HAND ARM VIBRATION

International conference

6-9 JUNE 2023

Espace Prouvé,
Nancy, France

Necessity and Considerations for On-Body Vibration Measurement Equipment

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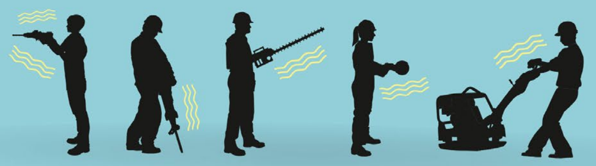


Contents of today's presentation

- Purpose
- Current Risk Assessment
- Necessity of on-body vibration measurement
- Consideration of on-body vibration measurement
- Conclusion

Purpose

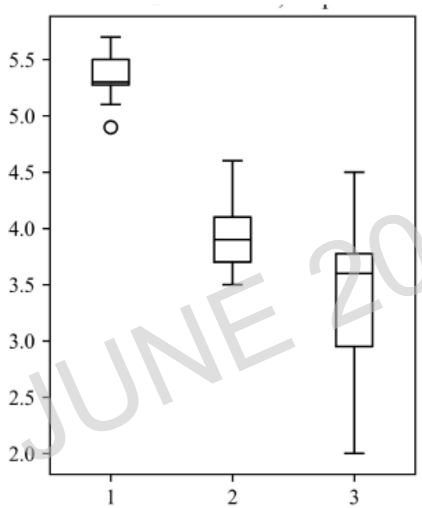
To clarify the necessity of on-body vibration measurement and to demonstrate the effectiveness of new considerations of on-body measurement equipment.

Current Risk Assessment **ISO 5349-1:2001**

Many researchers have worked on clarifying the relationship between dose and human responses to vibration, such as diseases, for many years. The vibration measurements were made in the field during real operating conditions performed by workers. The vibration was measured in three orthogonal directions according to the international standard ISO 5349-1 procedure (ISO 2001) on the tool handle. The vibration magnitudes were expressed as root–mean–square (r.m.s.) acceleration, and were frequency-weighted using frequency weighting Wh in accordance with ISO 5349-1. The root-sum-of-squares (vibration total value) of the frequency-weighted acceleration values ahv for the x-, y-, and z-axes were calculated as shown in Equation (1).

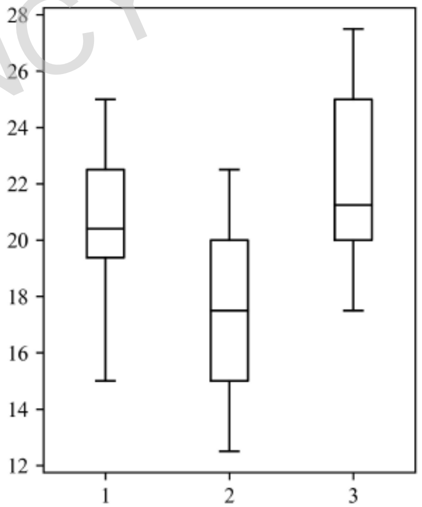
$$a_{\mathrm{hv}} = \left(a_{\mathrm{hw}x}^2 + a_{\mathrm{hw}y}^2 + a_{\mathrm{hwz}}^2\right)^{\frac{1}{2}} \qquad (1)$$

