



# SLOVENSKI STANDARD

## oSIST prEN 17558:2020

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### Ergonomija - Ergonomija kompletov osebne varovalne opreme (OVO)

Ergonomics - Ergonomics of PPE ensembles

Ergonomie - Ergonomie von PSA-Ensembles

Ergonomie - Ergonomie des ensembles d'EPI

Ta slovenski standard je istoveten z: prEN 17558

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## Ergonomics - Ergonomics of PPE ensembles

Ergonomie - Ergonomie des ensembles d'EPI

Ergonomie - Ergonomie von PSA-Ensembles

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If this draft becomes a European Standard, 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.

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EUROPEAN COMMITTEE FOR STANDARDIZATION  
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EUROPÄISCHES KOMITEE FÜR NORMUNG

**CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels**

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## European foreword

This document (prEN 17558:2020) has been prepared by Technical Committee CEN/TC 122 “Ergonomics”, the secretariat of which is held by DIN.

This document is currently submitted to the CEN Enquiry.

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## Introduction

It has long been recognized that PPE can have unwanted side-effects on the wearer in terms of imposing additional physical workload, hindering movement, impairing sensory perception or in some cases causing considerable discomfort. Such side-effects can reduce the efficiency of task performance and/or encourage the user not to wear the PPE or use the PPE incorrectly thereby impairing the level of protection afforded. This problem has been recognized in legislation. The Regulation (EU) 2016/425 of the European Parliament and of the Council of 9 March 2016 on personal protective equipment [23] places duties on PPE manufacturers to take account of ergonomic requirements and assists employers in demonstrating compliance with national legislation, whilst the associated EC Directive on the use by workers of personal protective equipment at the workplace (89/656/EEC) [24] places similar duties on employers providing PPE for use. These latter requirements have been transposed into national legislation in all Member States.

This document can be used to compare the performance of different ensembles as part of any PPE selection process, thereby again assisting employers in demonstrating compliance with national legislation and to evaluate PPE ensembles in standardized conditions embodying the provisions of EC Directive on the use of personal protective equipment (89/656/EEC).

To facilitate compliance with such legislation, European technical product standards for individual items of PPE are gradually introducing tests for ergonomic characteristics. However, such standards are mainly for testing individual products and seldom include the assessment of interactions with other items of PPE except in isolated cases (e.g. helmet-mounted ear-muffs conforming to EN 352-3) where they are an essential element of their use. An exception is ISO/TS 11999-2, which details a series of tests aimed at evaluating the compatibility of the different components of the PPE ensembles used by firefighters.

Some PPE items or ensembles incorporate Electronic Safety Equipment forming a smart system designed to enhance the protection provided. Such systems are included where they form a discreet wearable item or their integration is considered to possibly have an influence on the ergonomic impact of the ensemble on the wearer. For example, interconnections or integrated elements might have an adverse effect on the mobility of a wearer.

When such systems are separated from the PPE and intended to provide feedback to a monitoring system with no personal protective function then they would not be regarded as an item of PPE, although if they are integrated into PPE then they would require consideration.

This present European Standard has therefore been prepared to enable PPE ensembles, such as those worn by police, firefighters and other emergency services, as well as some industrial users; to be evaluated and objectively assessed for ergonomic performance as complete ensembles, rather than in their component parts. As such it will provide a valuable tool to aid PPE manufacturers and purchasers to make informed objective decisions in designing and selecting PPE as ensembles and creating awareness of interaction issues between PPE items. Test and evaluation of PPE ensembles and systems (efficiency and ergonomics) should be carried out by those who create the ensemble.

Some of the tests may also be suitable for adoption as part of product standards for individual items of PPE, although that is not their main purpose.

The principles relating to the ergonomics of PPE are presented in EN 13921. This present European standard builds on those principles and provides appropriate tests to verify that an ensemble meets those principles.



## 1 Scope

This document can be used to compare the performance of different ensembles as part of any PPE selection process.

This document does not replace the product standards for the certification of individual items of PPE. It specifies the testing of individual items of PPE as an ensemble, so that the interaction between the individual items of PPE can be evaluated and any adverse interactions between the individual items of PPE can be identified.

It specifies requirements for testing by either assessing the performance of a PPE ensemble against a benchmark condition (i.e. benchmark testing) or assessing the performance of two or more PPE ensembles against each other (i.e. comparative testing).

The standard incorporates laboratory as well as field based testing. It can also be used to assess the performance regarding the ergonomics of an ensemble that incorporates an item of PPE that has never before been incorporated into an ensemble.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 61260-1:2014, *Electroacoustics - Octave-band and fractional-octave-band filters - Part 1: Specifications*

EN 61672-1:2013, *Electroacoustics - Sound level meters - Part 1: Specifications*

EN ISO 9886, *Ergonomics - Evaluation of thermal strain by physiological measurements (ISO 9886)*

EN ISO 11904-1:2002, *Acoustics - Determination of sound immission from sound sources placed close to the ear - Part 1: Technique using a microphone in a real ear (MIRE technique) (ISO 11904-1:2002)*

EN ISO 12894, *Ergonomics of the thermal environment - Medical supervision of individuals exposed to extreme hot or cold environments (ISO 12894)*

## 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

### 3.1

#### benchmark condition

condition at which test person(s) is/are wearing non-restrictive, minimal, light clothing such as shorts and a cotton t-shirt and light, flexible footwear such as trainers or plimsolls

Note 1 to entry: Benchmark testing for thermal impact in accordance with Annex G might require the use of an alternative benchmark condition.

