



BSI Standards Publication

Walk-in cold rooms - Definition, thermal insulation performance and test methods

Part 2: Customized cold rooms

National foreword

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insulation performance and test methods - Part 2:
Customized cold rooms

Chambres froides - Définition, performance
d'isolation thermique et méthodes d'essai -
Partie 2 : Chambres froides personnalisées

Begehbare Kühlräume - Definitionen,
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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

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European foreword

This document (EN 16855-2:2018) has been prepared by Technical Committee CEN/TC 44 “Commercial and Professional Refrigerating Appliances and Systems, Performance and Energy Consumption”, the secretariat of which is held by UNI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by June 2019, and conflicting national standards shall be withdrawn at the latest by June 2019.

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Introduction

This document was drafted following the necessity to compare the systems placed on the market on the base of the minimum thermal insulation requirements and to establish the average level of energy consumption for a future minimum energy performance standard definition, with reference to the EU policy on increasing energy efficiency of energy related products (Directive 2009/125/EC) in the frame of the EU “20-20-20” targets.

It was necessary to identify the reference standards for calculation, measurement of insulation properties, identify the best practice rules for elimination of thermal bridges, assembly techniques and provisions to be taken in order to ensure the best level of insulation and power consumption.

1 Scope

This document provides test or calculation methods to assess thermal insulation performances for customized walk-in cold rooms and components under normal end-use conditions.

The normal end-use conditions of a walk-in cold room are considered to be:

- installation inside an existing building;
- not exposed to external weather conditions;
- internal side of panels subject to temperatures within the indicative range $-40\text{ °C} \leq T \leq 12\text{ °C}$;
- external side of panels subject to temperatures within the indicative range $-8\text{ °C} \leq T \leq 30\text{ °C}$; temperatures below 0 °C , or higher than 20 °C , can be reached if the walk-in cold room is located inside not air-conditioned premises.

NOTE In case the customized walk-in cold room working at positive storage temperature is used as a food processing room or a clean room, the standard is applied.

2 Normative references

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

[EN 12086](#), *Thermal insulating products for building applications — Determination of water vapour transmission properties*

[EN 12667:2001](#), *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*

[EN 12865](#), *Hygrothermal performance of building components and building elements — Determination of the resistance of external wall systems to driving rain under pulsating air pressure*

[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*

[EN 13162](#), *Thermal insulation products for buildings — Factory made mineral wool (MW) products — Specification*

[EN 13163](#), *Thermal insulation products for buildings — Factory made expanded polystyrene (EPS) products — Specification*

[EN 13164](#), *Thermal insulation products for buildings — Factory made extruded polystyrene foam (XPS) products — Specification*

[EN 13165](#), *Thermal insulation products for buildings — Factory made rigid polyurethane foam (PU) products — Specification*

[EN 13166](#), *Thermal insulation products for buildings — Factory made phenolic foam (PF) products — Specification*

[EN 13167](#), *Thermal insulation products for buildings — Factory made cellular glass (CG) products — Specification*

[EN ISO 4590](#), *Rigid cellular plastics — Determination of the volume percentage of open cells and of closed cells (ISO 4590)*

EN ISO 6946, *Building components and building elements — Thermal resistance and thermal transmittance — Calculation methods (ISO 6946)*

EN ISO 10077-1, *Thermal performance of windows, doors and shutters — Calculation of thermal transmittance — Part 1: General (ISO 10077-1)*

EN ISO 10077-2, *Thermal performance of windows, doors and shutters — Calculation of thermal transmittance — Part 2: Numerical method for frames (ISO 10077-2)*

[EN ISO 10211](#), *Thermal bridges in building construction — Heat flows and surface temperatures — Detailed calculations (ISO 10211)*

EN ISO 10456, *Building materials and products — Hygrothermal properties -Tabulated design values and procedures for determining declared and design thermal values (ISO 10456)*

[EN ISO 12572](#), *Hygrothermal performance of building materials and products — Determination of water vapour transmission properties — Cup method (ISO 12572)*

