

ICS 13.160

English Version

**Mechanical vibration and shock - Hand-transmitted vibration -
Influence of coupling forces at the hand-machine interface on
exposure evaluation**

Chocs et vibrations mécaniques - Vibrations transmises à
la main - Evaluation de l'exposition aux effets des forces de
couplage à l'interface entre la main et la machine

Mechanische Schwingungen und Stöße - Hand-Arm-
Schwingungen - Einfluss der Ankopplungskräfte an der
Schnittstelle zwischen Hand und Maschine auf die
Bewertung der Schwingungseinwirkung

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Foreword

This document (CEN/TR 16391:2012) has been prepared by Technical Committee CEN/TC 231 "Mechanical vibration and shock", the secretariat of which is held by DIN.

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Introduction

The coupling force between the hand-arm system and a hand-held, hand-guided or hand-fed machine during its use is an important factor in the transfer of damaging vibration energy to the hand and arm. There is evidence that reducing coupling forces is likely to decrease the damaging effects of exposure to hand-transmitted vibration. However, the relationship between vibration exposure, coupling forces and damage to the hand-arm system is still the subject of research studies. There is a need for practical advice for users on how to minimise and control contact forces and guidance on how to account for those reduced contact forces when assessing vibration exposures. Machine manufacturers of hand-held and hand-guided machines need advice on how to achieve the best compromise between the requirements for both low coupling forces and low vibration magnitudes.

The aims of this Technical Report are to:

- provide guidance on good-practice for both workplace control of exposure and machine design and
- encourage further research to improve the current state of knowledge.

This Technical Report provides an overview of the current state of knowledge on the relationship between vibration exposures, coupling forces and damage to the hand-arm system. It provides general guidance on how to build the reduction of coupling forces into workplace action plans to control vibration exposures and how the reduction of coupling forces may be incorporated into machine design. An example of an empirical relationship for accounting the coupling force in assessments of vibration magnitudes is also provided.

Technical Reports have no effect on the regulations specified by European Directives. That means that at present coupling forces should not be used to modify workplace assessments of vibration exposure according to the EU Physical Agents Directive (vibration) 2002/44/EC or the measurement of vibration emission declared according to the EU Machinery Directive 2006/42/EC.

1 Scope

This Technical Report provides an overview of the current state of knowledge on the relationship between vibration exposures, coupling forces and damage to the hand-arm system. It provides general guidance on how to build the reduction of coupling forces into workplace action plans to control vibration exposures and how the reduction of coupling forces may be incorporated into machine design. An example of an empirical relationship that accounts for the coupling force in assessments of vibration magnitudes is also provided.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 1005-2, *Safety of machinery — Human physical performance — Part 2: Manual handling of machinery and component parts of machinery*

EN 1005-3, *Safety of machinery — Human physical performance — Part 3: Recommended force limits for machinery operation*

EN ISO 5349-1, *Mechanical vibration — Measurement and evaluation of human exposure to hand-transmitted vibration — Part 1: General requirements (ISO 5349-1)*

EN ISO 5349-2, *Mechanical vibration — Measurement and evaluation of human exposure to hand-transmitted vibration — Part 2: Practical guidance for measurement at the workplace (ISO 5349-2)*

ISO 15230:2007, *Mechanical vibration and shock — Coupling forces at the man-machine interface for hand-transmitted vibration*

3 Symbols and abbreviations

For the purposes of this document, the symbols and abbreviations given in ISO 15230:2007 apply.

4 Contact force and hand-transmitted vibration

EN ISO 5349-1 recognises that, although characterisation of the vibration exposure currently uses the acceleration of the surface in contact with the hand as the primary quantity, it is reasonable to assume that the biological effects depend largely on the coupling of the hand to the vibration source. It further notes that the coupling of the hand to the vibrating surface can affect considerably the vibration magnitudes measured.

The importance of coupling force on measurement is also emphasised in EN ISO 5349-2, which advises that different measurement ought to be made if there are changes in the feed forces applied to machines.

EN ISO 5349-1 states that coupling forces should be measured, and notes that a standard on measurement of coupling forces was (in 2001) in preparation. ISO 15230 was published in 2007 and defines parameters relating to the measurement of coupling forces (feed-force, grip force, contact pressures, etc.).

ISO 15230 defines the coupling force as the combination of compressive push/pull and grip forces. It provides a basis for obtaining good-quality information on the forces between the vibrating surface and the hand. However, workplace measurement of coupling force is a complex process that requires specialised equipment and knowledge.