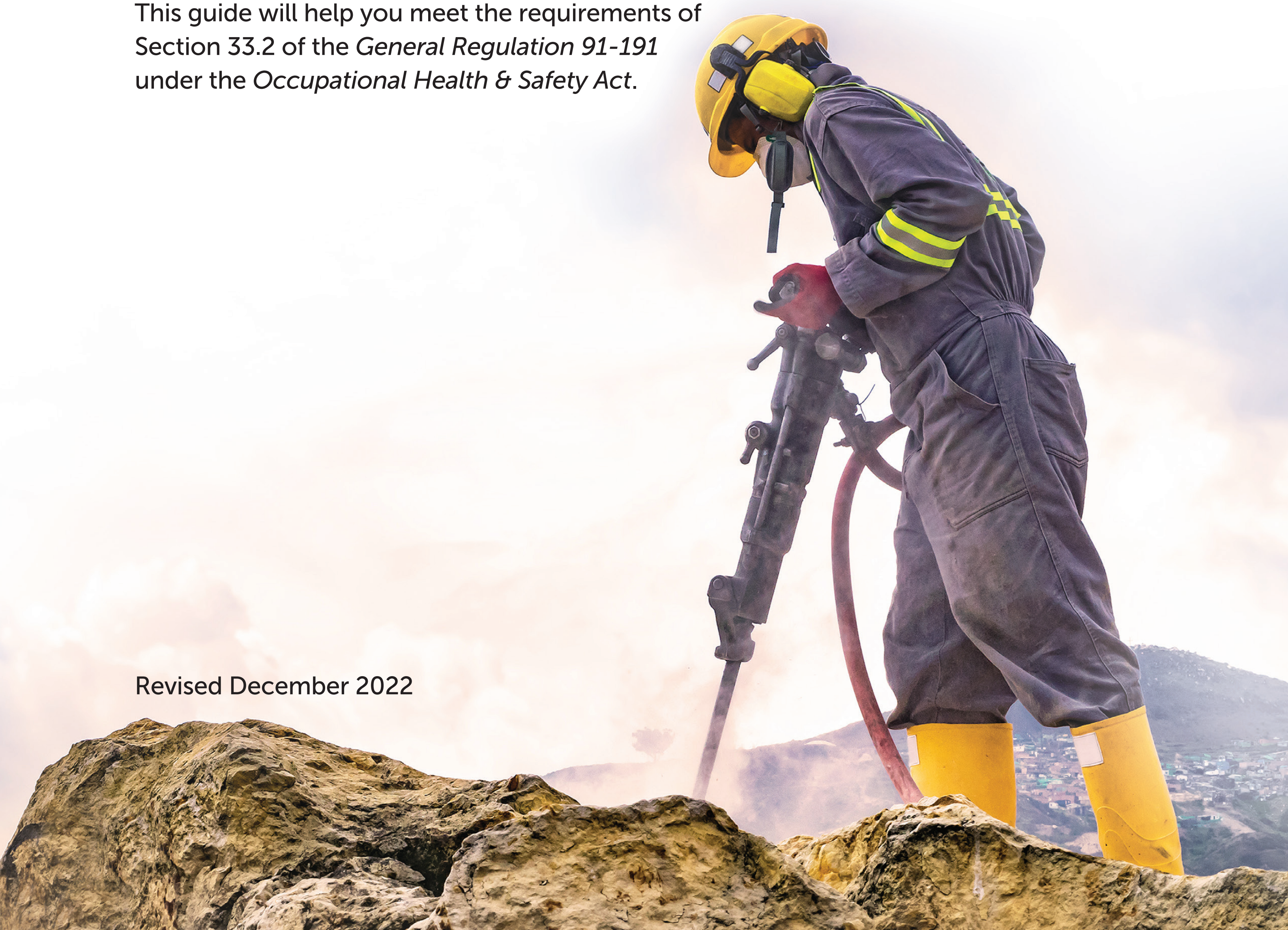
Guide for Developing a Code of Practice for Hand-Arm Vibration in New Brunswick

This guide will help you meet the requirements of Section 33.2 of the *General Regulation 91-191* under the *Occupational Health & Safety Act*.



