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MEASUREMENTS OF THE COMMUNICATION NOISE LEVEL ON THE INTERNAL ROADS OF THE MANUFACTURING METALLURGICAL ENTERPRISE

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This publication shows the results of measurements of the noise level emitted by the motor trucks on the internal roads of the steelworks. The distribution of the metallurgical products with the use of trucks is, next to the rail transport, one of the main logistic forms of products delivery to the customer. The research was conducted on one of the busiest internal roads of metallurgical enterprise ArcelorMittal Poland in Dąbrowa Górnicza. The enterprise conducts the whole production cycle and is the biggest steel producer in Poland. On the premises of the steelworks there were five points of measurements marked where the noise level is measured and the results were compared with the acceptable noise levels defined in the norms.

Key words: communication noise, steelworks, car transport, distribution of products

Mjerenje razine buke internih prometnica proizvodne metalurške tvrtke. Članak daje rezultate mjerenja razine buke emitirane od motornih vozila internih prometnica čeličane. Distribucija metalurških proizvoda rabeći ova vozila uz željeznički transport je najvažniji način isporuke proizvoda kupcima. Istraživanja su provedena na najprometnijoj internoj prometnici metalurške tvrtke ArcelorMittal Poland u Dąbrowa Górnicza. Poduzeće sadrži sve proizvodne cikluse i najveći je proizvođač čelika u Poljskoj. Unutar prostorija čeličana odabrano je pet točaka gdje je mjerenja razina buke, a rezultati su uspoređivani sa prihvatljivim razinama buke zacrtanim u normama.

Ključne riječi: buka prometnica, čeličane, automobilski transport, distribucija proizvoda

INTRODUCTION

Distribution of the metallurgical products is connected with their real delivery to the recipients. It is one of the primary tasks in the generic value chain by M.E. Porter [1]. In logistic systems of manufacturing enterprises it is the element of external logistics (outbound logistics). Logistics of distribution is present in every enterprise but not in all of them it is as important as in a metallurgical enterprise due to the size of production, the weight of transported products, their length and other parameters of technological and utility type. Distribution of metallurgical products to final customers is conducted with the use of two main forms of transport: car and rail transport. The mentioned forms of transport are a burden to the environment and are the source of dangers for the workers on the steelwork premises. One of the environmental aspects is noise.

This publication presents the results of measurements of the noise level emitted by the motor trucks loading the metallurgical products from the stockyard on the premises of metallurgical enterprise ArcelorMittal Poland JSC.

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CAR TRANSPORT IN DISTRIBUTION OF METALLURGICAL PRODUCTS IN METALLURGICAL ENTERPRISE ARCELORMITTAL POLAND

The analysed metallurgical enterprise ArcelorMittal Poland JSC the car transport of the metallurgical products of the enterprise equals about 40 % and the rail transport is 60 % of the whole transport in the enterprise [2]. In 2010 about 4,5 million tonnes of metallurgical products manufactured by this enterprise were delivered by rail and almost 2 million tonnes by cars. To deliver such an amount 90 000 of wagons and 80 000 cars were used. If we divide the products which were transported into long and flat it occurs that 8 % more of flat products in comparison to long products are delivered to customers by cars (Figure 1) [3].

On the premises of the enterprise there are over 5 kilometres of roads measured from gate to gate in a straight line. On all of them the speed limit is 40 km/h, and on some especially dangerous sections (crossroad with rail route) the limit is 20 km/h. Some of the roads are monitored and some have photo-radars installed. The enterprise has four entry gates, three of which are supply gates for car transport, two of which with car scales. Rail transport has a separate gate. All internal

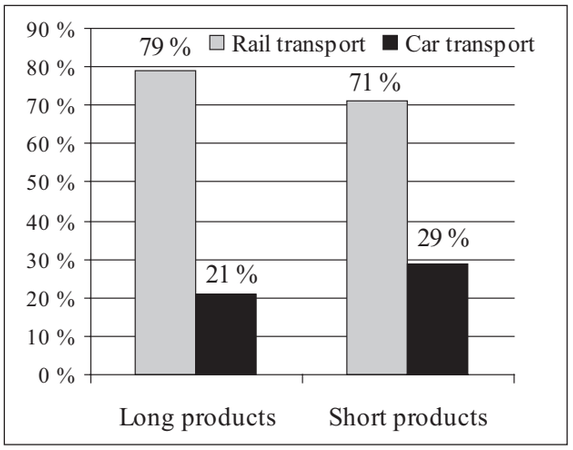

Figure 1 Structure of product transport in ArcelorMittal Poland

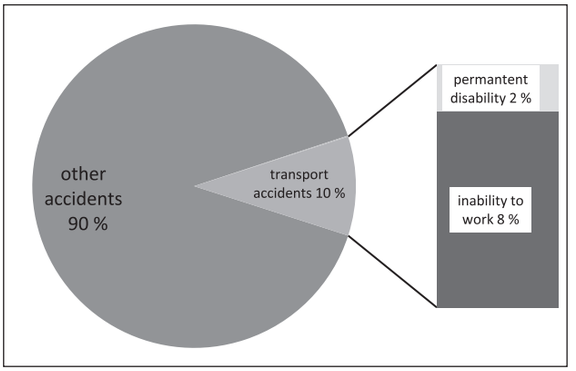

Figure 2 Types of injuries caused by transport accidents on the premises of industrial enterprises (death accident was 0,1 %)

roads of the steelworks are equipped with road signs (warning signs, information signs) and with traffic lights. There are maps of internal roads by each of the entry gates to the enterprise.

