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Building environment design — Design, test methods and control of hydronic radiant heating and cooling panel systems —

Part 4: Control of ceiling mounted radiant heating and cooling panels

Conception de l'environnement des bâtiments — Conception, méthodes d'essai et contrôle des systèmes de panneaux hydroniques radiants de chauffage et de refroidissement —

Partie 4: Contrôle des panneaux radiants de chauffage et de refroidissement montés au plafond

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ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 205, *Building environment design*.

A list of all parts in the ISO 18566 series can be found on the ISO website.

Introduction

The radiant heating and cooling system consists of heat emitting/absorbing, heat supply, distribution, and control systems. Typical applications are low temperature radiant heating and high temperature radiant cooling. They are classified as embedded radiant heating and cooling systems and prefabricated radiant heating and cooling panel systems.

While ISO 11855 is for embedded radiant heating and cooling systems without an open air gap, ISO 18566 is for radiant heating and cooling panel systems with an open air gap. Because the system specifications for ISO 18566 are different from those of ISO 11855, it was necessary to develop separate ISO standards regarding the design and test methods of the cooling and heating capacity and control and operation.

ISO 18566-1 specifies the comfort criteria, technical specifications and requirements which should be considered in the manufacturing and installation of radiant heating and cooling systems. ISO 18566-2 provides the test facility and test method for heating and cooling capacity of ceiling mounted radiant panels. ISO 18566-3 specifies the design considerations and design processes of ceiling mounted radiant panels. ISO 18566-4 addresses the control of ceiling mounted radiant heating and cooling panels to ensure the maximum performance which was intended in the design stage when the system is actually being operated in a building.

ISO 18566 does not cover the panels that are embedded into the ceiling, wall or floor structure.

Building environment design — Design, test methods and control of hydronic radiant heating and cooling panel systems —

Part 4: Control of ceiling mounted radiant heating and cooling panels

1 Scope

This document specifies the control of ceiling mounted radiant heating and cooling panels. The requirements in this document are applicable only to the components of the heating/cooling systems and the elements which are part of the heating/cooling panels and which are installed to provide heating and/or cooling.

This document is applicable to water-based ceiling mounted radiant heating and cooling panels in residential, commercial and industrial buildings. The methods apply to systems mounted under the ceiling with or without open air gaps between the panels and the ceiling.

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 18566-1, *Building environment design — Design, test methods and control of hydronic radiant heating and cooling panel systems — Part 1: Definition, symbols, technical specifications and requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 18566-1 apply.

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

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

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

4 Symbols

For the purposes of this document, the symbols in ISO 18566-1 apply.

5 Controls

5.1 General

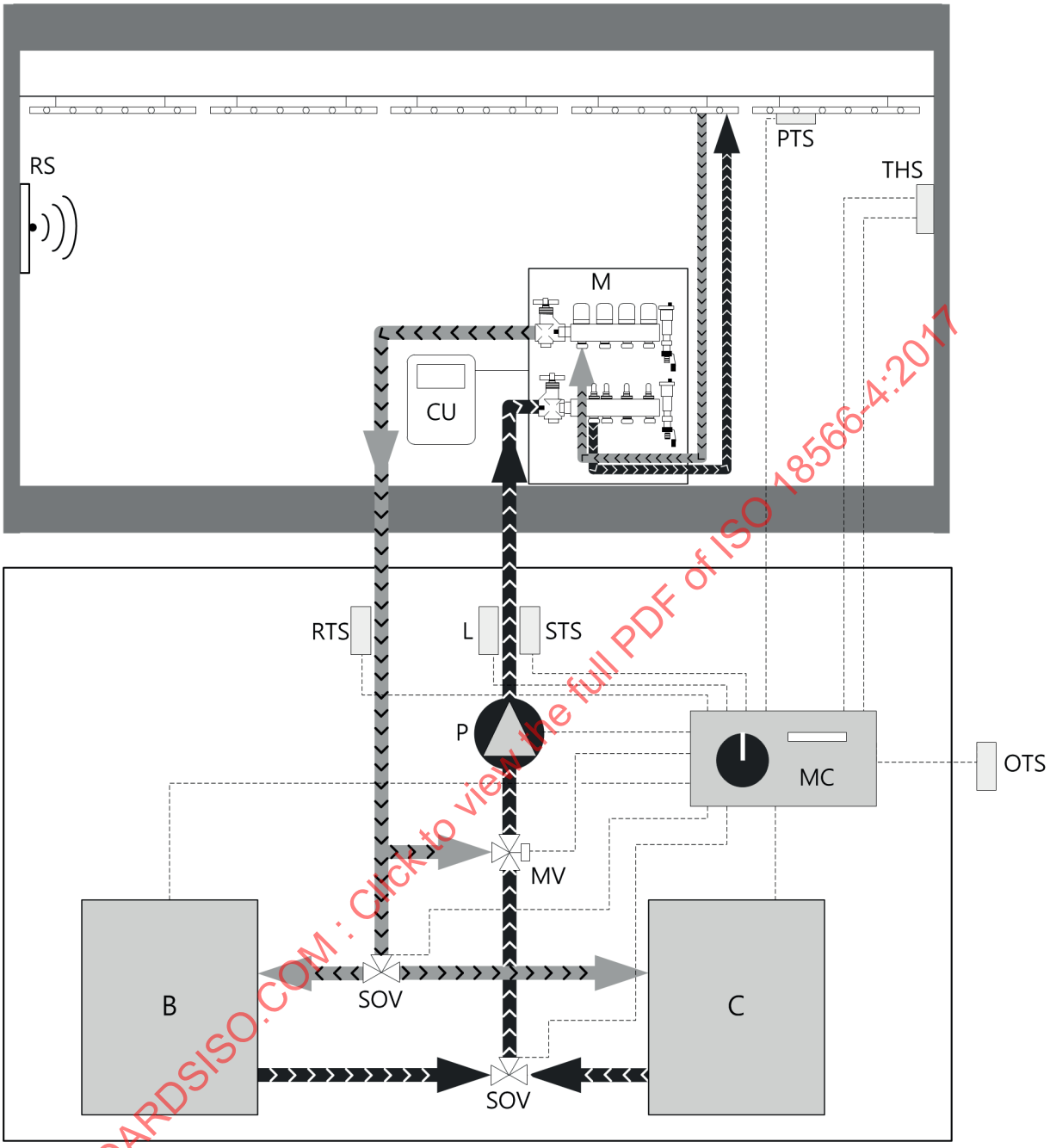
This clause describes the control of hydronic systems to enable all radiant panel systems to perform as simulated. The design documents shall include specifications for the control system. The control