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INTRODUCTION

By law, employers must assess and identify measures to eliminate or reduce risks from exposure to hand-arm vibration. Overexposure to vibration can result in white finger disease, also known as Raynaud's phenomenon. A code of practice will help employers identify specific workplace hazards and to clearly describe everything necessary to protect workers from hand-arm vibration.

Section 33.2 of *General Regulation 91-191* requires that an employer ensure that an employee's exposure to hand-arm vibration is kept as low as is practical and does not exceed the following exposure limits:

Exposure of the hand to vibration in either up and down, sideways or forward and back directions

Total daily exposure duration*	Values of the dominant**, frequency-weighted, root mean square, component acceleration which shall not be exceeded	
	m/s^2	g***
4 hours and less than 8 hours	4	0.40
2 hours and less than 4 hours	6	0.61
1 hour and less than 2 hours	8	0.81
Less than 1 hour	12	1.22

* The total time vibration enters the hand per day, whether continuously or intermittently.

** Usually one axis of vibration is dominant over the two remaining axes. If one or more vibration axis exceeds the total daily exposure, then the exposure limit has been exceeded.

*** 1 g = $9.81 m/s^2$

The first step in identifying the hazards is to determine the vibration rating in metres/second square (m/s^2) for each tool. There are two methods that can be used to obtain vibration level values for power tools:

1. Measure in-use vibration magnitude with a vibration meter.

2. Use declared vibration values provided by tool manufacturers as an estimate.

Measuring In-use Vibration Values and Determining Allowable Exposure Times

There are two methods that can be used methods can be used to measure a tool's vibration value and to establish allowable exposure times ("finger-on-trigger" times):

1. Determining the vibration value of the dominant axis of vibration by measuring the frequency-weighted, rms (root mean square) component acceleration for all three axes of vibration. The value of the axis with the highest rms acceleration will be compared to the exposure limits in section 33.2 of *General Regulation 91-191* (see table on page 2 of this guide).
2. Determining the 'vibration total value', which is the root sum of squares of the frequency weighted rms values of all three axes. Based on the vibration total value, allowable exposure times are calculated using the advice and equation contained in the ACGIH publication entitled "2016 Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices". The daily vibration exposure limit set in this publication is 5 meters/sec^2 as 8-hour energy equivalent total value.

When determining daily allowable exposure times, all potentially vibrating hand-held tools a worker might use must be included. For a worker operating two or more different vibrating tools, the cumulative vibration exposure must be considered.

A test-standard has been developed to help employers and contractors when measuring vibration exposure and to provide guidance on acquiring consistent hand-arm vibration data under typical workplace conditions: **Appendix C - Procedure for Testing**.

Obtaining the Manufacturer Declared Vibration Magnitude Values

Tool specifications

Model number	JCT-2610	JCT-2611	JCT-2612
Stock number	550610	550611	550612
Bore	1-3/16 in. (30 mm)		
Piston Stroke	11 in. (279 mm)	8 in. (203 mm)	6 in. (153 mm)
Impact rate (blows per minute)	850	1,140	1,560
Rivet capacity	1-1/4 in.	1-1/8 in.	1-1/16 in.
Energy per blow @90psi	80 lbf•ft	60 lbf•ft	45 lbf•ft
Average air consumption	44 CFM	44 CFM	50 CFM
Air inlet	1/2 in. NPT		
Air hose minimum inside diameter	1/2 in.		
Required air pressure	90 psi (6.2 bar)		
Vibration value	14 m/s^2	15 m/s^2	15 m/s^2
Noise level [1]	95-100 dB		
Overall length	25-1/2 in. (648 mm)	22-1/2 in. (572 mm)	20-1/2 in. (521 mm)
Handle	D-style, drop forged		
Retainer style	Jumbo 11X		
Housing material	Steel		
Required oil	Aire Tool Oil (or ISO VG32/SAE 10 W equivalent)		
Net weight	33 lb. (15 kg)	30 lb. (14 kg)	26 lb. (12 kg)
Shipping weight	35 lb. (15.9 kg)	32 lb. (14.6 kg)	28 lb. (12.7 kg)

