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## THE LEGISLATIONS AND PREVENTION MEASURES BASES REGARDING THE MECHANICAL VIBRATION TRANSMITTED ABOUT THE HUMAN BODY

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**Abstract:** The present paper represents a study about the possibilities of prevention of vibrations transmitted about human body from working place to operator exposure.

**Key words:** the vibrations transmitted about human body, the devices, and the machine-tools.

### 1. INTRODUCTION

The mechanical vibrations, of the medical point of view, transmitted of the human body have a complex action about it regarding the mechanical, thermal and psychological effects. All these would lead of the functional and psychological modifications of body [5].

Subjective responses of the human body of the vibrations (the perception, the uncomfortable sensation, fear and pain), depend of the vibrations parameters (the displacement, velocity, acceleration and frequency), of the vibration exposure time and how are transmitted vibrations [1], [6].

Mechanical vibrations action about human body has, usually, like result of the person health the stare deterioration, referring of person exposure of prolong vibrations [2], [3]. The prolong exposure of mechanical vibration lead of the professional affection about person, finally. For these reasons, it must be necessary to assure the person protection of the working place [4].

O shortly classification of the vibration after action mode about human body [5] is:

- the vibrations that acting about whole body (*WBV-Whole Body Vibration*);
- the local (segmental) vibrations including the hand-arm vibrations, these affect hand-arm

system, usually, of the Raynaud syndrome named *VWF-Vibration White Finger*. In this category take a part a sickness of motion duty the exposures of vibrations.

It mentioned fact that distinction between the local and whole body vibrations is not good specify. The both exposures of vibrations have like a result transmitted of vibrations about whole body.

Seldom person exposure of vibration make referring of the hand-arm system because exposure is caused of direct contact between hand and vibrating devices used in the working place (Fig. 1).

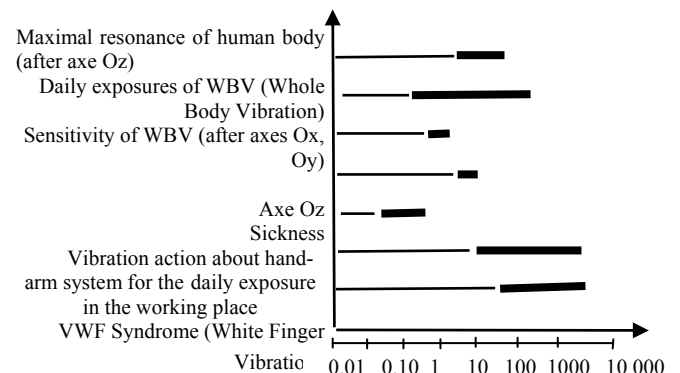


Fig. 1 The vibration action about human body [1].

### 2. THE PREVENTION MEASURES REGARDING THE VIBRATIONS

**TRANSMISSIBILITY ABOUT HAND-ARM SYSTEM**

The international studies demonstrated that effects of mechanical vibrations are harmfully about persons, exposure persons of these. The new settles of European Union (2002/44/EC) impose the legal new rules regarding the transmitted modes of these in the working place [1].

Also, it can take protection measurements regarding company obligation to pay the morale damages to person exposure in the vibration damage working place, without prevent before of vibration exposure and assure the protective equipments. All vibrating equipments, devices and machine-tools are built taking into account of legislative norms regarding the protection person of the working place. For hand one of protective equipment are the gloves using.

If a person works into the vibrating working place for diminish transmitting vibrations to body, it must be wearing the protective equipment [2] and:

- To must changing device using;
- It is preferred to exposure of the vibrating is not combined with the other environments factors (cold, wetting, corrosive medium, noise, etc);

The European Union legislations impose for daily exposure of vibrations to hand-arm system the limits of:

- For 8h daily exposure root mean square acceleration is  $5\text{m/s}^2$ .
- For 4h daily exposure root mean square acceleration is  $2.5\text{m/s}^2$ .

The European Union legislations impose for daily exposure of vibrations to human body the limits of:

- For 8h daily exposure root mean square acceleration is  $1.15\text{m/s}^2$ .
- For 4h daily exposure root mean square acceleration is  $0.5\text{m/s}^2$ .

The table 1.1 represents some usually persons that using the vibrating devices or equipments.

