

ERGONOMIC CONDITIONS ASSESSMENT OF A BUS FACTORY

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ARTICLE INFO	ABSTRACT
<p>Keywords Ergonomics Workforce Working Conditions Work Safety</p>	<p>Eventhough the production technology and capacity have been improved, manpower is indispensable. Coach production industry is one of the heavy industries. Production processes are mostly manpower in addition to automation and mechanization in these factories. Ergonomics is the one of the most important subject to increase the production efficiency and job security in heavy industry factories which use manpower heavily. Ergonomics is the field which aims to reduce the accidents and job related illnesses, anatomic problems in human body, psychological and physiological fatigue and minimize the workforce loss. Ergonomic statement evaluation is possible with providing ergonomic criteria such as anthrometric, environmental condition, and work place.</p> <p>In this study, some experimental studies are done in order to evaluate the ergonomical conditions in chassis frame production, cataphoresis, paint shop, assembly, and quality inspection processes. The experimental studies include static and dynamic anthrometric measurements on a choosen process and experimental subject workers. The environmental conditions namely, temperature, humudity, lightening, air quality, and noise level are periodicly measured with proper measuring devices and these data are recorded. The results are used to make an inference with comparing literature. Furthermore, inconvenient results are studied in order to determine the relation with work accidents, work related illnesses and total efficiency parameters in the factory. This study is considered to be a guidance for the effects of ergonomical conditions on workplace safety and health, work accidents and occurences, and production efficiency.</p>

INTRODUCTION

Human factor, which is one of the most important factors in industrial development, brought along various problems. One of the most important of these problems is human health. With the determination of the direct relationship between efficiency and human health, a discipline need has been determined that needs to be examined in detail. This need led to the formation of the science of ergonomics. While maintaining employee health, ergonomics also provides an increase in performance. It provides an increase in quality and productivity for businesses. In this study, ergonomic conditions in a bus production factory are analyzed and it is aimed to protect employee health and increase performance depending on the analysis results.

LITERATURE RESEARCH

Newman Lauand Henry Ma, who has presented approaches for work and performance analysis and has interpreted results based ergonomically, as a result of work, analysis methods and various approaches for ergonomic measurements in the design of workstations have been define.

Ashraf A. Shikdar and Naseem M. Sawaqed investigated occupational health problems in developing countries in their study. By examining the average injury rates, they found that the lack of ergonomic information and communication is due to poor ergonomic conditions. They found that the increase in poor ergonomic conditions also caused various health and safety problems.

People are often not resistant to climatic changes that can lead to changes in body temperatures. Working in heat emitting environments, where the climatic conditions are cold or in cold working environments generally affect work and employee productivity.

Noise can be defined as disturbing sound. It is possible to examine separately as indoor and outdoor noise. One of the most common problems seen in industrial enterprises is hearing loss caused by loud noise. Resulting from the loudness; it is observed that the distraction, motivation and work efficiency of employees decrease.

Vibration is defined as the motion of the objects systematically. Vibration from machinery and equipment generally used in production-oriented enterprises significantly affects employee productivity. The negative effects of vibration on people vary depending on vibration intensity, duration, direction and frequency. While low frequency vibrations do not have a major effect, vibrations usually between 1 and 100 herz create serious health problems. High frequency vertical vibrations cause various health problems such as headaches, balance disorders, numbness and tingling sensations in the fingertips, fatigue, neck, back, arms, chest pain.

In order to be protected from vibration related health problems, it is generally necessary to cover the handles of the hand tools with materials such as rubber and plastic, or to use protective gloves that reduce the exposure to vibration.

Today, one of the most important problems affecting employee health is dust and toxic substances caused by many substances from production. 70% of occupational diseases are caused by dust and toxic substances. Powders, largely respiratory function and allergic ailments; toxic substances cause many serious diseases that are carcinogenic and sometimes untreatable until early death.

