Status of Noise Environment Around Sindri Township, Post Closure FCIL

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Abstract

Noise is a major environmental issue, particularly in urban areas, affecting a large number of people. To date, most assessments of the problem of environmental noise have been based on the annoyance it causes to humans, or the extent to which it disturbs various human activities. Assessment of health outcomes potentially related to noise exposure has so far been limited. However, the important outcomes related to environmental noise include cardiovascular disease, cognitive impairment, sleep disturbance, tinnitus, annoyance, etc. Considering all these aspects, an assessment has been conducted through this study for integrating the present scenario of environmental status after closure of FCI, Sindri Unit in the area.

Keywords: Annoyance, cardiovascular disease, cognitive impairment, tinnitus

I. INTRODUCTION

There is sufficient evidence from large-scale epidemiological studies linking the population's exposure to environmental noise with adverse health effects. Therefore, environmental noise should be considered not only as a cause of nuisance but also a concern for public health and environmental health. It is estimated that DALYs lost from environmental noise in the western European countries are 61 000 years for ischaemic heart disease, 45 000 years for cognitive impairment of children, 903 000 years for sleep disturbance, 22 000 years for tinnitus and 654 000 years for annoyance. If all of these are considered together, the range of burden would be 1.0–1.6 million SDDALYs.1 This means that at least 1 million healthy life years are lost every year from traffic-related noise in the western European countries, including the EU Member States. Sleep disturbance and annoyance related to road traffic noise constitute most of the burden of environmental noise in western Europe [1]. Owing to a lack of exposure data in south-east Europe and the newly independent states, it was not possible to estimate the disease burden in the whole of the WHO European Region.

II. METHODOLOGY FOR DATA GENERATION

The following methodologies have been adopted for data generation and interpretation of the results:

1) dB = 10 x Log(x), where x = Sound Intensity
2) $L_{eq,\ day}$ (L_{eq} Value during day hours)
3) $L_{eq,night}$ (L_{eq} Value during night hours)
4) 24-hours Average Leq Value
5) Tabular representation between RMS Pressure (Dyne/Cm^2)
6) RMS Sound Particle Velocity (cm/sec)
7) RMS Sound Particle Motion at 1,000 Hz cm)
8) Sound Pressure level dB(A)
9) OHSAS Hearing Conservation Chart
10) Relation of Sound Intensity& Perceived Loudness including damage effect to hearing
11) Damage Risk Criteria for steady noise
12) Graphical Method for presentation of noise level against standard limit for day & night

The following tables have been used for evaluation of health impact on noise:

III. RESULTS & DISCUSSION

The annual status of environmental noise in the study area (Sindri) has been conducted as per standard practices and available guidelines [2].

Six sampling locations were fixed to determine the present status of environmental noise and it was compared with respect to CPCB standard. The noise monitoring locations has been presented in Table-1 and the locations have also been shown in the location map.

The noise monitoring have been conducted in the three seasons namely:

1) Post Monsoon - October 2012,
2) Winter - February 2013 and
3) Summer - June 2013.

A. Post Monsoon Study – 2012:

The post monsoon noise monitoring has been conducted from 13th October, 2012 to 27th October 2012 as per schedule given below:

1) On October 2012 day time study has been conducted on 13th October 2012 from 6 hrs to 10 hrs.
2) On 14.10.12 the study has been conducted from 10 hrs to 14 hrs.
3) On 27.10.12, the study has been conducted from 14 hrs to 18 hrs., and
4) On 20.10.12 the study has been conducted from 18 hrs to 22 hrs.

The consolidated value of noise has been presented in Table- 2 representing the day time noise level. The table also presents the minimum, maximum, average and Day time Leq of all the six stations. Similarly, the environmental noise for night hours has been monitored in two phases namely on 13.10.12 and 14.10.12. The noise level was measured on hourly basis from 22 hrs to 2 hrs and in the second phase, the noise level was measured on 28.10.12 from 2 hrs to 6 hrs. The collected data has been consolidated and presented in Table- 3 along with minimum, maximum, average and Night time Leq of all the six stations. The data have been computed in terms of Average Leq value for 24 hrs, Day time Leq value and Night time Leq value. These data have been compared with NAAQ Standard for day time and night time. These computed findings have been presented in Table-4 as representative noise environmental status for post monsoon season. The findings of the environmental noise level for the month of October 2012, (Fig. 1) have been also been graphically presented for 24-hrs Average Leq, Day time Average Leq and Night Time average Leq in comparison with Day time and Night time standards.

B. Sound Intensity Factor:

The sound intensity factor on the receptor has been computed using the following:

$dB = 10 \times \log(x)$

where x = sound intensity factor

The maximum Leq value during the month of October in day time has been computed equivalent to 58.1 dB which corresponds to sound intensity factor of 645,654 (as per Table-N-7). This value corresponds to perceived loudness in lower moderate loud probably due to light traffic noise. Similarly the minimum Leq value for day time has been computed as 51.6 which is equivalent to sound intensity factor of 144,544 (as per Table- 4) which corresponds to noise equivalent to just above the quiet loudness corresponding to above average living room. The Leq value in night hours has been found to vary between 49.2 dB(A) to 42.1 dB(A) corresponding to sound intensity factor equivalent 83,176 to 16,218 respectively. The sound intensity in night hours is low in comparison with day time sound intensity [3]. The impact of sound intensity in the environment does not draw any significant controversial remarks. A little intensity in sound intensity in day time appears probably due to movement of light vehicles and social activities in the study area. The results related to environmental noise level for the month of October have been compared with different guidelines such as Mechanical Characteristics of Sound Waves presented in Table--5 and OSHA Hearing Conservation Table presented in Table- 6. Due to plantation and vegetation in Sindri area, the variation in sound intensity has been recorded in narrow range. Noise level in Manohartand area which is less among noise of all the other stations may be due to location of the station in low lying area.

