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appendix c1 check list for auditors (buildings)

Appendix C1, *Check-list for auditors of candidate registered laboratories (building insulation products)*

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1 General

Laboratory documentation required by the standard(s), available for inspection by the auditor.

Items to be discussed during an audit visit

- Annex 1, *Requirements for a registered laboratory*
- Annex 2, *Example of a table of content for an equipment manual for Guarded hot plate apparatus (according to EN 1946-2)*
- Annex 3, *Example of a table of contents for an equipment manual Heat flow meter apparatus (according to EN 1946-3)*
- Annex 4, *General experience/rules for audits, additional information for candidate registered laboratories and the auditor (Expert group member)*
- Annex 5: *Checklist for HFM equipment of (candidate) registered laboratories*

2 Introduction

This document has two aims:

- to give a check-list to the auditors to be used during an audit visit
- to inform the audited laboratory of the items that will be discussed during an audit visit and of the required documentation that shall be available for examination before an audit

The audit visit by Expert group member will focus on the equipment and testing details

- for thermal conductivity for building insulation products EN 1946-2, and 3 EN 12664, EN 12667, EN 12939, ISO 8301 and ISO 8302.

Documentary evidence of compliance shall be retained by the laboratory for the purposes of auditing.

3 Laboratory documentation required by the standard(s), available for inspection by the auditor

The laboratory is required to have the following documentation according to EN 1946-2, and/or EN 1946-3 for building insulation products and in conformity with EN ISO/IEC 17025.

- Equipment manual

Is not the manual of an external manufacture of the test equipment.

Is made by the laboratory staff.

This manual shall contain (See Annex 2 and 3 of this document):

- equipment performance specifications
- equipment description
- equipment design and uncertainty analysis

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- equipment performance check complete with experimental data
- Calibration and maintenance files
Equipment maintenance and results of calibrations shall be annotated in the calibration and maintenance files.
- Measurement procedures document
The measurement procedures document shall contain all detailed instructions that the operator requires to perform measurements within the stated uncertainty.
- For required information see also the Annex 1 of this document.

The auditor shall be informed before the visit that this documentation will be available for inspection during the audit.

4 Items to be discussed during an audit visit

4.1 Application form and requirements for a registered laboratory

The application form filled in by the audited laboratory and sent previously to the KEYMARK Secretariat will be examined by the auditor.

This application form gives, among others things, some information about the requirements for a registered laboratory indicated in Annex 1 of this document. These requirements will be examined in detail hence it is important to fill in the application form as fully as possible.

The application form and all evidences should be handled within one year.

The following items will be discussed:

- **Accreditation and conformity according EN ISO/IEC 17025:**
 - Accreditation by which body?
 - Accreditation to which standards?
 - Date of last audit and details of non-compliances if any?
 - ...
- **Competence of staff for testing within the KEYMARK scheme**
 - How many years of experience?
 - Comparative testing?
 - Qualifications
 - Evidence of training
 - ...
- ...

4.2 Equipment and testing details

The equipment used for testing within this KEYMARK scheme shall comply with the requirements of the relevant EN standards (e.g. EN 12664, 12667, 12939, EN 1946-2, EN 1946-3)

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The following items will be considered:

– **Validation according to the relevant EN standard(s) and uncertainty analyse(s)**

The equipment manual will be examined with attention to the following items (Annex 2 and/or 3 give examples of possible tables of contents for the equipment manual for GHP and HFM apparatus respectively) and shall include some experimental data:

- Equipment description (some information is available in the application form)
- Equipment performance check

The procedure for the equipment performance check shall be described in detail and shall include experimental data.

- Uncertainty analysis or uncertainty budget
(See Annex 2 and/or 3, HFM see also Annex 5)

Detailed information shall be given of the uncertainty analysis (best measurement capability) leading to an estimate of the measurement uncertainties under different testing conditions

– **Measurement procedures document**

This document shall contain all detailed instructions that the operator requires to perform measurements within the stated uncertainty

- Specimen preparation for testing (demonstrate to handle thin and thick specimens)
- Testing procedures, step-by-step
- Thickness measurement (outside the equipment)
- Test reporting
- Appropriate calibration checks and maintenance actions
- Procedure followed with samples thicker than the capability of the apparatus?
- ...

