BRITISH STANDARD

BS EN
13059:2002

Safety of industrial trucks — Test methods for measuring vibration

The European Standard EN 13059:2002 has the status of a British Standard

ICS 13.160; 53.060

National foreword

This British Standard is the official English language version of EN 13059:2002.

The UK participation in its preparation was entrusted to Technical Committee MHE/7, Industrial trucks, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this committee can be obtained on request to its secretary.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled "International Standards Correspondence Index", or by using the "Find" facility of the BSI Standards Electronic Catalogue.

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This British Standard, having been prepared under the direction of the Engineering Sector Policy and Strategy Committee, was published under the authority of the Standards Policy and Strategy Committee on 10 May 2002

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Safety of industrial trucks - Test methods for measuring vibration

Sécurité des chariots de manutention - Méthodes d'essai pour mesurer les vibrations

Sicherheit von Flurförderzeugen - Verfahren zur Schwingungsmessung

This European Standard was approved by CEN on 30 December 2001.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Management Centre has the same status as the official versions.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

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Contents

Foreword

This document has been prepared by Technical Committee CEN/TC 150 "Industrial trucks", the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by October 2002, and conflicting national standards shall be withdrawn at the latest by October 2002.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association and supports essential requirements of EC Directives.

For the relationship with EC Directives, see annex ZA, which is an integral part of this document.

This European Standard is one of a series of European Standards for the safety of industrial trucks.

EN 1175-1, *Safety of industrial trucks — Electrical requirements - Part 1: General requirements for battery powered trucks*

EN 1175-2, *Safety of industrial trucks — Electrical requirements - Part 2: General requirements of internal combustion engines*

EN 1175-3, *Safety of industrial trucks — Electrical requirements - Part 3: Specific requirements for the electric power transmission systems of internal combustion engine powered trucks*

EN 1459, *Safety of industrial trucks — Self-propelled variable reach trucks*

EN 1525, *Safety of industrial trucks — Driverless trucks and their systems*

EN 1526, *Safety of industrial trucks — Additional requirements for automated functions on trucks*

EN 1551, *Safety of industrial trucks — Self propelled trucks over 10 000 kg capacity*

EN 1726-1, *Safety of industrial trucks — Self propelled trucks up to and including 10000 kg capacity and industrial tractors with a drawbar pull up to and including 20000 N - Part 1: General requirements*

EN 1726-2, *Safety of industrial trucks — Self propelled trucks up to and including 10000 kg capacity and industrial tractors with a drawbar pull up to and including 20000 N - Part 2: Additional requirements for trucks with elevating operator position and trucks specifically designed to travel with elevated loads*

EN 1755, *Safety of industrial trucks — Operation in potentially explosive atmospheres – Use in flammable gas, vapour, mist and dust*

EN 1757-1, *Safety of industrial trucks — Pedestrian propelled trucks - Part 1: Stacker trucks*

EN 1757-2, *Safety of industrial trucks — Pedestrian propelled trucks - Part 2: Pallet trucks*

EN 1757-3, *Safety of industrial trucks — Pedestrian propelled trucks - Part 3: Platform trucks*

EN 1757-4, *Safety of industrial trucks — Pedestrian propelled trucks - Part 4: Scissor lift pallet trucks*

EN 12053, *Safety of industrial trucks — Test methods for measuring noise emissions*

EN 12895, *Industrial trucks — Electromagnetic compatibility*

EN 13059, *Safety of industrial trucks — Test methods for measuring vibration*

EN ISO 13564[1)], *Safety of industrial trucks — Test method for measuring visibility from self propelled trucks (ISO/DIS 13564:1996)*

The Machinery Directive 98/37/EC amended by Directive 98/79/EC requires that vibration measurements be made and values put into the instruction books if the whole-body vibration values are greater than 0,5 m/s^2.

A type test procedure is specified so that different establishments obtain comparable results of vibration measurements within specified limits. The specified procedure consists of measuring the vibration transmitted to the operator when the truck is travelling over a test track made of a straight length of good quality surface with obstacles whose characteristics depend on the type of truck and its wheel characteristics.

The annexes A, B, C and D are informative.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

[1] Under preparation, using the Vienna agreement with ISO lead.

