

# EVALUATION OF HUMAN EXPOSURE TO GENERATED VIBRATION FROM A GAS BOTTLE STATION

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*Abstract* Paper presents the analyze of the working conditions of the emplo that works into a gas station. The main vibration effects to human body are presented, limit values to vibration according to actual legislation, measuring devices used for vibration measuring, measuring results and employer obligations.

**Keywords:** working, conditions, vibration, human, body

## 1. INTRODUCTION

For the worker exposed to vibration action very important is the place where the vibration source acts upon the human body. A global action of the vibration to the human body has different effects comparing to vibration action on the hand-arm system. Other important parameter is time exposure to vibrations.

Generally, the vibration action to human body is characterised by:

- acceleration level;
- frequency domain;
- contact position between vibration source and human body (global vibrations or transmitted vibrations to hand-arm system);
- duration in time to exposure.

## 2. CASE STUDY

Experiments were done in a gas station where liquified petrol gas is bottled, property of Gaspeco L&D S.A. The company activity contains also distribution and reselling bottled gas. The total amount of liquified petrol gas that is bottled is 180 t/day in Negoiești, Prahova District.

## 3. PRINCIPAL EFFECTS OF THE VIBRATIONS TO THE HUMAN BODY

Negative influence of the vibrations affects not only the human healths but also its productivity. Vibration introduced on human body can produce [1, 2]:

- influence of the physical activity and intellectual, fatigue;
- mechanical damages - at different acceleration fracture of the bone can developed, lungs deterioration, heart injuries;
- subjectively phenomenas - lack of comfort, pain and agitation.

In this study three steps of vibration effects are considered: perception level, inconvenience level and intolerance level.

Complex distribution of forces and oscillatory movement in the body during vibrations action, during general vibration action with general application produces complex sensations. Localization and sensation character can vary as a function of vibration frequency, vibration direction and other factors.

The following elements can affect the sanguine circulation modification caused by transmitted vibrations to hand-arm system [3, 4]:

- factors from the working environment, especially micro-climate, noise and chemical agents;
- some medical personal problems;
- agents that affects periferical blood vessel circulation like smoking or some drugs.

### **3.1 Effects on peripheral sanguine circulation**

One of the first problems to be studied is blood vessel perturbation because of tool vibration manipulated by human operators. Manifestation of blood vessel disturbance are vascular throe in fingers followed by skin cyanosis or tumefaction. These blood vessel perturbances appears independently of cold or hot microclimate.

### **3.2 Effects on articular and osseous system**

Injures induced by mechanical vibration on the osseous articular system ar defined like professional illness and represents one of the oldest problems that need surgical treatment. These injuries are the result of vibrations transmitted by hand-tool to human extremities. During work process, the worker opose to the tool his muscular force that fixed them into de material this fact contribute to vibration force transmision.

### **3.3 Raynaud sindrome**

This sindrome represents an abnormal statement of sanguine circulation at the fingers level. This affects the fingers at cold conducting at the "white fingers" sindrom by severe sanguine reduction. Cold expousure reduces at abnormal values the sanguine circulation, conducting at a white-yellow colour at the finger level. Typical crysis are developed like:

- slow tactile sensibility reduction;
- fingers whitening usually without great finger affection;
- pain, sometimes with red colour of fingers simultainiously with sanguine circulation restoration after 30 min up to 2 hours.

Different causes could produce this sindrome, sometimes at work place. It is associated usually with vibration action at the arm level but it is implied also in others general illness. Raynaud sindrome simptoms are indicated to be known also with its associated risks in order to prevent this illness or it progression. Ligh illness can affect the social activity and professional activity of the worker. Severe situations produces work incapacity and changes in work place has to be done.

#### **4. MINIMAL WORK REQUIREMENTS REGARDING HUMAN VIBRATION EXPOUSURE**

In Romania, the minimal health and security requirements for vibration expousure are presented in law no. 1876/22.12.2005. This law establish the minimal requirement regarding workers protection against vibration produced at work place. In this order, the following definitions are available:

- transmitted vibration to arm-hand system - mechanical vibration, in the case in which is transmitted to human arm-hand system, that generate risks for the workers health and security. These risks regards vascular affections, osseous or articular injuries, neurological or muscular system.

