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Assessment of noise pollution of two vulnerable sites of Sylhet city, Bangladesh

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The study reports the analysis and measurement of the noise levels of CNG refueling Stations and Power Generators of Power Development Board (PDB) induced noise pollution in Sylhet City. For this purpose noise levels have been measured at ten major locations of the city for CNG refueling Stations and in PDB, Kumargaon. Sound levels are measured at different location at different time interval for the respective study locations with the help of a standard Sound meter. It was found that the noise levels for both study locations are much higher that exceed the allowable permissible noise limits. The study suggests that noise path must be controlled by using appropriate sound barriers that can reflect and diffuse noise appropriately and particularly use of sound enclosure can reduce noise level.

Key words: Noise pollution, sound level, permissible exposure level.

INTRODUCTION

Sylhet city is one of the largest cities of Bangladesh in the northeast portion of the country. Sylhet is the 4th largest city of Bangladesh by the population. It covers an area of 26.5 km^2. Day by day the unplanned Urbanization is going on in this city in a threaten way. Infrastructure is not developing in the right places. As a result of unplanned urbanization, hospitals, schools, colleges and universities like sensitive institutions are building in the noisy area (Shilpy, 2007).

The noise pollution is one of the major problems for developing countries like Bangladesh. Sylhet city is one of the largest cities of Bangladesh in the northeast portion of the country (Shilpy, 2007). The noise originates from human activities, especially the urbanization and the development of transport and industry. Measuring noise levels and workers' noise exposures is the most important part of a workplace hearing conservation and noise control program. It helps identify work locations where there are noise problems, employees who may be affected, and where additional noise measurements need to be made (Asthana and Asthana, 2013). Noise is any sound-independent of loudness- that can produce an undesired physiological or psychological effect in an individual, and that may interfere with the social ends of an individual group (Mackenzie and David, 2006).

Noise level was measured at two points which were considered as silent zones and at every point the noise level exceeded the permissible value. In this study the highest noise level found at Biroti CNG refueling Station, Mira Bazaar. Also we analyze the noise level & exposure level of Power Generator of Power Development Board (PDB). The selected Power Development Board and some CNG refueling stations were located near the residence rather than a safe distance away from the

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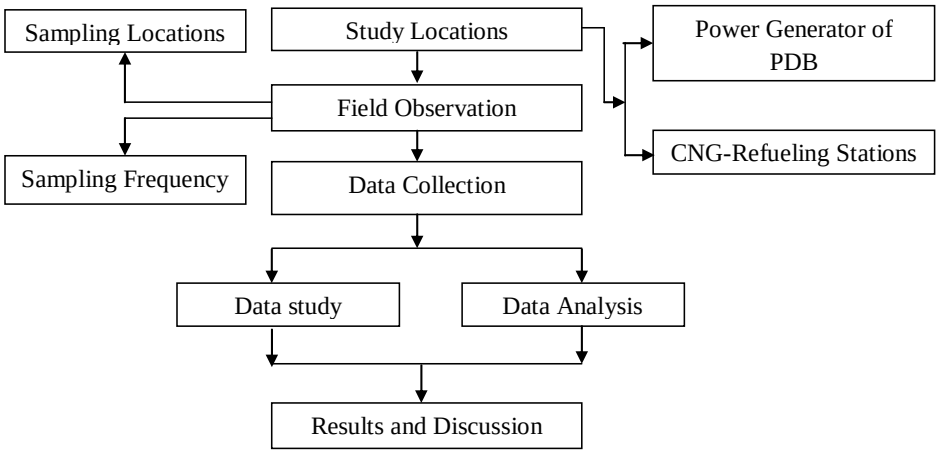

Figure 1. Flow chart of methodology which illustrates the methodology to assess the noise pollution of two major point of Sylhet City.

roadside.

METHODOLOGY

Noise measurement is an important diagnostic tool in noise control technology. The objective of noise measurement is to make accurate measurements which give us a purposeful act of comparing noises under different conditions for assessment of adverse impacts of noise and adopting suitable control techniques for noise reduction (Shilpy, 2007).

Noise measurements are usually conducted for one of three purposes:

1. To understand the mechanisms of noise generation so that engineering methods can be applied to control the noise.
2. To rate the sound field at various locations on a scale related to the physiological or psychological effects of noise on human beings.
3. To rate the sound power output of a source, usually for future engineering calculations, that can the sound pressure it produces at a given location.

The flow diagram that depicts the methodology of the method is shown in Figure 1.

Sampling method

All the measurements were made on "A – weighting "scale and the sound level meter were switched to fast response position. During each hourly interval, sound levels have been measured for 10 s,1 min,5 min and 10 min for a couple of times .The average values of these measurements have been recorded as the sound level for the corresponding location and time interval. Data collected was analyzed statistically to determine L_{10}, L_{50}, L_{90}, L_{max}, L_{ae} and L_{aeq}. The average values of these measurements have been recorded as the sound level for the corresponding location and time interval (Shilpy, 2007).