**prEN 17558:2020 (E)****3.2****benchmark testing**

testing for assessing the performance of an ensemble against the benchmark condition

**3.3****comparative testing**

testing for assessing the performance of two or more ensembles against each other

**3.4****electronic safety equipment (ESE)**

products that contain electronics embedded in or associated with the product for use by wearers that provides enhanced safety functions for wearers during operations in a use environment

**3.5****performance test**

test procedure with wearers of PPE ensembles under specified conditions with simulated postures and motion sequences

**3.6****PPE ensemble**

collection of items of personal protective equipment worn by an individual

**3.7****practical performance test**

test procedure with wearers of PPE ensembles under simulated or real work tasks and if relevant then also under expected conditions of use

**3.8****use conditions**

conditions under which different items of PPE normally are used by the wearer

**3.9****smart PPE**

PPE that uses ESE or material solutions that interact actively, by responding or adapting to environmental changes or react according to external signal input

**4 Ergonomics testing**

Ergonomics of PPE can be tested by use of either test persons, use of manikins and/or use of (virtual) models. This document is dealing only with testing of the ergonomics of PPE with test persons. Information about alternative testing, e.g. with a manikin and/or (virtual) models, can be found in Annex K.

For relevant ergonomics evaluation, it is necessary to have a representative sample of target users (see Annex A for details). A balanced repeated measurement design shall be used for both the benchmark and comparative testing of ensembles to ensure that the order of experimentation does not influence the test results (Annex A).

Depending on the required level of complexity the tasks may consist of individual postures, e.g. static reach and joint angles, or motion sequences, e.g. jump height and dynamic reach; or simulated motion sequences incorporating several individual postures and motion sequences (performance tests) or simulated or real work tasks (practical performance tests) either in controlled laboratory or field settings resembling or not resembling expected use conditions, e.g. environmental parameters, such as

heat, cold, poor lighting, noise, etc. Ergonomic analysis of tasks under use conditions is recommended before selecting specific tests in order to guarantee that all major potential constraints are covered.

It is strongly recommended that a person who has been trained in the discipline, e.g. health and safety expert, ergonomist, work hygienist, should interpret the test results. It is often a person who has been certified for that qualification, but can also be a person who has a long (documented) experience in the field of ergonomics, e.g. publications, documented earlier evaluations, etc.

## 5 Test ensemble

### 5.1 General

All the items of a test ensemble shall be worn by the test person during testing in accordance with the instructions of the manufacturer. A complete description of a test ensemble shall be recorded in a test report conforming to Clause 10.

Although items of clothing being worn with the ensemble might not be classified as PPE, they can influence ensemble performance. For example, clothing worn beneath protective clothing can influence heat exchange and consequently thermal comfort or safety. Similarly, close fitting or bulky garments can influence mobility. Any description of a test ensemble should therefore include all clothing layers, footwear, hand wear and headwear (including helmets, hearing protection, communications systems and respiratory protection).

All testing shall either be conducted:

- a) to compare two or more PPE ensembles (with comparable protective functions), i.e. comparative testing in accordance with 5.2; or
- b) in an absolute comparison against an unrestricted benchmark condition, i.e. benchmark testing in accordance with 5.3.

### 5.2 Comparative testing

Where some items of an ensemble are being replaced, and undergoing assessment by comparative testing, other components of the existing ensemble need not be new. The status (new or used) of all items forming the ensemble shall be documented in the test report conforming to Clause 10.

Where all the items of an ensemble are undergoing assessment by comparative testing, each ensemble shall be subjected to all the tests specified in Clause 8.

Where only a selection of items of an ensemble is being tested, each ensemble shall be subjected to testing specified in Clause 8, however, if it can be reasonably assumed that the items of PPE undergoing testing have no influence on a particular test parameter specified in Clause 8, then it is not necessary to conduct the test for that parameter. Table 1 shows which tests from Clause 8 shall be conducted for a particular item undergoing assessment.

