Noise Risk Assessment on Noise Exposure Among Urban Rail Maintenance Worker using Personal Monitoring Method

M. Mifzal-Nazhan [0000-0001-6466-3733], J. Azlis-Sani [0000-0002-6629-3219], A. Nor-Azali [0000-0003-0720-0796], Y. Nur-Annuar [0000-0002-8194-5887], S. Shahrul-Azhar [0000-0000-0000-0000], A. Mohd-Zulhelmi [0000-0000-0000-0000].

Faculty of Mechanical and Manufacturing Engineering, Universiti Tun Hussein Onn Malaysia, 86400 Batu Pahat, Malaysia.
Safety, Health and Environment Department, Rapid Rail Sdn Bhd, No 1, Jalan PJU 1A/46, Off Jalan Lapangan Terbang Subang, 47301 Petaling Jaya, Selangor, Malaysia

mifzalnazhan97@gmail.com

Abstract. Urban Rail maintenance work usually involves a lot of daily maintenance work as proper maintenance must always be a priority for the rail industry to ensure the passengers are always comfortable and safe. These maintenance activities expose the technician to noise as they handle a lot of hand tools and machinery while performing their tasks. Noise Induced Hearing Loss (NIHL) is a major compensable occupational disease in Malaysia due to excessive noise-exposed above the permissible daily noise exposure limit. This study aimed to conduct Personal Monitoring as a part of Noise Risk Assessment (NRA) to measure the level of noise exposure received among maintenance technicians in the excessive noise area. This study focuses on the areas and tasks involved in the Track Network Maintenance Hall (TNMH) and Track Vehicle Storage Building (TVSB) at one of the urban rail companies. Noise Risk Assessment was the selected method to measure the level of noise exposure among maintenance technicians in the excessive noise area. The Personal Monitoring method was conducted as suggested in the ICOP provided by DOSH Malaysia. Data recorded shows that a total of 2 out of 3 technicians were exposed with a daily noise exposure limit exceeding 85dB(A) for 8 hours working shift. The exposure level was currently controlled by practicing the usage of a Personal Hearing Protector (PHP). Thus, this study confirmed that maintenance workers were exposed to high noise levels when performing their maintenance tasks.

Keywords: Maintenance Worker, Noise Risk Assessment, Excessive Noise, Railway, Transportation.

1 Introduction

Light Rapid Transit (LRT) is one of the public transports had been used by people to travel around the area of Kuala Lumpur and Selangor. Few rail operators provide urban rail services including Commuter, Light Rail Transit (LRT), Monorails, and Mass Rapid Transit (MRT) in Malaysia. In order to provide excellent service for the public, proper maintenance must always be a priority for the rail industry to ensure the passengers are always comfortable and safe. Usually, railway industries involve a lot of daily maintenance work including track maintenance, overhead lines, signalling systems, power supplies, security systems, and inspection of rail assets [1]. Other than that, the railway maintenance industry involves complex human-machine interactions and safety-critical operations with considerable risks to the health and safety of its employees during the maintenance process [2]. Recently, a high level of noise exposure is one of the most common occupational hazards that happen among industries in Malaysia [3]. In addition, noise-induced hearing loss (NIHL) was the highest notifiable occupational health issue among Malaysian workers in 2014 [4]. As noise-induced hearing loss (NIHL) usually happens in various industries, more research has been carried out to analyze, evaluate and receive more information about these problems. Previous research in the rail sector has stated that the maintenance crew was exposed to high noise during preventive maintenance activity, which involves the usage of compressed air to remove dust and particulates from the RPM or also known as the blowing activity [5]. By referring to another sector, research from the aircraft sector has stated that the aircraft maintenance workers at the hangar involve more than 85 dB(A) level of noise that is able to perceive Noise-Induced Hearing Loss (NIHL) [6]. Thus, it is important to study the possible causes of high noise exposure to prevent noise-induced hearing loss cases among maintenance workers in rail companies.

