

# VIBRATION EXPOSURE ASSESSMENT FOR INDUSTRIAL POWER TOOLS

Skogsberg L<sup>1</sup>

1. Manager Product Ergonomics  
Atlas Copco Tools AB SE 10523 Stockholm  
E-mail: lars.skogsberg@se.atlascopco.com

*The national legislations based on the Physical Agents Vibration Directive 2002/44/EG have now been active since July 2005. The new regulations put new demands on the employer to assess the risk for vibration exposure for all employees and for those at risk an action plan to manage risk must be set up.*

*Based on the information given in the paper A107 a three step method to do this is presented. The method is intended for employers to handle the demand to manage the risk from hand-arm vibration in the new national legislation.*

*To make an exposure assessment the in-use vibration and the exposure time is needed for all power tools used by the operator. Methods are suggested how to find those data with reasonable accuracy and with a minimum of effort.*

*To manage the risk often means a change of working-process or a change of tools to reduce the vibration exposure. It is explained how this can be done and how the results can be estimated.*

*Vibration exposure, Exposure assessment, Hand-Arm vibration*

## **1 Introduction**

The national legislation based on the Physical Agents Vibration Directive 2002/44/EG has put new demands on the employers to manage the risk from vibration exposure. A method that employers can use to handle this demand for employees working mainly with industrial power tools has been published in the Atlas Copco Pocket Guide, "Vibration exposure assessment for industrial power tools." This paper describes this method.

## **2 Background**

Hand-arm vibrations are regarded as a serious work-related disorder. The Physical Agents (Vibration) Directive (2002/44 EC) is intended to introduce into national regulations controls which aim to reduce ill health caused by exposure to hand-arm vibration and reduce costs for sick-leave and workers' compensation. The Physical Agents (Vibration) Directive was developed from an original proposal made by the European Commission in 1993. This proposal was revised, amended and eventually agreed by Member States and the European Parliament and came into force on 6 July 2002.

The Directive lays down the minimum standards for the health and safety of workers exposed to hand-arm vibration and supports the general requirements for improving health and safety that are outlined in the Framework Directive (89/391/EEC).

The employer must follow the national law regarding health and safety. Today the national regulations are harmonized by the requirements in the directive. The Directive specifically requires employers, where there is likely to be a risk from exposure to vibration, to:

- a. Reduce exposure to a minimum (Article 5.1)
- b. Assess risks (Article 4.1)
- c. Carry out a programme of measures to reduce risks (Article 5.2)
- d. Keep exposure below the exposure limit value (Article 5.3)
- e. Provide information and training on the risks and their control (Article 6)
- f. Provide appropriate health surveillance when exposure reaches the exposure action value (Article 8)

Exposure action and limit values are introduced. For hand-arm vibration the action value is set to  $2.5 \text{ m/s}^2$  and the limit value to  $5 \text{ m/s}^2$ . Both values are A(8) values meaning they are average values over the 8h working day. These values should not be confused with the declared vibration values given for all tools. The difference is fully explained in paper A107 "The development of revised vibration emission standards."

### **3 Introduction to the method**

For groups of operators where there have been cases of reported vibration disorders it is obviously a risk to manage and those cases should be taken care of first. The workflow is applicable only in situations where the risk is not known. It consists of three steps. First find and exclude the operators with an obvious low risk. Secondly make a rough exposure assessment and exclude operators found to be exposed well below the action value. For the group of operators not excluded from further action by step one and two the third and final step is to manage the risk by reducing the exposure to vibration.

#### **4 Step 1: Find the operators with low risk**

Among all operators at a work-site there are always groups of operators that are not exposed to vibrations or are exposed well below the action value. For those operators a risk assessment is a document where the groups are identified and a statement is included explaining on what grounds the groups are judged as being exposed far below the action value.

For industrial power tools some types of tools are known to have low vibrations. This includes, angle and pistol grip nutrunners, shut off screwdrivers, small impulse nutrunners and non-hammering drills. The action value will probably not be exceeded also if tools from these groups are used intensively for the whole working day. This is

not valid if the operator mixes the use of such tools with the use of other tools with higher vibrations values. You also have to make sure the tools are used under normal working conditions.