Table 1 — Parameters from Clause 8 required to be assessed for a particular item of PPE undergoing assessment

Item of PPE being assessed (part of body protected)	Parameters from Clause 8 required to be assessed								
	Shoulder/ arm mobility 8.2	Trunk flexion 8.2	Hip/knee flexion 8.2	Clarity within field of vision 8.3	Normal field of vision 8.3	Total range of vision 8.3	Manual dexterity 8.4	Hearing 8.5	Thermal impact 8.6
Head protection	×			×	×	×		×	×
Eye protection				×	×	×		×	×
Respiratory protection	×	×		×	×	×		×	×
Hearing protection	×				×	×			×
Clothing	×	×	×	×	×	×	×	×	×
Gloves	×	×					×		×
Footwear			×						×
Fall arrest	×	×	×						×
Auxiliary heating or cooling device	×	×	×				×	×	×
Smart PPE*	×	×	×	×	×	×	×	×	×

\*Smart PPE, for example ESE, may be very different and cover various body areas including intra- and intersystem communication means, thus, the assessment parameters depend on the specific application and need to be chosen individually (see CEN/TR 16298:2011 for reference).  
 × indicates which parameters from Clause 8 shall be assessed for a particular item undergoing assessment.

### 5.3 Benchmark testing

Where all the items of an ensemble are undergoing assessment by benchmark testing, all the items of the ensemble shall be new and each ensemble shall be subjected to all the tests specified in Clause 8, unless a product standard requires pre-treatment. In the latter case, individual items shall be treated according to procedures described in specific product standards.

Where only a selection of the items of an ensemble are undergoing assessment by benchmark testing, those items being tested and all of those items which potentially impact upon the items being tested shall be new. Table 2 shows which items shall be new for a particular item undergoing assessment by benchmark testing.

Where only a selection of items of an ensemble is being tested, each ensemble shall be subjected to testing specified in Clause 8, however, if it can be reasonably assumed that the items of PPE undergoing benchmark testing have no influence on a particular test parameter specified in Clause 8, then it is not necessary to conduct the test for that parameter. Table 1 shows which tests from Clause 8 shall be conducted for a particular item undergoing assessment by benchmark testing.

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Table 2 — Items of PPE required to be new for a particular item undergoing assessment

Item of PPE being assessed	Items of PPE required to be new during assessment									
	Head protection	Eye protection	Respiratory protection	Hearing protection	Clothing	Gloves	Footwear	Fall arrest	Auxiliary heating or cooling	Smart PPE*
Head protection	x	x	x	x	x				x	x
Eye protection	x	x	x	x		x			x	x
Respiratory protection	x	x	x	x	x	x			x	x
Hearing protection	x	x	x	x						x
Clothing	x		x		x	x	x	x	x	x
Gloves		x	x		x	x			x	x
Footwear							x		x	x
Fall arrest			x		x			x	x	x
Auxiliary heating or cooling device	x	x	x		x	x	x	x	x	x
Smart PPE*	x	x	x	x	x	x	x	x	x	x

\*Smart PPE may be very different and cover various body areas including intra- and intersystem communication means, thus, the assessment parameters depend on the specific application and need to be chosen individually (see CEN/TR 16298:2011 for reference).

x indicates which items of an ensemble shall be new for a particular item undergoing assessment by benchmark testing.

## 6 Test persons

### 6.1 Selection of test persons

The sample of test persons to be used should be established by statistical evaluation taking into account inter and intra-test person variability and the estimated magnitude of the effect of the combination of items of PPE on the user. It is recommended that a power analysis is used for this as described in Annex A. As a practical guideline it is recommended that at least six test persons shall be used to assess an ensemble against one or more others.

The test persons shall represent the total group of expected wearers reflecting the diversity among this group. Each test person shall be experienced or appropriately trained in the use of the PPE items' combination(s), and shall have passed medical examination (guidance on this can be found in EN ISO 12894). The items of PPE to be evaluated shall be of the appropriate size and correctly fitted for the wearer (see EN ISO 15537 for support).

If it is not possible to use a representative sample from the user population then the sample used should match as closely as possible to the user population (see also A.4). For the individual test persons the most important characteristics are:

- age;
- height;
- body mass;
- gender;
- reported physical fitness;
- skill at the task being simulated.

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### 6.2 Test person withdrawal

Where test persons voluntarily withdraw or are withdrawn from the test battery, results from any completed activities undertaken shall be included in any assessment of ensemble performance. Where that withdrawal is for reasons unrelated to the ensembles tested and remaining test persons are still sufficient to complete the analysis of test results and ensure the required level of statistical significance, then testing can continue. If not, a new test person shall be recruited as replacement. See also B.5.

If the withdrawal is related to the design of the ensemble it is an important indicator for terminating the testing and not approving the ensemble. Pass/fail criteria, including the permitted number of ensemble related drop outs, shall be defined clearly before starting the test (see Clause 8 for ergonomic test requirements). If a certain number of test persons drop out due to ensemble design factors, then testing shall be terminated and the ensemble failed. Reasons for withdrawal shall be reported (for reporting details see Clause 10).

## 7 Statistical testing

In order to compare ensembles with each other or to a reference ensemble it is essential to look at the differences in the results (means) in relation to their standard deviation. Differences between the test ensembles and the benchmark condition or between two or more test ensembles undergoing comparative testing, shall be compared using statistical tests in order to determine the likelihood of observed differences being due to chance (see more in Annex A).