In order to provide safety in road traffic on the premises of the steelworks ArcelorMittal Poland, the rules of traffic on the premises were constructed. The internal regulations were prepared in three languages: English, French and Polish. They are sets of orders and prohibitions and instructions which drivers of transport vehicles should respect. Besides the rules of traffic there are also rules of parking the vehicles, instructions in case of road accident(on the premises of the enterprise there is an Emergency and Fire-extinguishing Unit which should be informed) and the rules of clothing for the drivers (high-visibility vest).

The biggest traffic congestion of motor trucks in ArcelorMittal Poland in Dąbrowa Górnicza occurs on the road between the medium rolling mill and the big rolling mill, because the stockyard of the ready products is situated there. Motor trucks with loads from 7,5 to 32 tonnes move along the road. During the day the road is visited by 80 to 100 cars.

The dangers which are caused by the transport cars are: the noise, crash with another vehicle (car, forklift truck, bike, motorbike, train, emergency vehicle etc.), running down a pedestrian, running into an obstacle (road repair), running into a barrier (gate, rail barrier), sudden breakdown of a vehicle, uncontrolled skidding of a vehicle (particularly in winter), shift or slide of the transported load. Each of the dangers was indentified and assessed in the work safety card entitled: Traffic on the internal roads of ArcelorMittal Poland Dąbrowa Górnicza. In 100 % of accidents on the premises of the enterprise 10 % are road accidents (transport accidents). Figure 2 presents types of injuries caused by transport accidents on the premises of industrial enterprises [4].

One of the main dangers caused by motor truck vehicles moving round the internal roads of the steelworks is the noise which was measured within this research. Noise is defined as unwanted, unpleasant or tiresome sound for a given person in a given place and at a given time. Usually it is a sound of too high volume which means too loud sound. A human reacts to sounds with frequency from 20 Hz to 20 kHz (some sources say from 16 Hz to 16 kHz [5, 6]). Both the sounds below and above this level are inaudible for a human. In ArcelorMittal Poland JSC ¾ of occupational diseases of workers are caused by too high volume of noise. Communication noise caused by particular transport vehicles on internal roads of the steelwork is beyond measurement. Noise measurements are conducted only on work stations of individual workers. Table 1 presents the noise level of particular means of transport.

Table 1 **Level of noise created by different vehicles [7, 8]**

Type of vehicle	Level of created noise
Single track vehicles	79-87 dB
passenger car	75-84 dB
transport truck	83-93 dB
busses and tractors	85-92 dB
road and construction machines	75-85 dB
garbage trucks	77-95 dB

In ArcelorMittal Poland Dąbrowa Górnicza there are cards of risk assessment in relation to traffic on internal roads, the level of danger in reference to category: car vehicles were set on a moderate level (Table 2).

Table 2 **Job risk assessment on internal roads of ArcelorMittal Poland Dąbrowa Górnicza [9]**

Category	P	S	PxS	Type of danger
Driving a car vehicle	2	2	4	moderate
Driving a battery-electric truck, forklift truck or pallet-lift truck	1	2	2	small
Going on foot	1	3	3	moderate
Riding a bike or motorbike	2	3	6	big

Where:

P – Probability of danger occurrence (scale from 1 to 3, where 1 is low probability, 2 is average and 3 is high),

S – result which the danger can cause (assessment scale: 1 to 3, where 1 is low, 2 is average and 3 is high)

METHODOLOGY OF RESEARCH

Tests of communication noise were conducted in an enterprise ArcelorMittal section Dąbrowa Górnicza al. Piłsudskiego 92 on internal roads (access roads to production house, storehouses, and stockyards).

The communication noise inside production house strictly connected with the manufacturing process was not tested.

The number of kilometres of internal car roads in the enterprise is 17 km (the same length as a section of the motorway A4 from junction Chorzów Batory to junction Gliwice- Sośnica). Table 3 presents data concerning the internal roads of the enterprise.

Table 3 **Characteristics of internal communication system in ArcelorMittal Poland Dąbrowa Górnicza**

Specification	Unit of measurement	Data
Average daily road traffic	h	
Passenger cars		
Transport cars		
Motor trucks		
Railway crossing	amount	10
Railway crossing with a barrier	amount	2
Average distance covered by vehicles		
Passenger cars	km	6
Transport cars	km	4
Motor trucks	km	4
Passenger cars	%	38
Transport cars	%	25
Motor trucks	%	37

Measurements were conducted according to an ordinance of the Ministry of Environment in reference to the requirements connected with conduction of measurements of substances or energy in the environment by the manager of the road, rail line, tram line, airport or port [10]. Due to the fact that the norm requires the proper meteorological conditions before and during the measurement the speed of the wind and the air temperature were measured. During measurement the wind speed did not exceed 5 m/s and the air temperature was higher than (-5 °C).

