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RESEARCH ARTICLE
Property Protection and Security

Evaluation of Noise and Vibration Levels in Mining Activities in Terms of Occupational Health and Safety: A Sample Application

Madencilik Faaliyetlerinde Gürültü ve Titreşim Seviyelerinin İş Sağlığı ve Güvenliği Açısından Değerlendirilmesi: Örnek Bir Uygulama

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ABSTRACT

Noise and vibration are two important risk factors affecting the health and safety of workers. Noise is any sound that occurs irregularly and is unwanted. Noise is one of the elements that employees are most frequently exposed to in the workplace. Vibration is a term that refers to the situation that occurs as a result of oscillation around the equilibrium point. Vibration, like noise, is a serious risk factor for workers. Noise and vibration can often occur together and protective and preventive measures may need to be addressed in an integrated manner. At this point, various forms of protective and preventive measures (technical, substitution, administrative, etc.) can be taken to provide a healthier and safer working environment for employees. Since noise and vibration pose a risk to workers in almost many sectors, there may be some differences in the measures to be taken. Mining is one of these sectors. The fact that the mining sector is one of the very dangerous business lines and that mass deaths have occurred as a result of occupational accidents from past to present has been the determining factor in the research subject of the study. The study measured the noise and vibration exposure levels of employees in an underground mining operation. Cesva/DC112 device was used for noise measurement and Cesva VC 431 device was used for vibration measurement. In the noise measurement results, it was determined that only 1 point was 91.6 dB(A) above the limit values specified in the legislation, while the vibration measurement results were below the limit values specified in the legislation. As a result of the study, noise and vibration results were discussed within the scope of national and international regulations and some recommendations were made for protective and preventive measures.

Keywords: Vibration, Noise İntensity, Noise-Vibration Occupational Health and Safety Dimension

ÖZET

Gürültü ve titreşim, çalışanların sağlık ve güvenliğini etkileyen iki önemli risk faktörüdür. Gürültü, düzensiz olarak ortaya çıkan ve istenmeyen her türlü sestir. Gürültü, çalışanların işyerinde en sık maruz kaldığı unsurlardan biridir. Titreşim ise denge noktası etrafında salınım sonucu ortaya çıkan durumu ifade eden bir terimdir. Titreşim de gürültü gibi çalışanlar için ciddi bir risk faktörüdür. Gürültü ve titreşim çoğu zaman birlikte ortaya çıkabilir ve koruyucu ve önleyici tedbirlerin entegre bir şekilde ele alınması gerekebilir. Bu noktada, çalışanlara daha sağlıklı ve güvenli bir çalışma ortamı sağlamak için çeşitli koruyucu ve önleyici tedbirler (teknik, ikame, idari vb.) alınabilir. Gürültü ve titreşim hemen hemen birçok sektörde çalışanlar için risk oluşturduğundan alınacak önlemlerde bazı farklılıklar olabilmektedir. Madencilik de bu sektörlerden biridir. Madencilik sektörünün çok tehlikeli iş kollarından biri olması ve geçmişten günümüze iş kazaları sonucu toplu ölümlerin yaşanmış olması çalışmanın araştırma konusunun belirlenmesinde belirleyici etken olmuştur. Çalışmada bir yeraltı maden işletmesinde çalışanların gürültü ve titreşime maruz kalma düzeyleri ölçülmüştür. Gürültü ölçümü için Cesva/DC112 cihazı, titreşim ölçümü için ise Cesva VC 431 cihazı kullanılmıştır. Yapılan gürültü ölçüm sonuçlarında yalnızca 1 noktanın mevzuatta belirtilen sınır değerlerinin üzerinde 91,6 dB(A) olduğu tespit edilirken, titreşim ölçüm sonuçlarının mevzuatta belirtilen sınır değerlerin altında olduğu görülmüştür. Çalışma sonucunda gürültü ve titreşim sonuçları ulusal ve uluslararası düzenlemeler kapsamında ele alınmış ve koruyucu-önleyici tedbirlere yönelik bir takım tavsiyelerde bulunulmuştur.