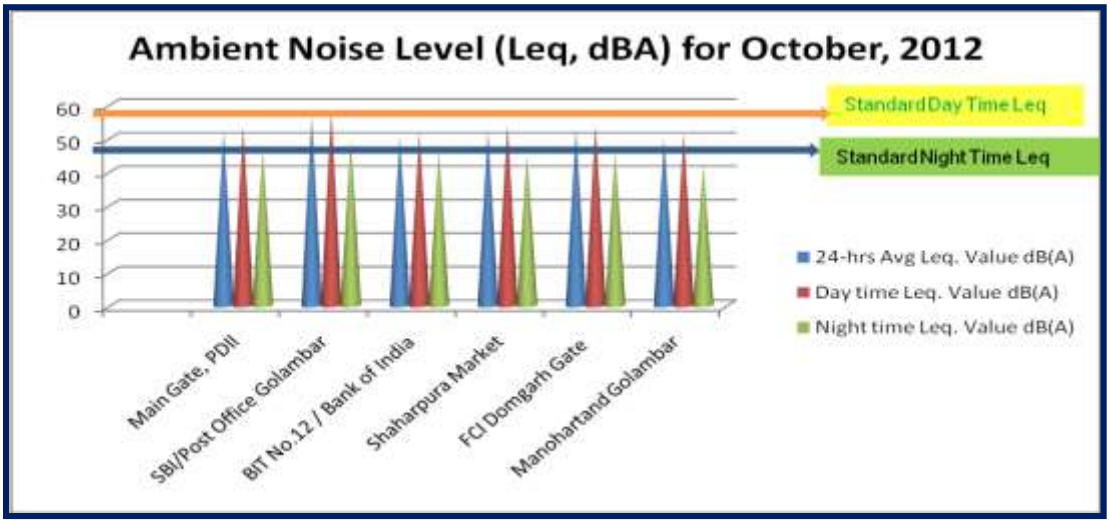

Fig. 1: Ambient Noise Level for Oct. 2012.

ii) Study Conducted during Winter Season (February 2013):

The noise monitoring during winter season has been conducted from 09th February, 2013 to 24th February 2013 as per schedule given below:

- In February 2013 day time study has been conducted on 09th February 2013 from 6 hrs to 10 hrs.
- On 10.02.13 the study has been conducted from 10 hrs to 14 hrs.
- On 23.02.13, the study has been conducted from 14 hrs to 18 hrs., and
- On 24.02.13 the study has been conducted from 18 hrs to 22 hrs.

The consolidated value of noise has been presented in Table- 7 representing the day time noise level. The table also presents the minimum, maximum, average and Day time Leq of all the six stations.

Similarly, the environmental noise for night hours has been monitored in two phases namely on 09.02.13 and 10.02.13. The noise level was measured on hourly basis from 22 hrs to 2 hrs and in the second phase, the noise level was measured on 23.02.13 from 2 hrs to 6 hrs. The collected data has been consolidated and presented in Table- 8 along with minimum, maximum, average and Night time Leq of all the six stations.

The data have been computed in terms of Average Leq value for 24 hrs, Day time Leq value and Night time Leq value. These data have been compared with NAAQ Standard for day time and night time. These computed findings have been presented in Table-N-11 as representative noise environmental status for winter season. The findings of the environmental noise level for the month of February 2013 have been also been graphically presented for 24-hrs Average Leq, Day time Average Leq and Night Time average Leq in comparison with Day time and Night time standards through Figure-1.

C. *Sound Intensity Factor:*

The formula for computation of sound intensity factor on the receptor has been presented in Post Monsoon study. The maximum Leq value during the month of February in day time has been computed equivalent to 55.1 dB which corresponds to sound intensity factor of 323594 (as per Table- 9). This value corresponds to perceived loudness in lower moderate loud probably due to light traffic noise. Similarly the minimum Leq value for day time has been computed as 48.9 which is equivalent to sound intensity factor of 77,625 (as per Table-9) which corresponds to noise equivalent to just above the quiet loudness corresponding to above average living room. The Leq value in night hours has been found to vary between 46.7 dB(A) to 39.9 dB(A) corresponding to sound intensity factor equivalent 46,774 to 9,772 respectively. The sound intensity in night hours is low in comparison with day time sound intensity. The impact of sound intensity in the environment does not draw any significant controversial remarks. A little intensity in sound intensity in day time appears probably due to movement of light vehicles and social activities in the study area. The results related to environmental noise level for the month of February 2013 (fig. 2) have been compared with different guidelines such as Mechanical Characteristics of Sound Waves presented in Table-N-5 and OSHA Hearing Conservation Table presented in Table-N-6.