system shall be capable of varying heating or cooling outputs as well as maintaining predetermined room or surface temperatures.

Control of the heating and cooling system shall enable the specified designed indoor temperatures to be achieved under the specified variation of internal loads and external climate. The control system shall, if specified, protect buildings and equipment against frost and moisture damage where necessary (when normal comfort temperature level is not required) and prevent condensation from occurring.

The design of the control system shall take into account the dynamics of the space, its intended use and the effective functioning of the panel system. It shall also ensure efficient use of energy and avoid conditioning the space to full design conditions when not required. This shall include keeping distribution heat losses as low as possible, e.g. by reducing flow rates and temperatures, when normal comfort temperature level is not required. Control of the system will enable control of the conditioning systems to obtain possible savings of operational costs and enable the maintenance of required indoor environmental conditions. The control shall ensure that heating and cooling does not occur at the same time in the same space.

In order to maintain a stable thermal environment, the control system needs to maintain the balance between supplied energy from the system and the losses/gains of the space environment under transient conditions. Slowly varying energy flows in the form of energy losses or gains through the envelope are determined by indoor and outdoor temperature, and direction and speed of wind.



Key

B	boiler	OTS	outside temperature sensor
C	chiller	P	pump
CU	control unit	RS	room sensor
PTS	panel temperature sensor	RTS	return medium temperature sensor
L	limiter	SOV	shut off valve
M	manifold	STS	supply medium temperature sensor
MC	main controller	THS	temperature-humidity sensor
MV	mixing valve		

Figure 1 — Principal diagram of a radiant ceiling panel system for heating and cooling

Figure 1 shows the principles of control. The supply water temperature to the radiant ceiling is controlled by a mixing valve actuated to maintain the design condition. In the occupied space, there is a sensor for temperature and humidity which can be used for zone control and/or give input to the control of the mixing valve and provide information to the building management system (BMS) to determine space dew point temperature which is necessary to ensure that condensation does not occur on the surfaces of the conditioned space. Outside temperature sensors, supply-return water temperature sensors and in some cases, surface temperature sensors are to be installed to influence the control. The control modes of panel systems are based on the following three system levels:

— local (space) control, where the energy supplied to a space is controlled;

— zone control, normally consisting of several spaces (rooms);

— central control, where energy supplied to the whole building is controlled by a central system.

The control system classification is based on performance level.

a) Manual: The energy supply to the conditioned space is only controlled by a manually operated device.

b) Automatic: A suitable system or device automatically controls energy to the conditioned spaces.

c) Timing: Function of energy supplied to a conditioned space is shut off or reduced during scheduled periods, e.g. night setback (not necessarily applicable for cooling).

d) Advanced timing: Function of energy supply to the conditioned space is shut off or reduced during scheduled periods, e.g. daytime with more expensive electricity tariff. Restarting of the energy supply is optimized based on various considerations, including reduction of energy use (not applicable in commercial buildings).

