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ASSESSMENT OF NOISE POLLUTION OF VEDANTA THERMAL POWER PLANT, JHARSGUDA, ODISHA, INDIA

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ABSTRACT

Noise assessment was carried out in various residential, commercial and industrial places in and around Vedanta Captive Power Plant (VCPP) during October, 2010 to February 2011 covering 15 locations ofIndustrial area and 10 buffer zone in and around of 9 x 135 MW power plants. Event LAeq and LN cycle were studied to identify the noisy machines and to generate baseline data. Lowest avg. noise 61.43 dB (A) was found at control room while the highest avg, 102.4 dB (A) at F. D. Fan. Boiler feed pump is the second highest noise, 92.1 dB (A). Operators of F.D. Fans are having a fair chance of exposure with >90 dB (A) i.e., beyond the prescribed standard. Noise may not jeopardize employee's life immediately but might be the cause of neurobehavioral change, psychological stress and unhappiness in daily life without showing the symptoms of chronic/acute diseases. Measured data has been compared with national and international agency like CPCB and WHO. The quality of life of industrial worker is one of the prime factors for production; hence it should not be neglected. Revision of occupational Indian noise standard is recommended at par with International/European standards. Noise-reducing options are also described. This investigation may help the implementing authority to adopt better policy for better work environment.

Key words: Acoustic treatment, Health hazard, Noise measurements, Captive thermal power plant.

INTRODUCTION

Thermal power plant is the back bone of power generation of India The target for annual electric energy generation in the country for the year 2011-12 is 2,09,276.04 MW out of which 66.99% (140206.18 MW) generated by thermal power plant 18.77% (39, 291.40 MW) by hydro power plant and 2.28% (4,780.00 MW) by nuclear power plant and rest by Renewable Energy Sources (RES) by 11.94% (24,998.46 MW)[1]. Among the different industry thermal power plant is one of the noisiest factories[2].

Noise pollution is a major problem in urban environments, affecting human behaviour,

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well-being, productivity and health[3]. Many industrial authorities as well as pollution control boards do not give due weightage to the problem of noise pollution because it does not jeopardize employee's life immediately after exposure. However, prolong exposure to industrial noise can't be neglected which may be the cause of neurobehavioral change, psychological stress and unhappiness in daily life without showing the symptoms of chronic acute diseases[4]. Speech interference and interruption of communication is undesirable effect of noise[5]. Vibrational Noise is one of the major Environmental problems in Industrial Plants. The operation of machinery in industrial workrooms, shopsyards, generate excessive noise levels. Workers exposed to these undesirable noise levels may suffer annoyance, reduction in work efficiency, reduced speech intelligibility, and permanent hearing loss[6-10].

The prime objectives of this present study was to identify the major sources of noise producing machines of the thermal power plant, to generate baseline data with regard to different machines in the fifteen monitoring stations in the industrial zone and ten buffer zone to assess the possible health effect on the workers working in the high noise zone and nearby local people affected by the plant noise based on the threshold limit of American Conference of Governmental Industrial Hygienists, EU, WHO, CPCB standard.

Geographical position of the plant

The 1215 MW Captive Power Plant (CPP) of Vedanta Aluminium Limited at Jharsuguda (Orissa) is the largest CPP of India. The plant is situated about 5 KM away from the bustling town of Jharsuguda. The plant coordinates area cover $21^0$49'10"N to $21^0$48' 57"N latitude and longitude $84^0$01'26"E to $84^0$03'09"E. The coal-based thermal power plant of Vedanta Aluminium has been built alongside one of India's largest deposit of coal at IB Valley and Asia's largest non-brackish reservoir 'Hirakud Reservoir'. Coal is the raw material of a thermal power plant transported dumpers from IB velly coal field. Coal, moisture content 15-18%, ash 32-41%, volatile carbon 19-23%, fixed carbon 21-27% and caloric value 2800-3400 kcal/Kg.

