Eumeps Construction
European Manufacturers of EPS

EPS White Book

EUMEPS Background Information on Standardisation of EPS

Issued by EUMEPS in 2003

Content

1 General

1.1 Purpose and scope of this document

Thermal insulation products were one of the very first group of construction products to be standardised under the CPD. In the beginning the task was not clearly defined and has even changed during this period and continues to change even after publication of the harmonised standards.
The Working Group 4 under the Technical Committee 88 (TC88) of CEN has been dealing with thermal insulating products of expanded polystyrene (EPS). Many data have been collected from different countries and new data have been produced to describe the performance of EPS. The large variety of applications all over Europe has been studied by WG4 and the experiences have been exchanged and recorded.
The work in CEN/TC88/WG4 has lead to a huge collection of European data, experience and knowledge of EPS. To offer all this information to producers, designers and users of EPS is one of the goals of this booklet.

The “Standardiser” in CEN/TC88/WG4 has been subjected to many instructions e.g. from CEN and the European Commission (EC), which has lead to the present form of the standards. There was a clear mandate, given from the EC to CEN, which TC88 and its working groups had to follow. This document will also explain the background of the standardisation work, which has lead to a specific structure and content of the standards, which followa common format agreed by CEN TC88.

With the first publication of the finalised European standard for EPS products the standardisation work did not come to an end. As a standard of the first generation it differsfrom those published later. The guidelines for the technical Committees became more precise and new guidelines have been published in between. Some issues like release of dangerous substances or ecological assessments will be incorporated in the next versions of EN 13163 and EN 14309. Another objective of this document is to help the experts with their continuing standardisation work on EPS products.The standardisation is an ongoing issue and there are standards for the use of EPS in industrial applications and building equipment, civil engineering applications, external thermal insulation composite systems (ETICS) and EPS gypsum boards in preparation. Data from research and developments in connection with these projects will be incorporated later. That is why this document is a living paper and will be revised from time to time.

1.2 Background

In 1985 the European Council published a white paper on completing the internal market for the European Community. The purpose of creating an internal market is to eliminate barriers to trade for products (and services) thus allowing them to be marketed freely through the EU and thereby promote competition. The construction industry, as an important part of commercial activity in the EU, was therefore to become subject to a directive covering construction products - the so called CPD - Council Directive 89/106/EEC [5].

This Directive is the practical manifestation of freeing the market in the construction sector by making transparent the specification of construction products, which are a major part of trade in the construction sector along with design expertise and contracting. At the time the CPD was formulated it was recognised that a common set of Building Regulations for the European Economic Area was a step too far and such regulations currently remain the responsibility of Member States.

The CPD introduces the concept of harmonised standards (or parts of standards) with which producers of products must comply when placing products on the market. These parts of a standard are detailed in the so called Annex ZA and will address the six *Essential Requirements* with which Building Works are expected to comply. By this means construction products can be shown to fulfil their part in ensuring that building works comply with the six Essential Requirements which are :

1) Mechanical resistance and stability
2) Safety in case of fire
3) Hygiene and environment
4) Safety in use
5) Protection against noise
6) Energy economy and heat retention

The work to write these standards is carried out by CEN (Comité Européen de Normalisation) a body comprising members of all the national standards bodies.

In order to ensure that this work is properly directed to fulfil the Commissions objective with the CPD a Standing Committee for Construction (SCC) had been established (CPD Article 19). Representing Regulators responsible for laws governing construction from the Member States, the SCC determines the properties to be included in the harmonised parts of families of standards, levels of attestation of conformity to be applied and rules governing labelling and marking.

To support all this activity the SCC has published a range of Interpretative Documents and the EC-services a series of Guidance Papers to ensure uniformity of interpretation of the CPD and testing products, transition periods and so on .

For insulation products, the work within CEN is covered by CEN TC 88 ‘Thermal insulating materials and products’ with CEN TC 89 ‘Thermal performance of buildings and building components’ conducting the work on calculation methods for the performance of buildings.

Working Group 4 of CEN TC 88 is responsible for factory made products of EPS .

1.3 Standardisation

To obtain common technical specifications all over Europe European product standards (or technical approvals) have to be created. This work is done by European standardisation body (CEN) or EOTA), which is recognised as competent in the area of voluntary technical standardisation. CEN prepares European Standards in specific sectors of activity and makes up the 'European standardisation system'.
In the construction field the European Commission has requested CEN to prepare standards in order to implement the European Construction Product Directive (CPD). This standardisation is 'mandated' by the Commission, through the Standing Committee on Construction, in support of the CPD. This initiative is also supported by the EFTA Secretariat.
The output must therefore be accepted by the Member States, which are represented in the SCC, and the EFTA countries if they make similar arrangements.

To achieve a common assessment of product performance European test methods are needed first. These test methods for thermal insulating products were developed by CEN/TC89 as far as they were dealing with thermal performances. All other test methods, e.g. for mechanical/physical properties were developed by CEN/TC88/WG1. Where international standards (ISO) were available, these testing standards were taken over and were transformed to harmonised European standards.

The European product standards were all newly created due to the specific purpose of obtaining a common European market. The ‘passport for the product ‘to travel inside the European community is the conformity with the product standard, which leads to the CE marking. For all thermal insulating products the attestation of conformity is the same and described in EN 13172.

To create common calculation procedures, e.g. heat retention for buildings, European calculation standards have been developed. This calculation standard EN 832 [6] and other European standards for design values were needed as well The field of European standardisation is restricted to product standards and calculation methods.
Application related requirements such as specific levels of heat retention, compressive stress, water uptake etc. remain the perogative of the Member States. Article 3 of the CPD reads:

“In order to take account of possible differences in geographical or climatic conditions or in way of life as well as different levels of protection that may prevail at national, regional or local level, each

essential requirement may give rise to the establishment of classes in the documents referred to in paragraph 3 and the technical specifications referred to in Article 4 for the requirement to be respected."

In all European countries where application rules for thermal insulation products were established, these rules had to be revised because they have to refer to the European product standards and to the levels and classes provided there. Figure 1 shows the area of European standardisation and the limit to the remaining field of national standardisation/regulations.

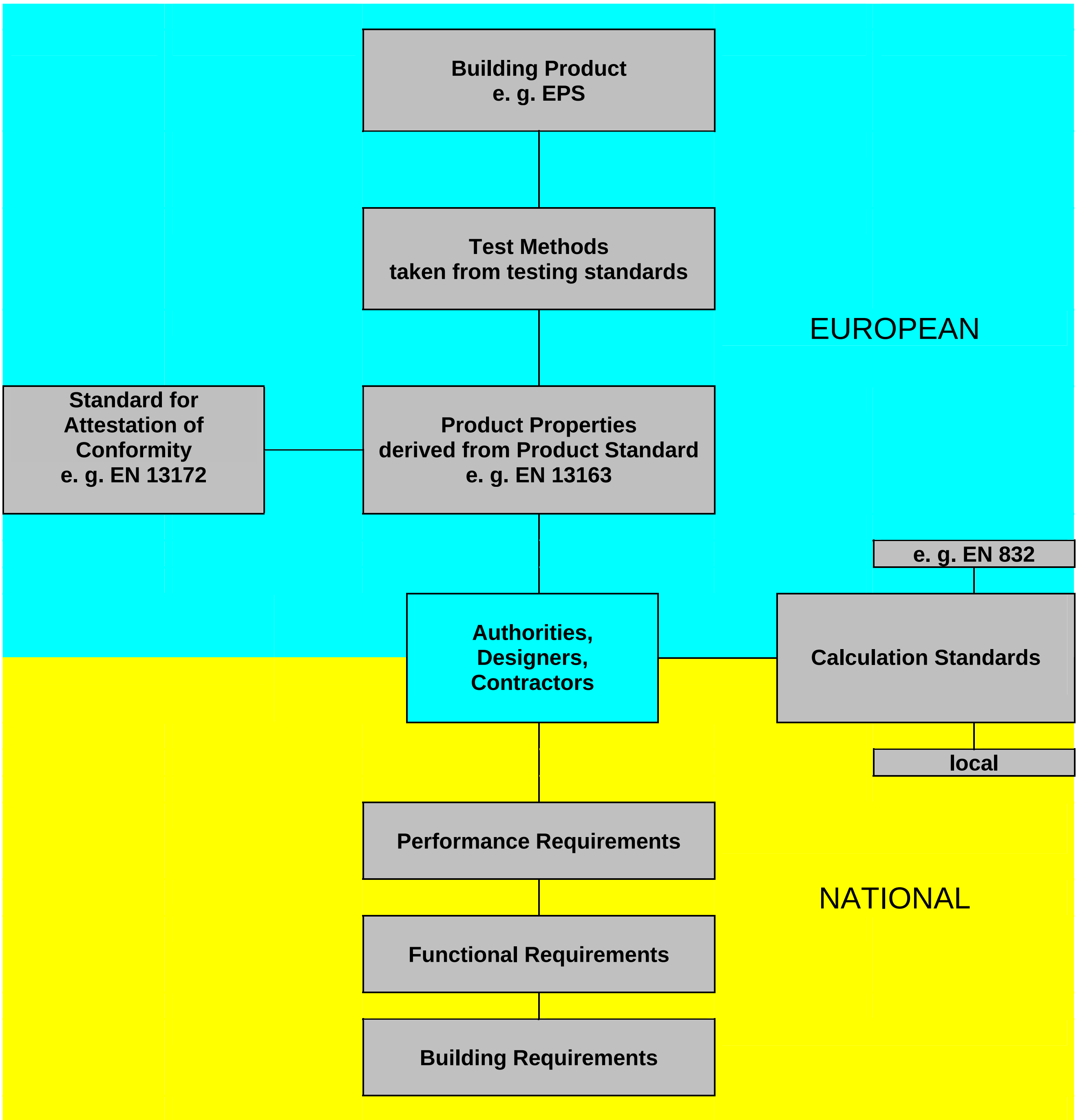

Figure 1: Limitation between European and national standardisation issues.

This Figure 1 can be created for every standardised building product. To cover more general aspects of building products like fire behaviour, acoustical behaviour, release of dangerous substances etc. so called horizontal standards have been developed by, e.g. CEN TC127 (fire) and TC126 (acoustics).
Although the application related requirements are the responsibility of the Member States, there are general application requirements covered by the European standards, for factory made thermal insulation products detailed in EN 13162 through EN 13171 thermal insulation for buildings. For EPS products there are additional standards like EN 14309 [7] for building equipment and industrial installation and EN xxxxx [8] for EPS in civil engineering applications (CEA). Furthermore there are standards specifying a kit of building components for a specific application such as EN 13499 External Thermal Insulating Composite Systems [9].

The harmonised European product standards may contain additional, voluntary clauses. The part of the harmonised standard is defined in Annex ZA. For more detailed information see 2.17.

2 Explanation of the EPS Standard for buildings

The information applies to EN 13163, EN 13172 and partly for EN 14309. The structure of clause 2 follows EN 13163. Deviations from this structure are explained in clause 3., 4 and 5. This information on EN 13163 is organised in the same structure as EN 13163 itself. That means the sub clauses of this chapter follow the same numbering system as the main clauses of EN 13163.

The foreword gives general information about the creation of the standard. The package of ten standards for factory made product standards for buildings was developed at the same time and all standards of this package were launched as ENs in May 2001. There are other packages of thermal insulation products, e. g. for building equipment and industrial installation (instead of Buildings) and in-situ products, which will be published later.

2.1 Scope

The scope covers all EPS products used as thermal insulation for buildings including shaped products, where the term preformed ware is used. Also all kinds of coatings and facings are included except those, which are covered by another product standard. e. g. EN 13168 [10] which covers wood wool products and composite wood wool slabs. These wood wool slabs are composite insulation products in which wood wool is bonded on one or both face(s) to an EPS core.

Composite panels made from EPS and gypsum boards are specified in EN 13950 [27]. Self supporting metal composite panels with an EPS core are covered by EN 14509 [28].

The minimum thermal resistance is given as0,25 m²K/W and the maximum thermal conductivity as 0,060 W/mK to ensure a minimum thermal resistance. Products having a thermal conductivity of 0,040 W/mK must be at least 10 mm thick. Normal EPS products have a thermal conductivity much lower than 0,060 W/mK typically in the range 0,030 to 0,045 W/mK.

2.2 Normative reference

This clause lists in a numerical order all standards which are referred to in the normative part of EN 13163. Those standards, which are mentioned in the informative annexes are referred to there with the full title, e. g. see Annex D of EN 13163.

Normally standards are referred to as undated references to avoid revisions of EN 13163 each time a new version of the reference standards is published. Only the preliminary standards (prEN) and EN 13172 are dated.

2.3 Terms, definitions, symbols, units and abbreviated terms

2.3.1 Terms

In this clause all EPS specific expressions are listed and defined. For specific terms of reaction to fire see 2.4.2.8.

EN 13163 contains definitions, which are used in this standard and which are not to be found in EN ISO 9229 [11]. For other fields of building products there are other definition standards in preparation:

EN 27345	Thermal insulation – Physical quantities and definitions [34]
EN 45020	Standardization and related activities - General vocabulary [12]
EN ISO 13943	Fire safety – Vocabulary [13]

Some of these definition standards are written in the three official languages English, French and German so that they can be used for translation purposes, too.

2.3.2 Symbols

Symbols in addition to those which are defined in EN 13163, 13499, 14309 and CEA and are used in this document are listed below.

Table 1: List of symbols, explanations and units

Symbol	Explanation	Unit
$1-\alpha$	confidence level	1
α_{th}	coefficient of thermal expansion	1/K
c_p	specific heat capacity	J(kg·K)
ϑ	temperature	°C
d_{meas}	measured thickness	m
D	water vapour diffusion coefficient	m²/h
δ	water vapour permeability	mg/(Pa·h·m)
δair	Water vapour permeability of the air	mg/(Pa·h·m)
ϑ_{mean}	mean temperature	°C
$FIGRA$	Fire growth rate index	W/s
F_ψ	moisture conversion factor	1
Fs	Flame spread	mm
γ	factor to calculate λ_U (German regulations)	1
$k_{n,p,1-\alpha}$	k factor	1
λ_ϑ	thermal conductivity at a mean temperature ϑ	W/m·K
λ_{lim}	limit value of thermal conductivity	W/m·K
λ_D	Declared thermal conductivity	W/m·K
λ_{meas}	measured thermal conductivity	W/m·K
λ_U	design thermal conductivity	W/m·K
λ_u	design thermal conductivity in relationship to the moisture content u	W/m·K
$L_{n,w,eq}$	equivalent weighted normalized sound pressure level	dB
$L'_{n,w}$	weighted normalized impact sound pressure level	dB
ΔL_w	weighted reduction of impact sound pressure level	dB
$L'_{nT,w}$	weighted standardized impact sound pressure level	dB
LFS	Lateral flame spread	m
m	mass	kg
Δm	mass difference	kg
m'	mass per unit area	kg/m³
m'_0	mass per unit area	kg/m³
μ	water vapour diffusion resistance factor	1
n	number of measurements	1
p	fractile	1
PCS	Gross calorific potential (pouvoir calorifique superieur)	MJ/kg
q	ratio	1
Q	energy	J
R_D	gas constant of water vapour (= $462 \cdot 10^{-6}$ Nm/(mg·K))	Nm/(mg·K)
R_{meas}	measured thermal resistance	m²K/W
σ_c	alternative stress (according EN 1606)	kPa
$s1-s3$	Additional reaction to fire classes	non
$d0$ $d2$	Additional reaction to fire classes	non
t_f	flaming time	s
ΔT	temperature difference	K
THR_{600}	Total Heat Release during the first 600 seconds	MJ
TSP_{600s}	Total smoke production	m²
u	Moisture content	vol-%
V	volume	m³
W_p	practical water content	vol-%
x_{th}	dimension depending on temperature	m
x	dimension	m
z	fractile of the standardized normal distribution	1

The term $1 - \alpha$ is described as prediction interval in EN 13163. In the context of its use in EN 13163 the correct term is confidence level.

2.3.3 Abbreviated Terms

<u>General terms</u>

AoC	Attestation of conformity
ASTM	American Society for Testing and Materials (American standardisation body)
BKB	BV Kwaliteistverklaringen Bouw
BS	British Standard
CEA	Civil Engineering Application
CEN	European Committee for Standardisation (CEN = Comité Européenne de Normalisation)
CPD	Construction Products Directive
CUAP	Common Unique Acceptance Procedure
DIBt	German Regulator Body (Deutsches Institut für Bautechnik)
DOA	Date of Acceptance
DOW	Date of Withdrawal
EEA	European Economic Area
EC	European Commission
EN	European Norm (European Standard)
EOTA	EOTA : European Organisation for Technical Approvals
EPS	Expanded Polystyrene
ETA	European Technical Approval
ETG	European Technical Guideline
ETICS	External thermal insulation composite systems
EU	European Union
EUMEPS	European Manufacturers of EPS
FIGRA	Fire Growth Rate Index
FIW	Forschungsinstitut für Wärmeschutz e. V., München
FPC	Factory production control
FR	Flame retarded
ISO	International Standards Organization
KIWA	Dutch Certification body
KOMO	Brand name of a dutch quality mark
LFS	Lateral Flame Spread
MRA	Mutual Recognition Agreements
PECA	Protocol to the European Agreement on Conformity Assessment
prEN	provisional European Norm (European standard)
SBI	Single Burning Item
SBK	Stichting BouwKwaliteit
SCC	Standing Committee of Construction
SEE	Service de l'Energie de l'Etat
SIPS	Structurally Insulated Panel Systems
SMOGRA	Index for rate of Smoke Development
SP	Swedish National Testing and Research Institute, Gothenburg
TC	Technical Committee
UAP	Unique Acceptance Procedure
UEAtc	Union Européenne pour l'Agrément Technique dans la Construction (European Union of Agrément)
VTT	Finish Technical Research Center
WG	Working Group
WI	Work Item

Table 2: CEN Members

Abbreviation	Organisation	Country
AENOR	Asociación Española de Normalización y Certificación	Spain
AFNOR	Association Française de Normalisation	France
BIN	Belgisch Instituut voor Normalisatie	Belgium
BSI	British Standard Institution	United Kingdom
CSNI	Czech Standards Institute	Czech Republic
DIN	Deutsches Institut für Normung	Germany
DS	Dansk Standard	Denmark
ELOT	Hellenic Organization for Standardization	Greece
IBN	Institut Belge de Normalisation	Belgium
IPQ	Instituto Português da Qualidade	Portugal
IST	Icelandic Standards	Iceland
MSA	Malta Standards Authority	Malta
MSZT	Hungarian Standards Institution	Hungary
NEN	Nederlands Normalisatie-instituut	Netherlands
NSF	Norges Standardiseringsforbund	Norway
NSAI	National Standards Authority if Ireland	Ireland
ÖN	Österreichisches Normungsinstitut	Austria
SEE	Service de l'Energie de l'Etat (SEE),Organisme Luxembourgeois de Normalisation	Luxemburg
SFS	Suomen Standardisoimisliitto r. y.	Finland
SIS	Swedish Standards Institute	Sweden
SNV	Schweizerische Normen-Vereinigung	Switzerland
SUTN	Slovak Institute for Standardization	Slovakia
UNI	Ente Nazionale Italiano di Unificazione	Italy

CEN members have to follow the CEN rules and have to implement all harmonized standards issued by CEN. They are involved in the creation and voting process of European standards.