As a result of various studies, it has been observed that the machine periods due to perception error are perceived as slow in environments with insufficient light and light vibrations. This effect, also called “stroboscopic effect”, is due to the fact that the lighting lamps used in the working environment are not correctly selected.

ERGONOMY

Define of Ergonomy

The word of ergonomy in ancient Greek, the word work is derived from ergon and the word law is derived from niomos.

Ergonomics is a science with a social and economic purpose. The science of ergonomics examines both the physical and psychological aspects of people, and also provides solutions for the technical and organizational domain.

History of Ergonomy

The history of ergonomy; It is based on research in ancient scientific fields such as psychological, physiological and engineering. In the literature, the word ergonomics was first used in Poland by Jastrzebowski, W. in 1857. The science of ergonomics emerged in the years of World War II when scientists began to design advanced systems and products. The designed systems and products were created without considering the users. It has been understood that human and environmental factors should also be taken into consideration in order to use the products safely and efficiently. With the determination of people's needs, the science of ergonomics started to develop.

Research of Environmental Conditions in Factory Environment

The study I have done at the factory on ambient conditions consists of respirable dust measurements, lighting measurements, noise measurements and vibration measurements.

METHODS

Respirable Dust Measurements

Respirable dust measurements were made at locations where dust density could be high at the factory. The measurement standard MDHS 14/3 has been adopted. Gravimetric Analysis was applied in the analysis. The air drawn was sampled at a suction rate of 2.21 / min for 120 minutes, and then filtered through a nylon cyclone. During the measurements, Gilian GilAir device was used.

Lighting Measurements

In lighting measurements, two different measurement values were calculated, day and night lighting. The standard COSHR / 928-1-IPG-039 was adopted. Measurements 4 measuring areas with a maximum distance of 3 meters between each measuring point were determined indoors. The measurements were started with reference to the point where the lighting source was located, and finished at the edges of the wall. In open area measurements, measurement points were determined as a straight line to indicate the level of illumination according to the length of the areas. 4 measuring points were determined on each measuring point, at least 3 meters between them. Measurements were started from the lowest point of illumination, and ended at the brightest point (under the lighting source). TS EN 12464-1 standards were accepted for indoor areas and TS EN 12464-2 standards for open areas. The limit values of the fields according to the standards are shown in Table 1. Testo 545 brand device was used in the measurements.

Table 1. TS EN 12464 Lighting Limit Values

Standard No.	Reference No.	Job Area or Activity Type	Limits (Lux)
TS EN 12464-1 (Indoor)	5.1.1	Traffic information, circulation areas and corridors inside the buildings	100
	5.1.4	Loading ramps & platforms	150
	5.2.2	Lounges	100
	5.2.4	Cloakrooms, Washbasins, Bathrooms, Toilets	200
	5.3.1	General areas inside buildings - Control rooms / Machine rooms, areas with control order	200
	5.4.1	Warehouses	100
	5.5.2	General areas inside buildings - Storage areas, Manned passageways.	150
	5.18.3	Industrial activities and crafts - Metal work and processing / Welding	300
	5.18.5	Industrial activities and crafts - Metal work and processing / Precision machining, grinding: tolerances <0,1mm	500
	5.18.11	Industrial activities and crafts - Metal work and processing / Rough Assembly	200
	5.24.2	Vehicle construction and repair / Painting; spraying room, polishing chamber	750
	5.24.3	Vehicle construction and repair / Painting; retouching, inspection	100
	5.24.6	Vehicle construction and repair / General vehicle services, repair and testing	300
TS EN 12464-2 (Outdoor)	5.1.1	Pedestrian walkways	5
	5.1.2	Traffic areas (up to 10km / h) for slow-moving vehicles such as bicycles, trucks and excavating machines	10
	5.1.3	Regular vehicle traffic (up to 40km/h)	20
	5.7.1	Short-term use of large units and rough materials, loading and unloading of goods without solid packaging	20
	5.9.1	Low traffic, such as parking spaces for shops, terraced houses and apartments, bicycle parking spaces	5

Noise Measurements

Noise measurements were made in areas where noise intensity could be the highest. Dosimeters were fixed at the ear level of the employees. TS 2607 ISO 1999 standard was adopted in the measurements. The limit value of the ear protectors used by the employees is 37dB. Measurements were made with Cirus CR: 110A doseBadge brand measuring device. The limit values taken into consideration when making measurements are shown in table 2.

