OCCUPATIONAL NOISE REDUCTION IN CNC STRIPING PROCESS

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Abstract. Occupational noise hearing loss with high level exposure is common occupational hazards. In CNC striping process, employee that exposed to high noise level for a long time as 8-hour contributes to hearing loss, create physical and psychological stress that reduce productivity. In this paper, CNC stripping process with high level noises are measured and reduced to the permissible noise exposure. First condition is all machines shutting down and second condition when all CNC machine under operations. For both conditions, noise exposures were measured to evaluate the noise problems and sources. After improvement made, the noise exposures were measured to evaluate the effectiveness of reduction. The initial average noise level at the first condition is 95.797 dB (A). After the pneumatic system with leakage was solved, the noise reduced to 55.517 dB (A). The average noise level at the second condition is 109.340 dB (A). After six machines were gathered at one area and cover that area with plastic curtain, the noise reduced to 95.209 dB (A). In conclusion, the noise level exposure in CNC striping machine is high and exceed the permissible noise exposure can be reduced to acceptable levels. The reduction of noise level in CNC striping processes enhanced productivity in the industry.

1. Introduction

Occupational noise, as a common occupational hazard, generally refers to noise at work or noise in the workplace. For the record, 16% of disabling hearing loss in adults is attributed to occupational noise worldwide [1]. For a manufacturing plant to evolve, an additional challenge appears such as requirements the Occupational Health and Safety problems (OHS) to limit the noise impact of manufacturing plants on operators [2] Among the aggression undergone by operators in a machining workshop, noise is a critical phenomenon since it affects them daily without any obvious short-term impact on hearing [3].

In most industrialized nation nowadays, noise becomes one of the major sources of environmental pollution [4]. Noise at CNC area come from several source such as machine itself or any additional element that add into the process. In industry it is very important to control the level of noise so that it will not harm workers. Extreme noise may harm workers when they are exposing to if for a long time as their working condition is not properly monitor by management. It is management duty to provide safe and comfortable working areas to the workers. That is also enforced by Department of Safety and Health (DOSH) about regulation regarding safety condition to the workers, any company that refuse to follow the regulation will be fined or the worst can be force to stop their operation. Increasing numbers of modern people are suffering hearing loss, and undue exposure to noise is one of the important reasons [5].

In most CNC area, workers become uncomfortable due to noise that produces from the machine. Some place chooses to use personnel protective equipment (PPE) to protect their workers as an option. The company must offer individual protection to the operators and to test their hearing capacity annually if the noise reading between 80 and 85 dBA. In the manufacturing industry the critical daily noise exposure is often exceeded 85 dBA level [6]. Exceed noise exposure to workers

will harm them in many ways especially their hearing ability. Several workers undergoing specific tasks in this XYZ company was observed to be working in high noise zones. They may be exposed to noise levels exceeding equivalent continuous sound level of 85dB (A) which is set as the action level in Malaysia. Some of the high noise area are identified were from the air compressor and CNC Machine area [7]. Within the range that the noise are produce in CNC Machine, the workers are need to wear a proper Personal Protective Equipment (PPE) especially earmuffs to cover their hearing [8,9]. In additional, the high noise also causes the behavioral effect and physiological effect for the workers [9-11].

In this paper, it is initially needed to identify source of noise at CNC area by measuring using sound level meter. To analyse a safe and comfortable working condition to the workers in CNC area after implement noise reduction method, noise level need to be measured the effectiveness of current methods.

2. Experimental details

Figure 1 shows the noise monitoring plant layout for data collection. Data are collected during working hours from CNC striping process area. By using CNC machine area plant layout, noise monitoring method was developed in detail on where the 11 points to be placed and repeated the instrument sound level meter. The instrument used to measure the noise level in this experiment is CEN0053 Heavy Duty Data Logger Sound Level Meter. It can measure minimum 30dB and maximum 130dB. There are several data were measured in this study during idle time, without operating conditions and during operating conditions. After that, current CNC machines were improved their noise level by several methods. All of this method is used to meet DOSH requirement on safety working condition on noise exposure to the workers. Most company will prefer low cost method and in the same time pass requirement set by DOSH. Finally, the similar data collection of noise was conducted to measure the effectiveness of current method to reduce noise level at CNC striping process.