Because acquiring actual field measurements with a vibration meter can be time-consuming and difficult, the guide allows the use of manufacturer-declared vibration values. Most manufacturers follow ISO test standards to determine vibration values and report these as vibration total values. These are different from, and cannot be readily converted into, dominant axis vibration values currently cited in *Regulation 91-191*. Therefore, the advice and equation contained in the ACGIH publication entitled "2016 Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices" must be followed when applying manufacturer-declared vibration total values.

Please note, however, that while manufacturers' values are measured according to internationally recognized test standards, the measurements are taken in controlled environments and may not actually reflect specific work conditions. The in-use vibration exposure to the user in a specific application may vary from the manufacturer's results. Therefore, onsite measurements should be used as the first choice to determine the hazard level. If measurements are not available, the default is to apply the manufacturer-declared vibration values.

Controlling Exposure to Vibration

1. Selecting the Equipment

Tool selection can make a difference to the vibration level. It should be suitable for the task and used correctly. When selecting the proper equipment, consider three factors: lower vibration values, decrease exposure time, and **good ergonomic design of tools**. For example, equipment with a higher vibration value may allow decreased exposure time by being more efficient, whereas equipment with lower vibration may reduce rest breaks. The important things to look for are equipment or tools that produce less vibration or that can do the job faster. Check that you are using the most effective tool for the task being performed.

2. Using the Equipment

The manufacturer will normally indicate proper equipment use or selection of the right tool. The failure to do either could result in a longer time to complete a task and may result in higher levels of vibration exposure. A worn tool will also cause increased working time. As an employer, it is important to provide training to supervisors and employees on how to properly operate the tool as per the manufacturer's recommendations.

3. Limiting Daily Exposure Time

Restricting exposure time ("finger-on-trigger" time) may be required to bring exposures below the exposure limit, even after all practical measures to reduce vibration levels are in place. Employers can implement administrative controls, such as job rotation, to reduce exposure. However, exposure duration is not the overall time spent on a specific job – it is only the finger-on-trigger time during which the hands are exposed to vibration.

4. Other Controls

Anti-Vibration Tools

Tools can be designed or mounted in ways that help reduce the vibration level. Some pneumatic tool manufacturers do supply anti-vibration tools such as anti-vibration pneumatic chipping hammers, pavement breakers and vibration-damped pneumatic riveting guns.

Safe Work Practices

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

- Using a minimum strength hand grip that still allows the safe operation of the tool or process.
- Wearing appropriate clothing, including gloves, to keep warm.
- Avoiding continuous exposure by taking regular breaks.
- Encouraging operators to exercise their fingers.
- Resting the tool on the work piece whenever practical.
- Not using faulty tools.
- Maintaining tools properly. Tools that are worn, blunt or out of alignment will vibrate more.
- Considering changing to a job with less exposure.

Employee Education and Training

Training programs can effectively heighten the awareness of HAVS in the workplace. Training should include proper use and maintenance of vibrating tools to avoid unnecessary exposure. Vibrating machines and equipment often produce loud noise as well. Therefore, training and education in controlling vibration should also address concerns about the effect of noise and noise control.

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

Anti-Vibration Gloves

Anti-vibration gloves may be used in some circumstances. However, since they have limited effectiveness, using gloves only is not recommended as a method of reducing exposure.

Discomfort Survey

A voluntary discomfort survey can be administered with workers who are exposed to vibration. When timely completed, the survey can identify symptoms before the health effects become permanent. **Appendix A - Discomfort Survey** provides an example of a survey.

