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PROFESSIONAL HAZARD OF THE OPERATION OF SELECTECTED FORESTRY MACHINES AND WAYS OF ITS PREVENTION

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Summary. An analysis was made of some hazards involved in the work of an operator of selected forestry machines (harvester Valmet produced in 2007, forwarder Valmet 840.2 produced in 2007 and tractor Zetor 7211 produced in 1983) as well as of the ways of controlling the risks. The measurements of harmful for the operator's health physical factors (vibration and noise) showed that the acceptable norms were exceeded only by the Zetor tractor. The paper also presented the evaluation of the forestry machine's operator's professional hazard caused by biological and other factors.

Key words: forestry machines, operator, vibrations, noise, biological factors, professional hazard.

INTRODUCTION

In recent years both in the European and Polish forestry a rapid growth has been observed in the mechanization of wood obtainment, mainly due to the introduction of multi-functional machines [Kusiak 2007, Święcicki 2004, Sokulski 2008a,b]. Despite the fact that the use of machines for the cutting and picking-up of wood has been very controversial, the economic effect of their application has undeniably been highly satisfactory [Brzózko 2008].

Wood obtainment is a very difficult and hazardous aspect of forestry. Its character, difficult working conditions as well as lack of caution and the offence of work safety regulations by both the employers and employees result in frequent accidents. [Opieliński 2008, Sokulski 2009].

Operators of forestry machines, conscious of hazards involved in their work, should perform it in a safe way and observe their employers' regulations and the labour law. They should also realize that work protection clothing and shoes as well as the individual protection means are an important element of their occupation.

The protection of the machine operators' health is their employer's duty, the compliance with which will result in safer working conditions as well as lower statistics of proffesional diseases and other illnesses, and thus will positively influence work quality and efficiency [Dryll 2007, Wawrzyniak 2007, Opieliński 2008].

The research aimed at the recognition of hazards involved in the work of an operator of selected forestry machines during the cutting and picking-up of wood as well as the presentation

of some preventive measures. The professional hazard of the work of a forestry machine operator was also evaluated.

MATERIAL AND METHODS

An analysis was made of hazards involved in the operation of the following machines: harvester Valmet 901.3 produced in 2007, forwarder Valmet 840.2 produced in 2007 and tractor Zetor 7211 produced in 1983.

Harvester Valmet 901.3 (Phot.1) is a multi-operational machine for thinning. Due to computer programming the cut-down trees are simultaneously trimmed and chopped to the proper length. Its cabin is 18% higher and 6% wider than in the previous models.

The seat rotates 180°. The integrated construction of cabin and crane, typical for the Valmet harvester, ensures an efficient sight range for its operator. The possibility of monitor settings regulation improves the service comfort [Brzózko 2008, Sokulski 2008a].

Phot. 1. Harvester Valmet 901.3

Forwarder Valmet 840.2 (Phot. 2) is a machine for wood transport equipped with a six cylinder internal-combustion engine with turbocharger. A pump and hydrostatic engine were applied for drive transfer. The gearbox has two gears: for field run and transport run with disconnectable drive axle. The gearbox is operated by means of the electro-hydraulic system. The machine is fitted with a double-circuit braking system. The main brake is composed of four multiple disc brakes on the front and rear axle. The hand brake is a switch brake with electro-hydraulic steering. The driving direction is changed by turning the joint. The machine has got two parallel steering systems i. e. the field system and the steering wheel. The cabine is equipped with protection systems in case of: turning upside-down, falling objects, objects invading the cabin. It is spacious, with big window-panes. The rear pane and the side-rear panes are made of protection glass. The cabin is equipped with the heating-cooling system. It is protected against noise – to minimize noise and vibration. There are three safety exits: the door, the roof hatchway and the right side window. The safety exits

in normal conditions cannot be open from the outside so in the conditions of increased risk their blockades should be released [Brzózko 2008, Sokulski 2008b].