Anahtar Kelimeler: Titreşim, Gürültü Yoğunluğu, Gürültü-Titreşim İş Sağlığı Ve Güvenliği

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INTRODUCTION

In 2012, occupational health and safety has become even more important with the Occupational Health and Safety Law No. 6331 and the many regulations issued with it. With the law, the duties, authorities and responsibilities of the employee and the employer are clearly stated. Within the scope of the law, the powers and responsibilities of the employee and the employer are clearly specified and the necessary punitive sanctions are also included. The employer / employer's representative is obliged to take all kinds of measures regarding the health and safety of the

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employees employed and to follow up. The employee is obliged to comply with the instructions prepared by the employer. Workplaces are places with a dynamic structure. It can contain many risks. For noise, the Regulation on the Protection of Employees from Noise-Related Risks sets the lower exposure action value as 80 dB (C), the upper exposure action value as 85 dB and the exposure limit values as 87 dB (A) (The Minimum Health and Safety Requirements Regarding The Exposure Of Workers To The Risks Arising From Physical Agents (Noise)(2003/10/EC)). When determining the exposure limit values of employees, the protective effect of the personal protective equipment used by the employees is also taken into account. However, the effect of hearing protectors is not taken into account in exposure action values. Daily exposure levels may vary during the day. For this reason, weekly, not daily, exposure levels can be used in the measurement of exposure limit values and daily exposure action values. Adequate noise exposure measurement level should not exceed 87dB(A) exposure limit values. Vibration is regulated by the Regulation on the Protection of Workers from Risks Related to Vibration. This regulation aims to protect employees against health and safety risks that may arise as a result of exposure to mechanical vibration. The whole body vibration mentioned in the regulation refers to mechanical vibration that causes discomfort and trauma to the spine, especially in the lumbar region, which poses a risk to the safety and health of the employee when transferred to the whole body. Hand arm vibration refers to mechanical vibration that, when transferred to the hand and arm, poses a risk to the safety and health of the employee, especially causing vascular, nerve, joint, bone and muscle disorders. For hand-arm vibration; Daily exposure limit value for an eight-hour working period: 5 m/s^2.Daily exposure action value for an eight-hour working period: 2.5 m/s^2. For whole body vibration; Daily exposure limit value for an eight-hour working period: 1.15 m/s^2. Daily exposure action value for an eight-hour working period: 0.5 m/s^2 ("The Minimum Health And Safety Requirements Regarding The Exposure Of Workers To The Risks Arising From Physical Agents (Vibration) (2002/44/EC)). There are many studies in the literature where noise and vibration are considered together and separately. Ediz et al. (2002) investigated the noise problem in mining and noise-induced hearing loss. Şahin (2003) made a sample application study on noise control methods. Seidel et al. (2005) conducted a study on health problems occurring in workers exposed to whole body vibration. Tuna (2005) conducted a study on noise in the industrial sector. Nyantumbu et al. (2007) conducted a study on the hand-arm vibration syndrome of mine workers in South Africa and the prevalence of issues that cause this effect. Karakuş (2010) investigated the directional variation of vibrations caused by blasting. Laçiner (2014) investigated the protection of employees from noise-related risks in occupational health and safety law. Xu et al. (2017) investigated the health problems (carpal tunnel, numbness in hands, etc.) occurring in workers exposed to hand-arm vibration in North China Coal mine. Duran et al. (2018) conducted a study on the frequency-noise relationship of mining machines. Arıtan and Tümer (2019) investigated the whole body vibration exposure of excavator operators in natural stone quarries. Keskin (2019) examined the determination of noise intensity in the working environment and its effects on employees within the scope of backhoe-loader construction machinery. Fidan et al. (2020) conducted a study on the noise levels of machines used in timber industry services. Keskin (2020) comparatively examined the effects of noise intensity on employees in a chromium enrichment plant. Erol (2022) investigated the noise and vibration exposures of underground coal mining machinery operators. Nalbant et al. (2022) investigated the noise intensity in underground mining. Kahraman (2022) investigated the effects of step blasting in Adana Cement Çaldağ raw material.

