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**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**

*Vibrations et chocs mécaniques — Évaluation de l'exposition des individus  
à des vibrations globales du corps —*

*Partie 4: Lignes directrices pour l'évaluation des effets des vibrations et du  
mouvement de rotation sur le confort des passagers et du personnel dans  
les systèmes de transport guidé*



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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this part of ISO 2631 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 2631-4 was prepared by Technical Committee ISO/TC 108, *Mechanical vibration and shock*, Subcommittee SC 4, *Human exposure to mechanical vibration and shock*.

ISO 2631 consists of the following parts, under the general title *Mechanical vibration and shock — Evaluation of human exposure to whole-body vibration*:

- Part 1: *General requirements*
- Part 2: *Vibration in buildings (1 Hz to 80 Hz)*
- Part 4: *Guidelines for the evaluation of the effects of vibration and rotational motion on passenger and crew comfort in fixed-guideway transport systems*

Annex A forms a normative part of this part of ISO 2631.

## 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.

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# 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 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.

## 2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 2631. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 2631 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 2631-1:1997, *Mechanical vibration and shock — Evaluation of human exposure to whole-body vibration — Part 1: General requirements*.