- transmitted vibration to the whole body - mechanical vibrations transmitted to the humanbody that generate risks for the health and security for the workers, specially for the scheletal system.

For the arm-hand transmitted vibration the following values are available:

- limit value for daily professional exposure, calculated for a reference period of 8 hours is  $5 \text{ m/s}^2$ .

- limit value for daily professional exposure considered for action starting for a reference 8 hours period is  $2,5 \text{ m/s}^2$ .

For the vibrations transmitted to whole body following values are available:

- limit value for a daily professional exposure of 8 hours has to be  $1,15 \text{ m/s}^2$ ;

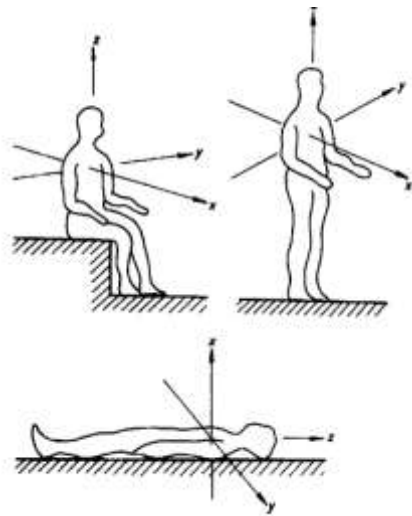
- limit value for daily professional exposure considered for action starting for a reference 8 hours period is  $0,5 \text{ m/s}^2$ .

#### **5. EXPERIMENTAL RESULTS**

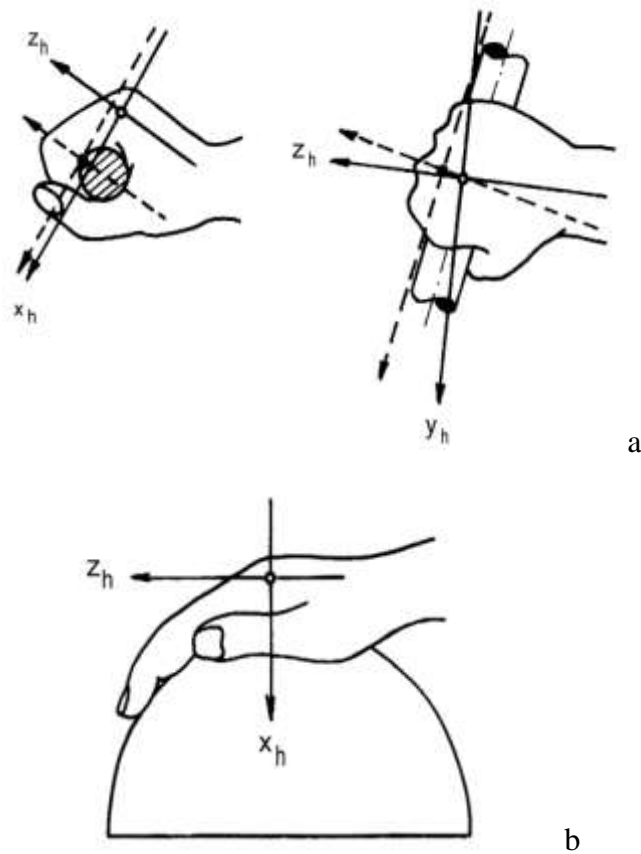
The measuring method for vibration expousure determination is established by **HG 1876/2005, SR EN ISO 2631-1:2001 Human exposure evaluation to global vibrations and SR EN ISO 5349-1:2001 Human exposure evaluation and measuring transmitted vibrations by hand**. The measuring vibration unit is acceleration. Vibrations has to be measured according to a coordinate system, with the origin set in the entrance vibration point of the human body. Figure 1 presents the corresponding image [5, 6].