This study was conducted to evaluate noise and vibration exposure levels in terms of employee health and safety. An underground mining operation was selected as the application area. The determinants of the study are that underground mines are restricted areas, they contain multiple risks together, some risks occur in an integrated manner and risks have a collective effect on workers.

NOISE AND VIBRATION

Noise and vibration are two important factors that pose problems in underground mining activities. Considering the impact levels of these elements, they have a negative impact on both the environment and the worker (Aydın, et al. 2013; Roy et al., 2016). There is no difference between noise, noise and sound as a physical concept. Noise usually occurs artificially. It is unwanted sounds whose quality and quantity are distorted. Noise is a personalized concept. Sound is an objective concept that does not vary depending on the person (Davıs, 1937). Noise in workplaces can be continuous, instantaneous or variable depending on time. Continuous noise is noise that remains constant over a certain period of time. Noise occurring in production processes can be intermittent and variable (Environmental Protection Agency, 1976). Noise affects worker health depending on the frequency and loudness of the sound. The frequency of sound is measured in units of Hertz (Hz) and the loudness of sound is measured in units of Decibels (dB). Sound heights are divided into A, B and C types. But type A is used in measurements. In this respect, when measuring the loudness of the sound, it should be checked whether it is measured in decibel A type and whether the measuring device is suitable for this. Briefly, Decibel A is shown as 'dB(A)'. The effect of noise on human health can be handled in two ways. These are effects other than hearing and effects on hearing. Auditory effects of noise:

The human ear can only perceive sounds between 16 hertz and 15 kilohertz. Noise-induced hearing loss is highly specific, with the first step being difficulty hearing sounds between 3000-6000 hertz. At 4000 hertz, there is an acoustic notch and acoustic dish. Workers suffer temporary hearing loss as a result of short-term exposure to high-frequency sounds (usually after 24 hours). If workers continue to work in a noisy environment, they may experience permanent deafness to sounds between 4000-6000 Hertz. The non-auditory effects of noise are so numerous that they can destroy people's quality of life. For example, employees exposed to noise may experience communication problems due to a decrease in verbal communication, which causes unrest among employees. Noise can cause distraction in employees and trigger the occurrence of accidents. Noise can increase the danger rate by blocking the warning systems of the danger that may arise. It causes a decrease in electrical resistance in the skin. It can cause uncontrolled movement of the eyeball and nystagmus (Tuna, 2005). Since the human ear is more sensitive to mid-frequency sounds than to high and low frequency sounds, the effect of this frequency range is much greater. Temporary hearing loss can turn into permanent hearing loss after 1-2 years in a noisy environment (Sharland, 1972). Protective devices used in personal protection can reduce the noise level up to 50 dBA at high frequencies and 30 dBA at low frequencies, and polyurethane plugs placed in the external auditory canal can reduce it up to 40 dBA at high frequencies and 25 dBA at low frequencies (Güler and Çobanoğlu, 1994). If an employee works in a noisy environment for at least two years and at least 30 days in workplaces with noise intensity above 85 decibels continuously, it is considered within the scope of hearing loss or occupational disease. In the diagnosis of occupational diseases, bilateral equal audiograms should be performed (Tuna, 2005).

According to the Regulation on Occupational Health and Safety in Mining Workplaces; in order to protect employees from the harmful effects of noise, vibration and dust, the provisions of the Regulation on the Protection of Employees from Risks Related to Noise published in the Official Gazette dated 28/07/2013 and numbered 28721 and the Regulation on the Protection of Employees from Risks Related to Vibration published in the Official Gazette dated 22/08/2013 and numbered 28743 are taken into consideration. According to this regulation; exposure limit values and exposure action values are determined as follows; for hand-arm vibration, the daily exposure limit value for eight hours of working time is 5 m/sec^2 exposure action value is 2.5 m/sec^2. For whole body vibration, the daily exposure limit value for an eight-hour working period is 1.15 m/sec^2 while the exposure action value is 0.5 m/sec^2. Vibration is defined as the oscillatory movement of an object as a result of the effect of external or internal forces. Vibration is transmitted to the human body through contact points. These points can be the surface of the machine, the part held or the seat of the machine. Vibration exposure occurs in two ways in workers. The first of these is hand-arm vibration as a result of work done by holding or touching, and the second is whole body vibration when sitting or sitting on motorized machines (Zeyrek, 2009). Hand-arm vibration exposure can be caused by energy-powered machinery and equipment used in many sectors such as mining, agriculture, manufacturing, construction and forestry. More than 0.5 million people in the UK, 150.000 in the Netherlands and 150 million in the US are reported to be exposed to hand-arm vibration.