Introduction

This European Standard has been prepared to be a harmonized standard to provide one means of conforming to the essential safety requirements of the Machinery Directive and associated EFTA regulations. This European Standard is a type C standard as stated in EN 1070.

The aim of this standard is to provide a method for the measurement of vibration emission transmitted to the whole body of operators of industrial trucks which will enable the information requirements of the Machinery Directive to be satisfied. It is intended that the results obtained also can be used to compare industrial trucks of the same category or a given truck when equipped with different seats or tyres, etc. This standard cannot be used for field measurements to determine the daily exposure of the operator to vibration.

For the measurements trucks shall be fitted with equipment corresponding to that offered by the manufacturers on the standard truck data sheet (lifting devices, batteries, etc.).

Type test measurements require accurate and reproducible results. It is essential that different establishments obtain comparable results within specified limits. This requires that the process or way in which the machinery is used during the measurement is precisely defined. This process will reproduce the whole-body vibration values typical of the machinery when in normal travelling use.

In the case of industrial trucks, there may be three predominant operating modes: travelling, lifting and engine idling; of these, only travelling exposes the driver to significant whole-body vibration. Therefore, in accordance with EN 1032, the test for whole-body vibration is based on the travelling operating mode.

Research has shown that the magnitude of hand-arm vibration on the steering wheel or control levers of trucks will normally be lower than 2,5 m/s^2. Therefore no test method has been developed for its measurement.

In practice, exposure over a working day is a mixture of the three modes and the average vibration values will generally be lower than the values given by this standard. Fitting the industrial trucks with different seats, changing the tyres, etc. can lead to different vibration values. Due to the specific operation of industrial trucks however, the existing EN 1032 standard cannot be applied directly, so that preparation of this standard for industrial trucks became necessary.

Although studies showed that it is possible to obtain repeatable and representative results with all-terrain trucks tested on an artificial test track, this family of trucks is covered by Informative annex A. The reason is that an inexplicable difference of about 20 % was found in the emission from one truck when it was tested at two different times of the year. Further consideration should be given to including all-terrain trucks in the normative section of the standard when more data is available for these trucks.

For the verification of the measurements the uncertainty is fixed at 0,3 times the vibration emission value reported in accordance with EN 12096. Further consideration should be given to revise this range of uncertainty when emission vibration data obtained from different places is available.

1 Scope

This European Standard is a type test procedure for establishing the values of vibration emission transmitted to the whole body of operators of industrial trucks under specified conditions. It is not applicable to hand-arm vibration.

This standard is applicable to powered industrial trucks listed in ISO 5053:1987. The annex A is applicable for "all-terrain" trucks. It also applies to other powered industrial trucks not covered by ISO 5053:1987, e.g. variable-reach trucks and "low-lift" "order picking" trucks, etc.

NOTE The standard may however be useful also for existing trucks.

This standard is not applicable to non-stacking "low-lift" straddle carriers (as specified in 3.1.3.2.3 of ISO 5053:1987) and stacking "high-lift" straddle carriers (as specified in 3.1.3.1.11 of ISO 5053:1987).

The test results, however, are not applicable to the determination of whole-body vibration exposure.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text, and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 292-1, *Safety of machinery – Basic concepts, general principles for design - Part 1: Basic terminology, methodology.*

EN 292-2, *Safety of machinery – Basic concepts, general principles for design - Part 2:Technical principals and specifications.*

EN 1032:1996, *Mechanical vibration — Testing of mobile machinery in order to determine the whole-body vibration emission value — General.*

EN 1070, *Safety of machinery – Terminology.*

EN 12096, *Mechanical vibration — Declaration and verification of vibration emission values.*

ISO 2041, *Vibration and shock — Vocabulary.*

ISO 5053:1987, *Powered industrial trucks — Terminology.*

ISO 5805, *Mechanical vibration and shock — Human exposure — Vocabulary.*

3 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in EN 1070, ISO 2041, ISO 5053 and ISO 5805, and the following apply.

