ensure safety and health while exposed to mechanical vibration caused by the equipment or situation. Therefore, a 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, tool manufacturers are 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 and similar products 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) (Agreements concerning technical barriers to trade).

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 individual tools

4: LSB (Labour Standards Bureau) Issue No.0710-5

Promotion of Comprehensive Measures against Vibration Hazards

The tool manufacturers had to declare the vibration magnitude of individual tools according to the LSB (Labour Standards Bureau) Issue No.0710-3.

4. Difference between 98/37/EC and 2006/42/EC

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:

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.

Considering the above, vibratory tools shall comply with the measuring standards, such as test protocols, specified in Table 1.

Table 1 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

(1) The vibration total value of frequency-weighted r.m.s. acceleration [7] 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 [8].

4.1 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. ISO 8662 series has been changed to ISO 28927 series. All tool manufacturers in Japan have to follow the vibration test protocols according to the ISO 28927 series for getting the declaration values of the tools and for exporting tools to European countries..

4.2 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 field or actual working situation 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.

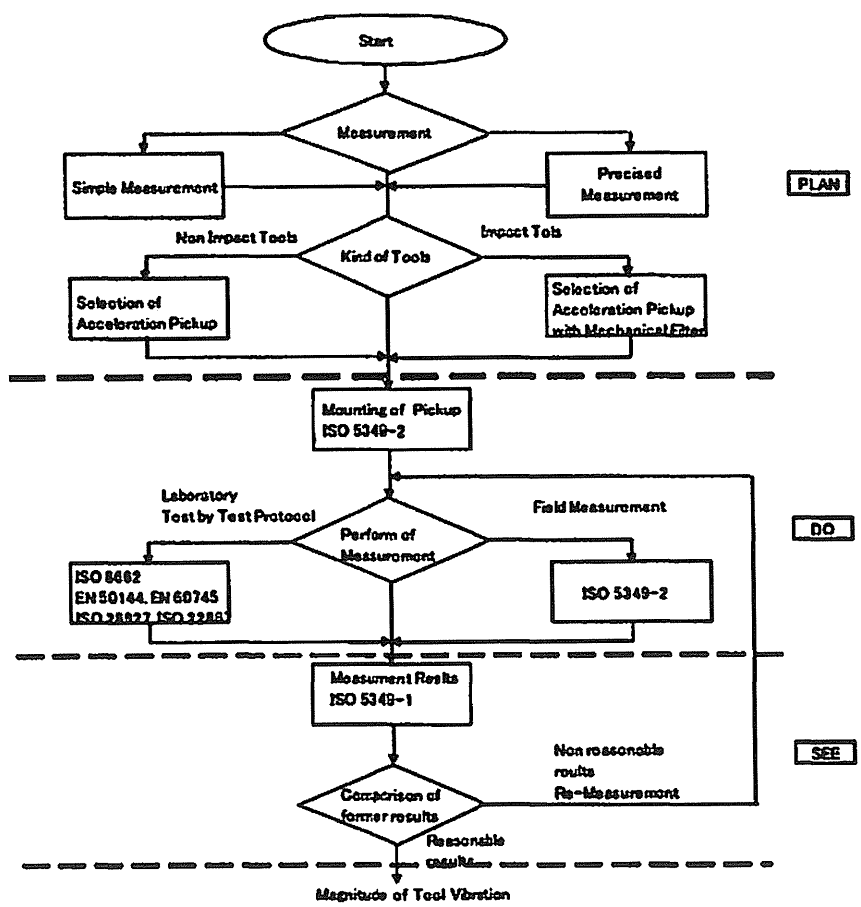

Figure 3 Measurement Procedure of Hand-Arm Vibration

5. Conclusions

The Machinery Directive 89/37/EC has been revised to 2006/42/EC. EU countries were required to revise their laws to conform to the latest Machinery Directive for preventing Hand-Arm Vibration Syndrome. The MSD of the EU Directive has had a great influence on Japanese tool manufacturers. It is generally recognized that the introduction of the EU Directive to Japan has been very useful in helping decrease the 400 new cases of vibration injuries that have generally occurred in Japan each year.
This paper provided a short introduction for the implementation and application of the MSD of 2006/2/EC to Japanese Tool manufacturers for preventing Hand-Arm Vibration Syndrome.

