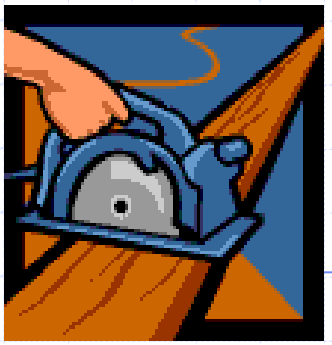
*State University of Medicine and Pharmacy "Nicolae Testemitanu"*
*Department of Internal Medicine*

**course «Occupational Diseases»**

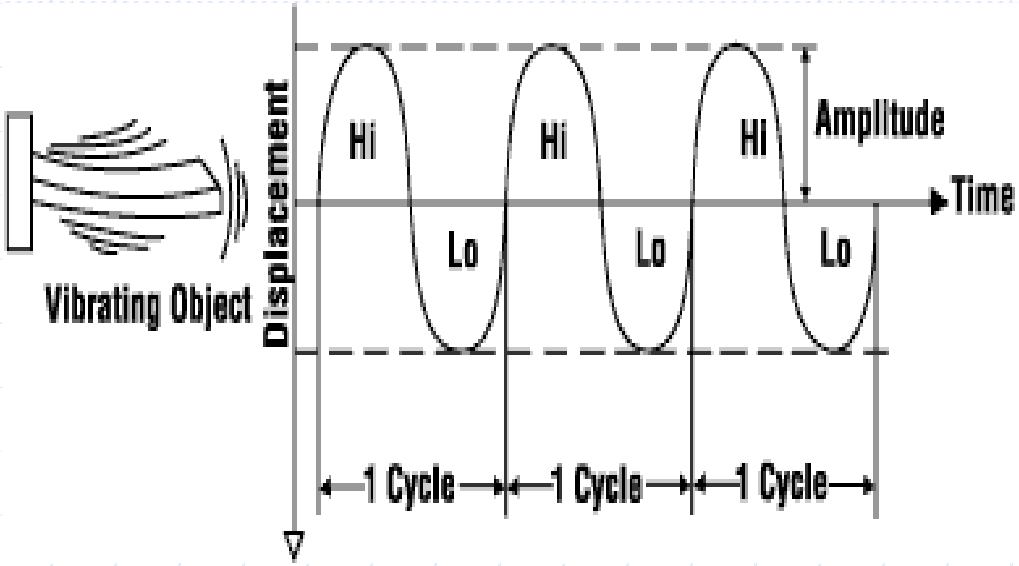
# Vibration



# Occupational Vibration - A Short History

- **1839** - Pneumatic tools were first used in French mines
- **1862** - Primary Raynaud's Phenomenon (Raynaud's Disease) identified.
- **1911** - Professor Loriga first described vascular spasm in the hands of Italian miners using pneumatic tools.
- **1918** - Alice Hamilton studied miners using drills in limestone quarries describing spastic anaemia of the hands.
- **1930-40s** - Cases of white finger were identified studies in fettlers, riveters, boot and shoe industry workers and users of electrical powered rotating tools
- **1950s** - Research links signs and symptoms in nerves, bones, joints and muscles with vibrating tools.
- **1968-69** - After 12-14 years of continuous chain saw use widespread complaints of VWF in operators.
- **1975** - Scale for assessing the extent of vascular injury associated with vibration white finger published by Taylor-Pelmear
- **1985** - VWF becomes a prescribed disease for Industrial Injuries Disablement Benefit purposes
- **1987** - Stockholm scale for assessment of VWF published. Standard for measurement of vibration published in BS 6842.
- **1988** – UK HSE research on exposure to HAV in a number of industries in Great Britain published.
- **1989** - EC Machinery Directive adopted; includes requirements on HAV.
- **1992** – UK HSE produce guidance on VWF in Foundries
- **1994** – UK HSE publish generic guidance on HAV
- **1997** – UK HSE publish a book of vibration-reduction case studies.
- **30 September 1997** UK High Court awards £127,000 compensation for VWF to 7 miners, 12,500 more cases in the pipeline
- **2002** - Directive 2002/44/EC on the minimum health and safety requirements regarding the expo-sure of workers to the risks arising from physical agents (vibration) was published in the Official Journal of the European Communities. Member States have 3 Years from 6 July 2002 to imple-ment the Directive.
- **2006** - Introduction of New Irish Regulations to implement the Physical Agents(Vibration) Directive 2002/44/EC.

# What is Vibration?




- Frequency
- Amplitude
- Acceleration

# Vibration Exposure

## Contact with Vibrating Machine:

- **Segmental Vibration**

'Segment of body' such as hand-transmitted vibration (known as hand-arm vibration or HAV)

- **Whole Body Vibration**

Vibration transmitted through the seat or feet (known as whole-body vibration or WBV).

| Industry | Type of Vibration | Common Source of Vibration |
|---|---|---|
| Agriculture | Whole body | Tractors |
| Construction | Whole body<br>Hand-arm | Heavy equipment vehicles<br>Pneumatic tools, Jackhammers |
| Forestry | Whole body<br>Hand-arm | Tractors<br>Chain saws |
| Furniture manufacture | Hand-arm | Pneumatic chisels |
| Machine tools | Hand-arm | Vibrating hand tools |
| Textile | Hand-arm | Sewing machines, Looms |
| Transportation | Whole body | Vehicles |
| Mining | Whole body<br>Hand-arm | Vehicle operation<br>Rock drills |

