Jurnal Dinamis (*Scientific Journal of Mechanical Engineering*)
Journal homepage: https://talenta.usu.ac.id/dinamis/

The Effect of Engine Noise on the Comfort of WA-360 Loader Heavy Equipment Operators Based on Capacity and Distance of 100, 150 and 200 cm

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ARTICLE INFO
Article history:
Received November 13th 2024
Revised November 19th 2024
Accepted December 10th 2024
Available online December 11th 2024

E-ISSN: 2809-3410

How to cite:
Suriady Sihombing, Wilson Sabastian Nababan, Miduk Tampubolon, Hendrik Sihombing. "The Effect of Engine Noise on the Comfort of WA-360 Loader Heavy Equipment Operators Based on Capacity and Distance of 100, 150 and 200 cm". Jurnal Dinamis (*Scientific Journal of Mechanical Engineering)*, Vol. 12 No 2, 72-78, December. 2024.

http://doi.org/10.32734/dinamis.v12i2.18727

ABSTRACT
The existence of a limited volume of machine room and coupled with the existence of various kinds of machinery in it, both main drive machinery such as the main motor and other supporting machinery such as electric motors, compressors, pumps and so on, all of which are sources of noise, will cause high noise noise. Where heavy equipment is a tool used to simplify the work process so that it becomes faster, easier and the results are in accordance with expectations and one example is the Whell Loader WA-360 heavy machine. Therefore, research is needed to measure the level of noise produced by the Whell Loader WA-360 heavy equipment engine to operator comfort. According to NAB According to Kepmenaker No. per-51/MEN/1999,2008 and SNI 16-7063-2004, the noise level that results in hearing damage of 90 dB for workers who are working for 8 hours per day. That the threshold value for the noise of the combustion chamber of the Wheel Loader WA-360 heavy equipment engine with a bucket capacity of 3, 4 and 5 tons produces a noise level of 106.5 dB with a hearing scale and it is recommended that the operator of the Whell Loader heavy equipment use Earphones while doing work.
Keyword: Loader WA-360, Distance, Capacity, Sound Level Meter

ABSTRAK
Adanya volume ruang mesin yang terbatas dan ditambah lagi dengan adanya berbagai macam permesinan yang ada didalamnya, baik permesinan penggerak utama seperti motor induk maupun permesinan pendukung yang lain seperti motor listrik, kompresor, pompa-pompa dan sebagainya, yang semuanya merupakan sumber bising, maka akan menimbulkan kebisingan suara yang tinggi. Dimana alat berat merupakan alat yang digunakan untuk mempermudah proses pekerjaan sehingga menjadi lebih cepat, mudah dan hasilnya sesuai dengan harapan dan salah satu contohnya alat berat Whell Loader WA-360. Sehingga diperlukan penelitian bertujuan mengukur tingkat kebisingan yang dihasilkan oleh mesin alat berat Whell Loader WA-360 terhadap kenyamanan operator. Sesuai NAB Menurut kepmenaker No. per-51/MEN/1999, ACGIH, 2008 dan SNI 16-7063-2004 tingkat kebisingan yg mengakibatkan kerusakan pendengaran 90 dB untuk pekerja yang sedang bekerja selama 8 jam perhari. Bahwa nilai ambang batas untuk kebisingan ruang pembakaran mesin alat berat Wheel Loader WA-360 dengan kapasitas bucket 3, 4 dan 5 ton menghasilkan tingkat kebisingan 106,5 dB dengan skala menulikan untuk pendengaran dan dianjurkan operator alat berat Whell Loader menggunakan *earphone* (penutup telinga) selama melakukan kerja.
Keyword: Loader WA - 360, Jarak, Kapasitas, Sound Level Meter

1. Introduction

In today's conditions, the influence of noise has become the main thing that needs to be considered in doing a job. Where in a safe and controlled work environment can allow a comfortable life for humans, but on the other hand, if the environment causes an uncontrolled release of energy, it will be harmful to human health. A form of energy that comes from the environment that is harmful if left uncontrolled is the noise of the work environment, which worldwide has exposed 600 million or more people in the work environment. Workers' response to noise can be in the form of work stress that has an impact on the health of the workforce [1]. Noise is a sound that is not desired by the human eye, namely sound that has multi-frequency and multi-amplitude and usually occurs at high frequencies. Where the nature of noise consists of various kinds including constant, fluctuation, continuous, intermittent, impulsive, radom and impact noise [2], [3].

Where noise measurement is one of the ways that can be done to monitor the vibration level and feasibility of a heavy equipment, where wheel loaders are heavy equipment that has a very strong sound so that it can interfere with human hearing and interfere with the activities of the local community [4]. Wheel loader as a type of heavy equipment is similar to a shovel dozer but with rubber wheels (tires) so it has slightly different capabilities and uses. Where wheel loaders are only able to operate in hard, flat, dry and non-slippery areas [5],[6].