Sampling frequency

Noise levels measured at 2 different locations in the Sylhet city. These are power generators of PDB, CNG refueling stations. For collecting data of noise level of Power generators of PDB, CNG refueling stations are always running for all day long and there is no change sound level. Sound levels were measured for 10 s, 1 min, 5 min and 10 min for each point.

Field survey

The field survey can be classified chronologically (Shilpy, 2007) as:

1. Field super vision
2. Data collection
3. Sampling and
4. Tabulation.

The survey can be classified into two types; first one is quantitative survey, and another is qualitative survey. The planning of survey is the combination of technical and organizational decisions. The following field investigations and surveys were undertaken:

1. Investigation in the CNG stations and power generators of PDB located on the major locations of Sylhet city.
2. There overall conditions such as sound proofing facilities, sound barrier, and other types of protection measures and categorized the effect of noise on the city dwellers.
3. Noise level measured on those specific locations according to the different time interval.
4. To find out the relationship of noise level among those specified locations.
5. Noise level measured for an ideal case.
6. In our analysis, we took noise level (dBA) just for one minute for each location.
7. In the analysis, we neglected L_{95}, L_{pA}, and L_5 noise parameter.

Sampling location

Power generators PDB is situated in Kumargaon, Sylhet and some CNG refueling stations are situated in commercial and residential area in the Sylhet city. The following CNG refueling stations was observed (Table 1).

DATA ANALYSIS AND DISCUSSION

Noise level parameter such as L_{eq}, L_E, L_{max}, L_5, L_{10}, L_{50},

Table 1. Observed stations.

Obs. point	Name of CNG-refueling stations
P1	Jess Intraco CNG Refueling station, Kumargaon
P2	Ahmad CNG Refueling station Subidbazar
P3	Northeast CNG Refueling station Modina Market
P4	Uttara CNG Refueling station, Shibgonj.
P5	DibaRatri CNG Refueling station, Moulovibazar Road
P6	Surma Auto Care, East Shibgonj
P7	Monwar CNG Refueling station East Shibgonj
P8	Biroti CNG Refueling station, Mirabazar
P9	Navana CNG Refueling station, Chowkidekhi
P10	Karimullah CNG Refueling station, Naiorpul

Table 2. Permissible noise levels in different types of location [Environment (Protection) Rules, 1986].

Area code	Permissible noise levels limits (dB)	
	Day (6 am to 9 pm)	Night (9 pm to 6 am)
Industrial area	75	65
Commercial area	65	55
Residential area	55	45
Silence zones	45	35
Educational institutions	40	30

L_{90}, L_{95}, and L_{pA} are important parameter for the noise pollution survey. That parameter has been measured at different locations in Sylhet City (Table 2), which has never been previously surveyed (Shilpy, 2007).

Analysis of noise level of CNG refueling station

Table 3 shows the noise level in various CNG refueling stations at Sylhet. It shows that noise levels differs from each observation point. Some of the CNG refueling stations are located near the residential areas. From Table 1, we know in residential areas the noise level is 55 dB in day time and 45 dB at night time. Each of these CNG refueling station produce greater amount of noise. The measurement shows that the noise levels exceed the Permissible noise levels. Noise Levels (dBA) of L_{eq}, L_{AE}, L_{max}, L_{10}, L_{50} and L_{90} at Various Locations are shown in Table 3.

L_{eq}

To show the overall picture of noise level at CNG refueling station the following graphs is plotted. This represents that in ten different CNG refueling station noise level is between 84.8 to 90.0 dBA. The curve shows that peak value is 90.0 dBA which is obtained in P8 point (Figure 2).

L_{AE}

The following graph shows the noise level between 101.9 to 107.8 dBA. The curve shows that peak value is 107.8 dBA which is obtained in P8 point (Figure 3).

L_{max}

The following curve shows that peak value is 93.1 dB which is obtained in P4 observation point. We found another highest value which is observed at P8 point and the observed value is 92.0 dB (Figure 4).

L_{10}

The following figure shows that peak value is 90.7 dB which is obtained in P8 point (Figure 5). Here the sound level exceeded 10% of the time (Peak level).

L_{50}

The following curve shows that peak value is 90.0 dB (Figure 6). Here the Sound level exceeded 50% of the time (average or mean value).

L_{90}

The following curve shows that peak value is 89.3 dB

Table 3. Noise level in various CNG refueling station at Sylhet.