Table 2. Limit values taken into consideration in noise measurements

	MSD (dBA)	EYMED (dBA)	EDMED (dBA)
Lex dB(A)	87	85	90
PTepe dB(C)	140	137	135

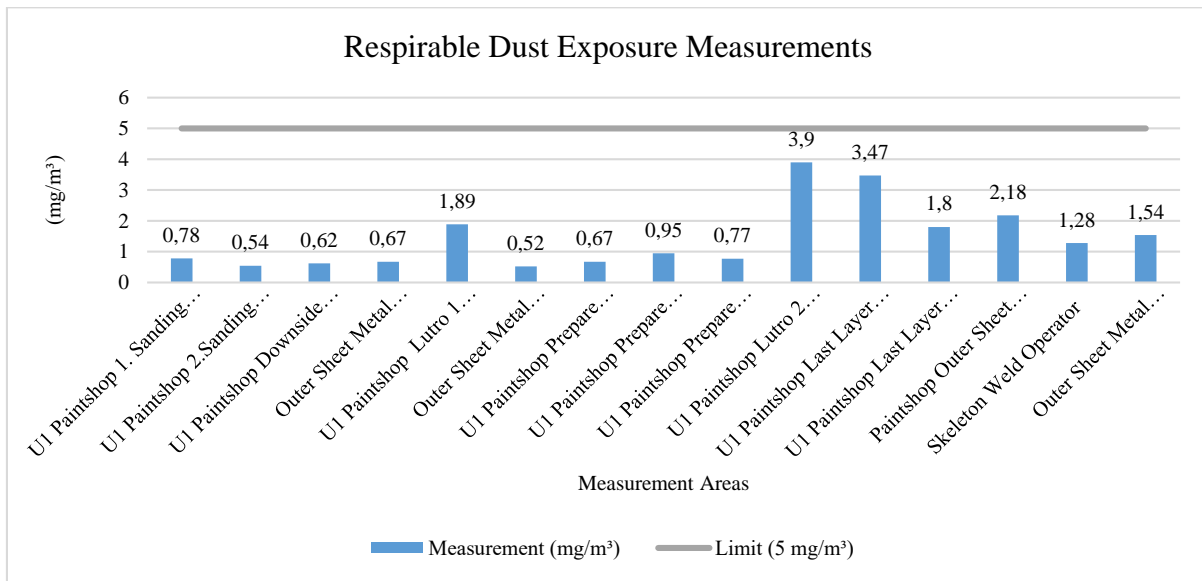
Vibration Exposure Measurements

Vibration exposure measurements were made to hand tool operators and forklift operators. Two different measurement methods ("Whole body vibration exposure" and "Hand-Arm Vibration exposure") were used. TS ISO 2631-1, TS EN 1032 + A1 for whole body vibration exposure, TS EN ISO 5349-1, TS EN ISO 5349-2 standards for Hand-Arm Vibration exposure. 3 consecutive measurements were made on 3 separate axes. Measurements were made with SVAN 958 device.