Electricity generation process

The coal chunk is brought from the mine to unloading station of coal handling plant and ultimately passes to crusher house for sizing. The coal then passes to open storage and coal bunkers in the plant, which feed coal to mills for pulverization process. Pulverized coal is fed directly into the boiler through forced draft fan. Demineralized water (DM water avoids scaling/corrosion in the boiler which reduce the efficiency) is used as make-up water for the power cycle. Pressure of the steam generated in the boiler is increased by air compressors that rotate the turbine and converts mechanical power to electrical energy with the help of a device called Alternator.

Methodology of noise measurements and monitoring locations

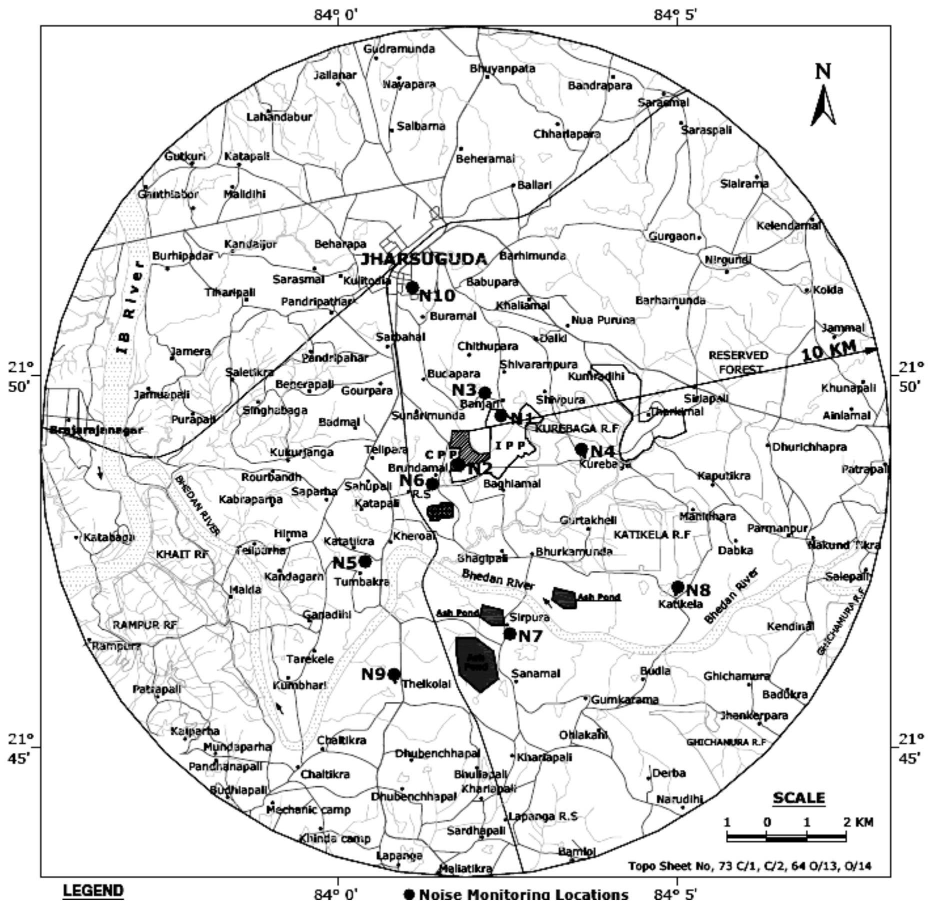

Fig. 1: Noise monitoring location of buffer and industrial zone

Monitoring locations

Industrial Zone: The monitoring stations with sources of noise in industrial zone are given in the Table 1.

After primary walk through the survey, 15 locations of plant area had been identified based on the maximum sound pressure for noise measurements. These locations are shown in Table 1 along with short description of the noise sources and the specific function of the noise source/machines. Besides the above major sources which contribute ~80 % noise, the remaining noise might be attributed to the background noise generated from incoming outgoing vehicles, servicing and repairing, minor construction, office work.

