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Building environment design — Embedded radiant heating and cooling systems —

Part 1: Definitions, symbols, and comfort criteria

Conception de l'environnement des bâtiments — Systèmes intégrés de chauffage et de refroidissement par rayonnement —

Partie 1: Définitions, symboles et critères de confort

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 205, *Building environment design*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 228, *Heating systems and water based cooling systems in buildings*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 11855-1:2012), which has been technically revised.

The main changes compared to the previous edition are as follows:

— only references cited normatively were kept in Clause 2, the others were moved to Bibliography;

— In Clause 3, self-explanatory terms were removed, two similar terms representing the same concept were unified into one term, and one term explaining two concepts were divided into two terms each having one concept;

— editorial changes were performed.

A list of all parts in the ISO 11855 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The radiant heating and cooling system consists of heat emitting/absorbing, heat supply, distribution, and control systems. The ISO 11855 series deals with the embedded surface heating and cooling system that directly controls heat exchange within the space. It does not include the system equipment itself, such as heat source, distribution system and controller.

The ISO 11855 series addresses an embedded system that is integrated with the building structure. Therefore, the panel system with open air gap, which is not integrated with the building structure, is not covered by this series.

The ISO 11855 series is applicable to water-based embedded surface heating and cooling systems in buildings. The ISO 11855 series is applied to systems using not only water but also other fluids or electricity as a heating or cooling medium. The ISO 11855 series is not applicable for testing of systems. The methods do not apply to heated or chilled ceiling panels or beams.

The object of the ISO 11855 series is to provide criteria to effectively design embedded systems. To do this, it presents comfort criteria for the space served by embedded systems, heat output calculation, dimensioning, dynamic analysis, installation, control method of embedded systems, and input parameters for the energy calculations.

The ISO 11855 series consists of the following parts, under the general title *Building environment design — Embedded radiant heating and cooling systems*:

— Part 1: *Definitions, symbols, and comfort criteria*

— Part 2: *Determination of the design heating and cooling capacity*

— Part 3: *Design and dimensioning*

— Part 4: *Dimensioning and calculation of the dynamic heating and cooling capacity of Thermo Active Building Systems (TABS)*

— Part 5: *Installation*

— Part 6: *Control*

— Part 7: *Input parameters for the energy calculation*

ISO 11855-1, this document, specifies the comfort criteria which should be considered in designing embedded radiant heating and cooling systems, since the main objective of the radiant heating and cooling system is to satisfy thermal comfort of the occupants. ISO 11855-2 provides steady-state calculation methods for determination of the heating and cooling capacity. ISO 11855-3 specifies design and dimensioning methods of radiant heating and cooling systems to ensure the heating and cooling capacity. ISO 11855-4 provides a dimensioning and calculation method to design Thermo Active Building Systems (TABS) for energy saving purposes, since radiant heating and cooling systems can reduce energy consumption and heat source size by using renewable energy. ISO 11855-5 addresses the installation process for the system to operate as intended. ISO 11855-6 shows a proper control method of the radiant heating and cooling systems to ensure the maximum performance which was intended in the design stage when the system is actually being operated in a building. ISO 11855-7 presents a calculation method for input parameters to ISO 52031.

Building environment design — Embedded radiant heating and cooling systems —

Part 1: Definitions, symbols, and comfort criteria

1 Scope

This document specifies the basic definitions, symbols, and comfort criteria for embedded radiant heating and cooling systems.

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.

ISO 11855-5:—[1)], *Building environment design — Embedded radiant heating and cooling systems — Part 5: Installation*

3 Terms and definitions

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

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
additional thermal resistance
thermal resistance representing layers added to the building structure and acting mostly as thermal resistances because of their own low thermal inertia

EXAMPLE Carpets, moquette, and suspended ceilings.

3.2
average specific thermal capacity of the internal walls
thermal capacity related to one square metre of the internal walls

Note 1 to entry: Since internal walls are shared with other rooms, then just half of the total specific thermal capacity of the wall shall be taken into account, since the second half is influenced by the opposite rooms that are considered to be at the same thermal conditions as the one under consideration.

3.3
average surface temperature
$\theta_{s,m}$
average value of all surface temperatures in the occupied or *peripheral area* (3.62)

1) Second edition under preparation. Stage at the time of publication: ISO/FDIS 11855-5:2021.

3.4
basic characteristic curve
curve reflecting the relationship between the *heat flux* (3.31) and the *mean surface temperature difference* (3.47)

Note 1 to entry: This depends on the heating or cooling and the surface (floor, wall or ceiling) but not on the type of embedded system.

3.5
calculation time step
length of time considered for the calculation

Note 1 to entry: This is typically assumed to equal 3 600 s.