# Occupational Vibration Legal Aspects

- **The Safety, Health and Welfare at Work (General Application) Regulations 2007, revoke and replace the Safety, Health and Welfare at Work (Control of Vibration) Regulations 2006. Part 5 Chapter 2 of the 2007 Regulations specifically addresses Control of Vibration at Work.**

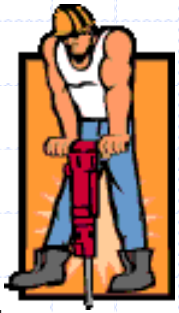
The Regulations include requirements for an employer to:

- **Assess the vibration risk to their employees;**
- **Decide if they are exposed above the daily exposure limit value (ELV); and if so take immediate action to reduce their exposure below the ELV;**
- **Decide if they are exposed above the daily exposure action value (EAV) and if so - introduce a programme of controls to eliminate or reduce their daily exposure so far as is reasonably practicable;**
- **Provide appropriate health surveillance to employees who continue to be exposed above the EAV;**
- **Provide information and training to employees on health risks and controls to employees at risk;**
- **Keep a record of their risk assessment and control actions;**
- **Review and update their risk assessment regularly.**

# Hand Arm Vibration

## Hand Arm Vibration

# Hand Arm Vibration

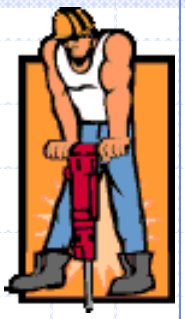


## WHAT IS HAV?

HAV is vibration transmitted from work processes into workers' hands and arms. It can be caused by operating hand-held power tools such as road breakers, hand-guided equipment such as lawn mowers, or by holding materials being processed by machines such as pedestal grinders.

## WHEN IS IT HAZARDOUS?

Regular and frequent exposure to high levels of vibration can lead to permanent injury. This is most likely when contact with a vibrating tool or process is a regular part of a person's job.

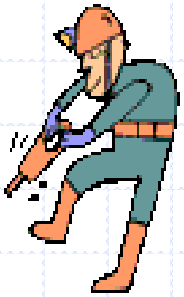


# Hand Arm Vibration

- **WHICH JOBS AND INDUSTRIES ARE MOST LIKELY TO BE AFFECTED BY HAV?**

Jobs requiring regular and frequent use of vibrating tools and equipment are found in a wide range of industries, for example:

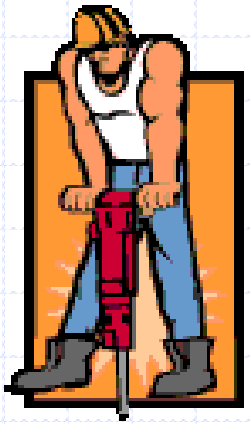
- Building and maintenance of roads and railways
- Concrete products
- Construction
- Forestry
- Foundries
- Heavy engineering
- Mines and quarries
- Plate and sheet metal fabrication;
- Public services
- Public utilities



# Hand Arm Vibration

## WHAT SORT OF TOOLS AND EQUIPMENT CAN CAUSE VIBRATION INJURY?

- **Chainsaws**
- **Concrete breakers/road drills**
- **Hammer drills**
- **Hand-held grinders**
- **Hand-held sanders**
- **Nut runners**
- **Pedestal grinders**
- **Power hammers and chisels**
- **Powered lawnmowers**
- **Riveting hammers and bolsters**
- **Strimmers/brush cutters**
- **Swaging machines.**



# Hand Arm Vibration

## Moderate vibration

- grinders
- sanders
- jig saws

## High vibration

- impact wrenches
- carpet strippers
- chain saws
- percussive tools
  - jack hammers
  - scalers
  - riveting or chipping hammers

# Hand Arm Vibration

Hand Arm Vibration
Causes & Effects

# Hand Arm Vibration - Causes & Effects

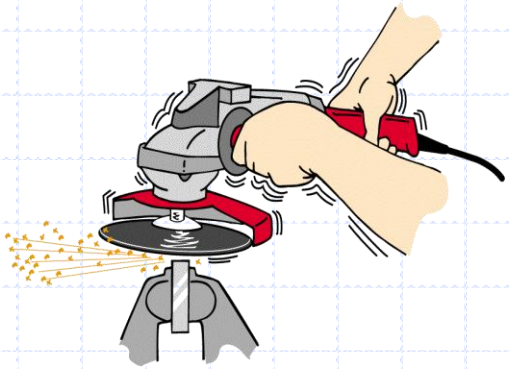
## WHAT INJURIES CAN HAV CAUSE?

Regular exposure to HAV can cause a range of permanent injuries to hands and arms including damage to the:

- Blood circulatory system (e.g. vibration white finger)
- Sensory nerves
- Muscles
- Bones
- Joints

# Hand Arm Vibration - Causes & Effects

- HAV Symptons
  - Attacks of whitening (blanching) of one or more fingers when exposed to cold/wet
  - Tingling and loss of sensation in the fingers
  - Loss of light touch
  - Pain and cold sensations between periodic white finger attacks
  - Loss of grip strength
  - Bone cysts in fingers and wrists
- Stockholm Classification



