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# Noise Level Investigation in Printing Industry in Novi Sad, Serbia

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***Abstract*—**The aim of this study was to determine noise level of six different types of machines in printing companies in Novi Sad. The A-weighted levels on $L_{eq}$, $L_{max}$ and $L_{min}$ Sound Pressure Level (SPL) in dBA were measured. It was found that the folders, offset printing presses and binding machines are the predominant noise sources. The noise levels produced by 12 of 38 machines exceed the limiting threshold level of 85 dBA, tolerated by law. Since it was determined that the average noise level for folders (87.7 dB) exceeds the permitted value the octave analysis of noise was performed.

***Keywords*—** noise levels, octave analysis, printing machines.



## I. INTRODUCTION

OCCUPATIONAL exposure to excessive noise is comonly encountered in a great variety of industrial processes. Printing industry is the source of heavy industrial noise. The mechanism of noise generation depends on the particular noise operations and equipment including: electromechanical devices, pumps, compressors, cutters, presses, etc. [1].

Noise occurs during printing, binding, folding, cutting and perforating processes. Results of many studies indicate that the workers in printing industry may be at risk of occupational hearing loss [2]. There is causal relationship between workplace noise and hearing loss and the other health problems of the workers [3]. Non-auditory effects of noise may also include lack of concentration, irritation, fatigue, headache, sleep disturbance, depression, increased breathing rate, social isolation and greater risk of accidents [4,5]. Noise may contribute to cardiovascular disorders such as faster pulse rate, coronary heart disease and hypertension [6,7]. The manifestation progress and the degree of occupational hearing impairment depend on several factors: sound intesity, duration of exposure, frequency of interfering sound, age, physical conditions of workers and individual sensitivity as well as concomitant harmfull occupational factors such as vibrations and ototoxic agents [8]. Internationally accepted noise level which does not cause temporary or permanent hearing loss is 75 dBA. However, sound levels of 85 dBA and above, for duration of 8 hours per day cause damage to the hearing after many years [9].

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## II. METHODS

The noise level of six different types of machines: digital color presses, offset printing presses, cutters, folders, binding machines and paper perforating machines was measured using TES-1358A Sound Level Meter (SLM), with RS-232 Interface. The A-weighted levels on $L_{eq}$, $L_{max}$ and $L_{min}$ SPL in dBA were collected. For conducting the noise survey**,** Serbian guidelines for noise measuring were followed [10]. The desired response of SLM was set at "fast". The noise levels were measured about 1.5 m above the floor and the measurements were taken over a period of 10 s for paper cutting machines and 30 s for other types of machines. At the end of experiment, the data were downloaded to a personal computer and, with the help of utility software, the equivalent SPL and noise spectrum at each reading were obtained.

## III. RESULTS AND DISCUSSION

Noise measurements were conducted for 5 digital colour presses, 11 offset printing machines, 5 folders, 6 cutters, 5 binding machines and 6 paper perforating machines.

The average levels with their standard deviations are given in Table 1. The measured $L_{eq}$ values for all machines generally varied between 70-88 dBA. The highest $L_{eq}$ levels were obtained for folders with the mean value of 87.7 (3.1) dBA. The noise levels produced by 12 of 38 machines exceed the limiting threshold level of 85 dBA, tolerated by law. The levels on $L_{eq}$, $L_{max}$ and $L_{min}$ SPL in dBA of surveyed machines are graphically shown in Fig. 1. As it can be seen the lowest were $L_{eq}$ levels of digital colour presses with the mean value of 70.7 (4.2) dBA. The offset printing presses produce greater noise levels when the compressors are switched on (the interrupted lines in Fig. 1). It can be noticed that the great range of noise levels (75.2-94.8) dBA and the high variance (6.87) were obtained for the cutters, which is due to the different type of cutting material used.

Since it was determined that the average noise level for folders exceeds the permitted value given by Serbian guidelines [10] the octave analysis of noise was performed.