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Validation of frequency weightings of hand-transmitted vibration for evaluating comfort

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ABSTRACT

The purpose of this research is to establish a suitable frequency-weighting curve for comfort evaluation with regard to hand-arm vibration using the category judgment method. Experiments were conducted using random signals as stimuli. These stimuli consisted of three types of signal, namely designated stimulus F, with flat PSD ranging from 1 to 1000Hz, stimulus H with PSD, which became 20dB higher at 1000Hz than at 1Hz, and stimulus L that had a PSD 20dB lower at 1000Hz. The signal levels were varied over a range of five steps to create 15 kinds of individual stimuli. The subjects were exposed to vertical vibrations before being asked to choose a numerical category to best indicate their perceived level of comfort (or otherwise) during each stimulus. The creation of this assessment scale, including the aforementioned categories, enabled not only clarification of the relationship between the vibration stimuli and the degree of comfort but also the discovery of the connection between the frequency-weighted r.m.s. acceleration and the corresponding categories representing each degree of comfort. From the current results, it was found that the current ISO 5349-1 Frequency-Weighting curve and the Palm-Wrist & Hand back Frequency Weighting Curves from the Biodynamic Response data are suitable frequency-weighting to evaluate the comfort of the hand-transmitted vibration.

Keywords: Frequency-weighting, Hand-arm, Vibration

1. INTRODUCTION

In the ISO/TC108/SC4/WG3, the new frequency-weighting curve is considering to revise the ISO 5349-1 standard [1] as PWI 18570: HAV frequency weighting. Moreover, many frequency-weighting curves based on the biodynamic responses or on the epidemiological data of the hand-arm vibration experiments are proposed by many researchers. It is not clear whether which frequency-weighting curve is better to evaluate the hand-arm vibration comfort in comparing with the frequency-weighting curve of the ISO 5349-1 standard. In this study, the effectiveness of the different frequency-weighting curve is investigated by the psychological experiment [2].

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The purpose of this research is to establish a suitable frequency-weighting curve for comfort evaluation with regard to hand-arm vibration using the category judgment method. The subjects were exposed to vertical vibrations before being asked to choose a numerical category to indicate their best perceived level of comfort (or otherwise) during each stimulus. The creation of this assessment scale, including the aforementioned categories, enabled not only the clarification of the relationship between the vibration stimuli and the degree of comfort but also the discovery of the connection between the frequency-weighted r.m.s. acceleration according to the alternative frequency weighting curves as shown in Figure 1 and the corresponding categories representing each degree of comfort.

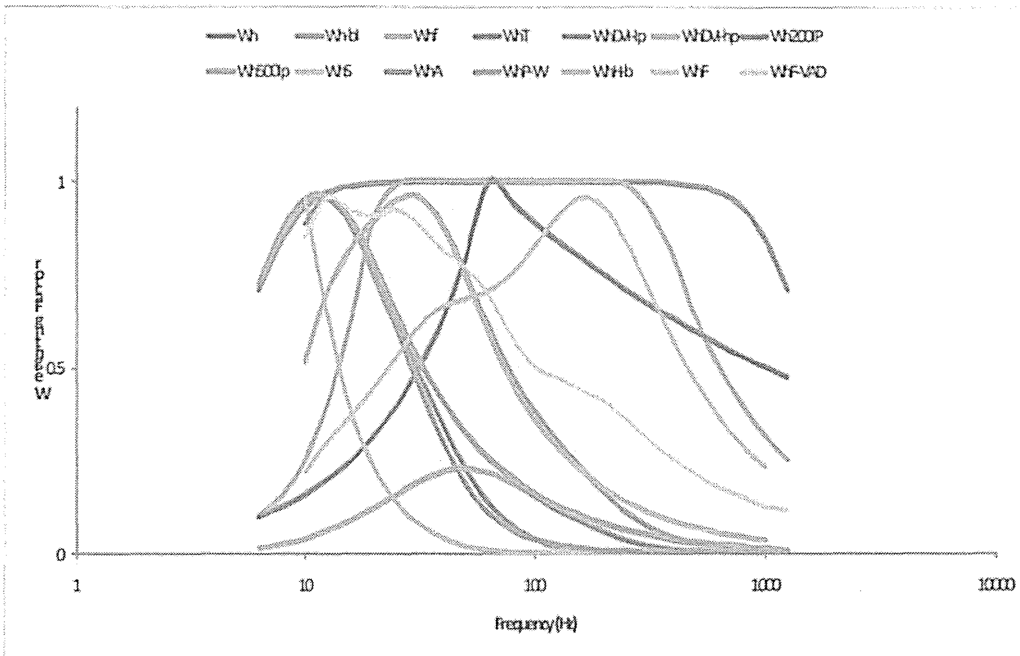

Figure 1 – Comparison of frequency weighting curves

The candidate frequency weighting curves as shown in Figure 1 are:

Wh:	The frequency-weighting specified in ISO 5349-1 [1]
Wh-bl:	The band-limiting component of Wh [1]
Whf:	A frequency weighting based on finger vibration power absorption [3]
WhT:	A frequency weighting based on epidemiological data of incidence of vascular injury [4]
WhVDI-lp:	The Wh weighting with an additional 24dB/octave low-pass filter at 50 Hz [5]
WhVDI-hp:	The Wh weighting with an additional 24dB/octave high-pass filter at 50 Hz [5]
Wh200IP:	The Wh weighting with an additional 24dB/octave low-pass filter at 200 Hz [5]
Wh500IP:	The Wh weighting with an additional 24dB/octave low-pass filter at 500 Hz [5]
WhS:	A frequency weighting based on biodynamic response at Shoulder [6]
WhA:	A frequency weighting based on biodynamic response at Arm [6]
WhP-W:	A frequency weighting based on biodynamic response at Palm-Wrist [6]
WhH-b:	A frequency weighting based on biodynamic response at Hand-Back [6]
WhF:	A frequency weighting based on biodynamic response at Finger [6]
WhF-VAD:	A frequency weighting based on biodynamic response at Finger from Vibration Absorbed Density [6]

2. APPARATUS AND METHOD

2.1 Apparatus

A shaker with a power amplifier (VA-ST-03, IMV corporation) and signal processing unit (F2 SPU, IMV corporation) were used in the experiments. All vibration stimuli were generated on the handle and the frequency-weighted r.m.s. vibration acceleration feedback controlled by F2 SPU controller and the computer.

2.2 Method

A series of 15 vibration stimuli (three times for five levels of vibration stimuli, respectively), each of which was ordered randomly, were applied in the X_h axis to the right hand of each subject, seated relaxed posture in a chair. All vibration stimuli had a duration time of five seconds with a two-second pause between them as shown Figure 2. The vibration load was applied in the direction of the X_h axis with a predetermined stimuli program input into the vibrator, then applied to the subject grasping on the vibration handle. The grasping force was about 2-3 N. The diameter of handle was 0.03 m and the length was 0.12 m. The subjects were issued verbal responses to each vibration stimulus, selecting from the five evaluation categories, using the designated numeric value (1 to 5) for each category as shown in Table 1. The experiments were conducted using random signals for the stimuli over a frequency range of 1-1000 Hz, similar to the ISO 5349-1 standard evaluation range.