# Factors that Influence the Effect of Vibration on the Hand

| Physical Factors | Biodynamic Factors | Individual Factors |
|---|---|---|
| Acceleration of vibration | Grip forces - how hard the worker grasps the vibrating equipment | Operator's control of tool |
| Frequency of vibration | Surface area, location, and mass of parts of the hand in contact with the source of vibration | Machine work rate |
| Duration of exposure each workday | Hardness of the material being contacted by the hand-held tools, for example metal in grinding and chipping | Skill and productivity |
| Years of employment involving vibration exposure | Position of the hand and arm relative to the body | Individual susceptibility to vibration |
| State of tool maintenance | Texture of handle-soft and compliant versus rigid material | Smoking and use of drugs. Exposure to other physical and chemical agents. |
| Protective practices and equipment including gloves, boots, work-rest periods. | Medical history of injury to fingers and hands, particularly frostbite | Disease or prior injury to the fingers or hands |

# Hand Arm Vibration - Causes & Effects

| Average latent periods for vibration-induced diseases in different occupations | | |
|---|---|---|
| **Occupation** | **Stage of VWF** | **Latency (years)** |
| Foundry worker | Tingling<br>Numbness<br>Blanching | 1.8<br>2.2<br>2.0 |
| Ship Yard worker | Tingling<br>Numbness<br><br>Blanching | 9.1<br>12.0<br>16.8 |
| Chain saw operator | Numbness | 4 |
| Grinder | Blanching | 13.7 |

# Hand Arm Vibration - Causes & Effects

## WHAT EFFECTS DO THESE INJURIES HAVE ON PEOPLE?

- Painful finger blanching attacks (triggered by cold or wet conditions)
- Loss of sense of touch and temperature
- Numbness and tingling
- Loss of grip strength
- Loss of manual dexterity
- Unable to work in cold/wet conditions
- Unable to do leisure activities such as fishing, golf, swimming
- Need to avoid further exposure to vibration, or cold and wet conditions
- Have difficulty handling tools and materials and with tasks requiring fine finger manipulation

**UK 36,000 people advanced stage, 228,000 with condition**

Hands of vibrating pneumatic hand-tool operator in later stages of irreversible Hand Arm Vibration Syndrome1

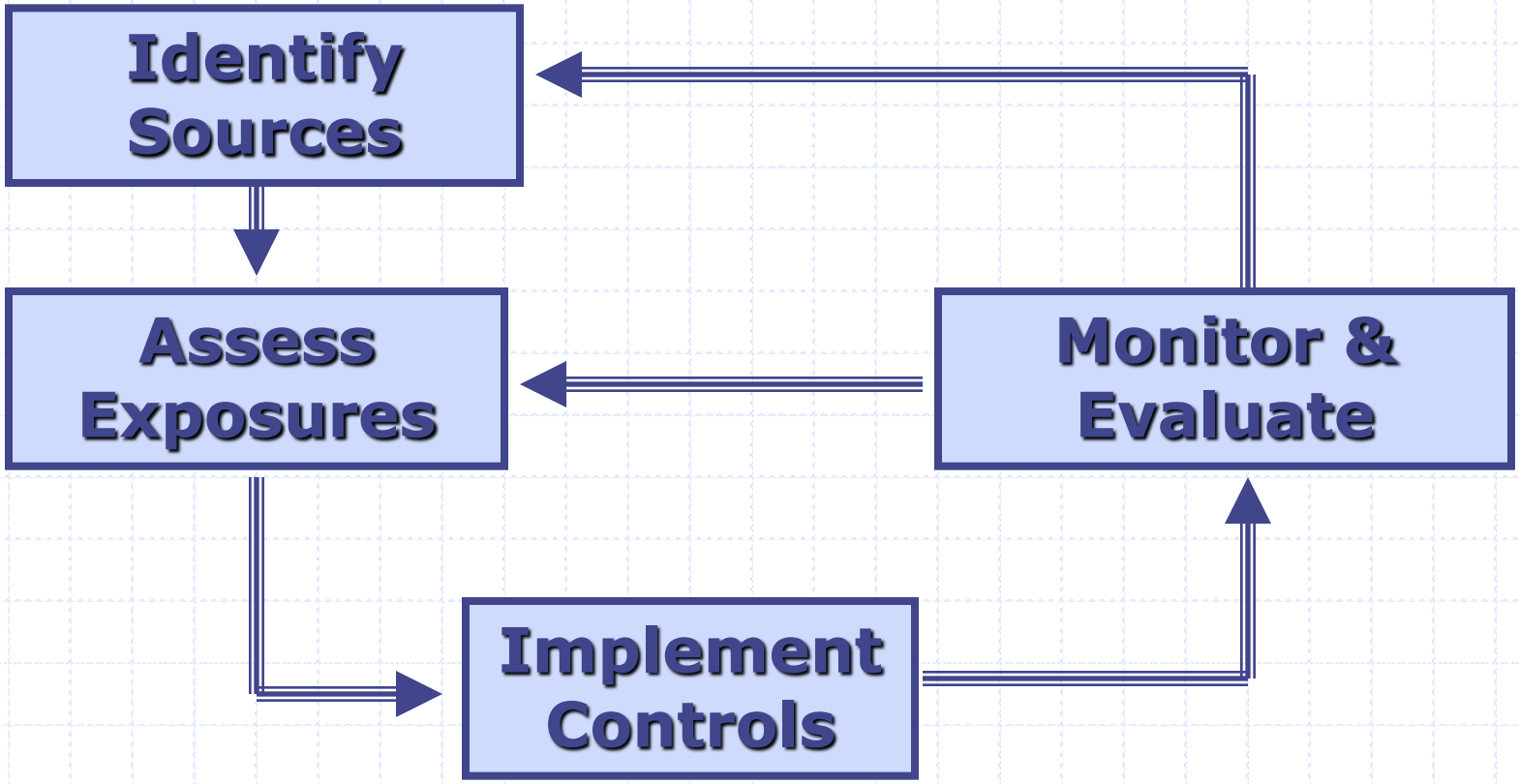
Rare case of gangrene in hands of vibrating pneumatic hand-tool operator at terminal stage of irreversible Hand Arm Vibration Syndrome2