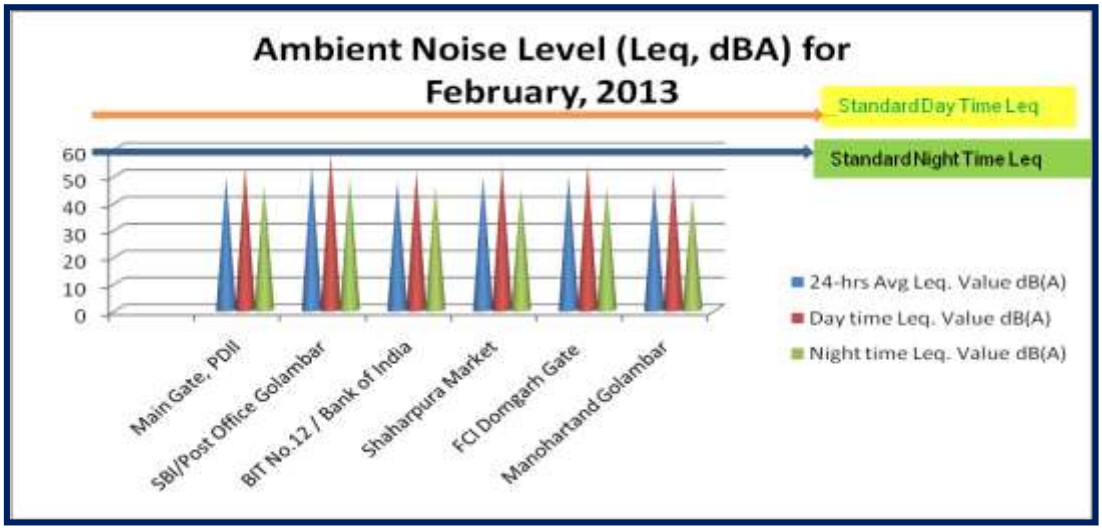

Fig. 2: Summary of Ambient Noise Monitoring during Winter Season

ii) Study Conducted during Summer Season (June 2013):

The noise monitoring during June season has been conducted from 08th June, 2013 to 22nd June 2013 as per schedule given below:

- In June 2013 day time study has been conducted on 08th June from 6 hrs to 10 hrs.
- On 09.06.13 the study has been conducted from 10 hrs to 14 hrs.
- On 22.06.13, the study has been conducted from 14 hrs to 18 hrs., and
- On 23.06.13 the study has been conducted from 18 hrs to 22 hrs.

The consolidated value of noise has been presented in Table- 10 representing the day time noise level. The table also presents the minimum, maximum, average and Day time Leq of all the six stations. Similarly, the environmental noise for night hours has been monitored in two phases namely on 08.06.13 and 09.06.13. The noise level was measured on hourly basis from 22 hrs to 2 hrs and in the second phase, the noise level was measured on 22.06.13 from 2 hrs to 6 hrs. The collected data has been consolidated and presented in Table-11 along with minimum, maximum, average and Night time Leq of all the six stations.

The data have been computed in terms of Average Leq value for 24 hrs, Day time Leq value and Night time Leq value. These data have been compared with NAAQ Standard for day time and night time. These computed findings have been presented in Table- 12 as representative noise environmental status for summer season. The findings of the environmental noise level for the month of June 2013 have been also been graphically presented for 24-hrs Average Leq, Day time Average Leq and Night Time average Leq in comparison with Day time and Night time standards through Figure-2.

D. Sound Intensity Factor:

As per the formula given in Post Monsoon season, the maximum Leq value during the month of June 2013 in day time has been computed equivalent to 61.1 dB which corresponds to sound intensity factor of 12,88,250 (as per Table-12). This value corresponds to perceived loudness in very loud probably due to social activities like marriage related activities.

Similarly the minimum Leq value for day time has been computed as 54.3 which is equivalent to sound intensity factor of 2,69,153 (as per Table-12) which corresponds to noise equivalent to just above the moderate noise. The Leq value in night hours has been found to vary between 51.7 dB(A) to 44.2 dB(A) corresponding to sound intensity factor equivalent 1,47,911 to 26,303 respectively. The sound intensity in night hours is low in comparison with day time sound intensity. The impact of sound intensity in the environment does not draw any significant controversial remarks. A little noise in sound intensity in day time appears probably due to movement of light vehicles and social activities in the study area. Results related to environmental noise level for the month of June 2013 (Fig. 3) have been compared with different guidelines such as Mechanical Characteristics of Sound Waves presented in Table-N-5 and OSHA Hearing Conservation Table presented in Table-N-6 (Fig. 4).

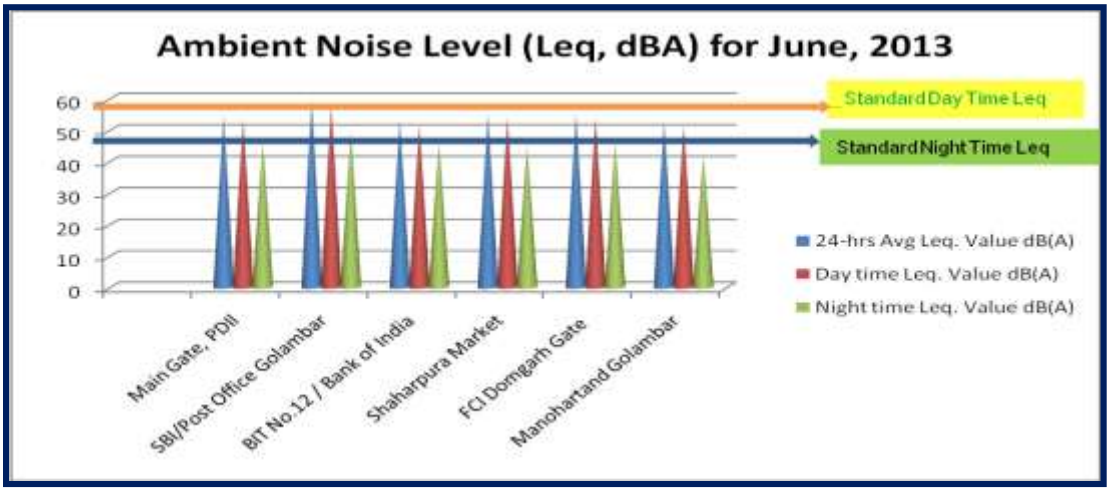

Fig. 3: Summary of Ambient Noise Monitoring during Summer Season

E. Assessment of Environmental Noise Pollution Exposure:

Assessment of exposure to noise requires consideration of many factors, including: Population noise exposure in this publication is based on the noise mapping mandated by the END, using the annual average metrics of L_{den} (day-evening-night equivalent level) and L_{night} (night equivalent level) proposed in the Directive.