Table 3: Affiliated CEN Members

Abbreviation	Organisation	Country
ASRO	Romanian Standards Association	Romania
CYS	Cyprus Organisation for Standards	Cyprus
DPS	General Directorate of standardisation	Albania
DZNM	State Office for Standardization and Metrology	Croatia
EVS	Estonian Centre for Standardisation	Estonia
LST	Lithuanian Standards Board	Lithuania
LVS	Latvian Standards Ltd	Latvia
PKN	Polish Committee for Standardization	Poland
SASM	State Agency for Standardization and Metrology	Bulgaria
SIST	Slovenian Institute for Standardization	Slovenia
TSE	Turkish Standards Institution	Turkey

Affiliated CEN members are not obliged to follow the CEN rules and to implement all harmonized standards issued by CEN. They are involved in the creation but not in the voting process of European standards.

2.4 Requirements

An EPS thermal insulation product must fulfil a variety of performance requirements independent of the intended application. Other properties are only needed for specific applications. That is the reason why EN 13163 distinguishes between requirements for all applications in clause 4.2 and requirements for specific applications in clause 4.3. The consequence is that every product put on the market with the CE mark has (at least) to fulfil the requirements according clause 4.2 of EN 13163. In addition to these properties the manufacturer may choose and declare levels / classes of requirements given in clause 4.3.

2.4.1 General

As mentioned in this clause one test result of a product property is the average of the measured values required in the relevant test method. This rule is valid for all requirements where limit values are requested. In cases where statistical evaluation is performed averaging values must not used to calculate standard deviations or predicted values, see Annex A and B of EN 13163. Calculation procedures to determine a declared value achieving 90 % fractile and 90 % confidence level is described in Annex A of EN 13163.

In addition to the requirements to obtain a test result, which is an average of several single values, for mechanical properties it is required that no single value shall be more than 10 % lower than the declared value. This has to be taken into account for the requirements according clause 4.2.6, 4.2.7, 4.3.2, 4.3.3, 4.3.4, 4.3.5, 4.3.6, 4.3.8, 4.3.11, 4.3.12 and 4.3.13.

2.4.2 For all applications

2.4.2.1 Thermal resistance and thermal conductivity

The thermal properties of a sample of insulation board are measured according to EN 12667 or EN 12939, taking into account the thickness (measured according to EN 823) and the specified product type. The result of the test is the thermal resistance of that specific sample. When the sample is sourced from a product type with no thickness effect or is not a multi-layered sample, the thermal conductivity can be calculated using the equation

$$\lambda_{meas} = \frac{d_{meas}}{R_{meas}}$$ in W/mK

In accordance with EN 13163 (B.2.4) boards of a thickness of 50 mm and a thermal conductivity equal to or less than 0,038 W/mK the thickness effect is negligible.

Statistical treatment is then necessary to obtain the declared value which must represent 90 % of the production determined with a confidence level of 90 % (90/90) . The thermal resistance R shall always be declared and if possible the thermal conductivity λ as well. In most cases the EPS producer will choose to apply the statistics to the thermal conductivity values in one defined product group. He will then state in his official documents the declared thermal conductivity λ_D and the thermal resistance R_D at that thickness.
The thermal properties will be declared on the product or the pack label.

Effect of temperature on thermal conductivity
The thermal conductivity for building products is declared at a mean temperature of 10 °C. For products used in building equipment or industrial installations other mean temperatures may be of interest. The thermal conductivity versus temperature is described in reference 22 and shown in Figure 2.

For thickness effect see A.**Error! Reference source not found.**.

Mechanism of heat transfer
The mechanism of heat transfer in a thermal insulation layer like EPS may be divided in three components:

- Conductivity;
- Radiation;
- Mass transfer.

More details are to be found in ISO 9251 [38]. For radiation see [39] and for mass transfer see [40].

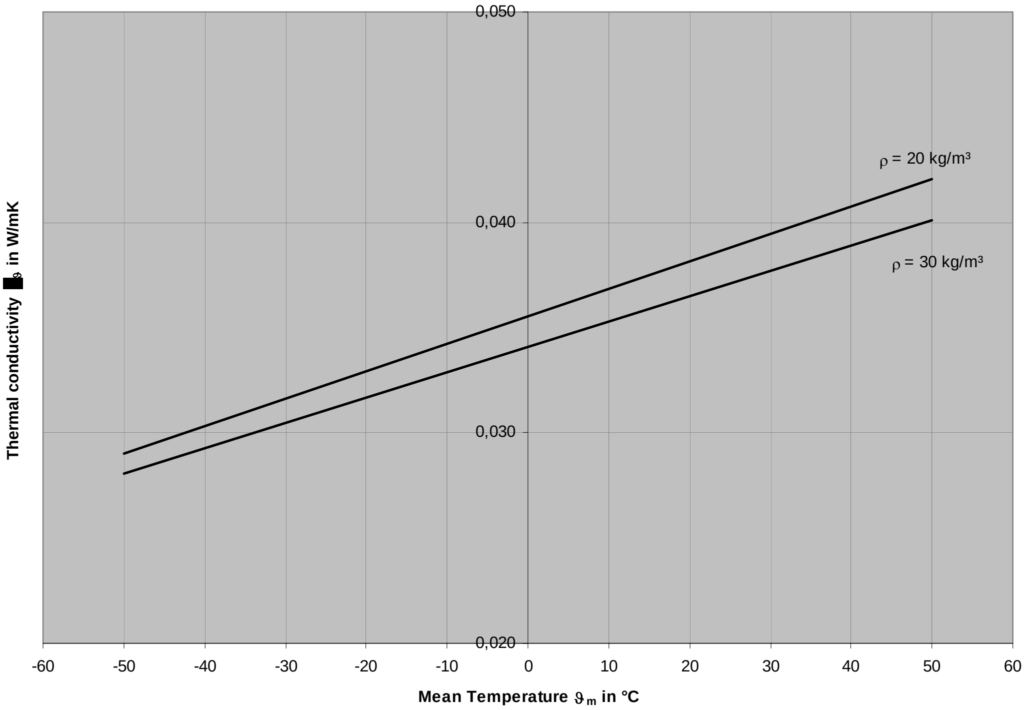

Figure 2: Thermal conductivity of EPS versus mean temperature derived from reference [22].

The curves for the density of 20 kg/m³ and 30 kg/m³ can be calculated as follows:

$$\lambda_{\vartheta,20} = 0{,}03555 W/mK + 0{,}00013\vartheta$$

$$\lambda_{\vartheta,30} = 0{,}03407 W/mK + 0{,}00012\vartheta$$

For building products the thermal conductivity is measured at 10°C, for building equipment and industrial installations it must be measured at various temperatures (at least three) to establish a curve of thermal conductivity of the declared temperature range. It is clear that at different temperatures the thermal conductivity varies. The lower the temperature, the lower the thermal conductivity.

Effect of moisture on thermal conductivity

The change of the thermal conductivity with 1 vol-% water uptake is according to Figure 3 (3,8 ± 0,6) %. In practice the water content of EPS in typical construction applications does not increase above 0,1 vol-%. The practical change of the thermal conductivity due to water uptake is therefore about 0,4 %.
More information has to be found in 2.4.3.9.

The change of thermal conductivity with moisture content from thermal insulation and other construction materials was determined by a German research [52]. Figure 3 taken from this literature shows that EPS has a much more favourable behaviour concerning the increase of thermal conductivity than other insulation materials having no closed cell structure. To calculate the relationship between moisture content and thermal conductivity for different densities the factor F_Ψ was introduced by the authors of this research. The equations below present this relationship more precisely than the values given in Table 8 and

Table 9.

$F_{\Psi} = \lambda_u / \lambda_{u=0}$

Where u is the variable water content in vol-% and $\lambda_{u=0}$ is the thermal conductivity of a dry material.

$F_{\Psi} = 1,0 + 0,032078 \cdot u + 0,0010031 \cdot u^2$

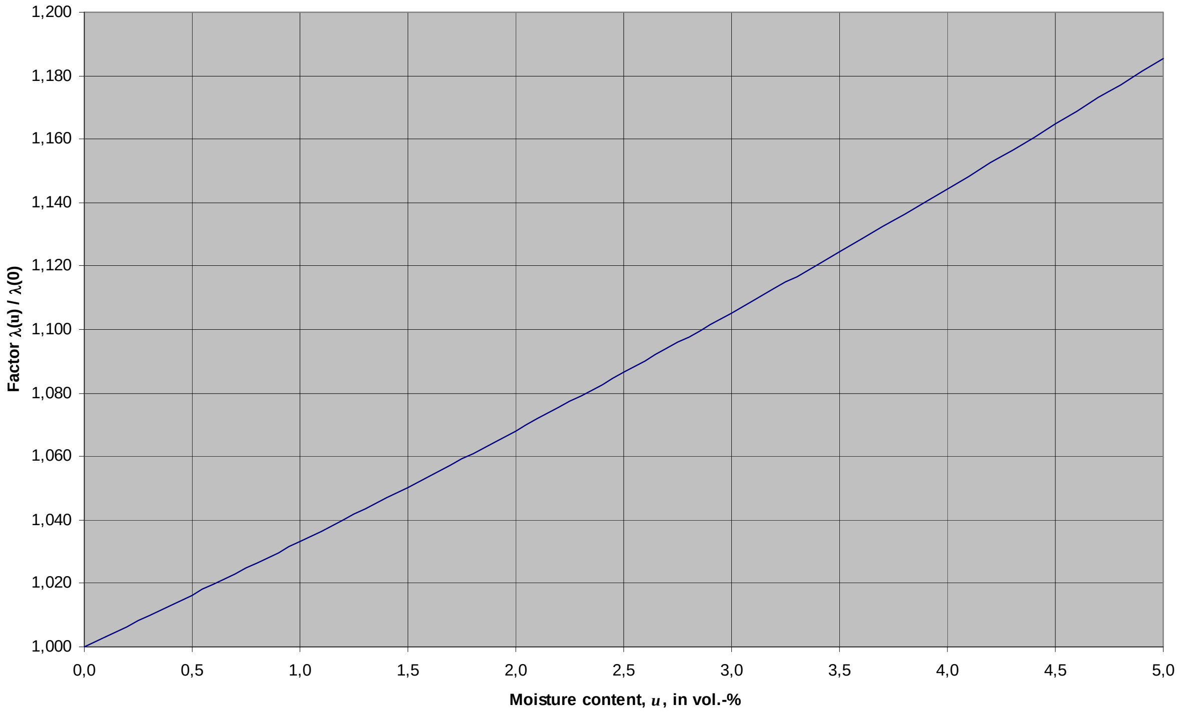

Figure 3: Change of thermal conductivity with moisture according [52].

2.4.2.2 Length and width

The classes of tolerances for length and width (see table 1 of EN 13163) reflect national (regulatory) requirements. Tight tolerances as L2 and W2 are only needed for very specific applications. See also EPS Eurotypes 7.4.

2.4.2.3 Thickness

The classes of tolerances for thickness (see table 1 of EN 13163) reflect (regulatory) requirements. Tight tolerances as T2 are only needed for very specific applications. See also EPS Eurotypes 7.4.

2.4.2.4 Squareness

The classes for squareness (see table 1 of EN 13163) reflect national (regulatory) requirements. Tight tolerances as S2 are only needed for very specific applications. See also EPS Eurotypes 7.4.

2.4.2.5 Flatness

The classes for flatness (see table 1 of EN 13163) reflect national (regulatory) requirements. Tight tolerances as P4 are only needed for very specific applications. See also EPS Eurotypes 7.4.

2.4.2.6 Dimensional stability

The classes of dimensional stability (see table 2 of EN 13163) reflect national (regulatory) requirements. Tight tolerances as DS(N) 2 are only needed for very specific applications. See also EPS Eurotypes 7.4.

The dimensional stability is also used to prove the durability of thermal resistance against ageing and degradation, see table ZA.1 of EN 13163.

2.4.2.7 Bending strength

Bending strength is used to ensure handling properties for EPS. In the mandate for the thermal insulation products tensile strength is foreseen for this requirement. The standardiser is free to replace e. g. the tensile strength by another property which is the case for EPS. In table ZA.1 of EN 13163 tensile strength or flexural strength is required to ensure handling and this was combined with bending strength.

For applications where higher levels of bending strength are required see clause 4.3.2 of EN 13163. In clause 4.2.7 a threshold value of only 50 kPa is required, which will be achieved by every well fused EPS product.

2.4.2.8 Reaction to fire

On constant exposure to temperatures above 100 °C, EPS softens and shrinks and finally melts. On further exposure to heat, gaseous combustible products are formed by decomposition of the melt. Whether or not these can be ignited by a flame or spark depends largely on the temperature, duration of exposure to heat and the air flow around the material (oxygen availability).

Molten EPS will normally not be ignited by welding sparks or glowing cigarettes; however, small flames will ignite a standard grade EPS readily unless it contains flame retardant additives. These fire retarded (FR) grades of EPS, also referred to as EPS-SE quality, contain a small quantity of a cycloaliphatic organobromine compound. When exposed to a fire source the decomposition products of the additive cause flame quenching so that when the ignition source is removed EPS-SE will not continue to burn.

When tested to ASTM D 1929 [51], the flash ignition temperature in the presence of a pilot flame of standard grade EPS is 360 °C and that of EPS-SE is 370 °C. These values indicate that, when molten EPS decomposes, ignitable gases are only formed at or above 350 °C. In the absence of a pilot flame, the self-ignition temperature of molten EPS is 450 °C.

In the presence of large ignition sources or significant heat fluxes, e.g. greater then 50 kW/m^2 from fires involving other material, EPS-SE will eventually burn, reflecting the organic nature of polystyrene. Burning EPS has a heat release of 40 MJ/kg (by mass) or 400-2.000 MJ/m^3 (by volume) [19].

Reaction to fire is the only property in the field of thermal insulation products for which the EC has provided Euroclasses.

The new European fire classification system brings about the harmonisation of fire test methods. The European fire test package will replace the large number of national fire test methods. The new system will bring a number of changes for producers and users of construction products in terms of understanding the new system and in terms how construction products are treated and labelled.
Performance will relate to construction products in their end-use application. This differs from the existing system, as is now common in national prescriptive building regulations. These have to be changed into performance based regulations.

Some things will not change. This includes the level of (fire) safety in the individual Member States. National regulations will be and are being modified only in so far as to accommodate the new European classifications. The safety levels in the Member states, representative of a country's building practice and experience in construction and fire, remain their prerogative and are not harmonised.
Member States are currently assessing how the new classification system will be accommodated nationally.

The new European fire test package includes:

- EN ISO 1182 Non-combustibility test [35]
- EN ISO 1716 Determination of calorific value [36]
- EN ISO 11925-2 Ignitability test
- EN 13823 Single Burning item (SBI)Test

These test methods are all quoted in the classification standard (EN 13501-1), which describes the performance required in the tests to obtain Euroclasses A1, A2- E and is shown in Table 4. Euroclass F denotes performance 'not determined' or a failure to class E. Class E is obtained when test results in the Small Flame ignitability test do not exceed certain values (15cm flame height and no burning droplets, as prescribed in the standard EN ISO 11925-2). The Small Flame Test gives some information on the ignitability of the product, which is of importance during the first phase in a fire situation, i.e. the ignition phase.

To obtain Classes D, C or B, both the Small Flame Test and the SBI test need to be carried out. In addition the SBI is also required to obtain Class A2 and in special cases for Class A1 (see footnote 2[a] in Table 4.

The SBI criteria are:

- FIGRA = Fire Growth Rate Index
- LFS = Lateral Flame Spread
- THR_{600} = Total Heat Release during the first 600 seconds

Smoke production (s_1 to s_3) and the occurrence of burning droplets (d_0 to d_2) are additional classifications.

These are based on :

- SMOGRA = Index for rate of Smoke Development (for s-ranking)
- Burning droplets = Occurrence and burning duration of burning droplets (for d-ranking)

A product's performance in reaction to fire is related to its end-use application as well as to its fundamental material properties and thermal attack. Product performance should therefore be tested to reflect its end use application. A product and a product in its end use application can therefore have different performances and hence classifications.

Mounting and fixing (M&F) details, as required in the Ignitability and SBI tests, are being prepared by TC88 with guidance from TC127. Two options are considered and could be incorporated in the relevant product standards, viz.: standardised M&F specifications for the purpose of CE-marking of products as placed on the market with or without end-use application and mounting suggestions for specific end-use applications. For all standardised M&F specifications their field of application has to be defined.

EPS-SE passes the small burner test (EN ISO 11925-2) at all thicknesses and densities and therefore meets the requirements of Euroclass E. EPS without fire retardant additives (Standard EPS or N-grade) is classified as Euroclass F (without testing). Higher classes, determined in the SBI test (EN 13823), depend on the thickness, density and mounting & fixing, representing the end-use condition, of the samples. EPS is used in many different applications. Depending on that application Euroclass E, D, C or B can be obtained. E. g. EPS in its application behind plasterboard, cavity wall or steel sandwich panel will obtain Euroclass B.

When exposed to higher temperatures from 80 °C onwards, EPS will start to soften, shrink and finally melt.

In the presence of large ignition sources or significant heat fluxes, e.g. greater than 50 kW/m² from fires involving other material, EPS in F-grade will eventually burn, reflecting its organic nature. Burning EPS has a heat release of 40 MJ/kg (by mass). For EPS products the fire load is of more interest, since the mass of EPS used in constructions is rather low compared to other materials.

The durability of reaction to fire behaviour is covered in section 2.17.2.11. For definitions in the field of fire safety, see EN ISO 13943 [13].

Table 4: Classes of reaction to fire performance for construction products except floorings *

Class	Test method(s)	Classification criteria	Additional classification
A1	EN ISO 1182 (1); and	$\Delta T \leq 30°C$; and $\Delta m \leq 50\%$; and $t_f = 0$ (i.e. no sustained flaming)	
	EN ISO 1716	$PCS \leq 2{,}0$ MJ ·kg^{-1} (1); and $PCS \leq 2{,}0$ MJ·kg^{-1} (2) (2a); and $PCS \leq 1{,}4$ MJ·m^{-2} (3); and $PCS \leq 2{,}0$ MJ·kg^{-1} (4)	
A2	EN ISO 1182 (1); or	$\Delta T \leq 50°C$; and $\Delta m \leq 50\%$; and $t_f \leq 20s$	
	EN ISO 1716; and	$PCS \leq 3{,}0$ MJ·kg^{-1} (1); and $PCS \leq 4{,}0$ MJ·m^{-2} (2); and $PCS \leq 4{,}0$ MJ·m^{-2} (3); and $PCS \leq 3{,}0$ MJ·kg^{-1} (4)	
	EN 13823 (SBI)	*FIGR*A ≤ 120 W·s^{-1}; and *LFS* < edge of specimen; and $THR_{600s} \leq 7{,}5$ MJ	Smoke production(5); and Flaming droplets/ particles (6)
B	EN 13823 (SBI); and	*FIGRA* ≤ 120 W·s^{-1}; and *LFS* < edge of specimen; and $THR_{600s} \leq 7{,}5$ MJ	Smoke production(5); and Flaming droplets/ particles (6)
	EN ISO 11925-2(8): Exposure = 30s	*Fs* ≤ 150 mm within 60 s	
C	EN 13823 (SBI); and	*FIGRA* ≤ 250 W·s^{-1}; and *LFS* < edge of specimen; and $THR_{600s} \leq 15$ MJ	Smoke production(5); and Flaming droplets/ particles (6)
	EN ISO 11925-2(8): Exposure = 30s	*Fs* ≤ 150mm within 60s	
D	EN 13823 (SBI); and	*FIGRA* ≤ 750 W·s^{-1}	Smoke production(5); and Flaming droplets/ particles (6)
	EN ISO 11925-2(8): Exposure = 30s	*Fs* ≤ 150mm within 60s	
E	EN ISO 11925-2(8): Exposure = 15s	*Fs* ≤ 150mm within 20s	Flaming droplets/ particles (7)
F	No performance determined		

* The treatment of some families of products, e.g. linear products (pipes, ducts, cables etc), is still under review and may necessitate an amendment to this decision.

