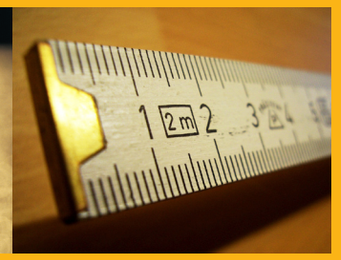

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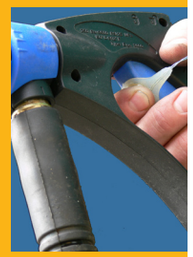

Messanforderungen in Produktnormen

Measurement requirements in product standards

Les exigences de mesure dans les normes de produits

VFA

KAN Kommission Arbeitsschutz und Normung

cen/KAN was formed in 1994 with the objective of safeguarding German occupational safety and health interests during the harmonization of standards within the European Single Market and of assuring the participation of the social partners in standardization processes. At the same time, KAN's objective is that not only German and European but also international standardization should give the best possible consideration to OSH issues. The Commission is composed of five representatives each from the employers, the trade unions and the State, plus one representative each from the German Social Accident Insurance (DGUV) and the DIN Deutsches Institut für Normung.

KAN commissions studies and reports in order to analyse issues of relevance to OSH and to identify scope for improvement in standardization activity.

Background

The term "measurement uncertainty" is used to describe the quality of measurement results and therefore their reliability. Possible measurement results are subject to variability as a result of random and systematic errors; this variability can be associated with the measured quantity, and is described quantitatively by the measurement uncertainty. In the absence of any indication of the measurement uncertainty, measurement results can be compared neither with each other, nor with reference values such as those specified in a standard or statutory provision.

If consideration is not given to the measurement uncertainty, decisions taken on the basis of measurement results may be incorrect, possibly with serious consequences. In the sphere of occupational safety and health and product safety, unsafe products may for example be declared good, thereby possibly leading to hazards. Equally, the sale and use of safe products may be prohibited, leading to litigation. Although the concept of "uncertainty" suggests that of "doubt", it does in fact lead to greater confidence in the validity of the measurement.

The revised Machinery Directive, 2006/42/EC, expressly requires that emission values for noise and vibration be stated together with the associated measurement uncertainty. In the context of the PPE Directive, 89/686/EEC, the stakeholders have long recognized the need for the large number of measurements which are performed to be given greater validity, by ascertainment of the measurement uncertainty. The issue of uncertainty is particularly significant for measurements which are influenced by a large number of highly variable boundary conditions.

Purpose of the study

A study was to be conducted in which harmonized standards pursuant to the Machinery Directive (98/37/EC, now 2006/42/EC)

or the PPE Directive (89/686/EEC) – including current draft standards which are candidates for harmonization – were to be examined with regard to whether they adequately address the issue of measurement uncertainty from an OSH perspective.

Owing to the large number of affected standards, the diversity of measurement methods and the wide technical spectrum, and in order to provide an overview of the scale of measurement requirements within the area covered by these harmonized standards, an initial project phase began by considering the following issues, rather than the measurement uncertainty as such:

1. Do the standards and draft standards referred to above contain safety-related requirements that are described by measured quantities?

2.a) Is it necessary for specific methods to be described for measurement of these quantities?

If the answer to 2.a is "yes":

2.b) Are the relevant measurement methods described or are references made to such methods?

KAN wishes to thank the project partners (*die ergonomie.experten*, Project Manager: Dr. Stephan Riedel, Feilbingert) for conducting the project, and the following experts in the project working group for supervising and supporting it:

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Norbert Breutmann, Confederation of German Employers' Associations (BDA)

Dieter Hansen, DIN, Berlin

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Karl-Heinz Noetel, head of the PPE expert committee, Wuppertal

Marc Schulze, German Federal Ministry of Labour and Social Affairs (BMAS), Bonn

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Werner Sterk, Head of the KAN Secretariat, Sankt Augustin

Method

In order for the approach taken by the project partners to be transparent, the method employed is explained below.

Re Question 1.:

Each document was first examined to ascertain whether it does in fact contain safety-related requirements described by measured quantities.

Where this was not the case, the response to Question 1 was *No* for the entire document, and the response to Questions 2a and 2b was *Not applicable*. The document concerned was therefore not considered further.

Where the document did contain safety-related requirements described by measured quantities, the response to Question 1 was *Yes*, and the requirements in question were examined further.

