Occupational Noise in Urban Buses,a case study in Curitia, Brazil

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Introduction

This paper reports the findings of a research designed to quantify the occupational noise inside urban buses. The Integrated Transport Network system of Curitiba is constituted by 2160 buses which about 1,9 million people. The measurements have been carried out inside several types of buses: 1) Bi-articulated, 2) Speedybuses and 3) Feeder buses. Bi-articulated buses are formed by three cars and two articulations, and can carry up to 270 passengers. They operate in exclusive lanes - busways - where cars are not allowed, and they stop at tube shaped stations intended for rapid passenger load and unload. Speedybuses operate in regular streets across the city, but they stop at fewer stations than other buses, and also only at the tube shaped stations. The third type of bus, feeder buses, operate normally in the whole city, along regular streets and bus stops.

Materials and Method

Measurements have been carried out in several buses of several lines under normal operating conditions: buses loaded with passengers and running under no rainy conditions, during workdays. A total of 60 buses have been evaluated: 20 were Speedybuses, 20 were Bi-articulated buses, and 20 were Feeder buses.

Measurements were performed according to ISO 1999 [5]. The noise exposure level was normalized to a nominal 8 h working day $L_{EX,\,8h}$ calculated from the measured equivalent sound pressure level $L_{eq,T}$. Normalized exposure levels were calculated with the software BK 7825.

In Curitiba bus drivers work for a period of 6 h per day, with a brief 10-15 min pause after ~ 3 h of driving. Therefore, T_e = 6 h in the formula above. The 6-h working day is a practice for Curitiba bus drivers since 1987; before that year, the working day for the drivers lasted 7 h and 23 minutes on average, continuously. Occupational Health Standard NHO-01 legislation has been used for classification purposes. Table 1 shows the judgement and decision making criteria according to NHO-01, considering the calculated values of normalized exposure level $L_{EX,\,8\,h}$. The Brasilian Standard for Ergonomics NR-17 has also been considered for classifying the workplace of the bus drivers, according toa a different criterium. This standard considers the work environmental conditions for factors such as light, humidity, temperature and noise. With respect to noise emission, this standard describes the situation at the receiver. It classifies workplaces where constant attention is required, such as in bus driving, as either confortable or uncomfortable. Confortable workplaces with respect to noise offer noise exposure levels normalized to a nominal 8 h working day $L_{ex,8h}$ <= 65 dBA; uncomfortable workplaces offer noise levels > 65 dBA.

Results and Discussion

The results obtained from measurements in the workplaces of the bus drivers of Curitiba, inside 60 buses of the models Biarticulated, Speedybuses, and Feeder Buses. Data show that the Biarticulated buses, which only have middle-mounted engines, led to exposure of the drivers to noise levels of 73.8<=$L_{Ex,8h}$<79 dBA. Speedybuses with rear- and middle-mounted engines offered noise levels of 67.9<= $L_{Ex,8h}$ <74.4 dBA for their drivers. Feeder buses with rear-mounted engines offered noise levels of 74.7<= $L_{Ex,8h}$<76.9 dBA to their drivers. Feeder buses with front-mounted engines displayed the highest noise levels, of 78.6<= $L_{Ex,8h}$ <85.5dBA. Biarticulated buses were assembled between the years 1995 and 2000, Speedybuses between 1996 and 2002, and Feeder buses between 1991 and 1999. Feeder buses are then mostly the oldest among the analysed fleet.Except for 4 buses surveyed, all noise exposure levels $L_{EX,\,8\,h}$ were below 82 dBA. This means, according to Table 1, that mostly no special measure is required, if minimally the current condition is maintained. This situation can be considered as "acceptable" (NHO-01). Of the 4 buses in "unacceptable" condition, three of them are in the "action level" condition, that is, $L_{EX,\,8\,h}$ between 82 and 84 dB(A). Preventive measures should be considered, in order to reduce the current noise levels in those buses. Only one bus was found to offer $L_{EX,\,8\,h}$ greater than 85 dB(A), implying the necessity for immediate adoption of corrective measures.The brazilian legislation, as well as that of other countries [6], all adopt the threshold value of 85 dBA for monitoring hearing loss. Thus, according to this criterium, the workplace for bus drivers of the city of Curitiba can be considered "safe", from