RESULTS

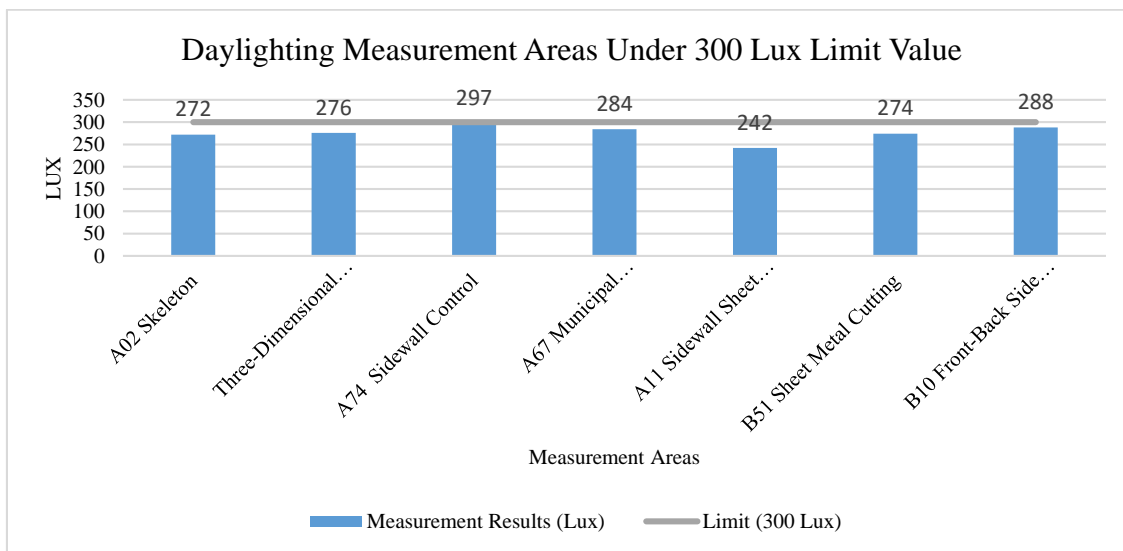
15 of the respirable dust measurements made on 15 employees remained below the legal limit of 5 mg / m³ in accordance with the Regulation on Fighting Dust. The measurement results are shown in figure 1.

Figure 1. Respirable Dust Exposure Measurements



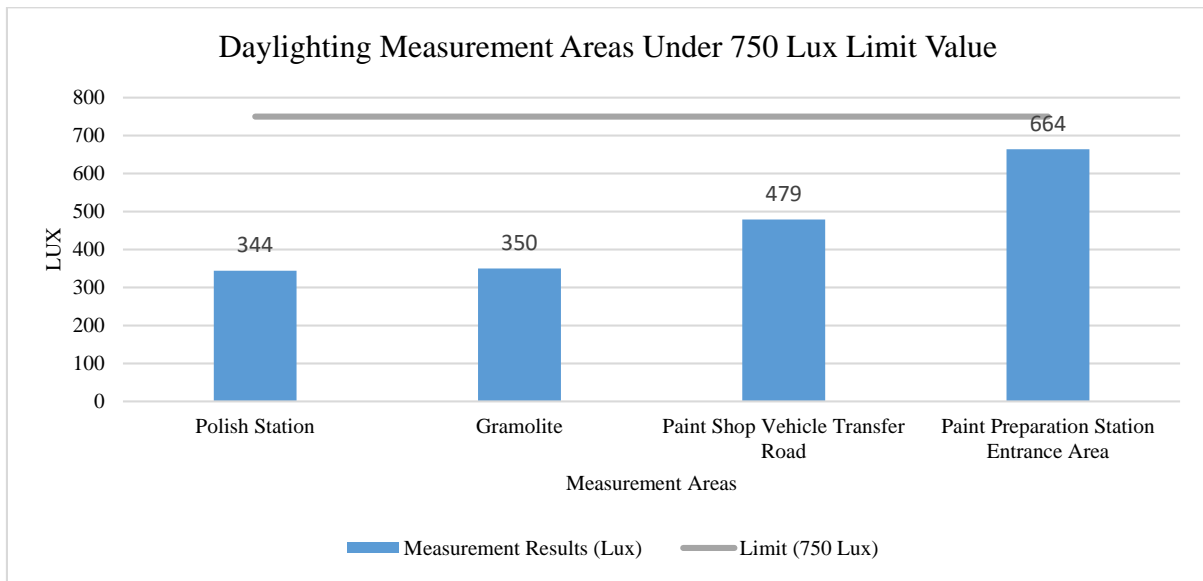
In daytime lighting measurements at 124 different points, illumination below the limit value was detected at 11 different points as shown in Figure 2 and Figure 3. Illumination under the limit value was determined in 8.87% of the measurement points in daytime lighting measurements.