Elements of a Code of Practice

The code of practice for hand-arm vibration equipment should address the following:

1. **Administering the program**
   Who is responsible to administer and maintain the program in the workplace?
2. **Identifying the person(s) at risk from hazardous task/jobs/situations**
   Who will need to follow this code of practice?
3. **Identifying the hazards**
   What vibration hazards do employees need to be protected against? What is the frequency and intensity?
4. **Selecting the equipment**
   Is the equipment the proper tool for the job?
5. **Limiting daily exposure time**
   Restricting exposure time ("finger-on-trigger" time) maybe be required to bring exposures below the exposure limit, even after all practical measures to reduce vibration levels are in place. Field measurements of vibration or the limits outlined by the manufacturer can be used to establish exposure time.
6. **Identifying other risk controls risk controls**
   Control of hand-arm vibration syndrome (HAVS) risk by means other than reducing vibration exposure, by alternative tools and methods for certain jobs (such as hydraulic tools in place of vibratory tools).
7. **Instructing and training**
   Have employees been properly trained in the selection, use and care of their equipment, and are they aware of the hazards associated with hand-arm vibration?
8. **Using the equipment**
   Are supervisors ensuring that employees use and care for their equipment? Are they aware of the manufacturer's recommendations, and are they being followed?
9. **Evaluating the program**
   Is the code of practice being evaluated regularly to ensure it is adequate to protect all employees?
10. **Record keeping**
    Are training records kept for all employees? Has a hazard assessment been done for the task, and is there documentation?

In addition to the above, consider a health surveillance program that includes pre-placement and periodic medical evaluation of workers to enhance the detection of and response to early HAVS.

In **Appendix B - Hand-Arm Vibration Code of Practice** you will find a template to help you develop a code of practice for your workplace and work practices.

APPENDIX A

Discomfort Survey

Name: ____ Date: _____________

Job title: ____

Job description: ____

1. How many years or months have you been working in this job or set of tasks?

   ______ years ________ months

2. Do you have any numbness or tingling of the fingers lasting more than 20 minutes after using vibrating equipment?

   ☐ Yes ☐ No

   If yes, please indicate discomfort using the scale 0 = no discomfort, 10 = worst imaginable discomfort.

