



**SLOVENSKI STANDARD**  
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Thermal solar systems and components - Solar collectors - Part 2: Test methods

Thermische Solaranlagen und ihre Bauteile - Kollektoren - Teil 2: Prüfverfahren

Installations solaires thermiques et leurs composants - Capteurs solaires - Partie 2 :  
Méthode d'essai

**Ta slovenski standard je istoveten z: EN 12975-2:2006**

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## Thermal solar systems and components - Solar collectors - Part 2: Test methods

Installations solaires thermiques et leurs composants -  
Capteurs solaires - Partie 2 : Méthode d'essai

Thermische Solaranlagen und ihre Bauteile - Kollektoren -  
Teil 2: Prüfverfahren

This European Standard was approved by CEN on 6 February 2006.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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**EN 12975-2:2006 (E)****Foreword**

This European Standard (EN 12975-2:2006) 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of an identical text or by endorsement, at the latest by September 2006, and conflicting national standards shall be withdrawn at the latest by September 2006.

This European Standard supersedes EN 12975-2:2001.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

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## Introduction

This standard specifies test methods for determining the ability of a liquid heating solar collector to resist the influence of degrading agents. It defines procedures for testing collectors under well-defined and repeatable conditions.

This standard also provides test methods and calculation procedures for determining the steady-state and quasi-dynamic thermal performance of glazed liquid heating solar collectors. It contains methods for conducting tests outdoors under natural solar irradiance and natural and simulated wind and for conducting tests indoors under simulated solar irradiance and wind.

This standard also provides methods for determining the thermal performance of unglazed liquid heating solar collectors. Unglazed collectors are in most cases used for heating swimming pools or other low temperature consumers. In general the collectors are put together on-site, connecting absorber strips with manifolds. Real absorber areas are mostly between ten to one hundred square meters. For unglazed absorbers, readily fabricated modules with a specific size are seldom used. Therefore, during the test, it should be checked that a realistic flow pattern and flow velocity is used.

This standard also provides test methods and calculation procedures for determining the steady-state as well as the all-day thermal performance parameters for liquid heating solar collectors, under changing weather conditions. It contains methods for conducting tests outdoors during whole days and under stationary inlet temperature conditions and natural solar irradiance and natural and/or simulated wind conditions. Important effects for the all-day performance of the collector, as the dependence on incident angle, wind speed, diffuse fraction of solar irradiance, thermal sky radiation and thermal capacity are taken into account. Dependence on flowrate is not included in this standard.

Some of the advantages of the proposed extension of the present steady-state test methods of all-day testing are:

- shorter and less expensive outdoor test, suitable for European climate conditions.
- much wider range of collectors can be tested with the same method.
- at the same time, a much more complete characterisation of the collector is achieved.
- collector model is still directly compatible with that of the present basic test standards, and only correction terms are applied in this extended approach.
- all additions are based on long agreed collector theory.
- at any time, full backwards comparability to steady-state can be established by evaluating only periods of the test days that correspond to steady-state test requirements.
- same test equipment can be used as for stationary testing with only minor changes, which will also improve the accuracy of steady-state testing.
- commonly available standard PC software can be used for the parameter identification, such as spreadsheets or more advanced statistical packages that have Multiple Linear Regression (MLR) as an option.

**EN 12975-2:2006 (E)****1 Scope**

This European Standard specifies test methods for validating the durability, reliability and safety requirements for liquid heating collectors as specified in EN 12975-1. This standard also includes three test methods for the thermal performance characterisation for liquid heating collectors.

It is not applicable to those collectors in which the thermal storage unit is an integral part of the collector to such an extent that the collection process cannot be separated from the storage process for the purpose of making measurements of these two processes.

It is basically applicable to tracking concentrating collectors, thermal performance testing as given in 6.3 (quasi dynamic testing) is also applicable to most concentrating collector designs, from stationary non-imaging concentrators as CPCs to high concentrating tracking designs. Parts of the solar radiation measurement should be adjusted in case of a tracking collector and in case a pyrheliometer is used to measure beam radiation.

Collectors that are custom built (built in; e.g. roof integrated collectors that do not compose of factory made modules and are assembled directly on the place of installation) cannot be tested in their actual form for durability, reliability and thermal performance according to this standard. Instead, a module with the same structure as the ready collector may be tested. The module gross area should be at least 2 m<sup>2</sup>. The test is valid only for larger collectors than the tested module.