5.2 Central control

The central control shall control the heating or cooling of the water temperature through the panel system. In residential systems, the control is normally done according to the outside climate (based on the heating/cooling curve, which is influenced by building mass, heat loss and differences in heat required by the individual spaces), and regulates the supply water temperature to the system.

To reduce losses in the distribution system, the central control shall control according to the outside temperature, i.e. higher water temperature for lower outside temperatures, for heating only.

Instead of controlling the supply water temperature, in heating mode it is recommended to control the average water temperature, ϑ_m, (mean value of supply and return water temperature) according to outside and/or indoor temperatures. This is more directly related to the energy flux into the space. If during the heating period, for example, the internal load in the space increases, the heat output of the panel system will decrease and the return temperature will increase.

If the panel system in heating mode is operated intermittently (e.g. night and/or weekend set-back), the central control is also important for providing high enough water temperatures (boost effect) during the pre-conditioning period in the morning. The energy savings by night set-back in residential buildings are, however, relatively low due to the high thermal insulation standard in new houses.

The control is normally done according to the heat loss or gain and differences in heat or cooling required by the individual spaces which control the supply water temperature to the system.

For cooling, it is also recommended to control the supply water temperature based on the zone with the highest dew point temperature. In many buildings with cooling, the internal load is of significant importance and it is recommended to let the room temperature and humidity of representative spaces influence the control of the water temperature.

Ceiling-mounted radiant cooling panel systems shall include controls to avoid condensation on internal cooled surfaces or condensation in critical parts of the building (see Annex A). This can be done by a

central control of the supply water temperature and a limit on the minimum water temperature based on a measured dew point in the conditioned space or by feedback from surface temperature sensors.

5.3 Zone control

To optimize energy and control performance, larger buildings should be divided into zones where the individual spaces in each zone require about the same water temperature (north to south). An apartment or one-family house is normally regarded as one zone. The whole zone can be controlled with reference to a temperature sensor in a representative space of the zone.

5.4 Local (space) control

National building codes shall be followed regarding individual room control.

The installation of individual room temperature controls is recommended in order to improve comfort and for potential energy savings. Besides energy benefits, it is essential for the thermal comfort of the occupants that they have a possibility for individual adjustment of the room temperature set-point from room to room.

In the case of a radiant panel system, the valve (and then the water flow) is controlled by a room sensor (wired or wireless). The wiring is often installed together with the main power wiring. Room sensors are therefore often installed near a switch for the main power (door) and not in a representative position of the occupied zone. In order to eliminate this problem, individual room temperature control systems, using a link based on wireless transmission between the room sensors and the control valves (see Figure 1), can improve the quality of the control.

In terms of comfort, it is preferable to control the room temperature as a function of the operative temperature in the area occupied by the person. Besides the position, it is important to consider the shape, size and colour (important for short wave radiation, sunlight) of the sensor in order to express convective and radiant heat exchange between sensor and space similarly as for the person (refer to EN 7726).

5.5 Influence of thermal mass of panel systems

The thermal mass and time constant of radiant panel systems are, in most cases, negligible compared to the thermal mass and time constant of a space. The time response and the thermal storage capacity of systems will depend on the design and materials used for the panels with integrated pipes.

Panels with a higher thermal mass or panels with phase change materials (PCM) will have a significant effect if a change in room temperature level is needed. On the other hand, regarding controlling for changes in external climate and internal loads (people, sun, etc.), all the systems are quite fast in responding to the room side because of the self-regulating effect (see 5.6).

5.6 Self-regulating effect

Due to the high impact that fast varying heat gains (e.g. sunshine through windows) may have on the room temperature, it is necessary that the radiant system control compensates by reducing or increasing the temperature difference between room and heated/cooled surface and partly on the difference between room and the average temperature output. For a low temperature heating system and high temperature cooling systems such as ceiling panels systems, the “self-regulating effect” is significant. The “self-regulating” depends on the average water temperature in the panels. It means that a fast change of operative temperature will equally change the heat exchange and result in influence on total heat exchange. This impact is bigger for systems with surface temperatures close to room temperature because the change of one degree represents a higher percentage based on a small temperature difference than on a high temperature difference.

The self-regulating effect of low temperature heating and high temperature cooling systems supports the control equipment (e.g. individual room temperature control) in maintaining a stable thermal environment providing comfort to the person in the room.

5.7 Flow control

Water-based ceiling panel systems need to be hydronically balanced. The components shall be adjusted in order to ensure the required flow rates. Under dynamic conditions, e.g. during the heating up/cooling down period, it shall be ensured that the hydraulic interaction between the different circuits is small (the flow rates in the different circuits shall not be greater than the design flow rates). Depending on the situation of the heating/cooling system, the ceiling panel distribution system shall be equipped with facilities for degassing and sludge separation.