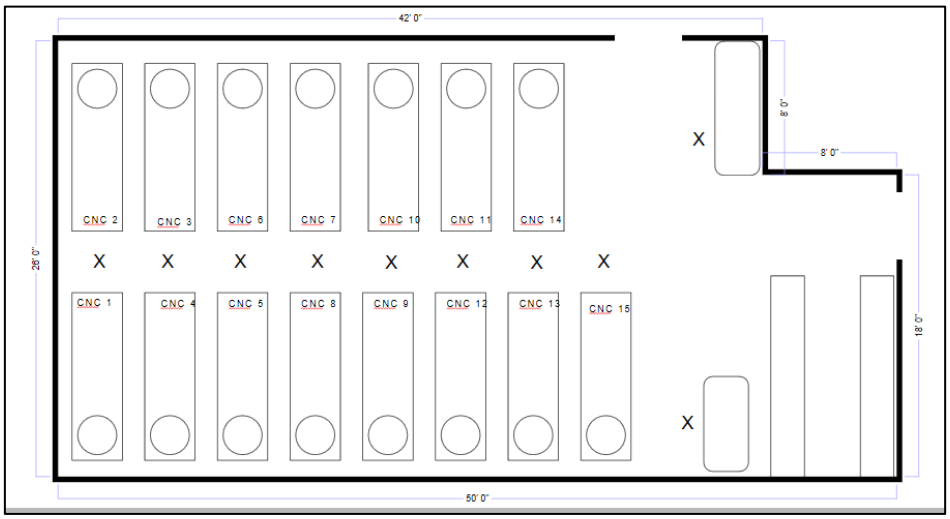
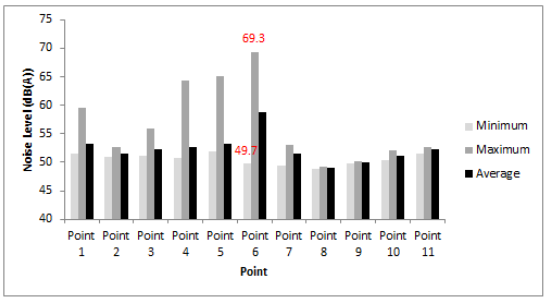


Figure 1 Noise monitoring plant layout

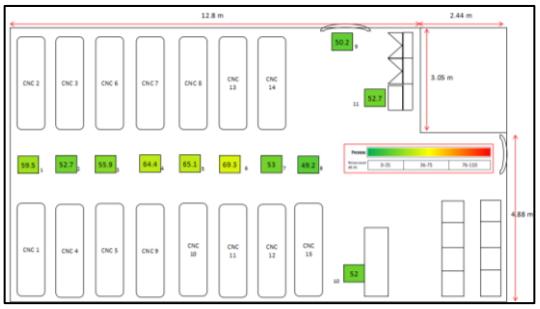
3. Result and Discussion

Figure 2a shows the noise monitoring at the idle time. The maximum noise level are in point 6 with 69.3 dB (A) and 49.7 dB (A) for the minimum noise level. The average between the maximum and minimum are 58.8 dB (A). Figure 2b shows the noise mapping for the noise monitoring at the idle time. Noise level average when the entire machines at CNC Machine area switch off is 53.214 dB (A). Source of noise is important to determine because the noise level produce affecting the whole area. There is a few spot that are potential to affect the noise level after all the machine without operations.