# Hand Arm & Whole Body Vibration

Hand Arm Vibration Management & Control

# Hand Arm Vibration Management & Control

## Risk Management Process



# Hand Arm Vibration Management & Control

- **Identify those at risk from occupational vibration**
- **Assess the risk involved:**
  - The level, type and duration of exposure
  - Any effects concerning the health and safety of workers at particularly sensitive risk
  - Any indirect effects from interactions between vibration and the workplace/other work equipment
  - Information provided by the manufacturers of work equipment
  - The existence of replacement equipment
  - Specific working conditions such as low temperatures
  - Appropriate information obtained from health surveillance
- **Prevent and/or control the risk**

# Hand Arm Vibration – Management & Control

## WHAT CAN I DO TO CONTROL THE RISK?

- Look for alternative ways of working which eliminate the vibrating equipment altogether
- Make sure your employees use the most appropriate equipment for each job
- Minimise the time individuals use the equipment
- Break up periods of continuous equipment use by individuals
- Design the job so that poor posture is avoided.
- Construct jigs to hold materials or tools.
- Maintain tools to the manufacturer's specifications to avoid worsening vibration for example:
  - Replace vibration mounts before they are worn out;
  - Ensure rotating parts are checked for balance and replace them if necessary;
  - Keep tools sharp.
  - Get advice from your trade association on best practice.
  - Get advice from the equipment manufacturer on safe use of the equipment.
- Mechanise or automate the work or change the way of working
- Ask the manufacturer to add anti-vibration mounts to isolate the operator from the vibration source
- Provide tool support to take the weight of the tool allowing the operator to reduce grip and feed force
- Introduce a purchasing policy specifying low vibration performance for new equipment

# Hand Arm Vibration – Management & Control

Workers can reduce the risk of hand-arm vibration syndrome (HAVS) by following **safe work practices**:

- Employ a minimum hand grip consistent with safe operation of the tool or process.
- Wear sufficient clothing, including gloves, to keep warm.
- Avoid continuous exposure by taking rest periods.
- Rest the tool on the work piece whenever practical.
- Refrain from using faulty tools.
- Maintain properly sharpened cutting tools.
- Consult a doctor at the first sign of vibration disease and ask about the possibility of changing to a job with less exposure

# Hand Arm Vibration – Management & Control

## Employee Information and Training


- Potential sources of hand-arm vibration
- The health effects of hand-arm vibration;
- Risk factors (e.g. high levels of vibration, daily length/regularity of exposure);
- How to recognise and report signs of injury;
- Ways to minimise risk, including:
  - Changes to working practices to reduce vibration exposure;
  - Correct selection, use and maintenance of equipment;
  - How to use tools to reduce grip force, strain etc;
  - Maintenance of good blood circulation at work, eg by keeping warm, exercising fingers and not smoking.

**Employees should also have access to a proactive health surveillance programme.**

# Hand Arm Vibration – Management & Control

**Employees should also have access to a proactive health surveillance programme.**

## Regular Employees Checks:

- Have your fingers gone white on exposure to cold?
- Have you had any tingling or numbness in your fingers after using vibrating equipment?
- Are you experiencing any problems with muscles or joints in your hands or arms?
- Do you have any difficulty picking up small objects such as screws or nails?
- Is it difficult to tell if something is hot or cold to the touch?

*If the answer to any of these questions is 'yes', assume that there is a risk from HAV to your employees.You should refer the employee to a doctor and take action to reduce exposure.*

# Hand Arm Vibration – Management & Control

**Tool & Machine Manufacturers are required by law to:**

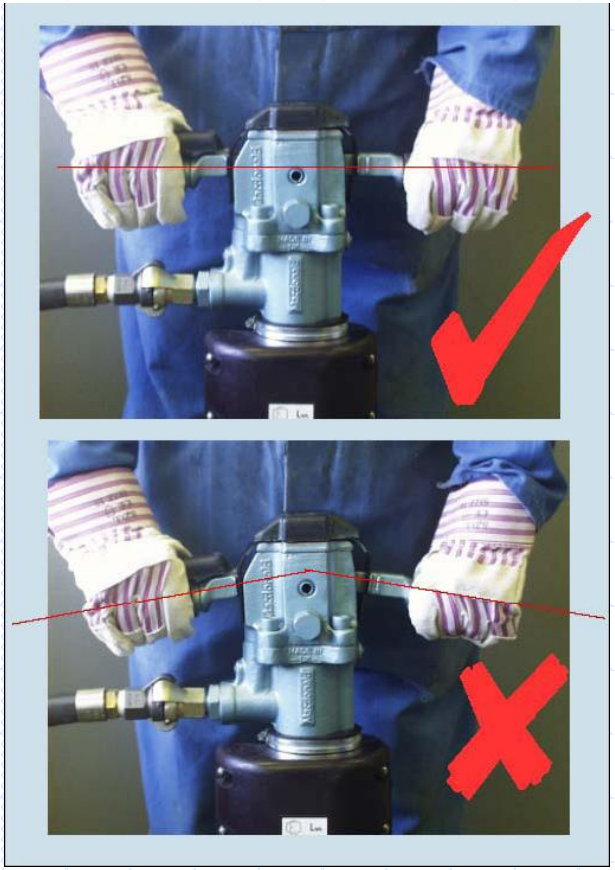
- Design and construct equipment which will cause the minimum risk of vibration injury;
- Provide you with warning of any residual risks from vibration;
- Provide you with information on vibration levels;
- Provide you with instructions on how to use the equipment to avoid risks from vibration.