[EN ISO 14683](#), *Thermal bridges in building construction — Linear thermal transmittance — Simplified methods and default values (ISO 14683)*

3 Terms and definitions

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

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

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

3.1

walk-in cold room

thermally insulated enclosure made of sandwich panels intended for the storage of chilled and/or frozen perishable items, accessible via at least one door, and which is large enough to let somebody walk in it

3.1.1

customized walk- in cold room

walk-in cold room installed by assembling the single components, requiring on-site cutting of the sandwich panels

3.1.2

customized walk-in cold room with floor

walk-in cold room equipped with a thermally insulated floor, above ground level or embedded in the ground; the room has all insulated faces

3.1.3

customized walk-in cold room with pre-insulated floor

walk-in cold room equipped with a thermally insulated floor embedded in the ground, below ground level, covered with a structural layer (i.e.: concrete) usually levelled to the external ground level; the room has all insulated faces

3.1.4

customized walk-in cold room without floor

walk-in cold room without a thermally insulated floor; the room has only insulated walls and ceiling

3.1.5

walk-in cold room component

element that, when assembled together, compose a walk-in cold room; components can be for example: panels, doors, corner flashings, claddings and profiles used for head-to-head panels connection

3.2

sandwich panel

building product consisting of two metal faces positioned on either side of a core that is a thermally insulating material, which is firmly bonded to both faces so that the three components act compositely when under load, with different type of perimetrical profile

[SOURCE: EN 14509:2013, 3.17]

3.3

perimetrical design

cross section and characteristics of the perimetrical surface of the sandwich panel related to the joint system

NOTE A perimetrical design is realized with [3.3.1](#), [3.3.2](#) and [3.3.3](#) or a combination of [3.3.1](#), [3.3.2](#) and [3.3.3](#) or none of them.

3.3.1

male-female perimetrical design

design solution that allows sealing, structural resistance, thermal insulation, correct alignment at installation

3.3.2

gasket perimetrical design

design solution that allows sealing by embedding into a sandwich panel a sealing material

3.3.3

camlock perimetrical design

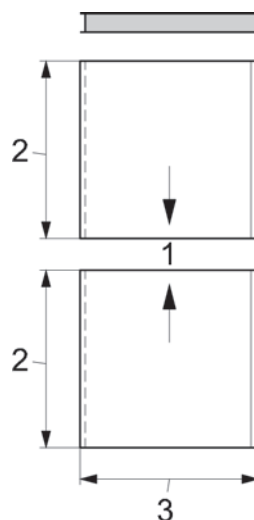
design solution that allows sealing, structural resistance, mechanical locking between adjacent sandwich panels

3.3.4

edge of the panel

side of the panel where adjacent panels join together in the same plane along the width

NOTE See [Figure 1](#).



Key

- 1 edge of panel
- 2 length
- 3 width

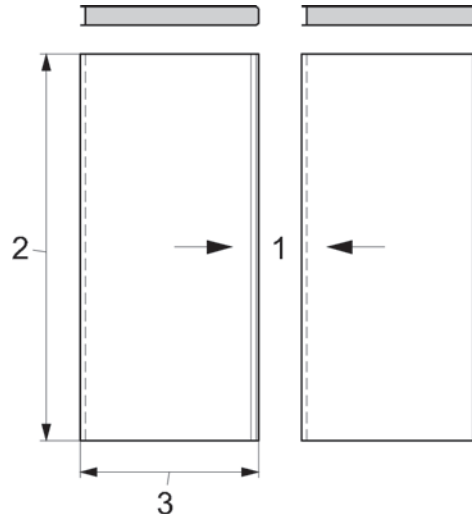
Figure 1 — Example of the edge of the panel

3.3.5

longitudinal edge of the panel

side of the panel where adjacent panels join together in the same plane along the length

NOTE See [Figure 2](#).