There are four machine involve in this experiment which is CNC3, CNC6, CNC9 and CNC14. There are four spot that produce noise exactly after the machine are off.



a) Noise monitoring

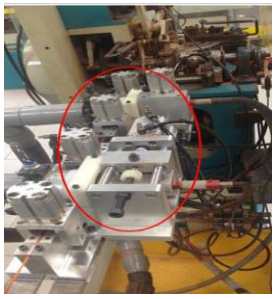


b) Noise level mapping

Figure 2 Noise monitoring at idle time

Figure 3a shows point 1 at machine CNC3. This is because of the airs that blow out from spot at red circle. Even the machine are running the process, the air will blow to push the air coil product. Therefore, this point affects the high noise level monitoring with 98.2 dB (A). Figure 3b also shows the point 2 and point 3 cause the noise sound at machine CNC6 and CNC9 respectively. These points are same as previous point caused the noise from pneumatic. The points are where the stripping process taking place. Consequently, the air pump blow the dust from the coil and cause a noise level at 93.5 dB (A) and 91.2 dB (A), respectively. Figure 3c shows the point 4 at machine CNC14. The air pressure blows out from the red circle about two minutes after the machine are off. The air pressure at this spot is 105 dB (A), which is very high level.

a) CNC3



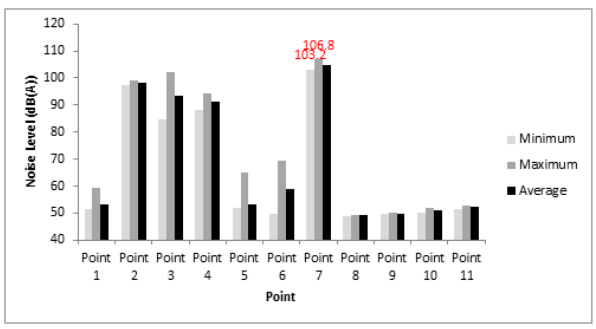
b) CNC6

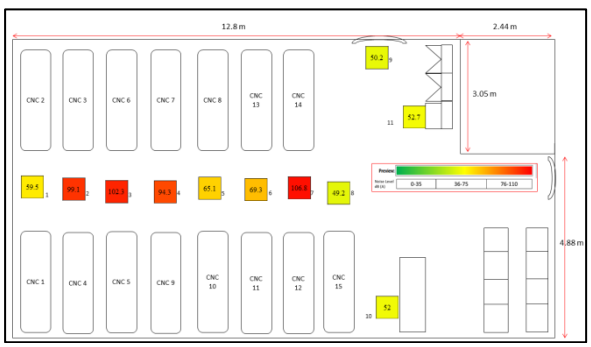
c) CNC9

d) CNC14

Figure 3 Noise source at four points at CNC

Figure 4a shows the noise monitoring when machine not operate. The maximum noise level are in point 7 with 106.8 dB (A) and 103.2 dB (A) for the minimum noise level. The average between the maximum and minimum are 105.0 dB (A). Figure 4b shows the noise mapping for the noise monitoring without machine operation. Noise level average when the entire machines at CNC machine are switch-off is 95.797 dB (A).

