

Proposed OHS Guidelines

Part 7

Vibration Exposure

Guidelines to accompany proposed 2004 amendments to the
Occupational Health and Safety Regulation

Issued by the Prevention Division
Workers' Compensation Board of B.C.

G7.11-1 Exposure limits – Hand-arm vibration

Issued August 1999 as G7.26-2; Proposed revision November 19, 2003

Proposed Amendment

Section 7.11(a) of the *Occupational Health and Safety Regulation* states:

The employer must ensure, to the extent practicable, that workers are not exposed to vibration in excess of the limits specified in

- (a) for hand-arm vibration, the most current edition of the American Conference of Governmental Industrial Hygienists publication entitled “Threshold Limit and Biological Exposure Indices”, except as otherwise determined by the board; . . .

Proposed Guideline

The American Conference of Governmental Industrial Hygienists’ publication includes the following table of recommended daily limits of exposure (TLVs) to frequency-weighted acceleration.

TLVs for exposure of the hand to vibration in either x_h , y_h , or z_h directions

Total daily exposure duration	TLV of the dominant, frequency-weighted (rms), component acceleration which shall not be exceeded ms^{-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

rms = root mean square

ms^{-2} = metres per second squared

Note: In this case, the value of the frequency-weighted acceleration (x_h , y_h , or z_h) refers to the three perpendicular x-, y-, and z-axes as it applies to the hand. The term “dominant” means that usually only one axis is dominant. If one or more axes exceeds the total daily exposure, then the TLV has been exceeded.

G7.11-2 Exposure limits – Whole-body vibration

Issued August 1999 as G7.26-3; Proposed revision November 19, 2003

Proposed Amendment

Section 7.11(b) of the *Occupational Health and Safety Regulation* states:

The employer must ensure, to the extent practicable, that workers are not exposed to vibration in excess of the limits specified in . . .

- (b) for whole-body vibration, the most current applicable ISO standard, except as otherwise determined by the board.

Proposed Guideline

With respect to section 7.11(b), Appendix B of *ANSI S3.18-2002 / ISO 2631-1:1997, Mechanical Vibration and Shock – Evaluation of Human Exposure to Whole-Body Vibration – Part 1: General Requirements*, addresses the health effects of vibration on the human body and defines a “health caution guidance zone” for daily exposures of 4 to 8 hours, as follows:

- **Within the zone** – caution is indicated with respect to potential risks for adverse health effects
- **Above the zone** – adverse health risks are likely
- **Below the zone** – adverse health effects have not been clearly documented and/or objectively observed

Whole-body vibration exposure limits in either x, y, or z directions

Daily Exposure Duration	Values of the dominant, frequency-weighted (rms), component acceleration, ms ⁻²		
	No clear effects	Caution	Health risks likely
4 hours	Less than 0.6	0.6 to 1.1	Greater than 1.1
8 hours	Less than 0.5	0.5 to 0.9	Greater than 0.9

rms = root mean square
ms⁻² = metres per second squared

The *OHS Regulation* recognizes, in the phrase “to the extent practicable” in section 7.11, that there are circumstances in which the exposure limit cannot be fully complied with. In such circumstances, section 7.11 requires the employer to reduce the exposure using all practicable means currently available (see OHS Guideline G7.13 for further information), even if the exposure limit cannot be achieved.

G7.12 Evaluation

Issued August 1999 as part of G7.26-1; Proposed revision November 19, 2003

Proposed Amendment

Section 7.12 of the *Occupational Health and Safety Regulation* states:

The evaluation of hand-arm vibration and whole-body vibration must be conducted by the employer in accordance with the most current applicable ISO or ANSI standard, except as otherwise determined by the board.

Proposed Guideline

For the purposes of this section, *ANSI S3.18-2002 / ISO 2631-1:1997, Mechanical Vibration and Shock – Evaluation of Human Exposure to Whole Body Vibration – Part 1: General Requirements*, are acceptable standards.

In the exposure limit tables presented in OHS Guidelines G7.11-1 and G7.11-2 for hand-arm vibration (HAV) and whole-body vibration (WBV), acceleration limits are listed according to an “axis.” The reason for this is that the body’s response to vibration depends on the direction along which vibration enters the body. For both HAV and WBV, three perpendicular “biodynamic” axes (the x-, y-, and z-axes) are defined. The directions of these axes are described here.

Axes of vibration

Axis	Hand-arm vibration (HAV)	Whole-body vibration (WBV)
x-axis	Through the hand, from top towards the palm	Through the body, from the back towards the chest
y-axis	From the right side to the left side, parallel to the knuckles	From the right side to the left side
z-axis	From the wrist through to fingers, parallel to top of the hand	From the feet (or buttocks) to the head

Usually acceleration is dominant along one axis; for whole-body vibration this is often the z-axis.

