

# VIBRATION POCKET GUIDE

A Guide for Prioritizing Hand-Arm Vibration Exposure



*Cover photo by Spc. Terrence Ewing*

## Purpose

The Vibration Pocket Guide is intended to provide—

- A way to prioritize work areas needing further investigation relative to worker exposure to hand-arm vibration (HAV).
- A method for determining an approximate estimate of a worker's HAV exposure.
- A reference document of methods to minimize HAV exposure.

*This guide is NOT intended to provide a method for a definitive measurement of workers' exposure to HAV (that is, a method for actually taking measurements).*

## Background Information

This document uses American National Standards Institute (ANSI)/Acoustical Society of America (ASA) Standard S2.70-2006 (R2011) and International Organization for Standardization (ISO) standard 5349 as guidance for the measurement, data analysis and evaluation of health risks associated with HAV exposure. Briefly, ANSI/ASA S2.70-2006 (R2011) calls for frequency weighted analysis of vibration data in three axes (x, y, and z) and evaluation of health risks based on a daily exposure action value (DEAV) and a daily exposure limit value (DELV). The ANSI/ASA Standard S2.70-2006 (R2011) uses the same guidance as the European Union's (EU) Directive 2002/44/EC which is law in some EU countries.

The ANSI S2.70-2006 (R2011) guidance for HAV sets a frequency weighted root mean square (RMS) acceleration DELV of 5 meters per second squared ( $\text{m/s}^2$ ) for an 8-hour period.

Workers who are exposed to hand-transmitted vibration at or above this level are expected to have a high health risk. A DEAV of  $2.5 \text{ m/s}^2$  is the guidance for an 8-hour period. Workers exposed to hand-transmitted vibration at or above the DEAV are being exposed to a dose sufficient to produce abnormal signs and/or symptoms in some exposed individuals.

### Identifying Areas of Immediate Concern

Areas of immediate concern include any area where —

- A case of HAV syndrome has been documented.
- Power tools are used, and there is a documented medical diagnosis in a hand, arm, or wrist.
- Workers have reported a tingling sensation or a “pins and needles” feeling after using a power tool.

If any of the above situations occur on your installation, a person trained in performing vibration measurements should perform a detailed evaluation, and corrective actions should be implemented immediately.

### Determining Areas That Warrant Further Evaluation

Like most occupational hazards, exposure duration and magnitude of exposure are the main areas of concern. In order to properly evaluate the hazard of HAV, you have to determine both the exposure duration and the magnitude of exposure. Figure 1, and the subsequent pages describe a step-by-step process for determining a daily vibration exposure value standardized to an 8-hour reference period (A(8)). By determining an A(8) value, comparisons to the DELV and DEAV can be made, and you can focus your resources on investigating areas that have been identified as likely to have high HAV exposure.



