Technical Protocol

for the Bilateral Comparison on

Luminous Responsivity

May 2004

Bilateral Comparison

Luminous Responsivity

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Contents

1. Introduction

1.1 Under the Mutual Recognition Arrangement (MRA) [1] the metrological equivalence of national measurement standards will be determined by a set of key comparisons chosen and organized by the Consultative Committees of the CIPM working closely with the Regional Metrology Organizations (RMOs).

1.2 According to paragraphs T.8 and T.9 of the MRA, a bilateral key comparison is to be carried out between two institutes as outlined in CIPM Guideline for key comparisons [2]. The scheme for performing comparisons within the framework of EUROMET is presented in Euromet Guidelines on Conducting Comparisons [3].

1.3 Luminous responsivity is a key comparison quantity for the Consultative Committee on Photometry and Radiometry (CCPR) of the International Bureau of Weights and Measures (BIPM), linked to the SI base unit for luminous intensity, the candela. The CCPR completed a comparison of luminous responsivity in 1998, subsequently designated CCPR-K3.b.

1.4 On the bases of the referenced documents, it is intended to propose an intercomparison on luminous responsivity to PHORA TC as a EUROMET Bilateral Intercomparison. This intercomparison will be linked to the CIPM key comparison and will provide the result of the measurements and thus record of measurement capabilities in the BIPM database as required by the MRA.

1.5 This technical protocol has been drawn up by the pilot and participating laboratories.

1.6 The procedures outlined in this document cover the technical procedure to be followed during measurement of the transfer standards. This procedure has been prepared following the main procedure applied in the CCPR-K3.b International comparison on luminous responsivity of 2001 [4].

2. Organization

2.1. Participants

2.1.1 The members for this bilateral comparison are; IFA-CSIC / Spain and UME / Turkey.

2.1.2 IFA-CSIC / Spain has been recognised as the pilot laboratory for this comparison following the recommendation depicted in para 10 (a) of CIPM guideline [2].

2.1.3 The participants will demonstrate their traceability to an independent realisation of the quantity, or make clear the route of traceability to the quantity via another named laboratory.

2.1.4 By their declared intention to participate in this bilateral key comparison, the laboratories accept the general instructions and the technical protocols written down in this document and commit themselves to follow the procedures strictly.

1 MRA, Mutual Recognition Arrangement, BIPM, 1999.
2 Guidelines for CIPM key comparisons, 1 March 1999
3 Euromet Guide No.3, Euromet Guidelines on Conducting Comparisons Ver 02.7 (2002)
4 BIPM Report 2001/09 CCPR-K3.b International comparison on luminous responsivity

2.2. Participants' details

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2.3. Form of comparison

2.3.1 The comparison will mainly be carried out through the calibration of 2 photometer heads and 2 filter radiometers. The same type of photometer heads has been used in the CCPR key comparison of luminous responsivity due to their excellent short and long-term stability characteristics.

2.3.2 A description of the transfer standards for use in this comparison is given in section 3 of this protocol.

2.3.3 All detectors are suitably mounted in thermally stabilized housings with LEMO connectors. They have been checked for stability at UME.

2.3.4 All detectors will be supplied by the UME. They will be returned to UME after completion of the comparison.

2.3.5 The bilateral comparison will mainly be carried out in three steps. Initial measurements will be performed by UME before delivery to the IFA-CSIC. The IFA-CSIC will then calibrate the detectors at the illuminance levels required. They will then return the detectors to UME to carry out a repeat calibration.

2.3.6 The timetable on how the comparison is planned is given in the next section.

2.4. Timetable

The timetable for the comparison is presented below:

Activity	**Start Date**
Full protocol agreed by participants	May 2004
Protocol and notification of comparison sent to Euromet Chairman	June 2004
Initial Measurements and sending detectors to IFA-CSIC	May/June 2004
Detectors returned to UME	July 2004
Repeat calibrations at UME	Sept 2004
Draft A	Oct 2004
Comments on Draft A	Nov 2004
Draft B submitted to Euromet	Dec 2004

2.5. Handling of artefacts

2.5.1 The standard detectors should be examined immediately upon receipt by the participants. If a problem is diagnosed upon receipt (or unusual occurrence during operation of the detectors, i.e. change of sensitivity etc) the condition of the detectors and associated packaging should be noted and communicated immadiately to the other laboratory. However, care should be taken to ensure that the detectors have sufficient time to acclimatise to the rooms environment thus preventing any condensation etc.