**2 Normative references**

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The following referenced documents are indispensable for the application of this European Standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies. [SIST EN 12975-2:2006](https://standards.iteh.ai/catalog/standards/sist/57525cc4-6c22-4463-bb7f-7b50b44829e/sist-en-12975-2-2006)

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EN 1991 (all parts), *Eurocode 1: Actions on structures*

EN 12975-1:2006, *Thermal solar systems and components – Solar collectors – Part 1: General requirements*

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

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

**3 Terms and definitions**

For the purposes of this European Standard, the terms and definitions given in EN ISO 9488 apply.

#### 4 Symbols and units

$a_1$	heat loss coefficient at $(T_m - T_a)=0$	$Wm^{-2}K^{-1}$
$a_2$	temperature dependence of the heat loss coefficient	$Wm^{-2}K^{-2}$
$A_A$	absorber area of collector	$m^2$
$A_a$	aperture area of collector	$m^2$
$A_G$	gross area of collector	$m^2$
$AM$	optical air mass	
$b_u$	collector efficiency coefficient (wind dependence)	$m^{-1} s$
$b_o$	constant for the calculation of the incident angle modifier	
$b_1$	heat loss coefficient at $(T_m - T_a)=0$	$Wm^{-2}K^{-1}$
$b_2$	collector efficiency coefficient	$Wsm^{-3}K^{-1}$
$c_1$	heat loss coefficient at $(T_m - T_a)=0$	$Wm^{-2}K^{-1}$
$c_2$	temperature dependence of the heat loss coefficient	$Wm^{-2}K^{-2}$
$c_3$	wind speed dependence of the heat loss coefficient	$Jm^{-3}K^{-1}$
$c_4$	sky temperature dependence of the heat loss coefficient	$Wm^{-2}K^{-1}$
$c_5$	effective thermal capacity	$J m^{-2}K^{-1}$
$c_6$	wind dependence in the zero loss efficiency	$sm^{-1}$
$c_f$	specific heat capacity of heat transfer fluid	$Jkg^{-1}K^{-1}$
$C$	effective thermal capacity of collector	$JK^{-1}$
$D$	date	YYMMDD
$E_L$	longwave irradiance ( $\lambda > 3\mu m$ )	$Wm^{-2}$
$E_\beta$	longwave irradiance on an inclined surface outdoors	$Wm^{-2}$
$E_s$	longwave irradiance	$Wm^{-2}$
$F$	radiation view factor	
$F'$	collector efficiency factor	
$G$	hemispherical solar irradiance	$Wm^{-2}$
$G^*$	global hemispherical solar irradiance	$Wm^{-2}$
$G''$	net irradiance	$Wm^{-2}$
$G_b$	direct solar irradiance (beam irradiance)	$Wm^{-2}$

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$G_d$	diffuse solar irradiance	$Wm^{-2}$
$LT$	local time	h
$K_\theta$	incidence angle modifier	
$K_{\theta b}$	incidence angle modifier for direct radiation	
$K_{\theta d}$	incidence angle modifier for diffuse radiation	
$m$	thermally active mass of the collector	kg
$\dot{m}$	mass flowrate of heat transfer fluid	$kg s^{-1}$
$\dot{Q}$	useful power extracted from collector	W
$\dot{Q}_L$	power loss of collector	W
SF	safety factor	
$t$	time	s
$t_a$	ambient or surrounding air temperature	$^{\circ}C$
$t_{dp}$	atmospheric dew point temperature	$^{\circ}C$
$t_e$	collector outlet (exit) temperature	$^{\circ}C$
$t_{in}$	collector inlet temperature	$^{\circ}C$
$t_m$	mean temperature of heat transfer fluid	$^{\circ}C$
$t_s$	atmospheric or sky temperature	$^{\circ}C$
$t_{stg}$	stagnation temperature	$^{\circ}C$
$T$	absolute temperature	K
$T_a$	ambient or surrounding air temperature	$^{\circ}C$
$T_m^*$	reduced temperature difference ( $= (t_m - t_a)/G^*$ )	$m^2KW^{-1}$
$T_s$	atmospheric or equivalent sky radiation temperature	K
$U$	measured overall heat loss coefficient of collector, with reference to $T_m^*$	$Wm^{-2}K^{-1}$
$U_L$	overall heat loss coefficient of a collector with uni- form absorber temperature $t_m$	$Wm^{-2}K^{-1}$
$u$	surrounding air speed	$ms^{-1}$