*Photo by Sgt. 1st Class Phillip Eugene*

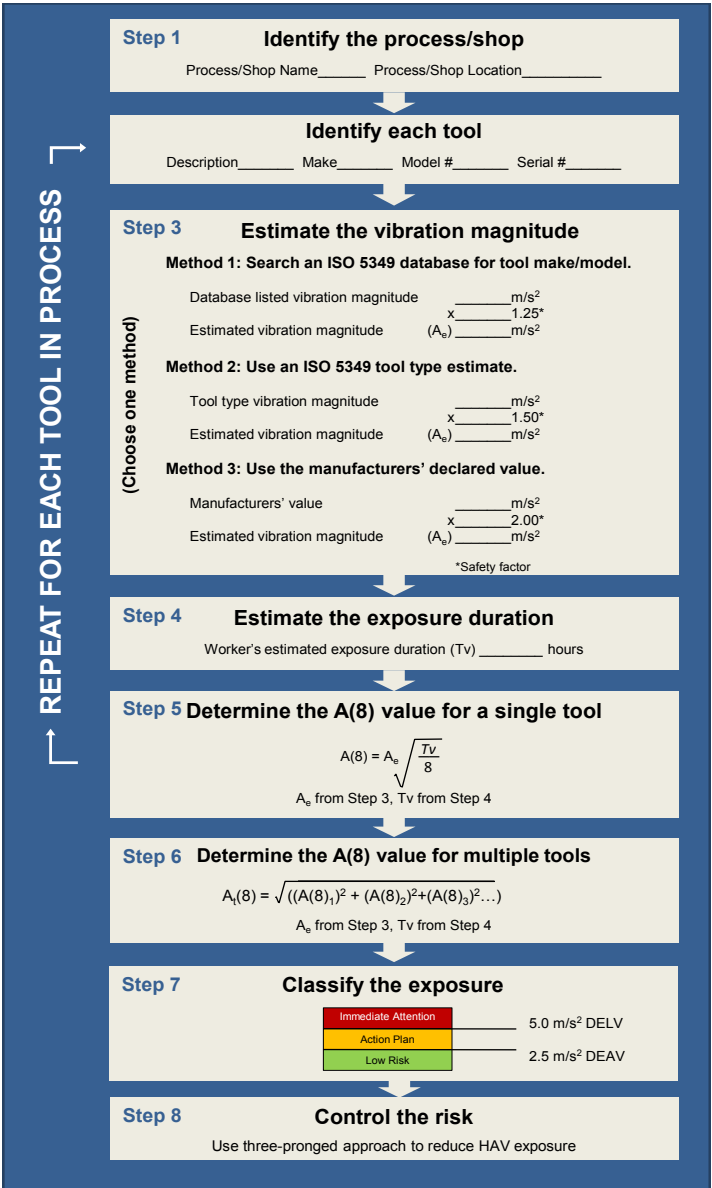


Figure 1. Hand-Arm Vibration Exposure Algorithm

### STEP 1

#### Identify the process/shop

Identify the process/shop that you want to use to estimate HAV exposure. Typical processes that have high HAV characteristics are processes that use grinders, riveters, impact wrenches, hammer drills, scabblers, jack hammers, etc.

- Process/Shop \_\_\_\_\_
- Location \_\_\_\_\_

### STEP 2

#### Identify each tool

Identify each tool that produces vibration in the process. Identify the make and model number. For each tool identified, proceed with steps 3, 4, and 5.

- Tool Description \_\_\_\_\_
- Tool Make \_\_\_\_\_
- Tool Model # \_\_\_\_\_
- Tool Serial # \_\_\_\_\_

### STEP 3

#### Estimate the vibration magnitude

Estimate the “in-use” vibration level. The in-use vibration level is the level of vibration being produced by the tool while the tool trigger is active. Because these are estimates, a safety factor also needs to be incorporated. Listed below are three methods (in order of preference) for estimating the in-use vibration level. If you use more than one method, choose the method with the highest vibration level.

- Method 1: Search an ISO 5349 database for tool make/model.
- Method 2: Use an ISO 5349 tool type estimate.
- Method 3: Use the manufacturers’ declared value that was obtained via the ISO 8662 or 28927 series.

### Method 1: Search an ISO 5349 database for tool make/model.

There are several databases available that contain information about the vibration magnitude of various types of power hand tools. These databases allow you to search for specific makes and models or tool classifications. The values represented in these databases have been tested under working conditions unlike manufacturer values that have been tested according to the ISO 8662 series. Three such databases are—

- **National Institute for Occupational Safety and Health (NIOSH) Power Tools Database:**

<http://www.cdc.gov/niosh-sound-vibration/>

All of the vibration tests performed by NIOSH are carried out under “real work conditions” according to ISO 5349-1 and 5349-2.

- **Hand-Arm Vibration Test Centre (HAVTEC) Vibration Database:**

<http://www.operc.com/havtec/>

The HAVTEC vibration database is operated by the Off-highway Plant and Equipment Research Centre (OPERC). All of the vibration tests performed by HAVTEC are carried out under “real work conditions” according to ISO 5349-1 and 5349-2. Note: Registration (free) is required to access the database.

- **Umea University Hand and Arm Vibration Database:**

<http://www.vibration.db.umu.se/HavSok.aspx?lang=en>

Umea University in Sweden has a HAV database that can be searched by tool type, manufacturer, model number, etc. Search by field measure value (ISO 5349).

#### EXAMPLE

Look up the make and model

Vibration Magnitude \* \_\_\_\_\_ m/s<sup>2</sup>

Multiply by the Safety Factor\*\* X (1.25)

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Estimated (Adjusted)

Vibration Magnitude ( $A_e$ ) = \_\_\_\_\_ m/s<sup>2</sup>

\* Consult the NIOSH, HAVTEC, or Umea make and model databases.

\*\* A safety factor of 1.25 is used to adjust for the uncertainty based on work conditions by the actual end users.

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## Method 2: Use an ISO 5349 tool type estimate.