– **Instrument calibration and status on calibration**

- calibration of temperature sensors, heat flow meters and other relevant elements of the equipment (present example documents)
- Status on calibration?
- Frequency?
- Call up procedure for re-calibrations

– **Proficiency testing**

- Which test was performed and results?

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- Records of these tests and results?
- History of calibration of equipment?
- For a specific test (the auditor can pick up one report from the archive for example), is the staff able to show all results and records?
- Details of inter-laboratory comparisons and level of agreement

– **Witness testing only for thermal conductivity (10 °C)**

- System for sample marking
- Preparation of one specimen for measuring thermal conductivity
- Identification of this specimen
- Steps for measuring this specimen
- Thickness, weight, length measurement, if relevant
- Calculation sheet
- Report
- Checking of results before reporting

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Annex 1: Requirements for registered laboratories

A laboratory shall fulfil the following requirements in order to be accepted by the Expert Group as a registered laboratory:

1. The laboratory shall be accredited against EN ISO/IEC 17025 (EA accreditation). In particular, the laboratory shall be able to demonstrate participation in inter-laboratory comparative testing for thermal conductivity.
2. The laboratory shall be notified within the frame of the CPR for insulation products
3. The laboratory shall have recent experience with test procedures (conditioning, ageing and measuring according to product specifications) according to the specific product standards.
4. The competence of staff and fitness for purpose of the equipment used for testing within the KEYMARK scheme shall comply with the requirements of relevant European standards:
 - For thermal conductivity for building insulation product EN 1946-2, and/or EN 1946-3, EN 12664, EN 12667, EN 12939, ISO 8301 and ISO 8302

Documentary evidence of compliance shall be retained by the laboratory for the purposes of auditing.

5. Measurements shall be carried out with registered test equipment at a mean temperature of 10 ± 0.3 °C for test on insulation product for buildings.
6. Results shall be in agreement with the European levels of conformity requirements as follows:
 - For thermal conductivity for building insulation product $\pm 1.5\%$

This shall be demonstrated by the laboratory's participation in a programme of comparative testing every third year.

NOTE 1 It is recommended to use a Guarded Hot Plate apparatus.

NOTE 2 Where a registered laboratory is contracted by a manufacturer to conduct testing for the manufacturer's own factory production control, the acceptance of that registered laboratory to conduct testing for a Certification Body for the KEYMARK scheme, will be at the discretion of the Certification Body. In such a case the certification body shall inform the Quality Assurance Committee.

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**Annex 2: Example of a table of content for an equipment manual
Guarded hot plate apparatus (according to EN 1946-2)**

1 INTRODUCTION

2 TEST METHOD

3 EQUIPMENT PERFORMANCE SPECIFICATIONS

4 LIMITING VALUES FOR APPARATUS PERFORMANCE

5 EQUIPMENT DESCRIPTION

- 5.1 PRINCIPLE OF OPERATION
- 5.2 TYPE OF APPARATUS
- 5.3 PRINCIPAL DIMENSIONS OF APPARATUS
- 5.4 DIAGRAMS ILLUSTRATING THE DESIGN OF THE EQUIPMENT
- 5.5 POSITION, CONNECTIONS AND NUMBERING OF TEMPERATURE SENSORS
- 5.6 ELECTRICAL COMPONENTS, ENCLOSURE AND MAIN ANCILLARY EQUIPMENT
- 5.7 DATA ACQUISITION SYSTEM AND COMPUTER PROGRAMS