Phot. 2. Forwarder Valmet 840.2

The tractor Zetor 7211 (Phot. 3) is a machine for a variety of tasks in agriculture as well as in agricultural and forestry transport. It has a four-cylinder internal-combustion engine cooled with liquid. The tractor has got a power steering wheel convertible to four positions and a gearbox with five gears and reductor. It is also fitted with hydraulic disc brakes including two pedals and automatic pressure adjustment acting on the rear wheels. Pneumatic brakes are used to brake trailers or semitrailers. The capacity of the lift is 1700 kg without an extra auxiliary actuator. The cabin of the tractor cabin is safe and fitted with noise-proof material. Its door and windows are glass-panelled and the windscreen is fitted with a roller blind.

Phot. 3. Tractor Zetor 7211

The achievement of the research aim required the measurements of the health-impairing physical factors on the work stand of an operator of the tested forestry machines as well as an assessment of professional hazard connected with other harmful factors.

The measurements of the physical factors (noise and vibration) was performed by the 'Grupa Interlis' – civil law partnership – at the Laboratory of Workplace Environmental Research in Kalisz. During the tests the operator of the machine was performing the activities connected with its operation. The results of measurements were expressed as multiple WEEL (Workplace Environmental Exposure Levels). The professional hazard on the stand of forestry machines operator was assessed on the basis of PN 18002 on the three-stage scale (Tab.1).

Table 1. Assessment of professional hazard

Probability	Severity of consequences		
	Low	Medium	High
Not very probable	low	low	medium
Probable	low	medium	high
Very probable	medium	high	high

At the assessment of professional hazard according to Table 1 the severity of harmful consequences of dangers and the probability of their occurrence can be described in the following way:

- consequences of low severity are those injuries and diseases which do not cause long- lasting ailments or absence at work. They cause temporary deterioration of health condition e.g. not very serious bruises or wounds, eye irritation, light poisoning, headaches etc.
- consequences of medium severity are those injuries and diseases which cause light but long-lasting or recurrent ailments and involve short periods of absence. They are e.g. injuries, second grade burns on a small body area, skin allergies, simple fractures, syndroms of the muscular- bone system's overload (e.g. inflammation of tendon).
- consequences of high severity are those injuries and diseases which cause severe, permanent ailments and/or death. They are e.g. third degree burns, second degree burns on a large body area, amputations, complicated fractures with following disfunction, cancer diseases, toxic damage to internal organs or the neurological system due to exposure to chemical factors, vibration syndrome, professional hearing impairment, asthma, cataract etc.
- hazard consequences of low probability are those which should not appear during the whole work period of a given worker
- probable hazard consequences are those which can occur not more frequently than only a few times during the whole work period of a given worker
- highly probable hazard consequences are those which can frequently occur during the whole work period of a given worker .

At those factors for which the WEEL was determined the hazard was assessed as high whenever the parametr characterizing the worker's risk exceeded the WEEL value. However, when the parametr characterizing the worker's risk was below half of the WEEL value, professional hazard was estimated as low.

RESULTS OF RESEARCH

Table 2 presents the identified hazards on the stand of forestry machine operator, their causes, probable results as well as possible preventive measures.

Table 2. Identification of hazards at the workplace of forestry machine operator

Kind of hazard	Reasons	Probable consequences	Preventive measures
Slipping, falling down at the same level	Rough, slippery surface in the forest, bad atmospheric conditions	Fracture of a limb, sprains, bruises	Attention of the worker, proper shoes
Cuts, stabbings	Sharp blades, tools, tree branches	Most commonly the wounds of hands and arms, more seldom of face and other body parts	Attention of the worker, individual protection
Crushing	Repairing of a tractor, felling of a tree	Fractures, crushing, disability, death	Attention, obeying the rules
Falling down onto a lower level	Getting into the cabin, working on slopes	Fractures, disability	Attention, proper shoes
Road accident	Driving on public roads and in the forest	Fractures, disability, death	Attention, obeying traffic rules, good technical condition of the tractor
Monotonny of work	Work in the cabin of the machine, working alone	Mental tiredness, boredom, lack of concentration	Rest intervals, performance of different tasks
Overburdenning of the motor system	Manual transport works	Diseases of the motor system	Obeing the standards of weight-lifting, proper posture during the lifting
Overturning of the machine	Operating the machine on rough surfaces, slopes and other obstacles	Wounds, fractures, numerous injuries	Driving perpendicularly to contours, obeying traffic rules, good choice of gear
Physical overload	Monotonous work, forced work position, repetitive movements	Muscle and bone aches, diseases of the motor system	Rest intervals, changing the position at work, working according to the instruction
Generally affecting mechanical vibrations	Transport and forestry works inside a machine	Diseases of the alimentary and motor systems	Ergonomic seat, rest intervals
Noise	Working engine and machine	Hearing impairment	Noise-proof cabin, earplugs
Microclimate	Working in different climatic conditions	Heat stroke, fainting, colds, frostbite	Proper clothing, drinks, heated cabins or air-conditioning
Biological factors	Dogs, wasps, ticks etc.	Wounds, borreliosis, tick-borne meningoencephalitis etc.	Attention, proper clothing, vaccination