Re Question 2.a):

One difficulty of the project lay in identifying which measurements could be classified as *trivial*, i.e. for which it is not absolutely necessary to describe a measurement method.

In the context of this study, it was agreed that measurements were to be considered trivial if they could generally be performed with standard equipment **and** from which reproducible results can be expected even where no measurement method is described. This concerns, for example, the following quantities:

- ▷ Length
- ▷ Angle
- ▷ Mass or weight
- ▷ Temperature, where not extremely high (> 900 °C) or involving a very high measurement accuracy
- ▷ Low, linear velocity
- ▷ Simple line pressure
- ▷ Electrical voltage, current, resistance
- ▷ Period of time within the human capacity for reaction
- ▷ Quantities with relatively high tolerances

For measured quantities of this kind, the response to Question 2 was therefore generally *No* and that to the subsequent question 2.b) *Not applicable*. The measurement requirements affected in these cases were not examined further.

For other measured quantities, it was generally assumed that measurements can be performed effectively only if a method (and where applicable a suitable type of instrument) is specified. In these cases, the response to Question 2.a) was *Yes*, and the requirements concerned were examined further.

Re Question 2.b):

The purpose of the final step was to determine whether a description of the required measurement method or a reference to such a method is provided for the requirements in question.

Figure 1: Example page from a table of results

Standard	TC	Subject	Date	Measured quantity	Unit stated
DIN EN 14238	**CEN/TC147**	**Cranes**	**Oct 04**		
				Weight	kg
				Service pressure	bar
				Time	min
				Noise emission	
				A-weighted sound pressure level	(dB)
				A-weighted sound power level	
				Spatial dimensions	m
				Time	min
DIN EN 14439	**CEN/TC147**	**Cranes**	**March 07**		
				Travel speed	m/min
				Spatial dimensions	m, mm
				Ladder dimensions, hatch dimensions	m
				Ambient temperature	°C
				Time	s, min
				Illumination	lux
				A-weighted sound power level	(dB)
				A-weighted sound pressure level	(dB)
				Surface	m^2
DIN EN 14439 A1	**CEN/TC147**	**Cranes**	**Aug 05**		
				Wind speed	m/s
				Wind load	N/m^2
				Speed	m/min
DIN EN 14492-1	**CEN/TC147**	**Cranes**	**Feb 07**		
				Load-bearing capacity	kg, t
				Tension force	N
				Time	s
				Spatial dimensions	m
				Deflexion angle	°
				Aperture angle	°
				Hardness	HRC
				Pressure	bar
				Engine speed	1/min
				Temperature	°C
				Emission sound pressure level	(dB)
				Sound power level	(dB)
				Speed	m/s
				Surface resistance	Ω
				Degree of protection 55	IP
				Sound pressure	dB
				Frequency	Hz

