

REVISION OF ANSI S3.34 (2.70-2006) – GUIDE FOR THE MEASUREMENT AND EVALUATION OF HUMAN EXPOSURE TO VIBRATION TRANSMITTED TO THE HAND

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Introduction

Intense vibration can be transmitted to the hands and arms of workers who use hand-held percussive or vibrating devices, tools, and work pieces. Continued habitual exposure to vibration directed to the hands can cause patterns of various symptoms associated with hand-arm vibration syndrome (HAVS). The International Organization for Standardization (ISO) first published ISO 5349 in 1986.³ This standard specified methods for measuring and evaluating vibration directed into the hands from hand-held vibrating devices, tools, and work pieces. The American National Standards Institute (ANSI) published ANSI S3.34 the same year.¹ This standard was modeled after ISO 5349-1986 and specified methods for assessing exposure to hand-arm vibration.

The Parliament of the European Union has issued the European Union Human Vibration Directive-2002/44/EC, which specifies vibration daily exposure action values (DEAV) of 2.5 m/s² and daily exposure limit values (DELV) of 5.0 m/s². These values have generally been accepted by medical experts, scientists, and engineers in governmental agencies, research institutions, and industry in the USA and other countries.² When they are achieved, they will reduce the potential for the development of symptoms related to HAVS among workers exposed to hand-arm vibration.

Significant improvements in measurement and analysis instrumentation, miniature and subminiature accelerometers, and medical diagnostic and assessment protocols have been introduced since 1986 when ANSI S3.34 was first published. In response to these improvements and the introduction of the EU Human Vibration Directive, ANSI Working Group S2.39 developed the revision to ANSI S3.34, which has now been published as ANSI S2.70-2006.²

Method

ANSI S2.70 specifies the use of the hand-arm vibration measurement procedures outlined in ISO 5349, Parts 1 and 2.^{2,4,5} It requires the measurement of ISO frequency-weighted acceleration values in three mutually orthogonal axes of vibration. These values are then vectorially added to obtain the vibration total value, a_{hv} :

$$a_{hv} = \sqrt{a_{hwx}^2 + a_{hwy}^2 + a_{hwz}^2} \quad (1)$$

where a_{hwx} , a_{hwy} , and a_{hwz} are the measured r.m.s. ISO frequency-weighted acceleration values in the x, y, and z directions, respectively. If multiple vibration exposure events are experienced during a work day, the overall vibration total value is obtained from:

$$a_{hv} = \sqrt{\frac{1}{T} \sum_{i=1}^n (a_{hvi}^2 T_i)} \quad (2)$$

where a_{hvi} is the vibration total value of the i^{th} operation, T_i is time duration in hours of the i^{th} operation, n is the total number of operations, and T is total time in hours associated with the n

operations. Finally, the daily vibration exposure value, $A(8)$, standardized to an 8-hour reference period, is obtained from:

$$A(8) = a_{hv} \sqrt{\frac{T}{T_0}} \quad (3)$$

where T_0 is the reference duration of 8 h.

ANSI S2.70 defines a value of $A(8)$ equal to 2.5 m/s^2 as the Daily Exposure Action Value (DEAV).² The DEAV represents the health risk threshold to hand-transmitted vibration. “Health risk threshold is defined as the dose of hand-transmitted vibration exposure sufficient to produce abnormal signs, symptoms, and laboratory findings in the vascular, bone or joint, neurological, or muscular systems of the hands and arms in some exposed individuals.”² ANSI S2.70 recommends that a program be designed to reduce worker exposure to hand-transmitted when $A(8)$ exceeds the DEAV to reduce health risks.

ANSI S2.70 defines a value of $A(8)$ equal to 5.0 m/s^2 as the Daily Exposure Limit Value (DELV).² Workers who are exposed to hand-transmitted vibration at or above this level are expected to have a high health risk. “High health risk is defined as the dose of hand-transmitted vibration exposure sufficient to produce abnormal signs, symptoms, and laboratory findings in the vascular, bone or joint, neurological, or muscular systems of the hands and arms in a high proportion of exposed individuals.”² ANSI S2.70 recommends that workers not be exposed to $A(8)$ values above the DELV.

Discussion

ANSI S2.70 is a timely and needed revision of ANSI S3.34. It gives the U.S. a modern standard that is in agreement with ISO 5349, Parts 1 and 2 and that has vibration assessment criteria that are accepted by medical experts, scientists, and engineers in governmental agencies, research institutions, and industry in the USA and other countries. ANSI S2.70 gives guidance for vibration exposure and health risks assessments, specifies methods for mitigating health risks associated with hand-transmitted vibration, and gives guidance for worker training and medical surveillance.

References

1. ANSI S3.34 (1986), Guide for the Measurement and Evaluation of Human Exposure to Vibration Transmitted to the Hands. American National Standards Institute.
2. ANSI S2.70 (2006), Guide for the Measurement and Evaluation of Human Exposure to Vibration Transmitted to the Hands. American National Standards Institute.
3. ISO 5349 (1986), Mechanical vibration — Measurement and evaluation of human exposure to hand-transmitted vibration. International Organization for Standardization
4. ISO 5349 (2001), Mechanical vibration – Measurement and evaluation of human exposure to hand-transmitted vibration – Part 1: General requirements. International Organization for Standardization.
5. ISO 5349 (2001), Mechanical vibration – Measurement and evaluation of human exposure to hand-transmitted vibration – Part 2: Practical guidance for measurement at the workplace. International Organization for Standardization.