Obs. point	L_{eq}	L_{AE}	L_{max}	L_{10}	L_{50}	L_{90}
P1	84.8	102.6	87.6	86.0	85.4	81.6
P2	86.2	104.0	91.6	87.3	86.5	84.0
P3	87.6	104.5	89.8	86.4	85.2	83.6
P4	87.2	103.9	93.1	90.5	89.2	86.3
P5	85.3	101.9	86.3	82.9	80.5	78.5
P6	87.4	105.2	88.7	87.8	87.4	87.0
P7	86.2	103.9	88.1	86.9	85.4	84.5
P8	90.0	107.8	92.0	90.7	90.0	89.3
P9	85.1	102.9	91.8	85.5	85.0	84.5
P10	88.5	105.3	89.3	85.4	84.7	83.2

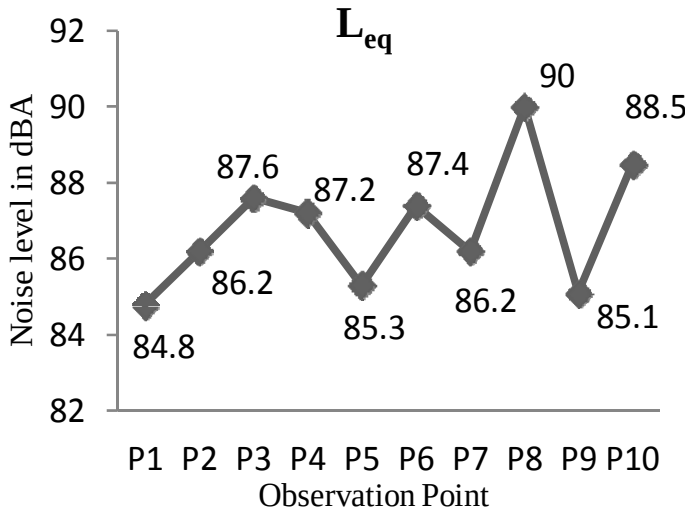

Figure 2. Noise levels at different CNG refueling station.

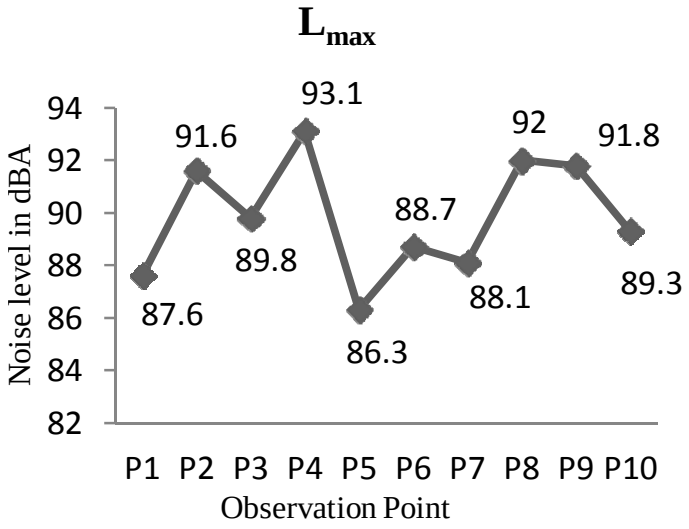

Figure 4. Noise levels at different CNG refueling station.

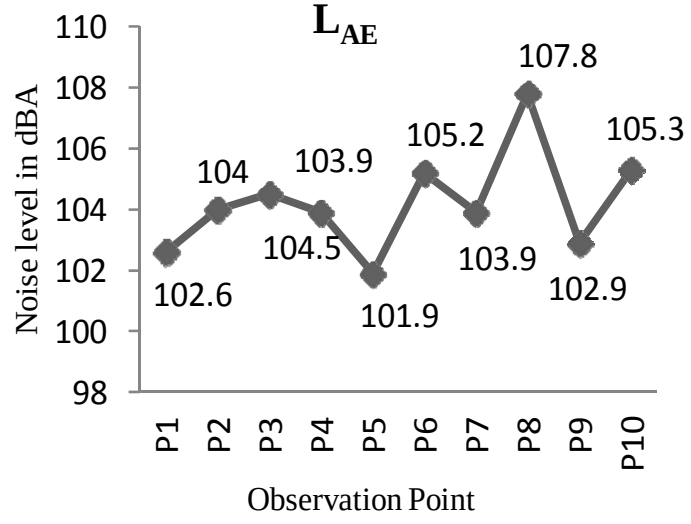

Figure 3. Noise levels at different CNG refueling station.