Key

- 1 longitudinal edge of panel
- 2 length
- 3 width

Figure 2 — Example of longitudinal edge of the panel

3.4

overall heat transfer coefficient

measure of the global insulating thermal performance of a walk-in cold room envelope, assembled with doors and all ancillaries, in terms of heat flux per unit area per degree difference in temperature

3.5

mean surface area

S

surface area calculated by the geometric mean between the outside surface area and the inside surface area

3.6

surface heat transfer coefficient

heat flux per unit area per degree difference in temperature

3.7

surface thermal resistance

ratio between temperature difference and heat flux through the surface

3.8

air curtain

technical equipment, producing a controlled stream of (cold) air aimed across an opening to create an air seal that separates different environments, while allowing flow of traffic and unobstructed vision through the opening

3.9

strip curtain

provision, made of strips, preventing sudden heat gains, when opening doors

3.10 Types of door

3.10.1

hinged door

door whose actuation takes place by means of rotation of the door leaf around the axis of rotation of the hinges

3.10.2

sliding door

door whose actuation takes place by means of sliding of the door leaf parallel to the wall

3.10.3

swing door

hinged door whose door leaf can rotate in both directions

3.10.4

roll shutter

door whose actuation takes place by means of rolling and unrolling of the flexible door leaf

3.11

mechanical closing device

mechanical device that helps self-closing of the door, and avoids door leaf to remain ajar, used to reduce energy losses and keep internal temperature

3.12

door switch device

switch to control evaporator fan motors, internal lighting, alarm and other device improving energy saving

3.13

thermal bridge

part of the walk-in cold room where the otherwise uniform thermal resistance is significantly changed by a material and/or geometrical discontinuity

3.13.1

linear thermal bridge

thermal bridge with a uniform cross-section along one of the three orthogonal axes

[SOURCE: EN ISO 10211:2007, definition 3.1.2]

3.13.2

punctual thermal bridge

localized thermal bridge whose influence can be represented by a punctual thermal transmittance

3.14

insulating material

thermally insulated product with a declared thermal conductivity lower than $0,06 \text{ W/(m}\cdot\text{K)}$ at 10°C

3.15

ageing

worsening of the thermal properties of an insulating material or structure along time

3.16

linear thermal transmittance

heat flow rate in the steady state divided by length and by the temperature difference between the environments on either side of a thermal bridge

3.17

punctual thermal transmittance

heat flow rate in the steady state divided by the temperature difference between the environments on either side of a thermal bridge (W/K)

3.18

walk-in cold room ceiling

covering of the walk-in cold room

3.19

core

layer of material, having thermal insulating properties, which is bonded between two metal faces

3.20

face, facing

flat, lightly profiled or profiled thin metal sheet firmly bonded to the core

3.21

fixing (fastening) system

system, fastening panels to the supporting system or other components to the panels or components to each other

3.22

joint

interface between two panels where the meeting edges have been designed to allow the panels to join together in the same plane

[SOURCE: EN 14509:2013, definition 3.13]

3.23

junction

connection between adjacent panels and corners, for example wall to wall, wall to ceiling, wall to floor

3.24

storage temperature

target storage temperature which is intended to be maintained within the operating walk-in cold room

3.25

positive storage temperature

PT

any temperature above -5°C and below 12°C , for chilled perishable items storage

3.26

negative storage temperature

NT

any temperature below -5°C , for frozen perishable items storage

3.27

gross storage volume

internal dimensions of the cold room, measured from floor to ceiling and from left to right (total height x total width x total length in cubic meters (m^3))

3.28

thermal conductivity

property of a material to conduct heat

3.29

thermal insulation

property of a material of reducing transfer of thermal energy through its thickness

3.30

supporting profile

system not structural part of the building, used to permanently support ceiling panels (when necessary), cooling systems, and other equipment of the walk in cold room

3.31
significant figure

digits that carry meaning contributing to the number precision, considering that leading zeros and trailing zeros placeholders merely indicating the scale are not significant

3.32
product sample

part of the sandwich panel or door leaf obtained by cutting in the central part of the same product, including any facings and core material

3.33
test specimen

slice of core material to be tested, taken from the middle thickness at an equal distance from the product sample edges