In Europe and America, it is estimated that between 1.7% and 3.6% of workers are exposed to potentially harmful levels of vibration (hand-arm vibration guide.pdf (csgb.gov.tr). Workers' whole body vibrations are usually in areas such as forestry, mining (quarries), construction, agriculture. Trucks used in transportation, some helicopters and some speed engines can also be included in the risk group. Whole body vibration exposure is not limited to drivers, but can also be seen in people who use concrete crushing machines while standing. The level of vibration is assessed by the points at which the vibration enters the body. For example, it may vary during the performance of a job or the use of a vehicle. At this point, the condition of the vehicle or machine used and the type of work performed may affect the vibration value. The employer must take the necessary protective and preventive measures in case the exposure action or limit values specified in the regulation are exceeded. If the use of any work or tool, the duration of work and the value of the vibration magnitude are known, the daily vibration exposure of workers can be calculated. This magnitude can be provided by vibration measurement, use of other data sources, vibration emission data provided by the manufacturer. If necessary precautions are not taken as a result of vibration exposure; epidemiological disorders, low back pain, back, shoulder and neck disorders, carpal tunnel, hand-arm vibration syndrome may occur (butunvucuttitresimrehberi.pdf (csgb.gov.tr)).

According to the International Labour Organization (ILO) Convention C148-Working Environment (Air Pollution, Noise and Vibration) Convention 1977 (No.148), the following points are mentioned within the scope of protective and preventive measures for noise, vibration and air pollution; authorized persons shall determine criteria for risks such as noise, air pollution and vibration in the working environment and determine exposure limit values based on these criteria. In determining the criteria and setting exposure limit values, the employer shall take into account the views and recommendations of experts identified by the representatives. In case of any increase in the criteria and exposure limit values, the regulations are revised within the scope of national or international standards. In the ILO Recommendation R156-Working Environment (Air Pollution, Noise and Vibration) Recommendation 1977

(No.156), the Working Environment (Vibration, Noise and Air Quality) Convention 1977 (No.156) and this Recommendation include a number of suggestions for taking similar measures (https://www.ilo.org/).

MATERIALS AND METHODS

In this study, vibration and noise exposure levels of workers in an underground mining operation were measured. Cesva/DC112 device was used for noise measurement. Task-based personal noise exposure measurement was performed at 3 different points; underground bucket (operator), truck, loder bucket (operator) were selected. The measurement start time was 15 minutes for a 7-hour exposure. Care was taken to ensure that the measurement areas were the areas where workers were most affected by noise. In determining the measurement points, factors such as meteorological factors (wind, temperature, etc.) and propagation environment (airborne transmission, waterborne transmission or building element) that will affect the propagation of sound were also taken into consideration. Device verifications were performed before and after the measurement. The data obtained as a result of the verification did not deviate more than (± 0.5) dB from the standard value and were suitable for measurement. According to TS EN ISO 9612 standard, it is recommended to keep the microphone at a distance of 1.55 m ± 0.075 m above the floor where standing workers stand, on the ear side where the microphone is most exposed to the employee and at a distance of 0.1 m and 0.4 m from the external ear canal entrance, and if the nature of the work does not allow the specified distances, it is recommended to wear it on the employee's clothing (Keskin, 2019). Cesva/VC431 model device was used for vibration measurement. Task-based personal exposure measurements were performed on underground bucket operator, truck and jumbo drill machines. The measurement transducer was determined as the hip parts. The measurement start time was 15 minutes for a 7-hour exposure on three different machines. Care was taken to ensure that the measurement areas were the areas where workers were most affected by vibration. Another measurement process is hand-arm vibration exposure and the transducer for underground bucket and underground Jumbo drill was determined as the palm of the right hand. During the 7-hour exposure period, 15 minutes of measurement was made. The measurement results and measurement times and measurement locations are given in Tables by correlating them with the operating conditions during the measurement.

