

Working document of:

SKN Working Group: "In-Situ WG"

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Foreword

The present document defines procedures for In-Situ-Certification. In-Situ-Certification is therewith understood as Solar Keymark certification based on in-situ measurement data collected at the *"manufacturers' premises"*, outside the laboratory at the installed collector (field) under the given operating and installation conditions.

In case of in-situ-tests and measurements it is not possible to be fully in compliance with the requirements of ISO 9806. Some boundary conditions (e.g. installation requirements during performance testing, stability criteria regarding the inlet/outlet temperature, and others) must be adapted to a certain installation. Nevertheless in-situ-testing shall lead to a

comparable set of collector parameters / collector power output like laboratory testing. Hence, to allow in-situ-certification it is necessary to:

- establish a new "Annex O" to the Solar Keymark Scheme Rules, which provides procedures for in-situ-testing.
- make some formal changes within the current Solar Keymark Specific Scheme Rules

Both parts are included in the present document. Section "Annex O" contains differing or additive requirements for performing in-situ-tests/-measurements.

Section "Formal changes" contains all necessary formal changes within the current Solar Keymark Specific Scheme Rules.

Content:

FOREWORD	1
ANNEX O TO THE SOLAR KEYMARK SPECIFIC SCHEME RULES:	4
INTRODUCTION	4
SCOPE.....	5
QUALITY AND FUNCTION TESTING	5
THERMAL PERFORMANCE TESTING	5
<i>Methods</i>	5
<i>Uncertainty determination</i>	5
<i>Fluid heat capacity</i>	5
<i>Collector mounting and location</i>	6
<i>Instrumentation</i>	7
Surrounding air speed	Error! Bookmark not defined.
Solar radiation measurement	7
Measurement of the heat transfer fluid temperature (Liquid heating collectors).....	7
Flow rate measurement (Liquid Heating Collectors).....	8
<i>Test conditions (ISO 9806, Chapter 23.3.2)</i>	8
<i>Test sequences (Chapter 23.4.5)</i>	9
ACCREDITATION REQUIREMENTS	10
FORMAL CHANGES WITHIN THE „SOLAR KEYMARK SPECIFIC SCHEME RULES“	12
SECTION 4.1: REMOTE RANDOM SAMPLING PROCEDURE.....	12
SECTION 7: SUPERVISED MANUFACTURERS’ TESTING	12

Annex O to the Solar Keymark Specific Scheme Rules:

In-Situ Certification / Type testing at the manufacturers' premises / installation site

Introduction

The present document defines procedures for In-Situ-Certification. In-Situ-Certification is therewith understood as Solar Keymark certification based on in-situ measurement data collected at the "manufacturers' premises" , outside the laboratory at the installed collector (field) under the given operating and installation conditions.

A "manufacturers' premises" is herein understood as either the place of production or the operational facility.

At any time of the certification procedure the measurement equipment has to be fully under control of the accredited testing laboratory. The selection, provision, maintenance, calibration and installation of the instrumentation as well as the performance of the measurement, the data storage and data transmission is subjected to the accredited testing laboratory.

"Witness testing" - tests done at the manufacturers' premises by an employer of an accredited testing laboratory in the presence of another person (from manufacture, certifier, ...) - and/or "supervised manufacturers' testing" – tests done at the manufacturers' premises by an employer of the manufacture in the presence of a supervising person from an accredited testing laboratory, are not covered by this document.

In-situ testing must not necessarily be limited to existing applications. It is also imaginable to consider in-situ-testing during the planning and installation of a collector field. Also in-situ

testing is not limited to performance characterization.

Scope

In-situ certification is targeting but not limited to collectors which because of their size, power output, weight, operating conditions or on-site production can hardly be tested in a laboratory.

Quality and function testing

Quality and function testing shall either be done at the field installation and/or in the testing laboratory using an additional collector / collector component. A minimum requirement is that the full set of function tests of EN ISO 9806 is to be reported.

Thermal performance testing

Methods

In-situ thermal performance testing has to be performed using QDT with the equation given in ISO 9806. All parameters have to be initially determined. If a parameter is found to be physically implausible or has a T-Ratio of less than 3, it can be excluded.