3.34
group of walk-in cold rooms components

walk-in cold rooms components of similar chemical and physical characteristics, produced on the same production line

3.35
edge to edge panels connection

system used to connect the heads of adjacent panels that have been previously cut on-site along the width of the panel

3.36
longitudinal edge by longitudinal edge joint

connection between panels that have been previously cut on-site along the length of the panel

3.37
pre-insulated floor

thermally insulated floor embedded in the ground, below ground level, consisting of several layers made of different materials or components

3.38
significant layer

layer of the pre-insulated floor that gives a not negligible contribution to the calculation of the thermal transmittance of the floor

3.39
concrete support below lower vapor barrier

slab made of concrete supporting the customized walk-in cold room, giving a negligible contribution to the calculation of the thermal transmittance of the floor

4 Symbols and abbreviations

U	thermal transfer coefficient ($\text{W/m}^2\cdot\text{K}$)
U_{tot}	overall heat transfer coefficient ($\text{W/m}^2\cdot\text{K}$)
U_j	single component heat transfer coefficient ($\text{W/m}^2\cdot\text{K}$)
W	heating power (W)
S	mean surface area (m^2)
R	thermal resistance ($\text{m}^2\cdot\text{K/W}$)
R_D	Declared value of thermal resistance ($\text{m}^2\cdot\text{K/W}$)
D	thickness (m)
λ	thermal conductivity coefficient ($\text{W/m}\cdot\text{K}$)
h	surface heat transfer coefficient ($\text{W/m}^2\cdot\text{K}$)

U thermal transfer coefficient ($\text{W/m}^2\cdot\text{K}$)

l length (m)

Ψ linear thermal transmittance of the joints per metre length of the panel ($\text{W/m}\cdot\text{K}$)

X punctual thermal bridges transmittance (W/K)

Subscripts

n nominal

i internal

e external

c core

f facing

s surface

f fluid (air)

w wall

a air

j generic index

5 Performance

5.1 General

Performance characteristics of walk-in cold rooms shall be assessed in terms of thermal insulating properties, in order to give a basis on which assessing energy consumption related properties of walk-in cold rooms, and of their components.

Performance characteristics shall be assessed for every single component of the walk-in cold room and for the assembled walk-in cold room as a whole.

For the calculations or tests, the reference point for walk-in cold rooms working at positive storage temperature is $T = +5\text{ }^{\circ}\text{C}$, and for negative storage temperature is $T = -18\text{ }^{\circ}\text{C}$.

5.2 Thermal insulation performances

Thermal insulation performances of customized walk-in cold rooms are assessed by considering the relevant characteristic of every single component of a walk-in cold room, which shall be assessed by test and/or by calculations. Components of walk-in cold rooms can be identified as follows:

- wall and ceiling panels;
- floor panels;
- pre-insulated floor;
- door(s);
- window(s);
- fixing systems and junctions;
- supporting profiles.

For comparison walk-in cold rooms with and without thermally insulated floor will be considered.

Air infiltration through the open door will be considered in terms of devices to avoid or limit the ingress of ambient air, from the environment outside the walk-in cold room. A classification of the used device will be proposed, in order to evaluate the contribution to the improvement of walk-in cold room performance characteristics in terms of energy consumption.

5.3 Other performances

5.3.1 Air permeability

Considering a useful life of the cold room of 10 years, taking into account the extremely low air permeability of the metal facings, air permeability of the panels is considered to have negligible effects on the behaviour of the room. Consequently no assessment is required. For different facing materials the air permeability shall be determined according to EN ISO 10456, unless tabulated values are available from other European Standards.

Air permeability of the joints shall be assessed according to [EN 12865](#).

5.3.2 Water vapour permeability

The content of [5.3.1](#) is also valid for water vapour permeability.

Water vapour permeability of the joints shall be assessed according to [EN 12086](#) or [EN ISO 12572](#).