(1) For homogeneous products and substantial components of non-homogeneous products.
(2) For any external non-substantial component of non-homogeneous products.
(2a) Alternatively, any external non-substantial component having a *PCS* ≤ 2,0 MJ·m^{-2}, provided that the product satisfies the following criteria of EN 13823(SBI) : *FIGRA* ≤ 20 W·s^{-1}; and *LFS* < edge of specimen; and THR_{600s} ≤ 4,0 MJ; and *s*1; and *d*0.
(3) For any internal non-substantial component of non-homogeneous products.
(4) For the product as a whole.
(5) *s*1 = *SMOGRA* ≤ 30m^2·s^{-2} and TSP_{600s} ≤ 50m^2 ; *s*2 = *SMOGR*A ≤ 180m^2·s^{-2} and TSP_{600s} ≤ 200m^2; *s*3 = not *s*1 or *s*2.
(6) *d*0 = No flaming droplets/ particles in EN 13823(SBI) within 600 s; *d*1 = No flaming droplets / particles persisting longer than 10 s in EN 13823(SBI) within 600 s; *d*2 = not *d*0 or *d*1; Ignition of the paper in EN ISO 11925-2 results in a *d*2 classification.
(7) Pass = no ignition of the paper (no classification); Fail = ignition of the paper (*d*2 classification).
(8) Under conditions of surface flame attack and, if appropriate to the end–use application of the product, edge flame attack.

2.4.3 For specific application

2.4.3.1 General

Every insulation product according EN 13162 through EN 13171 has to cover the requirements described in clause 4.2 of the ENs whereas the requirements given in clause 4.3 are optional. These additional requirements will be claimed by the manufacturer only if they are needed for the intended application. The application related requirements come from national regulations such as application standards, approvals or others. See also 7.3.

2.4.3.2 Dimensional stability under specified temperature and humidity conditions

There is no application rule known in Europe where dimensional stability under specified temperature and humidity is required for EPS. For harmonisation reasons (between the different thermal insulation products) this property was adopted in EN 13163.
As far as known humidity conditions do not effect the dimensions of EPS.

2.4.3.3 Deformation under specific compressive load and temperature conditions

The deformation under specific compressive load and temperature is needed in some countries for applications where pressure and temperature prevail for example on flat roofs.
The measurements from Zehendner [21] show that the pressure-deformation behaviour depends on the environmental temperature.
According to 3 the elastic deformation ends at about a value of 1,5 %.

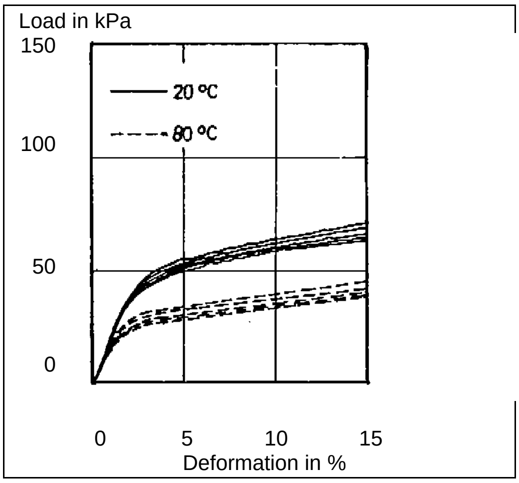

Figure 4: Compressive load and deformation of non flame retarded EPS, density 14 kg/m³ [21].

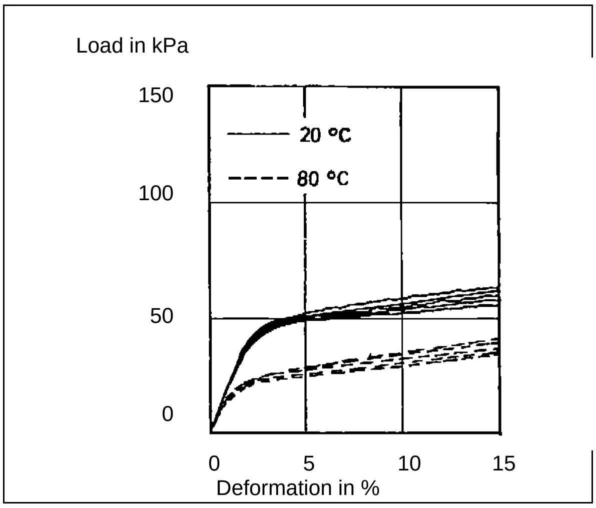

Figure 6: Compressive load and deformation of flame retarded EPS, density 14 kg/m³ [21].

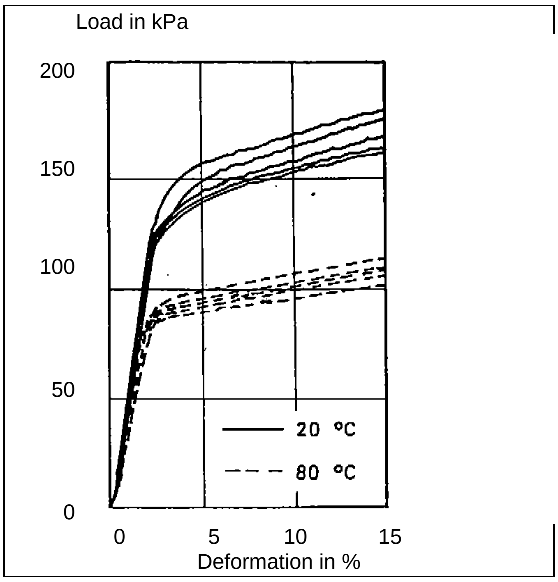

Figure 5: Compressive load and deformation of non flame retarded EPS, density 24 kg/m³ [21].

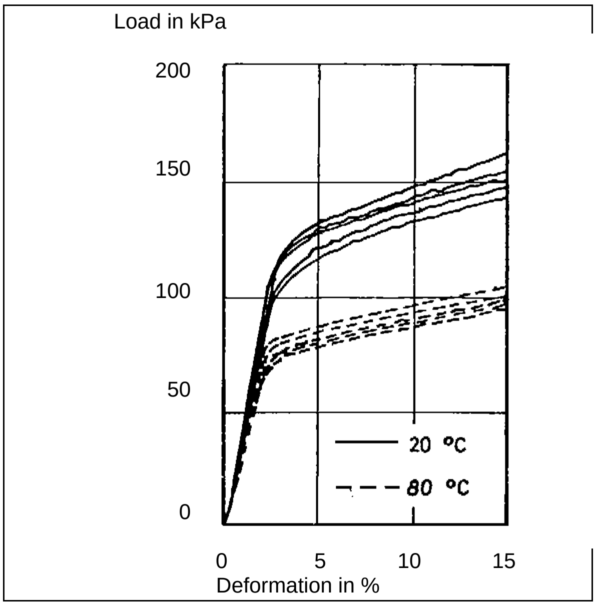

Figure 7: Compressive load and deformation of flame retarded EPS, density 24 kg/m³ [21].

2.4.3.4 Compressive stress

Compressive stress is normally needed for applications where a load prevails on the EPS e. g. under a floor, on a flat roof, perimeter insulation and so on. In practice the deformation of the EPS in load bearing application is much lower than 10 %. The compressive stress at 10 % is chosen to obtain repeatable test results for production control purposes. In principle it is possible to test EPS at deformations prevailing in end use conditions such as 1 to 3 %, which would lead to lower values of compressive stress. But the precision and repeatability of these test results is much lower than those taken at 10 %.

On the other hand the relationship between test results of compressive stress at 10 % deformation and long term compressive behaviour is well known and described in clause D.2 of EN 13163.

The compressive stress of EPS is one of the most important properties and therefore it is used to classify EPS products. Classification and relationship with bending strength is described in Annex C of EN 13163. The compressive stress depends directly on density as shown in clause B.2.2 of EN 13163. The relationship between compressive stress and the water vapour diffusion resistance factor / water vapour permeability is given in D.4 of EN 13163.

Compressive stress depends on the temperature of test which is also described in 2.4.3.3. The compressive behaviour at 20 °C is shown in Figure 8.

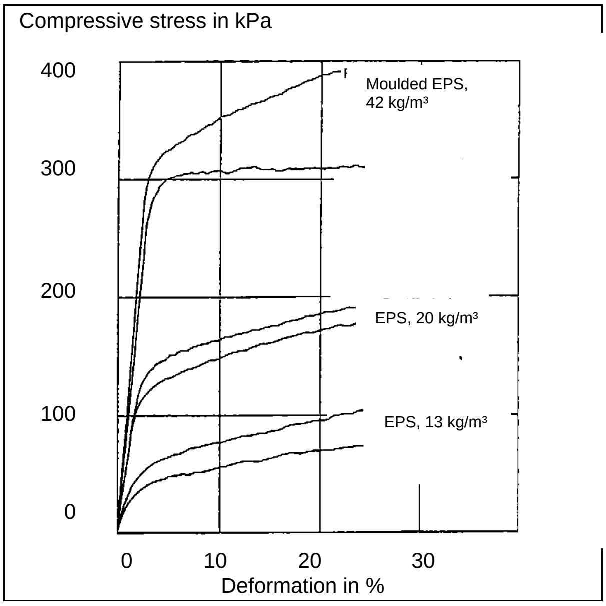

Figure 8: Compressive strength at 20 °C of different densities of EPS [23].

Different values of compressive strength at 10 % deformation at different temperatures were measured by Zehendner [23] and given in Table 5.

Table 5: Compressive strength at 10 % deformation at different reference temperatures.

Material	Density	Compressive strength at different temperatures in kPa				
		-170 °C	-60 °C	-30 °C	20 °C	70 °C
EPS block moulded, non flame retarded	14	42	46	58	56	42
	22	210	150	160	160	120
EPS block moulded, flame retarded	14	62	75	77	83	62
	22	190	170	170	160	120
EPS, moulded board	42	510	450	420	360	240

According to 3 the elastic deformation ends at about a value of 1,5 %.

2.4.3.5 Tensile strength perpendicular to faces

Tensile strength is needed where EPS is subjected to bond stress where the intrinsic weight or wind suction subject the EPS to tensile forces. For well fused EPS products a relationship between tensile strength and density can be shown [49].

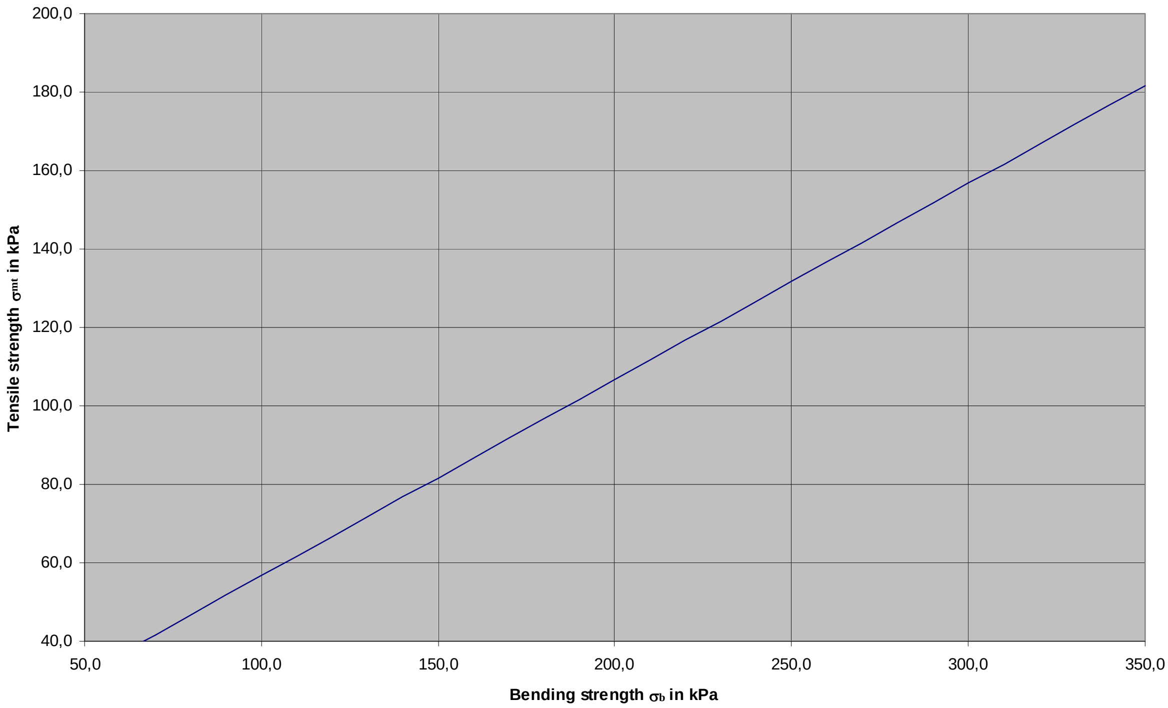

Figure 9: Relationship between tensile strength perpendicular to faces and density for well fused products.

σ_{mt}= 14,00·ρ - 72,5 kPa

Different values of tensile strength at different temperatures were measured by Zehendner [23] and given in Table 6.

Table 6: Tensile strength at different reference temperatures.

Material	Density	Tensile strength at different temperatures in kPa			
		-170 °C	-60 °C	20 °C	70 °C
EPS block moulded, non flame retarded	14	190	120	120	80
	24	330	400	370	250
EPS block moulded, flame retarded	14	190	190	190	130
	23	320	320	300	210
EPS, moulded board	40	720	790	550	270

2.4.3.6 Bending strength

Since bending strength is much easier to determine than tensile or flexural strength it is used for handling assessment and for quality control concerning the fusion of the EPS material. For a well fused product bending strength depends on the density as shown in Figure 10.

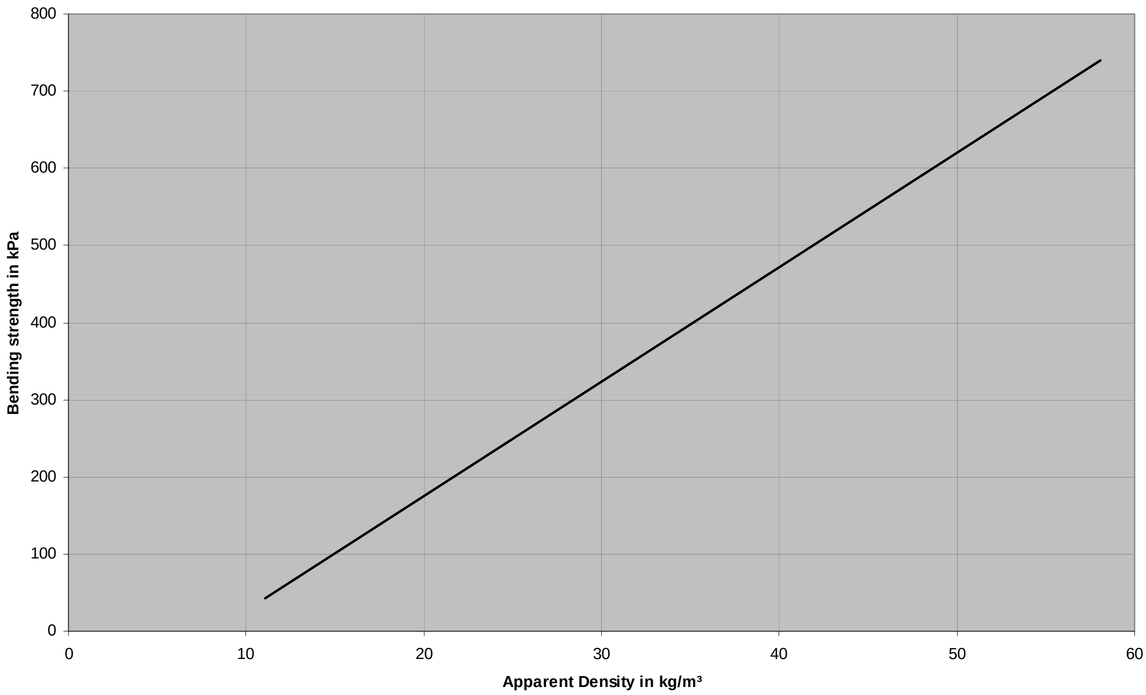

Figure 10: Correlation between bending strength and density.

To calculate the bending strength from density use the equation below.

$$\sigma_b = 14{,}84\rho_a - 122{,}6kPa$$

In Annex C of EN 13163 a link between compressive stress and bending strength is given for classification purpose. The figures in Table C.1 do not reflect the real correlation between these properties. The bending strength values in that table represent the minimum requirement for a well fused product. The average bending strength corresponding to compressive stress at 10 % deformation is significant higher than those values given in table C.1 of EN 13163.

Different values of bending strength at different temperatures were measured by [23] and given in Table 7.

Table 7: Bending strength at different temperatures.

Material	Density	Bending strength at different temperatures in kPa			
		-170 °C	-60 °C	20 °C	70 °C
EPS block moulded, non flame retarded	14	160	220	150	130
	23	290	300	330	290
EPS block moulded, flame retarded	14	200	200	170	130
	22	370	330	280	230
EPS, moulded board	40	690	670	510	300

Relationship to shear see 2.14.3.

2.4.3.7 Point load

The point load test method was developed specially for products that behave in a particular way on flat roofs during construction (e.g. mineral wool can be very flexible and cellular glass can be very brittle). EPS behaves in a different way, the loads during construction are rather low compared to the possible loads determined from compressive strength and they will certainly not affect EPS. Therefore the point load test is not determined. Determining testing the compressive strength is sufficient for flat roof applications.

2.4.3.8 Compressive creep

Compressive creep is the deformation under a specified load, σ_c, in relationship to the time. Just after the beginning of the load there is an initial deformation X_0. The total deformation, X_t, under load can be calculated as follows:

$$X_t = X_0 + 10^a * t^b$$

In this formula is t used for the time in hours and a and b are coefficient which have to be calculated according EN 1606.

Compressive creep will normally be needed for applications where continuous high loads are imposed on a structure supported by EPS, e. g. such as building foundations or cold store floors.

The SP Swedish National Testing and Research Institute in Gothenburg has published results of creep data of EPS in 2001 [31]. SP has measured samples of block moulded EPS of a mean densities of 18,9 kg/m³ and 30,0 kg/m³ over a period of 15.869 h (corresponding to 662 days, see also note 1 of clause 4.3.8 in EN 13163). The tested compressive stress, σ_c, was taken as a ratio from the compressive stress at 10 % deformation, σ_{10}. The following three different ratios have been tested:

$$q_1 = \sigma_{c1}/\sigma_{10} = 0{,}25$$

$$q_2 = \sigma_{c2}/\sigma_{10} = 0{,}35$$

$$q_3 = \sigma_{c3}/\sigma_{10} = 0{,}45$$

Figure 11 and Figure 12 show the long term creep behaviour evaluated according EN 1606.

