2. Equipment specification

1) Pick up for vibration detection(3 axis acceleration sensor)

The price of the marketed vibration pick-up is about 100,000～300,000 yen now. In the demanded measurement device, the thing that the worker daily uses is a precondition. Picking up has the necessity of the product that can be supplied as parts of the articles of consumption from the use. The acceleration sensor that is generally called MEMS as picking up is advanced as an examination.

① About MEMS

The one that mechanical parts and CMOSIC made by the micro machining technology were accumulated in one semiconductor chip is MEMS. [1]

(Principal use)

- Game machine
- Cellular phone

  Gravitational acceleration is measured, and the direction of the screen is corrected. [2]
- Life-saving automotive air bags
- Robot control and arm
- Machine tool

There are four kinds of the following by the difference of an internal structure.

① Electrostatic capacity type

② Piezo resistance type

③ Piezo-electric ceramic type

④ Analysis of temperature of gas type

(Feature)

- Productivity is good, and the adjustment is unnecessary.
- The miniaturization and making to intelligence were achieved. [1]

The sensor of the acceleration of the semiconductor is widespread from two points of the above-mentioned.

② **Current state of pick up (MEMS acceleration sensor)**

What suits the specification and the purpose is checked from the investigation of three axis (X,Y,Z) MEMS of the sold each manufacturer now.

Manufacturer for investigation　14 companies

Number of investigation target products　About 100 kinds

Category for investigation　Three axis detection simultaneously and analog output

(Selection condition)

- Acceleration input range ±10g or more　(three axis commonness)
- Range of frequency input　5Hz or less or ～ 1200Hz or more (three axis commonness
- Impact 5000g or more

Table 1　Comparison table of MEMS acceleration sensor

	Part Number	# of Axes	Output Type	Range	Sensitivity (mV/g)	Sensitivity Accuracy (%)	Typical Bandwidth (Hz)	Voltage Supply (V)	Current Supply (mA)	Temp Range (℃)	Package (mm)
A社	H34C	3	Analog	±3g	333	±10	100	2.2to3.6	0.36	-25to75	3.4x3.7x0.92
B社	LIS344ALH	3	Analog	±6g	333	±10	1800	2.4to3.6	0.68	-40to85	4.8x4.8x1.5
C社	HAAM-346A	3	Analog	±3g	333	±10	500	2.2to3.6	0.70	-25to75	3.0x3.0x1.0
D社	ADXL326	3	Analog	±16g	57	±10	1600	1.8to3.6	0.35	-40to85	4.0x4.0x1.45
E社	XC3334	3	Analog	±3g	333	±10	100	2.2to3.6	0.36	-25to75	3.4x3.7x0.92
F社	BMA140	3	Analog	±4g	300	±32	1500	1.8to3.5	0.20	-40to85	3.0x3.0x0.9
G社	KXD94-2802	3	Analog	±10g	200	±2.5	800	2.5to5.25	1.2	-40to85	5.0x5.0x1.2
H社		1or2	Analog	—	—	—	—	—	—	—	—
I社		1or2	Analog	—	—	—	—	—	—	—	—
J社		1or2	Analog	—	—	—	—	—	—	—	—
K社		—	—	—	—	—	—	—	—	—	—
L社		3	Digital	—	—	—	—	—	—	—	—
M社		—	—	—	—	—	—	—	—	—	—
N社		3	Digital	—	—	—	—	—	—	—	—

表1．ピックアップ(加速度センサ)の現状

About the manufacturer that manufactures the sensor of the analog output.

Data is not filled in of the manufacturer where the product of three axes doesn't exist and the manufacturer of the digital output type that turns into the feature.

Two module manufacturer companies were assumed to be similar.

Features in the investigation are the following two points.

1. The product with low value of sensitivity is a main current.

The product of lower sensitivity (10g or less) is from an investigation to the majority. In the reason, at first, the one that corresponded to higher acceleration detection was a main current where the MEMS acceleration sensor had been developed. However, it is a result of the summary in the specification that each company considered generality because of market trends few.

2.There are a lot of products of the digital output.

With the serial communications interface, the analog amplification circuit and the noise measures, etc. can easily unnecessarily use every acceleration sensor for the digital output product. In the manufacturer (Table 1) that specializes in digital goods, they are only two companies. In the manufacturer that manufactures analog goods, 80% commercializes digital goods.

It is thought that the current state cannot be used in the point that a digital sensor can be used to measure the hand arm vibration this time by occasion of the following.

- The data processing speed is slow.
- The data accuracy is low. (relation of resolution)

However, we want to advance the evaluation of the sample goods continuously.

③ Problem of pick up (MEMS acceleration sensor)

In the MEMS chip, there are one point problem by constructional. Each product is 10mm or less. the size of the package. It is a point that a mechanical part and CMOSIC have been cumulated in this. A movable range is necessary for the mechanical part. When it is Z axis, a movable range is about 1/3 in the mechanical part compared with the length of the X・Y axis as for the direction of thickness of the chip. Because the frequency band region that can correspond is decided depending on length within this movable range, z axis becomes it up to 550Hz though the x・y axis can correspond up to 1500Hz for instance in the product of D company.
The current state is thought the influence of the point of not marketable as for these. The MEMS chip can be evaluated as a product that suits very small, this theme as an acceleration sensor. It is thought that the investigation of the module goods is necessary again whether to modulate or to use the modulated product.