$L_{den} = 10 \times \lg (1/24) \times \{12 \times 10^{\wedge}(L_{day}/10) + 4 \times 10^{\wedge}((L_{evening}+5)/10) + 8 \times 10^{\wedge}((L_{night} + 10)/10)\}$

With $L_{day} = L_{eq,12h}$, $L_{evening} = L_{eq,4h}$

and $L_{night} = L_{eq,8h}$

with $L_{eq,th}$ the A weighted equivalent sound pressure level over "t" hours outside at the most exposed façade.

F. Environmental Noise Pollution Exposure–response relationships for Cardiovascular Diseases:

Numerical meta-analyses were carried out assessing exposure–response relationships between community noise and cardiovascular risk. A polynomial function was fitted through the data points from the analytic studies within the noise range from 55 to 80 dB(A). The risk related to ischemic heart disease, including myocardial infarction and high blood pressure is important.

OR (Odds Ratio) = $1.63 - 6.13 \times 10^{-4} \times L^2_{day,16h} + 7.36 \times 10^{-6} \times L^3_{day,16}$

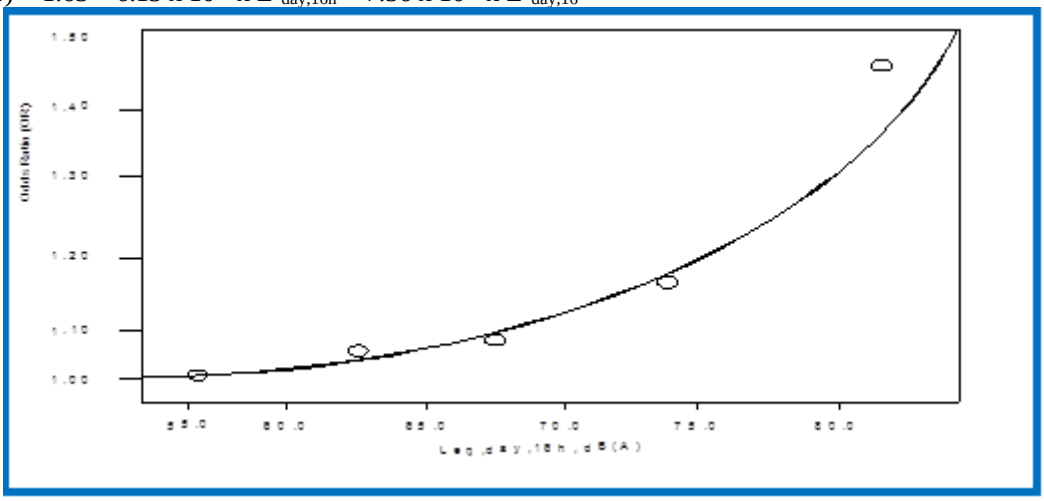

Fig. 4: Relationship between Noise Level and Odds Ratio

G. Environmental Noise Pollution exposure– response relationship for Sleep disturbance:

The percentage of "highly sleep disturbed" persons (HSD) as a function Lnight was calculated with the equation:

$$HSD\ (\%) = 20.8 - 1.05 \times L_{night} + 0.01486 \times L^2_{night}$$

H. Environmental Noise Pollution exposure– response relationship for Tinnitus:

Tinnitus is defined as the sensation of sound in the absence of an external sound source. Tinnitus caused by excessive noise exposure has long been described; 50% to 90% of patients with chronic noise trauma report tinnitus. In some people, tinnitus can cause sleep disturbance, cognitive effects, anxiety, psychological distress, depression, communication problems, frustration, irritability, tension, inability to work, reduced efficiency and restricted participation in social life.For tinnitus due to environmental noise, exposure to social/leisure noise such as personal music players, gun shooting events, music concerts, sporting events and events using firecrackers is most relevant for Western Europe and North American countries. Population-based studies associating exposure to leisure noise with the risk of tinnitus are rare. From studies on people with tinnitus, a mean prevalence was calculated of those with slight, moderate and severe tinnitus.

I. Environmental Noise Pollution exposure– response relationship for Annoyance:

WHO defines health as a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity? Therefore, a high level of annoyance caused by environmental noise should be considered as one of the environmental health burdens [4]. Standardized questionnaires are used to assess noise-induced annoyance at the population level. The percentage of highly annoyed is the most widely used prevalence indicator for annoyance in a population [5]. The percentage of "highly annoyed" persons (HA) due to road traffic noise was calculated with the equation:

$$HA[\%] = 0.5118 \times (L_{den} - 42) - 1.436 \times 10^{-2} \times (L_{den} - 42)^2 + 9.868 \times 10^{-4} \times (L_{den} - 42)^3$$

J. Assessment of Impact in terms of Odds Ratio for evaluation of Cardio Vascular Disease:

The degree of impact of Environmental Noise Pollution in relation to Card Vascular diseases has been estimated mathematically and graphically in terms of OR (Odds Ratio) with the result of noise level between 55 to 80 dB(A) on the basis of $L_{eq, day,16h}$.During the month of October 2012) only one value of 58.1 dB(A) has been recorded at SBI/ Post Office Golambar between 55-80 dB(A). During the month of February 2013 only one value of 55.1 dB(A) has been recorded at SBI/ Post Office Golambar between 55-80 dB(A). During the month of June 2013 noise level in the range of 55-80 dB(A) has been recorded at five locations except Manohartand Golambar. Based on above observations a minor probability of Cardo Vascular disease cannot be ruled out.