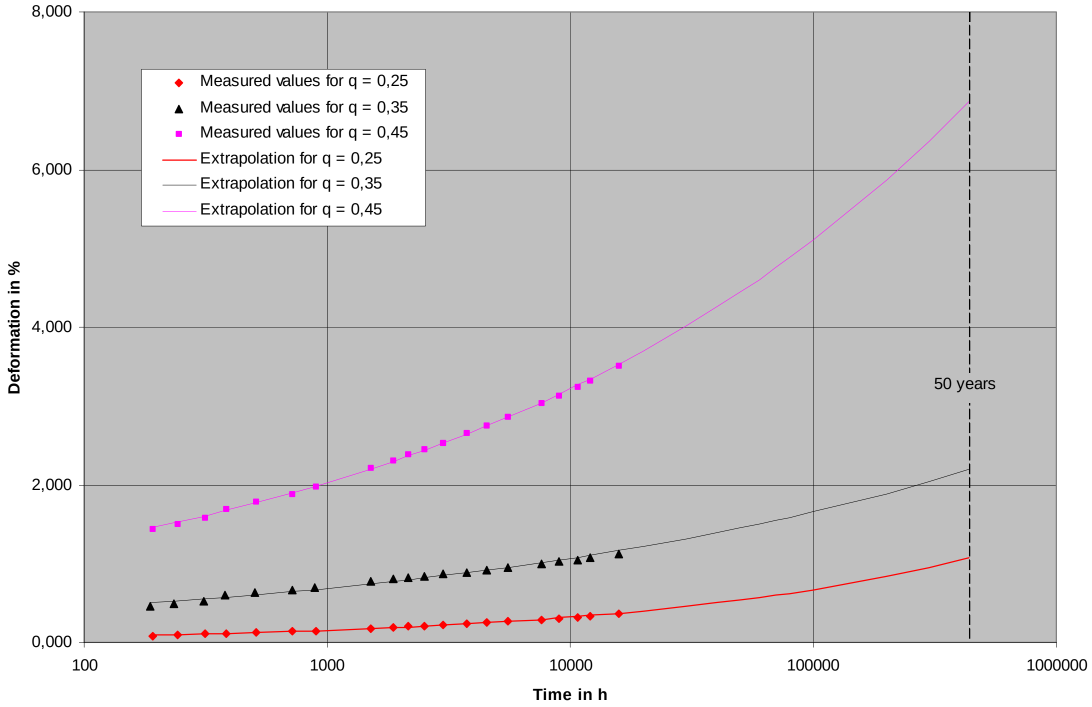

Figure 11: Measured total deformation of EPS 100, ε_t, and extrapolation to 50 years.

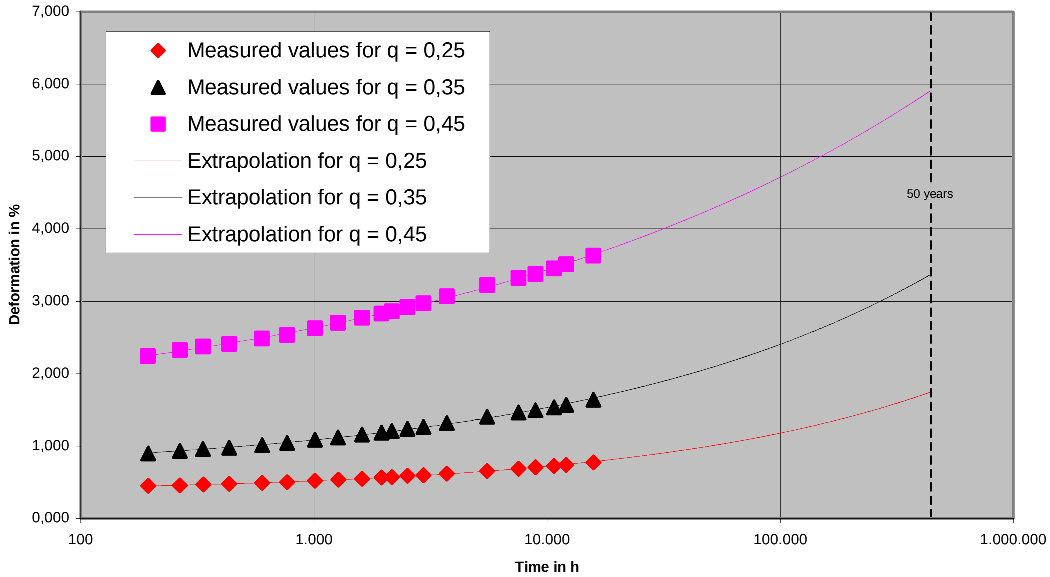

Figure 12: Measured total deformation of EPS 200, ε_t, and extrapolation to 50 years.

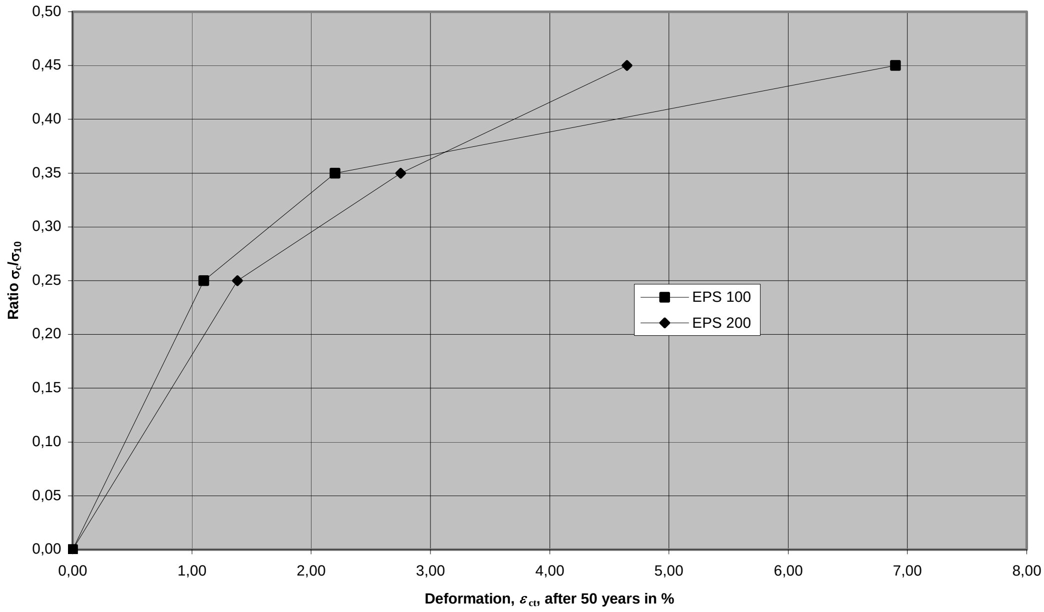

Figure 13: Creep compression, ε_{ct}, of EPS 100 and EPS 200 after 50 years in relationship to the ratio q.

To avoid a huge number of measurements for all possible products and practical conditions the ratio q may be used to declare the correct compressive stress, σ_c, which leads to a deformation of 2 % after 50 years. According to Figure 13 this ratio is about 0,30 which proves that the factor of 0,30 given in D.2 of EN 13163 is correct.

The initial deformation derived from the measurements from SP are for a ratio of 0,30 as follows:

EPS 100 0,54 %
EPS 200 0,48 %

<u>Example</u>

An EPS insulation shall be designed for the use under a foundation which will impose a compressive stress of 75 kPa. The deformation of 2 % shall not be exceeded. Which material has to be chosen?

σ_c = 75 kPa

$\sigma_{10} = \sigma_c / q$ = 75 kPa / 0,30 = 250 kPa

That means an EPS material of σ_{10} = 250 kPa has to be chosen for this application. To decide on the apparent density, ρ_a, which has to be selected the equation B.2 of EN 13163 (Annex B) may apply:

$\sigma_{10,\ pred} \approx$ 10,0 kPa·m³/kg × ρ_a - 109,1 kPa

$\rho_a = (\sigma_{10,\ pred}$ + 109,1 kPa) / 10,0 kPa·m³/kg

ρ_a = (250 kPa + 109,1 kPa) / 10,0 kPa·m³/kg

ρ_a = <u>35,9 kg/m³</u>

The compressive creep of a product designed in such a way would have a declared value of CC(2%/1,5%,50)75.

If the producer uses a specific proven correlation of compressive stress and density this may be applied which may lead to other results.

2.4.3.9 Water absorption

The different test methods for water absorption are accelerated tests to describe the material but the results may not directly be relevant for design purposes.
For common applications the design thermal conductivity, λ_U, is the same as the declared thermal conductivity, λ_D. In applications where the EPS product is in permanent contact with water, the moisture conversion factor of the thermal conductivity should be estimated according to EN ISO 10456.

Table 8: Thermal conductivity in relationship to moisture content according ISO 10456.

Moisture content %	**Design thermal conductivity**	
	λ_D = 0,033 W/mK	λ_D = 0,036 W/mK
1,0	0,034	0,037
2,0	0,036	0,039
3,0	0,037	0,041
5,0	0,040	0,044
10,0	0,049	0,054
15,0	0,060	0,066

<u>Example</u>

In drained building foundations where the EPS product is against or within the ground, the practical long term water content, W_p, is approximately

$$W_p \approx W_{lt} / 2$$

and in non drained foundations

$$W_p \approx W_{lt}$$

According to the levels given in EN 13163 (table 8) the design thermal conductivity may be calculated as follows:

$$\lambda_U = \lambda_D \cdot F_\Psi$$

F_Ψ

The values for F_Ψ are given in Table 9.

Table 9: Moisture conversion factor F_ψ derived from [4].

Level according to EN 13163	Practical water content W_P vol-%		Moisture conversion factor F_ψ 1	
	Drained	Not drained	Drained	Not drained
WL(T)5	≤ 2,5	≤ 5,0	1,11	1,22
WL(T)3	≤ 1,5	≤ 3,0	1,06	1,13
WL(T)2	≤ 1,0	≤ 2,0	1,04	1,08
WL(T)1	≤ 0,5	≤ 1,0	1,02	1,04

For the behaviour under water exposure in practical conditions see also 2.4.3.10.

2.4.3.10 Freeze thaw resistance

The determination of the freeze-thaw resistance is only needed for applications where EPS is permanently exposed directly to water and a temperature range from below zero up to higher than zero degrees Celsius. These conditions may occur in non-protected frost insulation systems (no gravel layers or insulation under ground water etc.) or in inverted roofs.

The freeze-thaw resistance is tested according to the standard EN 12091 in which the changes of compression strength and moisture content will be determined. The test has 300 cycles from dry conditions at the temperature of – 20 ºC to the wet conditions at the temperature of + 20 º C. A large amount of measurements of the freeze-thaw resistance shows that EPS products having a density higher than 20 kg/m³ are not degraded by freeze-thaw cycles. Also the thermal conductivity of EPS frost insulation boards is not affected by freeze-thaw cycles.

The Canadian Institute for Research in Construction has tested moulded EPS boards in a perimeter application over a long term period of two years [41]. The thickness of boards was 76 mm and the density varied approximately from 12 to 18 kg/m³. After a two year monitoring period the measurements indicated stable thermal performance of EPS frost insulation. The thermal performance of the specimen was not significantly affected by water movement. It also appears that the EPS insulation protected the concrete during these events. Thermal conductivity showed no significant difference from that measured on the initial EPS product. Also the compressive strength of the EPS samples were the same as those of samples tested at the beginning of the test. The in situ performance of EPS frost insulation indicated a high stability of EPS.

For normal horizontal frost insulation materials, the determination of the freeze-thaw resistance is not necessary when the insulation is used in normal drained conditions (insulation above the ground water level). The insulation should be surrounded from both sides by layers of gravel and sand that have low capillarity. These layers form a part of drainage system that keeps the free water level mainly below the insulation layer. EPS frost insulation should have only occasional contact with free water. At least a 200 mm layer of gravel and sand is recommended to be used between the free water level and frost insulation. The EPS frost insulation should also be protected against high moisture loads from above. Both the ground surface and the frost insulation layers should be inclined (at least 2 %) away from the building so that the possible free water from above will be lead away from the foundation. In the above mentioned conditions the long term moisture content of EPS frost insulation with properly arranged drainage of free water will typically be in the range of 0,5 to 2,5 % Vol. [50].

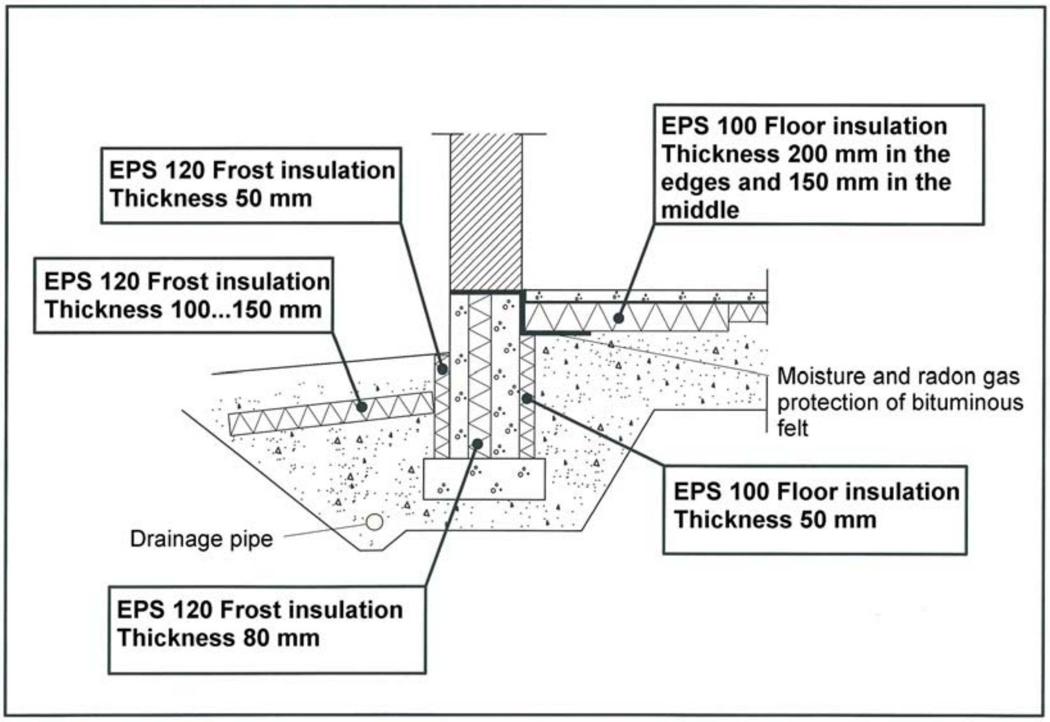

Figure 14: Example of how to use EPS frost and floor insulation materials in ground slab structures.

Conclusion:

- EPS frost insulation materials with a density of 22 kg/m³ or above have good results in freeze-thaw tests, if the boards are well fused.
- The classification of Finnish EPS Division's EPS frost products is (based on test method EN 12087, method 2A):
  - EPS 120 Frost: short-term compressive strength at 10 % deformation 120 kPa, and the moisture content below 2 Vol %
  - EPS 200 Frost: short-term compressive strength at 10 % deformation 200 kPa and the moisture content below 1 Vol %
  - EPS 300 Frost: short-term compressive strength at 10 % deformation 300 kPa and the moisture content below 1 Vol %
  - EPS 400 Frost: short-term compressive strength at 10 % deformation 400 kPa and the moisture content below 1 Vol %

2.4.3.11 Water vapour transmission

The water vapour transmission through the thermal insulation product is needed for constructions where the water vapour condensation has to be calculated. A calculation method for this purpose is given in EN 13788 [25], which requires water vapour diffusion resistance factors. These factors are given in table D.2 of EN 13163. Since there is always a range given in table D.2 some national application rules require the use of the unfavourable value and therefore it has to be decided whether the upper or the lower value should be used. In cases where the condensation point is located inside the insulation layer the higher value should be used. In cases where the condensation point is located outside the insulation the lower value should be used. If the condensation is located inside the EPS layer it makes no difference which value has been chosen.

In addition to EN 12086, EN ISO 12572 is another test standard for this property. For other building materials the EN 12524 [18] containing tabulated values may be used.

2.4.3.12 Dynamic stiffness

The dynamic stiffness is needed for applications where acoustical performances have to be assessed. The dynamic stiffness is always determined together with a heavy layer (e. g. a slab) and describes the transmission of vibrations between the two layers. Low values of dynamic stiffness lead to a high sound reduction index. For indirect testing of dynamic stiffness see clause B.2.5 of EN 13163. Normally the dynamic stiffness is needed to calculate the weighted impact sound reduction index of intermediate floors with a floating floor finish.

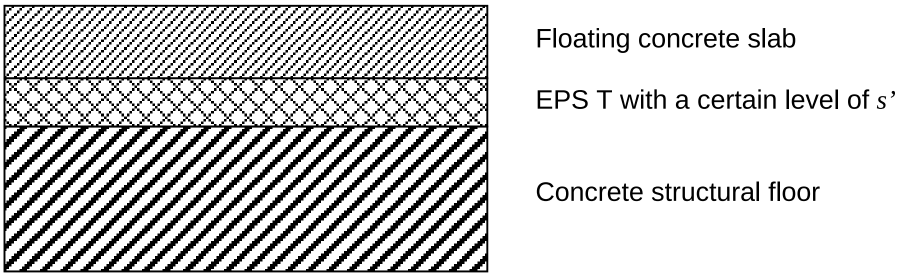

Figure 15: Example of a ceiling construction with a floating floor.

For detailed information how to calculate the impact sound reduction see the following example and EN 12354-2 [26].

Example

Two floors of a building are separated by an in-situ concrete solid floor, thickness 200 mm. To achieve a certain acoustic performance a floating floor, thickness 60 mm, made of concrete shall be fabricated on a layer of EPS T. The properties of the EPS T are:

thickness	40 mm
compressibility	3 mm
dynamic stiffness	10 MN/m³

If the density of the concrete floor is 2.300 kg/m³ and the density of the slab is 2.000 kg/m³ the mass per unit area is

for the floor	460 kg/m²
for the screed	120 kg/m²

According to Annex B of EN 12354-2, equation B.5 the equivalent weighted normalized sound pressure level $L_{n,w,eq}$ of homogeneous floor constructions is

$$L_{n,w,eq} = 164 - 35 \lg \frac{m'}{m'_0} \text{ in dB}$$

where

m' is the mass per unit area of the floor and
m'_0 is 1 kg/m².

$$L_{n,w,eq} = 164 - 35 \lg \frac{460 kg/m^2}{1 kg/m^2} 164 - 35 \lg 460 = 164 - 35 \cdot 2{,}663 = 70{,}8 dB$$

The weighted reduction of impact sound pressure level, ΔL_w, for floating floor screeds may be taken from figure C.1 of EN 12354-2. For a mass per unit area of the screed of 120 kg/m² and a dynamic stiffness of 10 MN/m³ of the impact sound insulation layer ΔL_w is 33 dB.

The correction K for flanking transmission has to be taken from Table C.1 of EN 12354-2. Assuming the mean mass per unit area of the homogeneous flanking elements is 200 kg/m² the correction K will be 2 dB.