2) Achievement of miniaturization and price cutting of main body of measurement device

It aims at the miniaturization and the price cutting according to the following composition.

- The latest processor (CPU・DSP)
- Analog to digital conversion machine (Type ΔΣ)
- USB communication interface

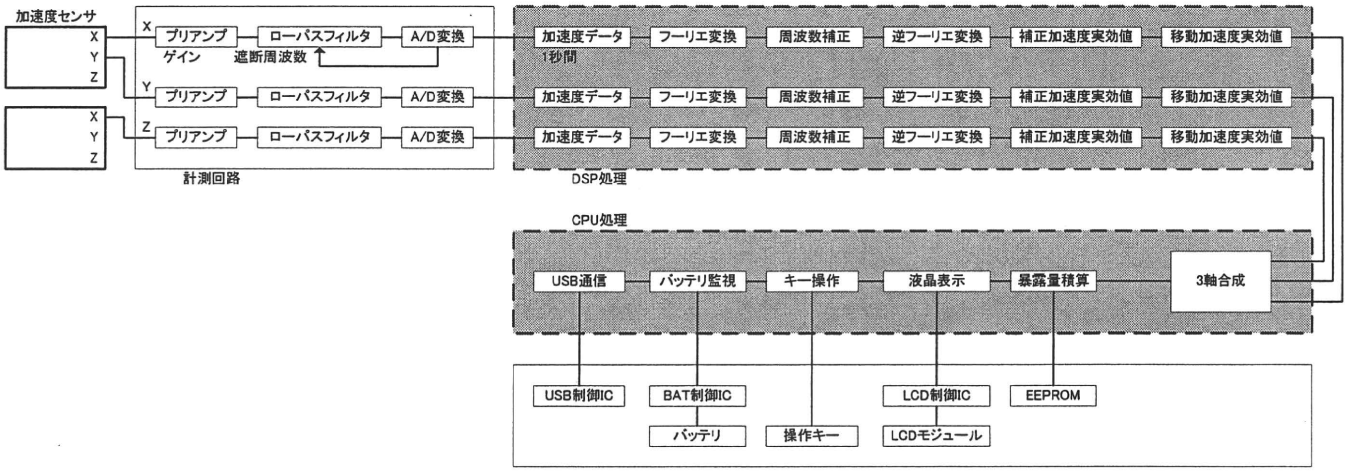


Fig.1 Block chart where MEMS was used

3. Results and Agenda

The following evaluation problem in the future is executed in advancing development, and the stabilization of a further product is evaluated now.

- Vibration pick up

  Evaluation test and durability test on each manufacturer sample.

- Environmental performance examination as measurement device

  It evaluates it from the regular vibration examination and the field test in a site in making of the device a system requirements.

- Data management after measurement is processed

  The tool that makes information management easy is made for the tool manager. To be easily treatable of making to the data link data base, the interface is constructed.

4. References

[1] Chapter of Nishihara accountant (March 20, 2007) 「Introduction to Sen Synge」 (ohm company)

[2] Written by Masanori Kikuchi (December 20, 2005) 「Electronic device」 (Japanese business publisher)

The 18th Japan Conference on Human Response to Vibration (JCHRV2010)

TEAC CORPORATION, Tokyo, Japan

August 4 - 6, 2010

New Japanese Guidelines for Preventing Hand-Arm Vibration Syndrome

Setsuo Maeda*
Department of Applied Sociology
Kinki University
3-4-1 Kowakae,
Higashiosaka 577-8502, Japan
maeda@socio.kindai.ac.jp

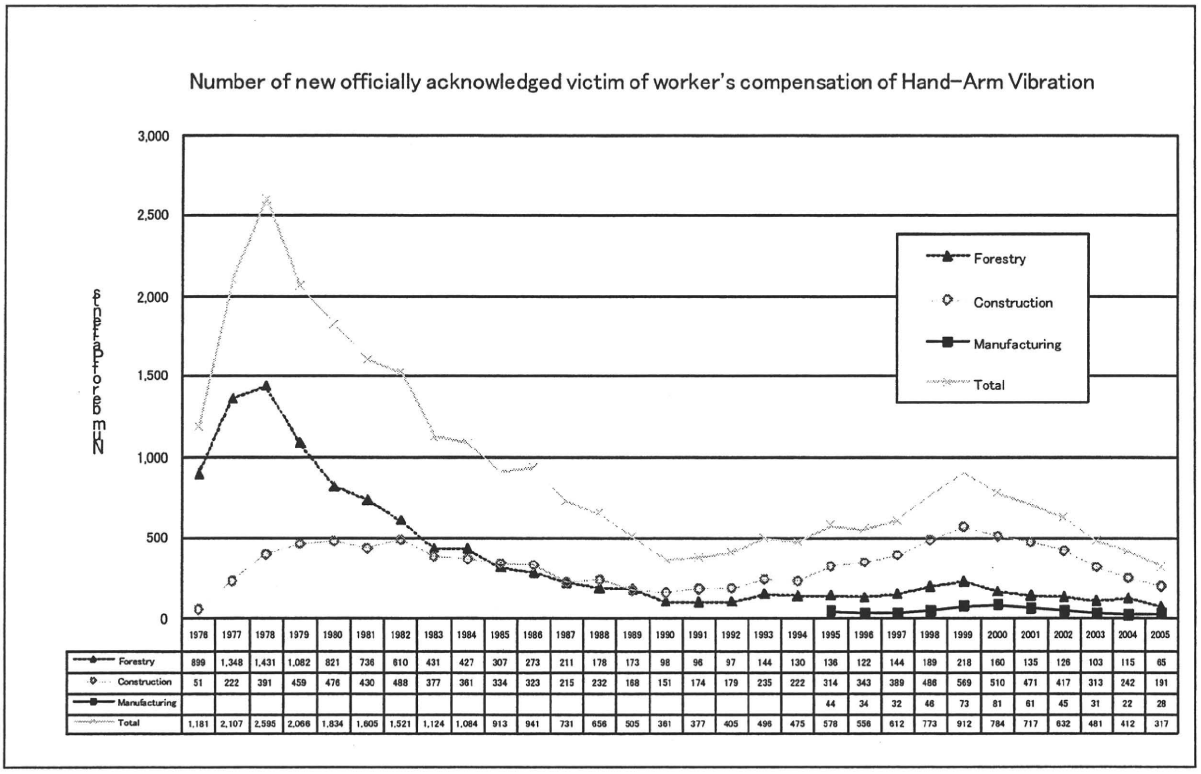
Thomas Koch
Department of Agriculture
Kinki University
3327–204 Naka-machi,
Nara 631-8505,
Japan