6 EQUIPMENT DESIGN AND UNCERTAINTY ANALYSIS

- 6.1 UNCERTAINTY SOURCES
- 6.2 EDGE HEAT LOSSES AND MAXIMUM SPECIMEN THICKNESS
- 6.3 MAXIMUM GAP WIDTH AND MINIMUM SPECIMEN THICKNESS
- 6.4 IMBALANCE ERROR (systematic uncertainty)
- 6.5 UNCERTAINTY IN MEASURED ELECTRICAL POWER
- 6.6 UNCERTAINTY IN THE DEFINITION OF THE METERING AREA
- 6.7 UNCERTAINTY IN THE TEMPERATURE DIFFERENCE
- 6.8 UNCERTAINTY IN THE MEASUREMENT OF THE SPECIMEN THICKNESS
- 6.9 UNCERTAINTY DUE TO NON-SYMMETRICAL CONDITIONS
- 6.10 UNCERTAINTY DUE TO IMPERFECT CONTACT CONDITIONS WITH RIGID SAMPLES
- 6.11 UNCERTAINTY DUE TO VARIATION OF THERMAL CONDUCTIVITY WITH TEMPERATURE
- 6.12 MAXIMUM PROBABLE UNCERTAINTY (uncertainty budget)

7 EQUIPMENT PERFORMANCE CHECK

- 7.1 FLATNESS
- 7.2 ELECTRICAL CONNECTIONS AND AUTOMATIC CONTROLLERS
- 7.3 TEMPERATURE MEASUREMENTS
- 7.4 IMBALANCE ERROR (systematic uncertainty)
- 7.5 EDGE HEAT LOSSES
- 7.6 EMISSIVITY OF APPARATUS SURFACES
- 7.7 LINEARITY TEST
- 7.8 PROVEN PERFORMANCE CHECK
- 7.9 REPRODUCIBILITY

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Annex 3: Example of a table of contents for an equipment manual
Heat flow meter apparatus (according to EN 1946-3)

1 INTRODUCTION

2 TEST METHOD

3 EQUIPMENT PERFORMANCE SPECIFICATIONS

4 LIMITING VALUES FOR APPARATUS PERFORMANCE

5 EQUIPMENT DESCRIPTION

- 5.1 PRINCIPLE OF OPERATION
- 5.2 TYPE OF APPARATUS
- 5.3 PRINCIPAL DIMENSIONS OF APPARATUS
- 5.4 DIAGRAMS ILLUSTRATING THE DESIGN OF THE EQUIPMENT
- 5.5 POSITION, CONNECTIONS AND NUMBERING OF TEMPERATURE SENSORS
- 5.6 ELECTRICAL COMPONENTS, ENCLOSURE AND MAIN ANCILLARY EQUIPMENT
- 5.7 DATA ACQUISITION SYSTEM AND COMPUTER PROGRAMS

6 EQUIPMENT DESIGN AND UNCERTAINTY ANALYSIS

- 6.1 UNCERTAINTY SOURCES
- 6.2 EDGE HEAT LOSSES AND MAXIMUM SPECIMEN THICKNESS
- 6.3 MINIMUM SPECIMEN THICKNESS
- 6.4 TEMPERATURE UNIFORMITY OF THE HEATING OR COOLING UNIT
- 6.5 UNCERTAINTY IN THE TEMPERATURE DIFFERENCE
- 6.6 UNCERTAINTY IN THE MEASUREMENT OF THE SPECIMEN THICKNESS
- 6.7 ACCURACY OF THE CALIBRATION SPECIMEN
- 6.8 NON-LINEARITY OF THE CALIBRATION
- 6.9 CALIBRATION DRIFTS
- 6.10 UNCERTAINTY DUE TO IMPERFECT CONTACT CONDITIONS WITH RIGID SAMPLES
- 6.11 UNCERTAINTY DUE TO VARIATION OF THERMAL CONDUCTIVITY WITH TEMPERATURE
- 6.12 MAXIMUM PROBABLE UNCERTAINTY (uncertainty budget)

7 EQUIPMENT PERFORMANCE CHECK

- 7.1 FLATNESS
- 7.2 COMPUTING CIRCUITRY, IF APPLICABLE
- 7.3 HEAT FLOW METER ZERO OFFSET, DRIFTS, NON LINEARITY, ETC.
- 7.4 ELECTRICAL CONNECTIONS AND AUTOMATIC CONTROLLERS
- 7.5 TEMPERATURE MEASUREMENTS
- 7.6 EDGE HEAT LOSSES
- 7.7 EMISSIVITY OF APPARATUS SURFACES
- 7.8 LINEARITY TEST
- 7.9 PROVEN PERFORMANCE CHECK
- 7.10 REPRODUCIBILITY