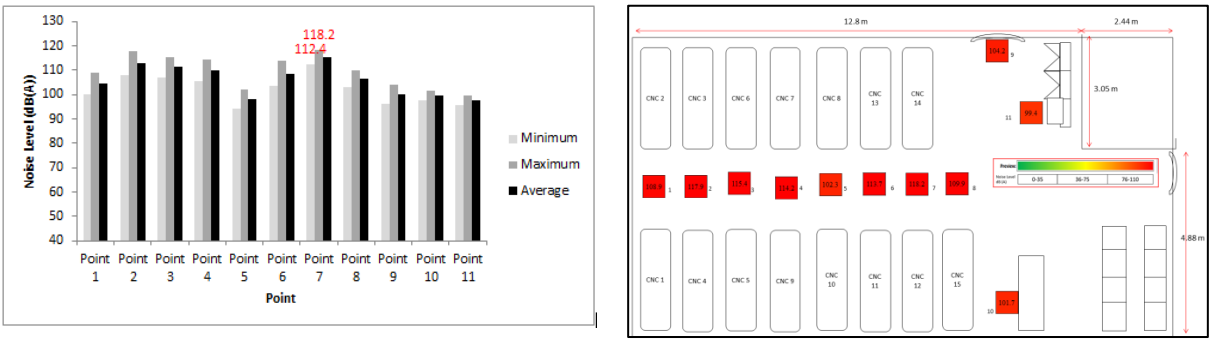




a) Noise monitoring b) Noise level mapping

Figure 3 Noise monitoring when machine without operating condition

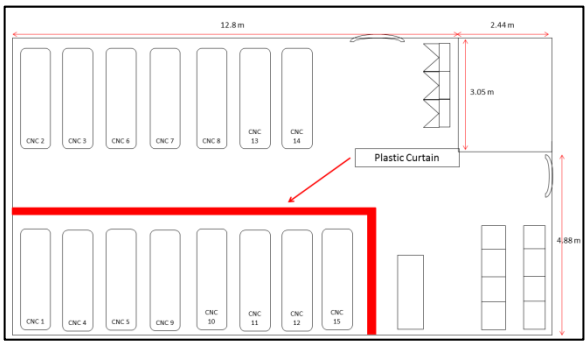
Results are now presented for the entire CNC machine during operating conditions. There are 11 points that used to be measured the noise levels. Figure 4a shows the noise level for 11 points in this room during operating conditions. The maximum noise level are in point 7 with 118.2 dB (A) and 112.4 dB (A) for the minimum noise level. The average between the maximum and minimum are 115.3 dB (A). Figure 4a shows the noise mapping for the noise monitoring at operating machine condition. The noise levels average is 95.797 dB(A). The output indicated that there are several points producing very high noise. It is influenced by the machine running the stripping process. Even though the without operating machine, there are still a noise produced for a certain time and this conclude that the noise caused by striping process.



a) Noise monitoring b) Noise level mapping

Figure 4 Noise monitoring when machine in operating condition

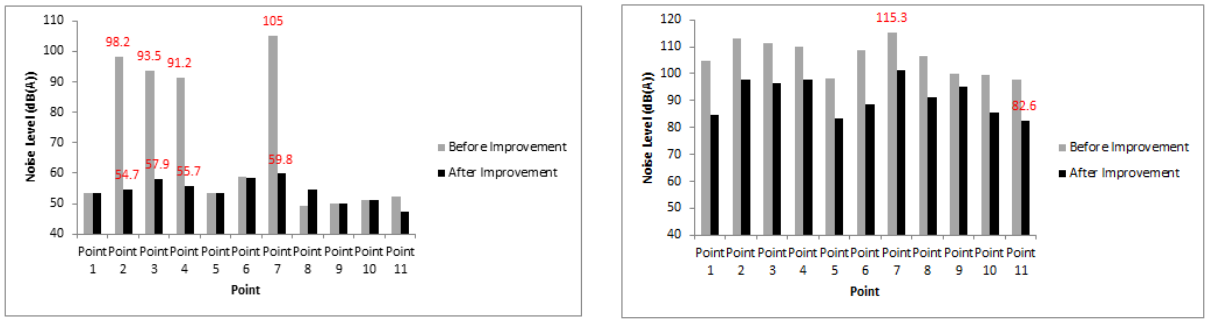
First, the high noise at CNC area problem is pneumatic leakage. From the noise monitoring, there are four CNC Machine contribute to pneumatic leakage which are CNC3, CNC6, CNC9 and CNC14. The problem was solved by installation of pneumatic muffler. Figure 5a shows pneumatic muffler used to solve pneumatic leakage. After considering some causes of high noise at CNC area and also how operators and technician doing their job in that area, a suitable method needs to be selected. For this case, plastic curtain was installed to reduce the noise. Initially, all CNC machines with stripping process were moved to one side of CNC area to be be covered by plastic curtain. It is make separation between the high and low noise from the machine. It is also seems to be most suitable for maintaining job. This plastic material can help reduce noise about 10db to 20db when apply at noise exposure area like CNC Area [7]. So for this case it is suitable to be used as it will not disturb routine work and maintenance on that area. Figure 5b and 5c shows condition after plastic cover was installed.