Abstract

The purpose of this paper is to describe the implementation of the new Japanese Guidelines for preventing Hand-Arm Vibration Syndrome. It was published on 10th July 2009 by the Ministry of Health, Labour and Welfare.

1. Introduction

Figure 1 shows the number of new officially acknowledged victims of Hand-Arm Vibration Syndrome who qualify for worker's compensation. In order to reduce the number of injured workers and the number of workers needing compensation, the Ministry of Health, Labour and Welfare launched the 10th Industrial Accident Prevention Plan from 2003 to 2007. In addition, special consideration was given to the current high incidences of vibration-related disorders caused by construction equipment, such as jackhammers and pick hammers as shown in Table 1.



	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Forestry	899	1,348	1,431	1,082	821	736	610	431	427	307	273	211	178	173	98	96	97	144	130	136	122	144	189	218	160	135	126	103	115	65
Construction	51	222	391	459	476	430	488	377	361	334	323	215	232	168	151	174	179	235	222	314	343	389	486	569	510	471	417	313	242	191
Manufacturing																				44	34	32	46	73	81	61	45	31	22	28
Total	1,181	2,107	2,595	2,066	1,834	1,605	1,521	1,124	1,084	913	941	731	656	505	361	377	405	496	475	578	556	612	773	912	784	717	632	481	412	317

Figure 1 - Number of new officially acknowledged victims of Hand-Arm Vibration Syndrome receiving worker's compensation

Table 1 - Number of cases by tools in 1999 (The longest usage tools)

1)Rockdrill 229	10)Impact wrench 11
2)Chainsaw 229	11)Chippinghammer 8
3)Pick hammer 143	12)Electric hammer 7
4)Concrete vibrator 127	13)Sand rammer 6
5)Bush cutter 34	14)Engine cutter 3
6)Sander 34	15)Portable tight tamper 2
7)Concrete breaker 27	16)Baby hammer 1
8)Portable grinder 26	17)Others 12
9)Vibration drill 13	Total 912

The number of recognized cases of vibration-related disorders is over 700 a year and primarily occurs in the construction industry. In order to reduce vibration-related disorders, the Ministry program will review the effectiveness of safety measures to prevent vibration-related disorders, and it will devise necessary measures to minimize such injuries.

In 1947, hand-arm vibration disease was described in the Enforcement Regulation of New Labour Standards Law. The Ministry of Labour issued a number of National Labour Standards Bureau Notification notices to private industries from 1970 to 1992 as part of the comprehensive health, safety and injury prevention system to promote the improvement of worker's health and safety in the workplace. It provides for a general framework that incorporates European principles while at the same time honoring common international principles. The list of Notifications is shown in Table 2.

Table 2 - Labour Standards Bureau Notifications

Year	Industrial Health-Related Laws, Regulations, Ordinances and Other Notifications in Japan
1947	The Labour Standards Law
1953	Examination of the evaluation index of the vibration syndrome
1970	Labour Standards Bureau Notification No. 134
	Guidelines for the Prevention of Vibration-induced Disorders
	Guidelines for the Prevention of Vibration-induced Disorders in Chainsaw Handling Work
1973	Labour Standards Bureau Notification No. 597
	Guidelines for the Medical Examinations of Vibration-induced Disorders in Chainsaw Handling Work
1975	Labour Standards Bureau Notification No. 610
	Guidelines for the Medical Examinations of Vibration-induced Disorders in Chainsaw Handling Work
	Labour Standards Bureau Notification No. 608
	Guidelines for the Prevention of Vibration-induced Disorders in Handling Tools Other Than Cainsaws
1976	Labour Standards Bureau Notification No. 494
	Guidelines for the Medical Treatment of Vibration-induced Disorders
1978	The Labour Standards Law No. 35
	Start of Compensation
1983	Labour Standards Bureau Notification No. 258
	Promotion of Safety and Health Education to Workers in Handling Tools Other Than Cainsaws
1988	Labour Standards Bureau Notification No. 11
	Measurement method of tool vibration level in Hand-held Power Tools (Except Chaisaw)
1993	Labour Standards Bureau Notification No. 203
	Promotion of Comprehensive Measures against Vibration Disorders

Moreover, as part of the measures based on the comprehensive safety standards of machinery, the plan will encourage manufacturers of vibrating equipment to implement risk reduction measures, and to provide information on the hazard of vibration to employees.