FINDINGS

In this study, noise and vibration levels to which mine workers are exposed were measured. During the measurement process, the most frequently exposed situations and the most affected points were determined by taking the opinions of the employees. Measurements were also made taking into account these opinions and suggestions. In the tables below, the numerical values used in the study and which should be taken into account in the measurement processes are given. Table 1 includes the information required for personal exposure measurement.

Table 1: Information required for personal noise exposure measurement

Information on Task-Based Personal Noise Exposure Measurement								
No	**Measurement Date**	**Measurement Department/Work Performed**	**Measurement Time (min.)**	**Exposure Time (hours)**	**Temperature (C°)**	**Moisture (%)**	**Pressure (kPa)**	**Air Flow Velocity (m/sn)**
1	17.06.2023	Underground digger Operator	15	7	17	56	960	0.1
2	17.06.2023	Truck Operator	15	7	17	56	960	0.1
3	17.06.2023	Loder bucket Operator	15	7	19	61	960	0.1

Table 2 shows the results of personal noise exposure measurements. According to the measurement result for the 1st operator, the (Lex, 8h) dB(A) value was 91.6, while the Ppeak dB(C) value was 119.7. Considering the Regulation on the Protection of Workers from Noise-Related Risks; the lowest exposure action value (Lex, 8h) is 80 dB (80), the highest exposure action value (Lex, 8h) is 85 dB(A) or Ppeak 137 dB(C), the exposure limit value (Lex, 8h) is 87 dB(A) or 140 dB(C). When the measurement results at three different points were compared, it was seen that only the value measured at point 1 was 91.6, which is above the limit values specified in the legislation. The measurement results at the other points were below the limit values specified in the legislation.

Table 2: Personal Noise Exposure Measurement Results

Task-based Personal Noise Exposure Measurement Results									
No	**Mission**	**Conclusion ($L_{ex, 8h}$) dB (A)**	**P_{peak} dB(C)**	***Lower Exposure Action Value**		*** Upper Exposure Action Value**		***Exposure Limit Value**	
				($L_{ex, 8h}$) dB (A)	P_{peak} dB(C)	($L_{ex, 8h}$) dB (A)	P_{peak} dB(C)	($L_{ex, 8h}$) dB (A)	P_{peak} dB(C)
1	**Operator**	91.6	119.7	80	135	85	137	87	140
2	**Operator**	78.5	119.6	80	135	85	137	87	140
3	**Operator**	78.4	127.1	80	135	85	137	87	140

Information about hand-arm vibration exposure measurement is given in Table 3. Cesva/DC112 device was used for noise measurement. Hand-arm vibration exposure measurement; Measurement number 1 was made on 17.06.2023 on a bucket (construction machine). The transducer location was the right palm and 15 minutes of measurement was made within 7 hours of exposure. Measurement number 2 was made on 17.06.2023 on the underground Jumbo machine. The transducer location is on the right hand palm and 15 minutes of measurement was made within 7 hours of exposure. The measurement at point no. 1 was made in the palm of the right hand of the employee working on the loder work machine and the exposure limit value was found to be 0.39 m/sec^2. At point 2, the measurement was made in the palm of the right hand of the employee in the Jumbo work machine and the exposure limit value was found to be 0.38 m/sn^2. According to the Regulation on the Protection of Employees from Risks Related to Vibration, the daily exposure limit value for hand-arm vibration for eight hours of working time is 5 m/sec^2 and the exposure action value is 2.5 m/sec^2. According to these results, hand-arm vibration values were found to be below the exposure limit values.