a) Pneumatic muffler b) Plastic Curtain c) CNC area with plastic curtain

Figure 5 Improvement made for current high noise levels

Figure 6a shows comparison of noise level reading without machine working after solving the pneumatic leakage problem at CNC3, CNC6, CNC9 and CNC14. The noise levels decrease to 40.28 dB (A) with 42% improvement on noise reduction. At point 2, 3, 4 and 7 on before improvement, the noise is very high due to pneumatic leakages. After pneumatic leakage was solved by pneumatic muffler installed, the noise was greatly reduced. Figure 6b shows the comparison between noise level reading at machine during operating conditions after installed with plastic curtain at certain area. The noise level are decrease to 14.131 dB (A). It is about 12.9% improvement on noise reduction. Noises at all points are reducing consistently after plastic curtain was installed. After improvement were made, the noise during operating conditions reduce from 109.340 dB (A) to 98.246 dB (A).



a) Without operation condition b) During operation condition

Figure 6 Noise monitoring reduction

The machine OEE was a data recorded monthly by production department to show on CNC machine performance. It is generally affected by CNC machine downtime and output by the machine. When the downtime was low and output was high the machine OEE increased. In this case, technician plays a role to reduce machine downtime and operators on increasing machine output. Table 1 shows the comparison of machine OEE performance before and after improvement was made. Obviously, output was improved on CNC area. Output, unplanned downtime and actual operating time was improved after improvement, it shows that machine work efficient. This condition happens when workers on that area have better working environment by reducing noise at CNC Area. Over limit noise that expose to workers can reduce their efficiency while working and harm them after a long time. By reducing noise at CNC Area, technician can focused more to do machine maintenance so that machine downtime can be lower and operators can work more efficient to make sure machine producing higher output with machine OEE increase by 12.10%.

Table 4.13 Comparison of machine OEE performance

Performance	**Before Improvement**	**After Improvement**
Output	1,779,000 pcs	2,340,000 pcs
Unplanned Downtime	630 hours	350 hours
Actual Operating Time	6,060 hours	7,210 hours
OEE	54.9%	67.0%

The other recommendation is to provide the employee with training about hearing damage and protection. This is important to the employee that exposed to the noise for a long time as 8-hour shift. In addition, the company should provide the correct hearing protection due to the high noise level present. Even though, the recommendation is for a short term because the noise level may be high in time. Hence, the long term solution should be implementing in that area to reduce more noise from time to time. As for pneumatic leakage problem, technicians have to plays an important role to do proper preventive maintenance and predictive maintenance to the CNC machine. It is to ensure

stripping mechanism that using pneumatic run in a good condition and did not contribute much to the high noise at CNC area. A proper setting during installation also needed to avoid any pneumatic leakage after machine running. Permanent action can be done to solve pneumatic problem is to change from pneumatic mechanism to motor mechanism. By using motor, the noise produced lower noise compare to pneumatic. But, it is need to use dust proof motor as the stripping process produce a lot of dust that can affect motor performance.

4. Conclusions

For the first condition, there are four major points that produce the noise. Most of the noise point produce by the pneumatic pressure. The pressures are quite high and affect the noise level. The average noise level at the first condition before improvement was made is 95.797 dB (A) and this cause at the part when the coil have stripping process using pneumatic system with leakage. Then pneumatic leakage problem was solved, after improvement data was taken and the noise was reduced to 55.517 dB (A). For the second condition, there are about six CNC machines that have stripping process with it when running so these six machines contribute most in high noise. The average noise level at the second condition before improvement was made is 109.340 dB (A). By gather all six machine at one area and cover that area with plastic material, noise reading was taken. After improvement data shows the noise reduce to 95.209 dB (A). From noise monitoring conditions, the noise level exposure is the CNC machine room area is high and exceeds the permissible noise level exposure regulation. After some modification and improvement made, it can be reduced maximum 42 percent to acceptable levels. The reduction of noise level in CNC striping processes enhanced productivity in the industry about 12 percent.

Acknowledgements

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