This heavy equipment is generally used to handle project materials, especially materials from excavation or material heaps. The inventor of this machine came from a contractor named Ed Wagner & Sons who created the world's first articulated loader in 1936 (called Scoopmobiles), the Volvo credited with the invention of the first wheel loader in 1954. They named it the H10, and the inspiration came from the inverted tractor. By the early 1970s, larger loaders had been produced by Volvo that had a new lift arm system and a safer and more comfortable cabin [7]. Previous research conducted a study on the noise of the Fatty Alcohol making machine and obtained the results of the noise that occurs in the production area has an effect on the health and comfort of the operator while working [8].

Then another researcher measured the noise level in the ship's engine room. Among others, from the main engine itself which is the largest source of noise, exhaust gas outlets on the deck and auxiliary machinery and produces an average noise of 102.7 dB. The noise in the engine room is above the NAB which is 85 dB so PPE is needed to reduce the noise level [9]. Other researchers also characterize specific noises by analyzing them in various spaces on military and commercial ships, such as accommodations, navigation bridges, and other workspaces. It is found that the prevalence of high noise levels in various spaces may exceed generally accepted limits, characterized by higher noise levels at low and high frequencies[10].

So the researcher wants to conduct a study on the effect of noise on the comfort of Whell Loader WA-360 heavy equipment operators. This research was conducted by studying and analyzing the noise in the Whell Loader heavy equipment engine against the capacity and noise distance. The object of this research is divided into several stages, namely using descriptive methods and experimental methods on the Whell Loader machine during operation where the heavy equipment is loaded with coral stone capacity.

2. Methods

The method used to analyze the noise on the WA-360 wheel loader machine based on the difference in capacity is an experimental method. The research was conducted at PT. Mitha Sarana Niaga, Perbahingan Village, Galang District, Deli Serdang. This research will be carried out within 5 months. The research was carried out in the early stages of the previous research. Where the Whell Loader WA-360 heavy equipment engine is given a load of coral stones on a bucket and then measurements are taken with a Sound Level Meter measuring device with a variation in distance, namely 100 cm, 150 cm and 200 cm. The test was carried out 3 times with a time span of 2 minutes and the noise was measured at the 10th second for each vertical, horizontal and longitudinal direction. With a percentage of capacity and operator distance of 3, 4 and 5 tons respectively at a distance of 100 cm, 150 cm and 200 cm. The Whell Loader WA-360 machine and Sound Level Meter can be seen in the following figures 2.1 and 2.2.

Figure 2.1. Whell Loader WA-360

Figure 2.2. Fluke 945 Sound Level Meter

Specifications: Fluke 945 Sound Level Meter

Measurement parameters	Range	Resolution	Accuracy
Environmental noise measurement (A-weighted)	30 to 130 dB	0.1 dB	±1.5 dB (ref 94 dB@1KHZ)
Environmental noise measurement (C-weighted)	35 to 130 dB	0.1 dB	±1.5 dB (ref 94 dB@1KHZ)
Display	0.1 dB stage on 4-digit LCD display		
Frequency response	From 31.5 Hz to 8 kHz		
Recording interval	From 1 second to 8 hours		
Safety standards	CE, designed to meet IEC651 Type 2, ANSI S1.4 Type 2		
Microphone	Microphone condenser electric 0.5 th		
Time weighting	Fast and slow		
Dimension	200 x 56 x 32 mm		

Furthermore, the design of the research scheme can be seen in the design image analysis of the influence of noise on the Whell Loader WA-360 heavy equipment engine in the following figure 2.3.