Table 3: Information about hand-arm vibration

Information on Hand-Arm Vibration Exposure Measurement							
No	**Measured Section**	**Work Done**	**Transuder Location**	**Vibration Levels (m/sec^2)**			**Result A(8) m/sec^2**
				X	**Y**	**Z**	
1	Loder Bucket	Bucket Operator	Right hand palm	0.391420	0.333064	0.438179	**0.39 m/sn^2**
2	Underground Jumbo	Grab Operator	Right hand palm	0.5525483	0.426261	0.191938	**0.38 m/sn^2**
Daily exposure limit value for an eight-hour working period A (8) m/sec^2							**5 m/sn^2**

In Table 4, whole body vibration exposure measurements were made at three different points. Accordingly, the 1st measurement was made on 17.06.2023 on a backhoe (construction machine). The transducer point was determined as below the hip. The measurement was made for 15 minutes within a 7-hour exposure period. Measurement no. 2 was made on the same date in a truck. The transducer point was below the buttocks. The measurement was made for 15 minutes within a 7-hour exposure period. Measurement 3 was made on the same date on a Jumbo machine. The transducer point was below the buttocks. The measurement was made for 15 minutes within a 7-hour exposure period. According to the results of the measurement, the result of the measurement number 1 was 0.47, the result of the measurement number 2 was 0.70 and the result of the measurement number 3 was 0.13. The daily exposure limit value for an eight-hour working period is 1.15m/sec^2. Accordingly, it was determined that none of the values obtained as a result of the measurements made exceeded the exposure limit value, i.e. 1.15m/sec^2.

Table 4: Personal vibration exposure measurement results (for whole body)

No	**Work Done**	**Measured Section**	**Vibration Levels m/sec^2**			**Conclusion A (8) m/sn^2**
			X	Y	Z	
1	**Operator**	Loder Bucket	0.421056189	0.531008533	0.456074361	0.47 **m/sn^2**
2	**Operator**	Truck	0.955233906	0.608614249	0.541576844	0.70 **m/sn^2**
3	**Operator**	Underground Jumbo	0.138894064	0.120939721	0.139522662	0.13 **m/sn^2**
Daily exposure limit value for an eight-hour working period (A(8)) m/sn^2						**1.15 m/sn^2**

CONCLUSIONS AND RECOMMENDATIONS

This study was conducted in an underground mining operation located in the Eastern Black Sea Region. The results obtained from the study were evaluated within the scope of the Regulation on the Protection of Workers from Risks Related to Noise and the Regulation on the Protection of Workers from Risks Related to Vibration. Accordingly, when the results obtained from the noise measurement are taken into consideration; it was observed that the noise intensity of the measurement made at point 1 was 91.6 dB (A). This value was above the lowest exposure action value (Lex, 8h) 80 dB (80) and the highest exposure action value (Lex, 8h) 85 dB (A) considering the Regulation on the Protection of Workers from Noise-Related Risks. As a result of the measurements made at three different points, the noise exposure level at only one point was above the limit values specified in the legislation. Employees face many risks while they are in the workplace. Noise is one of these risks. Exposure levels become a serious risk factor (2 years) in the long term and if adequate safety measures are not taken. A healthier and safer environment can be created by implementing the following protective and preventive practices in noisy working environments.

- ✓ Increase the number of employees and shorten working hours,Sound and noise absorbing systems should be available
- ✓ Periodic maintenance and repair of machines should be carried out (schedules),
- ✓ Design insulated surfaces,
- ✓ Employees should be trained to combat noise,
- ✓ Periodic health examinations of employees should be carried out,
- ✓ Personal protective equipment should be provided and training given on its use.