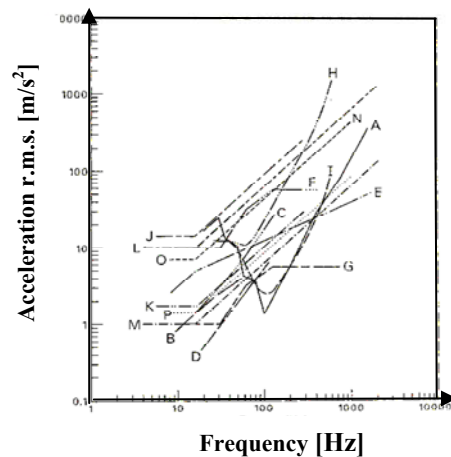
The vibrating limit [7], [8] comfort is give by the sensation thresholds till to the pain threshold and it is presented in standards in concordance with responses of exposure

persons. It is situations when the affections appear before the sensitive threshold to vibrations. This is reason to avoid of these vibrating values.

Table 1

**Usually persons that using the vibrating devices or equipments.**

<ul style="list-style-type: none"> <li>- Devices productions (have impose the vibrating limits to devices);</li> <li>- User devices (function of exposure period);</li> <li>- Medical Assistant (function of using period of medical equipments or devices);</li> <li>- The persons responsible with legislation (with scope to take the prevents measure in the working place);</li> <li>- Justice Court (the knowledge of protective norms in case to the appearance of conflict between producer and user);</li> <li>- Epidemiologique researches (tracing the affections that could be appear duty of vibrations exposure);</li> <li>- Technical consultants (with diminish scope vibrations effects, it produces of machine-tool and transmitted till operator);</li> <li>- The academic others (for improving of the existents studies);</li> <li>- Instrumental producers of vibrations measures (must know vibrations limits for established measures limits and a interpreted parameters);</li> <li>- The other standardizations commissions (for measures values comparison with the standardization limits.</li> </ul>
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**Fig. 2** The limits of vibrations [5] corresponding to the hand-arm system, proposal in 1980 of:

- A) U.R.S.S. 191-55 (U.R.S.S. Standardization Committee, 1955);
- B) Andreeva Galanina modifications for U.R.S.S. standards, 191-55;
- C) Miura and other (1957), 50% of the exposure persons at vibrations do not complain of affection;

- D) Miura and other (1957), of the exposure persons at vibrations do not complain of affection;
- E) U.R.S.S. Amendments 626-66 (Standardization Committee of U.R.S.S., 1966) and 1770-72 (1972);
- F) CSSR 33 hygienically rules (Czechoslovak health Ministry, 1967) for vibrations exposure till 30 min;
- G) CSSR 33 hygienically rules (Czechoslovak health Ministry, 1967) for vibrations exposure till 120 min;
- H) Axelsson (1968), pain limits duty of professional exposures;
- I) Axelsson (1968), pain limits risks;
- J) Japan Health Industrial Associations (Anon, 1970), referring of vibrations exposures till 10 min;
- K) Japan Health Industrial Associations (Anon, 1970), referring of vibrations exposures till 480 min;
- L) BSI DD 43 (British Standardization Institution, 1975), for vibrations exposure of 150 min;
- M) BSI DD 43 (British standardization Institution, 1975) for exposures of vibrations of 400 min.
- N) Canadian Association Standardization (1977), referring of electromechanically portable saws using in forest field;
- O) ISO/DIS 5349 (International Organization of Standardization, 1979a) for exposure of vibration < 30 min.;
- P) ISO/DIS 5349 (International Organization of Standardization, 1979a) for exposure of vibration between 240 - 480 min.

## 2.1. Vibration standards regarding transmitted limits of vibrations about human hand-arm system

**a.** Into graphical representation in 1980 year [7] it can observe that the accelerations vibrations limits around of 100 Hz permit big displacements magnitudes, in comparison with vibrations displacements at the big frequency (**curve A**). Andreeva Galenina proposed a reconfiguration of vibrations limits of vibrations for frequencies smaller of 64 Hz, because exists risk of the big magnitudes of vibrations and small frequencies to appear pain in the bones (**curve B**).

The U.R.S.S. Standards 626-66 referring of medical limits was defined for frequencies measures in the octave bands 16-2000 Hz (**curve E**). Also, it was standardized the values referring of the device mass, the values corresponding to push forces used for device manipulate and took ergonomically measures, such as to ensure a correct surface of contact between hand and device.