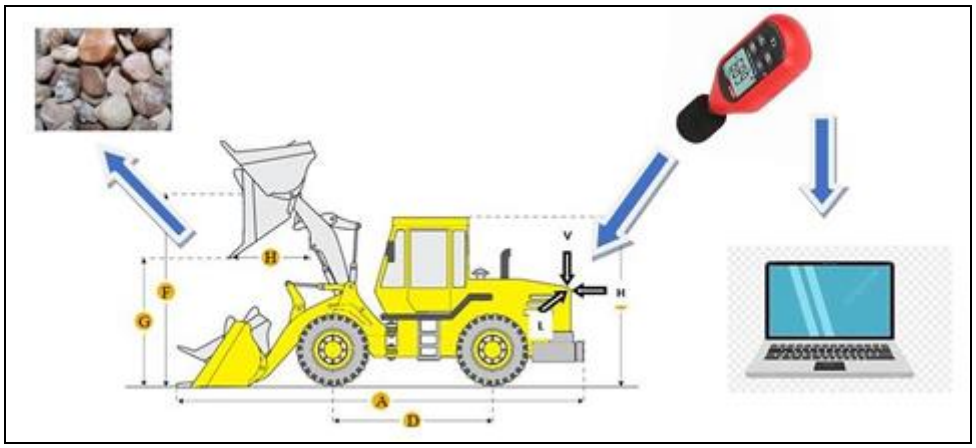

Figure 2.3. Noise Research Design on Whell Loader Machine WA-360

Figure 2.3 shows the design of the research design where first the capacity of the coral rock to be loaded into the bucket of the Whell Loader Heavy Equipment varies 3, 4 and 5 tons. Then the Whell Loader machine lifts the bucket up and noise measurements are taken from the Whell Loader machine room at a distance of 100, 150 and 200 cm with a time range of 10 seconds for 2 minutes. Measurements are carried out using Sound Level Meters in the vertical, horizontal and longitudinal directions. So next for the capacity of coral rocks of 4 and 5 tons.

3. Results and Discussion

In testing and measuring noise on wheel loaders, sound level meters with a distance of 100, 150, and 200 cm on the combustion chamber of the engine with measurement directions: vertical, horizontal, longitudinal.

Figure 3.1. Noise Measurement Test in the combustion chamber of Wheel Loader engines with a distance of 100 cm, 150 cm and 200 cm with a capacity of coral stones of 3, 4 and 5 tons.

1. Noise Data Acquisition in the vertical directions.

The test method used is to directly measure the noise produced by the wheel loader using a sound level meter when the wheel loader is loading coral stones into the Wheel Loader bucket. Where the calculated bucket capacity is 3, 4 and 5 tons at the time of operation (ideal, intermediate, maximum) with the distance tested for noise is 100 cm, 150 cm and 200 cm with vertical, horizontal, longitudinal directions of measurement axis can be seen in table 3.1.

Table 3.1. Vertical directional noise test data with a capacity of 3 tons

Time (s)	Noise data in the vertical direction with distance		
	100 cm	150 cm	200 cm
10	94.4	92.1	89.2
20	92.4	91.8	90.4
30	94.4	92.3	91.9
40	94.0	92.2	90.8
50	94.6	93.3	92.2
60	95.3	92.5	91.0
70	94.5	93.1	92.0
80	95.3	91.8	90.9
90	94.6	93.5	92.0
100	93.4	92.3	91.6
110	94.6	93.1	92.3
120	93.1	92.5	91.1
Average	94.0	92.4	91.5

From the noise data above, a noise vs time graph can be made that will show the comparison of noise in the engine combustion chamber with a bucket capacity of 3 tons in the vertical direction.

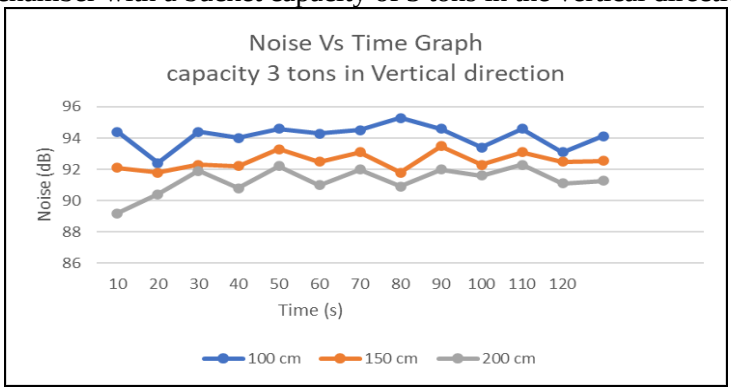

Figure 3.2. Vertical noise vs direction time graph with a bucket capacity of 3 tons.

Based on the graph in Figure 3.2, the data obtained shows that the highest noise exposure with a distance of 100 cm at the 80th second of 95.3 dB from the working area of the loader machine has exceeded the standard set by the Decree of the Minister of Manpower and Transmigration of the Republic of Indonesia

Kepmenaker no. per-51/MEN/1999,2008, namely for the threshold value of noise level of 90 dB with 8 working hours/day. So operators cannot work productively for 8 working hours/per day.

2. Noise Data Acquisition in the horizontal directions.

For noise testing in the horizontal and longitudinal directions with a capacity of 3 tons, it can be seen from the following table data.

Table 3.2. Horizontal directional noise test data with a capacity of 3 tons

Time(s)	Noise data in the horizontal direction with distance		
	100 cm	150 cm	200 cm
10	99.4	96.0	94.9
20	99.1	96.4	95.1
30	98.9	97.4	94.4
40	99.1	96.8	94.6
50	97.8	97.1	96.5
60	99.0	97.4	95.9
70	98.6	96.4	94.7
80	98.1	96.8	95.3
90	99.0	95.9	94.5
100	99.5	96.1	95.3
110	97.9	96.3	94.5
120	99.0	95.2	94.8
Average	98.7	96.4	95.0

From the noise data above, a noise vs time graph can be made that will show the comparison of noise in the engine combustion chamber with a bucket capacity of 3 tons in the horizontal direction.

