vibration

Reducing Vibration Risk
Identify potential hazardous tools and operations
Assess risks for tools and operations
Train managers, supervisors and operators
Implement Risk Reduction Programme
  • *ergonomics, operating conditions, maintenance, methods/techniques, engineering modifications* ......
Buy / Hire Smooth
  • *implement low vibration purchase/hire policy*
Health Surveillance Programme
  • *where A(8) exposure likely > 2.5m/s²*
Audit Programme
Exposure Times / Job Rotation
Getting a Dose - The Risk Factors

- daily vibration dose
  - tool vibration amplitude and total "finger on trigger" time
- tool design
  - ergonomics, weight ......
- tool use on any particular job
  - access, position ......
- working conditions
  - temperature, frequency of breaks
- individual susceptibility and habits
  - genetic factors, general health, smoking

Suspect any process that causes tingling or numbness after 5 - 10 minutes continuous use.
The following are the areas in which mistakes are most commonly made in the field of HAV management.

- **PPE**
  - there is no effective PPE for HAV

- **Manufacturers' Declared Values**
  - lab data cannot always be used for exposure assessment

- **Maintenance Vibration Data**
  - most "tool vibration maintenance check" measurements provide no useful information on either tool condition or HAV risk

- **Exposure Assessment**
  - inaccuracies due to faulty measurement techniques and inappropriate use of manufacturers' values
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Operational Factors
PPE² with gloves on ...

Hard hats, safety glasses, visors, masks, earmuffs .....  

But for Hand-Arm vibration ................. NONE!!

However, conventional gloves keep hands warm.
Pedestrian Vibratory Roller

16m/s²: 30 minutes use before exceeding EAV
Exhaust Air - Hand Temperature

Temperature Problems
Air exhausts can cool operators' hands which makes them more susceptible to the effects of vibration. Cold handles can also produce a similar effect.

Solutions
Scrap tubing and an old gauntlet were used here to direct exhaust air away from the hands. Rubber sleeving can also be used as insulation on metal handles to keep hands warmer.

pictures: HSE Vibration Solutions
Problem
High vibration nut running and torquing tools on engine assembly line (used by a single operator).

Solution
- Group working sharing vibration task, halving exposure time and improving job satisfaction.
- Selection of lower vibration tools.
- Suspended tooling system to improve ergonomics.

Tools c £1000 each; suspension system c £1500.
The ergonomics of any particular tool use have a substantial effect on the risk to the operator for any given vibration exposure.

- select tools for ergonomic reasons as well as vibration and other factors
- create guidelines for correct tool selection and use on each type of operation
- ensure operators are properly trained and understand the reasons for correct use

*What happens to your hand and fingers when you carry a heavy suitcase with a narrow handle for any length of time?*
Summary of Measures to Reduce Personal Risk

- **M**aintenance - keep tools well maintained
- **E**xercise hands during work periods
- **A**lways report any Hand-Arm symptoms
- **S**moking - don't smoke, especially before using tools
- **U**se the right tool for the job in the right way (ergonomics)
- **R**eport faulty, ineffective or poorly maintained tools
- **E**nsure you keep your hands as warm as possible
- **S**hort breaks - multiple short breaks better than long ones
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Reduce Vibration Exposure
Remote control vibratory plate

Operator vibration exposure -

ZERO!

There can also be productivity and other operational benefits that make remote control plant more cost effective than manual operation.

Casting Shell Knockout
Replaced manual riveting hammer with jig mounted breaker reducing exposure from 10m/s$^2$ to 0m/s$^2$. Cost c £2500.
Change Tool Type

Problem
Extensive fettling operations on fabrications using mostly straight grinders. A rotary burr produced 2m/s² over a typical working cycle.

Solution
Change over to belt grinders for most jobs. These produce only 0.5m/s².

Belt grinders cost c £700 compared with £100 - £200 for the straight grinders. However, the tools are easier to use and with additional operational and productivity benefits.

picture: HSE Vibration Solutions
Operation
Aluminium components were held on a pedestal against an abrasive band to remove flash for c 4 hours/day.

HAV Risk
The measured $A(8) = 32 \text{ m/s}^2$ which posed a substantial risk to health - the ELV would be reached after only a few minutes use per day.

Solution
Re-design of the pedestal (c£100 cost) to reduce the vibration exposure down to an $A(8)$ of only 1$m/s^2$. This allowed continuous operation without HAV risk.
For some tool / operations, the levels of vibration can be very dependent on the make and type of consumable used and the care with which it is fitted.

