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MEASUREMENTS, ANALYSIS AND IMPACT OF INDUSTRIAL NOISE ON WORKERS AND COMMUNITY RESIDENTS IN PARTS OF CROSS RIVER STATE – NIGERIA

A. O. AKPAN, M. U. ONUU AND E. O. OBISUNG

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ABSTRACT

Objective assessment of industrial noise in twelve (12) industries in Cross River State with the sound level meter has shown that workers were exposed to mean L_{max} value as high as 117.5 dBA with L_A and $L_{(deaf)}$ of 113.38 and 99.88 dBA respectively. The calculated noise pollution (L_{NP}) level was as high as 142 dB (NP) while L_{eq} and L_{dn} were 115.0 and 117.4 dBA respectively. The social survey response from 74.9% of the respondents made up of workers and community residents revealed that industrial noise had great social, physiological and psychological impact on workers and community residents. 73.5% of the respondents wanted the noise to be controlled since they were not adapted to it. The correlation coefficient between the objective and subjective assessment of this noise was found to be as high as 0.87. It is therefore imperative to call on Government, through appropriate environmental agencies, to make and enforce necessary laws, for the control and abatement of this pollution.

KEYWORD: Industrial noise, objective assessment, subjective assessment, pollution, impact.

INTRODUCTION

Sound waves are classic waves that may be produced by vibrating bodies such as industrial plants while in operation and is characterized by the intensity, frequency and duration.

Sounds whose frequencies are less than 16Hz are called infrasound. Situation occurs where people are exposed to sounds that lie outside the audible range or to audible sounds that are particularly short in time and duration.

When a particular sound is complex and has little or no periodicity, it is described as noise. Industrial noise is noise generated from industrial plants and covers noise from industries and construction sites and is considered to be a principal source of noise in some communities. It is often assessed through the rating level parameter L_r where the A-weighted equivalent sound level L_{Aeq} from the specific source is adjusted for tonal content and compared to legislative limits dependent on time of day and usage of the property at which the levels are measured. The A-weighted network is specified for use in estimating the probability of hearing damage in industries. In addition, A-weighted values can be correlated with annoyance caused by traffic and aircraft noise. The B, C and D weighting networks are used for more specialized readings such as airport jet engine noise (McNulty 1987).

The major sources of industrial noise range from electrochemical machines, like motors and generators, combustion processes like the furnace, fluid motion such as fans and compressors, impact machines like punch press, hammers and stampers to unbalanced and improperly fitted mechanical parts such as shafts and gears.

The noise from industrial plants contaminate the environment and this becomes noise pollution. Noise pollution level L_{NP} is a cumulative rating method that includes both steady sound present as well as fluctuations in the measured sound. Any annoyance associated with the total energy and the variability of the sound are taken into consideration by this measurement rating scheme.

Mathematically

Noise pollution level

$$L_{NP} = L_{EQ} + 2.5 \quad dB\ (NP) \quad \ldots\ldots\ldots\ldots (1)$$

where L_{eq} = energy equivalent sound level of a sufficiently long A-weighted sample of noise in dB(A).

δ = Standard deviation of the sample in dB(A)

$$Leq = 10Log\sum_{i=1}^{n} f_i \times 10^{L_i/10} \quad \ldots\ldots\ldots\ldots (2)$$

where f_i is the factors of time the constant L_i is present. Modifications of the L_{eq} have been suggested in the form of penalty levels for sensitive time of the day. The day-night average sound level L_{dn} is an L_{eq} A-weighted sound level during a 24-hour period with a 10dB penalty for nighttime sound levels. Day-time means noise levels measured between 7 a.m. to 10p.m. while nighttime are noise levels measured between 10p.m. to 7a.m. which attracts additional 10dB as a penalty for that time of the day (Cunniff, 1977).

$$L_{dn} = 10\log_{10}\left[0.525 \times 10^{L_d/10} + 0.375 \times 10^{L_n+10/10}\right] \ldots (3)$$

where L_d = daytime levels

L_n = nighttime levels

Investigating community noise complaints around large industrial sites can be very complex. There are often a multitude of noise sources which may be contributing the overall noise environment. Often the whole external envelop of a building radiates noise.