Figure 2 shows the relationship among Machinery Directives, the EU directive, International Standards and National Standards. This directive aims to introduce measures that promote

the improvement of worker's health and safety in the workplace. It provides for a general framework that executes European principles while at the same time honoring common international principles.

The guiding principles of the content are as follows.

1) This directive is applied to the activities of all public and private sections.
2) The employer's responsibilities
3) Responsibilities of workers and workers rights

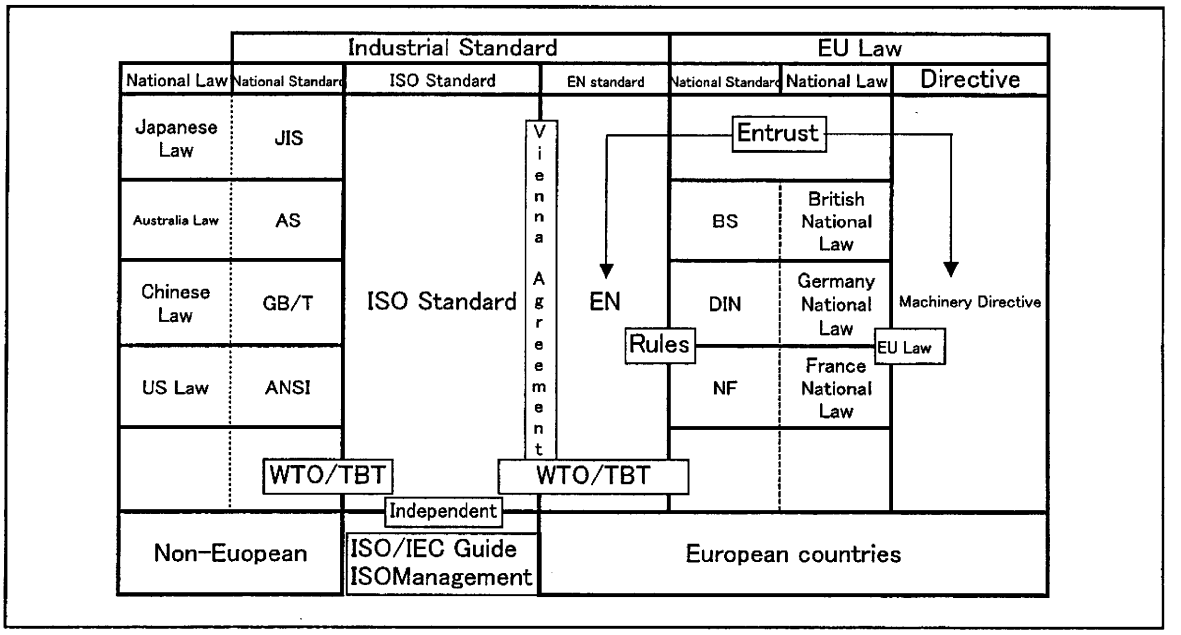


Figure 2. The relationships among Machinery Directives, EU Directives, International Standards and National Standards

In achieving the market integration of Europe, it seems that it is an indicator that the "Framework instructions" concerning this Machinery Directive and labor safety hygiene (board of directors instruction 89/391/EEC, which introduces measures to promote the improvement of labor safety hygiene and the following 98/37/EC: (1998) are the safety hygiene policy. In the design and the production of machines, it is mandated that both limiting the dangers associated with vibration in the vibratory source and improved methods in which the machine is used that minimize injury should be considered. The vibration in the tool or equipment should be suppressed to the lowest level consistent with the development of vibration decreasing technology. The following daily exposure limit value and daily exposure action value are

provided for hand-transmitted vibration.

1. In the case of hand-transmitted vibration

(a) The daily exposure limit value standardized to an eight-hour reference period shall be $5m/s^2$.

(b) The daily exposure action value standardized to an eight-hour reference period shall be $2.5m/s^2$.

The assessment is based on the calculation of the daily exposure value normalized to an eight-hour reference period as defined in ISO 5349-1 standard. The minimum condition is to protect the worker from danger and ensure safety and health when being exposed to mechanical vibration exposure in the workplace.

Directive 98/37/EC (Machinery Safety Directive) and Directive 2002/44/EC(Physical Agent Directive-Vibration) have been in force since July, 2005, and thus, the effort target value of the vibration reduction are well established and have been incorporated by the hand-transmitted vibration tool manufacturers. The manufacturers use international standards and make international adjustments to test and classify the hand-transmitted vibration value tool. Moreover, the company has the additional obligation to protect the worker from the possible danger to ensure safety and health while exposed to mechanical vibration caused by the equipment or situation. Therefore, the hand-held power tool manufacturer should measure the tool vibration value based on international test standards before the tool can be made available to consumers, and declare the vibration value so that the user may perform a risk assessment of the tool. Moreover, the tool manufacturer is required to evaluate the safety of each tool, and to meet the machine instruction standards.