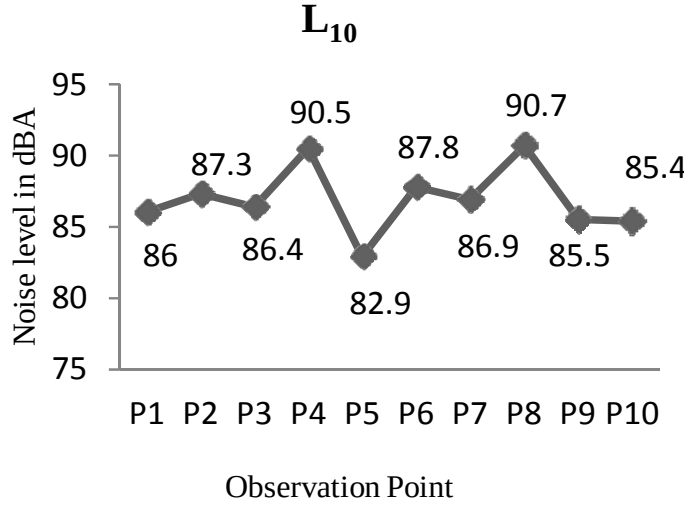

Figure 5. Noise levels at different CNG refueling station.

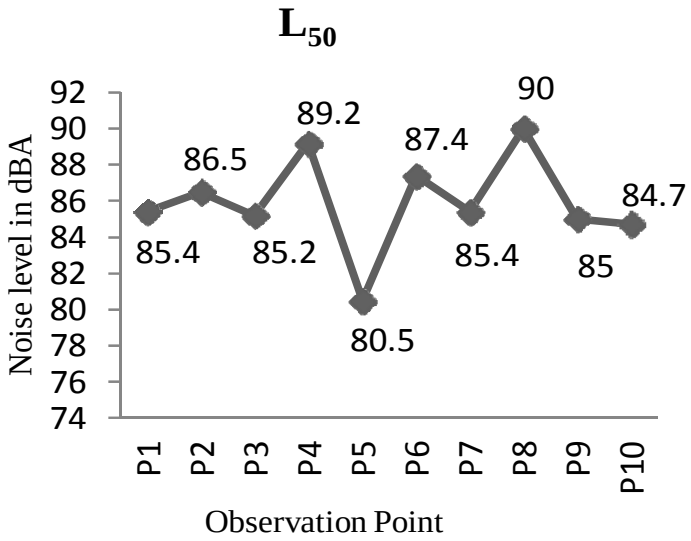

Figure 6. Noise levels at different CNG refueling station.

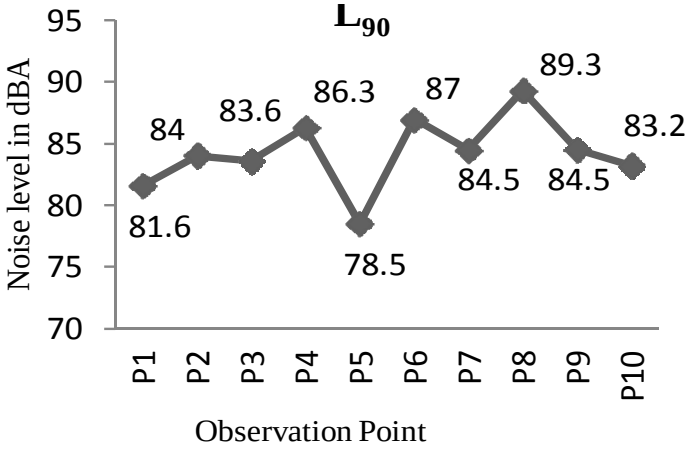

Figure 7. Noise levels at different CNG refueling station.

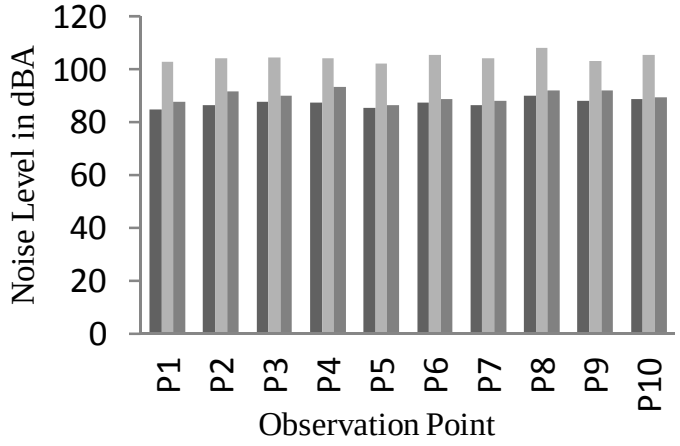

Figure 8. L_{eq}, L_{AE}, L_{max} of CNG-stations.

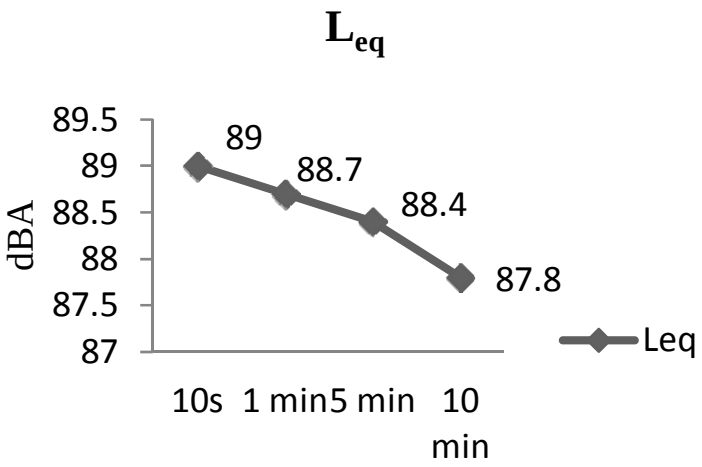

Figure 9. Noise levels at different time interval.