Exposure- response relationship due to environmental noise pollution and cardio vascular disease cannot be ruled out in the month of June at about 80% of the sampling locations [5], [6]. However, the probability of cardio vascular diseases is very poor due to calculated O.R. value equivalent to less than 1.02. Therefore, it is recommended that the outdoor movement of sensitive persons should be limited in the month of June.

K. Assessment of Impact on Cognitive Impairment of Children:

Based on available evidence, a hypothetical exposure–response relationship between noise level (L_{dn}) and risk of cognitive impairment was formulated: all of the noise exposed children were cognitively affected at a level as high as 95 dB(A) L_{dn}, and no children were affected at a relatively low level, such as 50 dB(A) L_{dn}. A linear relationship in the range of these two limits was assumed as a basis for a conservative approximation of YLD. Most of our result in day time has been found just above 50 dB(A). Hence, a poor probability of cognitive impairment in children cannot be ruled out more particularly movement of infants should be restricted in the month of June.

L. Assessment of Impact on Sleep Disturbance:

The percentage of "highly sleep disturbed" persons (HSD) as a function Lnight was calculated with the equation:

$$HSD\ (\%) = 20.8 - 1.05 \times L_{night} + 0.01486 \times L^2_{night}$$

In the month of October 2012 the minimum of noise level has been recorded as 42.1 dB(A) which corresponds to 2.93% of Highly Sleep Disturbed Persons and with maximum noise value of 49.2 dB(A) corresponds to 5.11% of Highly Sleep Disturbed Persons.

In the month of February 2013 the minimum of noise level has been recorded as 40.0 dB(A) which corresponds to 2.56% of Highly Sleep Disturbed Persons and with maximum noise value of 46.7 dB(A) corresponds to 4.17% of Highly Sleep Disturbed Persons. In the month of June 2013 the minimum of noise level has been recorded as 44.2 dB(A) which corresponds to 3.42% of Highly Sleep Disturbed Persons and with maximum noise value of 51.7 dB(A) corresponds to 6.23% of Highly Sleep Disturbed Persons.

M. Assessment of Impact on Annoyance:

The percentage of "highly annoyed" persons (HA) due to road traffic noise has been calculated with the following equation:

$$HA[\%] = 0.5118 \times (L_{den} - 42) - 1.436 \times 10^{-2} \times (L_{den} - 42)^2 + 9.868 \times 10^{-4} \times (L_{den} - 42)^3$$

In the month of October 2012 (Post-Monsoon) minimum Leq_{day} has been recorded as 51.6 dB(A) which corresponds to 4.46% HA and maximum Leq_{day} has been recorded as 58.1 dB(A) which corresponds to 8.64%HA. In the month of February 2013 (Winter) minimum Leq_{day} has been recorded as 48.9 dB(A) which corresponds to 3.17% HA and maximum Leq_{day} has been recorded as 55.1 dB(A) which corresponds to 6.46%HA. In the month of June 2013 (Summer) minimum Leq_{day} has been recorded as 54.3 dB(A) which corresponds to 5.96% HA and maximum Leq_{day} has been recorded as 61.1 dB(A) which corresponds to 11.41%HA. The calculation is based on the assumption is that the source of noise is only road traffic.

IV. CONCLUSION

1) Noise pollution is a complex socio-technical and political problem.
2) Unlike Air, Water & Soil, noise pollution is a transient and short-lived problem.
3) The problem related to noise is a serious concern related to rising living standard
4) Noise pollution can be easily tackled in comparison with air, water & soil pollution.
5) The present standard is based on OHSAS threshold tolerance limited.
6) The rising living standard may demand for better environmental quality related to the noise and more organization protest against noise is invariable and the concept of noise standard is likely to change from tolerance to comfortable level [7]
7) Some of the recent studies show that noise level of 50 dB(A) at night may increase the risk of chronic noise related diseases [8]
8) Noise Abatement through social, technical and political tool is highly warranted related to growth of parks, plantation, use of silencer, avoidance of loud speaker and stringent rules and regulation will help to provide comfortable noise environment.

Table – 1
Noise Level Monitoring Locations

Sl. No	*Location Code*	*Name of Monitoring location*
1	SN_1	*Main Gate, PDIl*
2	SN_2	*SBI/Post Office Golambar*
3	SN_3	*BIT No.12 / Bank of India*
4	SN_4	*Shaharpura Market*
5	SN_5	*FCI Domgarh Gate*
6	SN_6	*Manohartand Golambar*

Table – 2
Ambient Noise Level Data During Day Time (Month: Oct. 2012)