While industrial plants noise are not as high as those of aircraft when landing or taking off nor as broadly distributed as those from highways, numerous neighbours of individual plants are affected continuously by such noise (Croker and price 1995).

These effects include temporal and permanent hearing loss, annoyance, sleep interference, task interference, rise in blood pressure etc.

Research have found that when people are exposed to infrasounds under laboratory conditions, they may experience difficulties in performing mental work as well as a general sense of discomfort (Mosskov and Ettema, 1977). As the intensity increases, dizziness, nervous fatigue, neausea and loss of balance is experienced by same people. At still

A. O. Akpan, Department of Physics, University of Calabar, Calabar, Nigeria.
M. U. Onuu, Department of Physics, University of Calabar, Calabar, Nigeria.
E. O. Obisung, Department of Physics, University of Calabar, Calabar, Nigeria.

higher intensities, a person's internal organs will vibrate causing pain and possibly death (Cunniff, 1977).

MATERIALS AND METHODS

Objective measurements of sound level were made with sound level meter, Bruel and Kjaer (B&K) type 2203 with associated octave band filter B&K type 1613 (Breul, and Kjaer (1976) while the subjective assessment were carried out using questionnaires. Twelve industries and surrounding communities were assessed after a careful preliminary study.

Physical Measurements

Preliminary noise survey was carried out to determine suitable measuring position by setting the octave band filter at 500Hz and taking reading around the machine at five different locations. The reading positions were placed at 1.5 to 2 meters from the nearest major source of the noise at a height of 1.5 meters corresponding to the average hearing position or ear level of workers and community residents. The position of maximum overall sound level was located. This point was then chosen as the measuring position. Measurement of sound level were then made with the meter held steadily as far away from the body as possible and from any hard reflecting surface or material for about two (2) minutes. These measurements were made with the meter set at A-weighted network, slow meter response to enable a more sluggish response for accurate readings to be taken. Background levels were taken outside the factory room but within the factory premises where the noise from the machines was not heard.

All measurements for each industries were made for two (2) days between the usual business hours of 8.00 a.m. and 5.00 p.m. when the factories were fully in operation.

Subjective Assessment

Workers and community residents reaction towards the noise from the industrial plants were investigated subjectively using questionnaires. They constitute the respondents in this work.

Table 1.0: Industry/Location, Major Machineries and Codes

S/N	INDUSTRIES/LOCATIONS	MAJOR MACHINERY	CODES
1.	Strabag Company, Old Netim, Akamkpa	Stone cracking and crushing machines	CR1
2.	Crush rock Company, Old Netim, Akamkpa	Stone Cracking and Crushing Machines	CR2
3.	Hitech Company, Old Netim, Akamkpa	Stone cracking and Crushing Machines	CR3
4.	Pamol (Nig) Limited, Calabar	Crepper hammer Mill	CR4
5.	Pamol Plastic Division, Calabar	Frazer Machines	CR5
6.	System Metal Company, Calabar	Pressing machines	CR6
7.	Mechanical Workshop, Physics Department, University of Calabar	Lathe, Milling, boring, cutting and shaping machines	CR7
8.	Bao Yoa Huan Jian Iron/Steel Company, Calabar Free Trade Zone CFTZ, Calabar.	Welding, Shaping and Cutting Machines	CR8
9.	Kevin wood Industry, CFTZ, Calabar	Sawing, planing and spraying machines	CR9
10.	Ayos wood International Company, CFTZ, Calabar		CR10
11.	Larna Gold Industry, CFTZ, Calabar	Weaving Machines	CR11
12.	Niger Mills Company Plc, Calabar	Roller Mills (Buhler)	CR12

