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AMERICAN NATIONAL STANDARD

Mechanical Vibration and Shock – Evaluation of Human Exposure to Whole Body Vibration – Part 4: Guidelines for the Evaluation of the Effects of Vibration and Rotational Motion on Passenger and Crew Comfort in Fixed-Guideway Transport Systems

A Nationally Adopted International Standard

NAIS
ANSI S2.72-2003/Part 4 /
ISO 2631-4: 2001

Accredited Standards Committee S2, Mechanical Vibration and Shock

Standards Secretariat
Acoustical Society of America
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Melville, NY 11747-3177

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Secretariat

Acoustical Society of America

Approved July 29, 2003

American National Standards Institute, Inc.

Abstract

The purpose of this part of ANSI S2.72 / ISO 2631 is to help in the design and evaluation of fixed-guideway passenger systems, with regard to the impact of vibration and repetitive motions on passenger comfort. Fixed-guideway vehicles provide a predictable but complex multi-axis motion environment that is a function of the guideway, vehicle and seat or berth. Passengers evaluate ride comfort not only based on motion but also on their expectations with regard to the class of service that they have purchased. The duration of the trip has not been demonstrated to be a direct factor in predicting comfort (with the possible exception of kinetosis), but the anticipated duration of the trip is related to the types of activities passengers expect to accomplish while on board. Passengers on trips of more than a few minutes may expect to read, write, eat and drink; on trips of longer duration they will expect to sleep. To the extent that ride-induced vibration interferes with these activities, passengers may rate differently the comfort of vehicles with the same motion environment but different expected levels of service or different trip durations. Passengers are likely to judge comfort based on the interaction of vibration with factors such as acoustic noise, temperature, humidity, air quality and seat design.

AMERICAN NATIONAL STANDARDS ON ACOUSTICS

The Acoustical Society of America (ASA) provides the Secretariat for Accredited Standards Committees S1 on Acoustics, S2 on Mechanical Vibration and Shock, S3 on Bioacoustics, and S12 on Noise. These committees have wide representation from the technical community (manufacturers, consumers, trade associations, general interest, and government representatives). The standards are published by the Acoustical Society of America through the American Institute of Physics as American National Standards after approval by their respective Standards Committees and the American National Standards Institute.

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An American National Standard implies a consensus of those substantially concerned with its scope and provisions. Consensus is established when, in the judgment of the ANSI Board of Standards Review, substantial agreement has been reached by directly and materially affected interests. Substantial agreement means much more than a simple majority, but not necessarily unanimity. Consensus requires that all views and objections be considered and that a concerted effort be made towards their resolution.

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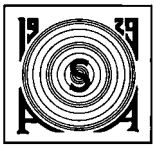
NOTICE: This American National Standard may be revised or withdrawn at any time. The procedures of the American National Standards Institute require that action be taken periodically to reaffirm, revise, or withdraw this Standard.



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Foreword

[*This foreword is not part of the Nationally Adopted International Standard (NAIS), Mechanical vibration and shock – Evaluation of human exposure to whole body vibration – Part 4: Guidelines for the evaluation of the effects of vibration and rotational motion on passenger and crew comfort in fixed-guideway transport systems, ANSI S2.72-2003/Part 4/ISO 2631-4:2001 (formerly S3.18-2003 Part 4/ISO 2631-4: 2001).*]

This Nationally Adopted International Standard (NAIS) comprises a part of a group of definitions, standards, and specifications for use in work related to human exposure to mechanical vibration and shock. It has been adopted by the American National Standards Institute utilizing the Accredited Standards Committee Procedures, under the Secretariat of the Acoustical Society of America.

Accredited Standards Committee S3, Bioacoustics, under whose jurisdiction this NAIS was adopted, had the following scope at that time:

> *Standards, specifications, methods of measurement and test, and terminology in the fields of psychological and physiological acoustics, including aspects of general acoustics, shock, and vibration which pertain to biological safety, tolerance and comfort.*

This Standard is identical to International Standard ISO 2631-4:2001, *Mechanical vibration and shock – Evaluation of human exposure to whole body vibration – Part 4: Guidelines for the evaluation of the effects of vibration and rotational motion on passenger and crew comfort in fixed-guideway transport systems*, which was prepared by Technical Committee ISO/TC 108, Mechanical vibration and shock, Subcommittee SC 4, Human exposure to mechanical vibration and shock. However, in conformance with ANSI and ISO rules, decimal points were substituted in place of the commas used in ISO document, the words "American National Standard" replace the words "International Standard" where they appear in the ISO document, and an informational footnote has been added to page 1.

In 2004, work related to human exposure to mechanical vibration and shock was transferred to Accredited Standards Committee S2, Mechanical Vibration and Shock. Five approved S3 standards were transferred to S2 at that time and were redesignated and republished as they each came up for reaffirmation in the normal standards cycle. This redesignation of ANSI S3.18-2003/Part 4 / ISO 2631-4:2001 is taking place under this process. No substantive changes have been made to the approved 2003 text, except as noted in the preceding paragraph.