3.6
circuit
section of system connected to a *distributor* (3.25) which can be independently switched and controlled

3.7
circuit total thermal resistance
thermal resistance representing the *circuit* (3.6) as a whole, determining a straight connection between the water inlet temperature and the mean temperature at the *pipe level* (3.63)

Note 1 to entry: It includes the *water flow thermal resistance* (3.92), the *convection thermal resistance at the pipe inner side* (3.10), the *pipe thickness thermal resistance* (3.66), and the *pipe level thermal resistance* (3.64).

3.8
clothing insulation
resistance of a uniform layer of insulation covering the entire body that has the same effect on sensible heat flow as the actual clothing under standardized (static, wind-still) conditions

Note 1 to entry: The definition of clothing insulation also includes the uncovered parts of the body, e.g. the head. It is specified as the intrinsic insulation from the skin to the clothing surface, not including the resistance provided by the air layer around the clothed body, and is expressed in the clo unit or in m^2K/W; 1 clo = 0,155 m^2K/W.

3.9
conductive region of the slab
region of the *slab* (3.75) that includes the pipes with thermal conductivities of the layers higher than 0,8 W/(m·K)

Note 1 to entry: Due to the subdivision of the slab into an upper slab and a lower slab, the conductive region is also subdivided into an upper conductive region and a lower conductive region.

3.10
convection thermal resistance at the pipe inner side
thermal resistance associated to the convection heat transfer taking place between the water flowing in the pipe and the pipe inner side, thus connecting the mean water temperature along the *circuit* (3.6) with the mean temperature of the pipe inner side

3.11
convective heating and cooling system
system that directly conditions the air in the room for the purpose of heating and cooling

3.12
convective peak load
maximum cooling load to be extracted by a virtual convective system used to keep comfort conditions in the room

3.13
design cooling capacity
$Q_{H,c}$
thermal output by a cooling surface at design conditions

3.14
design cooling load
$Q_{N,c}$
required thermal output necessary to achieve the specified design conditions in outside summer design conditions

3.15
design sensible cooling load
required sensible thermal output necessary to achieve the specified design conditions in outside summer design conditions

3.16
design supply temperature of heating medium
$\theta_{V,des}$
value of flow water temperature with the thermal resistance of the chosen floor covering, at maximum value of heat flux q_{max}

Note 1 to entry: The flow and the supply temperature are the same throughout the EN 1264 series.

Note 2 to entry: For the radiant cooling system, the design supply temperature of cooling medium applies instead of design supply temperature of heating medium.

3.17
design heat flux
q_{des}
heat flow divided by the heating or cooling surface, taking into account the surface temperature required to reach the design thermal capacity of a surface heated or cooled space, Q_H, reduced by the thermal capacity of any supplementary heating or cooling equipment, if applicable

3.18
design heating capacity
$Q_{H,h}$
thermal output from a *heating surface* (3.33) at design conditions

3.19
design heating load
$Q_{N,h}$
required thermal output necessary to achieve the specified design conditions in outside winter design conditions

Note 1 to entry: When calculating the value of the design heat load, the heat flow from embedded heating systems into neighbouring rooms is not taken into account.

3.20
design heating medium differential temperature
$\Delta\theta_{H,des}$
temperature difference of heating medium at *design heat flux* (3.17)

3.21
design cooling medium differential temperature
$\Delta\theta_{C,des}$
temperature difference of cooling medium at *design heat flux* (3.17)

3.22
design heating medium differential supply temperature
$\Delta\theta_{V,des}$
temperature difference between the design supply medium temperature and indoor temperature at *design heat flux* (3.17)

3.23
design heating medium flow rate
m_H
mass flow rate in a *circuit* (3.6) which is needed to achieve the *design heat flux* (3.17)

Note 1 to entry: The design cooling medium flow rate is similar with the only difference being that it has an embedded radiant cooling system.

3.24
design indoor temperature
θ_i
operative temperature (3.58) at the centre of the conditioned space used for calculation of the design load and capacity

Note 1 to entry: The operative temperature is considered relevant for thermal comfort assessment and heat loss calculations. This value of internal temperature is used for the calculation method.

3.25
distributor
common connection point for several *circuits* (3.6)

3.26
draught
unwanted local cooling of a body caused by movement of air and related to temperature

3.27
electric heating system

several panel systems that convert electrical energy to heat, raising the temperature of conditioned indoor surfaces and the indoor air

Note 1 to entry: The electric heating system can be applied to floor, walls and ceiling.

3.28
embedded surface heating and cooling system
system consisting of *circuits* (3.6) of pipes embedded in floor, wall or ceiling construction, *distributors* (3.25) and control equipment

3.29
equivalent heat transmission coefficient
K_H
coefficient describing the relationship between the *heat flux* (3.31) from the surface and the *heating medium differential temperature* (3.36)

Note 1 to entry: For the radiant cooling system, the cooling medium differential temperature applies instead of heating medium differential temperature.