**b.** The Czechoslovak Standardization Limits based of Andreeva Galenina modifications in U.R.S.S. Kryze (1962) proposed like these values would be simplify for r.m.s. accelerations to

limits of  $4 \text{ m/s}^2$  and a limits velocity by  $0.019 \text{ m/s}$ .

In the publishing thesis in 1966 of Louda, he proposed a new system of vibrations limitations, based of vibrations transmissibility and individual subjective perceptibility. These dates have influenced the anterior amendments number 33 (1967) of the Czechoslovak Health Ministry and they have imposed the vibrations measurements to make between 8-500 Hz in the octave frequencies bands. It was effectuated corrections regarding the vibrations exposure of 0.5, 10 and 20 dB for continuum exposure of 2 h, 1 - 2 h, 0.5 - 1 h and < 30 min.

The Czechoslovak Amendments Ministry in the Health Field (1977) changed these vibrations limits corresponding of frequency 8-31.5 Hz and r.m.s. accelerations of  $1 \text{ m/s}^2$  for vibrations exposure by 2h (**curve G**). It changed, also, for vibrations corresponding of  $10 \text{ m/s}^2$  r.m.s. to continuum exposure of 30 minutes (**curve F**), it was changed with ISO DIS 5349/1/1977 recommendations limits for exposures bigger one hours.

The first standards of vibrations magnitudes limits for used devices in the vibrating environment in Japan were created for auto industry, naval and constructions builds (**curves C and D**) (Miura and other 1957). Later the vibrations limitations was changed of the hand sensation average limits, the values subscribed of Miwa and other (1967, 1968). By 10 studied subjects of Miwa it was determined the averages limits of tactility corresponding of vertical a horizontal vibrations, for hand that pushing a plate surface. Miwa studied the vibrations exposure responses by the horizontally and vertically vibrations, for vibrations with frequencies between 3-300 Hz and observe did not important differences between two directions measured. Miwa observed less than 6 Hz values the acceleration curve approach of the 60 Hz limits (the acceleration increase the proportional with square frequency). Also, Miwa determined the magnitudes corresponds the *unpleasure* sensations and the *tolerate limit*. He establishes of 20 Hz the limit tolerance of vibrations is 65 VAL ( $17.8 \text{ m/s}^2$  r.m.s.) and the unpleasure limit is 50 VAL ( $3.2 \text{ m/s}^2$  r.m.s.), where VAL represents the Limit Value:

$$VAL = 20 \lg \frac{a}{a_{ref}} \quad (1)$$

and:  $a_{ref}$  (references acceleration) =  $10^{-3} \text{ m/s}^2$ , corresponding the gravitational acceleration of  $g = 9.81 \text{ m/s}^2$ ;

$a$  = r.m.s. measured acceleration corresponding the gravitational acceleration of  $g = 9.81 \text{ m/s}^2$ .

**d)** Axelsson (1968) defined two limits, they are situated under pain limits (**curve I**) and (**curve J**) (Fig.2), curve define of preponderant pain limit. The vibrations measurements effectuated after three direction of anatomical coordinate, between frequencies 50-500 Hz and was determinate the accelerations magnitude like as a vector sum of square roots (r.m.s.).

In 1986 the Swedish standardization Organization adoptee a new standard based on ISO 5349/1977. This standard asks the vibrating devices producers to respect in the fabrication process some rules, like: the society must ensure the protective equipment for the person that work in the vibrating place, the persons exposure in the vibrating place must be inform of exposure vibrating risk and to periodically present of the medical examinations.

**e.** In 1975 the British Standardization Institution (BSI) published in the Development Project a simply version of existent standardization documents (Fig.2) and they defined there two limits: limits with a conventional base of  $1 \text{ m/s}^2$  r.m.s. and  $10 \text{ m/s}^2$  r.m.s. for frequencies values between 4-16 Hz (**curves L** and **M**).

**f.** The Standardization International Project DIS 5349.1 (1979) specified five vibrations limits situated between 8-1000 Hz and in the octave band analyzing. The frequencies values measured in the octave band are presented in the **curves O** and **P** (Fig.2).