Table 1: Monitoring location, noise sources and function of machine in and around industrial zone

Monitoring location	Sources of noise	Specific function
Coal loading plant	Vehicles	Unload the coal
Coal crusher plant	Crusher mill	Crushes coal into pulverized to increase the burning efficiency.
Compressors	Compressors	Increase the steam pressure before inject into the turbine.
Boiler feed pump	Boiler feed pump	Pulverized coal is fed directly into the boiler through force draft fan.
Operator sitting place of boiler feed pump	Turbine	Turbine is a machine which rotates itself by the force of injects high pressure steam and then does conversion of kinetic energy into mechanical work to electrical energy.
Control room		
Operator sitting place for Turbine		
Turbine floor	Turbine	
Boiler operating room	Boiler	Produce steam for the power plant.
Boiler operator sitting place	F. D. Fan	Pulverized coal has been inducted directly into the boiler.
Forced draft fan (FD fan)	F. D. Fan	
Induced draft fan (ID fan)	I. D. Fan	Help flue gas to exit through chimney.
Operator sitting place of I.D. fan	I. D. Fan	Produce demineralized water to avoid scaling and heating loss in the boiler.
Demineralized plant		
Cooling tower	Cooling tower	Heated steam condensed into water molecules and recycled and reuse.

Survey technique

Digital sound level meter (Model 8928,AZ instrumentation,Taiwan) make sensitive to sound pressures between 31.5 Hz to 8 KHz having electric condenser microphone diameter 10 mm was used to measure the noise level. Calibrated instrument was transported in a brief case containing sponge groove that protect from vibration and shock. The range and sensitivity of the instrument is 40-130 dB (A) with accuracy ± 2%. The noise level was recorded at a distance of 5-10 feet on the basis where cumulative noise was expected from different sources or at operator. Monitoring was done at a height of 1.2 to 1.5 m and 1 m away from the chest for 30 min at an interval of 15 s in the industrial area[11]. In buffer zone the reading were taken for every hour for 24 hrs. The day noise levels have been monitored during 6 AM to 10 PM and night level during 10 PM to 6 AM at all location location of the study area. Measurment was caried out in clear sky weather and sustained wind to avoid background noise level difference of more than 10 dBA[12,13]. The details of noise monitoring stations is given in Tables 1 and 2.

Table 2: Monitoring location, distance, direction in an around the buffer zone

Location code	Noise sampling location	Distance from plant	Direction w.r.t plant	Environmental setting
N1	Security gate, SEL plant	0.9	NE	Industrial area
N2	Interim house (Trainees hostel)	--	--	Residential area
N3	Banjari	0.8	N	Residential area
N4	Kurebaga	2.3	E	Residential area
N5	Tumbakra	5.4	SSW	Residential area
N6	Brundamal	0.4	WSW	Residential area
N7	Sirpura	3.2	SSE	Residential area
N8	Katikela	5.8	SE	Sensitive (Forest)
N9	Thelkolai	5.4	SSW	Commercial
N10	Jharsuguda	5.8	NNW	Commercial (Highway)

Principles of Leq (A)

The short Leq (equivalent continuous sound level) concept was proposed by Komorn and Luquet[14]. Leq is the level which, if maintained constant for the same period as the measurement, would contain the same amount of energy as the fluctuating noise level. It is measured directly by an integrating averaging sound level meter. It is a linear integration over time. The formula used for Leq calculation is given below in the form it appears in the international standard IEC 651, 804.

$$L_{Aeq} = 10 \log_{10} \left[\frac{1}{T} \int_0^T \frac{p(t)^2}{p_0^2} dt \right]$$

Here T is total time period for measurement.

P(t) is the A-weighted instantaneous acoustic pressure.

Po is the reference acoustic pressure (20 µ Pa).

Leq is used as the basis for calculating L_{DN} (day-night average sound level) and L_{NP} (noise pollution level). Among A-weighting (ears response to sounds near the 40 dB level), B-weighting (near 70 dB), C-weighting (near 100 dB (A) and D-weighting (jet plane noise) measuring scales, the A-weighting is the commonly used scale to measure steady sound levels[15].

RESULTS AND DISCUSSION

The observed noise levels recorded during survey work for different machines and locations are presented in Tables 3 and 4, respectively. SLM recorded noise in the form of Event Leq and L_N cycle. L_N cycle represents that N% of the time, the noise level was below the given value of X viz. Compressor No. 1 : L-1 represents that 1% of the measured time the noise level was above 100.6 dB (A) and L-99 represents that 99% of the measured time the noise level was below 86.2 dB (A) (Table 4).