There are applications where the exposure time is normally very short. In these cases quite high vibration values can be accepted. Again, these applications can only be regarded as non-critical if they are not mixed with other tasks with higher vibrations that add to the A(8) value.

## **5 Step 2: Make a rough exposure assessment**

The aim of this second step in the workflow is to make the best possible vibration-exposure assessment based on available information. This assessment is then used to eliminate a second group of operators from further actions.

It is often sufficient to use a rough estimate of the in-use vibration value and to combine that with a realistic estimation of the exposure time to show that the exposure is below the action value and thereby eliminate the need for an action plan for those operators.

The first rough exposure assessment consists of 3 parts:

1. Find a vibration value that is an estimate of the vibration value in real use.
2. Estimate the exposure time.
3. Calculate the vibration exposure.

### *5.1 Find a vibration value that is an estimate of the vibration value in real use*

Finding a value for the in-use vibration is by far the most difficult part of the exposure assessment. The vibration from a power tool varies over the day depending how the tool is used. The way the operator use the tool is also influencing the in-use vibration. The task is to find a value that is representative for the average in-use vibration.

Three possibilities exist.

1. Use the declared values supplied with the tool
2. Find representative values from other sources like databases on the internet.
3. Measure, in the actual work-situation, to find the in-use vibration for that specific workplace.

The three possibilities are discussed below and the conclusion is that the most realistic possibility is to use the manufacturers declared values corrected according to the rules given in CEN TR 15350 and this method is therefore suggested for the users of this workflow. The content of CEN TR 15350 is explained in paper A107.

#### *5.1.1 Use the declared values supplied with the tool*

This value is easy to find and measured in well controlled laboratory conditions. The spread is kept low because of the controlled conditions. The values are often based on one axis measurements. The values need to be corrected with correction factors that can best be taken from CEN TR 15350. After correction the values are normally good estimates of the average vibration values for the tool when used in the intended normal conditions. Also after correction the values must be used with care because they do not always represent a realistic in-use vibration for the specific work task performed especially when that work-task is not the intended normal use for the tool.

### 5.1.2 Find representative values from other sources like databases on the internet.

There are a number of databases on the Internet. Many also present in-use vibration values. Due to the large spread it is however difficult to know if the given value is a representative mean-value or just a snapshot. The in use values given in such databases can only be used when several different sources give similar in-use values for a specific tool used under given working conditions.

### 5.1.3 Measure, in the actual work-situation, to find the in-use vibration for a specific work-task.

Measurements are often regarded to be the most accurate possibility. Great care is necessary. The spread in the in-use vibration value over time is great. Therefore measurements over long time periods and at several occasions on different days must be done to make sure the measured value is a representative average value for the in-use vibration for that work-task.

As part of the ongoing revision of the grinder test code ISO 8662-4 a Round Robin test has been done. In this test a number of grinders have been sent around to independent laboratories in Europe. Among other things the laboratories also did real grinding with the tools in a well defined grinding operation. Still the result shows big spread. Seven laboratories have together made at least 105 grinding operations with each tool. The vibration in free running was measured before and after each grinding operation. Vibrations were measured in 3 directions on both handles. The locations of the accelerometers were precisely described in the test instruction. Still the spread between different one-minute grinding operations varies from 2 to 20 m/s<sup>2</sup> in the example given in fig 1.