Tool Handle Vibration
Magnitude ahv



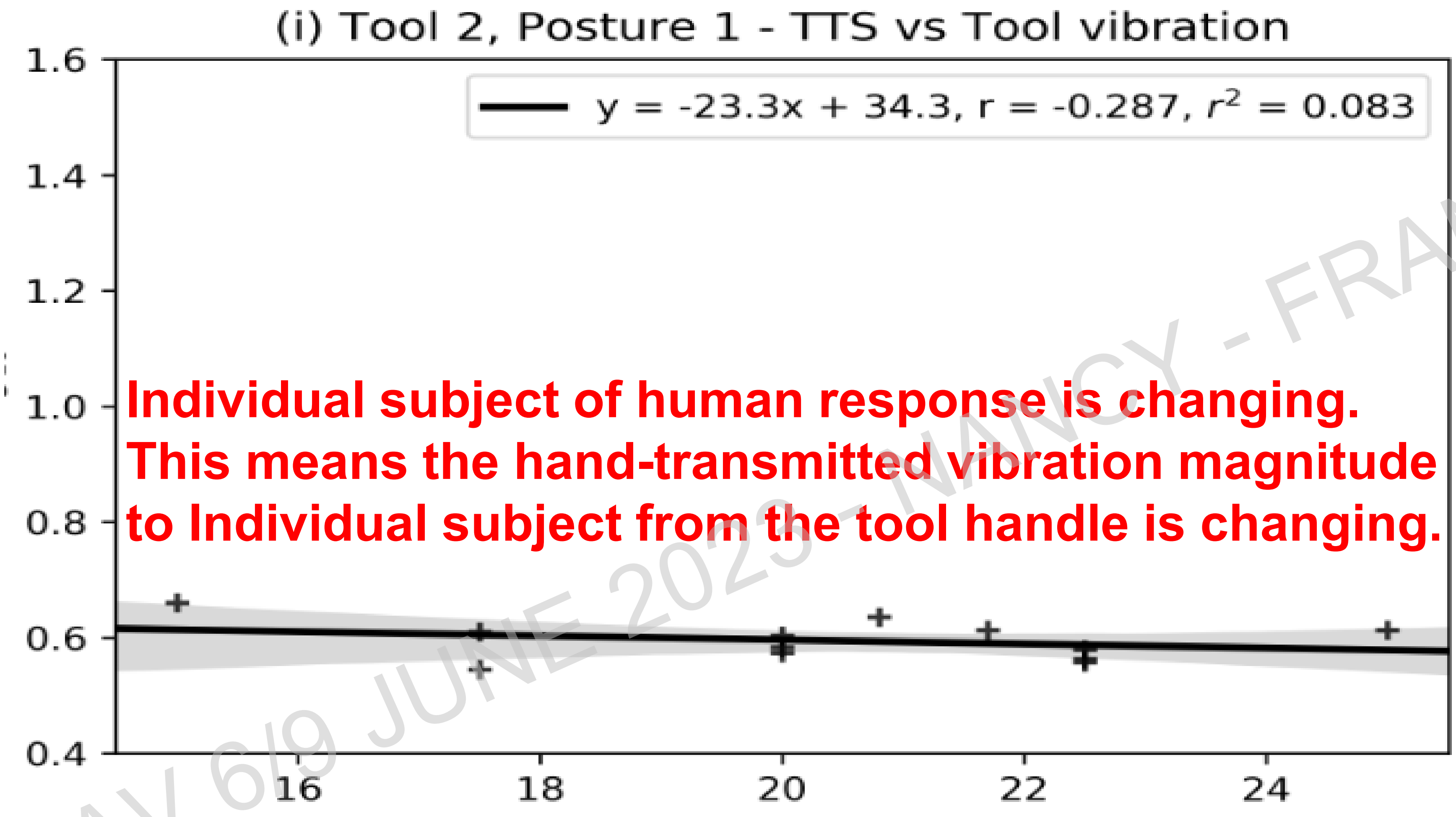
Posture

TTS (125Hz)



Posture

Mark Taylor, Setsuo Maeda, and Kazuhisa Miyashita
An Investigation of the Effects of Drill Operator Posture on Vibration Exposure and Temporary Threshold Shift of Vibrotactile Perception Threshold
In Vibration 2021, 4, 395–405.



Individual subject of human response is changing.
This means the hand-transmitted vibration magnitude to Individual subject from the tool handle is changing.

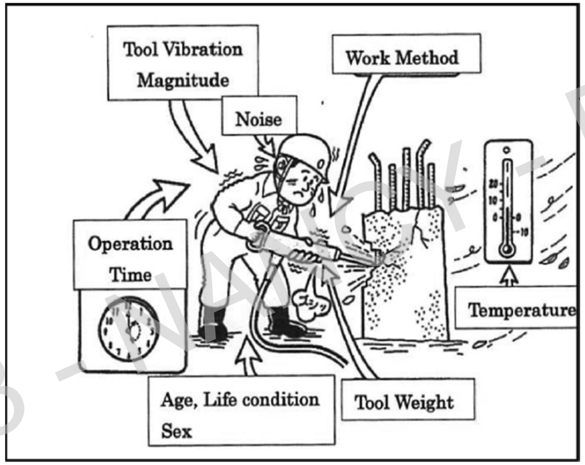
Temporary Threshold Shift of Vibrotactile Perception Threshold : dB

Maeda, S., Taylor, M.D., Anderson, L.C., McLaughlin, J., Determination of hand-transmitted vibration risk on the human. Int. J. Ind. Ergon. 70, 28–37. https://doi.org/10.1016/j.ergon.2019.01.002