3.1
truck family
trucks sharing the same major components that influence vibration emission

3.2
wheel diameter
arithmetic mean of the outside diameters of the load bearing wheels, e.g. : if the truck has some wheel(s) of diameter D_1, some wheel(s) of diameter D_2 and some wheel(s) of diameter D_3, the wheel mean diameter equals $(D_1 + D_2 + D_3)$/(number of tyre sizes fitted)

The outside diameter, D, is the maximum in service diameter quoted in the ETRTO manual (see annex D) for the size(s) and type(s) of tyres fitted. If a tyre is not listed, consult the tyre's manufacturer.

3.3
tyre
the tyre can be pneumatic or solid. Amongst the solid tyres a distinction can be made between high-load "non-rubber" solid tyres (Vulkollan, Contilan, etc.) and rubber solid tyres

Rubber solid tyres can be fitted to a cylindrical or conical base (e.g. cushion "bandages") or to a pneumatic tyre rim (e.g. super elastic tyres).

3.4
seat base
surface on which the seat and its suspension, if fitted, are mounted

3.5
seat pan
seat surface on which the operator is seated

4 Quantities to be measured

The quantities to be measured are as follows:

4.1 $a_{w,z}$: root mean square (r.m.s.) acceleration of whole-body vertical frequency-weighted vibration in accordance with EN 1032;

4.2 $\bar{a}_{w,z}F$: mean value of N r.m.s. weighted vertical acceleration values of a valid test series measured on the floor of the driving position with one standing operator;

4.3 $\bar{a}_{w,z}S$: average of acceleration mean values obtained for each of the two operators for a valid test series measured on the seat pan under the seated operator;

4.4 the mean truck speed when travelling on the test track. This may be determined from the time taken to drive along the test track or by means of the measuring instruments specified in 5.2;

4.5 pneumatic tyre pressures shall be checked;

4.6 ambient air temperature.

5 Instrumentation

5.1 Whole-body vibration

5.1.1 General

The specifications for the instrumentation given in EN 1032:1996, 5.1, for the measurement of whole-body vibration apply.

5.1.2 Transducers

General requirements for mounting of vibration transducers are given in EN 1032:1996, 5.2. In the case where the measurements are made on a seat pan the transducer shall be mounted in a semi rigid disc as described in EN 1032:1996, 5.2.

In the case where the measurements are made at the seat base or on the floor the transducer shall be firmly fixed to rigid parts of trucks e.g. by means of a magnet, or adhesive, etc.

NOTE In the case of stand on trucks, it is convenient to mount the transducer on a light rigid plate upon which the operator can place both feet.

5.1.3 Frequency weighting

Frequency weighting and band limiting characteristics shall be in accordance with 5.3 of EN 1032:1996.

5.1.4 Integration time

For each run, the r.m.s. acceleration shall be a linearly integrated average over one complete test run (see 8.2).

5.2 Truck speed

The truck speed on the test track shall be measured using instruments measuring the average speed with an accuracy of $\pm$ 5 %.

NOTE An alternative method is to measure the time to travel over the full length of the test track. From knowledge of the length of the track and the time taken to travel it, the truck average speed is calculated.

6 Vibration measurement direction and location

6.1 Measurement direction

Measurement shall be made in the vertical (Z) direction.

6.2 Measurement location

In the case where the exposed persons are sitting, the transducer mounted in a semi rigid disc shall be placed on the surface of the seat such that the transducer is located midway between the ischial tuberosities of the seated person. For comfort reasons, it is acceptable if the centre of the disc is located slightly in front (up to 5 cm) of the ischial tuberosities (Figure 1).

When measurement at the seat base are made (see 7.2), the transducer shall be firmly mounted, preferably at the centre of the seat base mounting; where this is not possible, it shall be mounted outside the seat base mounting at the same level as the seat base on a stiff part towards the side of the truck (see Figure 1) perpendicular to the direction of travel and as close as possible to the seat centre.

In the case where the exposed persons are standing on a driving or a working platform, the transducer shall be located (see 5.1.2) at a point immediately adjacent to the feet of the standing operator (preferably between the feet).

NOTE When the position of the standing driver can influence the results, the intended position of the driver should be clearly identified.

7 Set up and equipment

7.1 General

The trucks shall be categorized on the basis of tyre types and the wheel mean diameter. The test track is constructed basically of two obstacles. Further details shall be taken from Table 1 and Figures 2 and 3.