Analysis

The industries have been coded in Table 1.0 for the purpose of this analysis Deafening noise levels (L_{deaf}) as shown in Table 2.0 were obtained by subtracting 14.5 dBA from the measured A-weighted sound pressure levels (SPL). The noise pollution level (L_{NP}), the energy equivalent sound level (L_{eq}) and the day-night average level (L_{dn}) were calculated using equations 1, 2, and 3 respectively. Dose effect relationship on annoyance, nighttime sleeplessness, communication disturbance with colleagues, relaxation and mental disturbance have also been considered. Also considered are the respondents rating of industrial noise in the surveyed areas. The respondents impact rating of this noise has been looked into.

Results of objective measurement with sound level meter is shown in Table 2.0. Figure 1.0 shows L_{NP}, L_{eq} and L_{dN}.

RESULT OF SUBJECTIVE ASSESSMENT

Table 3.0 shows the statistics of questionnaires distributed at each measurement location of industries. Figure 2.0 shows the dose-effect relationship on very highly affected respondents while Fig. 3.0 shows the impact rating of this noise by respondents. The respondents rating of the noise is shown in Fig. 4.0.

Table 2.0: Daily industrial noise levels in Cross River State

S/N	Measurement location (industries)	Background noise level ±5(dBA)	A-Weighted SPL ±5(dBA)	Lmax ±5(Dba)	Deafening levels ±5(dBA)
1.	CR1	55.5	120.0	122.0	105.5
2.	CR2	50.5	116.0	119.0	101.5
3.	CR3	61.0	119.0	124.0	104.5
4.	CR4	48.0	123.0	126.0	108.5
5.	CR5	42.5	112.5	117.0	98.0
6.	CR6	60.0	112.0	118.0	97.5
7.	CR7	57.0	102.0	108.0	87.5
8.	CR8	54.5	111.0	115.0	96.5
9.	CR9	55.5	101.5	108.0	87.0
10.	CR10	54.0	109.5	112.0	95
11.	CR11	50.5	105.0	109.5	90.5
12	CR12	60.5	129.0	131.0	114.5
	Mean	**54.14**	**113.38**	**117.5**	**98.88**

