



Vibration injuries

Increase your productivity whilst taking care of your operators.

Atlas Copco



Reduce vibration exposure and improve productivity

Hand-arm vibration related injuries are one of the most common injuries in the industry today. Prolonged exposure to vibrations may result in irreversible injuries that also affect the daily life of the exposed person, but you do not need to worry. There are many ways to keep the operators healthy, increase the productivity, and maintain a high quality level of the produced products.

Many people are exposed to hand-arm vibrations

Vibration white fingers syndrome is the most common disease in Great Britain and hand-arm vibration injuries (HAV) the most common work related disorder in Sweden. It is estimated that some 5 million people in Britain are regularly exposed to HAV through their work activities

and 2 million of them are at risk of developing injuries. About 2.5 million workers in the U.S. are exposed to HAV from their daily work with power tools and the prevalence of hand-arm vibration syndrome ranges from 20% to 50%.

Common injuries due to vibration exposure

Hand-arm vibration syndrome (HAV) is a medical term for symptoms caused by exposure to vibrations. Symptoms associated with HAV are:

- Vascular disorders
- Nerve injuries
- Musculoskeletal disorders

Vascular injury: It is a condition where the arteries in the fingers thicken, thereby reducing flow area for the blood. The injury becomes apparent under cold temperatures where the body reduces blood supply to the extremities. Due to the restricted flow path the blood cannot pass through the affected areas and sensation is lost. The most common vascular disorder is vibration white fingers (VWF) where the affected fingers appear white during an attack, hence the name.

Nerve injuries: Nerve cells can be damaged by vibration and this is associated with a loss of sensitivity in the fingers. In early stages the damage may be reversible but prolonged exposure will cause permanent damage. This is the type of induced damage that gives rise to most complaints, because affected individuals

are restricted in their everyday activities. Things like buttoning up a shirt, picking up coins from a flat surface or sewing become difficult or impossible tasks.

Musculoskeletal disorders: Musculoskeletal disorders are caused by using tools that require high feed forces and of percussive type (e.g. chipping and riveting hammers). The vibration is passed through the hand and arm causing wear and even fracturing at the joints.

Carpal Tunnel Syndrome (CTS) is also linked to the vibration exposure but is not exclusively an injury caused by vibrations. Working with a bent wrist may also cause CTS. The symptoms are similar to those of nerve injuries.

Typical symptoms of HAV:

- Finger blanching
- Numbness and pain
- Tingling
- Reduced grip force
- Pain in joints

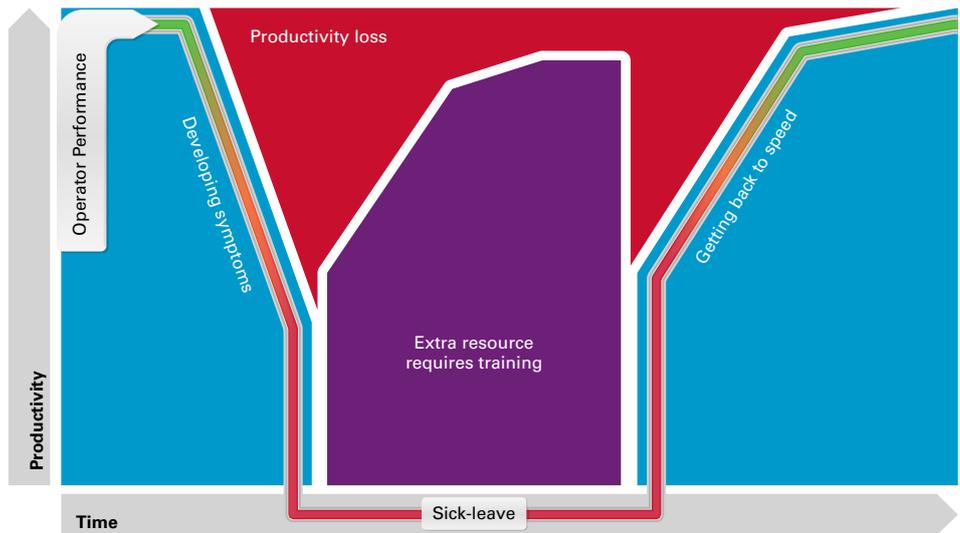
How to prevent these disorders

Fewer injuries mean better production and lower costs.

The costs related to bad ergonomics (including vibrations) can be divided in direct and indirect costs.

The direct costs are the obvious ones that come with an injury. Typical direct costs can be those for rehabilitation, insurance and medical costs as well as for hiring a replacement.

The indirect costs are less obvious but are in many cases far more expensive. **Decreased productivity** is a typical indirect cost that can be very expensive for a labor heavy production. When the operator experiences pain it normally leads to a slower work pace in order for the operator to avoid the pain (or not being able to work fast because of the pain).