7.2 Test track

The test track is a straight track and consists of a level, smooth length (ℓ) surface with two rigid obstacles each 15 cm wide of rectangular cross section (e.g. hard wood, metal, etc.) to drive over. The deflection of the obstacle material shall be negligible. Figures 2 and 3 illustrate the test track and obstacles. The length (ℓ) of the test track and the height of the two obstacles shall be chosen from Table 1. The total length of test track will also include a sufficient distance at each end to allow the truck to build up to the required speed at the actual start of the run and to slow down and turn at the end of the run. The test track surface shall be made of hard material like tarmac, concrete, etc. The smoothness of the surface shall also be such that the r.m.s. acceleration of the frequency weighted vertical vibration ($a_{w,z}$) measured at the seat base or foot plate when the truck is travelling over the test track without the obstacles is less than 50 % of the value measured at the same location when the truck is travelling over the test track with the obstacles. The conditions for the measurements made without obstacles are the same as with the obstacles. Before starting the measurements it is essential the test surface shall be cleared of any loose chippings, etc. It is essential that the obstacles do not move on the test track surface.

NOTE 1 The relationship between measurements made on the seat with and without obstacles is generally smaller than the same measurements made at the seat base.

NOTE 2 If the truck is equipped with a low frequency suspended cab (resonant frequency below 10 Hz), it is recommended to make the measurements on the chassis at a point aligned as closely as possible to a point vertically below the seat centre (see 6.2).

NOTE 3 If the vibration measured at the seat base or foot plate with obstacles is less than 0,5 m/s^2, then the 50 % criterion can be ignored.

7.3 Equipment and condition of the truck

7.3.1 Truck

Measurements shall be carried out on a new, properly serviced truck. Where a single truck is to be measured and then taken as representative of a truck family, it shall be fitted with equipment corresponding to that offered by the manufacturer on the standard truck data sheet (lifting devices,

batteries, etc.). For individual measurements and special equipment, the specific equipment shall be listed.

7.3.2 Load

Trucks of categories 1, 2, 3 and 4 (see Table 1) shall be tested with a load of 60^{0}_{-10} % of the rated load capacity of the truck at the rated load centre distance. Trucks of category 5 shall be tested unladen for practical reasons.

Pallet trucks shall be tested with the load support arms raised.

7.3.3 Tyres

The truck shall be fitted with new tyres. Pneumatic tyres shall be properly inflated in accordance with the truck manufacturer's instructions. The final inflation pressure verification shall be carried out immediately before and after the vibration testing. If a deviation of more than 10 % is noted on the tyre inflation pressure before and after the test the vibration tests shall be repeated.

If a truck can be equipped with different types of tyres (e.g. pneumatic tyres, resilient solid tyres, cushion tyres (bandages) or high-load "non-rubber" solid tyres), at least one series of measurements shall be made for each type of tyre.

NOTE When the relevant dynamic characteristics of the tyres and truck are known, then the truck can be tested with just one tyre type and the vibration calculated for other types of tyre.

7.3.4 Trucks with a cab

If or when a truck can be fitted with a cab with or without a suspension, measurements shall be carried out for both cases.

If the driver's cabin position can be moved horizontally, then measurements shall be carried out at the extremes of that movement and the highest values of vibration emission shall be reported (see clause 9). If the driver's position can be moved vertically, then measurements shall be carried out in the lowest position.

7.3.5 Trucks with seated operators

The seat (or seats) shall be adjusted such that the driver can comfortably reach the necessary controls. If the truck is equipped with a suspension seat, the suspension shall be adjusted to the driver's weight and to avoid topping and bottoming of the mobile part of the seat suspension. If a truck can be fitted with different models of seat, measurements shall be carried out for each model of seat.

7.4 Operators

7.4.1 Standing operator

Measurements shall be made with one operator with a mass of 75^{0}_{-10} kg.

7.4.2 Seated operator

Measurements shall be made with one operator with a mass of 75^{0}_{-10} kg if the seat which is fitted to the truck being tested has passed the seat laboratory test code (see EN 13490) for the corresponding category of truck.

If the seat manufacturer cannot prove that the seat has passed the seat test code in this case the truck shall be measured with two operators whose mass equals 55^{0}_{-5} kg and 98^{0}_{-8} kg.

7.5 Environmental parameter

The measurements shall be made within a temperature range 5 °C to 30 °C.