Manufacturers' vibration data needs careful interpretation

# Remote control vibratory plate Operator vibration exposure - Zero

# Vibration reduced breaker

- ❖Keep the moil point sharp
- ❖Break a little at a time,
- ❖Don’t get jammed
- ❖Don’t force anti-vibration handles
- ❖Stop breaker before pulling out

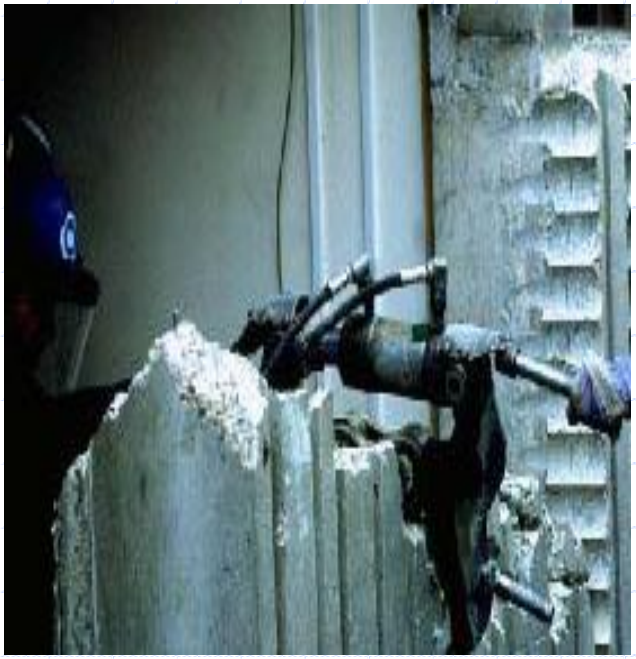


# Mechanisation removes the risk

Machine-mounted pick replaces hand-operated breakers

# Demolition without vibration

## Use hydraulic crushers instead of demolition hammers



# Occupational Vibration Control Standards

- The Safety, Health and Welfare at Work (General Application) Regulations 2007 (S.I. No 299 of 2007) revoke and replace the Safety, Health and Welfare at Work (Control of Vibration) Regulations 2006. Part 5 Chapter 2 of the 2007 Regulations addresses Control of Vibration at Work.
- EU Physical Agents (Vibration) Directive 2002/44/EC

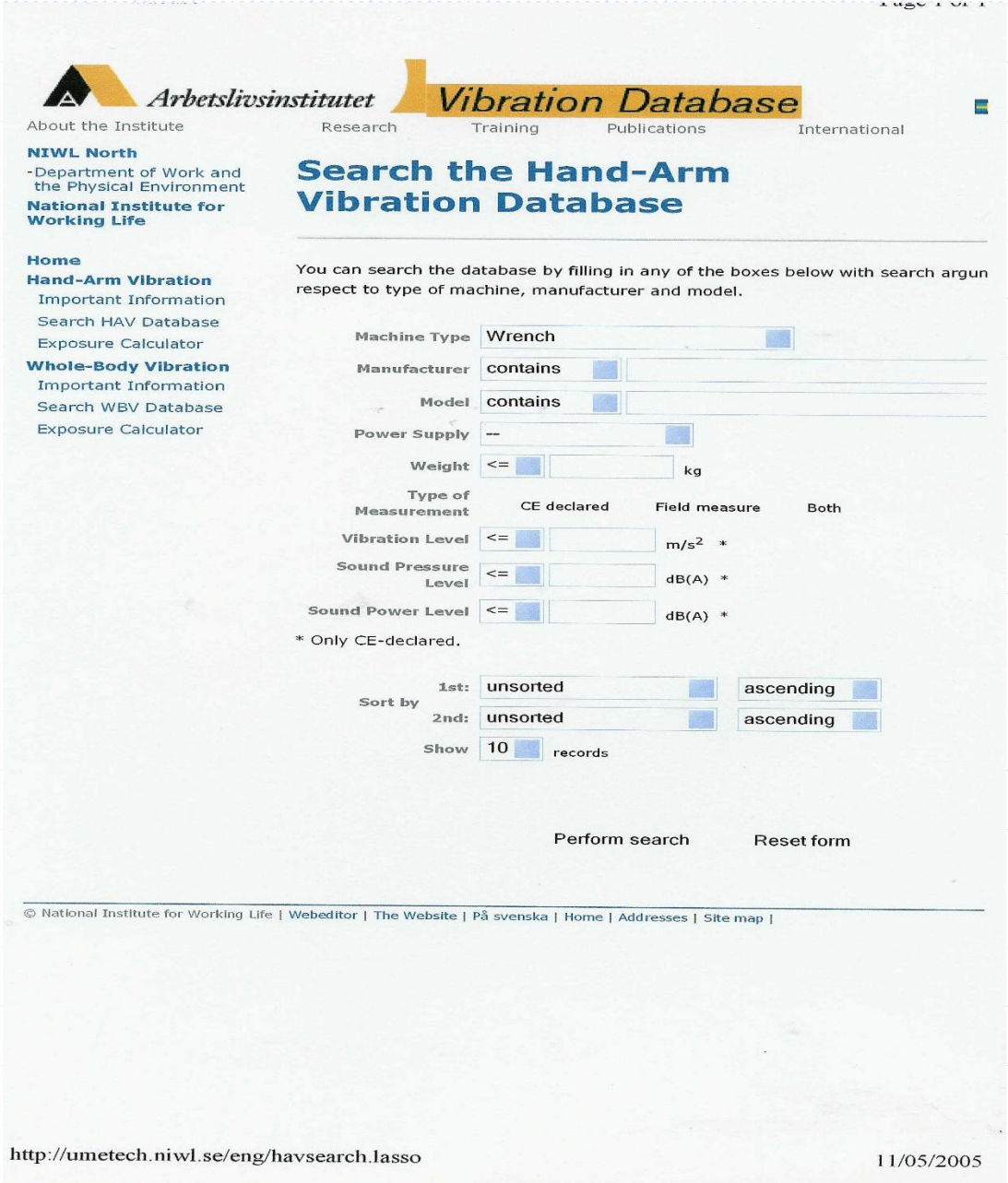
## For Hand Arm Vibration:

- The daily exposure limit value standardised to an eight-hour reference period shall be 5 m/s 2.
- The daily exposure action value standardised to an eight-hour reference period shall be 2,5 m/s 2.

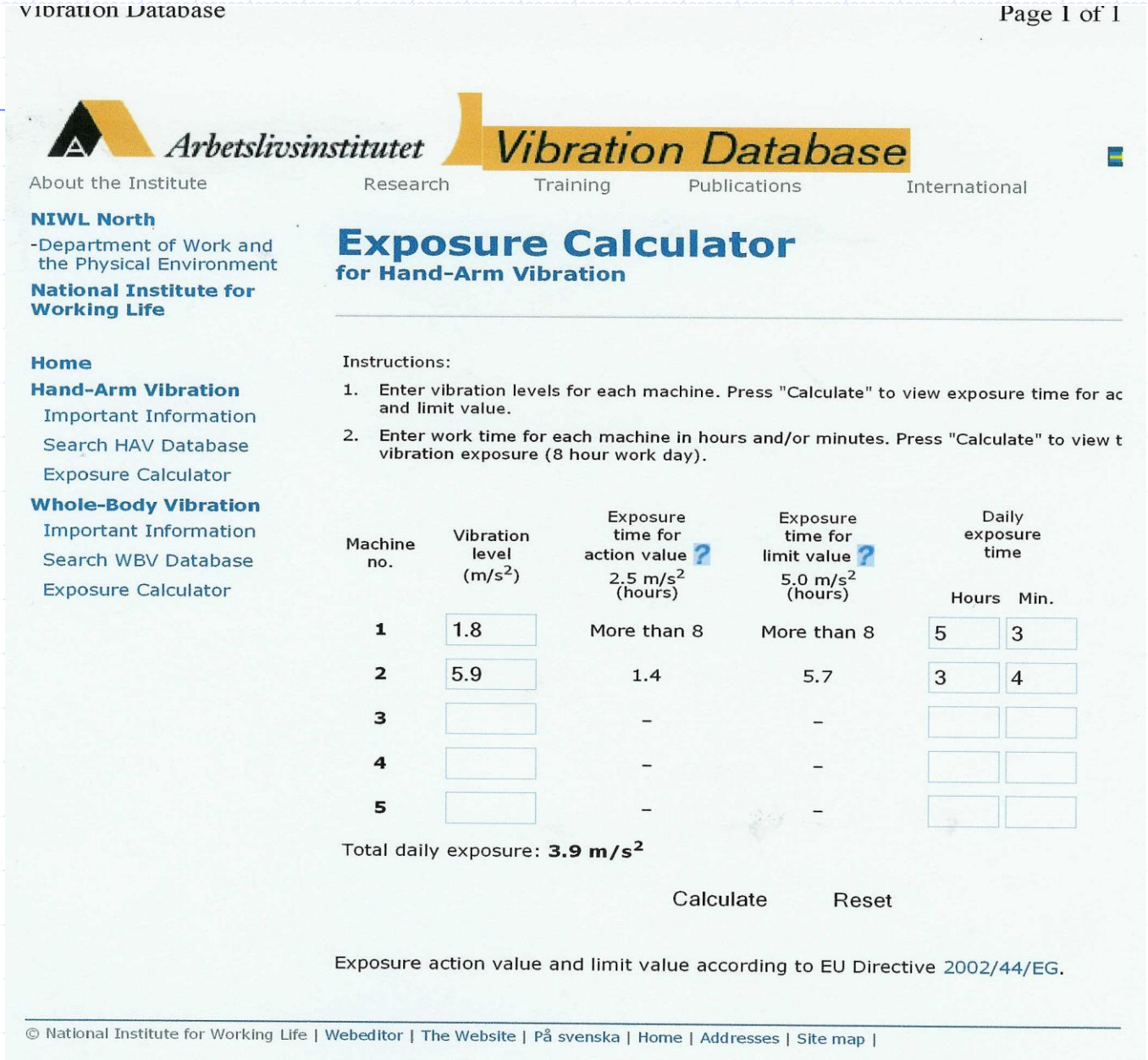
# Occupational Vibration Databases

The Centralised European Database is available at:
http://umetech.niwl.se/English

Also includes a Vibration Exposure Calculator



# Occupational Vibration Databases



Vibration Database



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**NIWL North**
-Department of Work and the Physical Environment
**National Institute for Working Life**

**Home**
**Hand-Arm Vibration**
Important Information
Search HAV Database
Exposure Calculator
**Whole-Body Vibration**
Important Information
Search WBV Database
Exposure Calculator

## Exposure Calculator
### for Hand-Arm Vibration

Instructions:

1. Enter vibration levels for each machine. Press "Calculate" to view exposure time for ac and limit value.
2. Enter work time for each machine in hours and/or minutes. Press "Calculate" to view t vibration exposure (8 hour work day).