The following results were obtained in the vibration measurement results of the study. According to the Regulation on the Protection of Employees from Vibration-Related Risks, the hand-arm vibration limit value is 5 m/s^2 No point obtained in the measurement was above this value. Accordingly, it can be said that this area is a safe area for hand-arm vibration. In the whole body vibration measurement values, it was determined that none of the results exceeded the exposure limit value of 1.15 s^2. Among the measurement results, only the Jumbo drill was close to the limit value. This machine is a machine that works by impacting the rock to make a hole during the drilling process. Therefore, people using (manual) drilling machines such as the Jumbo may need to take protective and preventive measures. Vibration is generally one of the most important problems that employees are exposed to in the workplace. Especially after the industrialization period (industrial revolutions), the increasing importance of machines in business life has increased the health and safety problems of employees due to noise and vibration. In some cases, risks may need to be addressed in an integrated manner. Against vibration and vibration-noise risks;

- ✓ Trainings should be provided to employees to inform them about the risks in vibrating environments,
- ✓ Maintenance and repair of machines should be done periodically,
- ✓ It should be ensured that the transportation, disassembly and assembly of the machines are carried out by experts and their controls (test processes) are carried out,
- ✓ Impact machines should be replaced with machines that can be controlled remotely instead of manually,
- ✓ The hand grip points of the machine or other vibrating tools used should be made of soft materials,
- ✓ It must be ensured that the ground structure on which the machines are placed is not rough, tilted or uneven in any way,
- ✓ In vibrating environments, the floor that employees come into contact with or the seat they sit on should be preferred to have a minimum level of impact,
- ✓ While increasing the number of employees, the exposure time of employees should be reduced,
- ✓ Employees should undergo periodic health checks,
- ✓ Personal protective equipment should be provided and training should be given on their use.

Developing technology has begun to necessitate the integration of systems used in the industrial industry and affecting production processes. In the near future, it will become inevitable that risks will emerge in much different ways. For this reason, it should be ensured that protective and preventive practices are compatible with developing and changing technology.

REFERENCEES

Erol, İ. (2022). Investigation of Noise and Vibration Exposures of Underground Coal Mining Machinery Operators. Çukurova University Journal of Engineering Faculty, 37(1),55-65 DOI: 10.21605/cukurovaumfd.1094945

Tuna, H. (2005). The Most Common Industrial Hazard: Noise. Labor and Society, 2 (5), 103-118. Retrieved from https://dergipark.org.tr/en/pub/ct/issue/71819/1155380

Laçiner, V. (2014). Protection of Employees from Noise-Related Risks in Occupational Health and Safety Law. Marmara University Faculty of Law Journal of Legal Research, 749-766. https://doi.org/10.33433/maruhad.607171

Ediz, İ. G., Beyhan, S., Akçakoca, H. & Sarı, E. (2002). Noise Problem in Mining and Hearing Losses Due to Noise. Journal of Science and Technology of Dumlupınar University, Journal of Dumlupınar University Institute of Science and Technology, 50-64. Retrieved from https://dergipark.org.tr/tr/pub/dpufbed/issue/36343/411227

Tekin, A., Nalbant, M. O., Orhan, M., Tekin, F., Suvaydan, F., Berki, K., Gümüş, S. & Savran, A. A. (2022). Investigation of Noise Intensity Occurring in Underground Mining. Soma Vocational School Technical Sciences Journal, 1 (33), 16-23. DOI: 10.47118/somatbd.1110492

Sahin, E. (2003). Noise Control Methods - An Application. Gazi University Journal of Engineering and Architecture Faculty, 18 (4), 0- . Retrieved from https://dergipark.org.tr/tr/pub/gazimmfd/issue/6658/89013

Kahraman, E. (2022). Investigation of Environmental Impacts of Step Blasting at Adana Cement Çaldağ Raw Material Site. Osmaniye Korkut Ata University Journal of Institute of Science and Technology, 5 (3), 1453-1467. DOI: 10.47495/okufbed.1089635

Karakuş, D. (2010). Investigation of Directional Variation of Vibration from Blasting. Dokuz Eylül University Faculty of Engineering Journal of Science and Engineering, 12 (2), 30-43. Retrieved from https://dergipark.org.tr/tr/pub/deumffmd/issue/40833/492695

Duran, Z., Erdem, B. & Doğan, T. (2018). Frequency-Noise Relationship of Mining Machinery. Selcuk University Journal of Engineering, Science and Technology, 6 (4), 737-752. DOI: 10.15317/Scitech.2018.164

Xu, X., Yuan, Z., Gong, M., He, L., Wang, R., Wang, J., Yang, Q., Wang, S. (2017). Occupational Hazards Survey Among Coal Workers Using Hand-held Vibrating Tools in a Northern China Coal Mine. International Journal of Industrial Ergonomics, 62, 21-26.