8 Measurement procedure and validity

8.1 Speed

The average speed of the truck travelling on the test track shall be as given in Table 1 with a tolerance better than ± 10 %.

NOTE 1 The driver keeps a constant speed over the length of the test track. Experience has shown that constant speed can be achieved e.g. by limiting the travel of the accelerator pedal and asking the operator to drive at full throttle under these conditions.

NOTE 2 It is important that the operator can drive the truck without difficulty e.g. such as steering wheel wobble.

NOTE 3 If the maximum speed given by the manufacturer is less than the recommended speed, specified in Table 1, the truck is tested at 80 % of the maximum unladen speed given by the manufacturer.

NOTE 4 It is recommended to test the trucks at different speeds within the permitted speed tolerance to eliminate or minimize any resonance effects.

8.2 Test procedure

For the measurements, the truck, tyres and seat suspension, if fitted, shall be at operating temperature (a warming-up time of at least 10 min shall be allowed during which the loaded truck is travelling).

With each type of equipment (set of tyres, type of cab and seat) each operator shall carry out one test series. A test series shall consist of N valid runs on the test track. N is the number of test runs necessary to satisfy the validity of test requirements of 8.3 (the minimum number for N is five). The operator shall drive forwards over the test track at the required constant speed (see 8.1). Vibration shall be measured only from when the front wheel crosses the start line until the same wheel crosses the finish line (see Figure 2).

8.3 Validity of test

Measurements of the r.m.s. acceleration of whole-body vertical weighted vibration shall be continued by each operator until a valid test series has been obtained. This is indicated when the coefficient of variation C_V (see 8.4) of N consecutive weighted r.m.s. acceleration values is less than 0,15.

For a valid test series, the mean value is obtained from:

$$\bar{a}_{w,z} = \frac{1}{N}\sum_{i=1}^{N} a_{w,zi}$$

where

$\bar{a}_{w,z}$ is the mean value of the series, in m/s^2;

$a_{w,zi}$ is the measured value, in m/s^2;

N is the number of measurement values of a valid test series.

8.4 Coefficient of variation

The coefficient of variation C_v of a test series is defined as the ratio of the standard deviation of a series of measurement values and the mean value of the series:

$$C_v = \frac{s_{N-1}}{\bar{a}_{w,z}}$$

where the standard deviation is

$$s_{N-1} = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(a_{w,zi} - \bar{a}_{w,z})^2}$$

8.5 Reported vibration values

8.5.1 Trucks with standing operator

The reported value $\bar{a}_{w,zF}$ for whole-body transmitted vibration is the mean value (see 8.3) of N r.m.s. vertical weighted acceleration values of a valid test series measured on the floor of the driving position with one operator.

8.5.2 Trucks with seated operator

If the seat which equipped the truck tested has passed the seat laboratory test code (see EN 13490) for the corresponding category of truck (see 7.4.2), the reported value $\bar{a}_{w,zS}$ for whole-body transmitted vibration is the mean value (see 8.3) of N r.m.s. vertical weighted acceleration values of a valid test series measured on the seat pan with one operator.

If the seat manufacturer cannot prove that the seat has passed the seat laboratory test code, the reported value $\bar{a}_{w,zS}$ for whole-body transmitted vibration is the average of mean acceleration values $\bar{a}_{w,zS1}$ and $\bar{a}_{w,zS2}$ (see 8.3) obtained for each of the two operators for a valid test series measured on the seat pan:

$$\bar{a}_{w,zS} = \frac{1}{2}(\bar{a}_{w,zS1} + \bar{a}_{w,zS2})$$

8.5.3 Trucks with standing and seated operator

The reported values are:

$\bar{a}_{w,zF}$ measured on the floor in accordance with 8.5.1 for a standing operator;

$\bar{a}_{w,zS}$ measured on the seat in accordance with 8.5.2 for a seated operator.

9 Items to be included in a test report

The test report shall include the following details:

— reference to this standard;

— specification of the tested industrial truck (manufacturer, trade mark, commercial designation, serial number) and the truck category;

— description of the truck attachment;

— position of operator;

— types of tyre (family, external diameter, pressure);

— type of cab (if any);

— model of seat (if any) and Seat Effective Amplitude Transmissibility values (SEAT) if known,

— climatic conditions (temperature);

— truck speed when travelling on the test track;

— test load;

— instrumentation used for vibration measurement (manufacturer and type);

— type of test track;

— measuring establishment, date of measurement, name of the person responsible for the test;

— values of vibration (see 8.5).