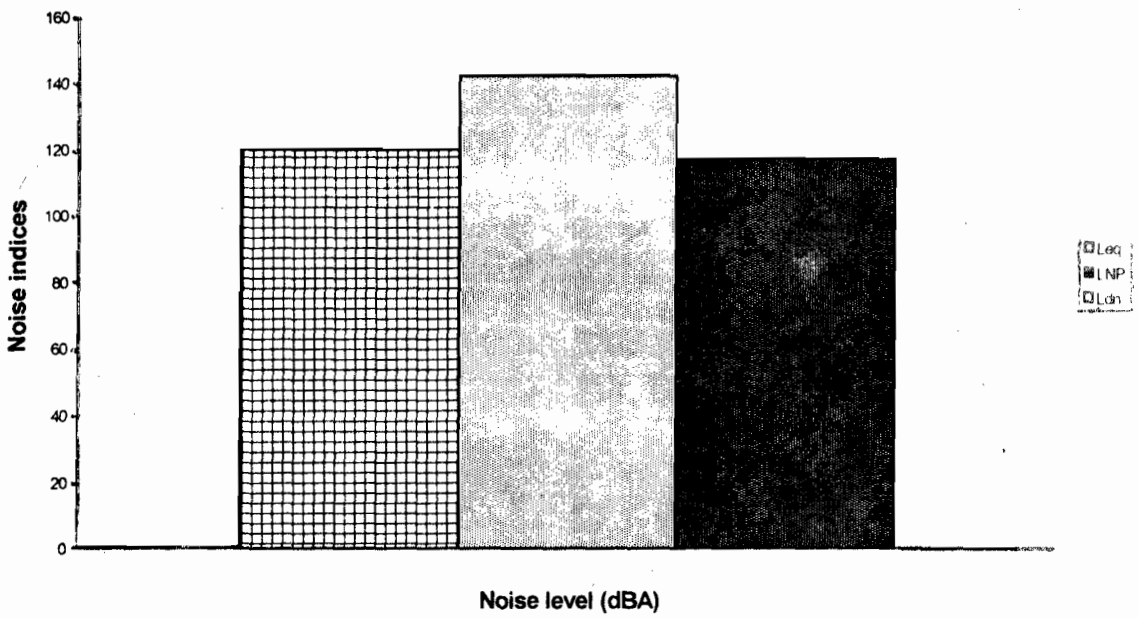

Fig. 1.0: Comparing some Industrial noise indices

Table 3.0: Statistics of questionnaires distributed at each measurement location of industries

Measurement locations	Number of questionnaires distributed	Responses received	Percentage of valid responses
CR1	55	38	69.10
CR2	55	44	80.00
CR3	55	47	85.45
CR4	55	44	80.00
CR5	55	48	87.27
CR6	55	48	87.27
CR7	55	41	74.55
CR8	55	45	81.81
CR9	55	37	67.27
CR10	55	46	83.64
CR11	55	48	87.27
CR12	55	47	85.46
TOTAL	660	533	80.76