Some companies in Sweden and the UK have estimated the cost of one vibration injury to approx. €50 000, which includes a decrease in productivity, hiring and training a new operator and finding new tasks for the injured operator.

Another important indirect cost is **reduction in quality**. When the work task is causing pain to the operator, it's common that the operator tries to do the task differently to avoid the pain. In most cases, there's a reason why the task should be performed in a certain way. The reason is often to ensure the quality of the product. Quality issues can be very expensive and time consuming to correct as they often are detected late in the process and require a lot of rework. Studies at SAAB Automobile and Volvo Cars have shown that improved ergonomics improves the quality significantly.

The cost of a vibration injury is rather difficult to estimate and varies from country to country. Examples of factors affecting the costs are national regulations for health care, insurance costs, labor costs, and how the indirect costs are measured and related to injuries etc. It's been estimated that if \$1 is spent on a direct cost an additional \$2 to \$5 is spent on indirect costs (Liberty Mutual Safety Index 2002).

Reduce exposure and increase productivity

The vibration exposure in the European Union is regulated by the Physical Agents (Vibration) Directive, (PA(V)D). The directive states two values; the action value and the limit value.

	A(8) - 8 hour exposure m/s ²
Action value	2.5
Limit value	5.0

When the action value is exceeded, the employer has to start an action program showing a plan for reduction of the exposure to lower the action value. It is not allowed to exceed the limit value except for some special circumstances.

The action and limit value should not be confused with the declared vibration emission value (DEV) given by the manufacturers for each machine.

The daily vibration exposure value A(8) is given by the DEV or in-use vibrations (measured at the work place during operation) and the trigger time (see equation). To calculate your A(8) exposure value, use Atlas Copco's online [Vibration Exposure Calculator: https://bit.ly/2Mwa6tH](https://bit.ly/2Mwa6tH)

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

The most efficient way to reduce daily exposure is to minimize the vibration emission from the machine. The trigger time has a smaller impact on the daily exposure than the vibration emission but may on the other hand improve productivity.

1. a_{hv} is the DEV or in-use vibrations in m/s²
2. T is the trigger time in hours or minutes
3. T_0 is the 8 hour (480 mins) workday.

Efficient ways to reduce vibration effects

1. Find a tool with lower declared emission value. This will improve the vibration exposure right away. A tool with 20% lower DEV will reduce the A(8) by 20%.
2. Change the process to one with less vibration emission. Example: Instead of using an impact wrench, a nutrunner can do the job equally good. A nutrunner has a DEV <math><2.5 \text{ m/s}^2</math> which allows the user to use it for 8 hours without exceeding the action value. The installed torque in the joint will also be more accurate which in turn improves quality. Gluing parts together instead of nailing them together with a hammer is another example where you eliminate exposure.
3. Job rotation reduces trigger time and thereby the vibration exposure.
4. Find a tool with more power. A tool with more power will do the job faster and thereby reduce the trigger time. As a rule of thumb, a tool with twice as much power will do the job in half the time. Reducing trigger time by 50% will result in a 30% reduction of vibration exposure and a 100% increase in productivity.
5. Pneumatic tools are designed to work at 6.3 bar (90 psi). Anything less than that will result in loss of power. It is therefore important to make sure that the dynamic pressure at the tool is 6.3 bar. Leaking connections and couplings, under-dimensioned hoses, couplings with restrictions etc. will all create pressure drops that affect the dynamic pressure at the tool in a negative way. Make sure to use full flow couplings and recommended hoses that are no longer in length than they need to be. The tool will work at maximum capacity and the trigger time will be as short as possible, resulting in less vibration exposure and higher productivity.
6. Use good and healthy consumables. A sharp drill bit or a chisel will do the job faster than a worn one. The vibrations from a grinder are linked to the quality of the grinding wheel. Choosing a high quality grinding wheel minimizes the risk of unnecessary vibrations. Choosing a fiber disc with ceramics instead of a traditional grinding wheel will not only increase productivity enormously, it will also reduce vibrations to a minimum almost allowing the grinder to be used for 8 hours. Find more information about this in the white paper *"How to save money with the right abrasive"*.
<https://bit.ly/2wssDfB>

A close-up photograph of a person's hand and forearm, pointing their index finger towards the 'Summary' section of the document. The hand is positioned on the left side of the page, with the finger pointing towards the right.

Summary

Vibration injuries are very common in the industry today and not only are the injuries expensive on a corporate level; they also affect the daily life of the injured person. By selecting tools with low vibration emission and good performance together with high quality consumables, vibration exposure can be reduced significantly.

Additional sources:

Vibration calculator: <https://bit.ly/2Mwa6tH>

AFA Insurance <https://www.afaforsakring.se/>

HSE UK <http://www.hse.gov.uk/>

Fact Sheet: Occupational Exposure to Hand-Arm Vibration (HAV):
https://www.gsa.gov/cdnstatic/Hand-Arm_Vibration_Syndrome_01-06-2016.pdf