The ANSI equivalent for an ISO standard referenced herein is given below:

- ANSI S2.72-2002/Part 1 / ISO 2631-1:1997 is an identical national adoption of ISO 2631-1:1997.

At the time this NAIS was submitted to Accredited Standards Committee S3, Bioacoustics, for final approval, the membership was as follows:

R.F. Burkard, *Chairman*
C. Champlin, *Vice Chairman*
S. B. Blaeser, *Secretary*

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..... J. Franks (Alt.)

American Academy of Audiology ..... L. Shotland
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American Speech-Language-Hearing Assoc ..... G. Linn
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..... J. Kalb (Alt.)

U.S. Department of Transportation ..... E.D. Sussman
..... T. Raslear (Alt.)

Individual Experts of Accredited Standards Committee S3, Bioacoustics, were:

J.R. Bareham
R.W. Benson
A.J. Brammer
A.J. Campanella
J.L. Fletcher
T.A. Frank
K.D. Kryter
R. McKinley
C.W. Nixon
D.D. Reynolds
J.D. Royster
L.H. Royster
P.D. Schomer
H.E. von Gierke
D.E. Wasserman
L.A. Wilber
W.A. Yost

Working Group S3-39, Human Exposure to Mechanical Vibration and Shock, which assisted Accredited Standards Committee S3, Bioacoustics, in the review of this Standard, had the following membership:

D.D. Reynolds, Chair

N. Alem	W. Pielemeier	D.E. Wasserman
M. Cherniack	D. Roley	J. Wasserman
R. Dong	S.D. Smith	D. Wilder
T. Jetzer	E.D. Sussman	

Suggestions for improvement of this Standard will be welcomed. They should be made in writing to the Standards Secretariat, Acoustical Society of America, 35 Pinelawn Road, Suite 114E, Melville, New York 11747-3177

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Introduction

The purpose of this part of ISO 2631 is to help in the design and evaluation of fixed-guideway passenger systems, with regard to the impact of vibration and repetitive motions on passenger comfort. This information is required because of the following.

Fixed-guideway vehicles provide a predictable but complex multi-axis motion environment that is a function of the guideway, vehicle and seat or berth. Passengers evaluate ride comfort not only based on motion but also on their expectations with regard to the class of service that they have purchased. The duration of the trip has not been demonstrated to be a direct factor in predicting comfort (with the possible exception of kinetosis), but the anticipated duration of the trip is related to the types of activities passengers expect to accomplish while on board. Passengers on trips of more than a few minutes may expect to read, write, eat and drink; on trips of longer duration they will expect to sleep. To the extent that ride-induced vibration interferes with these activities, passengers may rate differently the comfort of vehicles with the same motion environment but different expected levels of service or different trip durations. Passengers are likely to judge comfort based on the interaction of vibration with factors such as acoustic noise, temperature, humidity, air quality and seat design.

American National Standard

Mechanical vibration and shock — Evaluation of human exposure to whole-body vibration — Part 4: Guidelines for the evaluation of the effects of vibration and rotational motion on passenger and crew comfort in fixed-guideway transport systems

1 Scope

This part of ISO 2631 provides guidance on the application of ISO 2631-1[1] to the evaluation of the effects of mechanical vibration on the comfort of passengers and crew in fixed-guideway systems. It is intended to be used by organizations which purchase, specify or use fixed-guideway systems, to help them to understand the relationship between the design of the guideway as well as other features of the system and the comfort of passengers and crew. These guidelines establish methods for the evaluation of relative comfort between systems, as opposed to absolute levels of comfort.

This part of ISO 2631 is applicable to people in normal health exposed to rectilinear vibration along their x-, y- and z-axes, as well as rotational vibration about these (body-centred) axes. It is intended to provide guidance on the assessment of comfort as a function of motions along and about vehicle axes that produce the body motions. This part of ISO 2631 is not applicable to high-amplitude single transients which may cause trauma, such as those resulting from vehicle accidents or “run-ins” produced by “longitudinal slack action”, nor is it applicable to high-amplitude vibration which may affect health.

For the purposes of this part of ISO 2631, fixed-guideway passenger systems include rail systems (heavy and light rail), magnetically levitated (MAGLEV) systems and rubber tyre metro-type systems, as well as any of the system types listed above that incorporate a tilt capability to compensate for lateral acceleration when traversing curves.

This part of ISO 2631 provides guidance on the effects of very low-frequency accelerations (0.1 Hz to 0.5 Hz) experienced as vertical forces that may cause kinetosis. These forces may be caused by combinations of curve transition, super-elevation and tilt-body technology. However, this part of ISO 2631 is not intended to give guidance on comfort implications of very low-frequency accelerations (below 0.5 Hz) experienced as lateral or longitudinal forces. Such accelerations can be generated by guideway geometry (horizontal alignment and cant).

This part of ISO 2631 gives guidance on the evaluation of ride comfort based on motion environment only.

[1] (U.S. footnote. This note has been added to this American National Standard only for information and is not part of ISO 2631-4.) ISO 2631-1 has been nationally adopted and is identical to ANSI S2.72-2002/Part 1 / ISO 2631-1:1997.