2 Methods

2.1 Noise Risk Assessment (NRA)

Noise Risk Assessment is the new method under the Industry Code of Practice (ICOP) for Management of Occupational Noise Exposure and Hearing Conservation 2019 that was published by the Department of Safety and Health (DOSH) Malaysia that applied to all places of work where persons are employed in any industrial sector that covered under Occupational Safety and Health Act 1994 [Act 514] [7]. The purpose of this assessment is to identify the excessive noise possible to expose to the employees at the workplace. It is also able to identify the effectiveness of existing measures taken to reduce noise exposure. For this study, a noise exposure personal monitoring methodology is used to measure the level of noise exposure among maintenance technicians in the excessive noise area.

2.2 Procedure to Conduct Personal Monitoring

As stated in the guideline for conducting Noise Risk Assessment (NRA), the noise measuring equipment shall comply with the requirements of IEC 61672-1, IEC 61252, and all other relevant standards. In this study, the Noise Dosimeter LARSON DAVIS model 706 was used to comply with the requirements stated in the guideline. Other than that, the noise dosimeter was set up as follows; Criterion Level: Lc = 85dB(A), Threshold Level: Lt = 80dB(A), Exchange Rate: q = 3dB, Time Constant = 'slow', Peak Level = 140dB(C).

Next, the Similar Exposure Group (SEG) was identified, a sample of technicians from each working group was selected, and the daily noise exposure was measured during their working shift. The personal monitoring sampling duration for all identified technicians are 9 hours starting from 0800 until 1700 without pausing the dosimeter. The monitoring sampling was conducted on a different date due to the limited number of dosimeters in possession.

Before conducting the monitoring, the noise dosimeter was calibrated at the workplace. Then, the dosimeter was installed on the subject's body and the microphone was mounted on the top of the shoulder approximately 0.1 m from the entrance of the external ear canal at the side of the most exposed ear and approximately 0.04 m above the shoulder. Finally, the cable was attached neatly and safely as long as the subject felt comfortable and free to move while conducting any kind of work or activities.

Fig. 1. Example for the position of a microphone attached to a subject

3 Method Results and Discussion

3.1 Noise Risk Assessment (NRA)

The identification of the area and task is made through the discussion with the management of the Track Network Maintenance Department (TNMD). From the discussion, there were two main halls involved in the department, which are Track Network Maintenance Hall (TNMH) and Track Vehicle Storage Building (TVSB). Other than that, this department was divided into two main groups of technicians in Track Maintenance Group and Rail Equipment Maintenance Group.

Track Maintenance Group is divided into two sub-groups which are the Depot Group and Mainline Group. The Depot Group is divided into 4 sub-group Heavy Maintenance, Special Trackwork, Power Rail, and Switch Machine as shown in Figure 2. Switch Machine Group was selected among the others to conduct this assessment due to their tasks were located inside the Switch Machine Room at Track Vehicle Storage Building (TVSB). Other than that, the Rail Equipment Maintenance Group was divided into two sub-groups which include the Rail Grinding Group and the Rail Borne Group. For Rail Grinding Groups, the tasks conducted inside the hall were air-blowing activity and preventive maintenance for the Rail Grinding Unit (RGU) Vehicle. For Rail Borne Group, the preventive maintenance and inspection for all Rail Borne vehicles were conducted inside the halls and involved a lot of noise sources generated by different vehicle engines.

Therefore, the Noise Risk Assessment (NRA) was conducted by focusing on the three selected groups which include the Switch Machine Group, Rail Grinding Group, and Rail Borne Group. Figure 2 shows the illustration of every group and sub-group involved in the Track Network Maintenance Department (TNMD) and the selected groups for the assessments due to the identification of noise had been conducted by the employer whereby there is a potential of noise risk during working hours among the particular working group.