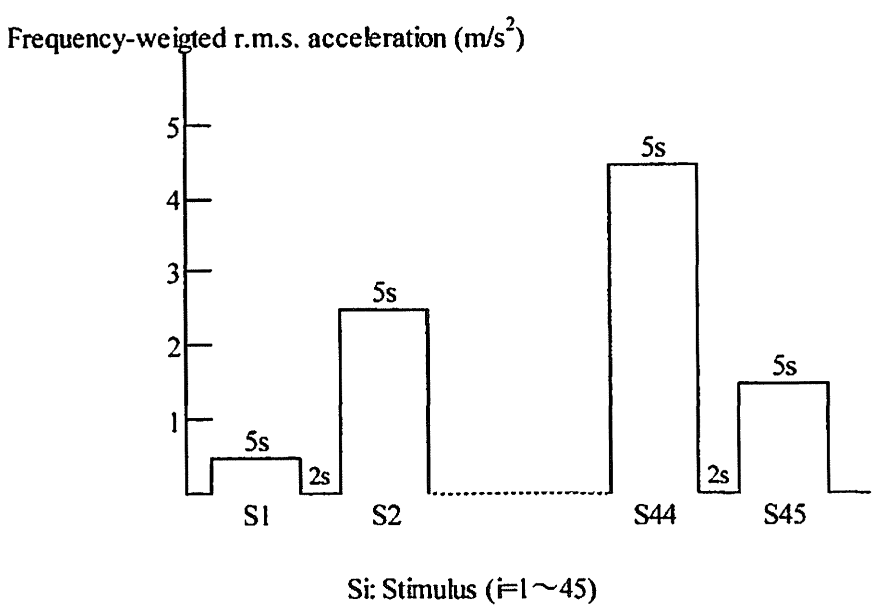

Figure 2 - Series of stimuli

Table 1 - Categories used in this experiment

1. Not uncomfortable
2. A little uncomfortable
3. Fairly uncomfortable
4. Uncomfortable
5. Very uncomfortable

In addition, in order to clarify the individual characteristics of the different spectrums with varying degrees of high and low frequency components were used. The stimuli consisted of three kinds of signals, namely designated stimulus F, with a flat PSD from 1 to 1000 Hz, stimulus H with a PSD, which became 20 dB higher at 1000 Hz than at 1 Hz and stimulus L with a PSD 20 dB lower at 1000Hz and the spectra of these signals as shown in Figure 3. The signals were modified using a frequency weighting of Wh based on the ISO 5349-1 standard, and the frequency-weighted r.m.s. acceleration were adjusted to be equal. Furthermore, the levels of the signals were varied over a range of five steps to make 15 kinds of stimuli. In order to enable the comparison of the ISO 5349-1 standard values with accelerations of 0.28, 0.56, 1.12, 2.48 and 4.48 m/s^2 r.m.s. were used for the five steps. These stimuli were selected from the specific vibration magnitudes of the hand-held vibration tools. Each one of these signals was used for three times, comprising a total of 45 stimulus applied in random order, each applied for a duration of five seconds with a two-second pause between stimuli for each subject in the experiment as shown in Figure 3. This meant that each subject was exposed to a total of 225 seconds of vibration, which even when the exposure time is considered, is in the acceptable range for the ISO 5439-1 standard.

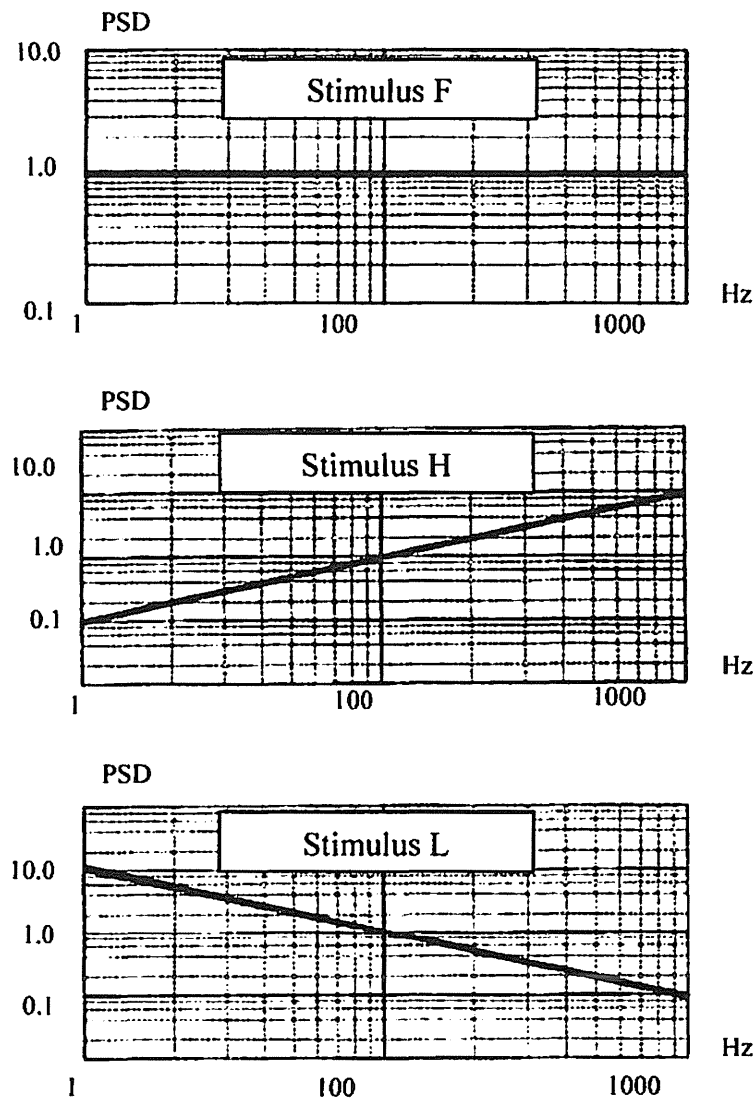

Figure 3 - Spectrum of stimuli used in the experiment

2.3 Subjects

The experiments were performed with totally twelve healthy subjects in twenties, six males and females with mean ages of 23.2 and 24.5, respectively. All the subjects were non-smokers. None of the subjects have been exposed to high levels or long periods of HAV occupationally or in their leisure time activities. The experiments were approved by the Research Ethics Committee of Japan National Institute of Occupational Safety and Health. All the subjects underwent an explanation of the test procedure and gave their written informed consent to participate in this study.