ISO 5349-1: Annex D

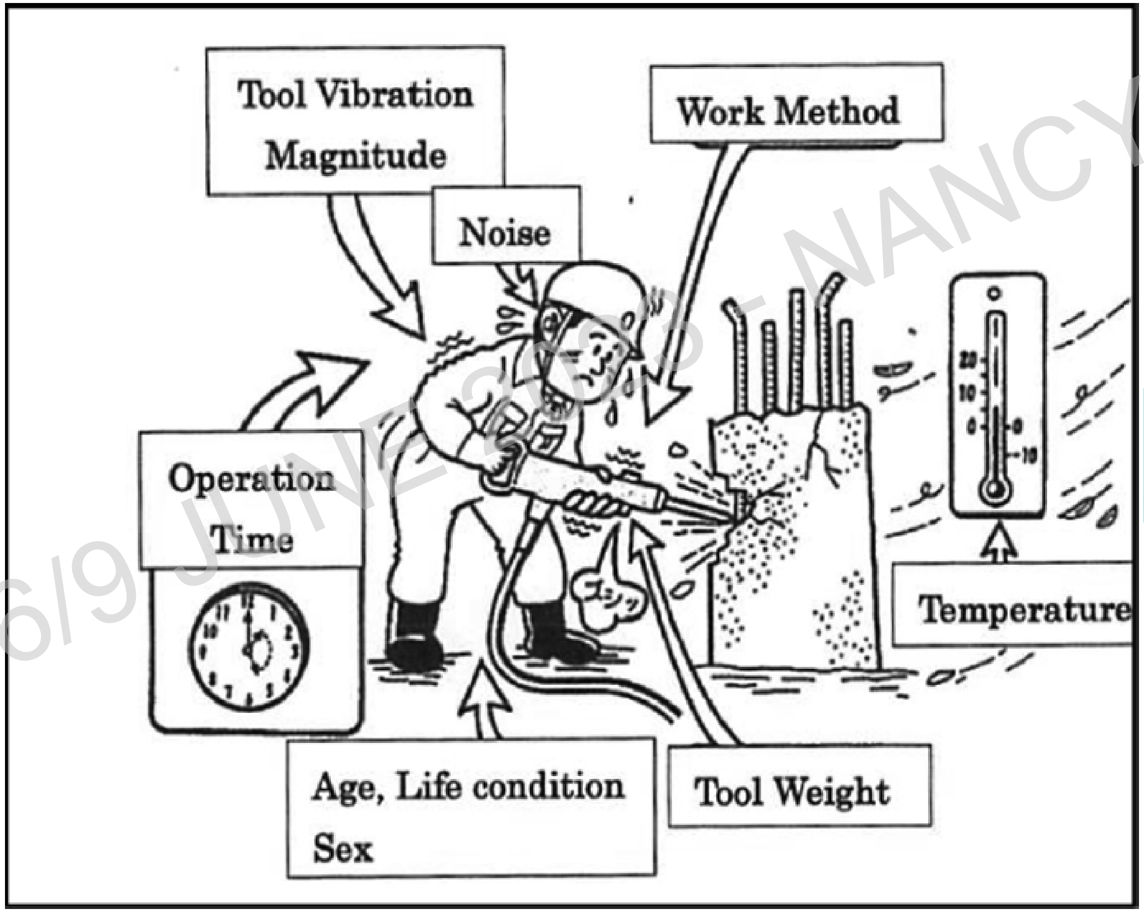
ISO 5349 recognises the presence of factors that may influence vibration exposure, which are not accounted for in the standard:

- Direction of the vibration
- Working method and operator's skill
- Age, constitution and health
- Coupling forces (grip and feed forces)
- Hand, arm and body posture
- Condition of the machinery used and accessories/workpieces used
- Area of the hand in contact with the tool



Many researchers are clarifying the individual factor in Laboratory experiments by using specific experimental conditions. Although all results are clarifying the individual factor effect on the Hand-Transmitted Vibration as mentioned in ISO5349-1 Annex D, we cannot get the Hand-Transmitted Vibration including all factors in the real working conditions from their results.