Chapter	Question 1.	Question 2.a)	Question 2.b)	Remarks
	Yes			
5.2.3; 5.6.5	Yes	No	Not applicable	
5.3	Yes	Yes	No	
5.4.2.3; 5.4.4.3; 6.3.2.2	Yes	No	Not applicable	
5.6.6	No	Not applicable	Not applicable	Heading incorrect: noise emission is not determined
7.2.1; A.3; A.7;A.9	Yes	Yes	Yes, EN ISO 11201, EN ISO 11202	"(A)" missing at statement of the sound pressure level
A.4	Yes	Yes	Yes, EN ISO 3744, EN ISO 3746	
A.3.2; A.4	Yes	No	Not applicable	
5.4.2.3; 5.4.4.3; 6.3.2.2	Yes	No	Not applicable	
	Yes			
5.2.2.5	Yes	No	Not applicable	
5.4.1.6; 5.4.1.7; 5.4.2.10; 5.4.4.2; 5.4.4.5.2; 5.4.4.5.4; 7.2.5; D.3.3.2; E.2.1; E.2.2.2; E.3.1;F	Yes	No	Not applicable	
5.4.4.3; 5.4.4.4	Yes	Yes	Yes, EN 13586	
5.4.1.8	Yes	No	Not applicable	
5.4.1.8; 5.4.1.9; D.3.3.2	Yes	No	Not applicable	
5.4.5	Yes	Yes	No	
6.4.1; 7.2.5; E.2	Yes	Yes	Yes, EN ISO 3744	
5.5.2; 6.4.2;E.3	Yes	Yes	Yes, EN ISO 11201	"(A)" missing at statement of the sound pressure level
E.2.2.3	Yes	No	Not applicable	
	Yes			
F.2.2	Yes	Yes	No	
F.2.2	Yes	Yes	No	
F.2.4.1; F.2.4.5	Yes	No	Not applicable	
	Yes			
5.2.2.1; F.6.2	Yes	No	Not applicable	
5.2.2.1	Yes	No	Not applicable	
5.2.2.2.3; 5.2.2.4; F.6.3	Yes	No	Not applicable	
5.2.2.4; 5.7.8; 5.7.9; B.3.3; F.4.1; F.5.3	Yes	No	Not applicable	
5.7.1	Yes	No	Not applicable	
5.7.4	Yes	No	Not applicable	
5.7.9	Yes	Yes	No	
5.11.3.2	Yes	No	Not applicable	Can be measured by means of a pressure gauge
5.12.8.3	Yes	Yes	No	Trivial?
5.12.10; B.3.3	Yes	No	Not applicable	
7.2; F.1; F.4	Yes	Yes	Yes, EN ISO 4871,EN ISO 11201	For information in instruction handbook
7.2; F.1; F.5	Yes	Yes	Yes, EN ISO 3744, EN ISO 4871	For information in instruction handbook
B.3.2	Yes	No	Not applicable	Specifications for fans
B.3.2	Yes	No	Not applicable	
C.2	Yes	Yes	EN 60529	
F.4.1; F.5.2; F.5.3	Yes	No	Not applicable	
F.6.3	Yes	Yes	No	Measurement accuracy: 1 Hz

With regard to statement of a suitable measurement method, the response was *Yes* if the measurement method was described within the standard under examination. If reference was made in the standard to other documents which describe the method, *these standard references* were indicated as the response. Where no apparently effective method or reference to a standard was stated, the response to Question 2.b) was *No*.

Data were not examined which initially appear to be measured quantities but in fact concern the quality of an item of test apparatus (such as material hardness, the concentration of test fluids, etc.) and its components. Material characteristics (such as the grade of steel to be employed) which are normally guaranteed by supply businesses, were also not studied. In general, quantities which are to be calculated were not regarded as measured quantities; only measured values upon which calculation is based were considered.

The results of the study were presented in table form (a sample page is shown in Figure 1).

In the "Remarks" column, the editors have noted comments and explanations for the table entries. Examples include:

- ▷ Reference to possible errors in the standard (such as incorrect units, incorrect references within the standard).
- ▷ Doubts concerning whether the stated description of a measurement method is adequate.
- ▷ Indication that the standard to which reference is made contains no information on the measurement method.

Results

The responses to the questions in the Section entitled "Purpose of the study" were presented in table form, separately for each Technical Committee (TC) at CEN or CENELEC. These tables show whether each document examined contains safety-related measured quantities, and if so which. For each individual measured quantity, the need or otherwise for a non-trivial[1] measurement method is indicated, and whether or not this method is in fact described or a reference provided to such a method.

The detailed results tables will be made available to interested experts upon request.

A total of 941 standards and draft standards from 54 Technical Committees (TCs) were analysed. As shown in Figure 2, measurement of spatial dimensions (clearance, length, width, etc.) was required in almost 2,100 cases. The next category, accounting for just under 1,000 cases, were measurements of sound-pressure levels (sound-power level, emission sound-pressure level), force and time (including duration).