Uncertainty determination

Since the boundary conditions during the performance test deviate from the normative requirements an uncertainty determination of the identified parameters is essential and has to be reported in proper manner for each parameter separately.

Fluid heat capacity

Current field measurements / evaluations show that the heat capacity of the heat transfer

fluid (can) have a high impact on the uncertainty of the determined parameters. Also huge deviations between manufacturers' specifications and experimental results regarding the density and the specific heat capacity occurred.

If a heat transfer fluid other than water is used, a sample of the fluid has to be taken and the density and specific heat capacity of the sample have to be determined experimentally in the temperature range required for in-situ testing.

Collector mounting and location

ISO 9806 requires that: „ *The collector shall be mounted such that the lower edge is not less than 0,5 m above the local ground surface.* ” .

This requirement is not applicable for In-Situ-Measurements, as collectors are tested in their real state of installation.

Proposal to add within the SK-Scheme_Rules:

“In case of in-situ-measurements the requirement defined in ISO 9806, section 20.1,“ The collector shall be mounted such that the lower edge is not less than 0,5m above the local ground surface.” is not applicable. The product shall be tested in its usual installation. A remark shall be included into the test report, describing the installation conditions.”

Shadowing

For efficiency testing collectors shall be chosen, that are not affected by shading from surrounding buildings or other obstacles. If this is not possible, measurement sequences including partial shadowing shall be excluded from the evaluation.

Instrumentation

Solar radiation measurement

For concentrating (CR>3) collectors the regulations of ISO 9806 apply without restrictions.

For collectors with a CR<3 the regulations of ISO 9806 apply only for the hemispherical irradiance. The share of diffuse irradiance may also be determined with alternative maintenance-free sensors, e.g. the SPN1 pyranometer from Delta-T-Devices Ltd. The determined diffuse share shall then be applied on the irradiance level determined with the class 1 pyranometer. The usage of other than the normative equipment shall be reported and taken into account for the uncertainty analysis.

The measurement equipment shall be placed at a representative position for the collector(s) under test.

Special attention shall also be paid to the subject of sensor cleaning and maintenance.

Annotation: In a laboratory comparison test on a FPC, the above mentioned combination of class 1 pyranometer for the determination of global irradiance and SPN1 pyranometer for the determination of the diffuse share, has shown very small deviations of 0,003 in $\eta_{0,hemv}$ and 0,01 in K_d . In laboratory as well as in field tests, the usage of the SPN1 pyranometer even for the global irradiance has shown to result in maximum deviations of 0.005-0.02 for η over the complete efficiency curve. The deviations were always to the disadvantage of the collector. The applicability of the SPN1 pyranometer as sole irradiance sensor also for hemispherical irradiance shall be further tested in the future.

Measurement of the heat transfer fluid temperature (Liquid heating collectors)

Placement

To identify parameters that represent the whole set of operating conditions for the field, it

may be necessary to combine measurement data from a number of different collectors in the field into one data set for parameter identification. It is recommended to take into account at least the first (cold) and the last (hot) collector of a row.

Sensor types

Previous results show that only immersion temperature sensors lead to useful results. Comparisons with clamp-on temperature sensors have shown large deviations of up to over 10%-points in the efficiency. Only immersion sensors according to normative requirements shall be used.

Surrounding air speed

Wind Speed shall be measured at each collector of the field which is considered for in the efficiency test.

Flow rate measurement (Liquid Heating Collectors)

There shall be no inflow or outflow between the installation point of the flow sensor and the balanced collectors.

In some cases, the installation of an integrated flow sensor in pre-existing collector fields may be impossible. Ultrasonic clamp-on flow meters may be an alternative. For this kind of sensors, in-depth knowledge of the prevailing flow conditions is crucial to obtain reliable results. The usage of sensors of this sensor type shall only be allowed if a measurement uncertainty of less than 2% can be assured.

Test conditions (ISO 9806, Chapter 23.3.2)

As operating conditions in the field are typically less stable than in the laboratory longer averaging intervals are helpful to find useful measurement sequences. Averaging intervals of 5 minutes are recommended (as in the former EN 12975) and have shown to be suitable in

previous tests.