Now the weighted normalized impact sound pressure level, $L'_{n,w}$, between two rooms can be calculated:

$L'_{n,w} = L_{n,w,eq} - \Delta L_w + K$ = 71 dB – 33 dB + 2 dB = 40 dB

Normally this is the required value in national application rules. If the weighted standardized impact sound pressure level is required the volume, V, of the receiving room has to be taken into account. Assuming a volume of 50 m³

$L'_{nT,w} = L'_{n,w} - 10\lg(V/30)$ = 40 dB – 2,2 dB = 38 dB.

Furthermore products having a low value of dynamic stiffness improve the performance concerning air born sound in some constructions like gypsum board faced walls or ETICS. At present there is no method available to calculate the sound reduction from the dynamic stiffness in this field.

2.4.3.13 Compressibility

The compressibility is used for EPS T products applied in load bearing constructions like floating floors. Since there are different levels of imposed load on the screed the compressibility levels are given in correlation to those load levels. To determine the compressibility, c, the thickness d_L and the thickness d_B have to measured first.

$$c = d_L - d_B$$

For constructions with a level of imposed load up to 5 kPa there is a great deal of experience of the long term behaviour. In these cases the long term thickness reduction is lower than or equal to c if the requirements of table 12 of EN 13163 are met. For higher levels of imposed load the long term thickness reduction, X_t must be determined in accordance with EN 1606.

This determination according EN 1606 may also be used for other load bearing application where the long term thickness reduction is of interest.

2.4.3.14 Apparent density

The apparent density is not a product performance but a very important parameter for quality assessment and for indirect testing. Many of the properties of an EPS product depend on density such as thermal conductivity, bending strength, deformation under load, compressive stress, tensile strength, compressive creep, water absorption, freeze thaw resistance, water vapour transmission, dynamic stiffness, compressibility, shear strength, dynamic load resistance. The properties bending strength, tensile strength, water absorption, freeze thaw resistance , water vapour transmission and shear strength depend very much on the fusion of the material.
Guidance on how to use the density for indirect testing is given in the clause B.2 of EN 13163.

2.4.3.15 Release of dangerous substances

<u>General</u>
The Guidance Paper H [32] is considered as the basic reference document with regard to the definition (and consequently the scope) and the approach ‘dangerous substances’ within the frame work of the CPD.
The definition of ‘dangerous substances’ derived from the Guidance Paper and the CPD is:

‘Chemical elements and their compounds in the natural state or obtained by any production process are considered dangerous when their substances may present a danger for men during normal use of construction products in their intended application in works. The requirements to the relevant performance of construction products are focussed on the emission of dangerous substances or radiation, in the air, in (drinking) water or soil.’

This definition is:

- based on the release approach,
- focussed on the intended application of construction products,
- restricted to normal use of construction products (excluding e. g. fire and excluding other life cycle phases of construction products like mineral extraction, performance during the building process, consideration regarding waste disposal or recycling),

Existing national regulations concerning the health and safety are expressed in the form of specifications limiting the emission of dangerous substances within the relevant types of environment, e. g. indoor air, soil and (drinking) water. Unless EU harmonisation of such specifications is achieved, harmonized product standards can only address the release performance of construction products and the specification of the relevant test methods.

In order to prevent that the issue of ‘dangerous substances’ being dealt with in a heterogeneous and therefore costly way, the EC is asked to provide conceptual guidance to CEN on how to address dangerous substances in harmonized product standards. This guidance should be based on the requirements of the CPD and the corresponding Guidance Paper H.

A horizontal approach regarding the selection of dangerous substances relevant for construction products is accordingly proposed. Obviously the Member States will continue to establish levels or values and an EC initiative which would give Member States guidance regarding this issue will be welcomed.

With regard to the release of dangerous substances from construction products in buildings during their intended use, different types of environment must be distinguished: indoor air, soil, ground and / or surface water, drinking water.

Unless harmonized regulatory requirements on permissible release performance exist, harmonized product standards can only specify rules concerning the release performance of those construction products which are relevant for the protection of the types of environment concerned.

A prerequisite for rules concerning the release performance of construction products are standard test methods (sampling, test procedure, chemical analysis, interpretation of results).

CEN should be requested to develop such procedures for the relevant release scenarios (evaporation, radiation, leaching etc.).

A list of relevant dangerous substances released from construction products to the different types of environment to be protected when applied in the works will be needed. Such a list should not be confused with a list of components of the content of construction products.

Taking into account the existing DG Enterprise G5 database [33], the above mentioned list in the Guidance Paper and the CPD (particularly in Essential Requirement no. 3). That is to say, only dangerous substances relevant to release of construction products to the environments of air, water and soil (whereby radiation is considered as air related).

Regarding the (CPD) release approach, it might prove necessary to accept in exceptional cases a so-called “content approach”. However, such a situation can only be accepted when the necessity of measures regarding risk reduction is scientifically well proven, and when, at the same time as the introduction of such measures, a release oriented test method will be developed. Nevertheless, in the different national regulations, bans or restrictions exist which concern the content of dangerous substances in some construction products. This ‘non CPD related legislative area’ can create barriers to trade. Together with the CPD process of harmonization of dangerous substances, this issue of content bans and restrictions should also be dealt with.

It is obviously the fact that the framework of the CPD relates to a specific area outside the broader context of both human health and the environment. The knowledge and experience gained in this broader context will be helpful to the resolution of the issue ‘dangerous substances’ within the framework of the CPD. However, it is necessary that the focus of attention continues to be the further implementation of the CPD.

Specific to EPS

EPS does not release any of the dangerous substances listed in reference 33 in such a way that it does not fulfil the local European environmental laws and guidelines. The released concentrations are of a lower order than the values set out in these legislation.

Recent years have shown growing concern for the environment, and in particular an increasing demand for sustainable building and development. For construction industry this means a need for accurate information about the environmental impact of the building materials and products that they use. The most reliable way to present this information has proved to be the *Life Cycle Assessment (LCA)* approach.

This approach investigates the process involved in the manufacture, use and disposal of a product or system – from cradle to grave.

The figures show the weighted averages of the characterisation and normalisation scores for the life cycle of 1 kg of EPS material. These are European averages for densities varying from 15 – 20 kg/m³. Proper comparison with other insulation materials is only possible when the same “functional unit” is used in calculations, e. g. one square meter of insulated area with the same thermal properties.

With this LCA we now have a complete picture of EPS, and it can support its inherent benefits with detailed, accurate information. The following environmental impacts and indicators were disregarded

in the study: biological depletion potential, terristic ecotoxity, noise, casualties, radiation and heat to water[46].
The study was carried out in 1998 by PRC-Bouwcentrum in the Netherlands, fulfilling the requirements of the SETAC-approach and the international ISO 14040 standard [48].
Intron B. V., the Quality Assessment Institute for Biulding Industry carried out the external critical expert review [47] according ISO 14040 and concluded "that the EUMEPS LCA was carried out in a very scrutinised way, which was transparent and very well documented. It reflects the best available LCA data on EPS that can be made available in 1999.

Table 10: Essential environmental properties.

Environmental effect / aspect	Abbreviation	Characterisation scores	Unit	Normalisation scores	Unit [b]
Environmental impact					
Abiotic depletion	ADP	0,83	1	1,04E-11	a
Global warming	GWP	5,98	kg	1,42E-12	a
Ozone depletion	ODP	2,11E-06	kg	3,75E-14	a
Human toxicity	HCT	0,0357	kg	9,06E-13	a
Aquatic ecotoxicity	ECA	101	m^3	2,29E-13	a
Smog	POCP	0,0207	kg	3,28E-12	a
Acidification	AP	0,0278	kg	8,19E-13	a
Nutrification	NP	0,00241	kg	2,81E-13	a
Land use	LU*t	0,00274	m^2		a
Environmental indicator					
Cumulative energy demand (excluding feedstock energy)	CED	48,9	MJ (lhv) [a]	8,45E-13	a
Cumulative energy demand (including feedstock energy)	CED+	93,1	MJ (lhv) [a]	1,61E-12	a
Not toxic final waste	W-NT	0,0453	kg	8,43E-14	a
Toxic final waste	W-T	0,0124	kg	3,09E-13	a

[a] lhv = lower heating value.
[b] a = year

The European Manufacturers of Expanded Polystyrene (EUMEPS) want the truth about their products to be known. They want accurate information to be available, and most importantly, they want to clarify the issues surrounding EPS. With this in mind, they commissioned a report into the manufacture, use anrecycling or disposal of EPS. This report presents the available and reliable information that has been gathered from the EUMEPS member associations and producers, and is a comprehensive Life Cicle Assessment of EPS.

2.5 Test methods

In order to create a specification standard for products, testing standards are required. All the testing standards referenced in clause 4 are those to be used even if alternative test methods may be available. Additional properties described in Annex D of EN 13163 should also use the referenced test standards.

2.5.1 Sampling

General sampling rules are given in the appropriate testing standard and specific sampling advice may be found in EN 13163 .

2.5.2 Conditioning

General conditioning rules are given in EN 13163 and specific conditioning advice may be found in the appropriate testing standard.

2.5.3 Testing

The important information about testing is to be found in table 13 of EN 13163 or table 12 of EN 14309. Measured values which will be used for statistical evaluations shall be single values. It is not allowed to use mean values or use multiple values or to omit values.

To measure thermal resistance and hence calculate thermal conductivity there are test methods given as described in Table 11.

Table 11: Applicable test methods for thermal conductivity.

Test method	Title	Guidance, when to be used
EN 12664	Thermal performance of building materials and products – Determination of thermal resistance by means of guarded hot plate and heat flow meter methods – Dry and moist products of medium and low thermal resistance	For all samples with a thermal resistance R: 0,02 m²K/W ≤ R < 0,5 m²K/W
EN 12667	Thermal performance of building materials and products – Determination of thermal resistance by means of guarded hot plate and heat flow meter methods – Products of high and medium thermal resistance	For all samples with a thermal resistance R: R ≥ 0,5 m²K/W
EN 12939	Thermal performance of building materials and products – Determination of thermal resistance by means of guarded hot plate and heat flow meter methods – Thick products of high and medium thermal resistance	For all thick insulation products (100 mm – 150 mm), depending on the apparatus used, if the total thickness of the test specimen cannot be measured.

2.6 Designation code

In the designation code all properties of clause 4.2 (EN 13163 and EN 14309) for which levels or classes are given must appear in the designation code.

For EN 13163

- tolerance of length,
- tolerance of width,
- tolerance of thickness,
- tolerance of squareness,
- tolerance of flatness,
- tolerance of dimensional stability under constant normal laboratory conditions,

For EN 14309

- tolerance of thickness,
- tolerance of dimensional stability under constant normal laboratory conditions,

Properties for which a single limit value is required as given in the standards EN 13163 and EN 14309 do not appear in the designation code. The producer may specify those properties on the product label or in his literature.

As far as properties from clause 4.3 (EN 13163 or EN 14309) are claimed by the producer the same procedure applies as mentioned above.

Examples of designation codes are given on the labels to be found in 2.8.

2.7 Evaluation of conformity

EPS products labelled with the CE mark have to conform with EN 13163 or EN 14309. It is the producer's task to follow the requirements listed in clause 7 of EN 13163 or EN 14309 and in EN 13172 for the evaluation of conformity.

2.7.1 Attestation systems and tasks

The attestation system is the term applied to the degree of involvement of third parties in assessing the conformity of the product according to the relevant technical specifications (EN 13163 and EN 14309). At present a significant barrier to trade arises from the different attestation systems required by Member States for the same product. Hence these requirements are also ‘harmonised’ under the Directive. For thermal insulation products the attestation system has been decided collectively by the Member States and the Commission on the basis of the implications of the produc on health and safety, and on the particular nature and production process for the product itself.

For thermal insulation products three systems of attestation are used as shown in Table 12:

The tasks for the manufacturer and the attestation body are summarised in Table 12. Note that for all systems, including the least onerous system 4, the manufacturer is required to have a fully recorded FPC system. The criteria and procedures for this are included in EN 13163, EN 14309 and EN 13172; see also Annex ZA.2 of the EPS standards.

Table 12: Tasks for the systems of attestation of conformity applying for EPS.

Tasks	**Systems of the attestation of conformity system**			
	According Annex A of EN 13172	**System 1**	**System 3**	**System 4**
Tasks for the manufacturer				
Factory production control	✓	✓	✓	✓
Further testing of samples taken at the factory according a prescribed test plan	✓	✓		
Initial type testing	✓			✓
Tasks for the notified body				
Initial type testing	✓	✓	✓	
Certification of FPC	✓	✓		
Surveillance of FPC	✓	✓		
Audit testing of samples	✓			

For EPS products in end use conditions (“in its application”) falling in Euroclass A1, A2, B or C, the attestation of conformity system 1 applies, unless it is placed on a list “Classified Without Further Testing” (CWFT). Then system 4 applies.
For EPS products in their end use conditions falling in Euroclass D or E, the attestation of conformity system 3 applies.
To choose the proper attestation of conformity system, note also Table B.2 , footnote d of EN 13163. Products in their end use conditions having Euroclass B, C or D may use an indirect test only if a notified body is involved, verifying the correlation to direct testing. If the product in its application is placed on a CWFT list, no testing is required and system 4 applies.

Manufacturers can choose the level of attestation of conformity from the following possibilities.
A product or product group in its application is classified as Euroclass E:

System 3, performing the small burner test (EN ISO 11925-2) once per day

or

System 3, performing the small burner test (EN ISO 11925-2) once per week, using certified raw material

or

System 4, if placed on a CWFT list

A product or product group in its application is classified as Euroclass D, C or B:
System 3, performing the SBI test (EN 13823) once per month

or

System 1 (for reaction to fire only) , performing the SBI test (EN 13823) once per two years and the small burner test (EN 11925-2) once per day

or

System 1 (for reaction to fire only) , performing the SBI test (EN 13823) once per two years and the small burner test (EN 11925-2) once per week, when using certified raw material

or

System 1 (for reaction to fire only), measuring the apparent density and the thickness of the EPS once per 2 hours and measuring the weight per unit area of the outer layer (for laminated products) once per day

or

System 4, if placed on a CWFT list.

<u>What are notified bodies?</u>
Member States have appointed notifying authorities with the power to notify bodies for certification, testing and inspection of construction products, to the commission. The same is valid for third countries, with which the European Union has concluded agreements (e. g. EEA, MRA, PECA) including such a notification procedure. States concerned may only notify bodies within their territories. The minimum requirements for the bodies to be notified are laid down in Annex IV of the CPD. Member States may add requirements for the bodies they notify. Additional requirements can be accreditation etc.

2.7.2 Manufacturer's declaration of conformity

Once a manufacturer has had all the appropriate attestation tasks carried out for his product he is required complete a 'Declaration of conformity' which is kept with his technical file concerning the product. This may supported by a certificate of product conformity, FPC certificate, test laboratory reports or certificates, and / or own test results, depending on the attestation system required.

An outline of the manufacturer's declaration of conformity and for the certificate of product conformity (if relevant), is included in Annex ZA.2 of EN 13163 and EN 14309.

2.7.3 Certification

There are several possibilities where a certification body is involved:

1. The EPS product falls in Euroclass C or B (on the basis of the present knowledge it is not possible to reach Euroclass A). The note 1 in clause 7 of EN 13163 and EN 14309 indicates that footnote * (footnote a in EN 14309) of table ZA.2.2 applies for EPS products.

2. The producer runs a voluntary certification scheme according Annex A of EN 13172.
   - to benefit from the opportunity of indirect testing for reaction to fire according table B.2 of EN 13163 or table A.2 of EN 14309, note d.
   - to provide a lower level of the design thermal conductivity, e. g. in France or Germany. See 7.3.
   - to follow an European (Keymark) or national quality scheme.

The tasks of the certification body in case 1 is limited to reaction to fire. In case 2 the certification covers all properties claimed by the manufacturer and a continues surveillance of the factory production control, details are given in Annex A of EN 13172.

2.8 Marking and Labelling

CE marking is a 'passport' enabling a product to be legally placed on the market in any Member State. However, this does not mean that the product will be suitable for all end uses in all Member States. Examples of CE markings for EPS are given Figure 18 through Figure 20.

The way in which CE marking should be approached for an EPS product is set out in the Annex ZA.3 of EN 13163 and EN 14309.

2.9 Annex A

All standards for insulation materials for building have an Annex A to determine the thermal conductivity with a fractile of 90 % of the production and a confidence level of 90 % as given in EN13163. Further detailed information about the statistical background is given in [37].

2.10 Annex B

2.11 Testing frequencies

The testing frequencies for all properties described in the normative part of the standard are given in table B.1 and table B.2 of EN 13163 or table A.1 and A.2 of EN 14309.

Remarks to the footnotes of table B.1 and table A.1

- b) The definition of an EPS production unit and an EPS production line is given in Annex, clause **Error! Reference source not found.**.
- c) In cases where the measurements will be statistically evaluated one measurement shall always be one test result. See also 2.5.3.
- d) Initial type testing (ITT) means once in a lifetime provided that the relevant production parameters are unchanged.
- e) As soon as test methods for dangerous substances are available the standards will be revised.

Table B.2 Minimum product testing frequencies for the reaction to fire characteristics, is being revised. The newer version of this table is to be found as table A.2 in EN 131409. The indirect testing of the insulation board and the adjacent components (e.g. facings) should be generally carried out via a manufacturers method (not further specified). For the Euroclasses B-E the indirect test for insulation board should be the Ignitability test (EN ISO 11925-2) one per week.

2.12 Indirect testing

Properties for which the relationship to another property, e. g. density, is well known, may be tested indirectly via that property. This option will be used if the indirect test is quicker or cheaper.

2.13 Annex C

The normative Annex C contains definitions of EPS product types. To ensure a certain level of quality of the EPS product table C.1 combines two properties, compressive stress and bending strength. Compressive stress depends on density as shown in Annex B of EN 13163 or Annex A of EN 14309. Bending strength depends on the fusion of the EPS product. This combination of compressive stress combines and fusion quality ensures a good correlation with other properties.

For non load bearing applications there is no compressive stress required and in this cases EPS S may be used. The bending strength level of 50 kPa is a threshold value which has to be fulfilled in any case – even for EPS T to ensure adequate handling properties.

Although EPS T is used for load bearing applications there is no compressive stress required but a certain level of compressibility. This compressibility reflects the long term behaviour of this product type and the value of the compressibility is approximately the same as the long term compressive behaviour under a floating floor under practical conditions.

2.14 Annex D

2.14.1 General

Annex D of EN 13163 and Annex C of EN 14309 have been designed to provide more information to the user of EPS than is given in the normative part of the EPS standard. Since the content of the normative part is restricted by the mandate given by the EC to CEN there was a need to adopt further properties.

2.14.2 Long-term compressive behaviour

The long term compressive behaviour is described in 2.4.3.8. Annex D.2 describes a simple calculation procedure to determine the testing loads which may be applied on EPS products to ensure predicted 50 year creep values of a maximum of 2 %.

2.14.3 Shear behaviour

The shear behaviour may be useful in cases where EPS is laminated and where EPS contributes to the mechanical performance of the element. The shear strength of EPS depends on the quality of fusion and on the density. For well fused products the correlation between shear strength and density is given in Figure 16.

