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Toplotni sončni sistemi in sestavni deli - Neserijsko izdelani sistemi - 5. del: Preskusne metode delovanja kontrolnih naprav

Thermal solar systems and components - Custom built systems - Part 5: Performance test methods for control equipment

Thermische Solaranlagen und ihre Bauteile - Kundenspezifisch gefertigte Anlagen - Teil 5: Prüfmethoden für die Regeleinrichtungen

Installations solaires thermiques et leurs composants - Installations assemblées à façon - Partie 5 : Méthodes d'essai pour chauffe-eau solaires et installations solaires combinées

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Foreword

This document (EN 12977-5:2012) has been prepared by Technical Committee CEN/TC 312 “Thermal solar systems and components”, the secretariat of which is held by ELOT.

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of an identical text or by endorsement, at the latest by October 2012, and conflicting national standards shall be withdrawn at the latest by October 2012.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes CEN/TS 12977-5:2010.

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Introduction

One purpose of this document is to define how to check that a controller is behaving as it is intended when in combination with associated equipment (e.g. sensors, pumps and other actuators). In addition, function testing of differential thermostats and so-called "multi-function" controllers are described in order to determine switch on and switch off temperature differentials as well as control algorithms where dependent on temperature differences, temperature levels or operating conditions of the system. For all functions and operations, it should be tested and documented, whether the controller and control equipment comply with the manufacturer's guidance.

In addition, the capability for all sensors to resist extreme operating conditions and to determine any significant drift in accuracy caused by this should be tested. The energy consumption of the controller and the associated control equipment should be documented, e.g. actuators. If the electrical supply is different from the mains supply this should be documented, e.g. PV powered pumps.

Performance predictions for the associated system that the control equipment belongs to are considered. For the determination of the component parameters according to the CTSS method, as specified in EN 12977-2, a detailed investigation of all relevant algorithms, features and parameters controlling the system is relevant.

NOTE The most widely used control equipment for solar heating systems is described in EN 12977-5. For control equipment not widely used in solar heating systems or auxiliary heaters, if part of the system, accompanying standards should be applied if available.

In respect of potential adverse effects to human health or life (e.g. drinking water quality) caused by the products covered by EN 12977-5 it should be noted that:

— this document provides no information as to whether the product may be used without restriction in any of the Member States of the EU or EFTA;

— while awaiting the adoption of verifiable European criteria, existing national regulations concerning the use and/or the characteristics of this product remain in force.

EN 12976-1, EN 12976-2 as well as EN 12977-1, EN 12977-2, EN 12977-3, and EN 12977-4 distinguish two categories of solar heating systems:

1) factory made solar heating systems;

2) custom built solar heating systems.

As defined in EN 12977-1, the classification of a system as factory made or custom built is a choice of the final supplier.

Custom built solar heating systems are subdivided into two categories:

i) large custom built systems are uniquely designed for a specific situation.

ii) small custom built systems offered by a company are described in a so-called assortment file, in which all components and possible system configurations, marketed by the company, are specified;

1 Scope

This European Standard specifies performance test methods for control equipment. Furthermore, this document contains requirements on accuracy, durability and reliability of control equipment.

The tests described in this document are limited to electrically activated components delivered with or for the system by the final supplier. For the purposes of this document controller and control equipment for solar heating systems and auxiliary heaters, if part of the system, are restricted to the following:

a) Controllers as:

   1) system clocks, timers and counters;

   2) differential thermostats;

   3) multi-function controllers.

b) Sensors as:

   1) temperature sensors;

   2) irradiance sensors (for short wave radiation);

   3) pressure sensors;

   4) level sensors;

   5) flow meters;

   6) heat meters.

c) Actuators as:

   1) pumps;

   2) solenoid and motor valves;

   3) relays.

d) Combinations of controllers, sensors and actuators listed above.

An additional objective of the procedures described in this document is to verify control algorithms and, together with the accuracy of sensors, to determine control parameters. In addition to verifying the functioning of a controller, its equipment and actuators, the determined parameters may be used for numerical system simulations.

Typically, electrical anodes are not part of the control equipment and are not controlled by the control equipment. However, because they are electrical appliances, electrical anodes are included in this document.

This document is valid for control equipment of solar heating systems for the purpose of hot water preparation and/or space heating. If the solar system is connected to or part of a conventional heating system, the validity is extended to the entire system. In combination with the standards EN 12976-1, EN 12976-2 as well as EN 12977-1, EN 12977-2, EN 12977-3 and EN 12977-4, this document is valid for

e) factory made solar heating systems,

f) small custom built solar heating systems,

g) large custom built solar heating systems,

h) auxiliary heater equipment used in connection with e), f) and g).