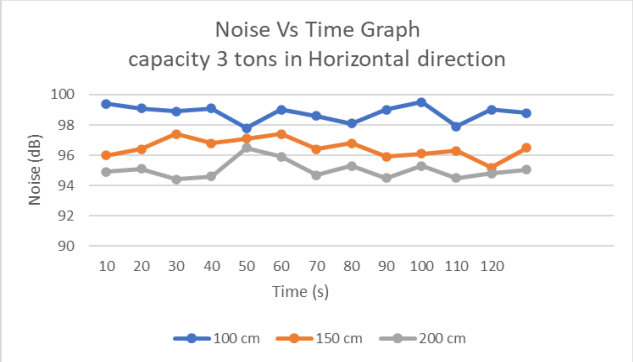

Figure 3.3. Horizontal directional noise vs time graph with a bucket capacity of 3 tons.

Based on the graph in Figure 3.3, the data obtained shows that the highest noise exposure with a distance of 100 cm at the 100th second of 99.5 dB from the working area of the loader machine has exceeded the standard set by the Decree of the Minister of Manpower and Transmigration of the Republic of Indonesia Kepmenaker No. per-51/MEN/1999,2008, namely for the threshold value of noise level of 90 dB with 8 working hours/day. So operators cannot work productively for 8 working hours/per day.

Table 3.3. Longitudinal directional noise test data with a capacity of 3 tons.

Time(s)	Noise data in the longitudinal direction with distance		
	100 cm	150 cm	200 cm
10	98.2	95.7	93.2
20	97.2	95.8	93.7
30	97.4	95.4	93.4
40	96.4	95.1	93.9
50	95.2	94.6	93.6
60	94.9	93.9	93.0
70	95.0	94.0	93.2
80	94.9	93.8	92.2
90	96.1	93.2	92.5

Time(s)	Noise data in the longitudinal direction with distance		
	100 cm	150 cm	200 cm
100	95.3	93.6	92.7
110	96.9	94.3	93.1
120	96.6	93.9	92.8
Average	96.1	94.4	93.1

From the noise data above, a noise vs time graph can be made that will show the comparison of noise in the engine combustion chamber with a bucket capacity of 3 tons in the longitudinal direction.

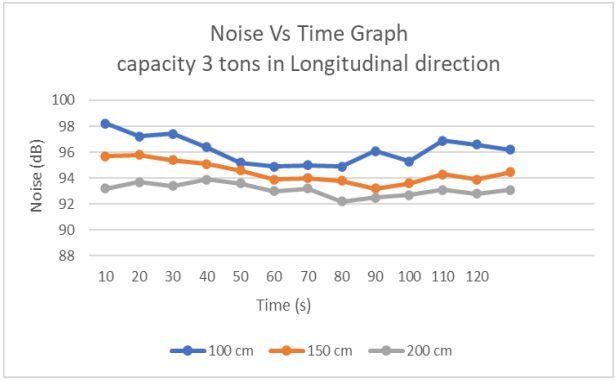

Figure 3.4. Longitudinal directional noise vs time graph with a bucket capacity of 3 tons.

Based on the graph in Figure 3.4, the data obtained shows that the highest noise exposure with a distance of 100 cm at the 10th second of 98.2 dB from the working area of the loader machine has exceeded the standard set by the Decree of the Minister of Manpower and Transmigration of the Republic of Indonesia Kepmenaker No. per-51/MEN/1999,2008, namely for the threshold value of noise level of 90 dB with 8 working hours/day. So operators cannot work productively for 8 working hours/per day.

4. Conclusion

According to NAB According to Kepmenaker No. per-51/MEN/1999,2008 and SNI 16-7063-2004, the noise level that results in hearing damage of 90 dB for workers who are working for 8 hours per day. That the threshold value for the noise of the combustion chamber of the Wheel Loader WA-360 heavy equipment engine with a bucket capacity of 3, 4 and 5 tons produces a noise level of 106.5 dB with a hearing scale and it is recommended that the operator of the Whell Loader heavy equipment use Earphones while doing work. Future research plans will focus on the development of more complex variables, especially in increasing the test time, noise measurement distance to obtain better results and data. In addition to the effect of engine noise by capacity and distance, researchers can examine the source of noise arising from diesel motors based on the source of noise, for example, noise arising from the combustion process in the cylinder and the movement of engine elements such as cams, gears, crankshaft mechanisms, cylinders, bearings, and others.

5. Acknowledgements

This research is supported by the Lecturer Internal Research Fund by Universitas HKBP Nommensen. Researchers are grateful for the financial support for the study.

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