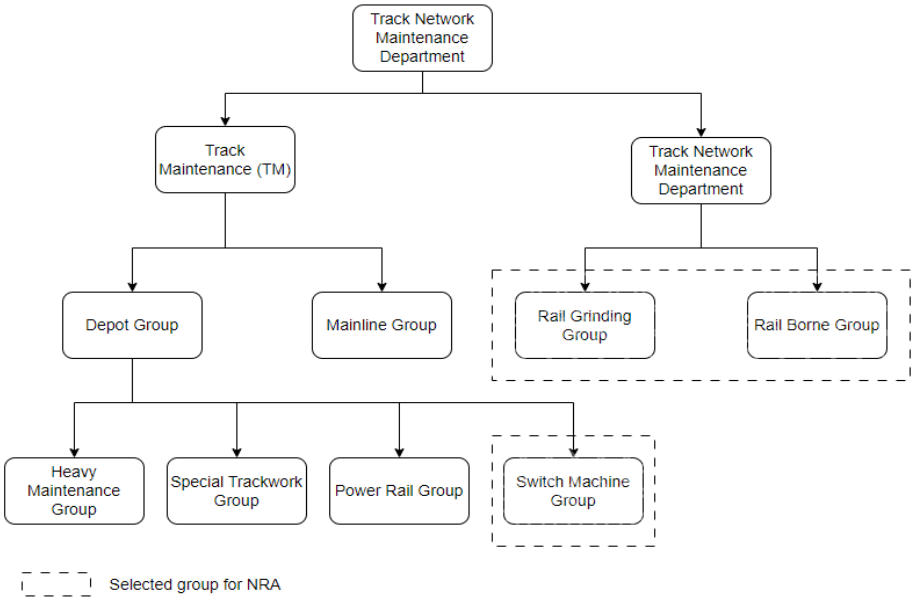

Fig. 2. Group of Workers in Track Network Maintenance Department (TNMD)

3.2 Personal Monitoring

Table 1 illustrates the overall results of the personal monitoring assessment. Subject 1 was a technician from the Switch Machine Group, Subject 2 represented the Rail Grinding Group, and Subject 3 represented the Rail Borne Group.

Table 1. Results of Personal Monitoring

Subjects	Subject 1	Subject 2	Subject 3
Working Area	Track Vehicle Storage Building	Track Network Maintenance Hall	Track Vehicle Storage Building
Sampling Duration	9 hours	9 hours	9 hours
$Dose_{Te}(\%)$	103.1	93.5	93.2
L_{eqTe}, *dB(A)*	84.0	93.4	100.6
$L_{EX,8h}$, *dB(A)*	84.0	93.4	100.6
Max Level, *dB(A)*	120.2	119.2	117.3
Peak Level, *dB(C)*	152.4	148.8	150.0

Subject 1 was monitored while performing maintenance activity and installing the Switch Machine Box onto the mainline track in the depot. Meanwhile, subject 2 task is blowing air activity and preventive maintenance on Rail Grinding Unit (RGU) vehicle

while Subject 3 performed preventive maintenance on the railborne vehicle in TVSB Hall.

Overall, the daily exposure limit for subject 1 was 84 dB(A) which is below the noise exposure limit as per specified under OSH (Noise Exposure) Regulations 2019. However, subjects 2 and 3 daily noise exposure levels are 93.4 dB(A) and 100.6 dB(A), respectively, while performing their task.

Subject 1 did not exceed a high noise exposure level due to the tasks involved in the basic installation switch machine box at the mainline track. This task does not involve high-level noise-generation machines in the workplace. For subject 2, the technician was exposed above the noise exposure limit due to the air pressure from air blowing gun while blowing air to clean the RGU vehicles from dust and impurities. The activities would stop until all the dust and impurities were cleaned from the RGU vehicle, and it typically took 45 to 60 minutes to complete. The noise was observed to be produced by the high pressure of air flowing from the gun nozzles with high velocity at the air gun tip. Previous research has shown that the noise generated by the air acceleration varies from near zero velocity in the reservoir to peak velocity at the nozzle's exit. Furthermore, the typical sound pressure level at 1 meter from a blow-off nozzle can reach up to 105 dB(A) [8]. After cleaning, the technician continued to perform preventive maintenance on the RGU vehicle while the engine was switched on. During the noise survey, the noise generated reached approximately 85 dB(A) at 5 meters and 82 dB(A) at 7.5 meters, respectively. Therefore, proper personal hearing protectors must be used to perform these tasks.