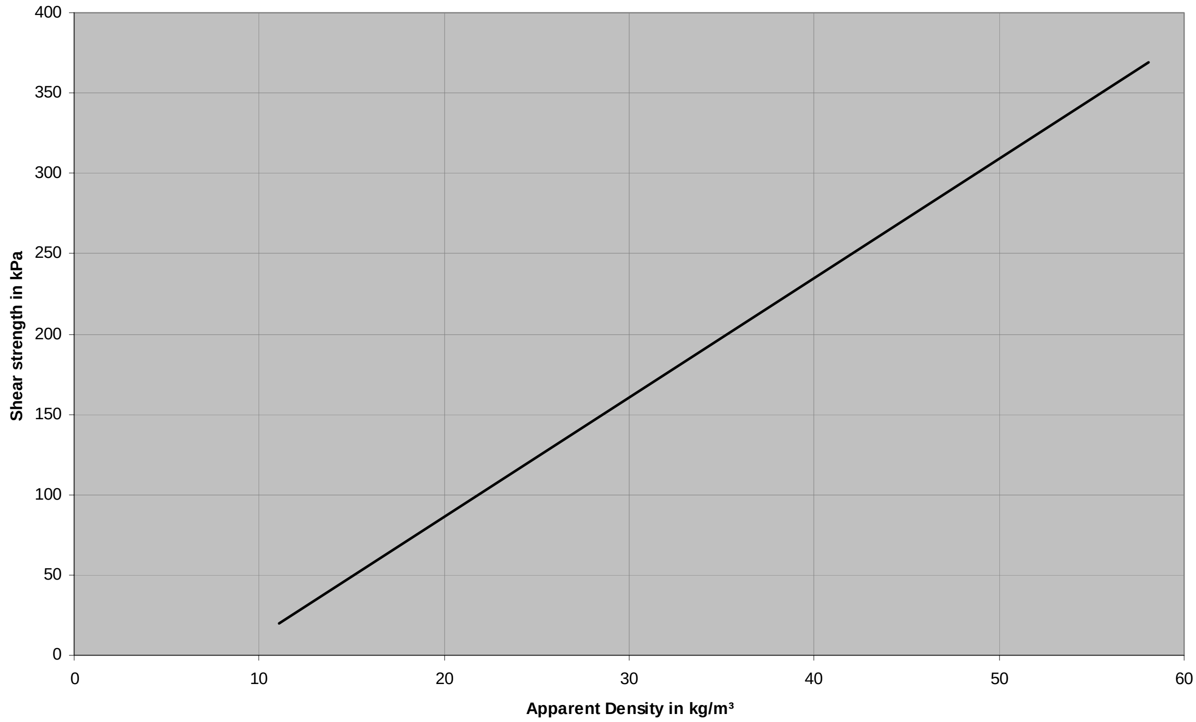

Figure 16: Correlation between shear strength and density.

$\tau = 7{,}43\rho_a - 62{,}8$ in kPa

Different values of shear strength at different temperatures were measured by Zehendner [23] and given in Table 13.

Table 13: Shear strength at different temperatures.

Material	Density	Shear strength at different temperatures in kPa	
		20 °C	70 °C
EPS block moulded, non flame retarded	14	550 – 1.000	280 – 410
	23	770 – 1.100	560 – 850
EPS block moulded, flame retarded	14	820 – 1.300	350 – 380
	22	670 – 1.300	530 – 750
EPS, moulded board	40	1.300 – 1.500	1.000 –1.100

More data are to be found in 49. In literature 49 a relationship between shear strength and bending strength is shown, see Figure 17

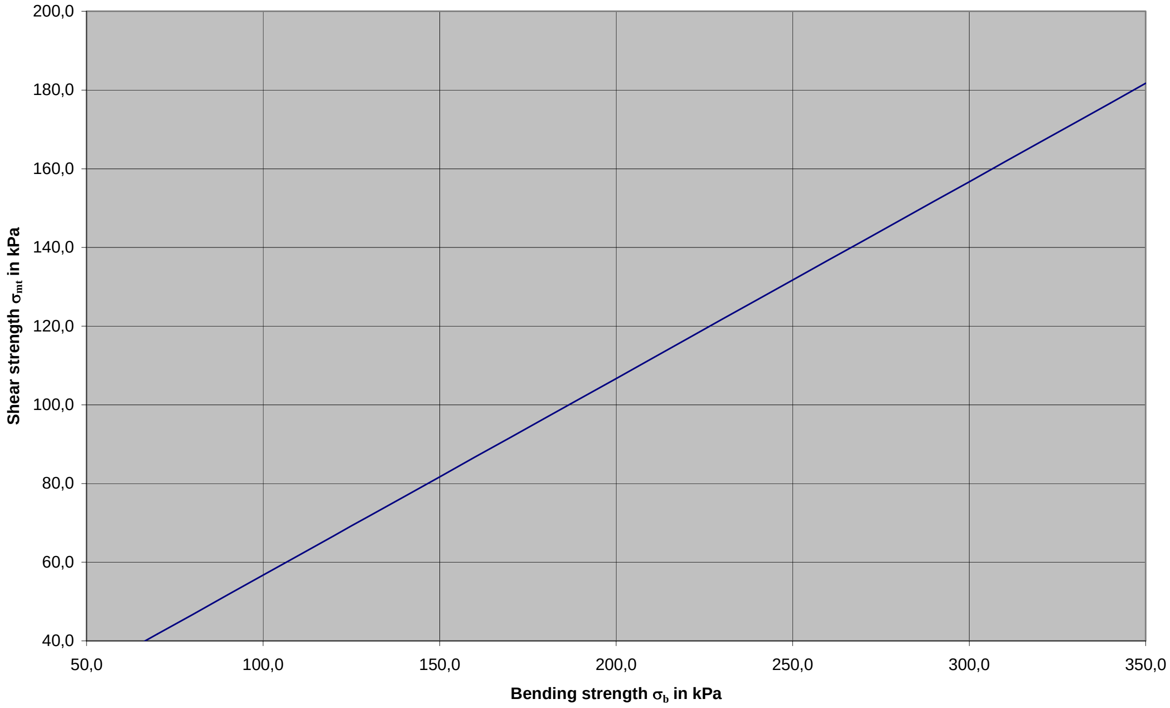

Figure 17: Relationship between shear strength and bending strength.

τ = 6,7 kPa + 0,5 · σ_b

2.14.4 Water vapour diffusion resistance factor

The water vapour diffusion resistance factor is used to calculate water vapour condensation inside a construction. For more details see 2.4.3.11.

In EN 12086 the following definitions are to be found:

Water vapour permeability, δ:
The product of the permeance and the thickness of the test specimen. The water vapour permeability of a homogeneous product is a property of the material. It is the quantity of water transmitted per unit of time through a unit of area of the product per unit of vapour pressure difference between its faces for a unit thickness.

Water vapour diffusion resistance factor, μ:
The quotient of the water vapour permeability of air and the water vapour permeability of the material or the homogeneous product concerned. It indicates the relative magnitude of the water vapour resistance of the product and that of an equally thick layer of stationary air at the same temperature.

The water vapour diffusion resistance factor µ is normally given at a temperature of 20 °C and a barometric pressure of 1.011 hPa. The water vapour permeability, δ_{air}, of air at that conditions is:

$$\delta_{air} = \frac{D}{R_D \cdot T}\left(\frac{T}{273K}\right)^{1,81}$$

D = 0,083 m²/h

R_D = $462 \cdot 10^{-6}$ Nm/(mgK)

$$\delta_{air} = \frac{0,083 m^2/h}{462 \cdot 10^{-6}\, Nm/(mgK) \cdot 283K}\left(\frac{283K}{273K}\right)^{1,81} = 0,635 mg/(Pa \cdot h \cdot m) \cdot 0,965^{1,81} = 0,6 mg/(Pa \cdot h \cdot m)$$

$$\delta = \frac{\delta_{air}}{\mu} = \frac{0,6}{\mu}$$

Due to this calculation table D.2 in EN 13163 has to be slightly revised as given in Table 14.

Table 14: Tabulated values of water vapour diffusion resistance factors and water vapour permeability.

Type	Water vapour diffusion resistance factor µ 1	Water vapour permeability δ mg/(Pa·h·m)
EPS 30	20 to 40	0,015 to 0,030
EPS 50	20 to 40	0,015 to 0,030
EPS 60	20 to 40	0,015 to 0,030
EPS 70	20 to 40	0,015 to 0,030
EPS 80	20 to 40	0,015 to 0,030
EPS 90	30 to 70	0,009 to 0,020
EPS 100	30 to 70	0,009 to 0,020
EPS 120	30 to 70	0,009 to 0,020
EPS 150	30 to 70	0,009 to 0,020
EPS 200	40 to 100	0,006 to 0,015
EPS 250	40 to 100	0,006 to 0,015
EPS 300	40 to 100	0,006 to 0,015
EPS 350	40 to 100	0,006 to 0,015
EPS 400	40 to 100	0,006 to 0,015
EPS 500	40 to 100	0,006 to 0,015
EPS T	20 to 40	0,015 to 0,030

2.14.5 Behaviour under cyclic load

For behaviour under cyclic load see 4.3.1.

2.14.6 Test methods

Test methods referred to in an informative annex do not appear in clause 2 *Normative references* of EN 13163 or EN 14309. That is why they are listed in the table D.3 of the Annex D.

2.14.7 Additional information

The additional information contains advice for installation and chemical behaviour. For chemical resistance of EPS see 6.6.

2.15 Annex E (normative)

It is foreseen to adopt in the next revision of EN 13163 an Annex E. This annex will contain test conditions for reaction to fire of EPS products in accordance with standard end-use application(s).

2.16 Annex F (informative)

It is foreseen to adopt in the next revision of EN 13163 an Annex F. This annex will contain test conditions for reaction to fire of a standard end-use construction not covered in Annex E using EPS products.

2.17 Annex ZA

2.17.1 Purpose

Annex ZA, in the context of the Construction Product Directive (CPD), is an informative yet compulsory annex which makes the standard harmonised. It shows which elements of this standard are the basis for the CE marking of an EPS product. Annex ZA is a full part of the standard.

Conformity with Annex ZA leads to the CE marking, which means that products may be freely placed on the EEA market. Although a product may need to have certain levels of performance to be able to be used in certain end use conditions, a CE marked product cannot, in general, be refused access to any EEA market. CE marking will prevent the manufacturer from having to produce different products for different markets and remove the need for the product to be tested and/or certified in the country of destination.

Annex ZA establishes the conditions for CE marking of the products covered by EN 13163 by identifying those clauses of the standard needed to meet the CPD (in sub-clause ZA.1) describing the systems of attestation of conformity in ZA.2, and giving the information that has to accompany the CE mark in Z.3.

Annex ZA identifies what all manufacturers have to do to place their products on the European market, both in their own country and in another EC country. There may be some flexibility in which characteristics need to be evaluated depending on the intended use of the product and, in general, Annex ZA will permit products having different levels of performance to be CE marked. But Annex ZA, although informative, is compulsory in the EEA. Where Annex ZA, by reference to the body of the standard, requires a “threshold level” of performance , a manufacturer producing below this level would not be able to claim conformity with the standard and, therefore, would not have access to CE marking and would not be able to place the product on the EEA market. Such a threshold level is given in EN 13163 and EN 14309 by the minimum requirement for bending strength of 50 kPA.

Furthermore EPS products having a thermal conductivity greater than 0,060 W/mK (see scope of the standards) are not covered, which can be seen as a threshold level as well..

The main consequence of harmonisation through Annex ZA is that products will be able to move more freely throughout Europe. Conformity with European standards will, however, be made compulsory in many cases. For the market, CE marking will provide technical information about the product, enabling specifiers and purchasers to make educated choices between products of difference performance levels.

2.17.2 Relevant Clauses

The EC has given mandates to CEN to develop harmonised product standards such as those for thermal insulation products. The mandate M/103 for the EPS standard contains all characteristics listed in the first column of table ZA.1 in EN 13163 or EN 14309. These mandated characteristics have been combined with standardised requirements as described in clause 4 of the EPS product standards. In some cases there is more than one requirement to cover one mandated characteristic. All requirements listed in column two are harmonized ones.

To create mandated classes or levels is the responsibility of the EC which was exercised for reaction to fire only, see Table 4 of this document. In cases where no mandated class or level was provided, technical classes, levels or limit values have been introduced.

2.17.2.1 Reaction to fire

For reaction to fire Euroclasses are given as described in Table 4 of this document. For the durability of this performance see 2.17.2.11.

2.17.2.2 Water permeability

The water permeability stands for behaviour under water influence in general. That is why clause 4.3.9 including all sub clauses of EN 13163 and EN 14309 are combined for this characteristic.

2.17.2.3 Release of dangerous substances

Although this requirement is mandated it is not possible at present to adopt further details. Probably the next revision of the EN 13163 and EN 14309 will contain requirements for the release of dangerous substances.

2.17.2.4 Direct airborne sound index

Product of a certain level of dynamic stiffness will contribute the direct airborne sound index in a construction.

2.17.2.5 Acoustic absorption index

Closed cell materials as EPS have no significant absorption property.

2.17.2.6 Impact noise transmission index

The impact noise transmission index is an important acoustical performance in floating floors. That is why all requirements relating to products used in floating floors are combined.

2.17.2.7 Thermal resistance

The thermal resistance is the most important property of an insulation product. It is derived from the thermal conductivity and the thickness which are listed in table ZA.1.

2.17.2.8 Water vapour permeability

Water vapour permeability is needed to determine the condensation behaviour. To calculate water vapour movement in constructions the water vapour resistance factor, μ, is used.

2.17.2.9 Compressive strength

The short term compressive behaviour is described by compressive stress at 10 % deformation and the deformation under specified compressive load and temperature conditions. For long term behaviour see 2.17.2.12.

2.17.2.10 Tensile / Flexural strength

Tensile and / or flexural strength are mandated for handling purposes. Since bending strength is much easier to determine and gives the same information about handling, bending is used here instead of tensile / flexural strength. For EPS in laminated or glued applications tensile strength perpendicular to faces may be relevant.

2.17.2.11 Durability of reaction to fire against heat, weathering, ageing and degradation

The long term behaviour of expanded polystyrene classified as ‘B1’ (hardly flammable) including ‘B2’ (normally flammable) products according DIN 4102 [1] was evaluated [2]. Polystyrene foam boards, containing flame retardants have been used in Europe for construction applications since the 1960’s. Since the late seventies, materials classified as ‘B1’ including ‘B2’ have been required for these applications in Germany. It was investigated as whether polystyrene foam boards containing flame retardants maintain their ‘B1 including ‘B2’ product characteristic in the long term, or whether ageing occurs, which could result in a change of the classification.

In order to answer this question, the radical burning mechanism of polystyrene and the action of the flame retardants are being summarised. Further, the calculated results of the temperature and time dependent behaviour of the flame retardants that the polystyrene foam contain are given. Additionally the leaching/migration behaviour of the flame retardants in the polystyrene has been experimentally determined. Various West-European EPS raw material producers have gathered laboratory data and results from practice related to the burning behaviour of polystyrene foam boards over a long term. These are also included in the report.

It is concluded that under the conditions tested no ageing of the flame retardants system used in EPS boards occurs far beyond the normal life span of a building of at least 100 years. So an ageing related change of the ‘B1’ including ‘B2’ classification does not occur and hence it can be assumed that the relevant Euroclasses established for EPS products are also stable.

2.17.2.12 Durability of compressive strength against ageing and degradation

The durability of compressive strength against ageing is assessed by compressive creep and long term thickness reduction for products used in floating floors. The evidence of the long term compressive behaviour is detailed in 2.4.3.8.

2.17.3 System of attestation of conformity

The systems of Attestation of conformity are decided by the commission. More details are to be found in 2.7.1.

2.17.4 Marking and labelling

The products have to be labelled at least as indicated in Annex ZA of the EN 13163 or EN14309, clause ZA.3. Additional voluntary indications may be needed e. g. reference to national application rules, length, width, content of the package etc. These voluntary indications shall be clearly separated from those belonging to CE marking.

Some examples based on national application regulations are given in the figures on pages 46 and 47.

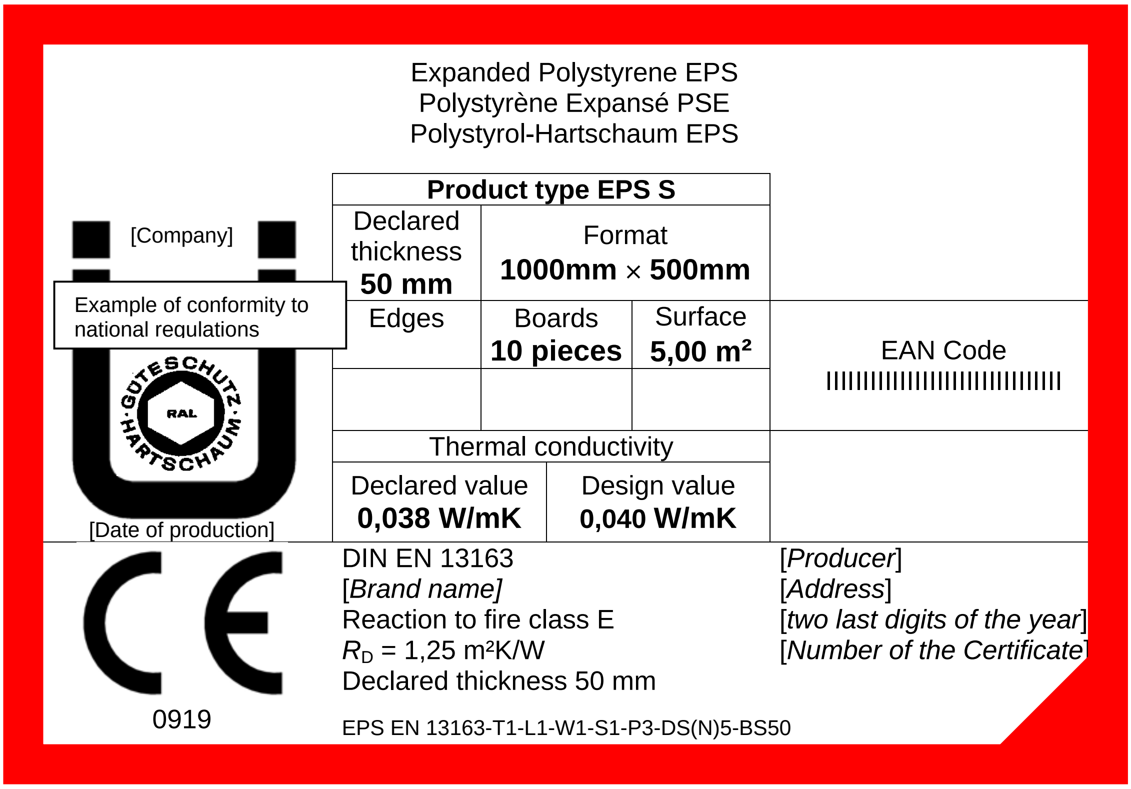

Figure 18: Example of an EPS S label, see also 8.2.7.

All labels shown in Figure 18 to Figure 20 are split into a compulsory area and a voluntary one. The legal area has to contain everything that is mentioned in table ZA.3 of EN 13163 or EN 14309. These indications needed for CE marking are to be found in the lower part of the label, where the CE mark is located on the left hand side. The indications given above this area follow the requirements given in clause 8 of EN 13163 and EN 14309. This area may contain national application related requirements and / or quality marks in addition.