2.5.2 The detectors should only be handled by authorised persons and stored in such a way as to prevent damage.

2.5.3 No cleaning of any detector filter surfaces should be attempted, except using dry air.

2.5.4 After the measurements, the other participant will be informed via fax or e-mail when the measurement on the detectors are completed to arrange a suitable date for dispatch. The detectors should be repackaged in their original transit cases while ensuring that the content of the package is complete before shipment.

2.6. Transport of artefacts

2.6.1 It is of utmost importance that the artefacts be transported in a manner in which they will not be lost, damaged or handled by unauthorised persons.

2.6.2 Packaging for the artefacts has been made which should be suitably robust to protect the artefacts from being deformed or damaged during transit.

2.6.3 The artefacts are sufficiently robust to be sent by courier. The packages should be marked as 'Fragile'. If the possibility arises to hand-carry the packages this is preferred.

2.6.4 The artefacts will be accompanied by a suitable customs carnet (where appropriate) or documentation identifying the items uniquely. The packaging will be lockable e.g. by clasp, but is easy to open with minimum delay to allow customs inspections to take place.

2.6.5 Transportation is at each laboratory's responsibility and cost. Each participating laboratory covers the costs for its own measurements, transportation and any customs charges as well as for any damages that may have occurred within its country.

3. Description of the standards

3.1. Artefacts

3.1.1 Both photometer heads are manufactured by PRC. The filter radiometers are V(λ) filtered and thermally stabilized home made Filter-Radiometers.

ITEM	Manufacturer	Type	Serial No.
Photometer Head	PRC Krochmann Germany	TH15BA, V(λ)-Si	970133-9704
Photometer Head	PRC Krochmann Germany	TH15BA, V(λ)-Si	941114-V
Filter Radiometer	UME Turkey	FR	25.0-1
Filter Radiometer	UME Turkey	FR	25.0-2

3.1.2 The detectors are mechanically robust but sensitive to dust and pollution. When not used they must always be stored in their original boxes they have been sent in. Dust-free clean air can be used to remove any apparent dust particle by gently blowing onto the detector.

3.1.3 The detector housings are shown in the figure below. Each detector is fitted with a LEMO connector.

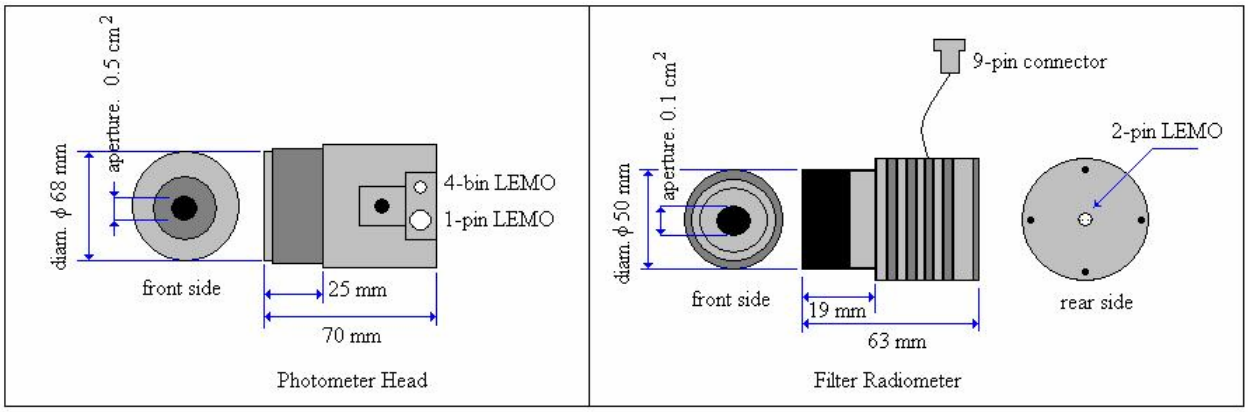

Figure 1. Dimensions of the transfer detectors

4. Measurement instructions

4.1. Traceability

4.1.1 Temperature measurements should be made using the International Temperature Scale of 1990 (ITS-90).

4.1.2 Electrical measurements should be independently traceable to the latest realisation of the Ampere and Volt.

4.2. *Measurand*

4.2.1 The measurand is the luminous responsivity of a detector, i.e. its responsivity in the units of nA/lux, for a CIE-A type illuminant source operating at a color temperature of 2856 K. The light must be perpendicular and centred onto the surface of the detectors while overfilling its sensitive area. The measurements should be performed in suitable laboratory conditions maintained at a temperature as close as possible to 23 °C. The exact temperature of the laboratory during the time of the measurements must be reported.