(Figure 7). Here the sound level exceeded 90% of the time (ambient level).

The variation and fluctuation of noise level at ten different CNG filling stations at Sylhet city is presented in the Figure 8. Figure shows the graphical presentation of L_{eq}, L_{AE}, L_{max} of filling stations noise level. Finally, from CNG refueling station Analysis, highest noise level found at Biroti CNG refueling Station, Mira bazaar is 90.0 dBA.

Analysis of noise level of PDB (Power generators), Kumargaon, Sylhet

Tables 4 and 5 shows the noise level in Kumargaon Power development board at Sylhet. It shows that noise levels are relatively same in four different time intervals. But in combination of three power generator the noise level is higher than others. From Table 1, we know in residential areas the noise level is 55 dB in day time and 45 dB at night time. But the measurement shows it exceed the permissible noise levels. Noise Levels (dBA) L_{eq}, L_{AE}, L_{max}, L_{PA}, L_{A5}, L_{10}, L_{50}, L_{90} and L_{95} at two generators are shown in both Tables 4 and 5.

L_{eq}

To show the overall picture of noise level covering whole day measurement the following graphs is plotted. This represents that in 150 MW generators noise level is between 87.8 to 89.0 dBA. The curve shows that peak value is 89.0 dBA obtained in 10 s time interval (Figure 9).

L_{50}

The following graph shows the noise level in 150 MW generators which vary between 86.5 to 88.9 dBA.

Table 4. Data of Noise Level Parameters in Kumargaon PDB (150 MW).

Time interval	L_{eq}	L_{AE}	L_{max}	L_{10}	L_{50}	L_{90}	L_{95}
10 s	89.0	99.0	89.6	89.3	88.9	88.7	88.5
1 min	88.7	106.5	90.4	89.2	88.7	88.3	88.2
5 min	88.4	113.1	90.4	88.7	88.3	88.0	88.0
10 min	87.8	116.3	89.5	87.8	86.5	86.1	86.0

Table 5. Noise level parameters in Kumargaon PDB combined power generator (150+20+10 MW).

Time interval	L_{eq}	L_{AE}	L_{max}	L_{10}	L_{50}	L_{90}	L_{95}
10 s	93.2	104.3	95.4	89.8	90.3	91.3	89.8
1 min	90.8	108.6	92.5	92.3	90.8	92.5	90.7
5 min	89.7	112.8	91.5	86.2	87.3	90.5	89.8
10 min	88.6	116.7	90.6	87.3	86.5	85.4	85.0

The curve shows that peak value is 88.9 dBA (Figure 10) which is obtained in 10 s interval.

L_{90}

The following curve shows that peak value is 88.7 dB (Figure 11) which is obtained in 10 s time interval.

Noise level analysis for combined (150+10+20 MW) generator

From Table 5, graphical presentation of L_{eq}, L_{50} and L_{90} are shown in the following graph.

L_{eq}

The following graph shows the noise level for combined generators which vary between 88.6 to 93.2 dBA. The curve shows that peak value is 93.2 dBA (Figure 12) which is obtained in 10 s interval.

L_{50}

The following graph shows the noise level for combined generators which vary between 86.5 to 90.8 dBA. The curve shows that peak value is 90.8 dBA (Figure 13) which is obtained in 10 s interval.

L_{90}

The following curve shows that peak value is 92.5 dB (Figure 14) which is obtained in 10 s time interval.

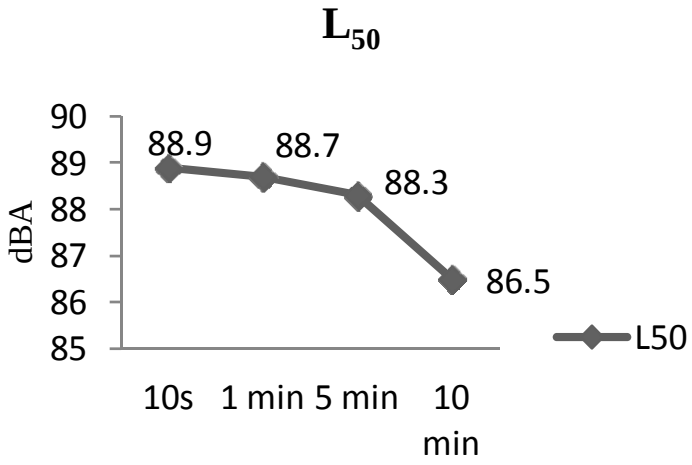

Figure 10. Noise levels at different time interval.