Guidance for reporting the vibration data is given in annex B.

NOTE Although this standard has been designed to cover many categories of trucks, it may be possible that new trucks appear on the market. In this case, it is recommended to follow the procedure given in the annex C.

10 Declaration of vibration emission values

The vibration declaration shall explicitly state that the vibration emission values have been obtained in accordance with this vibration test code and EN 12096.

The vibration emission declaration shall include the following details:

— the r.m.s. weighted acceleration of whole-body vertical vibration measured on the truck floor ($\bar{a}_{w,zF}$) with a standing operator or on the truck seat ($\bar{a}_{w,zS}$) with seated operator. In the case of a truck where the operator can sit or stand, both values ($\bar{a}_{w,zF}$) and ($\bar{a}_{w,zS}$) shall be declared.

The values declared shall be rounded to the nearest 0,1 m/s^2 on the basis of the results obtained in accordance with 8.5 and the requirements of EN 12096.

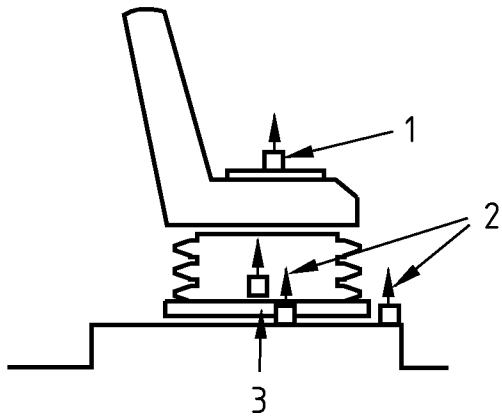
11 Verification of vibration emission values

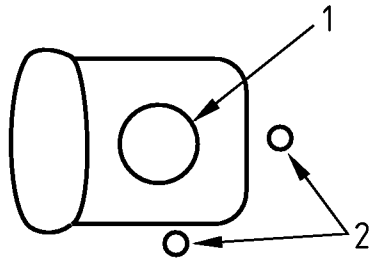
The vibration values shall be declared so that it shall be possible to check them in accordance with EN 12096. The verification shall be conducted using the same procedure and operating conditions as those used for the initial evaluation of vibration emission values. The uncertainty is fixed in accordance with EN 12096 to:

$K = 0{,}3\ \bar{a}_{w,z}$.

Table 1 — Truck categories and associated test conditions

Category		1	2	3	4	5
Specification of truck	Family of tyres*	High-load non-rubber solid tyres	High-load non-rubber solid tyres or cylindrical/ conical base rubber solid tyres	Rubber solid tyres or pneumatic tyres		
	Wheel mean diameter (∅) mm	∅ ≤ 200	200 < ∅	∅ ≤ 645	645 < ∅ ≤ 1 200	1 200 < ∅ ≤ 2 000
Specification of test track	Family of trucks (indicative)	Platform trucks, trucks rider controlled, etc.	Reach trucks, articulated trucks, etc.	Straddle trucks, counterbalanced trucks, etc.		
	Length (ℓ) of test track, m	15	25			
	Height (h) of obstacles, mm	5		8	10	15
	Distribution (a and b) of obstacles, m	4 and 6	5 and 10			
	Speed, km/h	5	7	10		
*) tyres : see clause 3 for definitions						





Key (above)