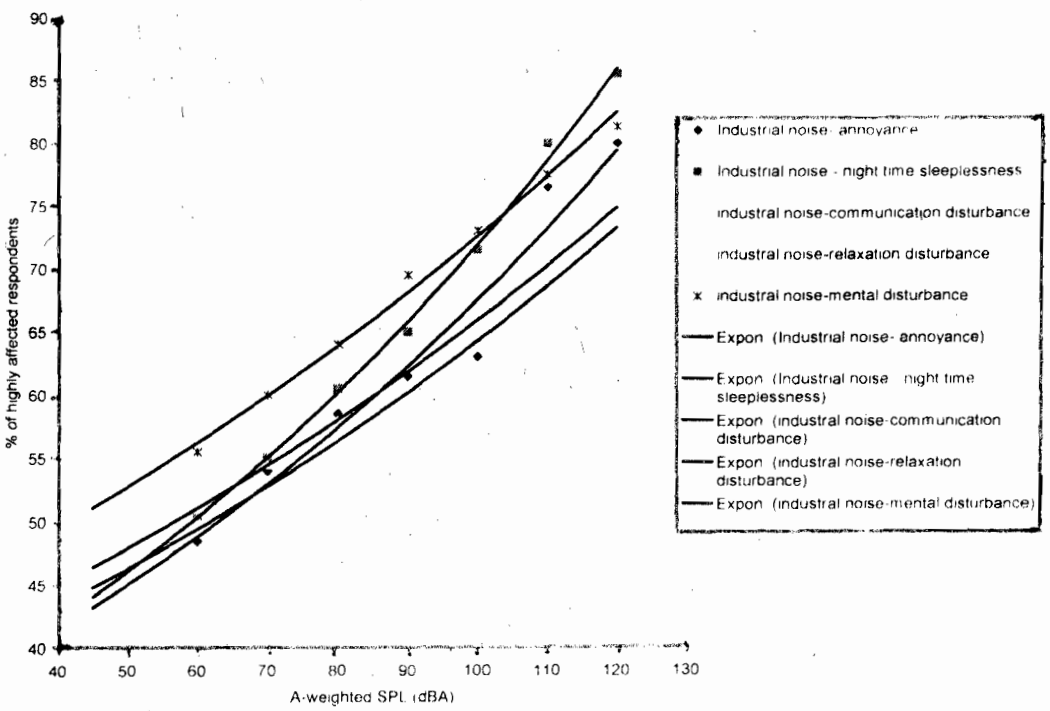

Fig. 2.0: Dose-effect relationships on some impact

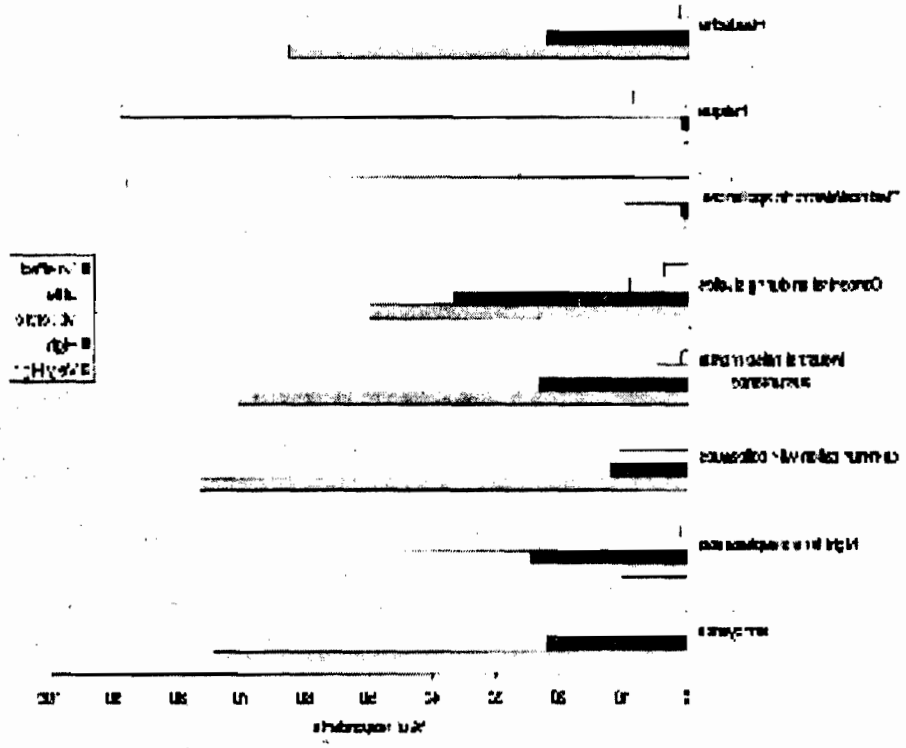

Fig. 3.0: Respondents impact rating of industrial noise

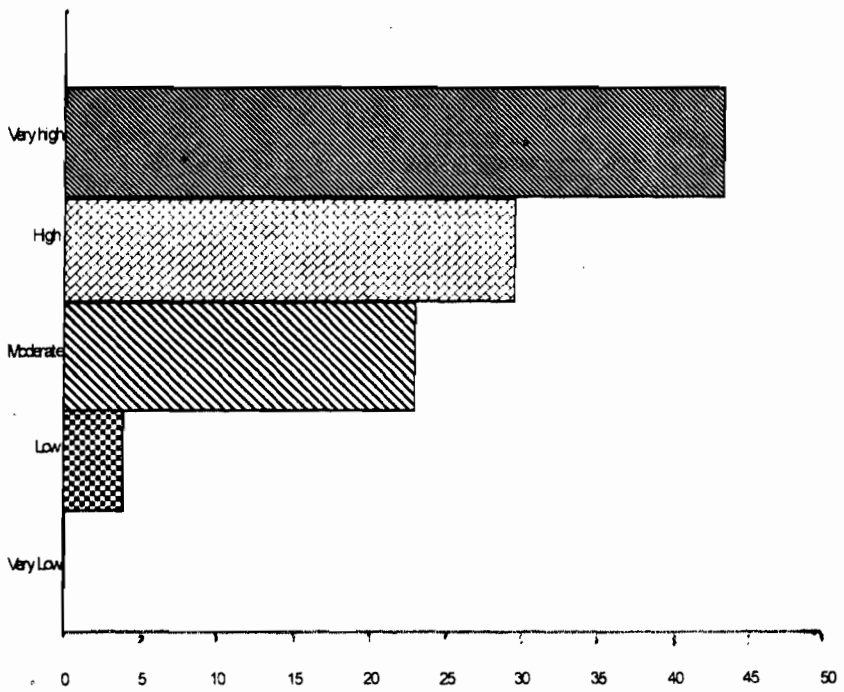

Fig. 4.0: Respondents industrial noise rating

DISCUSSION

The Occupational Safety and Health Act (OSHA) of 1970 prescribes a permissible level of 90 dB(A) for workers exposed for 8-hour-day and 5-day-week. In Nigeria, the Federal Environmental protection Agency (FEPA) recommends that daily exposure of workers to industrial noise should not exceed 90 dB(A) for a daily exposure time of 8 hours.

From Table 2.0 and Fig 1.0, it is clearly seen that the A-weighted SPL, the Lmax values LEq, LNP and Ldn of the surveyed industries far exceed the recommended levels of these regulatory bodies.

This must have probably been caused by the ageing of the machines. The impact of these high level of noise on workers and community residents are as reflected in Figs. 2.0 and 3.0. Fig. 2.0 also shows that the population of highly affected respondents increased as the Sound Pressure Level (SPL) from the machines increased. The impacts of the noise ranged from annoyance, nighttime sleeplessness, communication disturbance with colleagues, relaxation disturbance to mental disturbance. The exponential lines in this figure are trend lines meant to distinguish between the impact which are scattered dotted plots.

As shown in Fig. 4.0, no respondent rated the noise to be very low. Impacts headache, electrical/electronics appliances disturbance, concentration disturbance during studies, mental disturbance, communication disturbance with colleagues, nighttime sleeplessness and annoyance were rated by respondents as being very high, moderate or little.

CONCLUSION