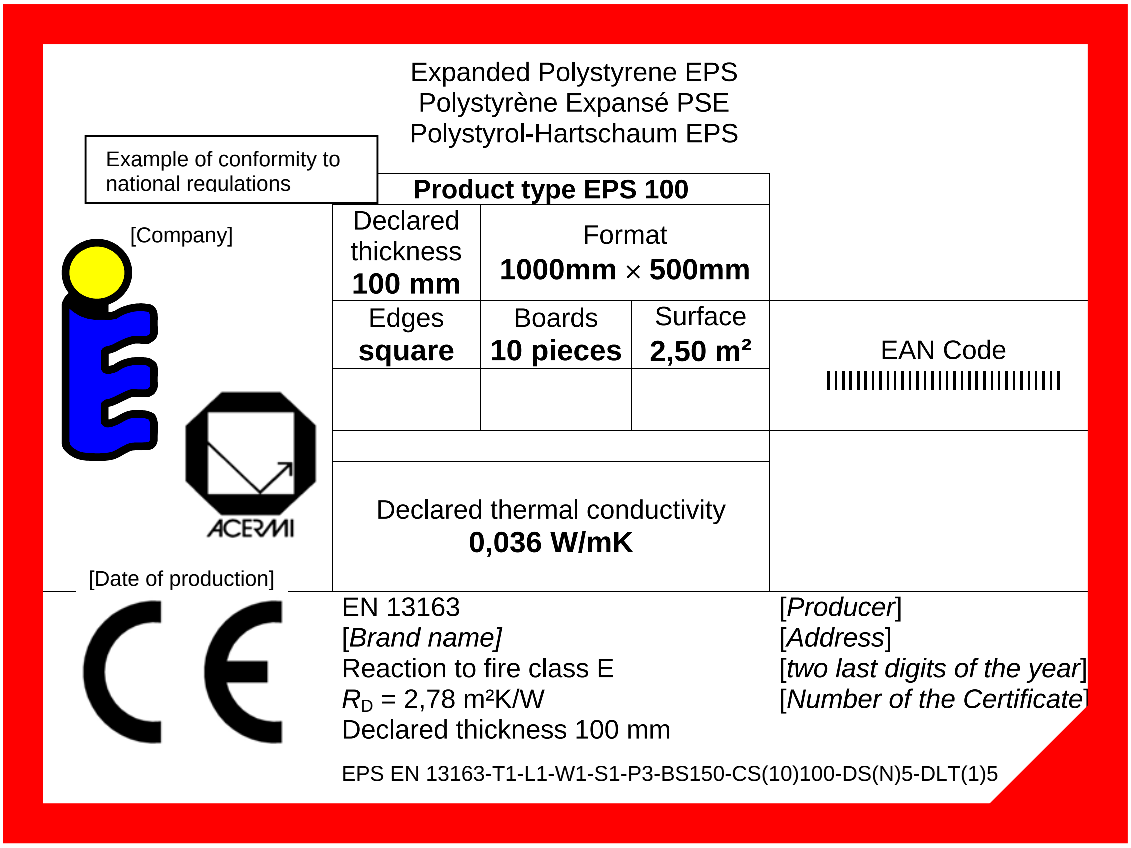

Figure 19: Example of an EPS 100 label.

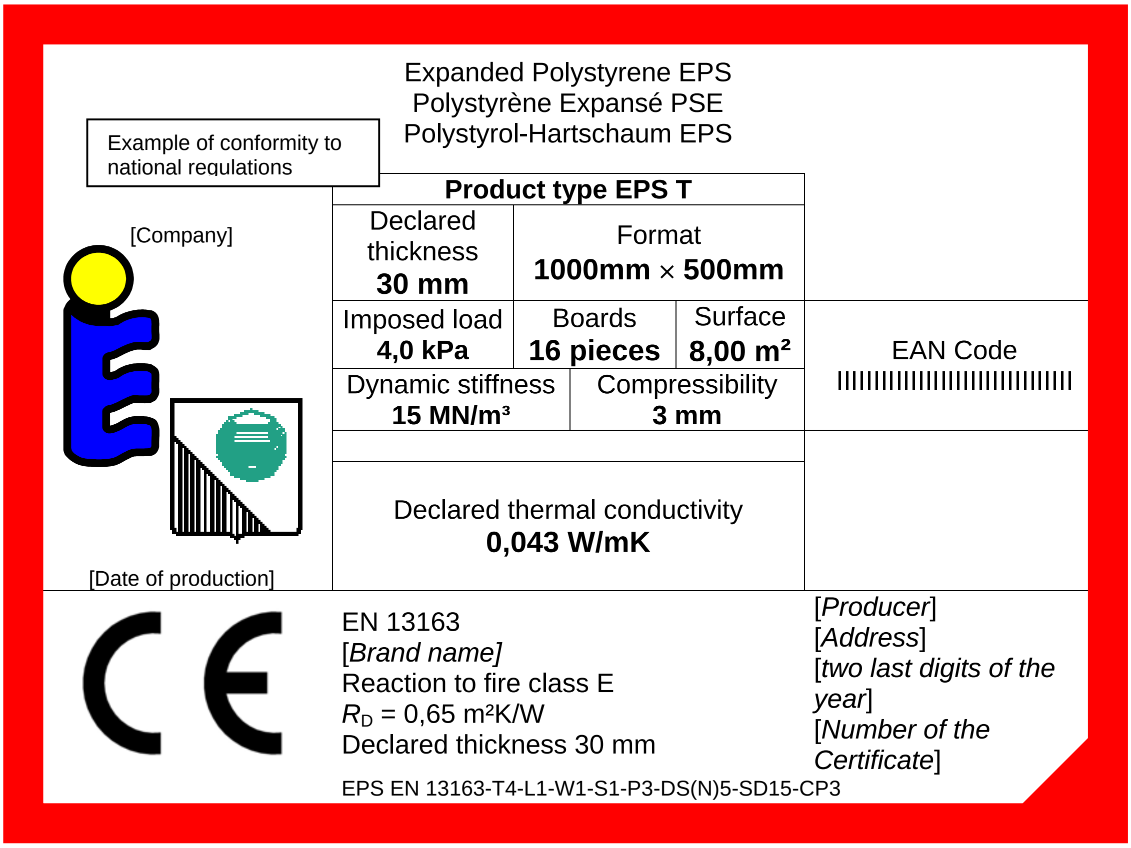

Figure 20: Example of an EPS T label.

3 Explanation of EN 14309

3.1 General

The EPS standard for building equipment and industrial applications has a similar structure as EN 13163. The properties which are described in both standards are to be found in clause 2. The deviations from EN 13163 are explained in the following clauses.

3.2 Properties which are in addition to EN 13163

3.2.1 Pipe section linearity

The pipe section linearity is given in clause 4.2.2.3 of EN 14309.

3.2.2 Maximum service temperature

The maximum service temperature is given in clause 4.3.2 of EN 14309.

3.2.3 Minimum service temperature

The minimum service temperature is given in clause 4.3.3 of EN 14309.

4 Explanation of EN CEA

4.1 General

The EPS standard for civil engineering applications (CEA) has the title

Light weight fill and insulation products for civil engineering applications (CEA)
Factory made products of expanded polystyrene (EPS) - Specification

and it has in principle a similar structure as EN 13163. The properties which are described in both standards are to be found in clause 2. The deviations from EN 13163 are explained in the following clauses.

4.2 Properties which are not adopted from EN 13163

The following properties are not needed for civil engineering and have been omitted:

- Tensile strength,
- Dynamic stiffness,
- Compressibility.

Furthermore the EPS types EPS T, EPS S and EPS 30 are not applicable for civil engineering application and are therefore not defined in EN xxxxx.

4.3 Properties which are in addition to EN 13163

4.3.1 Resistance to cyclic load

Apart from the test method EN 13793 referred to in EN 13163, in the specific EPS standard for civil engineering applications another test method, SP 2687, a dynamic load test has been developed for railroad applications in the Nordic countries [29].

4.4 Properties which are changed

4.4.1 Dimensions

Tolerances for dimensions are not always needed in civil engineering applications. Therefore zero classes have been introduced in clause 4.2.1 through 4.2.4 of EN xxxxx.

4.4.2 Compressive stress

For compressive stress additional deformations have been included in clause 4.2.6 of EN xxxxx

4.4.3 Thermal conductivity and thermal resistance

These properties are not normally needed in civil engineering applications and are therefore to be found in clause 4.3 of EN xxxxx.

4.4.4 Others

The text of the EN xxxxx relates to the specific applications and deviates from EN 13163. The sampling depends on fill sizes, see clause 5.1 of EN xxxxx.

5 Explanation of EN 13499

EN 13499 deals with external thermal insulation composite systems (ETICS) based on expanded polystyrene. This standard is a product standard specifying a kit of components and it is not an application standard.
The requirements for an EPS board of this kit are given in table 1 of EN 13499. Depending on the fixing method of the EPS boards two different levels of tensile strength perpendicular to faces are required. The designation codes for a product in this application may be as follows.

EPS EN 13163-T2-L2-W2-S2-P4-DS(N)2-BS50-TR100

or

EPS EN 13163-T2-L2-W2-S2-P4-DS(N)2-BS50-TR150

Additional national requirements have to be taken into account.

6 Additional properties

Properties described which are not mentioned in EN 13163, EN 14309 and EN CEA are described here.

6.1 Correlation between bending and tensile strength

The following correlation between bending strength and tensile strength was measured FIW.

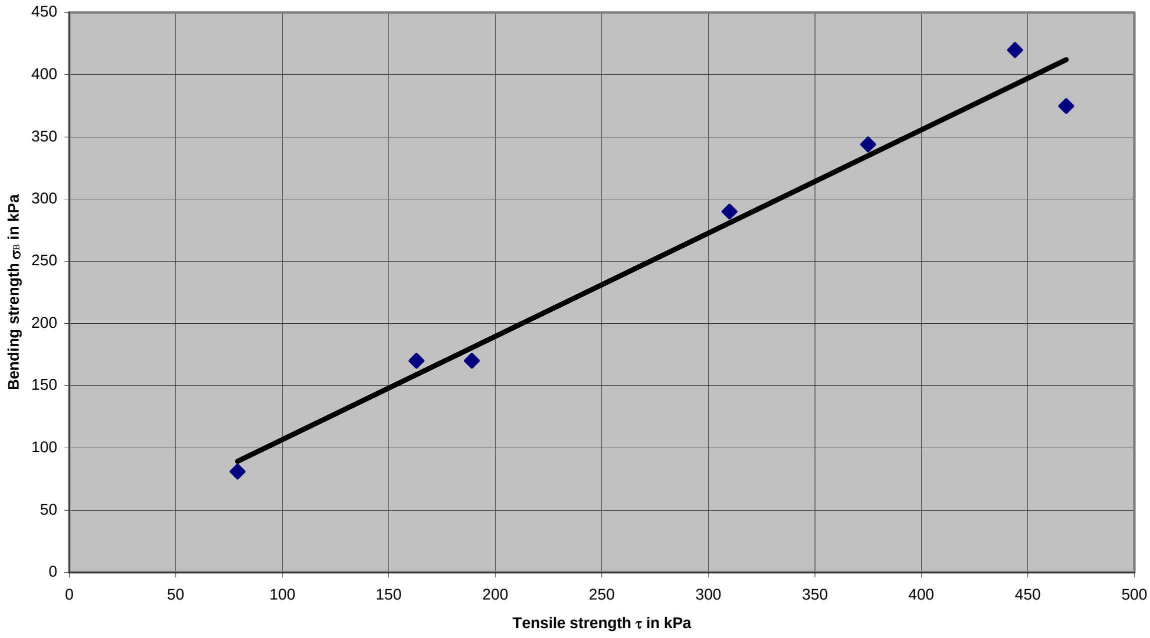

Figure 21: Correlation between bending and tensile strength.

The measured correlation is

σ_b = 0,83τ + 23,6 kPa

6.2 Moisture content

The moisture content should be determined in accordance with EN 12570 [16]. In cases where EPS is installed between layers of other materials assessment EN ISO 12571 [17] may be useful.

6.3 Thermal expansion

The thermal expansion is used to calculate the reversible change of the dimensions versus the temperature.

$$x_{th} = x(1 + \alpha_{th} \cdot \Delta T)$$

Where α_{th} is the material specific coefficient of thermal expansion. The coefficient of thermal expansion was measured by Zehendner [23] and is indicated in Table 15.

Table 15: Coefficients of thermal expansion of EPS.

Material	Density [kg/m³]	Direction in respect on the board	Coefficient [K^{-1}]
EPS Block moulded Non flame retarded	14	parallel	$9{,}3 \cdot 10^{-5}$
		perpendicular	$8{,}0 \cdot 10^{-5}$
	23	parallel	$6{,}7 \cdot 10^{-5}$
		perpendicular	$6{,}7 \cdot 10^{-5}$
EPS Block moulded flame retarded	13	parallel	$9{,}5 \cdot 10^{-5}$
		perpendicular	$9{,}8 \cdot 10^{-5}$
	20	parallel	$7{,}2 \cdot 10^{-5}$
		perpendicular	$7{,}8 \cdot 10^{-5}$
EPS moulded board	42	parallel	$6{,}4 \cdot 10^{-5}$
		perpendicular	$6{,}7 \cdot 10^{-5}$

6.4 Hygric expansion coefficient

EPS products have no essential hygric expansion. In cases where this property (e. g. for coatings and facings) is needed it should be determined in accordance with EN 13009 [15].

6.5 Specific heat capacity

Tabulated values of the specific heat capacity of most building products are to be found in EN 12524 [18]. The specific heat capacity, c_p, of polystyrene is 1.300 J/(kg·K). The energy, Q, which is taken up or given up by polystyrene at a change of the temperature, ΔT, is calculated:

$$Q = m \cdot \Delta T \cdot c_p \quad \text{[J]}$$

where m is the mass of polystyrene.

6.6 Chemical resistance

The resistance of expanded foams made from expanded polystyrene to chemicals corresponds to that of mouldings made from polystyrene. However, because the cell structure of expanded polystyrene gives the material a greater surface area, damage occurs more rapidly and to a greater extent than is the case with the solid polystyrene material. Accordingly, foamed materials of low bulk density are attacked more rapidly and to a greater extent than those of higher density.

In practice (e. g. in the construction or packaging sectors) it is very important to know how expanded materials made from expanded polystyrene react to chemical substances in order to prevent faults in application.

The test for resistance is based on [43] "Testing of expanded foam materials; Determination of the reaction to liquids, vapours, gases and solid materials". In this DIN standard, 5 foam cubes without expansion skin and with sides measuring 5 cm are immersed in the test medium for a definite length of time and changes occurring in the samples, e.g. in mass and dimensions, are determined. The exposure time depends on the test medium: for liquids it is 72 hours; for gases 24 hours and for liquefied gases, at least three hours.

For liquefied gases the immersion temperature is at, or just under, the boiling point of the test medium in question; in other media, immersion takes place at room temperature.

For visual assessment of damage, DIN 53428 suggests a scale of criteria from 0 (no change) to 5 (severely damaged). To provide a simplified overview, Table 16 contains the following assessment criteria:

+	= unchanged (≥ 0)	= resistant
+-	= slight change (≥ 2)	= limited resistance (small change in dimensions)
-	= severely damaged (≥ 5)	= not resistant

If expanded polystyrene foams are to come into contact with substances of unknown composition that could contain damaging solvents (e.g. paints or adhesives) it should be ensured in advance that the foam is not attacked by carrying out a trial under field conditions. The trial may be shortened considerably if it is carried out at temperatures above 20 °C (e.g. 50 °C). To obtain clearer evidence of the foam's resistance, the severity of the test conditions can be increased by testing foam with a density is much lower than that intended for the actual application.

Table 16 shows the resistance of expanded foam to the most important chemical substances.

Table 16: Chemical behaviour of EPS, derived from [3].

Water:		**Gases:**		**Alcohols:**	
Sea water	+	a) inorganic		Methanol	+-
Water	+	Ammonia	-	Ethanol	+-
		Bromine	-	Ethylene glycol	+
Alkalis:		Chlorine	-	Diethylene glycol	+
Ammonia water	+	Sulphur dioxide	-	Isopropanol	+
Bleaching solutions (hypochlorite, Hydrogen peroxide)	+			Butanol	+-
Potassium hydroxide solution	+	b) organic		Cyclohexanol	+
Lime water	+	Butadiene	-	Glycerine	+
Caustic soda solution	+	Butane	-	Coconut oil alcohol	+
Soap solutions	+	Butene	-		
		Natural gas	+	**Amines:**	
		Ethane	+	Aniline	-
Dilute acids:		Ethene (ethylene)	+	Diethylamine	-
Formic acid, 50%	+	Ethyne (acetylene)	+	Ethylamine	+
Acetic acid, 50%	+	Methane	+	Triethylamine	-
Hydrofluoric acid, 4%	+	Propane	+		
Hydrofluoric acid, 40 %	+	Propene (propylene)	+	**Miscellaneous organic substances:**	
Phosphoric acid, 7 %	+	Propene (propylen) oxide	-	Acetone	-
Phosphoric acid, 50%	+			Acetonitrile	-
Nitric acid, 13 %	+	**Liquefied gases:**		Acrylonitrile	-
Nitric acid, 50%	+	a) inorganic		Dimethylformamide	-
Hydrochloric acid, 7%	+	Ammonia	+	Esters	-
Hydrochloric acid, 18 %	+	Inert gases	+	Ethers	-
Sulphuric acid, 10%	+	Oxygen (risk of explosion)	+	Halogenated hydrocarbons	-
Sulphuric acid, 50%	+	Sulfur dioxide	-	Ketones	-
		Nitrogen	+	Paint thinners	-
		Hydrogen	+	Olive oil	+
Concentrated acids:				Tetrahydrofuran	-
Formic acid, 99 %	+	b) organic			
Acetic acid, 96 %	-	Methane	+	**Inorganic building materials:**	
Propane acid, 99%	-	Ethane	+	Anhydrite	+
Nitric acid, 65 %	+	Ethene	-	Gypsum	+
Hydrochloric acid, 36 %	+	Ethene oxide	-	Lime	+
Sulphuric acid, 98 %	+	Ethyne (acetylene)	-	Sand	+
		Propane	-	Cement	+
		Propene	-		
Fuming acids:		Propene oxide	-	**Organic building materials:**	

Nitric acid -	Butane -	Bitumen +
Sulphuric acid -	Butene -	Water-based rapid-curing cutback and bítuminous knife fillers +
	Butadiene -	Solvent-based rapid-curing cutback and bituminous knife fillers (free from aromatics) -
	Natural gas +	
Anhydrides:		**Aromatics:**
Acetic anhydride -		Benzene -
Carbon dioxide, solid +	**Aliphatic hydrocarbons:**	Cumene -
Sulphur trioxide -	Cyclohexane -	Ethylbenzene -
	Díesel fuel, Heating oil -	Phenol, 1 % aqu, soln. +
	Heptane -	Phenol, 33% aqu. soln. -
Weak acids:	Hexane -	Styrene -
Humic acid +	Paraffin oil +-	Toluene -
Carbonic acid +	White spirit 55-95 °C -	Xylene -
Lactic acid +	Whíte spirit 155-185 °C -	
Tartaric acid +	Vaseline +	**Vapors of:**
Citric acid +	Gasoline (regular & super grades) -	Camphor -
		Naphthalene -

Specific raw materials of polystyrene can be used to produce expanded foams that have increased resistance to aromatic free hydrocarbons by comparison with other expanded polystyrene grades. The suitability of products for a particular application must be checked in each case.
The information submitted in this publication is based on current knowledge and experience. In view of the many factors that may affect processing and application, these data do not relieve processors of the responsibility of carrying out their own tests and experiments; neither do they imply any legally binding assurance of certain properties or of suitability for a specific purpose.

