Vibration – Measurement, Control and Standards Fact Sheet

HOW CAN YOU MEASURE VIBRATION?

A complete assessment of exposure to vibration requires the measurement of vibration acceleration in meters per second squared (m/s2). Vibration exposure direction is also important and is measured in defined directions. Vibration frequencies and duration of exposure are also determined. How hard a person grips a tool affects the amount of vibrational energy entering the hands; therefore, hand-grip force is another important factor in the exposure assessment.

The amount of exposure is determined by measuring acceleration in the units of m/s2. Acceleration is often used as a measure of vibration exposure for the following reasons:

- Several types of instruments are available for measuring acceleration, the rate of change of velocity in speed or direction per unit time (e.g., per second).
- Measuring acceleration can also give information about velocity and amplitude of vibration.
- The degree of harm is related to the magnitude of acceleration.

Health research data tells us that the degree of harm is related to the magnitude of acceleration.

Instrumentation

A typical vibration measurement system includes a device to sense the vibration (accelerometer), and an instrument to measure the level of vibration. This equipment also has settings for measuring frequency, a frequency-weighting network, and a display such as a meter, printer or recorder.

The accelerometer produces an electrical signal. The size of this signal is proportional to the acceleration applied to it. The frequency-weighting network mimics the human sensitivity to vibration of different frequencies. The use of weighting networks gives a single number as a measure of vibration exposure and is expressed as the frequency-weighted vibration exposure in metres per second squared (m/s2) units of acceleration.

Figure 1

The frequency-weighting network for hand-arm vibration is given in the International Organization for Standardization (ISO) standard ISO 5349. Human hand is not equally sensitive to vibration energy at all frequencies. The sensitivity is the highest around 8-16 Hz (Hertz or cycles per second). Measuring equipment takes this fact into account by using a weighting network. The gain is assigned a value of 1 for vibration frequencies to which the hand-arm system has the highest sensitivity. The dashed lines in Figure 1 represent the filter tolerances in the weighting network.

Are there methods for controlling exposure to vibration?

Protecting workers from the effects of vibration usually requires a combination of appropriate tool selection, the use of appropriate vibration-absorbing materials (in gloves, for example), good work practices, and education programs.

What are some examples of controlling exposure to vibration?

Anti-Vibration Tools

Tools can be designed or mounted in ways that help reduce the vibration level. For example, using anti-vibration chain saws reduces acceleration levels by a factor of about 10. These types of chain saws must be well maintained. Maintenance must include periodic replacement of shock absorbers. Some pneumatic tool companies manufacture anti-vibration tools such as anti-vibration pneumatic chipping hammers, pavement breakers and vibration-damped pneumatic riveting guns.

Anti-Vibration Gloves

Conventional protective gloves (e.g., cotton, leather), commonly used by workers, do not reduce the vibration that is transferred to workers' hands when they are using vibrating tools or equipment. Anti-vibration gloves are made using a layer of viscoelastic material. Actual measurements have shown that such gloves have limited effectiveness. When the vibration hazard cannot be removed or controlled adequately, Personal Protective Equipment (PPE) such as anti-vibration gloves may be used.

Safe Work Practices

Along with using anti-vibration tools and gloves, workers can reduce the risk of hand-arm vibration syndrome (HAVS) by following work practices:

- Use a minimum strength hand grip that still allows the 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.
- Do not use faulty tools.
- Maintain tools properly. Tools that are worn, blunt or out of alignment will vibrate more.
- Consult a doctor at the first sign of vibration disease and ask about the possibility of changing to a job with less exposure.

Employee Education

Training programs are an effective means of heightening the awareness of HAVS in the workplace. Training should include proper use and maintain vibrating tools to avoid unnecessary exposure to vibration. Vibrating machines and equipment often produce loud noise as well. Therefore, training and education in controlling vibration should also address concerns about noise control.

Whole-Body Vibration

The following precautions help to reduce whole-body vibration exposure:

- Limit the time spent by workers on a vibrating surface.
- Mechanically isolate the vibrating source or surface to reduce exposure.

- Ensure that equipment is well maintained to avoid excessive vibration.
- Install vibration damping seats.

The vibration control design is an intricate engineering problem and must be set up by qualified professionals. Many factors specific to the individual workstation govern the choice of the vibration isolation material and the machine mounting methods.

Are there any Canadian regulations or guidelines for vibration exposure?

Many Canadian jurisdictions do not have regulations concerning vibration exposure. However, it is prudent to reduce the level of exposure as much as practical since vibration causes ill health effects. It is possible to do this by using engineering controls, safe work practices, and protective equipment. The design of vibration-damped equipment and engine mountings are the most effective engineering methods of controlling vibration exposure.

In the absence of formal regulations, Canadian agencies often use the Threshold Limit Values (TLVs) and guidelines recommended by the American Conference of Governmental Industrial Hygienists (ACGIH). These TLVs are based on the recommendations of the International Organization for Standardization (ISO).

What are the standards or guidelines for exposure to hand-arm vibration?

The American Conference of Governmental Industrial Hygienists (ACGIH) has developed Threshold Limit Values (TLVs) for hand-arm vibration exposure. The 2016 edition refers to a daily vibration exposure [8 hour equivalent total value] of 5 metres/sec2 to represent conditions where it is believed that most workers may be exposed repeatedly without progressing beyond Stage 1 of the Stockholm Workshop Classification System for Vibration-Induced White Finger. Stage 1 is termed “mild” and is described as “occasional attacks affecting only the tips of one or more fingers”.

What are the standards or guidelines for exposure to whole-body vibration?

The American Conference of Governmental Industrial Hygienists (ACGIH) has developed Threshold Limit Values (TLVs) for whole-body vibration exposure. The 2016 edition refers to the ISO Standard 2631-1 “Mechanical vibration and shock – Evaluation of human exposure to whole-body vibration” (published in1997, and confirmed current in 2014). The Standard focuses on the possible effects of vibration on health, comfort and perception, and on the incidence of motion sickness. They caution that vibration is often complex, contains many frequencies, occurs in several directions, and changes over time.

The ACGIH TLVs use a “curve” which compares ISO 2631 Health Guidance Caution Zones, the weighted acceleration, and the exposure time, as well as a series of calculations to assist users. Use of the ACGIH and/or ISO guidelines directly is recommended.

Also, it is important to remember that people vary in their susceptibility to effects of exposure to vibration so the “exposure limits” should be considered as guides in controlling exposure: they should not be considered as an upper “safe” limit of exposure or a boundary between safe and harmful levels.