3. RESULTS

In this research, using the category judgment method, a subjective scale for evaluation of comfort, namely an order scale with unequal intervals, was established to associate physical values by using the different frequency weighting curves as show in Figure 1 with psychologically continuous categories. In order to clarify the effectiveness of the different frequency-weighting curve for evaluating the hand-arm vibration comfort, the effectiveness was quantified in terms of the square root of the sum of the squared differences between the category results and the experimental data (i.e., R.M.S. errors) [7] as shown in Table 2.

Table 2 - The R.M.S. errors obtained from different frequency-weighting curves

Frequency-weighting curve names	R.M.S. errors
Wh (ISO 5349-1)	1.963
Wh-bl(band-limiting component of Wh)	6.167
Whf(Finger vibration power absorption)	5.441
WhT(Epideiological data)	5.775
WhVDI-lp(Wh with 24dB/Oct low-pass filter at 50 Hz	2.680
WhVDI-hp(Wh with 24dB/Oct high-pass filter at 50 Hz)	2.925
Wh200lP(VDI 2057 200 Hz)	2.245
Wh500lp(VDI 2057 500 Hz)	2.017
WhS(Biodynamic Response of Shoulder)	3.599
WhA(Biodynamic Response of Arm)	2.729
WhP-W(Biodynamic Response of Palm and Wrist)	1.966
WhH-b(Biodynamic Response of Hand back)	1.945
WhF(Biodynamic Response of Finger)	5.426
WhF-VAD(Finger of Vibration Absorption Density)	2.979

4. DISCUSSION

From the results of R.M.S. errors of Table 1, the suitable frequency-weighting curves for evaluating the hand-arm vibration comfort are WhH-b, Wh, and WhP-W.

From Fig.1, the shapes of weighting of WhH-b, Wh, and WhP-W are almost same. But, the weighting factors of WhH-b and WhP-W are different with the ISO 5349-1 standard weighting factors from Fig.1.

Although the frequency-weighting curves of Wh-bl, Whf, and WhT for evaluating the HAVS are suitable curves, the R.M.S. errors of the frequency- weighting curves of Wh-bl, Whf and WhT are very high number. Therefore, these weighting curves are not suitable for evaluating the hand-transmitted vibration comfort. From this experiment, it was clear that the frequency-weighting curve of Current standard ISO 5349-1 is suitable for evaluating the hand-transmitted vibration comfort.

5. CONCLUSIONS

The purpose of this research is to establish a suitable frequency-weighting curve for comfort evaluation with regard to hand-arm vibration using the category judgment method. From the point of comfort evaluation, it was found that the current ISO 5349-1 Frequency-Weighting curve and the Palm-Wrist & Hand back Frequency Weighting Curves from the Biodynamic Response data are suitable frequency-weighting to evaluate the comfort of the hand-transmitted vibration.

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Comparison of Hand-arm vibration syndrome (HAVS) among foresters between tropical and temperate climate

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Coldness is one of the important factors to involve in Hand-arm vibration (HAVS), however, reports of HAVS in the hot tropical environment are scare and remain uncertain. The present study aimed to investigate clinical characteristics of HAVS in the tropical environment in comparison with HAVS in the temperate to cool environment. In 2011 we examined 354 Japanese (Average age 47.6 yrs) and 33 Malaysian (36.8 yrs) male tree fellers who have been occupationally exposed to Hand transmitted Vibration (HTV). As for HAVS based on Stockholm Classification, Malaysian subjects complained more frequently compared with Japanese ones in numbness with significance (36.4% vs. 20.3%, *P*-value 0.032) and pain with almost significance (30.3% vs. 16.9%, *P* value 0.055). In contrast, Malaysian complained less cold sensation with almost significance (12.1% vs. 27.7%, *P* value 0.052). Among subjects who complain HAVS, Malaysian had consistently significantly larger Vibration perception threshould (VPT) in numbness (13.7 vs. 6.1), pain (18.4 vs. 7.3), and cold sensation (20.5 vs. 4.5) with *P* value <0.001, respectively. To diagnose HAVS in the tropical environment, the key is likely to be dumbness and pain in symptoms and ascending VPT in physical measurement data. These results also suggest that main factors of HAVS might be repented as neurological disturbance in the tropical environment and circulatory disturbance in the temperate to cool environment.