TABLE I
NOISE LEVELS OF $L_{EQ}$, $L_{MAX}$ AND $L_{MIN}$ (IN DBA) WITH AVERAGE LEVELS AND VARIANCES OF THE DIFFERENT TYPES OF MACHINES

| Type of machine | L (dBA) (SD) | | |
|---|---|---|---|
| | $L_{min}$ | $L_{max}$ | $L_{eq}$ |
| Digital printing presses | 67.5 (4.5) | 74.3 (4.3) | 70.7 (4.2) |
| Offset printing presses | 78.4 (5.6) | 86.0 (3.3) | 82.7 (3.9) |
| Cutters | 71.1 (7.8) | 90.8 (4.8) | 80.2 (6.9) |
| Folders | 81.2 (2.9) | 92.4 (7.2) | 87.7 (3.1) |
| Binding machines | 80.2 (2.3) | 85.6 (3.1) | 82.4 (2.5) |
| Paper perforating | 76.7 (5.9) | 88.9 (3.5) | 81.3 (3.2) |

The dBA avarages of $L_{eq}$ at 1/1 octave bands for folders in comparison with NR-80 curve at 1/1 octave bands as a histogram, is presented in Fig. 2. The noise rating - NR - curves are developed by International Organisation for Standardization (ISO) to determine the acceptable indoor environment for hearing preservation, speech communication and annoyance. The Noise Rating level for industrial noise should not exceed the levels of NR-80 curve.

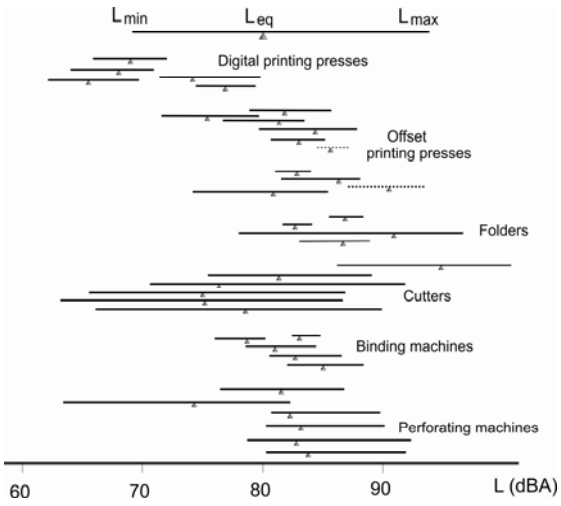


Fig. 1 Noise levels: $L_{eq}$, $L_{min}$ and $L_{max}$ ( in dBA) of different types of the machines

It was found that the means of $L_{eq}$ levels for folders were considerably greater than the permissible at higher frequencies (2kHz and above). It is important to note that hearing damage from excessive noise usually occurs at high frequencies (3, 4, 6 kHz) and then spreads to lower frequencies (0.5, 1, 2 kHz) [8].

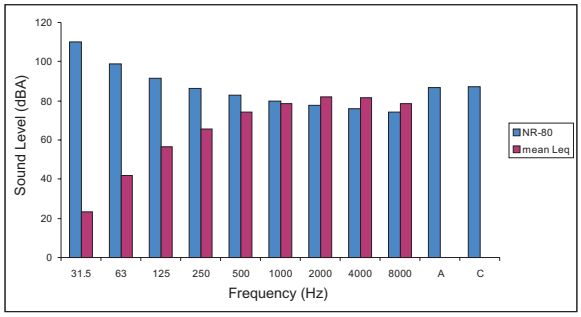


Fig. 2 Averages of $L_{eq}$ in dBA at 1/1 octave bands for folders in comparison with NR-80 curve

The present investigation of surveyed printing companies showed that most of the facilities are not located in workspace standardized to adequate acoustic criteria and the workers do not wear hearing protectors. Hearing protectors should be used when engineering controls and work practices are not feasible to reduce noise exposure to safe levels. Earmuffs, ear plugs and ear canal caps are the main types of hearing protectors [11].

Based on the previous analysis, the following recommendations which could be considered to decrease the noise level in the workplace are [12]:

1) noise reduction techniques such as engine modifications and modifications of a workroom with sound absorbent materials
2) hearing protection of the employees.

It can be concluded that the workers in printing companies should have periodic audiometric tests to check the effectiveness of the noise control and hearing conservation program.

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