Figure 2. Daylighting Measurement Areas Under 300 Lux Limit Value



(Skeleton, three-dimensional measurement, sidewall control, municipal sidewall mounting, sheet metal, sheet metal cutting point and front-back cover station) 7 points remained below the limit of 300 lux with a rate of 5.65%.

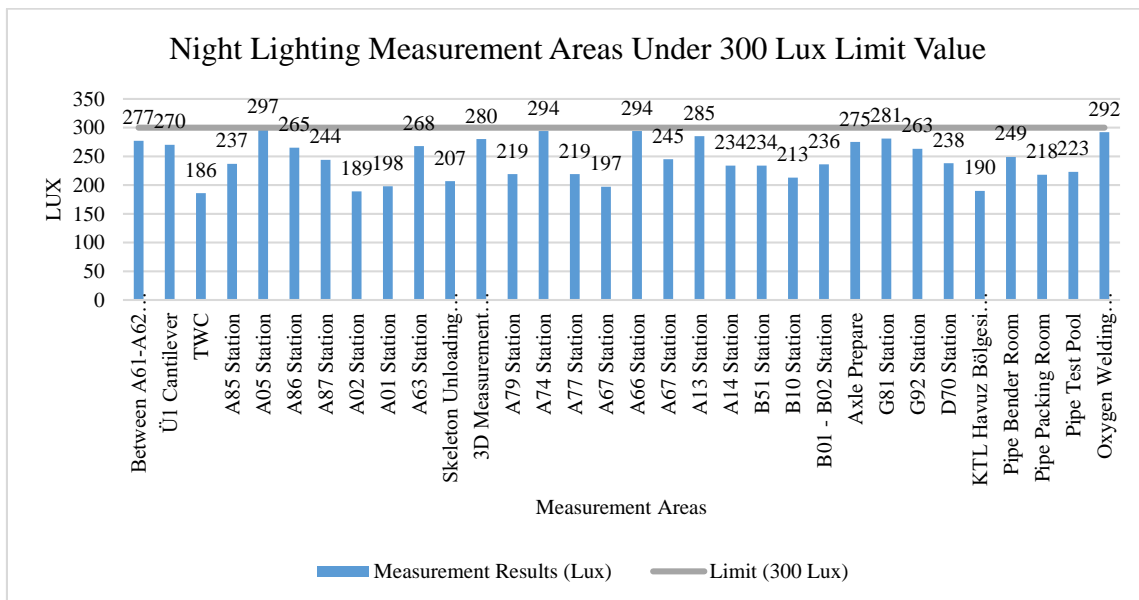
Figure 3. Daylighting Measurement Areas Under 750 Lux Limit Value



(Polish Station, Gramolite, Paint Shop Vehicle Transfer Road, Paint Preparation Station Entrance Area) 4 points remained below the limit of 750 lux with a rate of 3,23%.