   0 1 2 3 4 5 6 7 8 9 10

3. Do you wake at night with pain, tingling of the fingers, or numbness in your hand or wrist?

   ☐ Yes ☐ No

   If yes, please indicate how often 0 = not often, 10 = very often

   0 1 2 3 4 5 6 7 8 9 10

4. Have any of your fingers turned white on cold exposure?

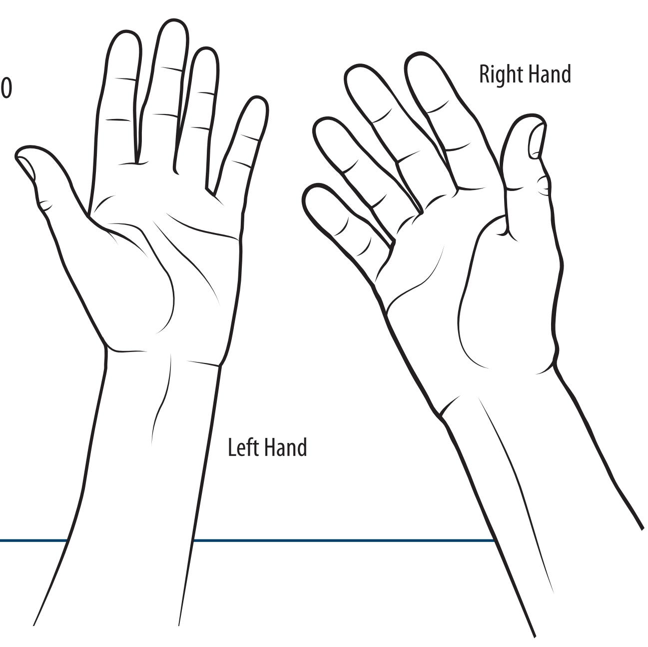
   ☐ Yes ☐ No

   If yes, please indicate how often 0 = not often, 10 = very often

   0 1 2 3 4 5 6 7 8 9 10

5. Which fingers are affected?
   (shade all parts that have ever turned white)

   Witnessed ☐ Not witnessed ☐ by person completing screening



APPENDIX B

Hand-Arm Vibration Code of Practice

Company: ____

Address: ____

1. Administering the program

Program administrator: ____

Phone: ____ Cellphone: ___________________________________

The employer authorizes the program administrator to manage the hand-arm vibration program and ensure that employees are trained and follow the program.

Employees are encouraged to bring all hand-arm vibration issues to their supervisor and then, if necessary, to the program administrator. All employees should co-operate with the program administrator in the performance of the administrator's duties.

2. Identifying the person(s) at risk from hazardous task/jobs/situations:

Employee	Hazards/Task	Equipment	Comments

3. Identifying the hazards/selecting equipment:

Power hand tools	Make/model description	No. units	Frequency (Hz)	Vibration (m/s^2)	How often the worker is exposed	Duration of operation	No. exposed workers
Brush cutters							
Chainsaws							
Chipping hammers							
Chisels							
Cleaning saws							
Compactors							
Cultivators/tillers							
Demolition hammers							
Die grinders							
Grinders							
Hammer drills							
Hedge trimmers							
Impact drills							
Impact wrenches							
Lawn mowers							
Needle scalers							
Pedestal grinders							
Powered mowers							
Rammers							
Riveters							
Road breakers							
Rock drills							
Sanders							
Saws							
Snow blowers							
Vibratory rammers							
Others							

4. Limiting daily exposure time:

Estimated finger-on-trigger time	Exposure limit	Allowable work period	Allowable rest period

Comments:____

5. Identifying risk controls:

Use a minimum strength hand grip that still allows safe operation of the tool or process.

☐ Yes ☐ No

Wear adequate clothing, including gloves, to keep warm and dry.

☐ Yes ☐ No

Maintain tools properly. Tools that are worn, blunt or out of alignment will vibrate more.

☐ Yes ☐ No

Do not use faulty tools. Inspect tools before use.

☐ Yes ☐ No

Allow job rotation that does not require the use of power tools.

☐ Yes ☐ No

Avoid continuous exposure by taking regular breaks from work involving vibrations and encourage employees to exercise fingers .

☐ Yes ☐ No

Comments:____

____

____

____

____

6. Using the equipment:

Employees have read or are familiar with the manufacturer’s operating instructions.

☐ Yes ☐ No

7. Evaluating the program

- Has someone from the workplace been assigned to maintain the program in the workplace? (This person should be competent and have the authority to stop work)
- Are all employees and supervisors receiving training on the risks from exposure to hand-arm vibration?
- Has training been given to supervisors and employees on best practices and how to use the equipment as per the manufacturer?
- Are limited exposure times being monitored and respected?
- Is there a program in place on who, when and how often tools are inspected for defects?
- Are supervisors ensuring safe work practices are being followed by employees?
- Are training records kept for all employees?
- Has a hazard assessment been done for the task; is there documentation identifying the hazards to employees?
- Have employees been consulted for their views on the effectiveness of the code of practice for any problems experienced? (numbness and tingling in the fingers, reduced sense of touch and temperature, difficulty to feeland to work small objects, whiteness in the finger tips due to lack of blood circulation)

8. Discomfort Survey

See **Appendix A – Body Discomfort Survey**

9. Record keeping

Code of practice has been reviewed by employees

☐ Yes ☐ No

Documentation of training

☐ Yes ☐ No

Health assessment/discomfort surveys conducted

☐ Yes ☐ No

APPENDIX C

Procedure for testing

Background

The goal of this document is to help you acquire consistent hand-arm vibration data under typical workplace conditions. As per WorkSafeNB's *Guide for Developing a Code of Practice for Hand-Arm Vibration in New Brunswick*, the specific goal is to determine the vibration magnitude in metres/second square (m/s2) for a tool using a vibration meter.