1 For details on the notion of "trivial" see the Section entitled **"Method"**, "Re Question 2.a)"

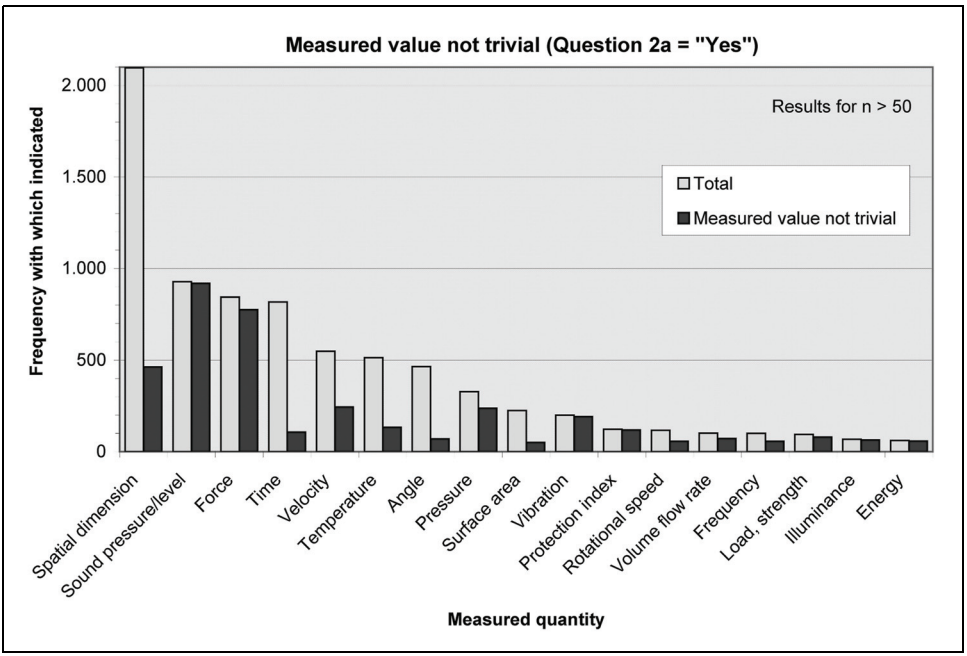

Figure 2: Overall frequency in the standards of the quantities stated, and the proportion of these for which measurement is not trivial

Spatial dimensions and the measurement of time variables may be regarded as trivial in the majority of cases. By contrast, measurements of quantities such as force and in particular sound pressure and vibration normally require a comprehensive description of the measurement method.

Whereas the methods for sound-pressure measurements are described in almost all standards or references provided to other relevant standards, this information is missing for numerous other measured quantities, such as load-bearing capacity, wind speed, energy, complex pressure measurements, etc. (see Figure 3).

This is conspicuously the case for the quantities of *force* (386 of 775 cases = 45 %) and *velocity* (32 %), since measurement of these

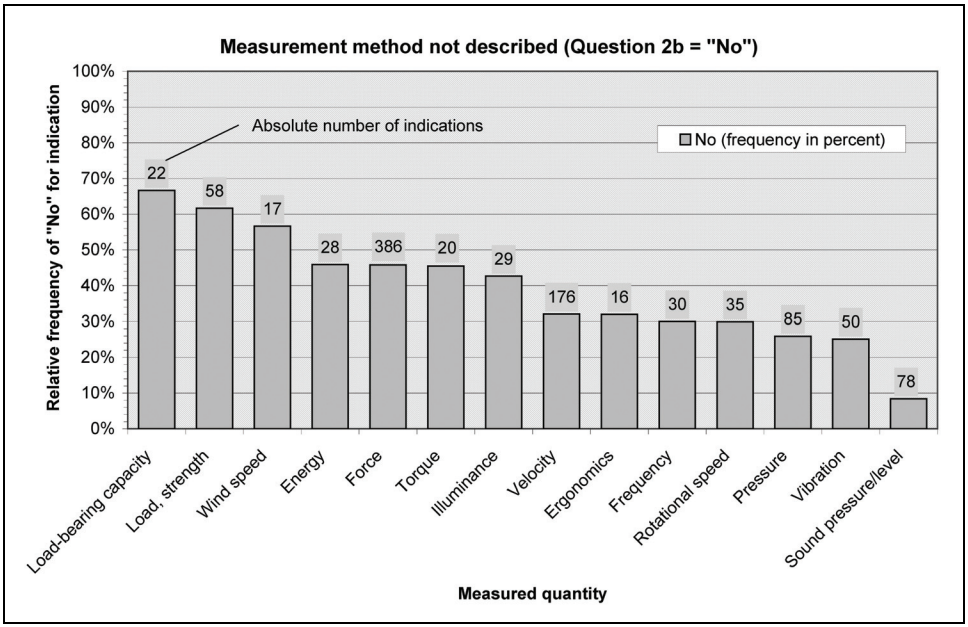

Figure 3: Frequency in percent of quantities for which measurement is non-trivial and no measurement method is stated or reference made to such a method

quantities is very frequently required in standards; and although the Machinery Directive, 2006/42/EC, requires statement of the measurement uncertainty in addition to the emission value for the quantity of *vibration*, no measurement methods are stated in 25 % of cases.