Necessity of on-body vibration measurement



Necessity of on-body vibration measurement

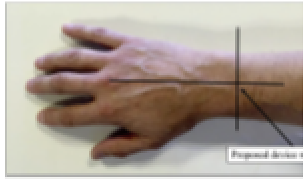
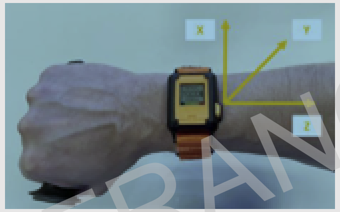
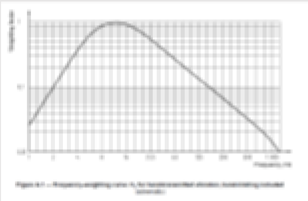
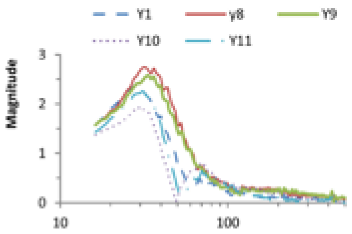
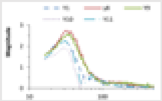
- Autonomous operation
- A small size, light-weight and that attachment is possible by on-body
- Don't damage workability and be a solid structure.
- Measure the vibration acceleration magnitude added to a hand palm face.
- To be able to measure equivalent tool vibration intensity levels.
- To be able to indicate the measured variable or indicate the exposure point
- Have the warning function when exceeding the EAV or ELV.

Consideration of on-body vibration measurement

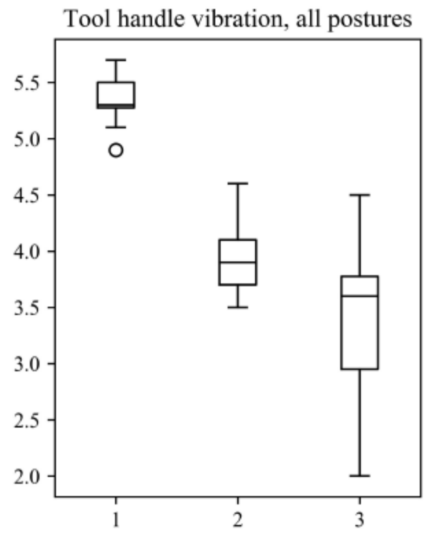
It is difficult to determine these effects on the vibration exposure magnitude to the human during work. Annex D of ISO 5349-1 identifies several factors that impact the hand-transmitted vibration magnitude. The proposed consideration of this study, to account for affecting factors on the vibration magnitude from the tool handle to the on-body human (on the wrist), is to estimate the tool vibration magnitude using the following Equation.

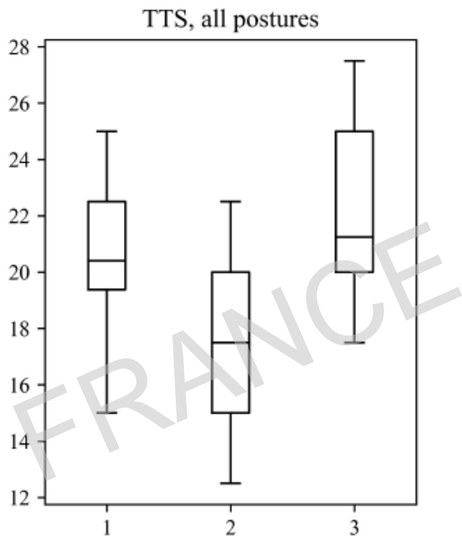
$$\textit{Estimated on tool vibration magnitude} = fw * TR\left(\frac{A_{\text{handle}}}{A_{\text{wrist}}}\right) * a_{\text{wrist}}$$

where *fw* is frequency weighting of ISO 5349-1 W_h, $TR(A_{handle}/A_{wrist})$ is the inverse of the transfer function from the tool handle to on the wrist, a_{wrist} is the vibration magnitude on the wrist including all affecting factors in Annex D of ISO 5349-1.

Tool	Hand interface	Hand transmitted	Wrist	Wearable sensor
				
Source Vib	Source Vib X Tool surface transmissibility = Hand interface Vib	Hand interface Vib X Human interaction = Hand transmitted Vib	Hand transmitted Vib X Transmissibility = Vib at wrist	Vib at wrist X HAV Transfer Function
				 X  X 

$$Estimated\ on\ tool\ vibration\ magnitude = fw * TR\left(\frac{A_{handle}}{A_{wrist}}\right) * a_{wrist}$$