For Subject 3, the technician was exposed to excessive noise due to the noise emitted from the rail-borne vehicle's engine while conducting preventive maintenance activities. This scenario was similar to subject 2 but riskier because the work involves various types of vehicles to perform preventive maintenance, compared to subject 2, which focuses on RGU vehicles only. In addition, preventive maintenance was performed inside the maintenance hall which may increase the value of noise exposure especially when two or more types of engines were switched on. Overall, for the value of maximum sound pressure level of 115 dB(A) and maximum peak level of 140 dB(C), as shown in Table 1, all subjects were exposed and exceeded the permissible limit during the assessments. However, all these values were recorded in a short time, less than 1 minute when performing their tasks. Hence, the noise was assumed to be emitted due to the uncertainty sources such as false contributions for instance from wind or suddenly knocking on the microphone with cloth or body parts. In conclusion, subjects 2 and 3 were exposed to noise exposure limit noise compared to subject 1, and further actions were suggested for noise reduction.

3.3 Noise Reduction

Personal Hearing Protectors (PHP).

Personal Hearing Protectors will be the last option for noise control when engineering and administrative control measures do not reduce the exposure to noise below the Noise Exposure Limit (NEL) specified in the Occupational Safety and Health (Noise

Exposure) Regulations 2019. As the results of personal monitoring show that the technicians were exposed to noise exceeded the noise exposure limit of 85dB(A); hence the Noise Reduction Rating (NRR) (ICOP, 2019) was determined to obtain the estimated noise exposure after wearing the PHP. Table 2 shows the Personal Noise Exposure Monitoring Result after using Personal Protection Protectors.

Table 2. Personal Noise Exposure Monitoring Result after Using Personal Protection Protectors

Subjects		Subject 1	Subject 2	Subject 3
Working Area		Track Vehicle Storage Building	Track Network Maintenance Hall	Track Vehicle Storage Building
Job Category		Switch Machine Group Technician	Rail Grinding Group Technician	Rail Borne Group Technician
Exposure Level without PHP, dB		84.0	93.4	100.6
NRR		9	10	9
Attenuation Level, dB		84.0	93.4	100.6
With PHP	Exposure Level, dB	75	83.4	91.6
	Exceed NEL?	NO	NO	YES

Based on Table 2, the Noise Reduction Rating (NRR) for subjects 1 and 2 was reduced after wearing PHP and the noise exposure value was below the noise exposure limit of 85dB(A). Meanwhile, subject 3 still received a high level of noise exposure after wearing the PHP. Thus it is recommended to use dual hearing protection with combinations of minimum NRR=29 earplugs and NRR=27 earmuffs to reduce the noise below the daily noise exposure level of 85 dB(A). The new estimated exposure, dB(A) after wearing dual protection is 84.6 dB(A) as shown in the calculation by using the formula below:

$$L_{EX,8h}(dB(A)) - \left[\frac{NRR_h - 7}{2} + 5\right] \quad (1)$$

$$100.6\ dB(A) - \left[\frac{29-7}{2} + 5\right] \quad (2)$$

$$84.6\ dB(A) \quad (3)$$

4 Conclusion

In conclusion, the Personal Monitoring from Noise Risk Assessment was conducted to measure the level of daily noise exposure among maintenance technicians in the excessive generation area. From the results, two out of three subjects were exposed to exceed the noise exposure limit corrected to 8 hours working duration. Finally, all the data were analyzed and discussed according to the previous research and the Industrial Code of Practice (ICOP) provided by DOSH Malaysia. At the end of this study, suggestions were made to the company in order to reduce noise exposure to the worker, especially the hearing protection control. Finally, this study has strengthened the understanding of the importance of noise exposure to workers in the workplace.

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