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$V_f$	fluid capacity of the collector	$m^3$
$\Delta p$	pressure difference between fluid inlet and outlet	Pa
$\Delta t$	time interval	s
$\Delta T$	temperature difference between fluid outlet and inlet ( $t_e - t_{in}$ )	K
$\alpha$	solar absorptance	
$\beta$	tilt angle of a plane with respect to horizontal	degrees
$\gamma$	azimuth angle	degrees
$\varepsilon$	hemispherical emittance	
$\omega$	solar hour angle	degrees
$\theta$	angle of incidence	degrees
$\Phi$	latitude	degrees
$\lambda$	wavelength	$\mu m$
$\eta$	collector efficiency, with reference to $T_m$	
$\eta_0$	zero-loss collector efficiency ( $\eta$ at $T_m = 0$ ), reference to $T_m^*$	
$\sigma$	Stefan-Boltzmann constant	$Wm^{-2}K^{-4}$
$\rho$	density of heat transfer fluid	$kgm^{-3}$
$\tau_c$	collector time constant	s
$\tau$	transmittance	
$(\tau\alpha)_e$	effective transmittance-absorptance product	
$(\tau\alpha)_{ed}$	effective transmittance-absorptance product for diffuse solar irradiance	
$(\tau\alpha)_{en}$	effective transmittance-absorptance product for direct solar radiation at normal incidence	
$(\tau\alpha)_{e\theta}$	effective transmittance-absorptance product for direct solar radiation at angle of incidence $\theta$	

NOTE 1 In the field of solar energy the symbol  $G$  is used to denote solar irradiance, rather than the generic symbol  $E$  for irradiance.

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NOTE 2  $C$  is often denoted  $(mC)_e$  in basic literature (see also Annex F)

NOTE 3 For more information about thermal performance coefficients (parameters)  $c_1$  to  $c_6$ , see Annex F.

**5 Reliability testing of liquid heating collectors****5.1 General**

The details regarding the number of collectors and sequences used to carry out the qualifications tests detailed in the list below (Table 1) shall be given in the report.

For some qualification tests, a part of the collector may have to be tampered with in some way, for example a hole may have to be drilled in the back of the collector to attach a temperature sensor to the absorber. In these cases care should be taken to ensure that any damage caused does not affect the results of subsequent qualification tests, for example by allowing water to enter into a previously raintight collector.

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Table 1 - Test List

Subclause	Test
5.2	Internal pressure
5.3	High-temperature resistance <sup>a, b</sup>
5.4	Exposure <sup>b</sup>
5.5	External thermal shock <sup>c</sup>
5.6	Internal thermal shock <sup>c</sup>
5.7	Rain penetration <sup>d</sup>
5.8	Freeze resistance <sup>e</sup>
5.9	Mechanical load
5.10	Impact resistance (optional test)
6.1-6.2-6.3	Thermal performance <sup>f</sup>

<sup>a</sup> For organic absorbers, the high-temperature resistance test shall be performed first in order to determine the collector stagnation temperature needed for the internal pressure test.

<sup>b</sup> The high temperature and exposure test shall be carried out on the same collector

<sup>c</sup> The external and internal thermal shock tests may be combined with the exposure test or the high-temperature resistance test.

<sup>d</sup> The rain penetration test shall be carried out only for glazed collectors.

<sup>e</sup> The freeze resistance test shall be carried out only for collectors claimed to be freeze resistant.

<sup>f</sup> The Thermal performance test shall be carried out on a collector that had not been used for other tests.

NOTE Regarding the durability and reliability of elastic materials it is recommended to refer to ISO 9808 and ISO 9553.

## 5.2 Internal pressure tests for absorbers

### 5.2.1 Inorganic absorbers

#### 5.2.1.1 Objective

The absorber shall be pressure-tested to assess the extent to which it can withstand the pressures which it might meet in service.