There are several publications that report vibration magnitudes for different tool classifications. Table 1 presents typical vibration magnitudes for power hand tools commonly used at Department of Defense installations. The list of tools in the table is comprised from the EU Good Practice Guide HAV V7.7 and the OPERC/Birmingham City University Hand-Arm Vibration Wall Chart.

**Table 1. Typical Vibration Magnitude for Commonly Used Tools**

Tool Type	Vibration Magnitude (m/s <sup>2</sup> )
Brushcutter <sup>a</sup>	5.8
Chain Saw <sup>a</sup>	7.2
Circular Saw <sup>a</sup>	4.2
Die Grinder <sup>b</sup>	4.0
Drill (Electric) <sup>a</sup>	3.3
Grinder <sup>b</sup>	5.5
Hammer (Impact) Drill <sup>b</sup>	12.5
Impact Wrench <sup>b</sup>	7.1
Jack Hammer <sup>b</sup>	17.0
Jig Saw <sup>a</sup>	11.2
Orbital Sander <sup>b</sup>	7.5
Reciprocating Saw <sup>a</sup>	20.7
Tamper <sup>a</sup>	13.8
<b>Notes:</b> <sup>a</sup> HAV Wall Chart—©OPERC 2011 (Used with permission of Professor David J. Edwards, Birmingham City University, United Kingdom.) <sup>b</sup> HAV Good Practice Guide V7.7	

### EXAMPLE

Look up the make and model

Vibration Magnitude \* \_\_\_\_\_ m/s<sup>2</sup>

Multiply by the Safety Factor\*\* X (1.5)

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Estimated (Adjusted)  
 Vibration Magnitude (A<sub>e</sub>) = \_\_\_\_\_ m/s<sup>2</sup>

\* Consult table 1, EU good Practice Guide HAV V7.7, or OPERC HAV Wall Chart.

\*\* A safety factor of 1.5 is used to adjust for the uncertainty based on tool type class and not the specific tool.



**Method 3: Use the manufacturers’ declared in-use values (ISO 8662 or ISO 28927 series).**

Tools are tested by their manufacturers via either the ISO 8662 or ISO 28927 series. The ISO 8662 and ISO 28927 series values are vibration values measured by the manufacturer that conform to the testing standard for a specific tool classification. If the tool was tested via the older ISO 8662 standard, the value will be a single-axis value. (Note: ANSI/ASA S2.70-2006 (R2011) requires measurement in three axes.) These values can usually be found in the manuals and paperwork that accompany each tool.

**EXAMPLE**

Look up the make and model

Vibration Magnitude \* \_\_\_\_\_ m/s<sup>2</sup>

Multiply by the Safety Factor\*\* X (2.0)

Estimated (Adjusted)  
Vibration Magnitude (A<sub>e</sub>) = \_\_\_\_\_ m/s<sup>2</sup>

\* Consult the manufacturer’s documentation.

\*\* A safety factor of 2.0 is used to adjust for the uncertainty based on testing on a single axis of vibration instead of multi-axis testing.



Photo by Staff Sgt. Heather Norris

## STEP 4

### Estimate the exposure duration

Before the daily vibration exposure can be estimated, you need to determine exposure duration. Another term for exposure duration is trigger time (the time the tool is actually in operation). Be careful to count only the time the tool is in operation. Holding a tool while it is not in operation does not count toward exposure duration.

The two simplest methods to estimate exposure duration are—

- Have workers estimate the amount of time they spend using the tool. Note: Workers will tend to overestimate their exposure duration.
- Perform a time-motion study on a work sample. Watch a worker for a set period of time (1 hour for example), and use a stop watch to record the amount of time the worker triggers the tool during the designated time period. Multiply the amount of time recorded by the number of hours the worker uses the tool during a work shift.

Worker's estimated exposure duration ( $T_v$ ) \_\_\_\_\_ hours



Photo by Joshua Breckon

**STEP 5****Determine the A(8) value for a single tool**

If the tool is not used for 8 hours, the A(8) value can be determined by—

$$A(8) = A_e \sqrt{\frac{T_v}{8}}$$

A(8) \_\_\_\_\_

**EXAMPLE:**

Chainsaw use for 3 hours (using method 2 from step 3)

$A_e = \text{Table Value} \times \text{Safety Factor}$

$$A_e = (7.2 * 1.5) = 10.8 \text{ m/s}^2$$

Workers estimated exposure (step 4)