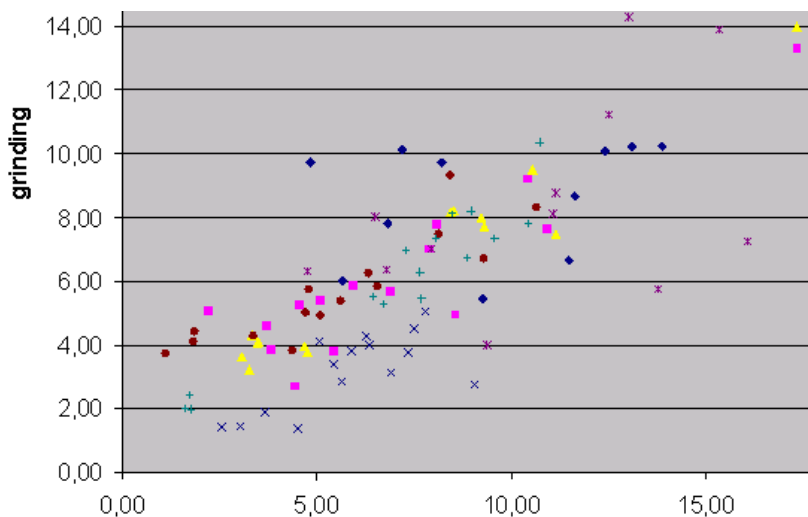


Fig 1.  
An example of all tests made on one handle on one of the test tools. Grinding values are plotted versus the mean value of the free running vibrations measured before and after each 1 minute grinding test. The different shapes and colours of the dots represent the different laboratories.

In this text the Round-Robin test is mentioned to exemplify the difficulties to do workplace measurements and get values that can be used as representative mean values for the vibration that an operator will be exposed to over a longer period of time.

## 5.2 Estimate the exposure time

When exposure time is investigated we often refer to it as trigger time. This explains what we are looking for. Only the time when the tool is actually triggered and working on the job shall be taken into account. Experience tells us that when asked operators tend to highly overestimate the exposure time. It is often better to measure exposure time instead of using estimations from the operator.

Exposure time varies a lot from one work-situation to another. It is therefore necessary to make estimations of the exposure time for all workplaces involved.

### 5.3 Calculate the vibration exposure

When in-use vibration and exposure time are known the calculation of vibration exposure is made with the formula:

$$A(8) = a_{hv} \sqrt{\frac{T}{T_0}}$$

In many cases operators use more than one tool during a shift. The exposure from each tool should then be combined to a total daily exposure. The simplest way is to use one of the exposure calculators that can be found on the Internet. One example is [hse.gov.uk/vibration](http://hse.gov.uk/vibration)

## 6 Step 3: Manage the risk

For the remaining part where the rough estimate made in step 2 shows that operators are close to or above the action value there are two possibilities. Either to manage the risk or do a more precise assessment to find if operators are above the action value or not. Our experience clearly shows that in most cases it is more cost effective to manage the risk directly on the indication from the first rough estimate rather than to spend a lot of money on a workplace measurement.

Managing the risk is the most central part of the whole directive. If an employer suspects having operators exposed to vibrations to an extent where they are in risk of getting vibration induced disorders, he has to manage the risk by reducing the exposure to vibrations.

There are basically four possibilities:

1. Change to a tool or work process that has lower vibrations.
2. Change to a tool or work process that can do the job in shorter time.
3. Check the installation to make sure the tool is used in the most effective way.
4. Use job rotation to reduce the trigger time.

### 6.1 Change to a tool or work process that has lower vibrations

Today most types of tools are available in versions that have lower vibrations. In applications where those tools are suitable, they can often reduce the exposure considerably. It is important though to make sure the tools have equal or better performance. Otherwise longer exposure times might reduce or eliminate the effect of the reduced vibration value.

### 6.2 Change to a tool or work process that can do the job faster

In many material removal processes the time to do the job is proportional to the power used. It is therefore often worth while to investigate the possibility to do the job with a more powerful tool to be able to reduce exposure time.

*6.3 Check your installation to make sure you use the tool in the most effective way*  
Too often in industry, hand-held power tools are not used efficiently because the air installation does not give enough air to the tool to run at maximum power. Power drops quickly with pressure loss and the insufficient power makes the process time unnecessarily long. The most common reason for pressure drop is too long hoses of too small diameter and quick-couplings with insufficient flow capacity

*6.4 Use job rotation to reduce the trigger time*  
In cases where there are no means to reduce the vibration exposure enough to allow an operator to work a full shift without exceeding the action value there is always a possibility to introduce job rotation to reduce exposure time.

## **7 Conclusions**

A cost effective way to meet the demand from the new legislation based on the Physical Agents (Vibration) directive is to use the 3 step method described above. The use of the manufacturers declared vibration values together with a proper correction based on the information in CEN TR 15350 is an effective way to estimate the in-use vibration value. Combined with an estimation of the exposure time relevant for the work-task studied, it gives rough exposure assessments with a minimum of effort. Instead resources can be used to reduce the vibration exposure for the operators found to be at risk.