The EU Commission is expected to make the guidelines provided in the Machinery Directive legally mandatory within three years after publishing the instructions as a legal notice in the official gazette as stipulated by EU law. These Machinery Directives are mandating the necessary standards that machine-made goods etc. must achieve without specifying the technology companies may utilize. The result is that the EU and EFTA (European Free Trade Association) will conform to an EN standard assuming that necessary the regulations are implemented, supplemented and supported by CEN (European Committee for Standardization) and CENELEC (European Electric Standardization Committee). The EN standard then is adopted by each EU country as a national standard under the bylaws of CEN and CENELEC. Moreover, this EN standard is offered as a proposed agreement in Vienna as

an ISO standard, and the ISO standard becomes a national standard in countries that are members of the WTO when an agreement is reached through the WTO/TBT (World Trade Organization)/TBT(Technical Barriers to Trade) (Agreement concerning technical barriers to trade).

For preventing HAVS, the A (8) introduces risk assessment. The A (8) consists of the vibration total value of frequency-weighted r.m.s. acceleration and the daily exposure times. In the work place, managers of vibration tool users must consider the risk to employees of using the 'tool work tasks' before considering 'real work tasks' according to A (8). For this reason, managers need the vibration total value of frequency-weighted r.m.s. acceleration of the individual tool. According to the EU Directive, the manufacturers have to declare the magnitude of the individual tool according to test protocols or to field measurements for preventing the HAVS in the workplace.

In March of 2006, the Ministry of Health, Labour and Welfare appointed a special committee to examine work management for the prevention of hand-arm vibration syndrome. This committee recommended adopting the EU Directive of MSD and PAD (Vibration) principles in the committee's final report in 2007.

On 10th of July 2009, the Ministry of Health, Labour and Welfare published the following 4 guidelines [1]-[4]:.

1: LSB (Labour Standards Bureau) Issue No.0710-1
Guidelines for Handling Chain Saws

2: LSB (Labour Standards Bureau) Issue No.0710-2
Guidelines for Preventive Measures against Vibration Hazards in Work with Vibratory Tools other than Chain Saws

3: LSB (Labour Standards Bureau) Issue No.0710-3
Management and Indication of Vibration Total Value of Frequency-Weighted r.m.s. Acceleration" of the individual tools

4: LSB (Labour Standards Bureau) Issue No.0710-5
Promotion of Comprehensive Measures against Vibration Hazards

The purpose of this section of the paper is to describe the implementation of the new Japanese Guidelines for preventing Hand-Arm Vibration Syndrome that was published on 10th July 2009 from the Ministry of Health Labour and Welfare.

2. Work Management for Preventing HAVS (Hand-Arm Vibration Syndrome) to Workers in Japan

In July 2002, the European Union published the Directive 2002/44/EC the Physical Agents (Vibration) Directive (PA(V)D). It outlines new guidelines for exposure to vibration in the workplace. It sets action and limit values for vibration exposure, and it describes the employer's obligations to manage the risks from exposure to vibration. This chapter is intended as a guide for the employer who has employees using vibrating hand-held power tools. We also give practical tips regarding what can be done to reduce vibration exposure from hand-held power tools. The Physical Agents (Vibration) Directive was developed from an original proposal made by the European Commission in 1993. This proposal was revised, amended and eventually agreed to by Member States and the European Parliament and came into force on 6 July 2002. The Directive lays down the minimum standards for the health and safety of workers exposed to hand-arm vibration and supports the general requirements for improving health and safety that are outlined in the Framework Directive (89/391 /EEC).

For preventing HAVS, the A (8) is introducing risk assessment. The A (8) consists of the vibration total value of frequency-weighted r.m.s. acceleration and the daily exposure times. In the work place, managers of the vibration tool users must consider the risk to employees of using of 'tool work tasks' before considering 'real work tasks' according to A(8).

For this reason, managers need the vibration total value of frequency-weighted r.m.s. acceleration of the individual tool. According to the EU Directive, the manufacturers have to declare the magnitude of the individual tool according to test protocols or to the field measurements for preventing the HAVS in the workplace.

2.1 Vibration Magnitude of Tools (The responsibility of the manufacturers)

The responsibility of the manufacturers is regulated according to Machinery Directive (98/37/EC) which was later reissued as (2006/42/EC) in December 2009. All manufacturers have to declare the vibration total value of frequency-weighted r.m.s. acceleration of the individual tool. The manufacturers also have to follow two methods of deriving the vibration total value of frequency-weighted r.m.s. acceleration of the individual tool:

(1) The vibration total value of frequency-weighted r.m.s. acceleration by test protocol;

This test protocol is used by vibration tool manufacturers. The measurement of the tool vibration value based on the test protocol is performed using the International Standards as shown in Table 1, and the manufacturers must provide users with a declaration value of the

vibration value from the vibration tool before the tool can be put on the market. As for this declaration value, it is necessary to obtain a vibration value that conforms to international standards so that the testing methods and the vibration evaluations of the hand-held vibration tool are consistent regardless of the country where the tests are conducted.