Exposure to vibration while operating equipment can cause health problems, discomfort, and affect work efficiency. This test standard is focused on measuring hand-arm vibration when operating hand-held equipment.

Two methods can be used to establish allowable exposure times ("finger-on-trigger" times):

1. Determining the vibration value of the dominant axis of vibration by measuring the frequency-weighted, rms (root mean square) component acceleration for all three axes of vibration. The value of the axis with the highest rms acceleration will be compared to the exposure limits in section 33.2 of NB *General Regulation 91-191*.
2. Determining the 'vibration total value', which is the root sum of squares of the frequency weighted rms values of all three axes. Allowable exposure times can be calculated using the advice and equation contained in the ACGIH publication entitled *2016 Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices*.

When determining daily allowable exposure times, all potentially vibrating hand-held tools must be included. For a worker operating two or more different vibrating tools, the cumulative vibration exposure must be considered.

Measurement method specified (per ISO 5349) considers factors known to be significant for measurements of hand-arm vibration when operating hand-held equipment:

- frequencies present (in the vibration spectrum)
- magnitude (amplitude) of vibration
- duration of exposure during a workday
- cumulative exposure

Other factors do exist, but ISO does not have standardized methods for reporting these.

This guide is divided into four sections:

1. Test preparation
2. Setup and testing
3. Post-analysis
4. Reporting

This document **focuses on testing only and does not address safety or other concerns which may exist in the test scenario**.

1. Test preparation

Equipment to be used - Instruments and sensor selection (outlined in ISO 8041)

Ensure the selected system meets relevant ISO standards (including those listed, at the time of drafting this guideline). Provide the supplier with the approximate anticipated vibration amplitudes (if known) for additional guidance in selecting an appropriate system. Rental companies provide complete systems which include sensor, adapters, and instruments to acquire, store and display data.

System selected should include these components:

- transducer (accelerometer, piezoelectric most often chosen)
- mounting system (to place on vibrating surface)
- connection cable (for electrical input)
- data acquisition unit (for signal conditioning)

The minimum requirements for human-vibration measurements (including HVM, human vibration meter) are outlined in the relevant ISO standards. These standards also outline numerous physical characteristics and tests to ensure test instruments and transducers are suitable. The following outlines some of the areas covered. Ensure the system meets the criteria either by verifying with an ISO-accredited supplier or following the requirements outlined in the standards.

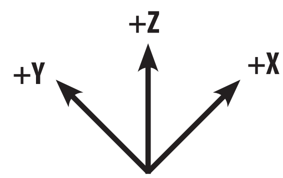
ISO 5349-2 contains further guidance for selecting transducers. A vibration transducer may be a general-purpose accelerometer (suggested for non-percussive tools) or a specifically designed sensor for large peak accelerations (suggested for percussive tools). A triaxial sensor is typically preferred although single-axis sensors may also be used.

2. Setup and testing

Setup – before testing, consider sensor placement and configuration, and the instrument's measurement parameter settings.

Place the sensor(s) so vibration in the three directions of the orthogonal coordinate system can be recorded (typically referred to as X, Y and Z). Use the 'right hand rule' as shown in the below figure (for reference the index finger points in the X, thumb points vertical and indicates Z and the second finger points in the Y direction, all 90 degrees apart).

Figure C1 – orthogonal coordinate system example



If possible, place the sensor so the coordinate axis of at least one direction is in line with the bones in the hand. In the below figure, X is in line with the hand bones, Y is perpendicular to X and Z. is 90 degrees to X and Y, coming out of the page.