3.30
family of characteristic curves
curves denoting the system-specific relationship between the *heat flux (q)* (3.31) and the required *heating medium differential temperature (ΔθH)* (3.36) for conduction resistance of various floor coverings

3.31
heat flux
q
heat flow between the space and surface divided by the heated or cooled surface

Note 1 to entry: For heating it is a positive value and for cooling it is a negative value.

3.32
heat transfer coefficient
h_t
combined convective and radiative heat transfer coefficient between the heated or cooled surface and the space *operative temperature* (3.58) [*design indoor temperature* (3.24)]

3.33
heating surface
surface (floor, wall, ceiling) covered by the embedded surface heating system between the pipes at the outer edges of the system with the addition of a strip at each edge of width equal to half the *pipe spacing* (3.65), but not exceeding 0,15 m

Note 1 to entry: The cooling surface is similar with the only difference being that it has an embedded surface cooling system.

3.34
heating surface area
A_F
area of surface (floor, wall, ceiling) covered by the embedded surface heating system between the pipes at the outer edges of the system with the addition of a strip at each edge of width equal to half the *pipe spacing* (3.65), but not exceeding 0,15 m

Note 1 to entry: The same concept of cooling surface area applies to the embedded cooling system.

3.35
heating capacity for circuit
Q_{HC}
heat exchange between a pipe *circuit* (3.6) and the conditioned room

Note 1 to entry: The same concept of cooling capacity for circuit applies to the embedded cooling system.

3.36
heating medium differential temperature
$\Delta\theta_H$
logarithmically determined average difference between the *temperature of the heating medium* (3.83) and the *design indoor temperature* (3.24)

Note 1 to entry: The same concept of cooling medium differential temperature applies to the embedded cooling system.

3.37
internal convective heat gain
convective contributions by internal heat gains acting in the room

Note 1 to entry: Mainly due to people or electrical equipment.

3.38
internal radiant heat gain
radiant contributions by internal heat gains acting in the room

Note 1 to entry: This is mainly due to people or electrical equipment.

3.39
internal thermal resistance of the slab conductive region
total thermal resistance connecting the *pipe level* (3.63) with the middle points of the upper conductive region and lower *conductive region of the slab* (3.9)

3.40
limit curve
curve in the field of characteristic curves showing the pattern of the *limit heat flux* (3.41) depending on the *heating medium differential temperature* (3.36) and the floor covering

3.41
limit heat flux
q_G
heat flux (3.31) at which the *maximum* (3.45) or *minimum permissible surface temperature* (3.49) is achieved

3.42
limit heating medium temperature difference
$\Delta\theta_{H,G}$
intersection of the system characteristic curve with the *limit curve* (3.40)

3.43
maximum cooling power
maximum thermal power of the cooling equipment, referring only to the room under consideration

3.44
maximum design heat flux
q_{max}
required *design heat flux* (3.17) in the room in order to design supply medium temperature

3.45
maximum permissible surface temperature
$\theta_{S,max}$
maximum temperature permissible for physiological reasons or for the physical building, for calculation of the *limit curves* (3.40), which may occur at a point on the surface (floor, wall, ceiling) in the occupied or *peripheral area* (3.62) depending on the particular usage at a *temperature drop (σ)* (3.82) of the heating medium equal to 0

3.46
mean radiant temperature
uniform surface temperature of an imaginary black enclosure in which an occupant would exchange the same amount of radiant heat as in the actual non-uniform enclosure

3.47
mean surface temperature difference
difference between the *average surface temperature* (3.3) and the *design indoor temperature(θi)* (3.24)

Note 1 to entry: It determines the *heat flux* (3.31).

3.48
metabolic rate
rate of transformation of chemical energy into heat and mechanical work by aerobic and anaerobic metabolic activities within an organism, usually expressed in terms of unit area of the total body surfaces

Note 1 to entry: The metabolic rate varies with each activity. It is expressed in the met unit or in W/m^2; 1 met = 58,2 W/m^2. 1 met is the energy produced per unit surface area of a sedentary person at rest. The surface area of an average person can be determined by Dubois equation, body surface area, in m^2 = 0,20 247 × height $(m)^{0,725}$ × weight $(kg)^{0,425}$.

3.49
minimum permissible surface temperature
$\theta_{S,min}$
minimum temperature permissible for physiological reasons or for the physical building, for calculation of the *limit curves* (3.40), which may occur at a point on the surface (floor, wall, ceiling) in the occupied or *peripheral area* (3.62) depending on the particular usage at a *temperature drop (σ)* (3.82) of the heating medium equal to 0