the standpoint of physical noise measurements. In the present study, the 4 buses which showed noise exposure levels $L_{EX,\ 8\ h}$ greater then 82 dBA all share the following characteristics: 1) They are among the oldest buses among the 60 buses studied; with year of manufacture between 1991 e 1994; 2) They display front-mounted engines. It should however not be forgotten that the effects of noise in workplace are not restricted to possible hearing losses of the workers, but may extend to psychophysiological effects. Several studies testify that bus driving is a stressful and unhealthy activity [7]. The Brazilian Standard for Ergonomics NR17 has been here also employed in order to analyze environmental working conditions. This legislation properly categorizes workplaces as confortable or not, considering not only the environmental parameters, but also the activity performed.Work activities that demand constant attention need noise emission values below 65dBA in order to be considered confortable. From this perspective, the data gathered in the current study demonstrate that all buses are uncomfortable workplaces for their drivers, with noise levels measured above $L_{EX,\ 8\ h}$= 65 dBA. The situation gets worse if the bus is relatively old and the the engine is front-mounted.

Conclusions

Data allow us to conclude that normalized noise exposure levels $L_{EX,\ 8h}$ measured next to bus drivers are directly related to the position of the engine. For the driver, the bus engine is the main noise source. Even though buses with rear mounted-engine cost between 70% to 100% more than buses with engine front-mounted, today, in Curitiba, most circulating buses have been manufactured recently, and are equipped with middle or rear engine, which means good news for the drivers.

Drivers of buses with front-mounted engines are at risk of occupational hearing loss, as their normalized noise exposure level $L_{EX,\ 8\ h}$ is next to or even greater than 85 dBA. The use of caution would suggest to consider that drivers regularly exposed to normalized exposure levels ~80 dBA are at risk of hearing impairment. In countries such as Sweden and Norway [6] this is the limit for monitoring hearing loss, 80 dBA. This study has demonstrated that one should not evaluate a complex environment such as a workplace using a single standard. According to the Brazilian Standard for Occupational Health, except for only 6.7 % (4 buses) of the evaluated buses, all others are acceptable in what concerns noise emission to the worker. However, from the standpoint of the Brazilian Standard for Ergonomics, all of the buses have been deemed uncomfortable, with noise levels above 65 dBA. And further, the drivers are exposed to those levels 6 hours a day, 6 days a week, almost the whole year, a situation which will lead to a real potential health problem. A possible administrative solution in order to reducethe exposure of bus drivers to noise would be to reduce the number of hours they work per day. In practice this does not happen in Brazil. On the contrary, aiming at increasing their wages (normally ~USD 554.00 per month), it is rather common that bus drivers work extra-hours.

Acknowledgments

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References

[1] BRAZILIAN OCCUPATIONAL HEALTH STANDARD, 1997(in portuguese).
[2] BRAZILIAN STANDARD FOR ERGONOMICS, 1997 (in portuguese).
[3] GUIDOTTI, T. and COTTLE, M., 1987, Occupational health problems among transit workers. Public Health Review, 15, 29 – 44.
[4] EWANS, GW, and JOHANSSON, G, 1998, Urban Bus Driving. J Occupational Health Psychology,3(2),99 – 108.
[5] ISO 1999.
[6] GOELZER, B., HANSEN, C.H.,2001, Occupational Exposure to Noise: Evaluation, Prevention and Control.
[7] GREINER, BA, KRAUSE, N,1998, J.OccupationalHealthPsychology,3(2),130–146.

Table 1: Judgement criteria and decision making according to NHO-01

Normalized Exposure Level $L_{EX,\ 8\ h}$	**Technical consideration**	**Required action**
Below 82 dBA	Acceptable	At least the maintenance of the current condition
82 – 84 dBA	Action level	Adoption of preventive measures
Normalized Exposure Level $L_{EX,\ 8\ h}$	**Technical consideration**	**Required action**
84 – 85 dBA	Uncertainty region	Adoption of preventive and corrective measures to seek the daily dose reduction.
Above 85 dBA	Above exposure level	Immediate adoption of corrective measures.