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Analysis of Noise Levels in the Engine Room & ST. Kernel Using the National Instutute for Occupational Safety and Health (NIOSH) Method in PT. Karya Tanah Subur (KTS)

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ABSTRACT

Industry in Indonesia began to show progress and improvement marked by the use of sophisticated machines, almost all production processes in the industry caused noise. Noise can cause damage to hearing devices and cause psychological, physiological disorders that have the potential to cause disruption to work so as to reduce work productivity. PT. Karya Tanah Subur (KTS) is a company engaged in the business of plantation and processing of palm oil, the products produced in the form of crude palm oil (CPO) and kernels. The purpose of this study is to determine the level of noise that occurs in several operator work stations. PT. KTS that is directly adjacent to the engine that causes noise. After that, an evaluation of the maximum time workers is exposed to the noise received based on the NIOSH calculation method. Selected noise sampling is the Engine Room Station (Turbine, Genset) and Kernel Station using the Sound level meter tool. From the results of this study, it shows that both points exceed the Threshold Value (NAB). The longest exposure time is point 2 which means the exposure time is 540 minutes or 9 hours per day, while the shortest exposure time is point 1 which means 72 minutes or 1.2 hours. Use personal protective equipment (PPE) such as blockers/earplugs and more Minimize noise levels for personal health and safety.

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I. Introduction

Noise is generally defined as a sound with an intensity exceeding normal limits that comes from a business or activity at a certain level and time, so that it can cause disturbances in communication, health problems, and have an impact on environmental comfort. [1].

Industry in Indonesia is experiencing progress and improvement marked by the use of sophisticated machines that can process and produce materials and commodities needed by humans.The increasing industrial growth without any security measures and industrial tools has side effects from various problems such as occupational diseases, disabilities and deaths in workers. Work accidents can occur due to poor or dangerous condition of tools or materials. [2].

Noise can affect communication, if it is continuous for a certain period of time it will cause damage to the hearing apparatus and even deafness. In addition, noise can also cause psychological, physiological disorders, and has the potential to cause disturbances to the work being done, thereby reducing work productivity. [3].

PT. Karya Tanah Subur (KTS) is a company engaged in oil palm plantation and processing business located in Padang Sikabu Village, Kaway XVI District, West Aceh Regency. The production produced is crude oil palm CPO (Crude Palm Oil), Palm kernel (PK) and shell. PT. Karya Tanah Subur was established in 1993 with a processing capacity of 65 tons / hour, in the process of CPO production at PT. KTS has several stations, starting from several stations ranging from Scales, Loading Ramps, Stews (Sterilizers), Hoist Cranes, Threshers, Digesters, Presses, Depericarpers, and Kernel Stations.

Some Operators in PT. Karya Tanah Subur (KTS) works in an area directly adjacent to the unit which is a source of noise for 8 hours per day. The sound from the operating machines is very clear and can also have a temporary effect when the operator checks the operating machine, resulting in a detrimental effect on hearing loss.

The NAV according to Kepmenaker No. per-51 / MEN / 1999, ACGIH, 2008 and SNI 16-7063-2004 is 85 dB for workers who are working for 8 hours per day or 40 hours per week. The threshold value for noise in the workplace is the highest intensity and is the average that labor still receives without eliminating the fixed hearing power for a continuous time of no more than 8 hours a day or 40 hours per week. [4].

(BPJS) employment, In Indonesia work accident cases from 103,285 cases of work accidents in 2015 increased to 129,911 cases of work accidents in 2016, and in 2017 there were 105,182 work accidents with a death toll of 2,375 workers. [5].

The National Institute for Occupational Safety and Health (NIOSH) notes that twenty million workers have the potential to experience hearing loss each year, ten million workers in the United States have work-related hearing loss problems. In 2008, approximately two million workers in the United States were exposed to workplace noise at risk of hearing loss. In 2007, around 23,000 cases were reported as work-related hearing loss, and work-related hearing loss was recorded at 14% [6]. If the worker is exposed to exceeding the recommended limits, it is considered dangerous for him. [7].

The research related to the author's research is Aryo Sasmita "Evaluation of Noise Levels as an Effort to Manage Occupational Health and Safety (K3) in the PLTD/G Unit of Teluk Lembu PT. PLN New Week With NIOSH Method". The previous research was the same as the research that the author will examine but the difference is the value of noise data. [8].