The measuring methos says that to determine the global vibration value, the vibration transducers must be placed in such a way to indicate the vibration in the interference point between human body and vibration source. Three principale surfaces are used for sitting persons: support surface of the chair, back of the chair and chair legs. Legs measuring has to be done on the frequently used surface [7, 8].

The measuring method to determine vibration value for arm-hand says that the transducers has to be placed in such a way that indicates vibrations in the interference point between hand and vibration source. The accelerometer must be placed in the middle of the hand. In this point, the representative value is get. The figure 2 presents the accelerometer placement during measurements [9].



**Fig. 1.**  $a_x, a_y, a_z$  – OX, OY, OZ corresponding acceleration; OX axis - from back to chest, OY axis - from right to left, OZ axis - from legs to head



**Fig. 2.** Coordinate system for vibration measuring methods: a - "strech hand" position, b - "layed hand" position

The vibration measuring was done using devices that are in accordance with legal references to metrological verification regarding to **SR EN ISO 8041:2006**. Usually, the vibration transducer is a common accelerometer or a special one dedicated to high values accelerations meet at chisel tools. Accelerometer dimensions must not affect machine working and measuring point position.

For measuring, the following devices were used:

- human vibration analyzer Brüel&Kjaer type 4447;
- Global vibration accelerometer Brüel&Kjaer type 4506;
- Global vibration accelerometer Endevco type 65100;
- Vibration arm-hand accelerometer Brüel&Kjaer type 4520;
- Vibration Explorer 4447 software;
- Calibration tool Brüel&Kjaer type 4294.

Determination were done in the production shop of the bottle line.

The following results were found according to schedule:

#### **Gas bottle shop**

- human operator - extraction from bottle line on pneumatic screw driver - transmitted acceleration to arm-hand system for a period of 8 hours is  $0.731 \text{ m/s}^2$ ;
- bolt nut assembling on pneumatic screw driver - transmitted acceleration to arm-hand system for a period of 8 hours is  $1.208 \text{ m/s}^2$ ;

#### **Caterpillar lift truck**

- driver - accelerometer placed on the wheel - transmitted acceleration to arm-hand system for a period of 8 hours is  $0.216 \text{ m/s}^2$ ;
- driver - accelerometer placed on the seat - transmitted acceleration to arm-hand system for a period of 8 hours is  $0.838 \text{ m/s}^2$ ;

#### **BT lift truck**

- driver - accelerometer placed on the wheel - transmitted acceleration to arm-hand system for a period of 8 hours is  $0.156 \text{ m/s}^2$ ;
- driver - accelerometer placed on the seat - transmitted acceleration to arm-hand system for a period of 8 hours is  $0.685 \text{ m/s}^2$ ;

In conclusion, the daily vibration exposure do not exceed the maximal value established by romanian national norm HG 1876/2005 [8],[9].

## **6. CONCLUSION**

The article shows the importance of vibration measuring in different workplaces. The measuring took in gas bottle station from GPL Negoiesti Romania are normal limits but shows that vibration exists and can affect the human body. If it is necessary, the employer has to measure the vibrations and in the case of over limit, illness can occur with important personal problems.

## **REFERENCES**

- [1] **Darabont A., Iorga, I., Ciodaru, M.**, *Noise vibration and noises in technique*, Technical Publisher House, Bucharest, 1983
- [2] **Darabont A., Văiteanu D.**, *Noise pollution and vibration*, Technical Publisher House, Bucharest, 1996
- [3] **Manu P.**, *Occupational health service*, Medical Publisher House, Bucharest, 1975

- [4] **Darabont A., Văiteanu D**, *Vibratii. Risks factors for health and security*, Technical Publisher House, Bucharest, 1999
- [5] **Government Ordonance no. 1876 from 22.12.2005** *Minimal request regarding health and security of the workers exposed to vibrations*
- [7] **Law no. 319/2006** – *Health and security law*
- [8] **SR EN ISO 2631-1:2001** – *Vibrations and mechanical shocks*,
- [9] **SR EN ISO 5349-1:2001** – *Measuring and evaluation of the human exposure to hand transmitted vibrations*