Time (Hrs)	*Noise Level, Leq (Hourly), dB(A)*					
	SN_1	SN_2	SN_3	SN_4	SN_5	SN_6
6.00 -7.00	*47.2*	*46.3*	*46.6*	*45.3*	*48.3*	*44.3*
7.00- 8.00	*46.5*	*47.8*	*48.2*	*46.3*	*52.3*	*45.6*
8.00- 9.00	*48.9*	*49.2*	*49.2*	*48.2*	*55.3*	*51.2*
9.00-10.00	*52.3*	*52.3*	*49.2*	*49.2*	*56.2*	*51.2*
10.00-11.00	*52.3*	*55.6*	*50.2*	*52.3*	*57.2*	*52.4*
11.00-12.00	*55.6*	*56.9*	*51.2*	*55.3*	*57.2*	*56.5*
12.00-13.00	*55.9*	*58.3*	*53.2*	*56.3*	*56.9*	*57.8*
13.00-14.00	*56.3*	*59.2*	*55.2*	*58.2*	*55.4*	*54.6*
14.00-15.00	*56.3*	*60.3*	*56.2*	*59.3*	*56.2*	*51.3*
15.00-16.00	*56.9*	*62.2*	*54.2*	*58.2*	*52.1*	*50.2*
16.00-17.00	*55.3*	*62.3*	*52.3*	*55.1*	*52.1*	*48.6*
17.00-18.00	*52.3*	*60.3*	*51*	*50.3*	*51.3*	*47.6*
18.00-19.00	*50.1*	*59.2*	*50.3*	*49.8*	*50.6*	*45.6*
19.00-20.00	*49.8*	*58.8*	*49.9*	*49.2*	*50.4*	*44.7*
20.00-21.00	*49.5*	*55.3*	*49.5*	*47.2*	*49.5*	*44.3*
21.00-22.00	*48.8*	*52.3*	*48.3*	*46.3*	*49.1*	*44.1*
Minimum	*46.5*	*46.3*	*46.6*	*45.3*	*48.3*	*44.1*
Maximum	*56.9*	*62.3*	*56.2*	*59.3*	*57.2*	*57.8*
Average	*52.1*	*56.0*	*50.9*	*51.7*	*53.1*	*49.4*
Leq (Day)	*53.4*	*58.1*	*51.7*	*54.0*	*54.1*	*51.6*

Table – 3
Ambient Noise Level Data During Night Time (Month: Oct. 2012)

Time (Hrs)	*Noise Level, Leq (Hourly), dB(A)*					
	SN_1	SN_2	SN_3	SN_4	SN_5	SN_6
22.00-23.00	*48.2*	*51.3*	*48.2*	*45.2*	*48.2*	*43.5*
23.00-24.00	*48.1*	*50.2*	*47.2*	*44.2*	*47.1*	*43.1*
24.00-1.00	*47.2*	*49.9*	*46.3*	*43.2*	*48.1*	*42.3*
1.00-2.00	*46.3*	*49.8*	*45.5*	*43.9*	*46.2*	*42.1*

2.00-3.00	*46.3*	*48.5*	*45.1*	*44.2*	*45.3*	*41.6*
3.00-4.00	*45.2*	*48.9*	*44.2*	*45.2*	*44.2*	*41.3*
4.00-5.00	*44.2*	*47.2*	*44.8*	*46.3*	*43.2*	*41.6*
5.00-6.00	*43.2*	*45.3*	*45.3*	*47.2*	*42.1*	*40.3*
Minimum	*43.2*	*45.3*	*44.2*	*43.2*	*42.1*	*40.3*
Maximum	*48.2*	*51.3*	*48.2*	*47.2*	*48.2*	*43.5*
Average	*46.1*	*48.9*	*45.8*	*44.9*	*45.6*	*42.0*
Leq (Night)	*46.4*	*49.2*	*46.0*	*45.1*	*46.0*	*42.1*

Table – 4

24. Hrs Average Leq Data of Ambient Noise Level (Month: Oct. 2012)

Sampling Locations	*24-hrs Avg Leq. Value dB(A)*	*Day time Leq. Value dB(A)*	*Night time Leq. Value dB(A)*	*Prescribed Limits in dB(A) as per NAAQS*		
				Category of Area	*Day Time*	*Night Time*
Main Gate, PDIl	*52.0*	*53.4*	*46.4*	*Residential Area*	*55*	*45*
SBI/Post Office Golambar	*56.6*	*58.1*	*49.2*	*Residential Area*	*55*	*45*
BIT No.12 / BOI	*50.5*	*51.7*	*46.0*	*Residential Area*	*55*	*45*
Shaharpura Market	*52.5*	*54.0*	*45.1*	*Residential Area*	*55*	*45*
FCI Domgarh Gate	*52.7*	*54.1*	*46.0*	*Residential Area*	*55*	*45*
Manohartand Golambar	*50.1*	*51.6*	*42.1*	*Residential Area*	*55*	*45*

Table – 5

Mechanical Characteristics of Sound Waves

	RMS Sound Presssure (Dyne/cm2)	*RMS Sound Particle Velocity (cm/sec)*	*RMS Sound Particle Motion at (1,000 Hz cm)*	*Sound Pressure Level (dB 0.0002 bar)*
Threshold of hearing	*0.0002*	*0.0000048*	*0.76 x $^{10-9}$*	*0*
	0.002	*0.000048*	*7.6 x 10^{-9}*	*20*
Quiet Room	*0.02*	*0.00048*	*7.60 x 10^{-9}*	*40*
	0.2	*0.0048*	*760 x 10^{-9}*	*60*
Normal speed at 3" Possible hearing impairment	*20.0*	*0.48*	*76.0 x10^{-6}*	*80*
	200.0	*4.8*	*760 x10^{-6}*	*100*
Threshold of Pain	*2000*	*48.0*	*7.60 x 10^{-3}*	*120*
Incipient mechanical damage	*20x10^{3}*	*480*	*76 x 10^{-3}*	*140*
	200x10^{3}	*4800*	*760 x10^{-3}*	*160*
Atmospheric Pressure	*2000x10^{3}*	*48000*	*7.6*	*180*

Table – 6

Osha Hearing Conservation Table

A-Weighted Sound Level, dB(A)	*Duration (Hours)*
80	*32*
85	*16*
90	*8*
95	*4*
100	*2*
105	*1*
110	*0.5*
115	*0.25*
120	*0.125*
125	*0.063*
130	*0.031*