Based on the background written above, it can be concluded. The purpose of this study is to determine the level of noise that occurs in several operator work stations. PT. KTS that is directly adjacent to the engine that causes noise. After that, an evaluation of the maximum time workers are exposed to the noise received based on the NIOSH calculation method.

II. Reasearch Methods

This research was conducted at PT. Karya Tanah Subur (KTS) works in West Aceh Regency. For this method the author uses quantitative methods. The quantitative method is a systematic scientific study of phenomena and causality. This method was chosen because by observing what is happening in the field can explain how the solution of such problems.

1. Sound Level Meter which has a measurement range of 30 – 130 to measure noise levels.
2. Stopwatch to determine the measurement time

The method used in this study was the National Institute of Occupational Safety Hazards (NIOSH).

This research was conducted at PT. Karya Tanah Subur (KTS) located in Padang Sikabu Village, Kaway XVI District, West Aceh Regency. The place used for research sampling was as many as 2 stations adjacent to the engine that was the source of the noise. The sampling points are the engine room (turbine, generator), kernel station.

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Table 1. Description of the location of the noise measurement point

No	*Noise measurement points*	*Information*
1	Point 1	St.Engine Room (Turbine, Generator)
2	Point 2	St.Kernel

III. Time and measurement procedure

The measurement time at 2 sample points was carried out for 1 day with a duration of 1 hour per station. Measurements for one day represent measurements for 7 days. Because the machine keeps running 24 hours a day. The noise measurement procedure is carried out in accordance with the provisions of the Decree of the Minister of Environment No. 48 Appendix II of 1996 and SNI 7231-2009 on How to Measure. Calculation and evaluation of environmental noise levels. The measurement time is divided into 3 parts, :

- L1 measured by the time span between (08.00-09.00) WIB;
- L2 measured by the time span between (09.00-10.00) WIB;
- L3 measured by the time span between (10.00-11.00) WIB;

A. Primary data collection

Primary data collection is data obtained directly from the results of measurements in the field. Primary data can be obtained by conducting field observations in the form of noise sampling, documentation and interviews. The primary data at the point of each measurement are as follows:

- Noise level
- Coordinates of the measuring point

B. Secondary data collection

Secondary data measurement aims to get an overview of the study area. Secondary data obtained by conducting literature studies and company data related to noise as a basis.

Table 2. Noise threshold value

Exposure time per day		***Noise itensity in NAB***
8	Hour	85
4	Hour	88
2	Hour	91
1	Hour	94
30	Minute	97
15	Minute	100
7,5	Minute	103
3,75	Minute	106
1,88	Minute	109
0,94	Minute	112
28,12	Second	115
14,06	Second	118
7,03	Second	121
3,52	Second	124
1,76	Second	127
0,88	Second	130
0,44	Second	133
0,22	Second	136
0,11	Second	139

C. Data processing

From the results of data processing will be obtained equivalent sound pressure level (Leq). Leq calculation using formula. [10].

$$L_{eq} = 10\ Log\left(\frac{1}{N} \times \left(\sum n_i \times 10^{0,1 \times L_i}\right)\right)$$

D. Calculation of maximum workers exposed by NIOSH method

Based on NIOSH calculations, the maximum time (T) allowed for workers to be in a location with noise intensity levels is as follows:

$$T = \frac{8}{2^{(L-85)/3}}$$

Where:

T = The maximum time during which a worker can come into contact with a noise level (in minutes), is known as the maximum exposure time (NIOSH formula).

480 = 8 business hours/day, 1 hour = 60 minute.

L = The level (intensity) of noise (dB), the terms intensity and loudness (loudnessI) of sound or noise have the same meaning.

85 = Recommended Exposure Limit (REL)/Threshold Value (NAV)

3 = Intensity trade off, is a number that shows the relationship between noise intensity. The Exchange Rate is equal to 3. That is, for every addition of an indented noise sunber (with the same noise intensity) there will be an additional noise level of 3 dB.

IV. Results and discussion

A. Meteorological conditions

Meteorological conditions are supporting data that are used as a reference in describing noise measurement situations. When measurements are made, the weather is quite clear, and there is no rain, hurricane, or other obstructions that can increase the intensity of the sound produced by the engine.