(2) The vibration total value of frequency-weighted r.m.s. acceleration by measurement in the workplace;

The vibration total value of frequency-weighted r.m.s. acceleration from hand-held vibration tools cannot be specified according to the vibration value obtained by the test protocol such as the International Standards as shown Table 1. It is necessary to evaluate the physical value of the vibration tool in the workplace according to the ISO 5349-2 standard.

2.1.1 Manufacturer's declared vibration value by Test Protocol

In order for these measures to be adopted by the businesses whose workers use vibratory tools, vibratory tool manufacturers need to measure and declare the "the vibration total value of frequency-weighted r.m.s. acceleration " of such tools.

With regard to vibratory tools, the "the vibration total value of frequency-weighted r.m.s. acceleration" shall be measured and calculated as follows:

Vibration acceleration shall be measured (hereinafter referred to as "vibration measurement") and declared conforming with the following notes and applicable measuring standards from orders ISO 8662 or ISO 28927-series, ISO 22867, EN 60745, and EN 50144.

If these measuring standards are deemed inapplicable, vibration measurement shall be conducted in accordance with ISO 5349-2 as shown in Figure 3.

Considering the above, vibratory tools shall comply with the measuring standards, such as test protocols, specified in Table 3.

Table 3 Test protocols for declaring the vibration magnitude of individual tool.

	Tool				Applicable Measuring Standard	
1	Chain saws				ISO 22867:2004	EN 60745-2-13
2	Tools having a piston striking mechanism	1	Rock drill		ISO 28927-10:ISO 8662-3;JIS B7762-3:2006	EN 60745-2-6
		2	Chipping hammer		ISO 28927-10:ISO 8662-2;JIS B7762-2:2006	EN 60745-2-6
		3	Riveting hammer		ISO 28927-10:ISO 8662-2;JIS B7762-2:2006	EN 60745-2-6
		4	Caulking hammer		ISO 28927-10:ISO 8662-2;JIS B7762-2:2006	EN 60745-2-6
		5	Hand hammer		ISO 28927-10:ISO 8662-2;JIS B7762-2:2006	EN 60745-2-6
		6	Baby hammer		ISO 28927-10:ISO 8662-2;JIS B7762-2:2006	EN 60745-2-6
		7	Concrete breaker		ISO 28927-10:ISO 8662-5;JIS B7762-5:2006	EN 60745-2-6
		8	Scaling hammer		ISO 28927-10:ISO 8662-2;JIS B7762-2:2006	EN 60745-2-6
		9	Sand rammer		ISO 28927-6:ISO 8662-9;JIS B7762-9:2006	EN 60745-2-6
		10	Pick hammer		ISO 28927-10:ISO 8662-5;JIS B7762-5:2006	EN 60745-2-6
		11	Multi-needle chisel		ISO 28927-9:ISO 8662-14;JIS B7762-14:2006	EN 60745-2-6
		12	Auto scraper		ISO 28927-10:ISO 8662-2;JIS B7762 -2:2006	EN 60745-2-6
		13	Electric hammer		ISO 28927-10:ISO 8662-5;JIS B7762-5:2006	EN 60745-2-6
3	Tools having an internal combustion engine (portable)	1	Engine cutter		ISO 28927-8:ISO 8662-12;JIS B7762-12:2006	
		2	Bush cleaner		ISO 22867:2004	
4	Rotating tools	1	Portable stripper		ISO 28927-10:ISO 8662-2;JIS B7761-2:2004	
		2	Sander		ISO 28927-3:ISO 8662-8;JIS B7762-8:2006	EN 60745-2-3 EN 60745-2-4
		3	Vibration drill		ISO 28927-5:ISO 8662-6;JIS B7762-6:2006	EN 60745-2-1
5	Tools having a built-in vibrator	1	Portable tie tamper		ISO 28927-6:ISO 8662-9;JIS B7762-9:2006	
		2	Concrete vibrator		EN 60745-2-12	JIS B7761-2:2004
6	Portable grinders (with grinding stones over 150 mm in diameter)				ISO 28927-1:ISO 8662-4;JIS B7762-4:2006	EN 60745-2-3
	Swing grinders (with grinding stones over 150 mm in diameter)				ISO 28927-10:ISO 8662-2;JIS B7761-2:2004	
7	Desktop or floor-type grinders (with grinding stones over 150 mm in diameter)				ISO 28927-8:ISO 8662-12;JIS B7761-2:2004	
8	Clamping tool	1	Impact wrench		ISO 28927-2:ISO 8662-7;JIS B7762-7:2006	EN 60745-2-2
9	Reciprocating tools	1	Vibration shear		ISO 28927-7:ISO 8662-10;JIS B7762-10:2006	EN 60745-2-8
		2	Jigsaw		ISO 28927-8:ISO 8662-12;JIS B7762-12:2006	EN 60745-2-11

A. Vibration measurement in accordance with ISO 8662.

Some parts of the ISO 8662 series prescribe measurement on a single axis "Z axis or priority axis (the axis of the greatest vibration value among the three orthogonal axes). The three axes shall be measured simultaneously to obtain a vibration synthetic value. If the three-axis simultaneous measurement is difficult, it shall be permissible to calculate a synthetic vibration value from the results of measuring the three axes sequentially under the same measuring conditions. If the single-axis measurement database on ISO 8662, etc. is available for a vibratory tool, it shall also be permissible to obtain the vibration total value of frequency-weighted r.m.s. acceleration by conversion where the applicable single-axis value is multiplied by 1.7. When presenting the applicable value in an instruction manual or on a website, it shall be stated clearly that the value is a product of multiplying the single-axis value

by 1.7. Refer to the following multipliers in Table 2. Multipliers are given in CEN/TR 15350:2006, "Mechanical vibration – Guideline for the assessment of exposure to hand-transmitted vibration using available information including that provided by manufacturers of machinery."