1 INTRODUCTION

Hand-arm vibration syndrome (HAVS) is one of the occupational diseases induced by long and constant hand-transmitted vibration (HTV) exposure, mainly observed among tree fellers, construction workers, and factory workers who use vibration tools. Coldness was regarded as one of the essential factor to involve in HAVS. In fact, reports concerning HAVS in the tropical environment are quite limited[1-4], revealing HAVS in tropical environment are characterized as mainly moderate neurological and circulatory disturbance such as high vibration perception threshould (VPT)[3], abnormal light touch sensation[4]. Severe HAVS such as Raynaud's syndrome were never reported.

In the present study, we aimed to assess the prevalence of HAVS among trees fellers in the tropical and the clinical characteristics of HAVS in the tropical environment by comparing data with those of Japanese tree fellers in the temperate to cool environment.

2 MATERIALS AND METHODS

2.1 Subjects and Climates of the Study Fields

This study was performed at both Malaysian and Japanese sites.

Malaysian study was performed on August 2011. The Malaysian subjects compromised all male 33 tree fellers who use vibratory tools, mainly chainsaws in the daily routine works. The mean age was 36.8 years old (Standard Deviation 9.4). The Malaysian study was performed in the timber logging camp located in the low highland in the north east Borneo Island, about 20-30 kilometers away from the sea coast. The local area is covered with typical tropical environment. The average temperature goes up to approximately 28.6 degrees centigrade (°C) annually and has a lot of rain fall all through the year.

The Japanese subjects compromised all male 385 tree fellers who received annual compulsory special health check of HAVS, also using vibratory tools, mainly chainsaws in the daily routine works, and mean age was 47.6 years old (SD 12.9). The study was performed at some places in Wakayama prefecture located in the south of mainland of Japan on November and December 2011. The local climate is roughly classified as temperate climate, however, virtually classified as cool inland climate because the altitude of the work site is about 700 meters above the sea level high covered with deep forests. In fact, the local annual average temperature is 14.5°C, falling down as low as 3.7°C in January.

2.2 Study Methods

The Malaysian study was performed by Malaysian and Japanese joint team, and the Japanese study was performed by Japanese team only.

First, the subjects were collected in each room in which the temperature was kept between 20-24°C and stayed for about 30 minutes for the purpose that body temperature to be accustomed to the room temperatures. During which subjects were explained the study and filled papers of the concentration. The subjects also filled some self-questionnaire to investigate basic lifestyles, histories of exposure to HTV and symptoms relating HAVS.

Second, subjects underwent a series of physical measurements such as skin temperature, hand grip strength, pinch grip strength and vibrotactile perception thresholds (VPT).

Third, subjects underwent cold water provocation tests, with methods water temperature 5°C and 1 minute in Malaysia and 12°C and 5 minutes in Japan. After provocation, recovery of skin temperatures and VPTs were observed for ten minutes.

Finally, respective native doctors checked and interviewed subjects to examine HAVS based on Stockholm Classification. Both of the studies were performed in accordance with uniformed study method originally produced by Japan except for cold water provocation test.

The present study was approved by committees of ethics by both Malaysian and Japanese universities.

2.3 Statistical analysis

Mann-Whitney U test was used to compare amount of operation of vibration tools of between Malaysia and Japanese subjects. In the present study, we adopted original unique term Total Operation Time (TOT) to estimate total amounts of exposure to vibration. TOT is calculated by operation hours/day times operation days/year times total engaged years.

Next, chi-squire test was used to compare clinical characteristics of HAVS (numbness, pain, chill and vibration induced white finger (VWF) among the subjects.

Finally, unpaired t-test was used to compare physical measurement data among HAVS positive subjects between Malaysia and Japan for the purpose of evaluating HAVS relating physical data between tropical and temperate environments.

3 RESLTS

Comparison of total amount of exposure to vibration is shown in Table1. Malaysian subjects were significantly younger and had less total operation years than Japanese subjects. In contrast, Malaysian subjects had significantly more operation hours and days resulting in having significantly more TOT than Japanese subjects.