Disk Sanding example:-
- George Renault SX Sander tests gave the following results during a particular sanding operation
  - Norton disk:- 12 m/s²
  - 3M Green Corps disk:- 2.2 m/s

For certain activities, test and select a tool/consumable combination to give the lowest vibration values.
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Maintenance
Maintenance Factors

Examples:-

• use correct air pressure
• check condition of seals (cushioning), bearings etc
• check condition of tool bits
• check condition of cutting disks and other rotating elements
• check for wear on spindles - accurate location is important for balance
• condition of gears
• condition of any vibration isolation features (bushes etc).........

Implement a reporting system for maintenance problems so that they can be corrected
I N V C

Maintenance - Needlegun

Field Assessment
A vibration check on-site revealed a weighted level of 15m/s² compared with an expected value of the order of 4m/s².

Maintenance
Dismantling the tool showed that many of the needles were broken and that one of them was jamming the vibration cushioning system. Once repaired, a field re-test produce a vibration level of 4m/s².

Operators should report unusually high levels of vibration on individual tools.

picture: HSE Vibration Solutions
Increasingly, post-maintenance vibration checks are included in tool maintenance contracts. This is either at the behest of the user or as an additional service available from the maintenance provider.

- **Publicity - Implied Benefits**
  - A HAV meter measurement proves that the refurbished tool vibration is within the manufacturers' declared value specification - and this will show that the tool has been returned to "as new" mechanical condition.

- **Reality**
  - They cannot be compared with the ISO 8662 declared values as the test conditions are completely different.
  - They do not provide reliable information on the mechanical condition of the tool.
Sophisticated comparison of tool vibration with "as new" signatures to identify out-of-tolerance components or faults that could soon cause a vibration increase and a higher risk to the operator. Unlike HAV meter measurements, this technique can be used to implement a condition based maintenance programme.
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Buy / Hire "Smooth"
Buy / Hire Smooth Purchasing Policy

- Buyers and specifying engineers should implement a "Buy / Hire Smooth" policy insisting on information about:
  
  - hand-arm vibration levels for hand-held, guided or mobile machinery
  
  **IDEALLY, RELIABLE, REPRESENTATIVE FIELD DATA**

  **LAB DATA MAY BE INSUFFICIENT TO DEFINE RISK**

  - body (feet or posterior) vibration levels for mobile machines
  - vibration control measures
The following is the "ideal" way to obtain accurate vibration data from potential new plant that relates to "real use":

- borrow sample tools from the different potential suppliers
- set-up realistic operational and productivity tests for all the tools on the same day
- carry out accurate vibration assessments on each tool in "normal" use
- assess operational factors (ergonomics, speed, reliability, etc) and any potential vibration reduction measures
- combine this information to decide which is the best tool for the job
- keep a record of the procedure and results as evidence of "best practice"
The Hire Association Europe has introduced a "traffic light" system for grading tool vibration levels.

- based on manufacturers' declared laboratory data

The colour coding implies that "green" tools do not pose a significant HAV risk - whereas many of these tools would be classified as "amber" or "red" if categorised according to field vibration data.

- use this grading as an initial guide - but not as the basis for exposure risk assessment

"Amber" rock drill (hirer catalogue extract) -
".. 5 - 10m/s², up to 2 hours use without further risk assessment .."

12 - 24m/s² field measurements on sample drills at the hirer.
### Manufacturers' v Field Vibration Data

<table>
<thead>
<tr>
<th>Tool</th>
<th>Supplier Data</th>
<th>Field Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>grinder</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>damped chipper</td>
<td>&lt;2.5</td>
<td>17</td>
</tr>
<tr>
<td>damped riveter</td>
<td>&lt;2.5</td>
<td>8</td>
</tr>
</tbody>
</table>

Supplier data (declared values to ISO 8662) v results obtained in the field for real activities (weighted m/s²)

As the difference between declared values and field measurements can be large, the former should not be used to assess personal exposures unless you can show that they are representative of the field vibration to which the operators are subjected.
WHC HAV Policy

- buy only low vibration plant for hire (making the decision for their customers) - based on direct comparisons of their own field vibration levels and on operational factors.
- provide customers with field vibration data for all hire plant
- re-check field vibration values after maintenance

This policy involves additional investment in training, instrumentation and time - but has been directly responsible for the success of the company in gaining a large long term hire contract with major utility company.
Cut-off v fettling - very different vibration values. You must know details of the activity for any quoted vibration levels.
Presentation of Vibration Data