1 Seat pan

2 Alternative position

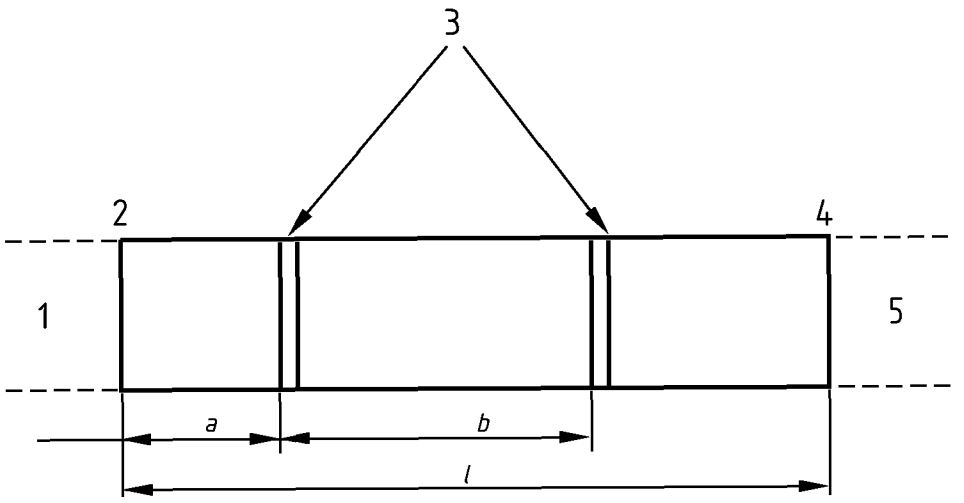
3 Preferable position

Key

1 Forward facing seat

2 Side facing seat

Figure 1 — Whole-body vibration - Acceleration direction



Key

1 Space to establish speed
2 Start line
3 Obstacles
4 Finish line
5 Space to slow down

Figure 2 — Characteristics of the test track (see Table 1)

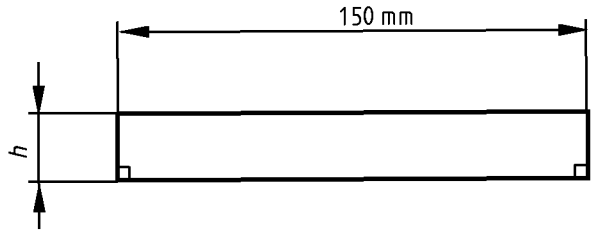


Figure 3 — Characteristics of the obstacles (see Table 1)

Annex A
(informative)

Guidance for testing "all terrain" trucks - Category 6

"All-terrain" trucks are designed either with a rigid chassis or pivot steering; they can be equipped with a mast or boom. They are generally equipped with large pneumatic tyres which can be different at the front and at the rear.

For various reasons (see NOTE below) it is judged premature to include "all-terrain" trucks in the body of the standard. Nevertheless in this annex it is proposed to use a method which is similar to the one proposed in the normative section of the standard.

The characteristics of the artificial test track are explained in 7.2 and are given in Table A.1. The truck should be tested with a load of 60 (0/–10) % of the rated load capacity of the truck. In the case of a machine with a telescopic boom, the rated load is taken with the boom retracted. Tyre inflation pressure verification should be carried out immediately before and after the vibration testing. If a deviation of more than 10 % is noted on the tyre inflation pressure before and after the test the vibration tests shall be repeated. The measurements should be made within a temperature range 5 °C to 20 °C.

NOTE Measurements of vibration show that the results are affected by many factors such as speed, type of tyre, tyre pressure, tyre temperature, seat type, total mass, weight distribution, etc. However when applying the test code proposed in the normative section of the standard, good repeatability for one truck is obtained on the same day with different drivers, under the same operating conditions and for consecutive tests.

Comparisons between measurements obtained in the field or when applying the test code proposed in the normative section of the standard or on another artificial test track consisting of seven obstacles of 5 cm or 7 cm height on which the right and left wheels are successively running show similar classification of the different trucks tested. Measurements show also that the results were representative of the working environment because the characteristics of artificial test track (obstacle height) were selected so as the vibration values correspond to those measured under real conditions. When the test is repeated, at different times of the year, with different outside temperatures, different results may be found generally explainable by variation of tyre dynamic response and pressure.

However an inexplicable difference of about 20 % was found in the emission from one vehicle when it was tested at two different times of the year despite that the ambient temperature and tyre pressures were the same. Therefore further consideration should be given to including all-terrain trucks in the normative section of the standard when more data is available for these trucks.

Table A.1 — Conditions of the test for "all-terrain" trucks

Category		6
Specification of truck	Family of tyres*)	Pneumatic
	Wheel mean diameter (∅), mm	All
Specification of test track	Family of trucks	"All-terrain" trucks
	Length (ℓ) of test track, m	25
	Height (h) of obstacles, mm	30
	Distribution (a and b) of obstacles, m	5 and 10
	Speed, km/h	10
*) see clause 3 for definitions		

Annex B
(informative)

Guidance for reporting vibration data

The results should be expressed as r.m.s. values of weighted acceleration in m/s^2.