Seidel. H. (2005). On the Relationship Between Whole-body Vibration Exposure and Spinal Health Risk. Industrial Health, 43, 361-377.

Nyantumbu, B., Barber, C.M., Ross, M., Curran, A.D., Fishwick, D., Dias, B., Kgalamono, S., Phillips, J.I. (2007). Hand-arm Vibration Syndrome in South African Gold Miners. Occupational Medicine, 57(1), 25–29.

Fidan, M.S., Yasar, S.S., Komut, O., Yasar, M. (2020). A study on noise levels of machinery used in lumber industry enterprises. Wood Res, 65, 785–796. [CrossRef]

Davıs A. H. (1937). Noise. Publisher: Watts & Co, 1 St Edition, pp.25-36, London.

United States, Washington: Environmental Protection Agency, Office of Noise Abatement and Control, About Sound, Sayfa: 23-36 U.S.,1976.

Sharland, I. (1972). Fläkt Woods Practical Guide to Noise Control, Fläkt Woods Ltd., Colchester, England.

Güler, Ç., Çobanoğlu, Z. (1994). Noise, Environmental Health Basic Resource Series No. 19, T.C. Ministry of Health General Coordinatorship of Health Project, T.C. Ministry of Health General Directorate of Basic Health Services, ISBN 975-7572-44-6, Ankara.

Aydin, G., Karakurt, I., Aydiner, K. (2013). Wear Performance of Sawblades in Processing of Granitic Rocks and Development of Models for Wear Estimation. Rock Mechanics and Rock Engineering, 46(6), 1559-1575.

Roy, M.P., Singh, P.K., Sarim, M., Shekhawat, L.S. (2016). Blast Design and Vibration Control at an Underground Metal Mine for the Safety of Surface Structures. International Journal of Rock Mechanics and Mining Sciences, 83, 107- 115.

Zeyrek, S. (2009). Vibration. Occupational Health and Safety, Specialization Thesis, Ministry of Labor and Social Security, General Directorate of Occupational Health and Safety, Ankara

Keskin, M.O. (2020). Comparative Investigation of the Effects of Noise Intensity on Employees in Chromium Enrichment Plants. International Journal of Innovative Approaches in Science Research, 4(2), 35-51. doi: 10.29329/ijiasr.2020.259.2

Keskin, M.O. (2019). Determination of Noise Intensity in the Working Environment and Investigation of its Effects on Employees: Backhoe-Loader Work Machines. V International Congress on Natural and Health Science December 13-15, Proceedings Book, 283-291.

Arıtan, A. E. & Tümer, M. (2019). Investigation of Whole Body Vibration Exposure of Excavator Operators in Natural Stone Quarries. Selcuk University Journal of Engineering, Science and Technology, 7 (2), 321-330. DOI: 10.15317/Scitech.2019.202

ILO, R156- Working Environment (Air Pollution, Noise and Vibration) Recommendation, 1977 (No. 156). Access Address: R156- Working Environment (Air Pollution, Noise and Vibration) Recommendation, 1977 (No. 156) (ilo.org).

ILO, C148 -Working Environment (Air Pollution, Noise and Vibration) Convention, 1977 (No. 148). Access Adress: Convention C148- Working Environment (Air Pollution, Noise and Vibration) Convention, 1977 (No. 148) (ilo.org).

Regulation on the Protection of Workers from Risks Related to Vibration (August 22, 2013) Official Gazette No. 28743: 28743. Access Date: 15.05.2023.

Regulation on the Protection of Employees from Noise-Related Risks (July 28, 2013) Official Gazette No: 28721. Access Date: 15.05.2023.