

# **RISK ASSESSMENT OF WHOLE BODY VIBRATION AT DRIVERS OF AGRICULTURAL TRACTORS**

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***Summary:** Agriculture tractor drivers are exposed during their work to various negative influences including vibrations. They are vibrations generated in engines, and which are transmitted to the driver's body (whole body vibrations) through the seat, floor and controls of a vehicle. The exposure to these vibrations over a long period of time can lead to serious health problems. Therefore, it is important to estimate risk to the health that comes from whole body vibrations in order to develop mechanisms of protection.*

*Although standard procedure assumes studying all risks and harms that may occur at one workplace, only estimation of risk to tractor drivers' health from vibrations was presented in this paper. The estimation of the risk of vibrations showed that the drivers and operators of agriculture tractor work in high risk working conditions. Therefore, some organizational and technical measures were proposed to be taken by employers so as to either reduce or eliminate the risk completely.*

***Key words:** risk estimation, whole body vibrations, agricultural tractors.*

## **1. INTRODUCTION**

During their activities, the drivers and operators of heavy construction, agriculture or mining machinery (bulldozers, dumpers, excavators, tractors, compactors, fork lift trucks, scrapers, graders, trucks, etc.) are exposed to many negative influences that have complex effect on man. Beside physical strain, precipitation, unfavorable micro-climate, temperature, various pollutions and noise, vibrations are also important factor [1-4].

They are whole body vibrations (wbv) generated in the interaction between the unevenness of the ground and the work of engine, as well as the work of implements and aggregates. Whole machine or a vehicle is exposed to complex oscillatory processes that are transmitted to the driver's body during the work. Vibration level depends, apart from the condition of the ground (terrain), on the tire type, vehicle velocity, seat type etc.

Today, it can be certainly said that a short-term exposure to vibrations can cause pain in the abdomen and in the chest, shortage of breath, nausea, loss of balance, etc, and on the other hand long-term exposure can lead to disorders in psychomotoric, physiological and psychic system of drivers and operators [5-8].

Harmful effects of vibrations are especially obvious in agricultural tractors, considering the implements they use, surfaces they work on and their life. There are more than 27 million tractors worldwide, that are older more than 20 years, so they can be generally considered outdated. Regardless of the fact that they still can work, their harmful effects remain, because of wbv especially.

Although standard procedure assumes studying all risks and harms that may occur at one workplace, this paper presents only estimation of risk from vibrations as one of the most harmful influences to drivers' health. This paper elaborates the most important steps that must be taken in order to determine the danger caused by vibrations. Subsequently, assessment of the real risk to health is carried out using a 3x3 matrix method. On the basis of these data it is possible to develop protection mechanisms (technical and organizational) that can reduce negative impact from vibrations. At the end of the paper, some measures will be proposed to reduce vibration levels in tractors.

## **2. EFFECTIVE MANAGEMENT OF WHOLE-BODY VIBRATION**

The risk management process can be estimated in four simple steps [9]:

- Identifying vibration hazards that might exist
- Risk estimation and evaluation
- Activities for risk elimination or reduction
- Monitor and evaluate

The beginning of the process is the collection of real information of a workplace and identification of vibration hazards. After that, the risk is estimated with the use of a method that can estimate and control OH&S risks. Necessary measures for risk reduction are taken only in case the estimation indicates increased risk. At the end of process is monitoring measures that we have done.

The first step in controlling whole-body vibration hazards is to identify and collect as much information as possible about which activities and sources are associated with harmful influences to drivers' health, how often do these problems occur, how severe are the problems etc.

The following sources of information could be used:

- Consultation with employees such as formal supervisor/safety representative reporting, informal discussions with employees who ride in, drive or operate vehicles, surveys, questionnaires and feedback sheets;
- Direct observation of the workers, tasks and activities, work area inspections, riding in and driving vehicles where permitted;
- Statistics and injury records such as medical and health records, health surveillance data, records of incidents and accidents.

However, while these data provide a list of past risks and precipitating events they may not be a true indication of the hazards that currently exist.

### 3. WHOLE BODY VIBRATION RISK ESTIMATION

The risk estimation is a research process that aims to increase the safety level at a workplace. When estimating the risk one should consider the fact that a driver's health risk depends on the vibration level and frequency, as well as on the length of exposure and the working practice. It is important to know that an individual sensation, during the period of exposure to vibrations, depends on the health of an operator and working practice. With appropriate risk estimation it is possible to identify and reduce exposure in the early stages. The understanding of the way workers are exposed to vibrations can help adopting methods of reducing or eliminating the exposure.