Table 3 presents results of measurements of physical factors harmful for the operator's health as well as their interpretation.

Table 3. Results of measurements of vibrations and noise at the workplace of an operator of the tested forestry machines

Specification	Name of the physical factor					
	Generally affecting vibrations			Noise		
Name of machine	Harvester Valmet 901.3	Forwarder Valmet 840.2	Traktor Zetor 7211	Harvester Valmet 901.3	Forwarder Valmet 840.2	Traktor Zetor 7211
Metod of measurement	According to the procedure GR-INT/ PB-03 ed. 1.			PN-E-01307:94		
Daily exposure, ms-2	0,526	0,459	1,320	-		
Exposure level–LEx,8h The maximum sound level A– LA, max, dB The peak sound level C– LC, peak				69,9 85,1 127,9	75,2 85,2 110,2	92,0 107,0 118,0
Interpretation of results	0,64 multiple VEEL	0,56 multiple VEEL	1,65 multiple VEEL	0,03 multiple VEEL	0,11 multiple VEEL	5,0 multiple VEEL
Hazard estimation	medium	medium	high	low	low	high

Table 3 has shown that high hazard involving the exceeding of acceptable standards of vibration and noise occurs only at the workplace of the Tractor Zetor 7211 operator. At that workplace the employer should introduce protective measures which would eliminate the existing hazard.

Table 4 presents the assessment of professional hazard involving the biological factors [Dutkiewicz et.al. 2007].

Table 4. Assessment of an operator's professional hazard involving biological factors

Kind of hazard	Estimation of professional hazard			
	Severity of consequences	Probability	Hazard level	Acceptability
Parasites of the 2nd hazard grade (*Babesia divergens, Babesia microti, Toxoplasma gondii*)	medium	not very probable	low	D
Fungi of the 2nd hazard grade (*Emmonsia parva var. Parva, Emmonsia parva var. Crescend, scedosporium apiospermum*)	medium	not very probable	low	D
Fungi of the 3rd hazard grade (*Cladophialophora bantiana*)	high	not very probable	medium	D

Bacteria of the 2nd hazard grade (*Bacillus thuringeisis, Borrelia burgdorferi, Borrelia spp., Ehrlicha spp., Francisella tularensis typ B, Rickettsia spp.*)	medium	not very probable	low	D
Bacteria of the 3rd hazard grade (*Coxiella burnetii, Brucela suis, Francisella typ A*)	high	not very probable	medium	D
Viruses of the 2nd hazard grade (*Wirus Sindbis*)	medium	not very probable	low	D
Viruses of the 3rd hazard grade (*virus of the central European tick-borne meningoencephalitis virus of rabies, virus of Rift fever*)	high	not very probable	medium	D

As Table 4 has shown, only in the case of fungi, bacteria and viruses of the 3rd group was the forestry machines operator's professional hazard estimated as the medium one. Table 5 presents the estimation of the operator's professional hazard involving other kinds of danger.

Table 5. Assessment of an operator's professional hazard involving other dangers

Kind of hazard	Estimation of professional hazard			
	Severity of consequences	Probabilisty	Hazard level	Acceptability
Slipping, falling down at the same level	medium	not very probable	low	D
Falling down onto a lower level	low	not very probable	low	D
Cuts, stabbings	low	not very probable	low	D
Crushing	medium	not very probable	low	D
Road accident	medium	not very probable	low	D
Monotonny of work	medium	not very probable	low	D
Overburdenuring of the motor system	medium	not very probable	low	D
Overturning of the machine	medium	not very probable	low	D
Physical overload	medium	not very probable	low	D
Microclimate	medium	not very probable	low	D

The operator's professional hazard involving the dangers specified in Table 5 was estimated as low on the 3-grade scale.