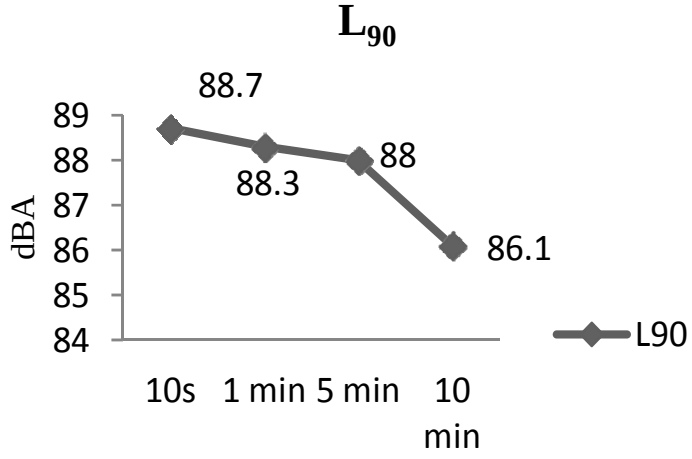

Figure 11. Noise levels at different time interval.

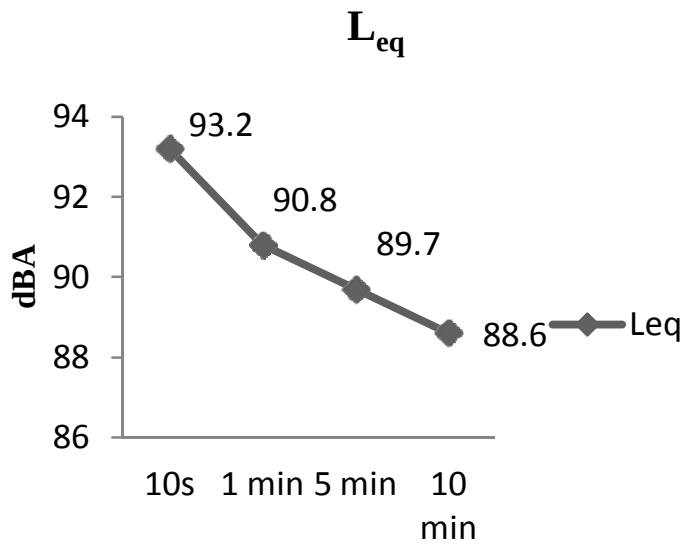

Figure 12. Noise levels at different time interval.

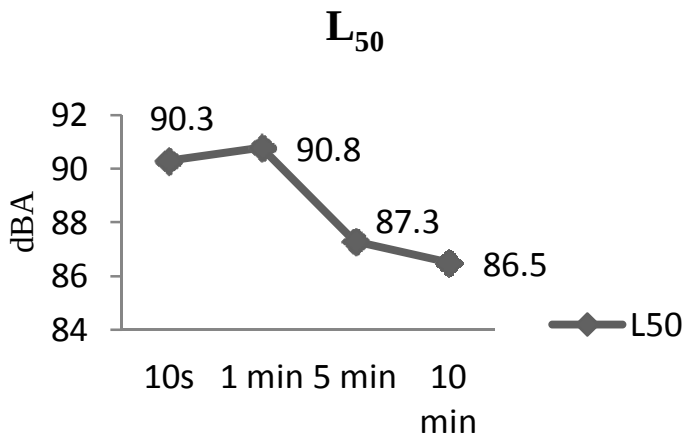

Figure 13. Noise levels at different time interval.

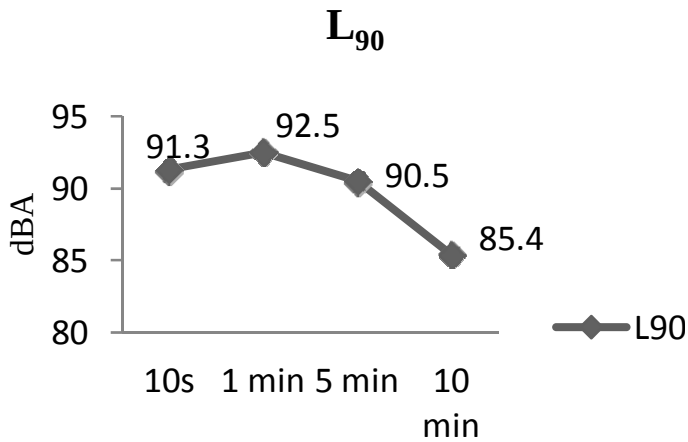

Figure 14. Noise levels at different time interval.