B.1 Truck with standing operator

Operator = ...kg	Acceleration in m/s^2						
Location	Test run					$\bar{a}_{w,zF}$	C_v
	1	2	3	…	N		
Whole body ($a_{w,zF}$) on floor							

B.2 Truck with seated operator

B.2.1 The seat has passed the seat test code

Operator = ...kg	Acceleration in m/s^2						
Location	Test run					$\bar{a}_{w,zS}$	C_v
	1	2	3	…	N		
Whole body ($a_{w,zS}$) on seat							

B.2.2 The seat has not passed the seat test code

Heavy operator (1) = ... kg	Acceleration in m/s^2						
Location	Test run					$\bar{a}_{w,zS1}$	C_v
	1	2	3	…	N		
Whole body ($a_{w,zS1}$) on seat							
Light operator (2) = ... kg	Acceleration in m/s^2						
Location	Test run					$\bar{a}_{w,zS2}$	C_v
	1	2	3	…	N		
Whole body ($a_{w,zS2}$) on seat							

Overall mean weighted value = $\frac{1}{2}(\bar{a}_{w,zS1} + \bar{a}_{w,zS2}) = \bar{a}_{w,zS}$ = ...

B.3 Truck with standing and seated operator

Same model report as B.1 and B.2.

Annex C
(informative)

Procedure for developing a measurement method for a specific category of industrial truck

Although this standard has been designed to cover many categories of trucks, it should be possible that new trucks appear on the market which can not be included in Table 1.

In this case, the following procedure is recommended to develop an appropriate test.

1) Collect information on vibration at the seat base and on the seat pan measured under real conditions when the trucks are mainly travelling.

— Collect information on truck speeds: maximum speeds according to the manufacturers, actual speeds under real conditions.

— Collect information on the quality of ground surface in the field (characteristics of obstacles, such as door sills, sewage cover, ramps, fractures, etc.).

2) Select a target acceleration value at the seat base which corresponds to the mean value of the accelerations measured in the field on many trucks of a specific category.

— Select a speed range sufficiently low to be possible for the majority of trucks of a specific category (it should be possible to drive the trucks over the test track without difficulty) but sufficiently high to be realistic of use in the field. Only one speed is recommended for a specific category of truck.

3) Determine the test track characteristics (see Table 1 and Figures 2 and 3).

— The obstacle characteristics should be adjusted so that the vibration values at the seat base approximate, on average, the target acceleration value defined in point 2. The test track should be as short as possible but long enough to enable vibration analysis and to get an acceptable repeatability of results (see 8.3).

— The smoothness of the test track surface should be such that the acceleration measured under the seat on the truck travelling over the test track without the obstacles is lower than 50 % of the acceleration measured with obstacles (see 7.1).

— It may be beneficial to select a lower speed and more severe obstacles to satisfy the above conditions.

4) Check the repeatability of measurements and identify causes of variability (variability of speed, tyre pressure, loose chippings, etc.) in order to study the possibility of minimizing their effects.

5) Organize comparison tests between measuring sites.

Annex D
(informative)

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(**** represents the year as it is published annually; e.g., the edition for the year 1998 is "Standards manual 1998")

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32/2 avenue Brugmann
1060 Brussels
Belgium
Tel. (+32 2) 344 40 59
Fax (+32 2) 344 12 34

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ETRTO's name in German is:

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Annex ZA
(informative)

Relationship of this document with EC Directives

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association and supports essential requirements of EC Directive(s):

Machinery Directive 98/37/EC, amended by Directive 98/79/EC.

The clauses of this standard are likely to support requirements of the above referred Directive.

Compliance to this document provides one means of conforming with the specific essential requirements of the Directive concerned and associated EFTA regulations.

WARNING : Other requirements and other EC Directives may be applicable to the product(s) falling within the scope of this document.

Bibliography

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EN 13490, *Mechanical vibration — Industrial trucks — Laboratory evaluation and specification of operator seat vibration.*

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