<table>
<thead>
<tr>
<th>Tool</th>
<th>Vibration m/s²</th>
<th>&quot;Safe&quot; Working Time (mins)</th>
</tr>
</thead>
<tbody>
<tr>
<td>662 Aerator : Sisis Auto Turfman</td>
<td></td>
<td></td>
</tr>
<tr>
<td>659 Aerator : Jacobson Aero King</td>
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<td></td>
</tr>
<tr>
<td>667 Breaker : CompAir Zitair 100</td>
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<td></td>
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<tr>
<td>629 Chainsaw : Husqvarna 3120xp</td>
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<td></td>
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<tr>
<td>624 Chainsaw : Husqvarna 254</td>
<td></td>
<td></td>
</tr>
<tr>
<td>630 Chainsaw : Stihl 020T</td>
<td></td>
<td></td>
</tr>
<tr>
<td>628 Chainsaw : Husqvarna 394xp</td>
<td></td>
<td></td>
</tr>
<tr>
<td>627 Chainsaw : Husqvarna 371xp</td>
<td></td>
<td></td>
</tr>
<tr>
<td>626 Chainsaw : Husqvarna 335xpt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>625 Chainsaw : Husqvarna 254xp</td>
<td></td>
<td></td>
</tr>
<tr>
<td>671 Drill : Kango 2371</td>
<td></td>
<td></td>
</tr>
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<td>672 Drill : Kango 2446</td>
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<td></td>
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<tr>
<td>673 Drill : Kango 950</td>
<td></td>
<td></td>
</tr>
<tr>
<td>666 Drill : Bosch GSB20-2RE</td>
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<td></td>
</tr>
<tr>
<td>644 Edger : Atom 202</td>
<td></td>
<td></td>
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<tr>
<td>631 Hedgecutter : Echo HC2100</td>
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<tr>
<td>632 Hedgecutter : Stihl HS85</td>
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<tr>
<td>640 Leaf Blower : Ryobi RGBV 310</td>
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<tr>
<td>641 Leaf Blower : Stihl BG75</td>
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<tr>
<td>639 Leaf Blower : Ransome 319cc</td>
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<tr>
<td>638 Leaf Blower : Husqvarna 141B</td>
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<td></td>
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<tr>
<td>642 Leaf Collector : Billy Goat PB8</td>
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<td></td>
</tr>
<tr>
<td>637 Leaf Collector : Billy Goat Sprin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>651 Mower : Bunton Greens Mower</td>
<td></td>
<td></td>
</tr>
<tr>
<td>650 Mower : John Deere 22 (Greens)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>646 Mower : Ransome Matador</td>
<td></td>
<td></td>
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<tr>
<td>652 Mower : Dennis FT510</td>
<td></td>
<td></td>
</tr>
<tr>
<td>649 Mower : Allett 36RHE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>643 Mower : Allen 218S1</td>
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</tr>
</tbody>
</table>
Risk Statistics - Vibration Variation

Variation in measured field vibration values is caused by factors such as:-

- condition of plant and consumable (where applicable)
- operator technique and operating environment

Consequently, the expected range of typical values for each tool is more useful than a single measurement.
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Vibration Control Technology
Low Vibration Grinder Features

- Air inlet grip incorporates latest advances in ergonomics
  - Grip angle is optimum for ergonomic use for grinding or cutting off
  - Ergonomic grip size for best operator comfort
  - Ergonomically correct shape reduces possibility of strain over longer usage periods
  - Ergonomic shape at rear promotes comfort in use by allowing alternative grip positions
  - Durable and practical combination start device
- Vibration damped side handle
- 2000W powerful lube free motor for a high removal rate
- Oil lubricated bevel gears
- Spindle lock button for quick grinding disc change
- Reduced vibration interface
- Autobalancing system
- Heavy duty guard, adjusted without tools
- Low pressure side exhaust air
Vibration Isolated Handle

rigid

isolated

low vibration point
Manufacturers are under increasing pressure to develop low vibration plant. In the case of Dennis, our prototype re-designed low vibration handle reduced operator exposure during simulated cutting from 5 - 6m/s² down to 1 - 2m/s² without affecting mower control.
vibration

Reducing Vibration Risk
Operational Factors

- operator training (e.g. correct use of low vibration breakers)
- ergonomics and operating conditions (e.g. weight, temperature, gloves...)
- job rotation; frequency of breaks

Reduce Vibration Exposure

- process change (avoid vibration process; mechanise; remote control ...)
- tools and tooling
  - alternative low vibration tools, processes or modify plant
  - tool operating conditions (pressure, speed, suitability for task ...)
  - consumable selection (disks, bits ...)
- maintenance
  - operator reporting system
  - time or condition based maintenance schedule

Buy / Hire "Smooth" Policy
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Reducing Vibration Risk