Clinical characteristics of HAVS among subjects are shown in Table2. Malaysian subjects complained more frequently compared with Japanese ones in numbness with significance (36.4%

vs. 20.3%, *P* value 0.032) and pain with margin significance (30.3% vs. 16.9%, *P* value 0.055). In contrast, Malaysian complained less cold sensation with margin significance (12.1% vs. 27.7%, *P* value 0.052). No Malaysian subjects complained they had vibration induced white finger (VWF), nine (2.6%) Japanese subjects notified they had VWF.

Among subjects who complain HAVS, Malaysian had consistently significantly larger VPT in numbness (13.7 vs. 6.1), pain (18.4 vs. 7.3), and cold sensation (20.5 vs. 4.5) with *P* value <0.001 compared with Japanese subjects, respectively.

4 DISCUSSION

In the present study, we performed international joint study to evaluate prevalence and characteristics of HAVS in tropical environment which still remain uncertain.

Compared with Japanese subjects, Malaysian subjects were significantly younger and had less total operation hour, however, Malaysian subjects had significantly more operation hours and days. The Japanese employment contracts are strongly preserved and working hours are strictly restricted. On the other hands, half of Malaysian workers consist of local native races and the rest Indonesians coming in search of work. They do not have working time limitation, health check system. Hence, compared with Japanese subjects, Malaysian subjects evidently work double times and have twice TOT.

As for HAVS, Malaysian subjects complained dumbness and pain more frequently, and so do Japanese subjects chill. These results might indicate that neurological disturbance is dominant in tropical environment and circulatory disturbance is dominant in temperate to cool environment. The finding in tropical environment agrees with previous report[4].

The difference of characteristics of HAVS positive subjects between tropical and temperate to cool environment are summarized as such; 1) No differences are observed among skin temperature, pinch strength measurement; 2) Nail suppression tests of all the tropical subjects are significantly prolonged (data not shown), however, the significance diminishes if the subjects are restricted with HAVS positive; 3) VPT is significantly larger in tropical environment; 4) Therefore, the key symptom of HAVS in tropical environment is likely to be dumbness in symptom and ascending VPT in physical measurement data.

We measured the magnitude of vibration the subjects exposed but did not take into account in analysis. The Malaysian collaborate researcher Anselm Su Ting is preparing a paper reporting the association HAVS and magnitude of vibration.

In summary, HAVS in tropical environment was examined in this study, revealing prevalence and characteristics which had remained uncertain due to scare reports. It is important to continue the study to examine HAVS in tropical environment and establish a method to protect tropical occupationally HAT exposed workers form HAVS.

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Table1 – Amount of operation of vibration tools of the subjects

	Malaysia (n=33)	Japan (n=350)	*P* value*
Age (year)	36.8 (9.4)	47.6 (12.9)	< 0.001
Operation total years	13.2 (8.5)	15.3 (10.2)	0.88
Operation days/year	275.0 (45.1)	163.7 (58.6)	< 0.001
Operation hours/day	10.1 (0.6)	4.9 (1.6)	< 0.001
Average TOT ($\times 10^3$)	37.1	11.2	< 0.001

Data are means +/- SD, *Mann-Whitney test. TOT, total operation time.
TOT is calculated age*operation total years*operation hours/day

Table2 - Clinical characteristics of HAVS among the subjects

	Malaysia (n=33)		Japan (n=350)		*P* value*
	YES	NO	YES	NO	
Numbness	12 (36.4%)	21 (63.6%)	71 (20.3%)	279 (79.4%)	0.032
Pain	10 (30.3%)	23 (67.9%)	59 (16.9%)	291 (83.1%)	0.055
Chill	4 (12.1%)	29 (87.9%)	97 (27.7%)	253 (72.3%)	0.052
VWF	0 (0.0%)	33 (100.0%)	9 (2.6%)	341 (73.4%)	0.351

*Using chi-square test. VWF, vibration induced white finger.

Table3 – Major physical measurement data among HAVS positive subjects

	Skin temperature (°C)			Nail suppression test (sec)			VPT (dB)			Pinch strength measurement (Kg)		
	Malaysia	Japan	*P* value	Malaysia	Japan	*P* value	Malaysia	Japan	*P* value	Malaysia	Japan	*P* value
Dumbness	26.9	27.6	0.61	1.62	1.43	0.05	13.7	6.1	<0.01	4.4	4.1	0.53
Pain	27.2	28.3	0.45	1.73	1.50	0.16	18.4	7.3	0.02	5.4	4.3	0.29
Chill	27.8	27.6	0.91	1.68	1.43	0.23	20.5	4.5	<0.01	4.0	4.1	0.86

*Using unpaired *t*-test. HAVS, hand arm vibration syndrome; VPT, vibrotactile perception threshold.