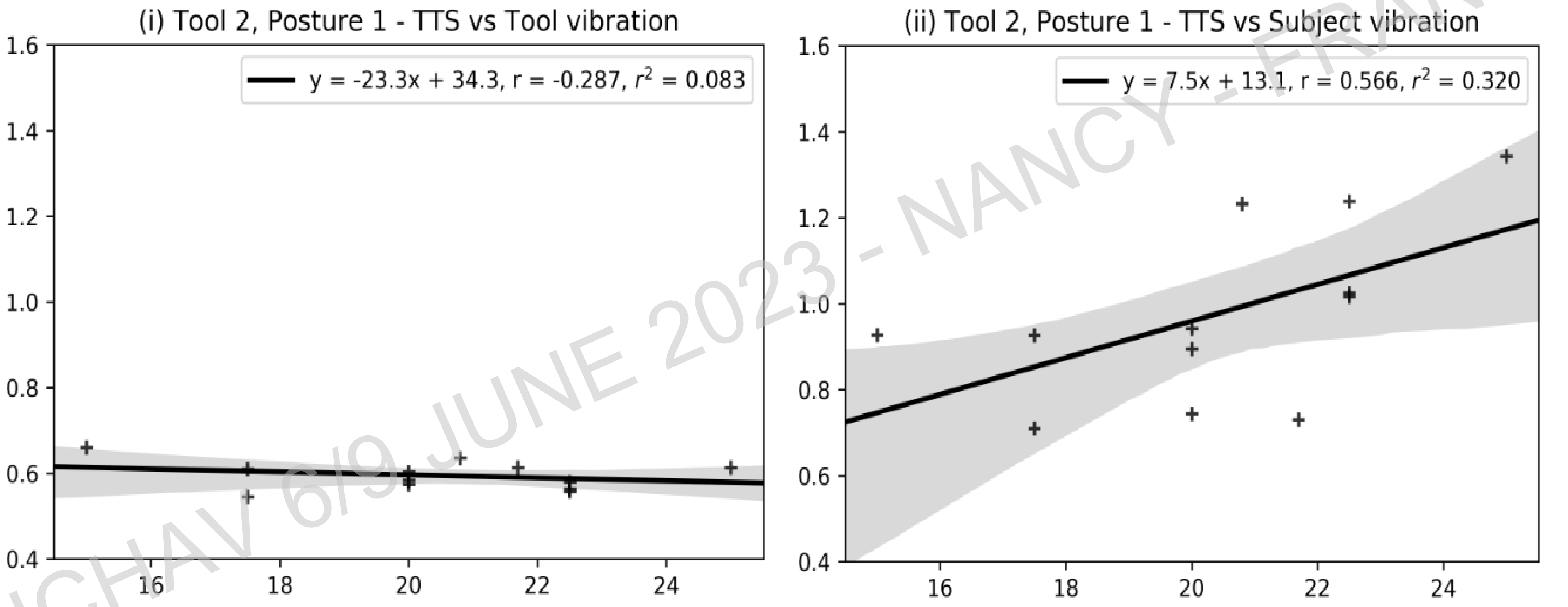


Tool Handle Vibration Magnitude ahv

TTS (125Hz)

Test results summary (average of all participants).

	Posture 1			Posture 2			Posture 3		
Subject	OnTool	OnSubject	TTS(dB)	OnTool	OnSubject	TTS(dB)	OnTool	OnSubject	TTS(dB)
Mean	5.33	8.82	20.42	3.95	8.51	17.50	3.44	10.57	21.88
SD	0.20	2.25	2.70	0.32	3.99	3.00	0.73	5.16	3.20



Temporary Threshold Shift of Vibrotactile Perception Threshold : dB

Conclusion

In the current study, the experiment was performed for clarifying whether the *a*hv can assess the risk from real tool work vibration exposure. From these experiments, it was cleared the following thing:

- **Although the values from the test protocol and ISO 5349-1 *a*hv values can't apply to all postures or subjects in real work conditions, it could be clarified that the new evaluation method of the wearable equipment can access the hand-transmitted vibration magnitude in real work for preventing HAVS instead of the usage of the *a*hv in real work site.**

- **And it became clear that it is necessary to carry out vibration measurement in a form that considers Annex D on-body vibration measurement equipment.**

WEARABLE DEVICE NEEDS TO PREVENT AN INDIVIDUAL WORKER BY PROVIDING A PRACTICAL REAL-TIME RISK ASSESSMENT.