Altogether, the study indicates that for a very significant number of measurement requirements which are considered non-trivial, the stated measurement methods may be unsuitable, or the standard may be entirely lacking a measurement method or a reference to such a method. This shows that the treatment of the measurement uncertainty in standards cannot be limited to the strict technical meaning of the term; instead, where non-trivial measurement tasks are concerned, the measurement uncertainty frequently becomes an issue with a missing or inadequate description of the measurement method. This issue must be examined more closely.

By definition, the tables of results contain only safety-related requirements. Uncertainties in the (evaluation of) measurement results relating to these requirements could therefore lead to uncertainties regarding the conformity of the product concerned. Such a situation may lead to technical or legal conflict, possibly with serious consequences.

The annex of the present report contains, for each TC, a brief summary of the essential *quantities which cannot be measured trivially* for which measurement methods are most frequently not specified.

KAN's recommendations

Recommendations to DIN

The standards committees concerned should review the non-trivial measurement requirements stated in this study for which no or no suitable measurement methods are described or no reference to such methods is provided. It would be desirable for suitable measurement methods to be added or reference made to such methods in the future in these cases.

Should the review reveal that creating the required measurement methods, defining them more precisely or applying them in practice would entail excessive effort, consideration may be given to formulating a qualitative product requirement (which may be more appropriate) in place of a quantitative safety requirement.

In addition, the standards committees may draw up further proposals for improvements based upon the *comments* contained in the tables, and should inform KAN regarding their estimation of the evaluations performed in the present report.

Recommendations to the KAN Secretariat

The KAN Secretariat is instructed to produce a guide, based upon existing standardization rules where they exist (for example in the ISO/IEC directives, the CEN/CENELEC Internal Regulations or the DIN 820 series of standards), indicating the form to be taken by measurement requirements, including the uncertainty of measurement, in product standards.

Essential quantities which are not trivial to measure and for which no measurement methods were most frequently set out, shown separately by Technical Committee (TC):

CEN/SS H10 Sewing machines
Pressure (1x), force (1x)

CEN/SS I24 Industrial fans
Electrostatic charge (1x), ergonomics (1x), sound pressure/sound pressure level (1x), temperature (1x), balancing quality (1x)

CEN/TC 010 Lifts escalators and moving walks
Force (10x), vibration (7x), load, strength (7x), velocity (5x)

CEN/TC 033 Doors, windows, shutters, building hardware and curtain walling
Force (5x), velocity (4x), pressure (1x), torque (1x)

CEN/TC 079 Respiratory protective devices
Sound pressure/sound pressure level (9x), force (7x), velocity (7x), frequency (6x)

CEN/TC 085 Eye protective equipment
Transmittance (14x), light transmittance (8x), illuminance (5x), angle (4x), mass (3x)

CEN/TC 098 Lifting platforms
Force (16x), velocity (14x), load/ strength (13x), pressure (8x)

CEN/TC 079 Respiratory protective devices
Sound-pressure level (9x), force (7x), velocity (7x), frequency (6x)

CEN/TC 114 Safety of machinery
Concentration (8x), sound-pressure/level (3x)

CEN/TC 122 Ergonomics
Spatial dimension (13x), frequency (7x), sound pressure/sound pressure level (5x), ergonomics (5x), vibration (5x)

CEN/TC 123 Lasers and laser-related equipment
No missing measurement methods were identified.

CEN/TC 142 Woodworking machines – Safety
Velocity (32x), force (25x), pressure (9x), torque (7x)

CEN/TC 143 Machine tools – Safety
Rotational speed (8x), energy (5x), force (4x), velocity (2x)

CEN/TC 144 Tractors and machinery for agriculture and forestry
Force (35x), pressure (17x), velocity (14x), rotational speed (13x)

CEN/TC 145 Rubber and plastics machines – Safety
Pressure (8x), force (7x), sound pressure/ sound pressure level (3x)

CEN/TC 146 Packaging machines – Safety
Force (5x), pressure (4x), energy (4x)

CEN/TC 147 Cranes – Safety
Force (5x), vibration (4x), wind speed (4x), velocity (3x)

CEN/TC 148 Continuous handling equipment and systems – Safety
Force (3x), sound pressure/sound pressure level (3x), energy (2x)