The statistical analysis is done for measured noise levels at ten locations. The parameters are analyzed for L_{10}, L_{50}, L_{90}, L_{eq}, L_{day}, L_{night}, and L_{dn}, The statistical analysis results are given in Table 3.

Table 3: Noise level dB (A) of different machine of thermal power plant

S. No.	Location	Noise level in dB (A)							
		L1	**L5**	**L10**	**L50**	**L90**	**L95**	**L99**	**Leq**
IN1	Coal loading plant	93.2	92.3	91.3	90	88.5	87.7	87.3	90.04
IN2	Coal crusher plant	95.5	94.2	93.2	92.3	90.2	89.3	89.1	91.97
IN3	Compressors	91.4	90.6	90.5	89.6	89.4	89.2	89.4	90.01
IN4	Boiler feed pump	97.2	96.1	93.5	91.3	89.1	89.0	88.5	92.1
IN5	Operator sitting place of boiler feed pump	88.7	84.8	83.4	83.0	82.4	82.6	82.4	83.9
IN6	Control room	68.2	68.5	66.6	57.8	56.4	56.3	56.2	61.43

Cont…

S. No.	Location	Noise level in dB (A)							
		L1	L5	L10	L50	L90	L95	L99	Leq
IN7	Operator sitting place for Turbine	88.2	83.1	81.2	80.3	80.1	80.1	80.1	81.87
IN8	Turbine Floor	91.6	87.5	85.7	84.8	84.4	74.4	84.6	84.71
IN9	Boiler operating room	82.6	77.6	71.6	70.3	69.2	69.0	68.9	72.74
IN10	Boiler operator sitting place	85.8	81.3	80.9	80.1	79.4	79.4	79.2	80.87
IN11	Forced draft fan (FD fan)	104.6	102.7	102.6	102.2	101.7	101.6	101.7	102.4
IN12	Induced draft fan (ID fan)	86.5	83.5	83.2	82.6	82.1	82.1	82.1	83.16
IN13	Operator sitting place of I.D. fan	85.4	81.3	80.9	80.7	78.8	78.4	78.5	80.57
IN14	Demineralized plant	83.6	83.8	83.6	82.8	82.8	82.8	82.8	83.17
IN15	Cooling tower	78.9	75.2	75.2	74.5	74.6	74.5	74.5	75.34

Table 4: Noise level dB (A) of different location of buffer area

S. No.	Location	Noise Level in dB(A)						
		L10	L50	L90	Leq.	L day	Light	Ldn.
N1	Security gate SEL plant (I)	88.4	80.60	72.2	85.0	84.2	74.7	74.4
N2	Interim house (Trainees hostel) (I)	68.6	65.2	62.1	66.8	71.2	64.9	63.0
N3	Banjari (R)	53.2	47.5	41.5	49.8	50.1	44.2	52.1
N4	Kurebaga (R)	51.1	45.3	41.3	46.9	51.7	43.2	51.0
N5	Tumbakra (R)	50.5	44.8	41.1	46.3	47.4	43.1	50.4
N6	Brundamal (R)	52.2	45.4	41.7	47.2	48.2	43.5	51.0
N7	Sirpura (R)	54.3	46.5	42.2	48.9	50.9	44.6	52.7
N8	Katikela (S)	48.4	42.2	37.9	44.0	44.6	39.8	47.3
N9	Thelkolai (C)	79.2	73.8	65.2	69.8	68.6	58.4	68.5
N10	Jharsuguda (C)	84.9	80.1	77.8	78.0	80.2	71.2	70.6

R: Residential area, C: Commercial area, I: Industrial area, S: Sensitive Zone

Industrial zone

Coal unloading plant

Among the two coal unloading plants, minimum Leq, 87.3 dB (A) was recorded near unloading plant-1 and while the maximum Leq, 93.2 dB (A) was recorded near unloading plant-2 with an log average Leq 90.04 ± 1.63 dB (A) (Table 3).