The law or standards don't prescribe any universal or specific risk estimation method. Practically, it is a licenced institution that determines which method will be applied (Kinney, Pilz, Guardmaster, 5x5 or 3x3 risk matrix etc.). One of the methods that enables OH&S risk estimation and management is a 3x3 matrix method . According to it, the risk (R) is expressed as a product of possibility for occupational injury, health damage and work-related injuries (V) and the level of injuries, health damage and occupational illnesses (T):

$$R = V \times T$$

The possibility of occurring and the effects of injuries is the matter of subjective assessment of person estimating the risk. The estimation of possibility is carried out according to the information the estimator acquired during measuring of vibration levels and calculating of the exposure levels in a number of vehicles or using such data from books, catalogues, manuals etc. The statistics related to occupational illnesses, injuries, damages are important as well.

In case of agricultural tractor drivers, according to many studies, a correlation between whole body vibration and health damage was determined, and for 8-hour working time the possibility of work-related injury (table 1) and the effects of severity of work-related injury (table 2) are **MEDIUM**.

*Table 1. Possibility levels and their description*

Possibility of work-related injury, health damage and work-related illness (V)	Description	
Low possibility	1	Work-related injury, health damage and work-related illness is not likely to occur
<b>Medium possibility</b>	<b>2</b>	<b>Work-related injury, health damage and work-related illness is likely to occur</b>
High possibility	3	Work-related injury, health damage and work-related illness occurs frequently or repeats

**Table 2.** Effects of the severity of work-related injury, health damage and work-related illness

Effect of severity of work-related injury, health damage and work-related illness ( T )	Description	
Minor effects	1	Effect of severity of work-related injury, health damage and work-related illness requires first aid only
Medium effects	2	<b>Effect of severity of work-related injury, health damage and work-related illness requires hospital treatment, the illness causes temporary weakness or disability</b>
Serious effects	3	Effect of severity of work-related injury, health damage and work-related illness is considered serious and as an occupational illness

After adopting numeric values from table 1 and 2, the risk can be calculated. In case of agricultural tractor drivers, medium risk from whole body vibrations was classified (Table 3).

**Table 3.** Matrix model for risk estimation

Effect of severity of work-related injury, health damage and work-related illness ( T )		Possibility of work-related injury, health damage and work-related illness ( V )		
		Low	Medium	High
		1	2	3
Minor effects	1	Negligible risk (1)	Slight risk (2)	Low risk (3)
Medium effects	2	Slight risk (2)	<b>Medium risk (4)</b>	High risk (6)
Serious effects	3	Low risk (3)	High risk (6)	Extreme risk (9)

Classified medium risk is **INCREASED** risk, i.e. a risk that is assumed to be the cause of work-related illnesses or workplace injuries and can exceed the legal limits (Table 4).

**Table 4.** Risk classification and description

Risk (R)	Risk classification	Risk description
1	Negligible risk	Acceptable risk
2	Slight risk	
3	Low risk	

4	Medium risk	Increased risk
6	High risk	Unacceptable risk
9	Extreme risk	

After determining the increased (or unacceptable) risk to health, it is important to take adequate measures so as to eliminate vibrations or decrease their levels under legally regulated limits.

In case of increased or unacceptable risk, an employer is obliged to take some corrective measures-methods for risk control, so as to reduce it or eliminate it completely. An important part in the process is the understanding of work processes that generate vibrations, i.e. understanding how the workers are exposed to vibrations. When taking corrective measures, achievable objective should be set, priorities should be determined, plan of activities should be made and duties should be assigned adequately.

#### 4. CONCLUSION

Detrimental effects of vibrations from heavy-duty vehicles and machines to workers and drivers is known, but is still not taken seriously. Comprehensive correlation between vibration effects and health damage cannot be determined because of combined effects of vibrations and other occupational risks and damages. Exposure to vibration can affect drivers and operators in various ways, from minor disorders and low efficiency of workers to serious health deterioration, depending on the length of exposure and vibration levels.

As a result of risk estimation, an increased tractor drivers' health risk was classified, therefore employers are obliged to take appropriate measures and activities so as to reduce or eliminate whole body vibrations completely. The effects of measures taken should be analysed occasionally in order to assess their adequacy and efficiency.

Risk estimation must be carried out each time new vehicles are used, when working practice or working hours spent in vehicles causing vibrations are changed

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