### 3. VIBRATING EFFECTS ABOUT HUMAN BODY

It is many graphics that present the vibrations effects about human body, function of frequency and of the kinematics characteristics. Dieckmann introduced perception coefficient notated  $K$  [6], this was in calculus like a vibrations effect measure

about human body. The  $K$  value could be determined in the formulas:

$$K = a_{ef} \frac{\alpha}{\sqrt{1 + (f/f_0)^2}} ;$$

$$K = v_{ef} \frac{\beta f}{\sqrt{1 + (f/f_0)^2}} ;$$

$$K = x_{ef} \frac{\gamma f^2}{\sqrt{1 + (f/f_0)^2}}$$
(2)

where:  $a_{ef}, v_{ef}, x_{ef}$  - is efficacy acceleration [ $\text{m/s}^2$ ], efficacy velocity [ $\text{m/s}$ ] and efficacy displacement [ $\text{m}$ ];

$f$  - vibration frequency [ $\text{Hz}$ ];

$f_0 = 10 \text{ Hz}$  – reference frequency;

$\alpha = 18 \text{ s}^2/\text{m}$ ;

$\beta = 0.112 \text{ s}^2/\text{mm}$ ;

$\gamma = 0.71 \text{ s}^2/\text{mm}$ .

In the table 2 is represented the perception stare and the perception threshold after germane rules „VDI – Richtlinien 2057“ function of  $K$  values.

Table 2

The vibrating human perception levels function of perception coefficient [6].

Perception coefficient $K$	Level	Perception threshold
0.1 0.25	A	Imperceptible
	B	Hardly perception level
0.63	C	Perceptible
1.6	D	Perceptible good
4	E	Strong perceptible
10 25	F	Very strong perceptible
63	G	Very strong perceptible
	H	Very strong perceptible
	I	Very strong perceptible

If it formed the diagrams in acceleration, velocity and displacement, function of frequency result the graphics by the figure 3. It can observe between 5-20 Hz frequency area, the results are uncertain; they depended of the every body structure submissively of vibrations.

The other graphics steps are in conformity with table 1, respectively A step with

perception values the smallest, and I step with vibrations exposure person perception “ very strong perceptible”.

The machine-tools presented in the figure 4, respectively M group (middle machine-tools with engine 15-45 kW) without special support and round machine-tools fixed on support, its having a engine power 300 kW, it could observed the „VDI – Richtlinien 2056“ and admissible values on graphic. It established by the admissible vibrations to these groups of machine-tools are perception levels superior of person [6].

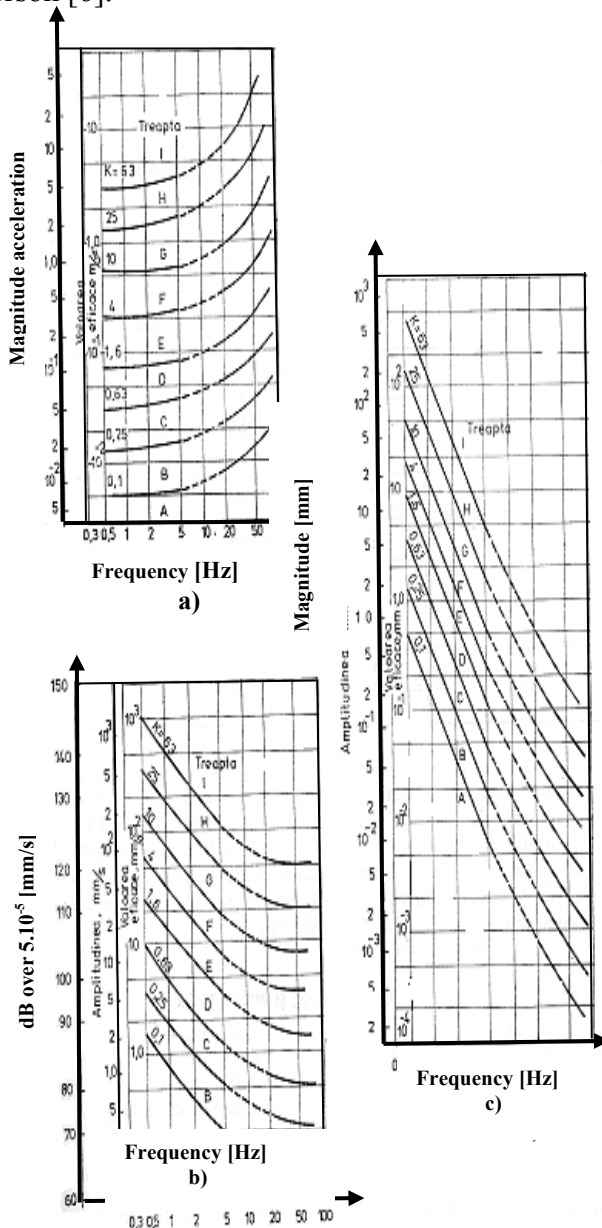


Fig. 3 Graphics: a) acceleration, b) velocity, c) displacements, corresponding to exposure person perception [6].