6.7 Air permeability

The air permeability of EPS in normal use is not needed. If in special cases this property is required it can be measured according EN 12114 [14].

6.8 Electrical properties

The electrical characteristics are similar to those of air. The dielectrical constant of EPS has a value of 1 in the frequency range from 100 Hz to 1 GHz at a temperature of 25 °C.
The surface resistance is 10^{11} to 10^{13} Ohm at a relative humidity of 50 %.

7 Application and calculation

7.1 International Application standards

EN 14114 — Thermal insulation of building equipment and industrial installations – Calculation of water vapour diffusion – Cold pipe insulation systems

ISO/CD 12575-1 — Building applications – Foundation insulating systems – Materials - Specification

ISO DTR 9774 — Properties of thermal insulation products for buildings according to their application – Guideline for the harmonization of international standards or specifications

prEN 13499 — Thermal insulation products for buildings – External thermal insulation composite systems (ETICS) based on expanded polystyrene - Specification

UEATC Rules

7.2 European Calculation standards

EN 832	Thermal performance of buildings – Calculation of energy use for heating – Residential buildings
EN 1190	Thermal performance of buildings – Heat exchange with the ground – Calculation methods
EN 13947	Thermal performance of curtain walling – Calculation of thermal transmittance – Simplified method
EN 27345	Thermal insulation – Physical quantities and definitions
EN 29251	Thermal insulation – Heat transfer conditions and properties of materials – Vocabulary
EN 29288	Thermal insulation – Heat transfer by radiation – Physical quantities and definitions
EN 29346	Thermal insulation – Mass transfer – Physical quantities and definitions
EN 30211	Building components and building elements – Thermal resistance and thermal transmittance – Calculation method
EN 32573	Thermal bridges in building construction – Heat flows and surface temperatures – General calculation methods
EN 33786	Thermal performance of building elements – Thermal inertia characteristics – Calculation methods
EN 33789	Thermal performance of buildings – Specific heat loss – Calculation method
EN ISO 10211-1	Thermal bridges in building constructions – Heat flows and surface temperatures – General calculation methods
EN ISO 10211-2	Thermal bridges in building construction – Calculation of heat flows and surface temperatures – Linear thermal bridges
EN ISO 13370	*Thermal performance of buildings – heat transfer via the ground – Calculation methods*
EN ISO 13786	*Thermal performance of building components – Dynamic thermal characteristics – Calculation methods*
EN ISO 13788	*Hygrothermal performance of building components and building elements – Internal service temperature to avoid critical surface humidity and interstitial condensation - Calculation methods*
EN ISO 13790	*Thermal performance of buildings – Calculation of energy use for space heating*
EN ISO 13791	*Thermal performance of buildings – Internal temperatures in summer of a room without mechanical cooling – General criteria and calculation procedures*
EN ISO 13792	*Thermal performance of buildings – Internal temperatures in summer of a room without mechanical cooling – General criteria for simplified calculation methods*

EN ISO 14683 Thermal bridges in building constructions – Linear thermal transmittance – Simplified method aund defaults values

EN ISO 15927-1 Hygrothermal performance of buildings – Calculation and presentation of climatic data – Data for accessing the annual energy demand for cooling and heating systems

EN ISO 15927-4 Hygrothermal performance of buildings – Calculation and presentation of climatic data – Data for accessing the annual energy demand for cooling and heating systems

EN ISO 15927-5 Hygrothermal performance of buildings – Calculation and presentation of climatic data – Winter external design air temperatures and related wind data

EN ISO 6946 Building components and building elements – Thermal resistance and thermal transmittance – Calculation method

EN ISO 8497 Thermal insulation – Determination of steady-state thermal transmission properties of thermal insulation for circular pipes

EN ISO 9251 Thermal insulation – Heat transfer conditions and properties of materials - Vocabulary

EN ISO 9288 Thermal insulation – Heat transfer by radiation – Physical quantities and definitions

EN ISO 9346 Thermal insulation – Mass transfer – Physical quantities and definitions

ISO 13789 Thermal performance of buildings – Transmission heat loss coefficient – Calculation method

7.3 National Application rules

Austria

ÖN B 3806 Anforderungen an Baustoffe im Bauwesen in brandschutztechnischer Hinsicht

Germany

DIN V 4108-4 Wärmeschutz und Energieeinsparung in Gebäuden – Wärme- und feuchteschutztechnische Kennwerte

DIN V 4108-10 Wärmeschutz und Energieeinsparung in Gebäuden – Anwendungsbezogene Anforderungen an Wärmedämmstoffe – Werkmäßig hergestellte Wärmedämmstoffe

For CEA Merkblatt für die Verwendung von EPS-Hartschaumstoffen beim Bau von Straßendämmen – Forschungsgesellschaft für Straßen- und Verkehrswesen

France

DTU 26.2/52.1 Traveau de bâtiment – Mise en oevre des sous couche isolantes sous chape ou dalle flottantes et sous carrelage
(Building works – Placing of insulationg underlayers underweath floating flow screeds or floors and underweath tile flowing

Finland For floor and frost insulation products requirements for water absorption by immersion are given. For wall and roof applications water vapor transmission properties are required. Certificates are provided by VTT.

Netherlands The Building Regulations (Bouwbesluit) were totally renewed as per 01/01/03. Performance requirements are based on the function of the use of the relevant construction-part. Per aspect a “tabulated building rule” is given.

For buildings as a whole performance on energy is defined as the epc-value (energy performance coefficient) with minimum requirements for the k-value of insulation in floors, walls and roofs.

The epc-value is dependent on: the insulation, ventilation and installation, the situation of the components towards the sun etc.

Producers are bringing naked EPS as commodities on the market to be applied guarded by concrete / brickwork or as insulated panels for gables, pitched and flat roofs.

All applications and materials are brought on the market with voluntary quality assurance, KOMO certified and to be accepted by local authorities as if expected to fulfil the req.'s.

The requirements on reducing energy consumption are set in the "Building Regulations 2003", in terms of an energy performance factor (e.p.c.) for the total building. Regardless of that threshold values are given for individual components, separating outdoor climate (k<0,4). Additional requirements are given for reducing air permeability of the building. Reaction to fire requirements are set in terms of performance requirements on the construction parts in end use applications. For the time being present NEN standards are considered on this.

Sweden

In Sweden there are:

BBR BUILDING RULES, BYGGREGLER 1999
and
KONSTRUKTION RULES BKR 1999

These rules are connected to guidelines or about 10 handbooks.
Energy saving and insulation requirements are given in 2 guidelines. They are connected to ISO-SSEN 6946, but will be revised and published in 2003.
The U-value has to be calculated of the whole building . The U-value shall not exceed the value:

$$U_{m,\,krav} = 0{,}18 + 0{,}95 \cdot A_f / A_{om}$$

where A_f is the total area of windows, doors, gates and A_{om} is total perimetric area that has normal room temperature. $U_{m,\,krav}$ is the highest accepted average U value.

The average U_m value for the building is calculated as:

$$U_m = (\Sigma\,(U_i \cdot A_i))/A_{om}$$

For these U value calculations the computer program EPSU is used and developed by the Swedish Plastic Federation. The program is free for designers.

Spain

Spain has no additional rules in the application field of EPS. See also 8.2.17.

7.4 European EPS Types

7.4.1 EUMEPS EPS types

The character of the European EPS product standard EN 13163 differs from the existing "local" standards. The thermal insulation product standards are now in fact a list of requirements of which the properties have to be declared by the manufacturer. These requirements are given in levels or classes to comfort all parties involved in comparing the specifications offered by the manufacturer on the one

hand and the customer or legislator on the other hand. Two series of requirements exist: for general applications and for specific applications.
The European product standards are accompanied by a series of test methods to which the product standard refers and a standard on “Evaluation of Conformity” was established to enable CE marking (EN 13172).
In general local, Building Regulation requirements are set for products in end- use-applications and not to materials as such brought on the market.
The EPS product standard (EN 13163) is a so called “open standard”. It gives the producer the possibility to define his own product specifications and declare them to the market. This freedom enables him to offer products with an optional performance, a specified use of recycle material and specific production methods**.** There is no reference to density: density is a product property only used for internal quality assurance, as for indirect testing if reference to a specific requirement is known.
As an example: EPS to be used in sandwich panels is subject to shear forces but the market requires a minimal thickness e.g. lambda value. Other examples lay in the field of frost and perimeter insulation.
Producers of EPS offering/ producing “down stream” products to the market will develop their own specific product types. Bringing EPS to the market for general or specific applications is also possible in a variety of specifications.
EUMEPS has agreed on a set of standard product types in order to give transparency to the customers and to enable “fair” competition between EPS producers.
This is hence for EPS brought on the market without intended specific application or for internal use in "down-stream" products (sandwich panels); these are often called "commodity EPS products".

Table 17: EUMEPS EPS types without intended specific application ("commodity").

EUMEPS-TYPE	**Compressive stress 10%**	**Bending strength**	**Thermal conductivity**	**Dimensional stability**	**Dimensional tolerances**
EPS 60	60	100	≤ 0,038	≤ 0.5	L2,W2,T2,S1,P2
EPS 100	100	150	≤ 0,036	≤ 0.5	L2,W2,T2,S2,P2
EPS 150	150	200	≤ 0,035	≤ 0.5	L2,W2,T2,S2,P2
EPS 200	200	250	≤ 0,034	≤ 0.5	L2,W2,T2,S2,P2
EPS 250	250	300	≤ 0,034	≤ 0.5	L2,W2,T2,S2,P2
	CS(10), [kPa]	BS, [kPa]	Lambda,[W/mK]	DS(N), %	Table 1, classes

All EPS types are available with or without the inclusion of flame retardants. Products containing a flame retardant will achieve Euroclass E (or better) and are identified with the addition of a red stripe. For historical reasons different member states the references in literature may differ and may continue to be used. For example reaction to fire class E may also be identified by the following equivalent definitions:

A or FRA	United Kingdom
A1	Belgium
B1	Germany
F	Sweden
M1	France, Spain
S	Finland
SE	Netherlands, Germany

For the EUMEPS types the following colour codes have been agreed.

Table 18: EUMEPS colour coding for EPS types.

EPS Eurotypes	Colour code for non flame retarded products		Colour code for flame retarded products	
	Description	Colour	Description	Colour
EPS 30	Brown		Brown + red	
EPS 50	Blue		Blue + red	
EPS 60	Blue + blue		Blue + blue + red	
EPS 70	Brown + brown		Brown + brown + red	
EPS 80	Orange		Orange + red	
EPS 90	Orange + orange		Orange + orange +red	
EPS 100	black		Black + red	
EPS 120	Green + green		Green + green + red	
EPS 150	yellow		Yellow + red	
EPS 200	Black + black		Black + black + red	
EPS 250	Violet		Violet + red	
EPS 300	Violet + violet		Violet + violet + red	
EPS 350	Grey		Grey + red	
EPS 400	Grey + grey		Grey + grey + red	
EPS 500	Black + green		Black + green + red	
EPS T	Green		Green + red	

The colour code is applied on at least one edge of the boards.

7.4.2 Application

The European EPS product standards EN 13163 and EN 14309 are so called “open standards”. It gives a producer the possibility to define his own product specifications depending on the intended application and to declare the properties to the market. This freedom enables him to offer products with a minimum raw material consumption, a specified use of recycle material and specific production methods**.** Producers of EPS offering/ producing “down stream” products to the market will develop their own specific product types for internal use. We simply refer here to the information from these producers.
In EUMEPS a set of standard product types have been developed in order to give transparency to the customers for “commodities”, here defined as products without any intended use.
For specific, intended applications it was getting clear anyhow that there is a great comparability between product types and their applications throughout the EU/ EUMEPS member companies.
In this document a overview of possible product/application combinations is given to make it for customers (authorities, contractors, suppliers, architects and owners) easier making a choice.

The overview is given in a simple matrix, whereas the applications are taken from ISO TR 9774. This covers probably 95% of all the known building insulation EPS applications.
Bullet points give possible and most used applications/product types combinations; left from these the EPS properties are too low for a reliable application; right from the bullet points the quality may be too good in relation to the price.

Table 19: Overview of examples of applications and EPS product types

Application versus EPS type	EPS S	EPS 60-100	EPS 100-150	EPS 150-200	EPS 200-250	EPS 250-300	EPS T
CELLARS							
Internal insulation	═	●	─	─	─	─	─
External, protected	═	═	●	●	─	─	─
Perimeter insulation	═	═	●+)	●+)	●+)	─	─
GROUND FLOORS							
Slab- on- ground	═	●	●	●	●	─	─
Concrete floor element	═	●	●	─	─	─	─
On construction floor	═	●	●	─	─	─	●
Renovation el.	═	●1)	●	─	─	─	─
FLOORS							
Ceilings/ loft insulation	═	●	─	─	─	─	─
Floating floors	═	●	●	●	─	─	●
WALLS/GABLES							
Doublage	●	─	─	─	─	─	●
SIPS / others	═	●	●	─	─	─	─
Cavity wall insulation	●	●+)	●	─	─	─	─
Sandwich panels-steel	═	●	●	─	─	─	─
External insulation	●	●	─	─	─	─	●
ETICS	═	●+)	●	─	─	─	─
PITCHED ROOFS							
Internal-insulation (all)	═	●	─	─	─	─	─
Sandwich panels (all)	═	●	─	─	─	─	─
External insulation	═	●	●2)	●2)	─	─	─
FLAT ROOFS							
Warm roofs	═	● 1)	●	●	●	─	─
Cold roofs	═	●	●	─	─	─	─
Inverted roofs	═	═	═	●	─	─	─
CIVIL ENG APPL.							
All/ general	═	●	●	●	●	●	─

LEGEND:
● normally used in the EUMEPS member states.
═ not possible from functional requirements.
─ not necessary / applied normally unless properties are explicitly needed.
1) when load distribution boards are applied.
2) when load bearing.

Depending on the "local" building regulations the properties required may be more severe (indicated: +) than given in EN 13163.

8 Voluntary quality marks

8.1 European marks

<u>KEYMARK</u>
The European quality mark KEYMARK can be used for all products, for which European standards or approvals exist and a scheme has been approved. Complete rules for thermal insulation products – one of the first family of construction products to have a KEYMARK scheme – have been created successfully. In Europe, the KEYMARK offers for thermal insulation material a common system of inspection, surveillance and certification. The KEYMARK will only be used in connection with an existing national quality mark (e. g. RAL quality mark in Germany).

Only bodies, which are already accredited as a European certification body for insulation material standards, are admitted to grant the KEYMARK.

To obtain the KEYMARK the manufacturer needs a complete product certification. This means he has to operate a factory production control and as well as a continuous product surveillance by a third party.

The rules of the KEYMARK for thermal insulation materials assure, that the manufacturers in Europe are all subjected to the same criteria and procedures. This prevents unfair competition by different expensive quality systems operating to different monitoring systems. The KEYMARK is likely to be attractive to companies operating internationally. The KEYMARK will only be awarded in conjunction with an existing national quality mark, which will increase its visibility and enhance its international reputation. In this way, the manufacturer has the opportunity to label products, which are distributed in different countries, in the same way.

The complete product certification will create a high confidence with the customer. The manufacturer can demonstrate that the products comply with European specifications. Regarding which the new warranty law which inverts the burden of evidence in the first six month this offers more security for the manufacturer because he can prove, that his products comply with his claims and have been controlled by an independent body.

Some European countries have given a benefit to those thermal insulation products subjected to third party control by imposing no addition to the design value of thermal conductivity or additional fees for product assurance. It is already known from France (18 %) and Germany (15 %) that these countries will implement an addition on thermal conductivity for non third party controlled products and it can be foreseen that other countries may follow this system.

In addition Germany will require a conformity mark (Ü mark) for the confirmation of the application related requirements (DIN 4108-10) by a certification body, which also includes a continuous surveillance by a third party. The combination of the national quality mark and the KEYMARK will cover in future all required assessments on a national and a European basis. All required performances will be tested by only one testing body leading to savings for international companies.

The national quality marks won’t be replaced by KEYMARK, but they must be based on European product standards in future. Therefore, the product needs to be tested only once to fulfil the requirements for both quality marks.

While the KEYMARK will assess the conformity of EPS with EN 13163, the national signs may focus in future on the conformity with the national application related requirements.

8.2 Voluntary national marks

8.2.1 Austria

GPH

8.2.2 Belgium

8.2.3 Czech Republic

8.2.4 Denmark

VIK

8.2.5 Finland

VTT

8.2.6 France

ACERMI

8.2.7 Germany

In Germany there are two voluntary application standards based on the European specifications EN 13163 and EN 14309.

The DIN V 4108-10 contains application related requirements for thermal insulation materials e. g. as for EPS in table 4.

The DIN V 4108-4 contains regulations how to obtain the design value of the thermal conductivity to use for energy saving calculations such as EN 832. The design value, λ_U, will be calculated from the declared value of the thermal conductivity, λ_D, by the following equation:

$$\lambda_U = \gamma \cdot \lambda_D$$

The factor, γ, depends on the fact whether an optional approval from DIBt requiring a third party certification is involved or not. In cases where a notified body controls the FPC and the product properties the factor will be 1,05. In all other cases the factor is 1,2.

8.2.8 Greece

8.2.9 Iceland

8.2.10 Ireland

8.2.11 Italy

8.2.12 Luxemburg

8.2.13 Malta

8.2.14 Netherlands

The current situation in the Netherlands is one, totally on a voluntary basis, that exists already for two decades in its present format. This set-up was the result of negotiation between authorities (the Ministries of Housing, Economic Affairs and Internal Affairs), building industry (suppliers, contractors, subcontractors), consultants (engineers and architects) and the certification bodies.

Three types of markings are existing:

a) a product certificate, for products of which a product standard is existing;

b) a technical approval with certification, for products or construction parts with its intended use/performance requirements;

c) a process-certificate for the application of specific products or kits based either on product standards or/and on performance requirements and application requirements.

All the types are bearing the KOMO label, third party control is carried out by accredited certification bodies as KIWA, Intron, BKB and SKH.

In the building regulations ("Woningwet" and "Bouwbesluit") these labels are mentioned as labels for which is expected that the products/kits/processes fulfil at least the official requirements. They are all put on a list, which is yearly updated.

For the co-ordination of activities between certification bodies, authorities and the industry - including UEAtc and EOTA contacts - the "Stichting Bouwkwaliteit (SBK)" - foundation for building quality, was formed in 1990. This foundation issues the permission to use the KOMO-label for marking to certification bodies.

At this moment the expectation is, that next to this quality labels (KOMO) the CE label as conformity label will be introduced as an extra. The EC is focussing on this KOMO system at this moment supposing it being a not-acceptable system next to the CE-marking and labelling.

8.2.15 Norway

8.2.16 Portugal

8.2.17 Spain

Based on UNE-EN-13163 and UNE-EN-13172, on a voluntary base, it is just a product certification. In the Building Regulations the standards are mentioned as reference but not the certification. For EPS, the N mark means CE marking with AoC system 1 for all specifications.

8.2.18 Sweden

8.2.19 Switzerland

8.2.20 United Kingdom

In the UK the BSI Kitemark has been used in the insulation sector but not specifically by the EPS industry. EPS manufacturers have relied on British Board of Agrement (BBA) or equivalent certification which covers not only the product quality but also the specific details of application. The more widely known applications for EPS are covered by this certification. In addition all producers of EPS have third party surveillance on their factory production control to BS EN ISO 9002.

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11 Alphabetic register