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Annex 4: General experience/rules for audits, additional information for candidate registered laboratories and the auditor

There is a limit to the length of time that discussions with a candidate can continue. Clear time schedules shall be agreed between parties. If no actions are taken by the candidate for more than 6 months after the audit all actions need to be repeated (audit and comparative testing).. The application and the approved audit must be completed in a maximum period of one year. To start the process again a new application should be filled in and forwarded.

An important element for candidates is that the EN ISO/IEC 17025 accreditation shall be in place before a laboratory can apply.

Confidentiality is taken very seriously, and e.g. detailed discussions in the Expert group on the individually candidates will not be in the minutes of the Expert group meetings and will not be discussed with anyone outside the group.

The individual experts are responsible for follow up on actions agreed and at Expert group meetings an item on the agenda will be to report on progress of these actions. The draft minutes of Expert group meetings shall reflect actions to be taken and can be used by auditors when checking updates on the individual candidates.

When a candidate laboratory believes it is ready for the audit and guidance has been given by the auditor, a mutually convenient date will be arranged for the audit to take place.

If laboratories want KEYMARK approval for more than one equipment for each test method, all such equipment shall be subject to comparative testing.

Only identified equipment where the 'known' test specimens and the European Reference Material meets the requirements on the 'European level' can be used for KEYMARK testing. In addition, internal calibration procedures shall be documented and used in all registered laboratories.

In general, the required documentation shall be forwarded to the auditor before the audit. The check list for audits (scheme rules Appendix C1, this document) will be made available to the applicants to help them prepare for the audits.

The basis for the auditing will be that candidate registered laboratories are accredited by an appropriate national body. That work shall not be repeated, but spot checks on technical details related to testing shall be made. Special emphasis shall be given to the EN 1946 technical assessment.

Observations will be made during the audit, and based upon the reporting of the auditor, the Expert group will make their decision. The Expert group secretariat will inform the candidate registered laboratory of the final conclusion.

All communication with the candidate will be handled by the secretariat with full information copied to the Expert group. Full confidentiality is essential here and shall be respected by all Expert group members.

The audit costs are covered by the TIAQ, as defined by the Expert Group.

The format of the audit reports will follow the check list (scheme rules Appendix C1, this document).

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Annex 5: Checklist for HFM (Heat flow meter) equipment of (candidate) registered laboratories

A5.1 Background

A HFM instrument of a (candidate) registered laboratory must normally fulfill all the requirements indicated in standard EN 1946-3. This condition is stated in Appendix B1 of the KEYMARK scheme rules.

However, some of these requirements could be very difficult, or impossible to be realized specially by some laboratories. The reason of this is that some tests and verifications need full access to internal parts of the equipment, and in many cases, this is not possible.

This situation can create difficulties when auditing and assessing candidate registered laboratories.

The present document was elaborated in order to list the EN 1946-3 requirements that must be fulfilled by a HFM apparatus, even when full access inside the instrument is not possible. It represents a set of guidelines to be used when auditing the (candidate) registered laboratories.

These guidelines are following the main principle of EN 1946-3 standard: the laboratory must elaborate an equipment manual including some specific items. The content of the manual is described below and it is very similar to that of EN 1946-3.

A5.2 Equipment performance specification

The range of following parameters shall be indicated:

- specimen thickness;
- specimen thermal resistance;
- temperature difference across the specimen;
- hot and cold plate temperature;
- surrounding environment (temperature, relative humidity) inside the equipment (e.g. air or insulation);
- surrounding environment around the test equipment

A5.3 Equipment description

The following information must be documented:

- principle of operation (see § 1.6 of ISO 8301:1991);
- type of configuration of the apparatus (see § 2.1 of ISO 8301:1991);
- principal dimensions of the apparatus, in particular hot and cold plate width; central heat flow meter area and guard width (if existing); and edge insulation (if relevant)

The other information required in § 4.3 of EN 1946-3:1999 is compulsory.

