

# INTERNATIONAL STANDARD

**ISO**  
**9459-2**

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## **Solar heating — Domestic water heating systems —**

### **Part 2:**

Outdoor test methods for system  
performance characterization and yearly  
performance prediction of solar-only systems

*Chauffage solaire — Systèmes de chauffage de l'eau sanitaire —*

*Partie 2: Méthode d'essai en extérieur pour la caractérisation de la  
performance des systèmes "tout solaire" et la prédiction de leur  
performance annuelle*



Reference number  
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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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 9459-2 was prepared by Technical Committee ISO/TC 180, *Solar energy*, Subcommittee SC 4, *Systems — Thermal performance, reliability and durability*.

ISO 9459 consists of the following parts, under the general title *Solar heating — Domestic water heating systems*:

- Part 1: *Performance rating procedure using indoor test methods*
- Part 2: *Outdoor test methods for system performance characterization and yearly performance prediction of solar-only systems*
- Part 3: *Performance test for solar plus supplementary systems*
- Part 4: *System performance characterization by means of component tests and computer simulation*
- Part 5: *System performance characterization by means of whole-system tests and computer simulation*

Annex A forms an integral part of this part of ISO 9459. Annexes B, C and D are for information only.

## Introduction

International Standard ISO 9459 has been developed to help facilitate the international comparison of solar domestic water heating systems. Because a generalized performance model which is applicable to all systems has not yet been developed, it has not been possible to obtain an international consensus for one test method and one standard set of test conditions. It has therefore been decided to promulgate the currently available simple methods while work continues to finalize the more broadly applicable procedures. The advantage of this approach is that each part can proceed on its own.

ISO 9459 is divided into five parts within three broad categories, as described below.

### Rating test

ISO 9459-1:1993, *Solar heating — Domestic water heating systems — Part 1: Performance rating procedure using indoor test methods*, involves testing for periods of one day for a standardized set of reference conditions. The results, therefore, allow systems to be compared under identical solar, ambient and load conditions.

### Black box correlation procedures

ISO 9459-2 is applicable to solar-only systems and solar-preheat systems. The performance test for solar-only systems is a "black box" procedure which produces a family of "input-output" characteristics for a system. The test results may be used directly with daily mean values of local solar irradiation, ambient air temperature and cold water temperature data to predict annual system performance.

ISO 9459-3 applies to solar plus supplementary systems. The performance test is a "black box" procedure which produces coefficients in a correlation equation that can be used with daily mean values of local solar irradiation, ambient air temperature and cold water temperature data to predict annual system performance. The test is limited to predicting annual performance for one load pattern.

### Testing and computer simulation

ISO 9459-4, a procedure for characterizing annual system performance, uses measured component characteristics in the computer simulation program "TRNSYS". Procedures for characterizing the performance of system components other than collectors are also presented in this part of ISO 9459. Procedures for characterizing the performance of collectors are given in other International Standards.

ISO 9459-5 presents a procedure for dynamic testing of complete systems to determine system parameters for use in a computer model. This model may be used with hourly values of local solar irradiation, ambient air temperature and cold water temperature data to predict annual system performance.

The procedures defined in ISO 9459-2, ISO 9459-3, ISO 9459-4 and ISO 9459-5 for predicting yearly performance allow the output of a system to be determined for a range of climatic conditions.

The results of tests performed in accordance with ISO 9459-1 provide a rating for a standard day.

The results of tests performed in accordance with ISO 9459-2 permit performance predictions for a range of system loads and operating conditions, but only for an evening draw-off.

The results of tests performed in accordance with ISO 9459-3 permit annual system performance predictions for one daily load pattern.

The results of tests performed in accordance with ISO 9459-4 or ISO 9459-5 are directly comparable. These procedures permit performance predictions for a range of system loads and operating conditions.

System reliability and safety will be dealt with in ISO 11924:—, *Solar heating — Domestic water heating systems — Test methods for the assessment of reliability and safety*.