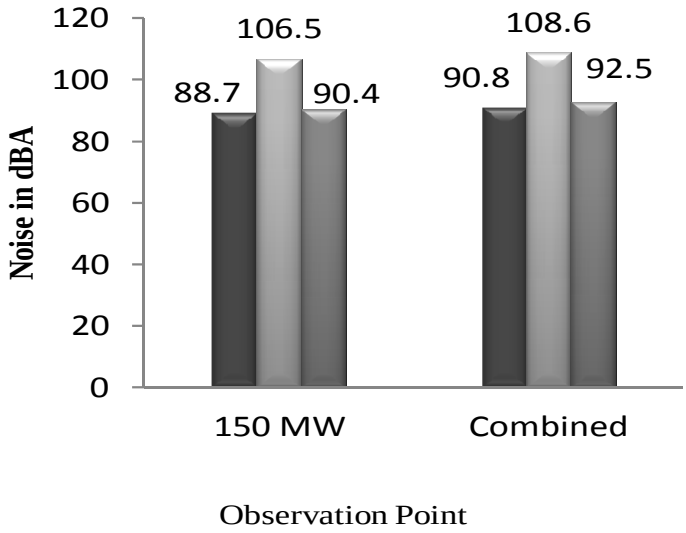

Figure 15. Comparision of L_{eq}, L_{AE}, L_{max} of PDB power generators.

As we plot the dBA versus observation point graph it shows the comparison between two observed areas noise level. Noise level increases for combined power generator. For rapid urbanization process noise increase at the same rate as it is the one of the major need of people. So it can be said that in future noise level will be increased at some rate. The variation and fluctuation of noise level at Kumargaon Power Development Board, Sylhet is presented in the Figure 15. The figure shows the graphical presentation of L_{eq}, L_{AE}, L_{max} of PDB noise level. Finally, from PDB (power generator) analysis, highest noise level found at Combined power generator is 93.2 dBA and noise level lies between 87.8 and 93.2 dBA.

Exposure level analysis

The amount of exposure time is reduced as the noise level increase. These time limits are shown in Table 6 for noise levels ranging from 90 to 115 dBA. As shown in the table, the allowable exposure time is cut in half each time the noise level increase by 5 dBA. For example, at 90 dBA, the allowable exposure is 8 h, but at 95 dBA, the allowable exposure is 4 h, and at 100 dBA it is reduced to 2 h. When a person is exposed to different noise levels throughout an 8 h period, the combined effect must be considered. This is done by calculating a combined exposure fraction, using the following equation (Gayle and Dianna, 1997)

$$\sum_{i=1}^{n} \frac{Ci}{Ti}$$

Where, n is the number of different noise levels, C_i is the

Table 6. Permissible noise exposures.

Noise duration per day, Ti (h)	Sound level dBA slow response (dB)
8	90
6	92
4	95
3	97
2	100
1.5	102
1	105
0.5	110
0.25 or Less	115

Source: Gayle and Dianna (1997).

Table 7. Noise levels.

Noise levels (dBA)	Actual exposure time (Ci)
99.0	4 h
106.5	2 h
113.1	1 h
116.3	45 min

amount of time a person is exposed to noise level i, and T_i is the total amount of time permitted at that noise level. Any amount of time the person is exposed to noise levels of less than 90 dBA is not include in the sum. If the sum of the individual C/T fraction is grater then 1.0, the allowable exposure is exceeded. If the allowable exposure is exceeded, the employer must be use administrative and engineering controls to reduce the exposure to allowable levels. The limits in Table 6 are based on continuous noise, not intermittent or impact-type noise (Gayle and Dianna, 1997).

Exposure level analysis of PDB (power generators)

Exposure level analysis for 150 MW generators

From Table 4, value of exposure (L_{AE}) level 99.0 dBA was measured for 10 s time duration. Similarly, 106.5 dBA was measured for 1 min, 113.1 dBA was measured for 5 min and 116.3 dBA was measured for 10 min time duration. From above literature, exposure level calculations require 4 h, 2 h, 1 h and 45 min noise level observations. But in this study it was not possible to take measurement for longer time duration such as for 4 h, 2 h, 1 h and 45 min. So for analysis we assume, at 99 dBA, the allowable exposure (Ci) is 4 h, 106.5 dBA the allowable exposure (Ci) is 2 h, 113.1 dBA the allowable exposure (Ci) is 1 h, 116.3 dBA the allowable exposure (Ci) is 45 min. Then noise level can be expressed as shown in Table 7.

Table 8. Exposure level analysis for PDB combined (150+20+10 MW) power generators.

