muffler on the power system of the ferryboat. This measure would be cost-effective and it leads to reduction of emission of harmful noise. Periodic medical examinations are proposed as a health measure, which, for employees whose hearing impairment is diagnosed, would be organized within shorter intervals (every 6 months). The therapeutic treatment, which would include giving medications that encourage circulation in human bloodstream and regulate blood pressure, would slow down the progressive hearing loss of employees and reduce the negative effects on visceral organs. The disturbances in the performance of work activities and normal communication on the boat, due to exceedance of the permitted noise level of 11 dB on the deck can be eliminated by using modern means of communication (wireless communication sets). The introduction of a normative measure that would define the obligation of wearing personal protection equipment (ear plugs or muffs), regardless of the fact that the upper permitted level of exposure of 85 dB is not exceeded, would eliminate the negative effect of noise on the boat crew. The conducted experiment provides good basis for further research that should include noise assessment at all work positions, as well as a more detailed analysis of those sources (radar transformers, electronic and navigation devices, etc.) where the noise emission has not been sufficiently researched.

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SAŽETAK

KONTROLA RIZIKA OD BUKE NA TRAJEKTU

Prisustvo prekomjerne buke predstavlja opasnost koja ugrožava zdravlje zaposlenih. Tokom redovnih ljekarskih pregleda zaposlenih u A.D. "Pomorski Saobraćaj", utvrđeno je da 5% mornara ima trajno oštećenje sluha. Rezultati pregleda bili su razlog da se izvrši eksperiment u kom će se procijeniti rizik od prekomjerne buke, utvrdi prisustvo buke kao zagađivača, definišu izvori buke i utvrde mjere za eliminaciju.

Izvođenje eksperimenta je podrazumjevalo snimanje nivoa buke na pet pozicija na trajektu „KAMENARI“. Mjerenja su vršena u skladu sa Direktivom Evropske Komisije za fizičke agense i propisima Velike Britanije za Trgovačku mornaricu i ribarske brodove iz 2007. godine.

Izmjereni nivoi buke prelaze dozvoljene vrijednosti za 1 do 5 dB. Nivo izloženosti buci mornara je 84.5 dB. Pogonski motori, sistem izduva i strukturna buka uzrokovali su prekomjernu buku.

Eksperimentom je dokazano prisustvo buke koja negativno utiče na zdravlje mornara. Buka predstavlja ozbilju smetnju za normanu komunikaciju i ugrožava bezbjednost plovidbe. Primjenom tehničkih mjera, redovnim ljekarskim pregledima i monitoringom buke moguće je otkloniti negativne efekte.

KLJUČNE RIJEČI

buka, zdravlje mornara, gubitak sluha, bezbjednost plovidbe

REFERENCES

- [1] **Praščević M., Cvetković D.:** *Noise in the environment*, Faculty of Occupational Safety, Niš, 2005
- [2] **Gruden, D.:** *Traffic and Environment*, Springer, 2001
- [3] **Directive 2003/10/EC of the European Parliament and of the Council of 6 February 2003 on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (noise).** Official Journal of the European Union, L 42/38 - L 42/44.
- [4] **Statutory Instrument 2007 No. 3075. Merchant Shipping the Merchant Shipping and Fishing Vessels (Control of Noise at Work) Regulations 2007.** The Stationery Office, London.
- [5] **Zvyagina, L.A.:** *Peripheral nervous disorders in seafarers.* European Journal of Neurology; Vol. 11, (Suppl. 2), 2004, pp. 136-182
- [6] **Stansfeld, S., Matheson, M.:** *Noise pollution: non-auditory effect on health*, British Medical Bulletin, Volume 68, 2003, pp. 243-257
- [7] **Grohol, J.:** *Noise Activates Our Stress Hormones*, <http://psychcentral.com/blog/archives/2007/06/06/noise-activates-our-stress-hormones/>
- [8] **Blukhn, G., Ericsson, C.:** *Cardiovascular effect on environmental noise*, Pub Med, Vol. 52, 2011, pp. 2012-2016
- [9] **Statutory Instrument 2005 No. 1643. Health and Safety the Control of Noise at Work Regulations 2005.** The Stationery Office, London.
- [10] **IMO Resolution A.468 (XII), "Code on noise levels on board ships", 1981**
- [11] **Crabtree, R.B., Rylands, J.M.:** *Benefits of active noise reduction to noise exposure in high-risk environments*, Proc. Inter. Noise'92, 1992, pp. 295-298
- [12] **Elliott, S.J.:** *Signal Processing for Active Control*, Academic Press, London, 2001.
- [13] **Witte, R.:** *Container Terminals and Noise*, Internoise, Shanghai, October 2008
- [14] **Witte, R.:** *Noise emissions RoRo terminals*, Euronoise, Edinburg, Scotland, October 2009
- [15] <http://www.manbw.dk>
- [16] <http://www.wartsila.com>
- [17] **Radanović, B.:** *Overview of noise condition on ships built in our shipyards.* Shipbuilding, No. 7, 1970, pp. 436-439
- [18] **Tae-Kyoung, L., Won-Ho, J., Jong-Gug, B.:** *Exhaust Noise Control of Diesel Engine using Hybrid Silencer*, Internoise, Shanghai, October 2008