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 1151-1, *Pumps — Rotodynamic pumps — Circulation pumps having a rated power input not exceeding 200 W for heating installations and domestic hot water installations — Part 1: Non-automatic circulation pumps, requirements, testing, marking*

EN 12975-2, *Thermal solar systems and components — Solar collectors — Part 2: Test methods*

EN 12976-1:2006, *Thermal solar systems and components — Factory made systems — Part 1: General requirements*

EN 12977-1:2012, *Thermal solar systems and components — Custom built systems — Part 1: General requirements for solar water heaters and combisystems*

EN 60038, *CENELEC standard voltages (IEC 60038)*

EN 60255 (all parts), *Measuring relays and protection equipment (IEC 60255, all parts)*

EN 60335-1, *Household and similar electrical appliances — Safety — Part 1: General requirements (IEC 60335-1)*

EN 60335-2-21, *Household and similar electrical appliances — Safety — Part 2-21: Particular requirements for storage water heaters (IEC 60335-2-21)*

EN 60730 (all parts), *Automatic electrical controls for household and similar use (IEC 60730, all parts)*

EN 62305-3, *Protection against lightning — Part 3: Physical damage to structures and life hazard (IEC 62305-3)*

EN ISO 4413, *Hydraulic fluid power - General rules and safety requirements for systems and their components (ISO 4413)*

EN ISO 9488:1999, *Solar energy — Vocabulary (ISO 9488:1999)*

ISO 9060, *Solar energy — Specification and classification of instruments for measuring hemispherical solar and direct solar radiation*

ISO/TR 9901, *Solar energy — Field pyranometers — Recommended practice for use*

ISO 15218, *Pneumatic fluid power — 3/2 solenoid valves — Mounting interface surfaces*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 12976-1:2006, EN 12977-1:2012, EN ISO 9488:1999 and the following apply.

3.1
actuator
component or device designed to perform actions to operate a solar heating system or auxiliary heating system according to signals from the control equipment

Note 1 to entry: For classification, see Table 3.

3.2
control equipment assortment
complete list of components (controller, sensors, actuators), which a company offers to control a solar heating system, including auxiliary heater control equipment, if the auxiliary heater is part of the solar heating system

3.3
controller
device to control a solar heating system, sometimes in connection/combination with auxiliary heater(s)

Note 1 to entry: For classification, see Table 1.

3.4
pump
any device capable of circulating liquid

3.5
reference device/measurement
device or measurement which control equipment under test or measured quantities are referred or compared to

3.6
sensor
device to measure physical (or chemical) qualities/properties

Note 1 to entry: With respect to solar heating systems, temperature, irradiance, flow/circulation, pressure and level sensors are most common.

Note 2 to entry: For classification see Table 2.

4 Symbols and abbreviations

G hemispherical solar irradiance in the plane of the radiation sensor, in watts per square metre;

t time, in seconds.

v_{air} surrounding air speed, in metres per second;

$\Delta\vartheta_{hyst}$ hysteresis, difference between ON- and OFF-temperature difference for switching an actuator, in Kelvin;

ϑ_{amb} ambient or surrounding air temperature, in degrees Celsius;

ϑ_{max} maximum (allowed) temperature of a temperature sensor, in degrees Celsius;

ϑ_{ref} reference temperature, in degrees Celsius;

ϑ_{start} start temperature, e.g. of pump in solar collector circuit, in degrees Celsius;

ϑ_{stop} stop temperature, e.g. of pump in solar collector circuit, in degrees Celsius;

ϑ_{store} temperature of the storage tank for heated water, in degrees Celsius;

5 Controller classification (including equipment classification)

5.1 Controller

Control devices designed to control a solar heating system, sometimes in connection/combination with auxiliary heaters are classified according Table 1.

Table 1 — Classification of controllers for solar heating systems

	Controller
C1	**System clock, timer and counter** Controlling the operation of one or more actuators by means of real or relative time. Timers and counters might be connected to different kinds of sensors influencing their behaviour by superposition of the commands. Beside time intervals counter might count and sum up events or quantities.
C2	**Differential thermostat** Control of one or more actuators by means of a temperature difference between two temperature sensors. In most cases, a hysteresis between switching ON and OFF is present. Differential controllers are sometimes used with other signals, e.g. solar irradiation, pressure or level sensors.
C3	**Multi-function controller** Controller designed to control one or more actuators based on measured quantities delivered by different kinds of sensors, real time or relative time and/or control concepts including specific control algorithms. With regard to this document multi-function controllers are used to control and operate a solar heating system, and may also control a combination of hot water preparation, space heating, heat distribution or any kind of back-up heating. Multi-function controllers may use more than one differential algorithm in one unit or at least one operation is caused by more than a simple differential algorithm. If a device operates its output(s) depending on more than one (temperature) difference or not simply in an ON/OFF mode, then a controller incorporating such differential algorithm (thermostat) should be treated as a multi-function controller. If this is not the case, the unit shall be treated as a differential thermostat.