B. Identification of noise sources

From the results of surveys and observations on the scope of the study, it is known that the source of noise contained at the research site comes from generating machines such as turbines, generators and others

Fig 1. Examples of noise sources

C. Noise level (Leq)

Noise measurement was carried out on Thursday, namely on November 24, 2022 at 2 measurement points. Noise data collection is carried out under normal conditions of operational activities, the absence of other activities that affect noise levels such as heavy rain, wind grabs, and work accidents. Noise data is read every 5 seconds for 5 minutes based on a predetermined time so that the data generated as much as 60 data for one noise measurement point is carried out based on

KepMen-LH No. 48 of 1996 and SNI 7231-2009. Noise measurement using a sound level meter (SLM) tool. The resulting noise level is in the range of 69.5 - 95.5 dB. For more details, here is an example of calculating the noise level (L1) at point one of Table 3.

Table 3. Example of one-hour point noise measurement data 08.00 WIB Noise measurement value (dB)

93.1	93.4	93.3	93.1	93.5	93.4
93.2	93.1	93.3	93.3	93.5	93.4
93.3	93.5	93.0	93.0	93.4	93.2
93.1	92.9	93.5	93.4	93.2	93.5
93.5	93.3	93.4	93.6	93.4	93.6
93.6	90.3	93.5	93.7	93.4	93.5
93.4	92.9	92.9	93.8	93.6	93.6
93.3	92.9	93.0	93.0	93.5	93.9
93.1	93.2	93.3	94.0	93.7	93.7
93.1	92.9	93.3	90.9	93.9	93.7

Based on table 3. The above can be seen for a minimum noise level of 90.3 and for a maximum noise level of 94.0. Then the values of r (Max-min range), k (class interval) and I (class interval) are determined to determine the frequency distribution.

r = max - min

= 94,0 – 90,3

= 3,7

k = 1+ 3,3 Log n

= 1 + 3,3 Log 60

= 6,9

$i = \frac{r}{k}$

= 3,7 / 6,9

= 0,5

Frequency distribution data are created based on the results of the above calculations. Then the frequency distribution is determined based on the noise interval, middle value, and frequency of that noisy interval (Table 4).

Table 4. Frequency Distributor

No	INTERVAL	Frequency	middle value
1	90.3	90.8	1
2	90.9	91.4	2
3	91.5	91.8	2
4	91.9	92.4	2
5	92.5	93.0	8
6	93.1	93.6	22
7	93.7	94.2	24

Then the calculation of the Leq value is carried out using (Press 1) as follows:

Calculate Leq = 10 *Log* $\left[\frac{1}{N}\sum Tn\ 10^{0,1\,ln}\right]$

$$= 10\ Log\left[\frac{1}{60}\ x\ (1.10^{0,1.90,6})\right] + \left(\frac{1}{60}\ x\ (2.10^{0,1.91,2}\right) + \left(\frac{1}{60}\ x\ (2.10^{0,1.92,2}\right)$$

$$+ \left(\frac{1}{60}\ x\ (8.10^{0,1.92,8}\right) + \left(\frac{1}{60}\ x\ (22.10^{0,1.93,4}\right) + \left(\frac{1}{60}\ x\ (24.10^{0,1.94,0}\right)$$

$$= 94{,}88\ dB$$

Based on the calculations above, it is known that the Leq value for L1 at point one is 94.88 dB. In determining the value of noise every hour and each other point, the same Leq formula is also used. So that the results of hourly noise are obtained at the following measurement points (Table 5):

Table 5. Leq calculation results at each point

No	Measurement Time (Hours)	Leq (dB)
1	Titik 1	94,88
2	Titik 2	86,34

After obtaining the Leq value for each point, the next step is to compare it with the existing standards according to the NAB through the Decree of the Minister of the Environment No.48/MENLH/11/1996 and Kepmenaker No. Per - 51 / MEN/ . 1999, ACGIH,2008 and SNI 16-7063-2004. It can be seen in Table 6, :