CONCLUSIONS

The measurements of the physical factors harmful for the operator's health, i.e. noise and mechanical vibrations during the operating of the tested forestry machines, showed that only the Tractor Zetor 7211 produced in 1983 did not fulfill the acceptable standards so the conclusion is it should not be used for forestry transport. The other tested machines, in the investigated respect, were proved safe for their operator's health.

The operator's health and fitness can also be affected by other factors such as:

- monotonny (recurrent charakter) of the performed tasks and working activities,
- the forced automation of work movements,
- long-lasting activity of practically always the same muscle groups,
- long-lasting exposure to harmful microclimactic conditions in the cabin,
- mental stress,
- loneliness at work.

Work monotonny as well as overload of the muscular-skeletal system has a negative influence on the worker's health and the performance of his tasks. The forestry machine's operator is especially confronted with long hours of work in the forced, excessively bowed sitting position. For the most part of his daily shift he has to perform the recurrent movements of his hands, arms and head. He is affected by continuous vibrations and shocks. He cannot afford even the shortest moment of distraction [Zawieski 1999].

In the conditions of monotonny the interest in the performed work and its results drops, an increase of irritability or sleepiness follows and the mental symptoms are accompanied by a range of physiological reactions such as: lower oxygen consumption, slower heart action, decrease in the body temperature and blood pressure [Konarska 2003].

Prevention of the health deterioration in the operators of machines requires multiple actions. The measures should be undertaken in the technological, humane and organizational aspects. An efficient way of improving the operator's working conditions is the rotation of workstands which can reduce the hardships of the sedentary and monotonous work. Another possible way is to provide more rest intervals during which the worker should do some short gymnastics.

Another negative aspect of the forestry machine operator's job is the unavoidable exposure to adverse meteorological factors (cold, damp). The harmful factors combine their negative influence, which results in numeorous diseases of the muscular-skeletal system [Zawieski 1999, Grzywiński 2009].

An important role in the safe work of the operator is played by the work safety training which makes the workers aware of the dangers involved in the obtainment of wood. Equally important are the measurements of adverse factors at the workstands as well as regular prophylactic medical examinations [Rączkowski 2005].

Another important preventive measure in the protection of the worker's health and life is the use of individual protection means, the proper clothing and working shoes adjusted to the atmospheric conditions. In the recent years there has been an increase in the number of borreliosis cases among the operators of forestry machines. Borreliosis has been classified as an occupational disease. At present there are no medical means for its prevention. The only possible precaution against ticks is proper work clothing and the use of anti-arachnid repellents. On return from the tick-infested area the skin on the whole body should be carefully examined and the found parasites immediately removed. The shorter tick's stay in the skin, the smaller the risk of infection is. [Wawrzyniak 2007]. Another hazard is tick-borne meningoencephalitis, which can be prevented, however, by prior vaccination [Jelińska 2009, Dryll 2007].

Manual transport works are also a problem which contributes to the muscular-skeletal system's diseases. Some areas are unavailable for the skidding machines. Some elements have to be manually carried to the spot where they can be collected. The best way to perform such tasks is by using special wood grabs [Stempski 2010].

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ANALIZA ZAGROŻEŃ I SPOSOBÓW PRZECIWDZIAŁANIA IM PRZY OBSŁUDZE WYBRANYCH MASZYN LEŚNYCH

Streszczenie. Przeprowadzono analizę zagrożeń na jakie narażony jest operator wybranych maszyn leśnych (harwestera Valmet 901.3, forwardera Valmet 840.2 i ciągnika Zetor 7211) oraz podano sposoby przeciwdziałania tym zagrożeniom. Pomiary szkodliwych dla zdrowia operatora czynników fizycznych (drgań i hałasu) wykazały, że tylko w przypadku ciągnika Zetor 7211 zostały przekroczone dopuszczalne normy. Przedstawiono również ocenę ryzyka zawodowego operatora ze względu na czynniki biologiczne i inne rodzaje zagrożeń.

Słowa kluczowe: maszyny leśne, operator, drgania, hałas, czynniki biologiczne, ryzyko zawodowe