5.2 Sensor

Typical sensors used for controllers listed in Table 1 are summarized in Table 2.

Table 2 — Common sensors for solar heating systems

	Sensor
S1	**Temperature sensor** Sensing of temperatures of different parts in the system. In connection with the electronic layout of a controller or accessory measuring device determination of temperatures, e.g. in degrees Celsius.
S2	**Irradiance sensor** Instrument measuring the hemispherical solar irradiance in the plane of the radiation sensor within a spectral range of approx. 0,3 µm to 3 µm. To control a (solar) heating system irradiance sensors and accessory control equipment might have special designs to meet the specific requirements to solar energy utilization. With respect to this document both, irradiance sensors with thermoelectric sensor and irradiance sensors based on the photoelectrical effect are included. Supplementary photocells or other devices used to measure the solar irradiance are treated equate to solar irradiance sensor.
S3	**Flow/circulation sensors** Sensing of the flow/circulation of a fluid. In connection with the electronic layout of a controller or accessory measuring device determination of the volume and/or mass flow.
S4	**Pressure sensor** Sensing of absolute or relative pressure. In connection with the electronic layout of a controller or accessory measuring device determination of absolute pressure or pressure differences.
S5	**Level sensor** Sensing of the level of a fluid within a vessel or a store.
NOTE 1 The controller or accessory-measuring devices shall enable the conversion of sensor signals to values suitable to serve as control criterion for functioning and supervising of the system. NOTE 2 Values serving as control criterion should be displayed by a control device or, at least, a read back of data should be possible. NOTE 3 If other physical quantities or conditions than listed under S1, S2, S3, S4 or S5 are measured, the use of those sensors and the data processing might be in a similar manner to S1, S2, S3, S4 or S5.	

5.3 Actuator

Table 3 gives a selection of the most common actuators that can be found in solar heating systems.

Table 3 — Most common actuators for solar heating systems

	Actuator
A1	**Pump** Device to circulate a heat transfer medium and/or water in a forced-circulation system, e.g. a collector circuit, a circuit for space heating/cooling and/or hot water preparation.
A2	**Solenoid and motor valve** Electric driven device to start and/or to stop flow/circulation as well as to join, divide and/or to divert flow streams.
A3	**Relay / Contactor** Device to connect and/or to switch electrical loads and/or actuators, e.g. when using a low-level signal (voltage and/or current) of a controller to start and stop a high voltage/power pump.

6 Requirements

6.1 General requirements

6.1.1 Basic principles

Any part of the control equipment has to be suitable for the application it is applied to and also suitable for all relevant conditions. Any part of the control equipment mounted outdoors shall be resistant to UV radiation and ozone. For indoor and outdoor mounted control equipment, harmful impact and mechanical damage, e.g. caused by birds or rodents and other operating conditions shall be prevented (see EN 60730 (all parts)). If any maintenance or replacement of the control equipment is required in order to maintain the system working, this shall be clearly stated in the documents for the user. The durability to withstand all operating conditions, which might occur during operation and depending on the mounting location, is mandatory. All equipment, particularly parts installed outside, have to be protected against corrosion and mechanical impact at least over the prescribed lifetime or maintenance interval specified by the manufacturer or final supplier.

6.1.2 Electrical safety

The control equipment shall fulfil general safety requirements.

See EN 60335-1, EN 60335-2-21, EN 60730 (all parts).

6.1.3 Freeze damage protection

If the control equipment includes algorithms and/or devices for freeze damage protection, e.g. preventing heat transfer medium in the collector circuit to freeze, those algorithms and/or devices shall be reliable.

6.1.4 Scald protection

If the control equipment includes algorithms and/or devices for scald protection, the algorithms and/or control equipment shall be reliable. The default value of the temperature for domestic hot water delivered to the user shall be at a maximum level of 60 °C.

If the temperature of the domestic hot water delivered to the user exceeds 60 °C, an external, automatic cold water mixing device or any other device to limit the temperature to a maximum level of 60 °C shall be installed.

6.1.5 High temperature protection for materials and components

If the control equipment includes algorithms and/or devices to avoid overheating of materials and/or components, e.g. stopping the collector loop pump(s) and possibly draining down the heat transfer medium from the collector, these algorithms and/or control equipment shall be reliable.

If an upper temperature limit for materials and/or components specified by the manufacturer or final supplier is reached, the control equipment should stop the circulation pump(s) of the collector loop. With regard to restarting the circulation pump(s), the control strategies should be designed in a way to prevent damage to the system, the components and materials.

If the control equipment includes algorithms and/or devices for limitation of the flow temperature, e.g. to a floor heating circuit, these algorithms and/or control equipment shall be reliable.

6.1.6 Lightning

The control equipment shall meet the requirements given in EN 62305-3. The manufacturer or the final supplier shall specify particular features for lightning protection within the control equipment.