Table 6. Comparison of Point 1 Results with Noise Quality Standard Values

No	Test Parameters	Duration	Result	Standard	Information
Point 1	Noise Equivalent (Leq)	1 hour	94,88	70	Above Standard
	Noise Equivalent (Lmax)	1 hour	94,0	-	
Point 2	Noise Equivalent (Leq)	1 hour	86,34	70	Above Standard
	Noise Equivalent (Lmax)	1 hour	84,0	-	

Table 7. Noise level PT. Fertile Land Works (KTS)

Measurement Points	Noise Level (dB)	NAB Noise (dB)	Information
Point 1	94,88	85	Exceeding NAV
Point 2	86,34	85	Exceeding NAB

From the results of measuring and calculating noise data for each point of work activity, data on the average noise level in PT. Fertile Land Works (KTS) for one day. There are 2 points that exceed the Threshold Value (NAV) as stipulated by the government of Kepmenaker No. per-51 / MEN / 1999, ACGIH, 2008 and SNI 16-7063-2004.

D. Analysis of maximum time workers exposed to noise using NIOSH method

Per day the workers who are in PT. Tanah Subur Works (KTS) works for 8 hours. The Threshold value (NAV) for workplace noise levels according to NIOSH is 85 dB for 8 hours of work per day. After calculating the Leq value, based on the existing Leq value, the calculation of the length of time the noise exposure is allowed for workers using the NIOSH method calculation. For more information, you can see the example of calculating NIOSH at the following point:

$$T = \frac{8}{2(L-85)/3}$$

$$T_1 = \frac{8}{2(94{,}88-85)/3}$$

$$T_1 = 1{,}2\,\text{Jam}$$

$$= 72\text{Menit}$$

From the formula used by the NIOSH measurement method, the length of exposure time for workers to noise at point one with a noise level of 94.88 dB is 1.2 hours or 72 minutes. In the same way, it is also done on the calculation data of other measurement points to get a long exposure time.

Table 8. Duration of Exposure Based on NIOSH Calculation Method

Measurement Points	Length of Exposure (minutes)	Length of Exposure (Hours)	Information
Titik 1	72	1.2	Above NIOSH
Titik 2	540	9.0	Under NIOSH

The employee's maximum allowable noise exposure time is obtained from the employee's noise exposure time calculated using the formula: There is one point that exceeds the NIOSH standard of 8 hours exposure at 85dB noise level. The longest exposure time is point 2 with an exposure time of 540 minutes or 9 hours per day and the shortest exposure time is point 1 with an exposure time of 72 minutes or 1.2 hours per day. The higher the noise level, the shorter the exposure time, and the lower the noise level, the longer the exposure time.

Workers are allowed to be exposed directly to the extent of predetermined limits. If working beyond the predetermined time limit, you should use a device such as an ear plug / ear. More handling of points that exceed noise quality standards is needed so that it does not cause occupational diseases, especially the risk of damage or hearing loss caused by the length of exposure time that exceeds the standard limit. The higher the noise produced, the shorter the exposure time, and vice versa, the lower the noise level, the longer the exposure time.

The adverse influence of continuous noise is very broad in effect on behavior in the form of physiological effects and psychological effects that result in impaired hearing, where normal humans are only able to hear sounds with a frequency of 20-20,000 Hz so that they will be very vulnerable to a decline in public health. [11]. Humans can also hear decibel sounds (noise intensity) from 0 (very quiet) to 140 dB (high and painful sounds). When the noise intensity is more than 140 dB, damage to the eardrum and internal organs of the eardrum can occur. The maximum safe threshold for humans is 80 dB, however, human hearing can tolerate more than 80 dB, provided that the time of exposure is observed. [12].

V. Conclusion

The conclusions that can be drawn from this study are as follows:

1. The results of measuring the noise level at 2 points and obtained the intensity of the noise exceeded the NAV >85 dB. Caused by engines operating at Engine Room and Kernel stations.

2. OSH recommends different exposure times based on the Leq value of each point. The longest exposure time is point 2 which means the exposure time is 540 minutes or 9 hours per day, while the shortest exposure time is point 1 which means 72 minutes or 1.2 hours. The higher the noise

intensity, the shorter the exposure time allowed, on the contrary, the lower the noise intensity, the longer the allowable exposure time.

3. Use personal protective equipment (PPE) such as blockers/earplugs and more Minimize noise levels for personal health and safety.

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