ISO 9806 requires that: *"The flow rate shall be held stable according to Table 6 (steady-state) or to within ± 2 % (quasi-dynamic) of the set value during each test period and shall not vary by more than ± 5 % of the set value from one test period to another."*

This requirement is not applicable for In-Situ-Measurements, as many installations use flow as control variable for temperature.

Proposal to add within the SK-Scheme-Rules:

"In case of in-situ measurements the limit for the flowrate stability may have to be adapted to the prevailing process conditions to obtain valid measurement sequences. Deviations from the normative requirements shall be mentioned in the test report and must be considered within the uncertainty determination."

Annotation: In previous tests, limits of up to 15% have shown to be acceptable if averaging intervals of 5 minutes are chosen. This value is empirical and its general validity shall be further examined and substantiated in the future.

Test sequences (Chapter 23.4.5)

ISO 9806 requires that: *"The inlet temperature shall be kept stable within ± 1 K during each test sequence."*

This requirement is not applicable for In-Situ-Measurements as feed temperatures are less stable in most installations.

Proposal to add within the SK-Scheme-Rules:

"In case of in-situ measurements the limit for the inlet temperature stability may

have to be adapted to the prevailing process conditions to obtain valid measurement sequences. Deviations from the normative requirements shall be mentioned in the test report and must be considered within the uncertainty determination.

Annotation: In previous tests, limits of up to 3.5K have shown to be acceptable if averaging intervals of 5 minutes are chosen. This value is empirical and its general validity shall be further examined and substantiated in the future.

Determination of IAM

For optically symmetric collectors the values of θ_i shall cover angles where the incidence angle modifier does not differ by more than 2 % from the one at normal incidence up to angles of at least 60°.

The determination of bi-axial IAM values is possible using the iterative method described in Hofer et al., 2015. As for this method it is crucial to provide a sufficient variety of incidence angles in both axes, it is recommended to evaluate the largest and smallest achievable incidence angles at the designated test site beforehand. In each axis angles where the incidence angle modifier does not differ by more than 2 % from the one at normal incidence up to angles of at least 60° shall be covered.

If a sufficient range of incidence angles cannot be provided, the IAM shall be evaluated by analytical means and incorporated in the efficiency test as fix values.

Accreditation Requirements

As the data for a certification process are generated at an external site, the respective

laboratory needs accreditation for doing so. This has to include methodological means to provide data security and uncorrupted data transfer.

References

Hofer A., Buchner D., Heimsath A., Fahr S., Kramer K., Platzer W., Scholl S., 2015. Comparison of Two Different (Quasi-) Dynamic Testing Methods for the Performance Evaluation of a Linear Fresnel Process Heat Collector, Energy Procedia (69) 84-95, ISSN 18766102, URL <http://www.elsevier.com/locate/procedia>.

Formal changes within the „Solar Keymark Specific Scheme Rules “

The following formal changes within the Solar Keymark Specific Scheme Rules are necessary to enable in-situ certification.

Section 4.1: Remote Random Sampling procedure

Currently states: „The test samples for initial type testing are taken out of the current production or from the stock of the manufacturer “

Proposal for Resolution (M...R..)

In case of in-situ measurements the following rules apply:

Case 1: in-situ-tests/-measurements are planned prior the installation of the collector field -> sampling procedure is applicable. The testing laboratory shall randomly select those collectors which are going to be tested within the field and shall define its positions within the field.

Case 2: the field is already installed -> random selection shall be done out of the field by choosing a collector/collector row for installing the measurement equipment.

If neither case 1 nor case 2 are applicable for some reasons (e.g. the field consists of a too small number of collectors), a different solution shall be agreed with the certifier. For example in order to compensate the random selection, more attention can be paid to physical inspection.

Section 7: Supervised manufacturers' testing

Currently states: „Procedures such as "supervised manufacturers' type testing" and/or "type testing at manufacturers' premises" are not included in these scheme rules.

Proposal for Resolution (M...R..)

Supervised manufacturers testing / Testing at the manufacturers' premises

Procedures for "supervised manufacturers' type testing" are not included in these scheme rules. Type testing at the "manufacturers' premises" may be possible if all requirements of Annex O are fulfilled.

A "manufacturers' premises" is herein understood as either the place of production or the operational facility.