

DoD Ergonomics Working Group NEWS



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Hand-Arm Vibration Threshold Limits



Measuring exposure levels of hand-arm vibration is a complicated process. An instrument called an accelerometer is used to measure the vibration present from a power tool and then converts it to a proportional electrical output. This output signal is modified to account for the range of frequencies that are particularly harmful to the hand and arm.

The result of this process is a frequency weighted acceleration value, which is measured in meters per second squared (m/s^2). When these acceleration exposure values are found, they are compared to scientifically accepted exposure limit values to determine if action is necessary to reduce a worker's exposure to vibration.

However, a dilemma faces the assessor because there are several guiding documents that can be used to compare their measured acceleration values with accepted exposure limit values. Which document the assessor uses will determine what values are needed to assess the amount of hand-arm vibration exposure.

The three most commonly used guiding documents are:

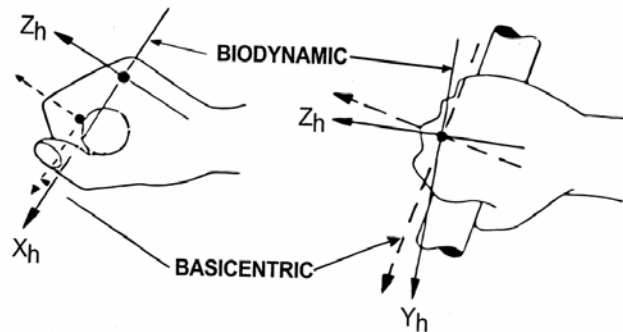
- American Conference of Government Industrial Hygienist (ACGIH) Threshold Limit Values (TLVs)
- American National Standards Institute (ANSI) S2.70-2006 (Revision of S3.34-1986) – Guide for the Measurement and Evaluation of Human Exposure to Vibration Transmitted to the Hand
- Directive 2002/44/EC of the European Parliament and the Council of the European Union

Continued on page 2

Good News

For measurement and frequency weighting techniques, the good news is all three documents refer to International Standards Organization (ISO) 5349: Guide for the Measurement and Assessment of Human Exposure to Hand Transmitted Vibration. This means that all three documents agree on how to perform the measurement and signal processing of the vibration measurement:

- Vibration measurements should be taken at a point close to where vibration encounters the hand.
- Vibration should be measured in three axes (x, y, and z) and the alignment of the accelerometer's axes should follow a standard configuration. (See standards for complete details.)



Courtesy of ACGIH.

Bad News

The bad news is the three documents do not agree on how to interpret the measured acceleration values or at what value level “action” should be taken to reduce vibration exposure.

Differences Between Documents

The ACGIH TLV treats each axis separately. The highest frequency-weight value, or worst case scenario, of the three axes measured is used to compare with their Total Daily Exposure Limits shown in the table below.

ACGIH TLVs Total Duration	Value of Dominant Frequency Weighted, rms Component Acceleration, m/s^2
4 hours and less than 8	4
2 hours and less than 4	6
1 hour and less than 2	8
Less than 1 hour	12

Unlike ACGIH TLV, ANSI S2.70 and the European Directive use a vibration total value where the result of the three axes of measurement is vectorially added to obtain a vibration total value A_{hv} as shown in this equation:

$A_{hv} = \sqrt{(A_{hx}^2 + A_{hy}^2 + A_{hz}^2)}$ where A_{hx} , A_{hy} , and A_{hz} are the weighted acceleration of the x, y, and z axis, respectively.

A_{hv} is then compared to two values:

- Daily Exposure Limit Value (standardized to an eight-hour day) of 5 m/s^2 .
- Daily Exposure Action Value (standardized to an eight-hour day) of 2.5 m/s^2 .

ANSI S2.70 and European Directive 2002/44/EC currently use the same daily exposure limit values and daily exposure action values.

- ANSI S2.70 defines the Daily Exposure Limit Value as a high health risk and further defines a high health risk as “the dose of hand-transmitted vibration exposure sufficient to produce abnormal signs, symptoms, and laboratory findings in the vascular, bone or joint, neurological, or muscular systems of the hands and arms in a **high proportion** of exposed individuals.”
- ANSI S2.70 defines the Daily Exposure Action Value as a health risk and further defines a health risk as “the dose of hand-transmitted vibration exposure sufficient to produce abnormal signs, symptoms, and laboratory findings in the vascular, bone or joint, neurological, or muscular systems of the hands and arms in **some** exposed individuals.”
- European Directive 2002/44/EC does not define daily exposure limit values or daily exposure action values within the context of the document but does state “In any event, workers shall not be exposed above the exposure limit value.”

Conclusion

Which values you use depends on your location, local regulations and situation. No matter which documents you use, the bottom line is the same: The less the exposure to hand-arm vibration, the healthier your workers will be.

For more information on measuring exposure levels of hand-arm vibration, or to request a vibration assessment from the Ergonomics Program at the U.S. Army’s Center for Health Promotion and Preventive Medicine, contact Steve Chervak at 410-436-3928, steven.chervak@us.army.mil.