Table – 7

Ambient Noise Level Data During Day Time Month : Feb. 2013

Time (Hrs)	*Noise Level, Leq (Hourly), dB(A)*					
	SN_1	*SN_2*	*SN_3*	*SN_4*	*SN_5*	*SN_6*
6.00 -7.00	*44.8*	*44.0*	*44.3*	*43.0*	*45.9*	*42.1*
7.00-8.00	*44.2*	*45.4*	*45.8*	*44.0*	*49.7*	*43.3*
8.00-9.00	*46.5*	*46.7*	*46.7*	*45.8*	*52.5*	*48.6*
9.00-10.00	*49.7*	*49.7*	*46.7*	*46.7*	*53.4*	*48.6*

10.00-11.00	*49.7*	*52.8*	*47.7*	*49.7*	*54.3*	*49.8*
11.00-12.00	*52.8*	*54.1*	*48.6*	*52.5*	*54.3*	*53.7*
12.00-13.00	*53.1*	*55.4*	*50.5*	*53.5*	*54.1*	*54.9*
13.00-14.00	*53.5*	*56.2*	*52.4*	*55.3*	*52.6*	*51.9*
14.00-15.00	*53.5*	*57.3*	*53.4*	*56.3*	*53.4*	*48.7*
15.00-16.00	*54.1*	*59.1*	*51.5*	*55.3*	*49.5*	*47.7*
16.00-17.00	*52.5*	*59.2*	*49.7*	*52.3*	*49.5*	*46.2*
17.00-18.00	*49.7*	*57.3*	*48.5*	*47.8*	*48.7*	*45.2*
18.00-19.00	*47.6*	*56.2*	*47.8*	*47.3*	*48.1*	*43.3*
19.00-20.00	*47.3*	*55.9*	*47.4*	*46.7*	*47.9*	*42.5*
20.00-21.00	*47.0*	*52.5*	*47.0*	*44.8*	*47.0*	*42.1*
21.00-22.00	*46.4*	*49.7*	*45.9*	*44.0*	*46.6*	*41.9*
Minimum	*44.2*	*44.0*	*44.3*	*43.0*	*45.9*	*41.9*
Maximum	*54.1*	*59.2*	*53.4*	*56.3*	*54.3*	*54.9*
Average	*49.5*	*53.2*	*48.4*	*49.1*	*50.5*	*46.9*
Leq (Day)	*50.6*	*55.1*	*49.1*	*51.2*	*51.4*	*48.9*

Table – 8

Ambient Noise Level Data During Night Time Month : Feb. 2013

Time (Hrs)	*Noise Level, Leq (Hourly), dB(A)*					
	SN_1	*SN_2*	*SN_3*	*SN_4*	*SN_5*	*SN_6*
22.00-23.00	*45.8*	*48.7*	*45.8*	*42.9*	*45.8*	*41.3*
23.00-24.00	*45.7*	*47.7*	*44.8*	*42.0*	*44.7*	*40.9*
24.00-1.00	*44.8*	*47.4*	*44.0*	*41.0*	*45.7*	*40.2*
1.00-2.00	*44.0*	*47.3*	*43.2*	*41.7*	*43.9*	*40.0*
2.00-3.00	*44.0*	*46.1*	*42.8*	*42.0*	*43.0*	*39.5*
3.00-4.00	*42.9*	*46.5*	*42.0*	*42.9*	*42.0*	*39.2*
4.00-5.00	*42.0*	*44.8*	*42.6*	*44.0*	*41.0*	*39.5*
5.00-6.00	*41.0*	*43.0*	*43.0*	*44.8*	*40.0*	*38.3*
Minimum	*41.0*	*43.0*	*42.0*	*41.0*	*40.0*	*38.3*
Maximum	*45.8*	*48.7*	*45.8*	*44.8*	*45.8*	*41.3*
Average	*43.8*	*46.4*	*43.5*	*42.7*	*43.3*	*39.9*
Leq (Night)	*44.1*	*46.7*	*43.7*	*42.8*	*43.7*	*40.0*

Table – 9

Summary Of Ambient Noise Level Data Month: Feb. 2013

Sampling Locations	*24-hrs Avg Leq. Value dB(A)*	*Day time Leq. Value dB(A)*	*Night time Leq. Value dB(A)*	*Prescribed Limits in dB(A) as per NAAQS*		
				Category of Area	*Day Time*	*Night Time*
Main Gate, PDIL	*49.3*	*50.7*	*44.1*	*Residential*	*55*	*45*
SBI/Post Office Golambar	*53.7*	*55.1*	*46.7*	*Residential*	*55*	*45*
BIT No.12 / BOI	*48.4*	*49.1*	*43.7*	*Residential*	*55*	*45*
Shaharpura Market	*49.7*	*51.2*	*42.8*	*Residential*	*55*	*45*
FCI Domgarh Gate	*50.0*	*51.4*	*43.7*	*Residential*	*55*	*45*
Manohartand Golambar	*47.4*	*48.9*	*40.0*	*Residential*	*55*	*45*