Table 2 Multipliers are given in CEN/TR 15350:2006

1 Tool type	2 Vibration test code	3 Real work task considered	4 Correction factor
Riveting hammer Chipping hammer	ISO 8662-2	Riveting, cutting	1.5
		Fettling, scaling, other applications	2
Rotary hammer Rock drill	ISO 8662-3	Hammer drilling chiselling	2
Grinder(pneumatic) Grinder(electric)	ISO 8662-4 EN 50144-2-3	Grinding, cutting Griding, cutting	1.5 1.5
		Polishing	Value in use likely to be lower
Pavement breaker Construction hammer	ISO 8662-5	Breaking concrete	2
		Breaking asphalt	1.5
Impact drill	ISO 8662-6	Impact drilling	1.5
Impact wrench Impulse tool Ratcheting screwdriver	ISO 8662-7	Tightening bolts	1.5
Polisher Rotary sander Orbital sander Random orbital sander	ISO 8662-4	Polishing Rotary sanding Orbital sanding Random orbital sanding	1.5
Rammer	ISO 8662-9	Ramming	1.5
Nibbler Shears	ISO 8662-10	Cutting sheet metal	1.5
Fastener driving tool	ISO 8662-11	Driving fasteners every 3s	1.5
Saw File	ISO 8662-12	Machining wood or steel	1.5
Straight die grinder Angle die grinder	ISO 8662-13	Using burrs or mounted points	1.5
Needle scaler Stone working tool	ISO 8662-14	Cleaning weld	2

In Japan, If the manufacture's declared values have been measured by using the JIS 7762 series: 2006 standards or the ISO 28927-series, or the EN 60745:2006 series or EN 50144 series, it will be "the vibration total value of frequency-weighted r.m.s. acceleration". Therefore, these manufacturers' do not need to apply the multipliers to the declared values to get the vibration total value of frequency-weighted r.m.s. acceleration.

B. Vibration measurement in accordance with ISO 22867

With regard to an engine-equipped chain saw or bush cleaner, vibration measurement shall be conducted in accordance with ISO22867:2004. When presenting the applicable value in an instruction manual or on a website, it shall be stated clearly that the value was converted from measurement data in accordance with the chain saw standards.

2.1.2 Field Measurements (Workplace Measurement) (Vibration measurement in accordance with ISO 5349-2)

When "the vibration total value of frequency-weighted r.m.s. acceleration" can't be measured by the test protocols, the measurement, computation of "the vibration total value of frequency-weighted r.m.s. acceleration" of the vibration tool in the actual field is necessary.

When conducting field tests, measuring methods defined in ISO 5349-2, vibration measurement shall be conducted in accordance with ISO 5349-2:2004 "Hand-transmitted Vibration - Part 2: Practical Guidance for Measurement at the Workplace". When presenting the manufacturers' declared value in an instruction manual or on a website, items specified in "9. Information to be Reported" in ISO 5349-2004 shall be stated clearly.

In field measurements, three processes should be utilized ([PLAN], [DO], [SEE]) as shown in the Figure 3.