For the measurement of vibration (HAV and WBC), measured accelerations are frequency-weighted according to the frequency weightingS defined in the latest ISO and ANSI standards. The frequency-weighted accelerations can then be compared with criterion values/exposure limits, which are also expressed in terms of frequency-weighted acceleration. (See OHS Guidelines G7.11-1 and G7.11-2 for exposure limits for HAV and WBV, respectively.)

The techniques for measurement and assessment of vibration now resemble those for noise, where frequency-weighted sound levels are measured and compared to criterion frequency-weighted sound levels in dBA.

G7.13 Exposure control plan

Issued August 1999 as part of G7.26-1; Proposed revision November 19, 2003

Proposed Amendment

Section 7.13 of the *Occupational Health and Safety Regulation* states:

The employer must, if a worker is or may be exposed to vibration in excess of the vibration exposure limits, develop and implement an exposure control plan that meets the requirements of section 5.54(2).

Proposed Guideline

A basic element of an exposure control plan is to determine the severity of the exposure to the agent. Not all equipment presents a hazard from vibration. Examples of equipment that may present a hazard to workers from either hand-arm vibration or whole-body vibration are listed below.

Some equipment that may present a vibration hazard

Hand-arm vibration	Whole-body vibration
Chainsaws, brush cutters, mowers Percussive tools (such as air-driven chisels, hammers, drills, and wrenches) Concrete vibrators Grinders and other rotary tools	Log decks Operator cabs for heavy equipment (commonly used in construction and forestry)

When there is a reasonable expectation that vibration presents a significant hazard, the exposure limits in section 7.11 should be considered in the purchase and design of new equipment. In determining whether an exposure control plan is required, the duration of daily exposure and the operating conditions should be taken into consideration, as well as any reports of injury and disease from workers using existing equipment. Equipment that is used less than 0.5 hour per day is not likely to present a significant long-term hazard from vibration, except for the most highly vibrating equipment. It is prudent to regard regular prolonged use of any high-vibration tool or machine as hazardous, especially if it causes tingling or numbness in the user's fingers after about 5 to 10 minutes of continuous operation.

Some useful references in assessing equipment for vibration are the following publications by the Health Safety Executive in the United Kingdom: *Hand-Arm Vibration (HSG88, 1994)* and *Vibration Solutions – Practical Ways to Reduce the Risk of Hand-Arm Vibration Injury (HSG170, 1997)*.

Evaluating equipment for potential for vibration

To evaluate the potential for vibration with respect to the exposure limits referred to in section 7.11, information on the vibration characteristics of the equipment or machinery is to be obtained. For example:

- *Obtaining information from the supplier of the equipment:* The employer should ask the following questions to obtain information from a supplier or designer:

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- Does the equipment meet the exposure limits in the referenced standards?
- What is the frequency-weighted acceleration of the equipment?
- Under what operating conditions were the measurements made?
- Which published standard was used when conducting the evaluation?
- *Researching the relevant literature and available databases:* The Swedish National Institute for Working Life maintains a vibration database. It can be viewed on the Internet at: <http://umetech.niwl.se/Vibration/WBVHome.html>
- *Measuring frequency-weighted acceleration values of designed equipment or of equipment before purchase:* These determinations are to be conducted in accordance with a standard acceptable under section 7.12 of the *OHS Regulation*.

Options for control measures

Control measures to protect against hand-arm vibration (HAV) may include the following:

- Ensure the tool is properly maintained, serviced and adjusted.
- Keep the tool sharpened or fitted with effective grinding discs.
- Ensure rotary tools are dynamically balanced.
- Where applicable, ensure the grinding disc is centred on the arbour.
- Grip the tool handle with the least hand strength practicable.
- Wear full-fingered, “antivibration” gloves meeting the requirements of *ISO Standard 10819-1996, Mechanical Vibration and Shock – Hand-Arm Vibration – Method for the Measurement and Evaluation of the Vibration Transmissibility of Gloves at the Palm of the Hand*.
- Replace with a tool having lower vibration.

Control measures to protect against whole-body vibration (WBV) may include the following:

- Choose a suspended seat containing a vibration-damping mechanism.
- Choose a suspended seat adjustable for the user’s weight.
- Dynamically balance rotary equipment.
- Regularly grade the surface over which vehicles operate.
- Reduce speed when moving over bumpy surfaces.
- Avoid sudden load changes (pick up, drop off).
- Avoid bumping into obstacles while driving.
- Fit vibration-damping mechanisms where possible.
- Maintain shock absorbers on vehicles.
- Isolate booths/cabs, etc., by setting them on their own separate foundations.
- Train workers not to jump in order to exit equipment, particularly from an elevation. Because the intervertebral discs may have been softened by the vibrating equipment, jumping can more easily cause shock and damage to the body.