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A5.4 Equipment design and uncertainty analysis

A5.4.1 Edge heat losses and maximum specimen thickness

The maximum specimen thickness shall be determined according to § 4.4.2 of EN 1946-3:1999.

A5.4.2 Minimum specimen thickness

The minimum specimen thickness shall be determined according to § 4.4.3 of EN 1946-3:1999.

A5.4.3 Temperature uniformity of the hot and the cold plate

The temperature uniformity of the working surfaces of the apparatus shall be checked experimentally as specified in § 4.4.4 of EN 1946-3:1999. A minimum of 5 measuring points (internal or external thermocouples), distributed on the entire surface of each plate, shall be verified.

A5.4.4 Uncertainty in temperature difference between the hot and the cold plate

The uncertainty in measurement of temperature difference shall be checked experimentally and shall not exceed 1% of this difference.

A5.4.5 Uncertainty in measurement of the specimen thickness

This uncertainty shall be checked experimentally according to § 4.4.6 of EN 1946-3:1999.

The requirements of § 4.4.7, § 4.4.8 and § 4.4.9 of EN 1946-3:1999 shall be respected.

A5.4.6 Uncertainty in absolute temperature measurement

Check apparatus temperature sensors against temperature sensors that are calibrated with traceability to national standards.

The above procedure will lead to the establishment of a maximum uncertainty. Alternatively, a detailed calibration can be made and an uncertainty budget established.

A5.5 Calibration of the heat flow meter(s)

The calibration of the heat flow meters shall be done in accordance with § 4.5 of EN 1946-3:1999. Only reference specimens traceable to European Reference Material (IRMM-440 or ERM-FC440) shall be used.

The calibration factor(s) and the calibration curve shall be determined as described in § 2.4 of ISO 8301:1991. The linearity of the calibration curve shall be checked on the entire range of heat flow density that corresponds to the thermal resistance range specified for the apparatus. If different calibration factors are used, then the thermal resistance ranges where they are valid shall be documented.

A5.6 Equipment performance check

A5.6.1 Requirements applicable to each piece of equipment

The equipment performance check shall include:

- planeness (according to § 2.5.1 of ISO 8301:1991);
- heat flow meter(s) zero offset, drifts, non-linearity as described in § 2.5.3 and 2.5.4 of
- ISO 8301:1991;

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- For HFM equipment the number of thermocouples in the metering area can be accepted as being one provided regular checks are being made of the stability and uniformity of the temperature on the hot and the cold plate. The frequency of the checks shall be determined by the individual laboratory based on the evidence of long-term stability. (ISO 8301 requirement is stated as a minimum of two).
- emissivity of apparatus surfaces (see Annex A of EN 1946-3:1999);
- proven performance check (using specimens traceable to European Reference Material (IRMM-440 or ERM-FC440) with known values of thermal conductivity and uncertainty - see below)

Heat flow meter(s) calibration will be checked at least once a week by testing a working sample. If proven very stable the frequency may be reduced. Different thicknesses shall be used as control samples.

A more detailed check, in at least 4 points covering the entire range of thermal resistance, will be done each six months.

If one of these checking fails, first an explanation should be searched in apparatus operation (see A5.4.3, A5.4.4, A5.4.5 and A5.4.6 of this document).

If this is not possible, then the heat flow meter(s) will be re-calibrated according to A5.5.

A5.6.2 Requirements applicable if equipment must perform tests according to EN 12939

Requirements of § 4.6.2 of EN 1946-3:1999 must be fulfilled.

A5.7 Calibration and maintenance files

Calibration files shall be kept as specified in § 5 of EN 1946-3:1999. The maintenance files will be kept only for the equipment components that maybe subject to maintenance operations.

A5.8 Measurement procedure document

The measurement procedure document must be realized in accordance with § 6 of EN 1946-3:1999.

A5.9 Apparatus assessment

Apparatus assessment must be done according to § 7 of EN 1946-3:1999, but taking into account only the items mentioned in A5.4, A5.5 and A5.6 of this annex.