CEN/TC 149 Power-operated warehouse equipment
Force (4x), vibration (3x), velocity (2x), load/strength (2x), stability (2x)

CEN/TC 150 Industrial trucks – Safety
Force (10x), spatial dimension (1x), vibration (1x), deceleration (1x), surface area (1x), wind speed (1x)

CEN/TC 151 Construction equipment and building material machines – Safety
Sound pressure/sound pressure level (30x), force (28x), illuminance (7x)

CEN/TC 153 Food processing machinery – Safety and hygiene specifications
Force (36x), velocity (9x), time (4x)

CEN/TC 158 Head protection
Force (11x), energy (5x), ergonomics (5x), current (4x)

CEN/TC 159 Hearing protectors
Sound pressure/sound pressure level (4x)

CEN/TC 160 Protection against falls from height including working belts
Force (31x), velocity (4x), pressure (2x)

CEN/TC 161 Foot and leg protectors
Force (6x), Shore A hardness (4x), energy (3x)

CEN/TC 162 Protective clothing including hand and arm protection and lifejackets
Force (23x), velocity (20x), spatial dimension (12x), pressure (7x)

CEN/TC 168 Chains, ropes, webbing, slings and accessories – Safety
Force (31x), force/strength (20x), load-bearing capacity (17x)

CEN/TC 169 Light and lighting
Illuminance (1x), colour rendering (1x), consistency (1x), colour of light (1x)

CEN/TC 183 Waste management
Vibration (3x), illuminance (2x), force (1x), air exchange rate (1x)

CEN/TC 186 Industrial thermoprocessing – Safety
EMC (1x), gas content (1x), velocity (1x), leakage rate (1x)

CEN/TC 188 Conveyor belts
Velocity (3x), force (1x)

CEN/TC 192 Fire service equipment
Force (6x), spatial dimension (4x), vibration (4x), wind speed (3x)

CEN/TC 196 Machines for underground mines – Safety
Force (4x), time (2x), vibration (1x)

CEN/TC 197 Pumps
Sound pressure/level (3x), pressure (3x), force (3x), chloride content (1x)

CEN/TC 198 Printing and paper machinery – Safety
Force (7x), velocity (4x), pressure (2x), surface area (2x)

CEN/TC 200 Tannery machinery – Safety
Force (6x)

CEN/TC 201 Leather and imitation leather goods and footwear manufacturing machinery – Safety
Force (8x), velocity (6x), pressure (5x)

CEN/TC 202 Foundry machinery
Pressure (4x), resistance (4x), vibration (3x), velocity (2x)

CEN/TC 211 Acoustics
Velocity (3x), wind speed (3x)

CEN/TC 213 Cartridge operated hand-held tools – Safety
Force (2x), velocity (1x), vibration (1x)

CEN/TC 214 Textile machinery and machinery for dry-cleaning and industrial laundry
Force (7x), energy (3x), surface area (3x)

CEN/TC 221 Shop fabricated metallic tanks and equipment for storage tanks and for service stations
Force (1x)

CEN/TC 231 Mechanical vibration and shock
Force (3x), relative humidity (1x), unbalance (1x)

CEN/TC 232 Compressors – Safety
Pressure (2x), sound pressure/sound pressure level (1x), power transmission (1x), power dissipation (1x)

CEN/TC 255 Hand-held non-electric power tools – Safety
Torque (2x), spatial dimensions (1x), rotational speed (1x), time (1x)

CEN/TC 270 Internal combustion engines
Illuminance (2x), pressure (2x), rotational speed (1x), force (1x), power range (1x)

CEN/TC 271 Surface treatment equipment – Safety
Resistance (2x), concentration (1x), vapour concentration (1x), gas concentration (1x), thermal output per unit volume (1x)

CEN/TC 274 Aircraft ground support equipment
Velocity (10x), force (5x), illuminance (2x), vibration (2x), load/strength (2x)

CEN/TC 310 Advanced manufacturing technologies
Velocity (3x), time (3x), limit value of dynamic performance (1x), force (1x)

CEN/TC 322 Equipments for making and shaping of metals – Safety requirements
Thermal insulation (1x)

CLC/TC 078 Equipment and tools for live working (PPE)
Force (6x), pressure (2x), resistance to mechanical puncture (2x), frequency (2x)

CLC/TC 044 and 061 (machines):
Force (18x), time (6x), torque (4x), velocity (2x)