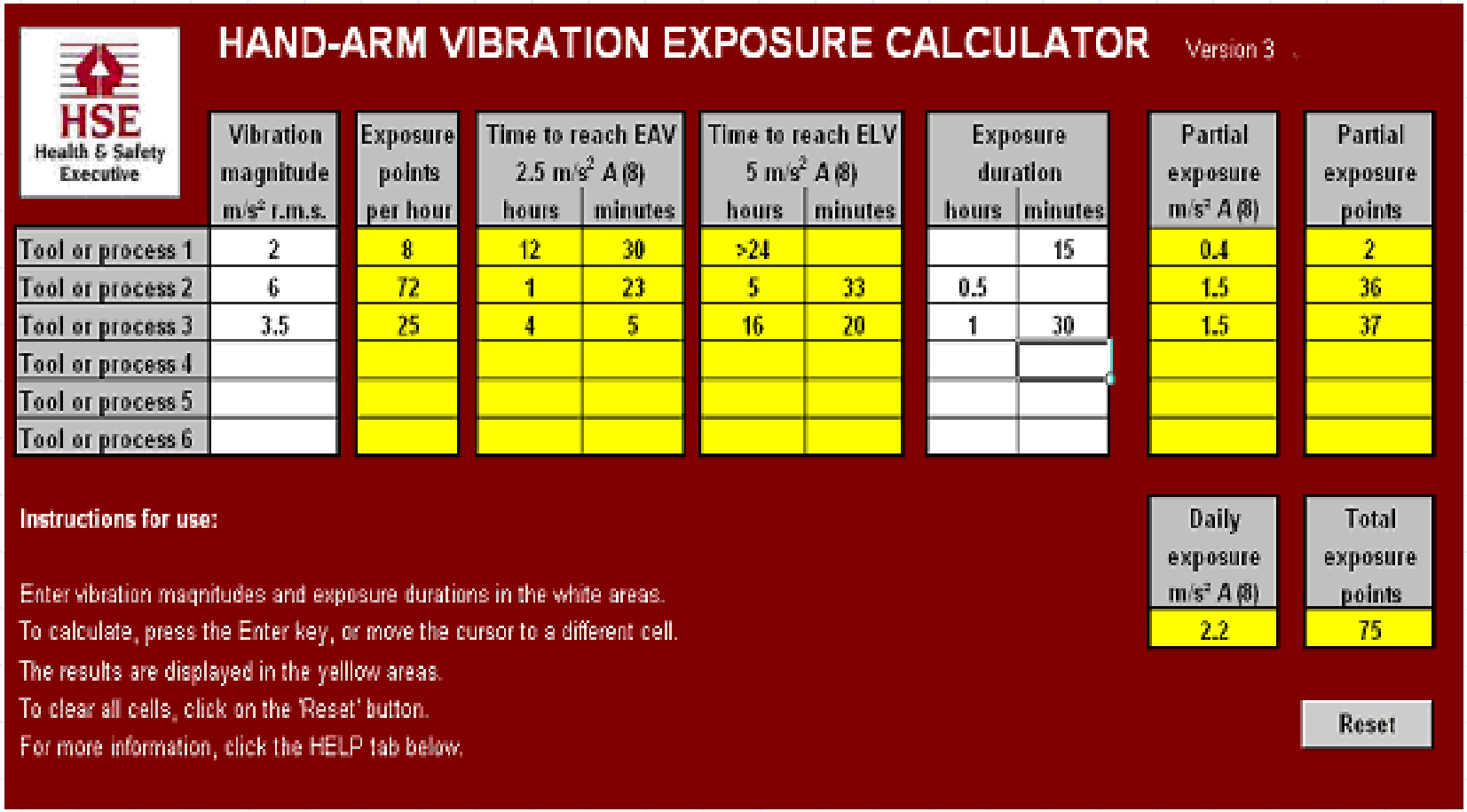
| Machine no. | Vibration level ($m/s^2$) | Exposure time for action value 2.5 $m/s^2$ (hours) | Exposure time for limit value 5.0 $m/s^2$ (hours) | Daily exposure time Hours | Min. |
|---|---|---|---|---|---|
| 1 | 1.8 | More than 8 | More than 8 | 5 | 3 |
| 2 | 5.9 | 1.4 | 5.7 | 3 | 4 |
| 3 | | - | - | | |
| 4 | | - | - | | |
| 5 | | - | - | | |

Total daily exposure: **3.9 $m/s^2$**

Calculate Reset

Exposure action value and limit value according to EU Directive 2002/44/EG.