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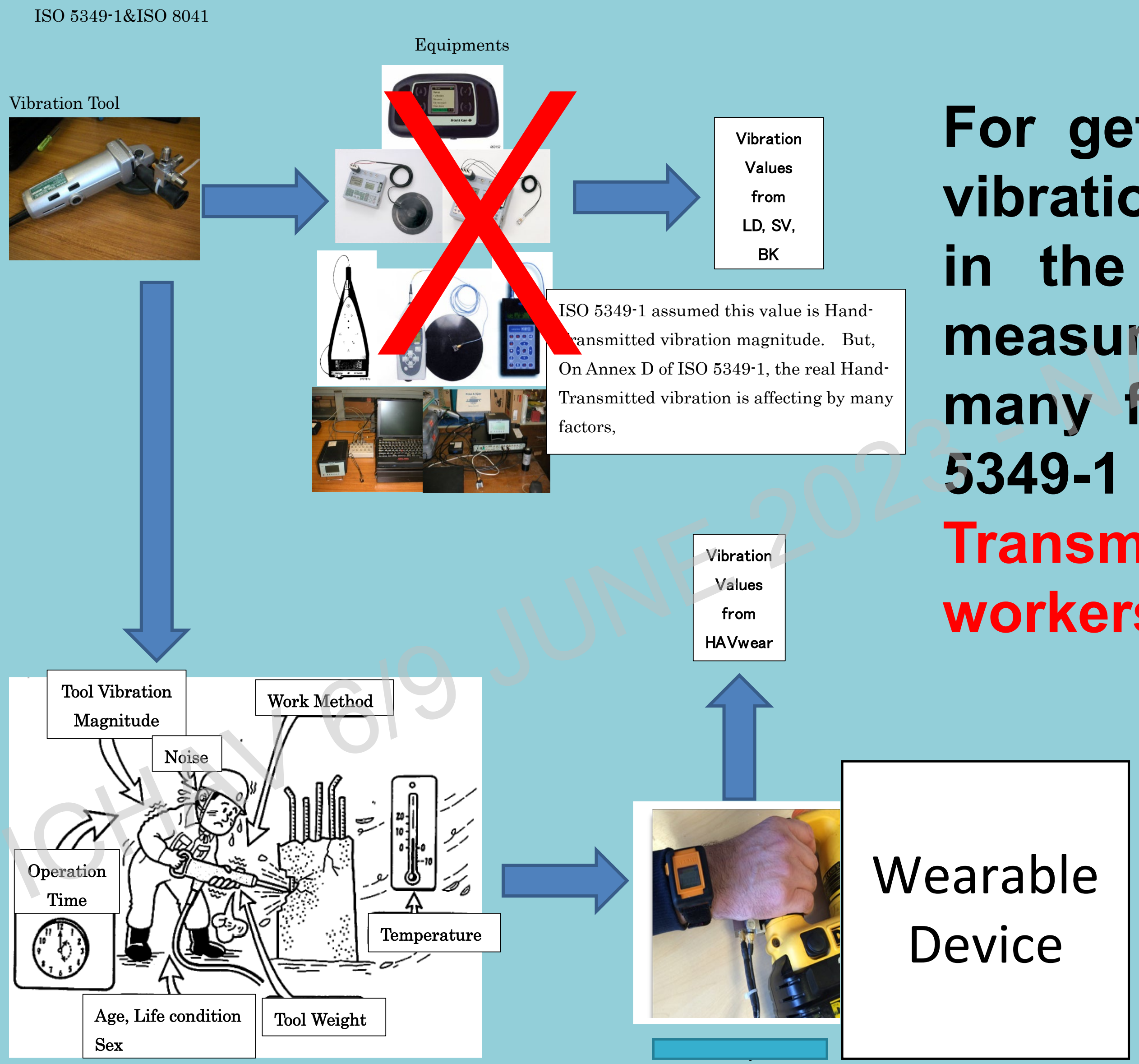
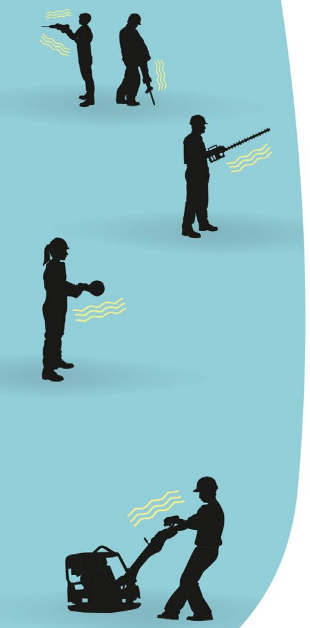


For getting the Hand-Transmitted vibration for preventing the HAVS in the work site, we need the measurement equipment to take many factors of Annex D of ISO 5349-1 standard into the Hand-Transmitted vibration to individual workers during work.



Thank you for your kind attention !!