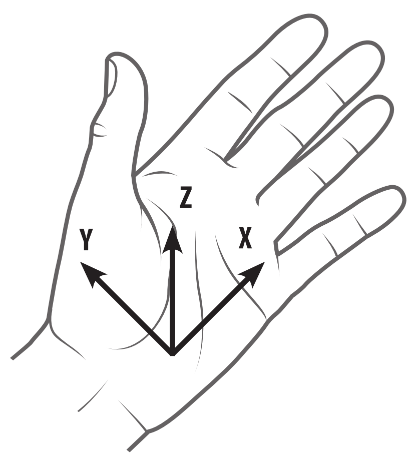


Figure C2 – Human hand image with coordinate axes

The orientation of the coordinate system may be defined with reference to another coordinate system (see ISO 8727 for further information).

Generally, sensor(s) should be placed as close to the centre line of the machine as possible. The figure below contains an example of a coordinate system that may be used. Depending on the accelerometer, the X, Y, and Z directions may vary. One triaxial sensor would be able to acquire data in all three directions simultaneously with a multi-channel instrument. Single-axis sensors would likely require one measurement at a time as it would be difficult to mount three sensors on this handle simultaneously, without interfering with operation. Note that single-axis measurements are acceptable provided test conditions are similar for each measurement. The sensors(s) should be mounted rigidly. Note that hand-held adapters may also be used.

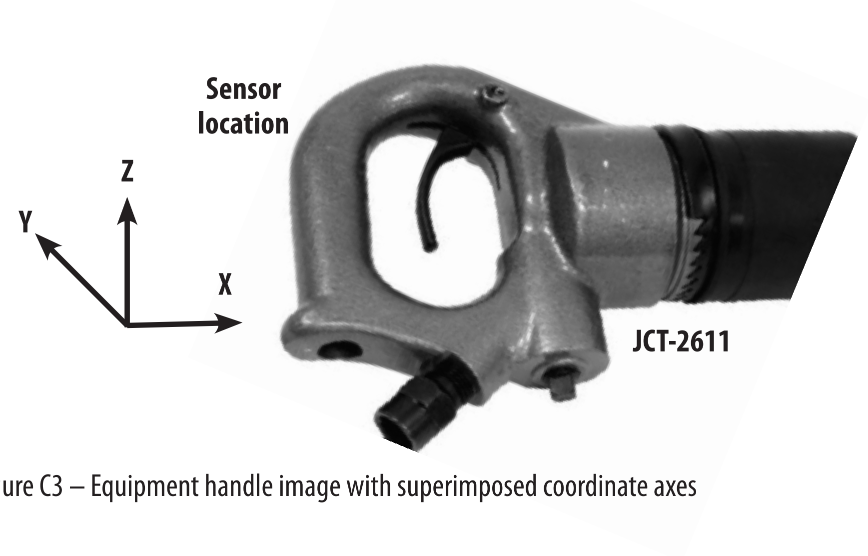


Figure C3 – Equipment handle image with superimposed coordinate axes

Further guidance including images of possible sensor placement is provided in ISO 5348 and ISO 5349-2 for various equipment types with coordinate axes examples.

The following information should be reported (per ISO 5349), so record the following data for each test.

- Equipment operator (person experiencing vibration exposure for the evaluation)
- Operator's posture during operation
- activity being performed and conditions (the operation causing the vibration exposure)
- tools involved and particulars (configuration, attachment, settings or other variables, age, or number of hours)
- material involved
- location and orientation of the transducers
- details for the transducer (specifications such as mass, orientation)
- date and time of each measurement
- the single-axis individual root-mean-square, frequency-weighted acceleration data measured (for each of three directions if possible)
- the vibration total value for each operation.

Confirm instrument time setting matches local time and adjust as required if possible.

Different frequencies are believed to produce vibration-related health effects in the hand and arm, although the frequency weighting used for severity ratings is defined only within a specified frequency range. Therefore, the measurement frequency range should be as broad as practical. Note the sensor natural frequency (typically higher than 5 kHz) must be considered for 'good' data to be acquired (maximum frequency recorded typically 1,250 Hz).

It is recommended to also record frequency spectra (see instrument documentation for more information).

Perform the testing

Ensure the appropriate information is noted (see reporting guidelines section at the end of this document). Ensure the equipment and material used, activity performed, and conditions observed during testing represent normal work operations and conditions.