G7.14 Information on adverse effects

Proposed Amendment

Section 7.14 of the *Occupational Health and Safety Regulation* states:

The employer must, if a worker is exposed to levels of vibration above the vibration exposure limits, inform the worker of the nature of the hazard and possible adverse effects.

Proposed Guideline

Excessive exposure to hand-arm vibration (HAV) can cause vascular, neurological, and musculoskeletal damage to workers' fingers and hands. The symptoms of hand-arm vibration syndrome (HAVS) include circulatory pain (notably triggered by cold), loss of dexterity, and development of bone cysts and joint abnormalities. Workers may complain of episodes of pale, white fingers often triggered by exposure to cold. It is believed that vibration can adversely affect the blood circulation, making fingers sensitive to the vasoconstriction due to cold. Initially, only the tips of one or more fingers are "blanched," but more segments and fingers are affected with further vibration exposure.

Workers also may experience tingling or numbness in the fingers and hands. With continued exposure, the sensations worsen and can interfere with work and result in the loss of the normal sense of touch. Some vibration-exposed workers (rock drillers, forestry workers) may show signs of carpal tunnel syndrome (CTS) suggesting that vibration can combine with repetitive motion, forceful gripping, and awkward postures (all ergonomic stressors) to contribute to hand and wrist disorders.

Higher occurrences of osteoarthritis in the wrist and elbow have been observed in workers using hand-held, pneumatic percussive tools (miners, construction, metal workers). Workers may also complain of muscular weakness, pain in the hands/arms, and reduced grip strength. In some cases, muscle fatigue can cause disability. Other occupational disorders in vibration-exposed workers include tendonitis and tenosynovitis (inflammation of tendons and their sheaths) in the upper limbs.

Whole-body vibration (WBV) may be associated with an increased risk for low back pain, sciatic pain, and degenerative changes in the spinal column including lumbar intervertebral disc disorders.

For the vibration magnitudes in all but the most severe occupational situations, the adverse health conditions of WBV and HAV may not develop until there has been a prolonged period of time (measured in years) of regular daily exposure.

G7.15 Labels

Issued August 1999 as G7.28; Proposed revision November 19, 2003

Proposed Amendment

Section 7.15 of the *Occupational Health and Safety Regulation* states:

If the manufacturer of equipment that produces levels of vibration in excess of the vibration exposure limit does not label the equipment to identify the hazard, the employer is responsible for doing so.

Proposed Guideline

This section requires that equipment producing levels of vibration in excess of recommended limits be labelled to identify the hazard. Ideally, this label will be permanently affixed by the equipment manufacturer during assembly. In many cases, however, the manufacturer will not have permanently affixed a label identifying the hazard. In these cases, the employer is required to affix the label.

There is no required format for the label. Any means that effectively communicates the vibration hazard is acceptable. For example, the employer could use a symbol instead of words as long as workers are trained to know what the symbol means.

It will be difficult an employer to securely apply a label to some small pieces of equipment. For example, an adhesive label applied to a chainsaw used in the woods will likely be damaged beyond legibility before long. In such cases, where a label will likely not stay intact on a piece of equipment, it is acceptable for an employer to keep the label in a location where it will not easily be damaged or destroyed. The label is to be kept near the equipment and be readily available to the worker. Acceptable locations include the equipment's storage case or an accompanying operations manual.

Where the label cannot be applied directly to the equipment, workers should receive instruction in the location of the label.

G7.16 Exposure to cold

Proposed Amendment

Section 7.16 of the *Occupational Health and Safety Regulation* states:

When a worker is exposed to hand-arm vibration, the employer, to the extent practicable, must ensure that the worker's hands or arms are not exposed to cold, either from the environment in which the worker is working or as a result of using equipment, or from coming into contact with cold objects.

Proposed Guideline

Hand-arm vibration can inflict vascular damage to workers' fingers – a condition known as hand-arm vibration syndrome (HAVS). See OHS Guideline G7.14 for further information. To reduce the incidence of HAVS (and the onset of pain for workers who already have HAVS), workers using vibrating tools should keep their hands warm to improve circulation.

Here are some examples of ways for workers to keep their hands warm:

- Redirect exhaust air from pneumatic tools away from the hands. Compressed air released from pneumatic tools' exhaust ports has a strong cooling effect as it expands to atmospheric pressure.
- Provide dry towels and a change of dry gloves for workers using vibratory tools when their hands may become wet from rain or perspiration.
- Insulate handles of vibratory tools in cold environments.