6 Methods to assess thermal insulation performances of customized walk-in cold room components

6.1 General

The assessment of energy consumption related characteristics of single components of a walk-in cold room will be performed considering the following aspects:

- A. Thermal conductivity of sandwich panels core
- B. Thermal transmittance of wall and ceiling panels
- C. Thermal transmittance of floor panels
- D. Thermal transmittance of pre-insulated floor
- E. Thermal transmittance of doors
- F. Thermal transmittance of windows
- G. Thermal transmittance of joints and junctions
- H. Influence of the supporting profiles

Gaskets are considered components of the doors, and sealants are considered part of the fixing system that is tested like reported in [6.6](#), [6.7](#) and [6.8](#).

6.2 Thermal conductivity of the insulating core of wall, ceiling and floor panels

Assessment of thermal conductivity of core material of components as in B, C, D and E, of [6.1](#), is performed according to [EN 12667](#) or [EN 12939](#) for products of high thickness.

Thermal conductivity shall be determined according to [Annex A](#) and [B](#), and declared by the manufacturer according to the following conditions:

- average temperature is $(10 \pm 0,3) ^\circ\text{C}$;
- measured values shall be expressed with three significant figures;
- the thermal resistance, R_D , shall always be declared; the thermal conductivity, λ_D , shall be declared when possible;
- the thermal resistance, R_D , and the thermal conductivity, λ_D , shall be expressed as representative limit values of at least 90 % of production, with a level of confidence of 90 %;

- the thermal conductivity value $\lambda_{90/90}$ shall be rounded to three significant figures expressed in W/m·K and declared as λ_D rounded to three significant figures and expressed W/(m·K);
- the declared thermal resistance, R_D , shall be calculated according to the nominal thickness, d_N , and the relevant thermal conductivity value $\lambda_{90/90}$, unless measured directly;
- the thermal resistance value, $R_{90/90}$, when calculated according to the nominal thickness, d_N , and the relevant thermal conductivity value, $\lambda_{90/90}$, shall be rounded downwards to three significant figures and expressed in m²·K/W, and declared as R_D with three significant figures and expressed in m²·K/W;
- the thermal resistance value, $R_{90/90}$, for those products whose thermal resistance is measured directly, shall be rounded downwards to three significant figures and expressed in m²·K/W, and declared as R_D with three significant figures and expressed in m²·K/W.

Thermal resistance and thermal conductivity shall be determined in accordance with [EN 12667](#) or [EN 12939](#) for thick products and under the following conditions:

- at a mean temperature of $(10 \pm 0,3)$ °C;
- after conditioning of test specimens that shall be stored for at least 6 h at (23 ± 5) °C and (50 ± 5) % relative humidity, unless otherwise specified in the test standard;
- taking into account the effect of ageing according to [Annex B](#).

Thermal resistance and thermal conductivity shall be determined directly at measured thickness. In the event that this is not possible, they shall be determined by measurements on other thicknesses of the product providing that:

- the product is of similar chemical and physical characteristics and is produced on the same production unit;
- and it can be demonstrated in accordance with [EN 12939](#) that the thermal conductivity does not vary more than 2 % over the range of thicknesses where the calculation is applied.

When measured thickness is used for testing of thermal resistance and thermal conductivity, the test thickness should be the smallest of the measured points on the test specimen (and not the mean) as far as possible to avoid any air gaps during testing.

For other core materials the test methods reported in the following relevant standard apply ([EN 13162](#); [EN 13163](#); [EN 13164](#); [EN 13166](#); [EN 13167](#)).

6.3 Thermal transmittance of wall and ceiling panels

6.3.1 Calculation of the thermal transmittance of a panel

The thermal transmittance (U) of the panel, in terms of thermal conductivities, is determined by calculation with the formula:

$$U = \frac{1}{R_{si} + \frac{t_{ni}}{\lambda_{fi}} + \sum \frac{s_{dj}}{\lambda_j} + \frac{t_{ne}}{\lambda_{fe}} + R_{se}} \quad (1)$$

where

s_d is the nominal thickness of each slab of the panel (ignoring the thickness of the facings) [m];

t_{ni} is the nominal thickness of the internal facing [m];