Coal crusher plant

The minimum Leq, 89.3 dB (A) was found at crusher plant-2 while the maximum Leq, 93.7 dB (A) was found near crusher Plant-1. The log average Leq of crusher plants was 91.97 ± 4.30 dB (A) which is higher than the prescribed standard of 90 dB (A) (Tables 3).

Compressor noise

The minimum event Leq, 89.2 dB (A) was recorded near Compressor-4 and while the maximum event Leq, 91.4 dB (A) was recorded near compressor-1 with log average Leq 90.01 ± 2.41 dB (A). All the compressors were producing noise level which touches the maximum permissible limit of 90 dB (A) for 8 h. Especially compressor-1 showed levels beyond the maximum permissible limit of 90 dB (A) for 8 h/day [Table 3]. Compressors generated second highest log average Leq 89.98 dB (A) noise level after the F.D. Fan with log average Leq 102.4 ± 6.15 dB (A) (Table 3). These data do not fall in the safe zone for occupational environment; out of 5 compressors; 2 were producing beyond the permissible limit of 90 dB (A) (Table 3).

Boiler feed pump (BFP)

The minimum event Leq, 88.5 dB (A) was recorded near BFP-2A and while the maximum event Leq, 97.2 dB (A) was recorded at BFP-3B with log average Leq 92.1 ± 1.76 dB (A) (Table 3). All the BFPs were producing noise level which touched the maximum permissible limit of 90 dB (A), especially; BFP-3B showed beyond the maximum permissible limit of 90 dB (A) for 8 h/day.

Turbine floor

The noise level found between 74.4-91.6 dB (A) with log average Leq 84.71 ± 3.82 dB (A). The lowest was measured for turbine No. 5 while highest for turbine No. 1 and 8. Turbine sound pressure is lesser than F.D. fan, boiler feed pump but higher than I. D. fan and cooling tower. It produced almost equivalent sound pressure of DM plant and aerial rope way (Table 3).

F. D. fan

The minimum event Leq, 101.6 dB (A) was recorded for F.D. fan No. 1 A and while the maximum event Leq, 104.6 dB (A) was recorded for F. D. Fan No. 6A with log average Leq 102.4 ± 6.15 dB (A). F. D. Fans were the noisiest one among the power plants.

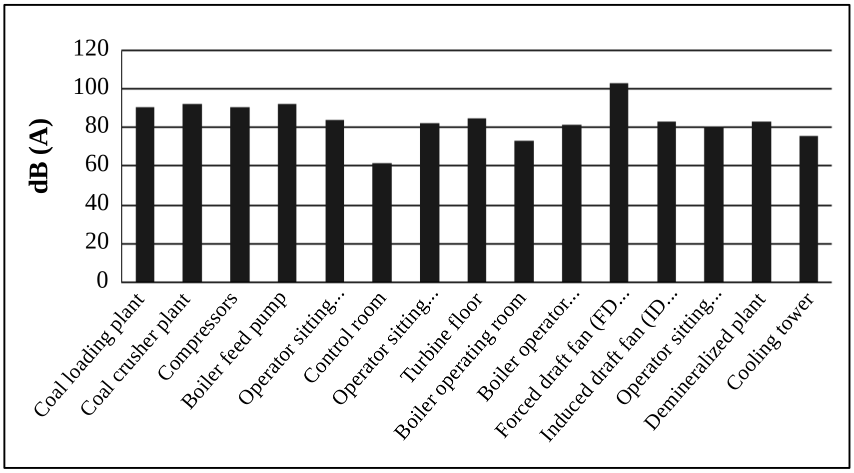

Fig. 2: Leq value of industrial zone

Buffer zone

Day time noise level (L day)

The day time noise level at most of the industrial location observed to be with in the limit of prescribed limit of 55 dB (A). The day time noise levels at all the residential locations were ranged between 44.6-51.7 dB (A). At Katikela forest area the day time noise level was 44.6 dB (A). Day time noise level of commercial area had crossed the limit it was observed to be 80.2 dB (A) which is higher than the prescribed limit of 65 dB (A).

Leqof Industrial area was 85.0 dB (A) and commercial area was 69.8-78.0 dB (A). It had crossed the prescribed limit of 75 dB (A) and 65 dB (A) industrial and commercial arearespectively (Table 4). At Katikela reserve forest the Leq value is within the limit.