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Results of vibration measurement of Wire Brushes mounted on hand held power tools

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Abstract

The purpose of this study is to clarify the vibration value of wire cup brushes mounted on handheld power tools. The measurement of the vibration value was taken by the hand vibration and evaluation method stipulated by ISO5394-2(JIS B7761-2&JIS7761-3), and the result of the measurement was evaluated by the influence assessment method stipulated by ISO, JIS and `The Vibration Guideline` issued by the Japanese Ministry of Health, Labor and Welfare on July 10th, 2009. Additionally, we measured the balance value of the wire cup brushes and investigated its relationship with the vibration value.

As a result, we found out the correlation between the vibration value and the balance value of wire cup brushes. Furthermore, the result shows that if the balance value of the wire cup brushes were controlled within 2.3g, keeping the vibration value within 5.0m/s2 (the Daily Vibration Exposure Limited Time suggested by `The Vibration Guideline`) could be possible.

1. Introduction

The purpose of this study is to clarify the relationship between the vibration value of wire cup brushes mounted on handheld power tools and the balance value of wire cup brushes.
According to Professor Maeda of Kinki University (Safety and Healthy Vol12 No2 2012 , issued by Japan Industrial Safety and Health Association), it is possible to prevent Hand-Arm Vibration Syndrome by choosing tools with the least vibration as possible.
It is considered that the exposure to vibration through the use of handheld power tools at one's workplace should be the cause of Hand-Arm Vibration Syndrome. Therefore, it becomes necessary to reveal whether the actual vibration exposure of the handheld tools is dangerous enough to be the cause of Hand-Arm Vibration Syndrome.
However, there is not so many data available regarding to the vibration values when a wire cup brush is attached to the grinder in use, and there are no international rules and regulation for measuring the vibration values of various types of handheld vibrating tools with wire cup brushes attached.
Therefore, in order to reveal the vibration risk hidden in the worksite, we investigated the actual vibration situation of wire cup brushes mounted on handheld power tools, and made this investigation by the method stipulated by ISO5349-1 and ISO5394-2 (JIS B 7761-2, JIS B 7761-3). And we evaluated the result of which according to ISO, JIS, and vibration guidelines issued by Japanese Ministry of Health, Labor and Welfare on July, 10 2009.

2. Cup brush

The wire cup brush is used on handheld tools such as grinders, to clean & polish the surface of the workpiece by spinning at high speed. (Fig2)
There are two types, one for electric tools and one for pneumatic, which have an outer diameter of 30 to 150 mm.

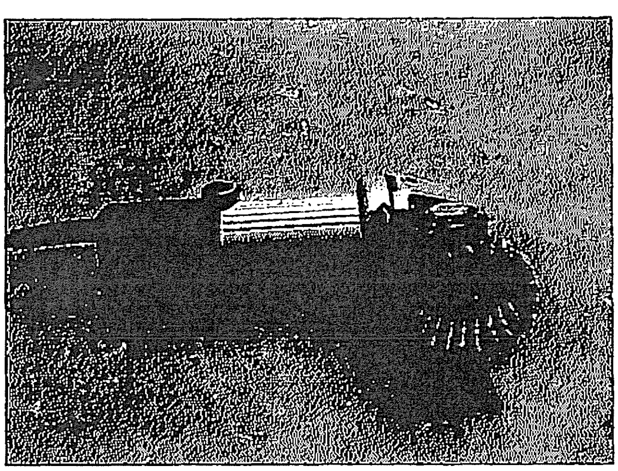

Fig.1 Cup brush is attached to a handheld power tool (grinder)

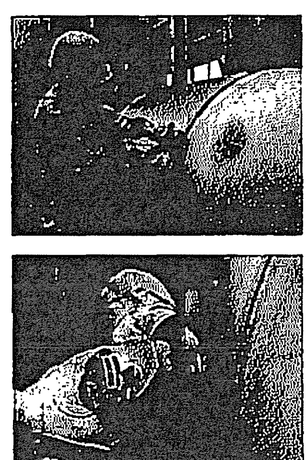

Fig.2 state of work