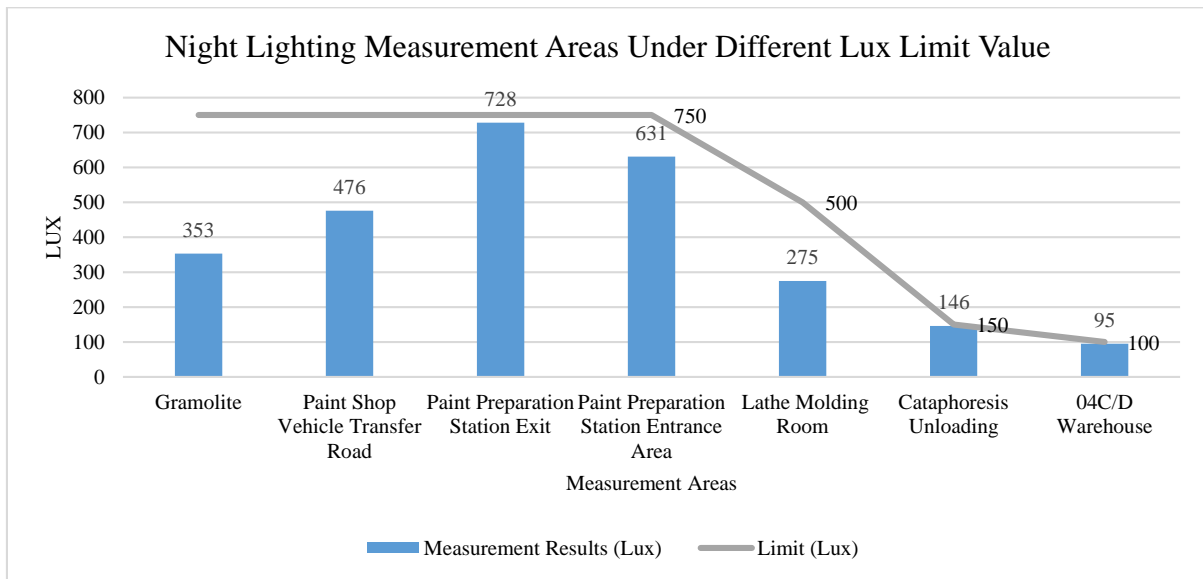
In night lighting measurements made at 140 different points, as shown in Figure 4 and Figure 5, illumination below the limit value was detected with a rate of 27.85% at 39 different points.

Figure 4. Night Lighting Measurement Areas Under 300 Lux Limit Value



In the lighting measurements made for night lighting, lighting was detected at 32 points of 140 points and at the limit of 300 lux with a rate of 22.86%.