This work has clearly shown that the noise levels generated by industrial plants in the surveyed industries far exceed recommendations set by some world regulatory bodies such as the occupational safety and Health Act (OSHA) and the Federal Environmental Protection Agency (FEPA). This high level of noise have various impacts on industrial workers and community residents in Cross River State. These impacts range from annoyance, nighttime sleeplessness, communication disturbance with colleagues and mental disturbance. Others are lack of concentration during studies, electrical/electronic appliances disturbance, fatigue and headache.

RECOMMENDATION

Because of these impacts on workers community residents, industrial noise pollution needs to be controlled. This involves reducing energy dissipated as noise. Approach is to first examine the source of the noise. Preference should be given to control techniques that reduce noise during production. Alternatively, to reduce employee exposure, measures that reduce transmission of sound is recommended (Eldridge and Miller, 1971). Preliminary and comprehensive plant noise surveys to determine employee and community noise exposure should be conducted. Noise level measurements should be carried out on individual machines and reductions methods which are economically feasible and cause a minimum of interference to normal operations be recommended (Koolshaw, 1979).

All stake holders in the industrial sectors of the economy should join hands to control this menace so as to reduce the short and long term impact inflicted on industry workers and community residents.

REFERENCES

Akpan, A. O., Onuu, M. U, Menkiti, A. I. and Asuquo U. E., 2003. Measurements and Analysis of Industrial Noise and its Impact on Workers in Akwa Ibom State, South-Eastern Nigeria. Journal of Physics, 15(2): 41-45.

Asuquo, U. E, Menkiti, A. I., Onuu, M. U., and Apaluwa E. H. O., 2000. Environmental Noise Study in some Areas of Calabar and Uyo. Gobal Journal of Pure and Applied Sciences, 7(2): 339 – 344.

Asuquo, U. E, Inyang S. O., Egbe, N. O., and Asuquo A. U., 2005. The Effect of Noise on Human Blood Pressure. Global Journal of Pure and Applied Sciences, 11(1): 149 – 152.

Breul and Kjaer, 1976. Measuring Sound, Octave Filter Set, Type 1613, Instruction Manual. Bruel and Kjaer Denmark.