The figure 4 represents admissible vibrations values graphics for machine-tools, VDI – Richtlinien 2056, it given values (the vertical axe have two gradations scales: one exterior for perception coefficients  $K = 2.8$  and  $7.1$  and one interior perception coefficients  $K = 0.11$  and  $1.1$ ).

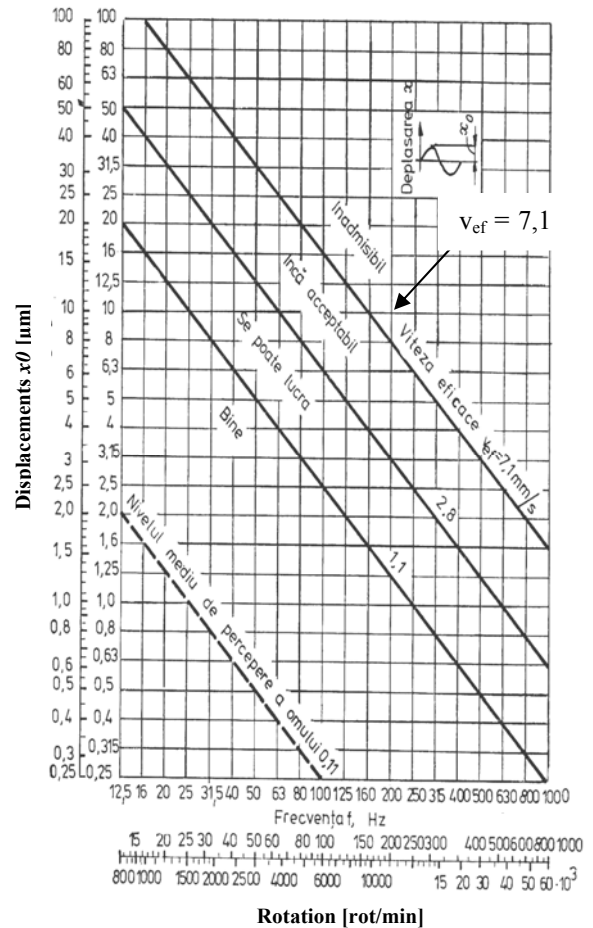


Fig. 4 Admissible values regarding the machine-tools of point of view of human perception, given by „VDI – Richtlinien 2056“ [6].

It observed like a frequencies of 100 Hz the vibrations perceptions to men is into medium perception limit ( $K = 0.11$ ), till 800 Hz and  $20 \mu\text{m}$  vibrations magnitude it can be good working, but exceeding these values lead of the big perception coefficients, but acceptable yet, it is good a be avoid ( $K = 2.8$ ). The unacceptable perception coefficients for a person are  $K > 2.8$  at the efficacy velocities  $7.1 \text{ mm/s}$  it is very dangerous for the health of person. The person protection is daily exposure of vibrations in the working place is evaluate on the rigorously standards [SREN 2637-1-1997], [SREN 5349-2-2003],

and are imposed the exposure vibrations periods, magnitude acceleration, protection equipments and periodical checking of health exposure person.

### 3. CONCLUSIONS

The paper presents the possibly causes of vibrations transmissibility about human body and the protective equipment for minimizing of their. Also, it is represents the limits give by standards regarding vibrations exposure of person. The paper analyzed the perception coefficients of vibrations and the admissible values regarding the machine-tools take in account the perception human gibe by VDI-Richtlinien 2056.

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### **Bazele măsurilor pentru prevenire și legislație privind transmiterea vibrațiilor mecanice asupra organismului uman**

**Rezumat:** Lucrarea de față reprezintă un studiu asupra posibilităților de prevenire a transmiterii vibrațiilor mecanice asupra organismului uman de la locul de muncă la operatorul expus la vibrații.

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