Ensure equipment is operating correctly before and after testing (both the device producing the vibration to be measured, and the data acquisition system being used to record the vibration).

If the tool can be operated with either hand, acquire data using both hands if possible.

Duration of measurements – ensure appropriate amount of time for the evaluation.

- Typical to record samples of vibration (depending on the signal, instrumentation, and equipment operation).
- Long- or short-term measurements may be required. Some tools are operated for short periods of time throughout the day, some are operated continuously for the full day (not required to measure vibration for the full day).
- The time for a machine to get to normal operating speed/ load may be excluded from the sample.
- Shorter duration samples are preferred to a single long duration measurement (at least three if possible).
- Minimum time sample – at least one minute is recommended (may be the number of samples multiplied by the duration per measurement if operating time is less than one minute) .
- Measurements less than eight seconds should be avoided due to difficulty getting reliable low-frequency data in this short timespan. If unavoidable, collect more than three samples with a total time of more than one minute if possible.
- Averaging - measurements can be averaged over cycles of operation, usually only when the hand is in contact with the source (vibrating surface).

Monitor the vibration testing for errors/anomalies (including overload) if possible and review the data before concluding if the test was successful. If the instrument indicates overload, the measurement should be discarded, and the data acquisition reset.

It is recommended to review the post-analysis section (3) before testing to ensure the test is set up to capture all appropriate data.

Note that exposure to large accelerations of very short durations, which may be associated with other injuries to the hand-arm system, is not covered in this document or the referenced standards.

3. Post-analysis

To determine the in-use vibration magnitude as recommended in WorkSafeNB's *Guide for Developing a Code of Practice for Hand-Arm Vibration in New Brunswick*, calculate the ISO quantity vibration total value a_{hv}, in m/s^2. Calculate this value using the root-sum-of-squares of the three frequency-weighted root-mean-square values (one for each of the three directions measured), shown in the below equation.

$$a_{hv} = (a^2_{hwx} + a^2_{hwy} + a^2_{hwz})^{1/2}$$

where: a_{hv} = vibration total value, m/s^2

a^2_{hw} = frequency-weighted r.m.s. acceleration for each axis (X, Y and Z), m/s^2

Equation C1 – vibration total value, m/s^2

For most vibrating power tools, the vibration entering the hand contains energy from three measurement directions. ISO standards assumes vibration in each of the three directions may be harmful, so measurements in all three directions should be reported.

The frequency-weighted root-mean-square values may be calculated from raw data exported into a spreadsheet or similar program.

Vibration exposure depends on the magnitude of the vibration and on the duration of exposure. Refer to WorkSafeNB's *Guide for Developing a Code of Practice for Hand-Arm Vibration in New Brunswick*.

The average vibration values or other values may also be noted or analyzed as appropriate or required.

4. Reporting

The following information should be reported (per ISO 5349):

- Equipment operator (person experiencing vibration exposure for the evaluation), activity being performed and conditions (the operation causing the vibration exposure)
- Tools involved and particulars (configuration, attachment, settings, or other variables)
- Materials
- Location/orientation of the transducers
- The single-axis individual root-mean-square, frequency-weighted acceleration data measured
- The vibration total value for each test
- The total duration for each test
- The daily vibration exposure

Depending on the situation additional information is suggested, including:

- Company or customer
- Purpose of the testing
- Test dates
- Who performed the test measurements and evaluation (if different)
- Conditions at test site/workplace
- Details around test location
- Environmental factors – temperature, humidity, etc.
- Description test, machines, and tool details
- Materials or workpieces used
- Instrumentation detail including calibration, verification tests/ functionality checks
- Acceleration measurement –locations and orientations (suggest sketch with dimensions)
- Attachment details, any other information
- Test results (each frequency-weighted vibration value, ah, for each test)
- Test duration
- Unweighted frequency spectra if possible
- Multiplying factor (if used)