# HAV Exposure Calculator
## www.hse.gov.uk/vibration



HSE Health & Safety Executive

HAND-ARM VIBRATION EXPOSURE CALCULATOR Version 3

| | Vibration magnitude m/s² r.m.s. | Exposure points per hour | Time to reach EAV 2.5 m/s² A(8) hours | Time to reach EAV 2.5 m/s² A(8) minutes | Time to reach ELV 5 m/s² A(8) hours | Time to reach ELV 5 m/s² A(8) minutes | Exposure duration hours | Exposure duration minutes | Partial exposure m/s² A(8) | Partial exposure points |
|---|---|---|---|---|---|---|---|---|---|---|
| Tool or process 1 | 2 | 8 | 12 | 30 | >24 | | | 15 | 0.4 | 2 |
| Tool or process 2 | 6 | 72 | 1 | 23 | 5 | 33 | 0.5 | | 1.5 | 36 |
| Tool or process 3 | 3.5 | 25 | 4 | 5 | 16 | 20 | 1 | 30 | 1.5 | 37 |
| Tool or process 4 | | | | | | | | | | |
| Tool or process 5 | | | | | | | | | | |
| Tool or process 6 | | | | | | | | | | |

**Instructions for use:**

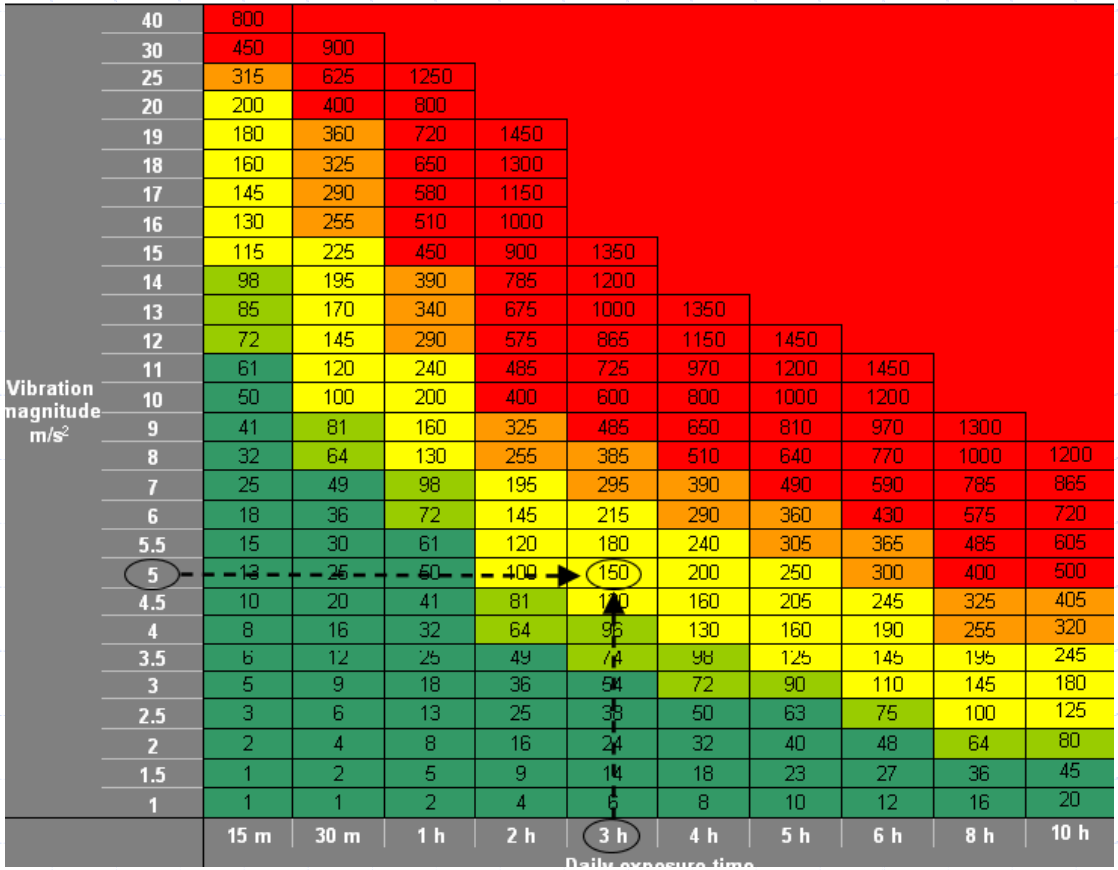
Enter vibration magnitudes and exposure durations in the white areas.
To calculate, press the Enter key, or move the cursor to a different cell.
The results are displayed in the yelllow areas.
To clear all cells, click on the 'Reset' button.
For more information, click the HELP tab below.

| Daily exposure m/s² A(8) | Total exposure points |
|---|---|
| 2.2 | 75 |

Reset

# UK HSE HAV Exposure Ready-Reckoner

**All values are exposure points**
**• Colours show exposures re. EAV & ELV**




| |
|---|
| Above limit value |
| Likely to be above limit value |
| Above action value |
| Likely to be above action value |
| Below action value |

# Pedestrian Vibratory Roller 16m/s$^2$: 30 minutes use before exceeding EAV

# HAV Key Messages

- HAVS is preventable, but once the damage is done it is permanent.
- HAVS is serious and disabling.
- Damage from HAVS can include the inability to do fine work and cold can trigger painful finger blanching attacks.
- The costs to employees and to employers of inaction could be high.
- There are simple and cost-effective ways to eliminate risk of HAVS.
- The 2007 Regulations focus on the elimination or control of vibration exposure.
- The long-term aim is to prevent new cases of HAVS occuring and enable workers to remain at work without disability.
- The most efficient and effective way of controlling exposure to hand-arm vibration is to look for new or alternative work methods which eliminate or reduce exposure to vibration.
- Health surveillance is vital to detect and respond to early signs of damage.

# Any questions?

**Links to information including vibration databases on occupational vibration available at: http://www.consultnet.ie/vibration.htm**

**Also for guidance & solutions see: www.hse.gov.uk/vibration**