Figure 5. Night Lighting Measurement Areas Under Different Lux Limit Value

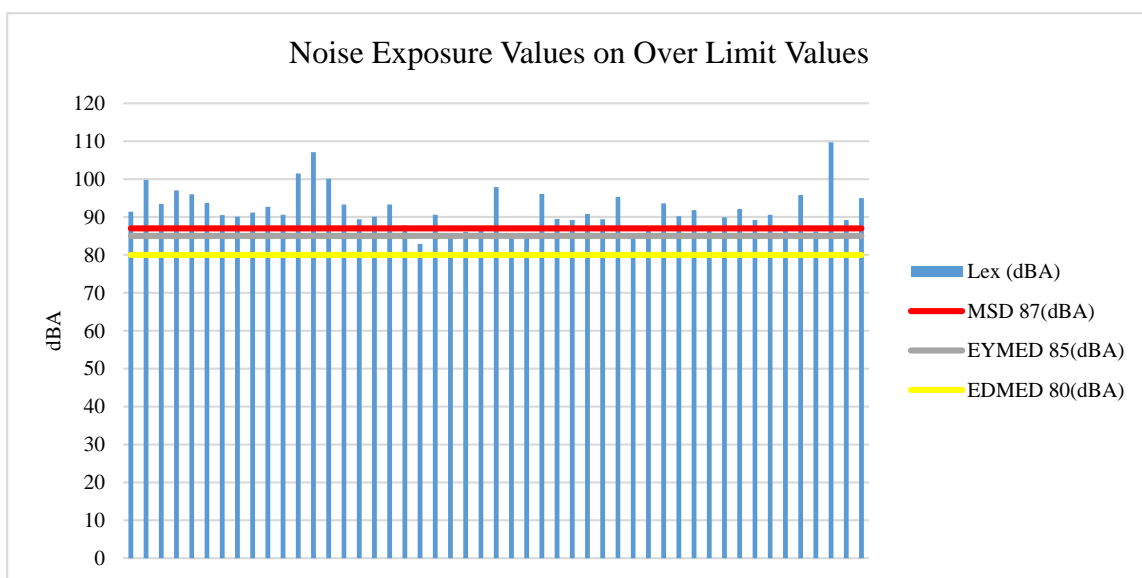


In the lighting measurements made for night lighting, lighting was detected at 7 points of 140 points, at points with different lux limit values with 5% ratio, under the limit value.

As a result of the studies, it has been determined that there are points that cannot be opened for natural lighting. It was decided to add additional lighting systems to the areas below the limit value in day and night lighting measurements.

Noise measurement results at 77 different points; shows that Figure 6 the 8-hour noise exposure values of 49 employees with a ratio of 63.64% are above the legal limit. MSD (87dBA), EYMED (85dBA) ve EMED(80dBA) standards taken into consideration.

Figure 6. Noise Exposure Values on Over Limit Values

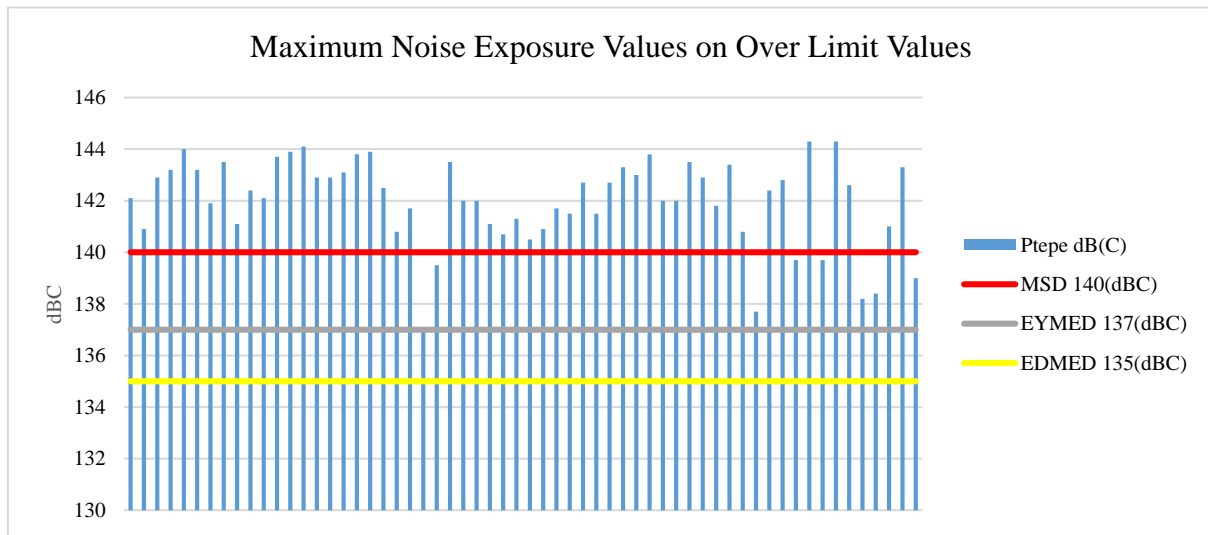


As
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result of the measurements at the same point in 77, the highest noise value where 60 employees

remained above the legal exposure limit values with a rate of 77.9% over an 8 hour period is shown in Figure 7. Measurements were evaluated considering MSD (140dBC), EYMED (137dBC) and EMED (135dBC) standards.