$T_v = 3 \text{ hours}$

$$A(8) = 10.8 \sqrt{\frac{3}{8}}$$

$$A(8) = 6.61 \text{ m/s}^2$$



Photo by Petty Officer 3rd Class Paul Perkins

**STEP 6**

**Determine the A(8) value for multiple tools**

If a worker uses more than one tool in an 8-hour period, the worker’s overall A(8) value,  $A_t(8)$ , can be determined by calculating a time-weighted average for each tool’s A(8) value used. Note: RMS time-weighted average is used because vibration is sinusoidal.

$$A_t(8) = \sqrt{((A(8)_1)^2 + (A(8)_2)^2 + (A(8)_3)^2 \dots)}$$

$A_t(8)$  \_\_\_\_\_

**Example:** Rivet gun, impact wrench, palm sander (from direct measurement)

Tool	Vibration Mag	Exposure	Tool A(8) value
Rivet Gun	$A_1 = 4.8 \text{ m/s}^2$	$T_1 = 3 \text{ hrs} =$	$A(8)_1 = 2.93 \text{ m/s}^2$
Impact wrench	$A_2 = 7.8 \text{ m/s}^2$	$T_2 = 1 \text{ hrs} =$	$A(8)_2 = 2.76 \text{ m/s}^2$
Palm sander	$A_3 = 5.8 \text{ m/s}^2$	$T_3 = 2 \text{ hrs} =$	$A(8)_3 = 2.9 \text{ m/s}^2$

$$A_t(8) = \sqrt{((A(8)_1)^2 + (A(8)_2)^2 + (A(8)_3)^2)}$$

$$A_t(8) = \sqrt{((2.93)^2 + (2.76)^2 + (2.9)^2)}$$

$$A_t(8) = 4.96 \text{ m/s}^2$$



Photo by Staff Sgt. Catrina Dorsey

## STEP 7

### Classify which exposures need further assessment

Use the calculated  $A(8)$  value, for one tool (from step 5) or  $A_t(8)$  for multiple tools (from step 6) to determine which exposures need further assessment. Any value,  $A(8)$  or  $A_t(8)$  that is above the DELV of  $5.0 \text{ m/s}^2$  needs immediate attention. Any value above the DEAV of  $2.5 \text{ m/s}^2$  needs to have an action plan in place to reduce the worker's exposure.

$A(8)$  or  $A_t(8)$  \_\_\_\_\_

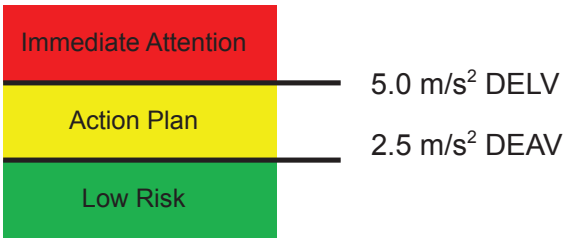


Photo by Sgt Ernest J. Barnes

### STEP 8

#### Control the risk

Once you have estimated daily exposures, it is time to take action. The process estimated to have the highest exposure should be targeted initially. To control the risk, use a three-pronged approach of: lowering the tools vibration magnitude, changing work practices, and using certified antivibration gloves.

Lower the tools vibration magnitude by—

- Changing the process. Use guides or jigs to reduce vibration magnitude or “engineer out” the exposure.
- Isolating workers from the vibration. Use antivibration handles, mounts, tension chains, or other accessories that lower the magnitude of vibration reaching the hands.
- Using more modern (antivibration) tools.
- Properly maintaining tools. Keeping tools properly maintained (oiled, with well-balanced components, sharp blades, correct tensions, etc.) will lower vibration levels.
- Providing proper training for workers. Properly training workers on techniques such as tool speed, grip strength, proper “shut off” times, etc., can lower vibration magnitude.

Change work practices by—

- Limiting the amount of time that a worker can use a particular vibrating tool.
- Implementing a work rotation schedule so that workers perform other work tasks (with no vibration exposure) at other times during their work day.
- Using work teams. Organize employees in teams so that they can “switch” tasks within the team to avoid long exposure durations.
- Planning work schedules so that individual workers are exposed to several short periods of vibration exposure rather than one continuous period.

-Use antivibration gloves that are –

- Certified, full-fingered, antivibration gloves that conform to ANSI/ASA S2.73-2002/ISO 10819:1996 (R2007).
- Used in conjunction with the other two control methods of lower vibration tools and alternative work practices.

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United States Army Public Health Command  
5158 Blackhawk Road  
Aberdeen Proving Ground, MD 21010- 5403  
<http://phc.amedd.army.mil>  
410-436-2439