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# Solar heating — Domestic water heating systems —

## Part 2:

Outdoor test methods for system performance characterization and yearly performance prediction of solar-only systems

### 1 Scope

This part of ISO 9459 establishes test procedures for characterizing the performance of solar domestic water heating systems operated without auxiliary boosting, and for predicting annual performance in any given climatic and operating conditions, but only for an evening draw-off. A "black box" approach is adopted which involves no assumptions about the type of system under test; the procedures are therefore suitable for testing all types of systems, including forced circulation, thermosiphon, fresh-charged and integrated collector-storage systems.

This part of ISO 9459 is not intended to be used for testing solar heating systems which have an auxiliary heater as an integral part of the system, since the operation of the auxiliary input may influence the performance of the solar heating system. To quantify the interaction between the energy inputs, the test procedure described in ISO 9459-3 is recommended.

This part of ISO 9459 applies to solar-only domestic water heating systems designed to heat potable water to be supplied for domestic water usage and is not intended to be applied to other systems. The test procedures are applicable only to systems of 0,6 m<sup>3</sup> of solar storage capacity or less.

The test procedures in this part of ISO 9459 do not require the solar water heating system to be subjected to freezing conditions. Consequently, the energy consumed or lost by a system while operating in the freeze-protection mode is not determined.

This part of ISO 9459 is not generally applicable to concentrating systems.

It is not intended to be used for testing the individual components of the system, nor is it intended to abridge any safety or health requirements.

### 2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 9459. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 9459 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 9060:1990, *Solar energy — Specification and classification of instruments for measuring hemispherical solar and direct solar radiation*.

ISO 9459-3:—<sup>1)</sup>, *Solar heating — Domestic water heating systems — Part 3: Performance test for solar plus supplementary systems*.

ISO 9846:1993, *Solar energy — Calibration of a pyranometer using a pyrhelimeter*.

ISO 9847:1992, *Solar energy — Calibration of field pyranometers by comparison to a reference pyranometer*.

ISO/TR 9901:1990, *Solar energy — Field pyranometers — Recommended practice for use*.

ISO 11924:—<sup>1)</sup>, *Solar heating — Domestic water heating systems — Test methods for the assessment of reliability and safety*.

World Meteorological Organization, *Guide to Meteorological Instruments and Methods of Observation*, No. 8, 5th edition, WMO, Geneva, 1983, Chapter 9 — World Radiometric Reference, known as the WRR.

### 3 Definitions

As stated in the Introduction, each part of ISO 9459 has been conceived as a self-contained document. Therefore, some of the terms with their definitions given in this clause may also appear in other part(s) of ISO 9459.

For the purposes of this International Standard, the following definitions apply.

**3.1 absorber:** Device within a solar collector for absorbing radiant energy and transferring this energy as heat into a fluid.

**3.2 accuracy:** Ability of an instrument to indicate the true value of the measured physical quantity.

**3.3 ambient air:** Air in the space (either indoors or outdoors) surrounding a thermal energy storage device, a solar collector, or any object being considered.

**3.4 angle of incidence** (of direct solar radiation): Angle between the solar radiation beam and the outward-drawn normal from the plane considered.

NOTE 1 Angle of incidence is often termed "incidence angle" or "incident angle". The use of these terms is deprecated.

**3.5 aperture area:** Maximum projected area through which the unconcentrated solar radiation enters a collector.

**3.6 aperture plane:** Plane at or above the solar collector through which the unconcentrated solar radiation is admitted.

**3.7 auxiliary energy:** See auxiliary (heat) source.

**3.8 auxiliary (heat) source:** Source of heat, other than solar, used to supplement the output provided by the solar energy system.

**3.9 collector:** Device containing an absorber.

**3.10 collector tilt angle:** Angle between the aperture plane of a solar collector and the horizontal plane.

**3.11 components:** Parts of the solar hot water system including collectors, storage, pumps, heat exchanger, controls, etc.

1) To be published.