From the result (Table 3 and Fig. 2), it has been clear that most of the industrial sampling stations noise level had crossed it limit. In buffer zone (Table 4 and Fig. 3) the prescribed limit was crossed by only commercial area due to heavy traffic of vehicles and interference of market place noise. The most important harmful effect is hearing damage resulting from prolonged exposure to excessive noise[16].

Table 5: Comparative noise value with national and international standard

Location	CPCB[28]		EU[29]		WHO[30]		Result (Leq)	
	Day	Night	Day	Night	Day	Night	Day max.	Night min.
Industrial	75	70	65	55	65	55	102.4	61.43
Commercial area	65	55	60	50	60	50	70.6	68.50
Residential	55	45	50	40	50	40	51.7	43.10
Sensitive area	50	40	45	35	45	35	44.6	39.8

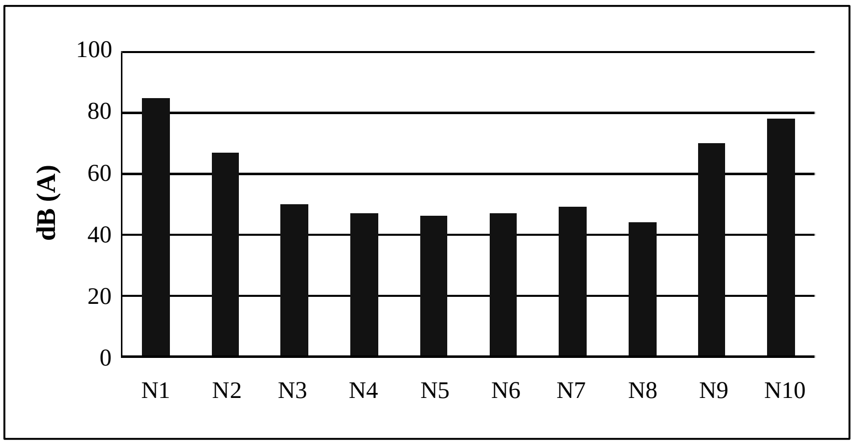

Fig. 3: Leq value of buffer zone

The damaging effect on hearing depends on (1) the level and spectrum of the noise, (2) duration of exposure,(3) how many times it occurs per day, (4) over how many years daily exposure is repeated, (5) the effects on hearing regarded as damage and (6) individual susceptibility to this type of injury.

The extra-auditory effects of noise result in physiologic changes other than hearing. The potential health effect of industrial noise includes hearing impairment defense reaction, aural pain, ear discomfort, and performance reduction and annoyance response. These health effects can leads to social handicap, reduced productivity, decreases performance in learning, increase drugs use. It can upset the sense of balance and can cause blood vessels to constrict, raising blood pressure and reducing the volume of blood flow. It causes the pupils of the eyes to dilate. Even when we are sleeping, noise can cause changes in electro-encephalograms and blood circulation without waking us. It can also cause fatigue, nervousness, irritability and hypertension and add to the overall stress of living[17-19].

Worldwide 16% of the disabling hearing loss in adults is attributed to occupational noise, ranging from 7-12% in the various sub-regions. The effects of exposure to occupational noise are longer for males than females in all sub-regions and higher in the developing countries[20]. There is a close relationship between noise and hearth disease[21-27].

CONCLUSION

Like Ambient air monitoring, stack emission monitoring, water and effluent testing are mandatory to compliance the needs of pollution control board to run the industry. Many industrial authorities as well as pollution control boards do not give due weightage to the problem of noise pollution because it does not jeopardize employee's life immediately after exposure. In the same way noise pollution studies and it mitigation measure should be mandatory for all Industries by applying suitable methods. Potential India is rapidly becoming industrialized in particular Jharsguda and it periphery area is flourishing as industrial zone. Large number of Megha industries like Aditya Birla Aluminium Smelting Plant, Bhusan Steel and Power plant and many more medium size plant are ready to start for their production therefore it is highly essential to control the Silent pollutant like industrial noise pollution otherwise local people as well as employee can severely affected in near future.

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