Table – 10

Ambient Noise Level Data During Day Time Month: June, 2013

Time (Hrs)	*Noise Level, Leq (Hourly), dB(A)*					
	SN_1	*SN_2*	*SN_3*	*SN_4*	*SN_5*	*SN_6*
6.00 -7.00	*49.6*	*48.6*	*48.9*	*47.6*	*50.7*	*46.5*
7.00-8.00	*48.8*	*50.2*	*50.6*	*48.6*	*54.9*	*47.9*
8.00-9.00	*51.3*	*51.7*	*51.7*	*50.6*	*58.1*	*53.8*
9.00-10.00	*54.9*	*54.9*	*51.7*	*51.7*	*59.0*	*53.8*
10.00-11.00	*54.9*	*58.4*	*52.7*	*54.9*	*60.1*	*55.0*
11.00-12.00	*58.4*	*59.7*	*53.8*	*58.1*	*60.1*	*59.3*
12.00-13.00	*58.7*	*61.2*	*55.9*	*59.1*	*59.7*	*60.7*
13.00-14.00	*59.1*	*62.2*	*58.0*	*61.1*	*58.2*	*57.3*
14.00-15.00	*59.1*	*63.3*	*59.0*	*62.3*	*59.0*	*53.9*
15.00-16.00	*59.7*	*65.3*	*56.9*	*61.1*	*54.7*	*52.7*
16.00-17.00	*58.1*	*65.4*	*54.9*	*57.9*	*54.7*	*51.0*

17.00-18.00	*54.9*	*63.3*	*53.6*	*52.8*	*53.9*	*50.0*
18.00-19.00	*52.6*	*62.2*	*52.8*	*52.3*	*53.1*	*47.9*
19.00-20.00	*52.3*	*61.7*	*52.4*	*51.7*	*52.9*	*46.9*
20.00-21.00	*52.0*	*58.1*	*52.0*	*49.6*	*52.0*	*46.5*
21.00-22.00	*51.2*	*54.9*	*50.7*	*48.6*	*51.6*	*46.3*
Minimum	*48.8*	*48.6*	*48.9*	*47.6*	*50.7*	*46.3*
Maximum	*59.7*	*65.4*	*59.0*	*62.3*	*60.1*	*60.7*
Average	*54.7*	*58.8*	*53.5*	*54.2*	*55.8*	*51.8*
Leq (Day)	*56.1*	*61.1*	*54.4*	*56.8*	*56.9*	*54.3*

Table – 11

Ambient Noise Level Data During Night Time Month: June, 2013

Time (Hrs)	*Noise Level, Leq (Hourly), dB(A)*					
	SN_1	SN_2	SN_3	SN_4	SN_5	SN_6
22.00-23.00	*50.6*	*53.9*	*50.6*	*47.5*	*50.6*	*45.7*
23.00-24.00	*50.5*	*52.7*	*49.6*	*46.4*	*49.5*	*45.3*
24.00-1.00	*49.6*	*52.4*	*48.6*	*45.4*	*50.5*	*44.4*
1.00-2.00	*48.6*	*52.3*	*47.8*	*46.1*	*48.5*	*44.2*
2.00-3.00	*48.6*	*50.9*	*47.4*	*46.4*	*47.6*	*43.7*
3.00-4.00	*47.5*	*51.3*	*46.4*	*47.5*	*46.4*	*43.4*
4.00-5.00	*46.4*	*49.6*	*47.0*	*48.6*	*45.4*	*43.7*
5.00-6.00	*45.4*	*47.6*	*47.6*	*49.6*	*44.2*	*42.3*
Minimum	*45.4*	*47.6*	*46.4*	*45.4*	*44.2*	*42.3*
Maximum	*50.6*	*53.9*	*50.6*	*49.6*	*50.6*	*45.7*
Average	*48.4*	*51.3*	*48.1*	*47.2*	*47.8*	*44.1*
Leq (Night)	*48.7*	*51.7*	*48.3*	*47.4*	*48.4*	*44.2*

Table – 12

Summary of Ambient Noise Level Month: June, 2013

Sampling Locations	*24-hrs Avg Leq. Value dB(A)*	*Day time Leq. Value dB(A)*	*Night time Leq. Value dB(A)*	*Prescribed Limits in dB(A) as per NAAQS*		
				Category of Area	*Day Time*	*Night Time*
Main Gate, PDIl	*54.7*	*56.1*	*48.7*	*Residential*	*55*	*45*
SBI/Post Office Golambar	*59.5*	*61.1*	*51.7*	*Residential*	*55*	*45*
BIT No.12 / BOI	*53.1*	*54.4*	*48.3*	*Residential*	*55*	*45*
Shaharpura Market	*55.3*	*56.8*	*47.4*	*Residential*	*55*	*45*
FCI Domgarh Gate	*55.4*	*56.9*	*48.4*	*Residential*	*55*	*45*
Manohartand Golambar	*52.8*	*54.3*	*44.2*	*Residential Area*	*55*	*45*

Table -13

Estimation of Odds Ratio

Noise Level $L_{eq,day,16h}$	*Period*	*Estimation of OR Value by*	
		Mathematical Formula	*Graphical Method*
58.1	*October 2012*	*1.0042*	*1.00*
55.1	*February 2013*	*1.0001*	*1.00*
56.1	*June 2013*	*1.0002*	*1.00*
61.1	*June 2013*	*1.0204*	*1.00*
56.8	*June 2013*	*1.0010*	*1.00*
56.9	*June 2013*	*1.0012*	*1.00*

Table –14

Estimation of HSD Effected Persons

Period	*Noise Level dB(A)*		*% HSD*	
	Minimum	*Maxm.*	*Minm.*	*Maxm.*
October 2012	*42.1*	*49.1*	*5.11%*	*2.93%*
February 2013	*40.0*	*46.7*	*2.56%*	*4.17%*
June 2013	*44.2*	*51.7*	*3.42%*	*6.23%*

Table – 15

Estimation of Highly Annoyed Persons

Period	*Noise Level dB(A)*		*% HSD*	
	Minimum	*Maximum*	*Minimum*	*Maximum*
October 2012	*51.6*	*58.1*	*4.46%*	*8.64%*
February 2013	*48.9*	*55.1*	*3.17%*	*6.46%*
June 2013	*54.3*	*61.1*	*5.96%*	*11.41%*

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