Carter, N. L. and Beh, H. C., 1989. The Effect of Intermittent Noise on Cardiovascular Functioning During Vigilance Task Performance Psychophysiology, 25, 548 – 559.

Cunniff, P. F., 1977. Environmental Noise Pollution. John Willey and Sons, New York.

Eldridge, D. H. and Miller, J. D., 1971. Acceptable Noise Exposure-Damage Risk Criteria. Journal of Acoustical Society of America, 7, 26 – 31.

Evans, G. W. and Maxwell, L., 1997. Chronic Noise Exposure and Reading Deficits. The Mediating Effects of Language Acquisition, Environment and Behaviour, Physiological Science, 29, 710 – 728.

Franks, J. R., 1990. Number of Workers Exposed to Occupational Noise (NIOSH Publication on Noise and Hearing). Cincinnati, OH: Department of Health and Human Services.

Heggins J., 1998. Effect of Industrial Noise on hearing, II, 5pp.

Hirai, A., Takata, M., Mikawa, M., Yashmito, K., Iida, H., Sasayama, S. and Kagamimori, S., 1991. Prolonged Exposure to Industrial Noise Causes Hearing loss but not High Blood Pressure: A Study of 2124 Factory Laborers in Japan. Journal of Hypertension, 9, 1069 – 1073.

Ivor H. 2000. "Noise from Pump Station in Wanaka, New Zealand Annoys Neighbours". Southland Time News Report New Section, National, 20, Wanaka, New Zealand.

Koolshaw, G. I., 1979. Reducing Machinery Noise in Cement Plants. Institute of Electronic and Electrical Engineers Transactions on Industry and General applications.

Lane, R. S. 1975. Sources of Reduction of Diesel Engine noise. Reduction of Machinery Noise Conference, Purdue University.

Mcnulty, G. J. 1987. Impact of Transportation Noise in some new Industrial Countries. Applied Acoustic, 21.

Melamed, S., Luz, Y. and Green, M. S. 1992. Noise Exposure, Noise Annoyance and their Relation to Psychological Distress, Accident and Sickness Absence among Blue-Collar Workers: The Cardiovascular Occupational Risk factors Determination in Israel (CORDIS) Study. Israel Journal of Medical Sciences, 28, 629 – 635.

Melamed S., Fried Y., and Froom P. 2001. The Interactive Effect of Chronic Exposure to Noise and Job Complexity on Changes in Blood Pressure and Job Satisfaction. A Longitudinal Study of Industrial

Employees. Journal of Occupational health psychology 6(3): 182 – 195.

Mosskov, J. I. and Ettema, J. H. 1977. Extra-Auditory Effects in Short-Term Exposure to Noise from a Textile Factory. International Archives of Occupational and Environmental Health, 3(40): 174 – 196.

National Institute for Occupational Safety and Health. 1988. Self-Reported Hearing Loss Among Workers Potentially Exposed to Industrial Noise-United States. Journal of America Medical Association, 259 (15): 2213 – 2217.

Oshrstron. E., Rylander, R. and Bjorkman, M. 1988. Effects of Nighttime Road Traffic Noise- An Overview of Laboratory and Filed Studies on Noise Dose. Journal of Sound and Vibration, 127, 441 – 448.

Onuu, M. U. Menkiti A. I. and Essien J. O., 1996. Spectral Analysis of Industrial Noise in Calabar, Nigeria, Global Journal of Pure and Applied Science, 2, 239 – 240.

Optiz, H., 1968. A Discussion on the Origin and Treatment of Noise in Industrial Environment, Noise Gears Proceedings of the Royal Society, 369 – 380.

Welch, B. L., 1979. Extra-Auditory Health Effects of Industrial Noise: Survey of Foreign Literature (Report No AMRL TR 79-41) Dayton, OH: Wright Patterson Air Force Base, Aerospace Medical Division.

Winston S., 2000. "OSHA Plans to Design hearing Rules for Construction Industry". Engineering new Record Publication, new Site, 244, 31 Washington DC