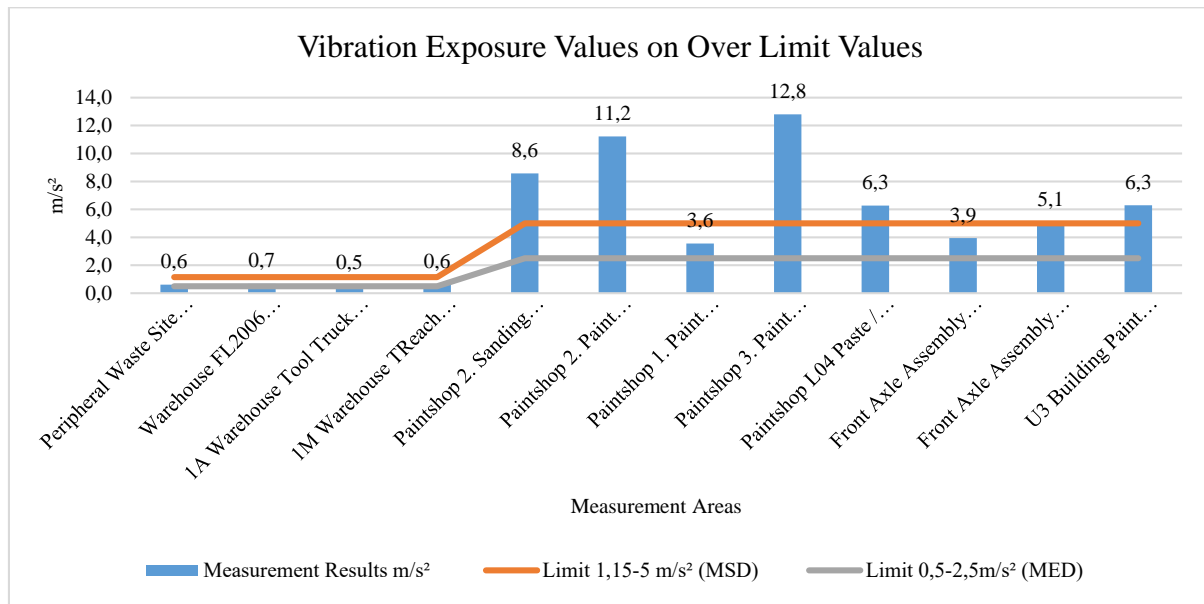
Figure 7. Maximum Noise Exposure Values on Over Limit Values



Ear-protective equipments are given to all personnel on first day of work and routine inspections are made. The personnel, who remain below the limit in the measurements, are also obliged to have their ear protective equipment with them. Necessary information was sent to the managers. Routine inspection frequency has been increased at these points of the factory.

In the vibration exposure measurements made on 29 employees consisting of forklift operators, air sanding operators, planing operators, jigsaws operators and pneumatic impact wrenchgun operators, vibration exposure above the limit value was detected in 14 employees with a ratio of 48.3% as seen in figure 8.

Figure 8. Vibration Exposure Values on Over Limit Values



4 of the 14 employees consist of forklift operators. Forklift operators make up 13.8% of the 29 personnel with a total measurement. Body vibration exposure measurements were made in these employees. 34% other 10 operators; Since there are operators using hand tools, hand-arm vibration exposure measurements were made.

The results were shared with the occupational safety unit and team leaders. A meeting was held on measures to be taken. According to the meeting's decision, it was decided to use anti-vibration gloves. With the condition that the employees will work at the same station, it was decided to work with one hand during the assembly of 1 vehicle, and then the rotation with the use of gloved hand tool during the installation of 1 vehicle. In this way, it is aimed to reduce the exposure during the 8-hour study. In order to reduce the exposure of forklift operators, working times were regulated. Accordingly, it was determined that extra forklift operator will be employed in 2020. Thus, it is aimed to reduce the 8-hour exposure times of forklift operators.

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Received 29 July 2020; Received in revised form 5 August 2020; Accepted 20 August 2020;

Available online 15 September 2020

doi: 10.46291/ICONTECHvol4iss2pp35-47

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