Noise levels (dBA)	Actual exposure time (Ci)
104.3	4 h
108.6	2 h
112.8	1 h
116.7	45 min

Now exposure fraction calculation for 99 dBA can be written as (Table 7):

Actual exposure fraction (Ci) ÷ Duration per day (Ti) = 4 ÷ 2 = 2

Similarly we can write,

Exposure fraction for 106.5 dBA = 2 ÷ 1 = 2
Exposure fraction for 113.1 dBA = 1 ÷ 0.5 = 2
Exposure fraction for 116.3 dBA = 0.75 ÷ 0.25 = 3

Then sum of the exposure fraction is,

2 + 2 + 2 + 3 = 9

Because the total exposure fraction is 9.0 is more greater than 1.0, the allowable exposure level is exceeded.

Exposure level analysis for PDB combined (150+20+10 MW) power generators

From Table 5, exposure level can be analyzed for combined generator.

Now exposure fraction calculation for 104.3 dBA (Table 8) can be written as,

Actual exposure fraction (Ci) ÷ Duration per day (Ti) = 4 ÷ 1 = 4

Similarly we can write,

Exposure fraction for 108.6 dBA = 2 ÷ 0.5 = 4
Exposure fraction for 112.8 dBA = 1 ÷ 0.5 = 2
Exposure fraction for 116.7 dBA = 0.75 ÷ 0.25 = 3

The sum of the exposure fraction is,

4 + 4 + 2 + 3 = 13

Because the total exposure fraction is 13.0 is more greater than 1.0, the allowable exposure level is exceeded. Figure 16 shows the exposure level of both generators.

Noise measuring device

In this study we use integrating sound level meter NL-07 which allows not only conventional sound pressure level

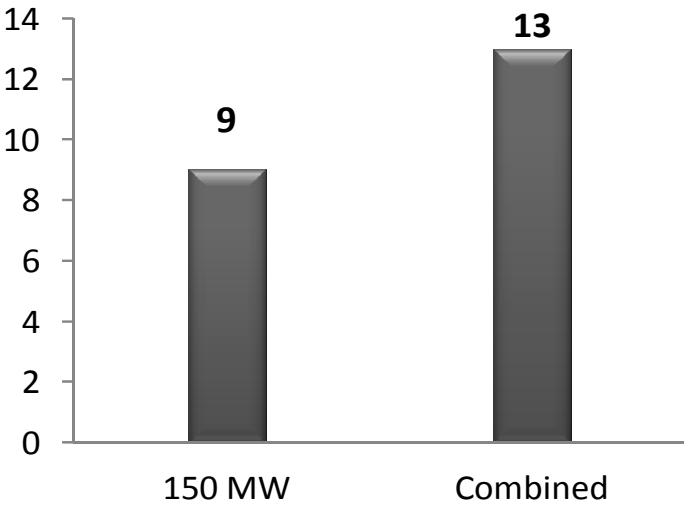

Figure 16. Exposure level of PDB Kumargaon, Sylhet.

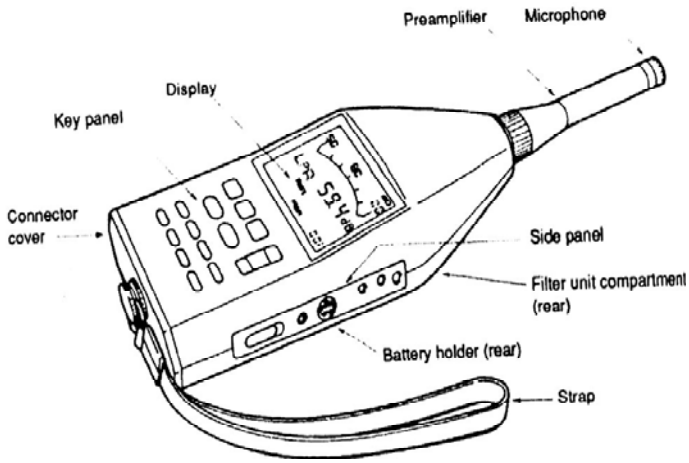

Figure 17. Noise level meter.

measurements, but also incorporate processing functions, which make it possible to determine equivalent continuous sound pressure level L_{eq} sound exposure level L_e, percentile sound pressure level L_x (L_5, L_{10}, L_{50}), maximum sound pressure level L_{max} (Shilpy, 2007).

The large, backlit display shows measurement results in numerical form and on a graphical scale, and gives information on measurement parameters and settings. The wide display range of 70 dB for numerical indication and 60 dB for graphical indication make range switching virtually unnecessary during normal measurements. A typical Noise Level Meter (NL07) has been shown in Figure 17 (Shilpy, 2007).

Conclusion

The result of the study reported in this paper is that noise level in Sylhet City near the vulnerable industry, CNG refueling stations and Kumargaon PDB, noise level are much higher than the acceptable limit; consequently careful measures should be taken to design and construct sides of the buildings which are situated in noisy area, people awareness should be increased by undertaking programs, respective authority should take effective measures to reduce noise level as soon as possible because it is high time to take initiatives against noise pollution; otherwise the environment of Sylhet City will be unfavorable to live in.

Conflict of Interests

The author(s) have not declared any conflict of interests.

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