4.2.2 Each independent measurement should consist of the detector being realigned in the measurement facility. It should be noted that each independent measurement may consist of more than one set of measurements, the exact number should be that normally used by the participating laboratory to obtain the appropriate accuracy as limited by the noise characteristics of their specific measurement facility. The exact number of measurements used should be stated in the measurement report but only the mean or final declared value of the set is required to be included.

4.3. Measurement instructions

The measurement instructions must be the same as in the CCPR. K3b.

4.3.1 Before aligning the detectors they should be inspected for damage or contamination. Any damage should be documented and communicated to the UME.

4.3.2 The operational conditions for each detector should be followed according to the details described in section 6 of this document.

4.3.3 After alignment and before starting measurements, sufficient time of 12 to 15 minutes should be allowed to let the detectors reach thermal equilibrium.

4.3.4 The luminous responsivity of the transfer standards should then be measured at a 4 m distance from the filament of the lamp operating at 2856 K, thus at an illuminance level of around 16 lux.

4.3.5 No other measurements are to be attempted by the participants nor any modification to the operating conditions during the course of this comparison. The transfer standards used in this comparison should not be used for any purpose other than described in this document nor given to any party other than the participants in the comparison.

5. Reporting of results

5.1 On completion of the measurements by the participating laboratory the provisional results of these measurements should be sent to the pilot laboratory with the transfer detectors.

5.2 As soon as possible the final results should be communicated to the pilot laboratory and at the latest within six weeks.

5.3 The report on the calibrations must include a description of the participants measurement facility. It would be useful for a schematic diagram of the facility to be included

5.4 The report on the calibrations must contain a comprehensive uncertainty budget, comprising all the contributions to the total uncertainty. The uncertainty of measurements shall be estimated according to the *ISO Guide to the Expression of Uncertainty in Measurements*.

5.5 A short but a descriptive explanation on how the luminous responsivity is realized should be given by participating laboratories. Uncertainty contributions from main sources must also be tabulated in the form of an uncertainty budget.

5.6 The measurement reports will be sent to pilot laboratory by fax or e-mail.

5.7 Following receipt of both measurement reports from the participating laboratory, the pilot laboratory will analyse the results and prepare a first draft report on the comparison. This will be circulated to the participant for comments, additions and

corrections. Subsequently, the procedure outlined in the EUROMET Guidelines will be followed.

6. Operation Conditions for detectors

6.1. **Photometer Heads:** Each photometer has two connection sockets; the large 1-pin LEMO one to be used for measurement of signal and the small 4-pin LEMO socket to control the temperature inside the reservoir. Using these two cables, each photometer is connected to the photocurrentmeter (PRC 321, Photostrommeter) device and readings are made using its LED display.

6.2. **Filter-Radiometers:** Each filter-radiometer has two connection sockets, which are used for measurement of signal (2-pin LEMO) and to control the temperature inside the reservoir (9-pin). Signal from the detector is measured using a DMM via LEMO-to-BNC cable. Using 9-pin socket, filter radiometer is attached to the temperature control unit.

6.3. Interior temperature of filter radiometer housings must be set to 25°C using UME made temperature control unit (SK01). The process for the setting of temperature is described below:

- 9-pin socket from the filter-radiometer is installed to the back socket of the temperature control unit.
- For operation, the MAIN switch at the rear of the control unit is pressed to “ON”.
- The front SET switch is pressed down. While holding it at the down position, temperature is set to desired temperature (i.e.25°C) using the ADJUST turn screw. The adjusted temperature is shown on the LED display. After adjustment, SET switch is brought to the normal position. In this position, LED display shows the current temperature.
- A final adjustment and repeat of the step-3 may be required before the measurements for the stabilization in the desired temperature range.