In order to define the noise levels the method of direct measurements of noise were use with the application of sampling, because according to the above mentioned regulation for roads which have traffic congestion higher than 300 vehicles per hour such method is advised.

The regulation requires giving the equivalent level. The equivalent level is one of the most common indicators of noise level assessment which has different intensity in time. The idea of this indicator is about defining the average level of acoustic pressure (in analysed time). The equivalent level is marked according to Formula 1.

$$L_{eq} = 10lg\frac{1}{T}\int_0^T \frac{p^2(t)}{p_0^2}dt \qquad (1)$$

where:
p(t) - moment value of acoustic pressure / Pa;
p_0 - acoustic pressure of reference / Pa;
T - time for which the equivalent level is marked /s [10].

In real situations the above mathematical definition is hard to apply. That is why a more practical formula number 2 is used to mark the equivalent level.

$$L_{eq} = lg\frac{1}{T}\sum_{i=1}^{n} t_i \cdot 10L_{ai} \qquad (2)$$

where:
L_{ai}- noise level at the time of t_i /dB(A),
T_i- time of noise presence with the level of L_{ai} / s,
where:

$T = \sum_{i=1}^{n} t_i$ – time of observation [10]

RESULTS

Measurements of noise level were conducted in five points on the premises of the steelworks. The visual graph of the momentary noise volume in measurement point 1 is presented in Figure 3.

The detailed results of the noise level measurements are presented together in Table 4.

Table 4 **Noise levels in measurement points**

	Measurement point 1	Measurement point 2	Measurement point 3	Measurement point 4	Measurement point 5
$L_{eaq\ 8h\ [db(A)]}$	62	63	63	65	66
Range	31,8	30,8	33,9	30,8	32,3
$L_{aeq\ min}$	55,4	58,1	52,8	53,7	58,9
$L_{aeq\ max}$	87,2	88,9	86,7	84,5	91,2

The measurements show that the highest volume of noise was noted down in points 4 and 5 which are the supply gates for motor trucks with car scales (gate 5 for direction: Ukraine, Slovakia, Cracow and Zawiercie) and gate 7 (direction: Slowakia, Czech Republik, Germany, Dabrowa Górnicza, Bielsko-Biała, Warszawa). In those points the noise level during measurement was

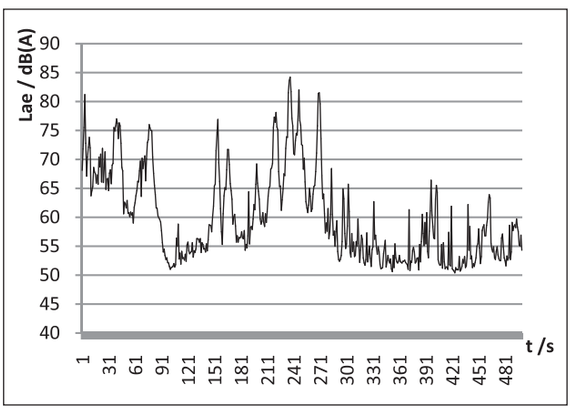

Figure 3 Volume of noise level in measurement point 1

from 65 to 66 dB(A). In measurement point 3, not far from the stockyard of ready products the noise was on the level of 63 dB(A). In this point the range noise level (Table 4) was the highest and equalled 33,9. In the remaining points (1 and 2) the noise level was from 62 to 63 dB(A). In all measurement points the levels of noise did not exceed the levels in norms of accepted noise volume.

CONCLUSIONS OF RESEARCH

- Due to the high level of background noise by the side of the road, that is 58 dB(A). caused by the production process in particular production houses the car traffic has a small influence on the overall level of noise. Noise level in measurement points did not exceed 66 dB(A).
- It is necessary to conduct noise measurement from the means of rail transport to present the communication noise in the enterprise in a complete way (currently the enterprise does not agree to such measurements).
- Although the level of acceptable noise level was not exceeded on the internal roads of the steelworks by the motor trucks transporting metallurgical products, it has to be pointed out that the noise in the steelworks is one of the main health hazard for the workers and due to that another noise category, even within the legally accepted norms may cause the workers' occupational diseases (accumulation of the noise levels) and, what is more, noise can be causing stress among the employees of the enterprise.

Safety and work hygiene in ArcelorMittal Poland is a priority and strategic aim and that is why there are certain steps taken in the enterprise to prevent the occupational diseases such as personal protection measures, training, preventive medical tests. Standards of safety worked out in the enterprise are available on the website wwwmyarcelormittal.com.

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Note: Responsible translators Damian Hadryś, Higher School of Labor Protection Management, Katowice, Poland