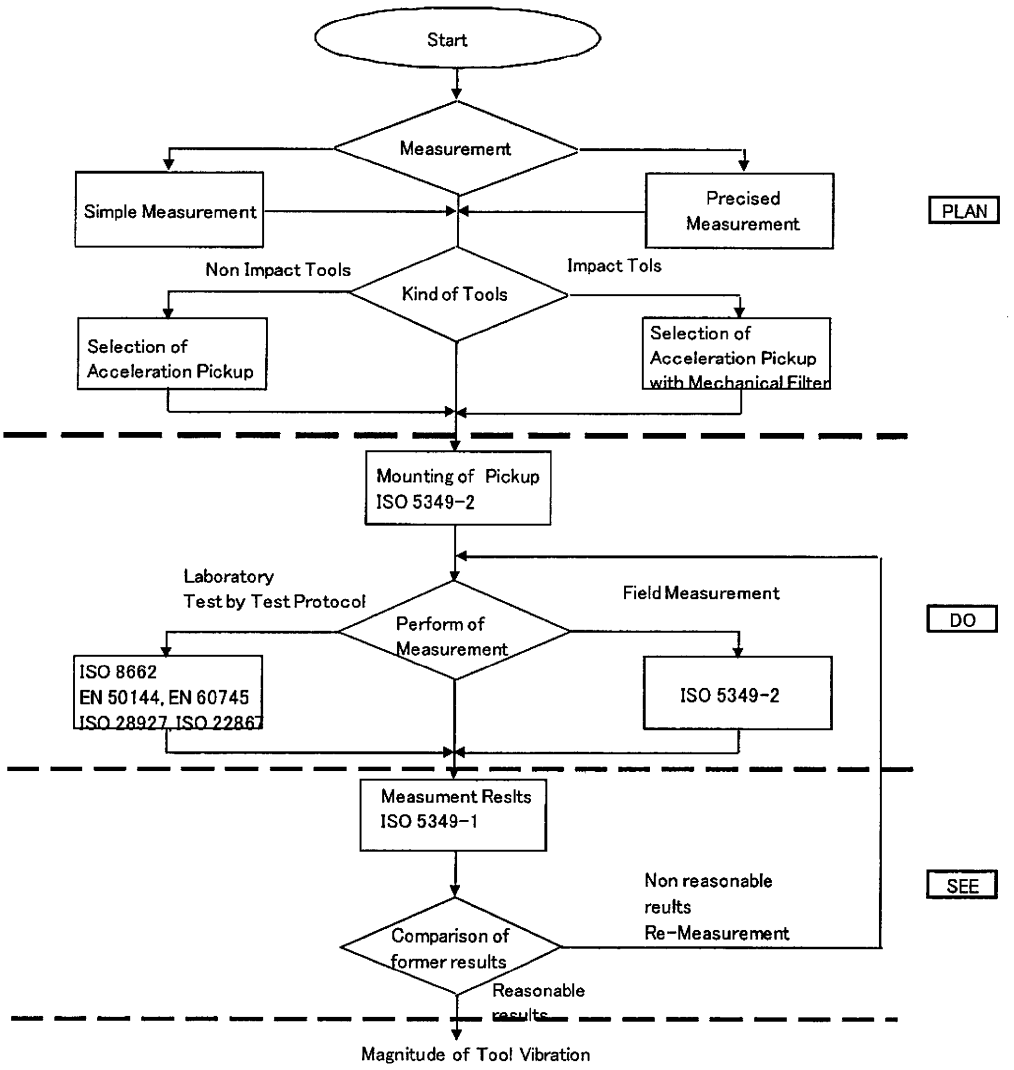


Figure 3 Measurement Procedure of Hand-Arm Vibration

When the measurement, the evaluation, and the assessment of the physical value of the hand-transmitted vibration from the hand-held vibration tool are done, the three procedures shown in Figure 3 should be utilized:

Figure 4 Vibration measurement equipment on the market.

① Measurement plan (PLAN): Selection of simple measuring instruments or general-purpose measuring instruments which can accurately register vibration acceleration as shown in Figure 4;

② Measurement (DO) of tool vibration: Selection of acceptable and reliable measurement standards;

③ Evaluation (SEE) of measurement data: Examination of the validity of the results of measurements;

When it is confirmed that the value chosen is suitable in comparison with "the vibration total value of frequency-weighted r.m.s. acceleration", by the vibration measurement in the recent testing, it is necessary to confirm that the measurements compare with the values produced with the tool "during the evaluation of the vibration level conditions of the hand-held power tool", as reported in previous testing. It is often necessary to retest the item since the testing may appear inaccurate when there is a large variation in results such as the measurement being too small or too large in comparison with the measurement values have been gotten experientially before the results of this report. The processes for obtaining the vibration total value of frequency-weighted r.m.s. acceleration are shown in the Figure 5.

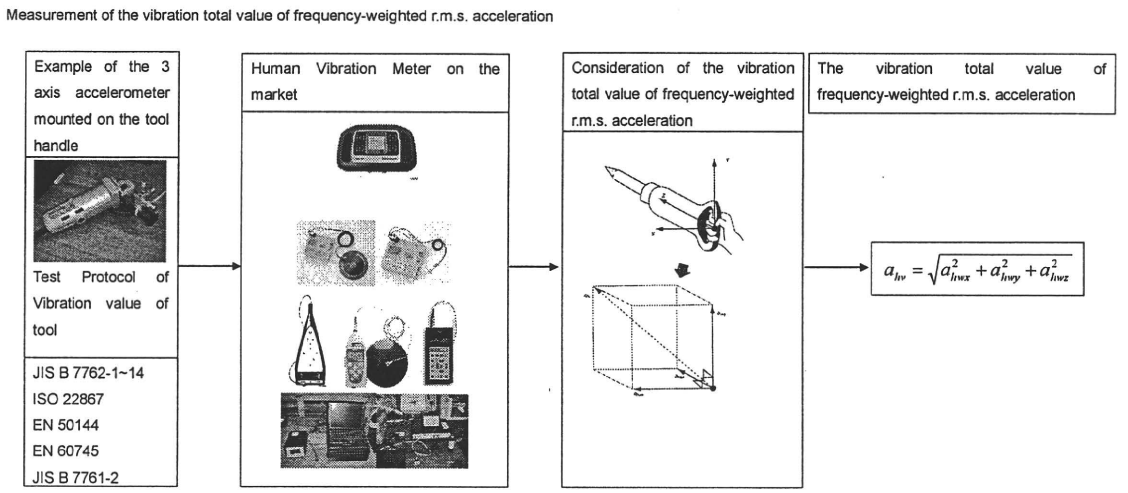


Figure 5 Measurement protocol of the vibration total value of frequency-weighted r.m.s. acceleration

The vibration value of frequency-weighted r.m.s. acceleration is defined by the following Equation (1):

$$a_{hw} = \sqrt{\frac{1}{T}\int_0^T {a_w}^2(t)dt} \quad (1)$$