



# fiducial reference measurements for satellite ocean colour

## FRM4SOC Laboratory Calibration Exercise 1 (LCE-1): Verification of Reference Irradiance and Radiance Sources

### D-90: Implementation Plan for LCE-1 (LCE-1-IP)

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## APPLICABLE DOCUMENTS

Ref. No.	Version / Issue	Document Title
1-8500 SoW	1	Fiducial Reference Measurements for Satellite Ocean Colour (FRM4SOC) Statement of Work (SOW)



## ACRONYMS AND ABBREVIATIONS

AC	Alternating Current
ANSI	American National Standards Institute
CEOS	Committee on Earth Observation Satellites
FRM	Fiducial Reference Measurements
IR	Infra-Red
ISO	International Organization for Standardization
JRC	Joint Research Centre
LCE	Laboratory Calibration Exercise
NMI	National Metrology Institute
NPL	National Physical Laboratory
OCR	Ocean Colour Radiometry
RefSpec	Reference Spectroradiometer System
SI	Système Internationale
SRIPS	Spectral Radiance and Irradiance Primary Scales facility
TO	Tartu Observatory
TR	Technical Report
V	Volts
W	Watt
WGCV	Working Group for Calibration and Validation



## 1 INTRODUCTION

The main aim of FRM4SOC is to establish and maintain SI traceability of ground-based Fiducial Reference Measurements (FRM) for satellite ocean colour radiometry (OCR). Specifically the project will develop, document, implement and report OCR measurement procedures and protocols. It will design, document and implement both laboratory and field inter-comparison experiments for FRM OCR radiometers to verify their FRM status. Furthermore, FRM4SOC will undertake international coordination activities to define the next generation of Ocean Colour 'system' vicarious calibration/adjustment infrastructure.

## 2 OBJECTIVES

The Laboratory Calibration Exercise 1: Reference Irradiance and Radiance Sources (LCE-1) is aimed at verifying the performance of irradiance and radiance sources used to calibrate ocean colour radiometers (OCRs). It therefore acts as the SI-traceable basis for all FRM4SOC activities and will establish and document protocols and best practice for the inter-comparisons based on approaches used at National Metrology Institutes (NMI).

## 3 ORGANIZATION

### 3.1 PILOT

LCE-1 will be implemented at NPL as a laboratory inter-comparison of the irradiance sources from as many OCR calibration labs as possible and through a round-robin inter-comparison of each participants radiance sources using transfer radiometers. NPL, the UK national metrology institute (NMI) will serve as pilot for these comparisons supported by Tartu, the coordinator of FRM4SOC. NPL, the pilot, will be responsible for inviting participants, circulating the transfer radiometers and for the analysis of data, following appropriate processing by individual participants. NPL, as pilot, will be the only organisation to have access and to view all data from all participants. This data will remain confidential to the participant and NPL at all times, until the publication of the report showing results of the comparison to participants.

### 3.2 PARTICIPANTS

The list of the potential participants, based on current contacts and expectation who will be likely to take part is given in the Section 3.3. Dates for the comparison activities are provided in Section 3.6. A full invitation to the international community will be made through CEOS WGCV and other relevant bodies and will be carried out to ensure full opportunity and encouragement is provided to all. All participants should be able to demonstrate independent traceability to SI of irradiance and radiance sources that they use, or make clear the route of traceability via another named laboratory. Where required, demonstrable traceability to SI will be obtained through the participation of NPL as the pilot.

By their declared intention to participate in this key comparison, the participants accept the general instructions and the technical protocols provided by this document and TR-3 (see SOW) and commit themselves to follow the procedures strictly.

Once the protocol (described in TR-3) and list of participants have been reviewed and agreed, no change to the protocol may be made without prior agreement of all participants.



## PARTICIPANTS' DETAILS

NB: This is not the full list as the international invitation has not been released yet.

**Table 1. Participants' Contact Details**

Contact Person	Short Version	Institute	Contact Details
Andrew Banks	NPL	National Physical Laboratory, UK	<a href="mailto:andrew.banks@npl.co.uk">andrew.banks@npl.co.uk</a> ; +44 (0)20 8943 6081
Riho Vendt	TO	Tartu Observatory, Estonia	<a href="mailto:riho.vendt@to.ee">riho.vendt@to.ee</a> +37 2696 2511
Giuseppe Zibordi	JRC	European Commission – DG Joint Research Centre	<a href="mailto:giuseppe.zibordi@jrc.ec.europa.eu">giuseppe.zibordi@jrc.ec.europa.eu</a> +39 0332 785902
Vincenzo Vellucci	LOV	Laboratoire d'Océanographie de Villefranche, France	<a href="mailto:enzo@obs-vlfr.fr">enzo@obs-vlfr.fr</a>
Rudiger Heuermann	TRIOS	TRIOS, Germany	<a href="mailto:heuermann@trios.de">heuermann@trios.de</a>
Ronnie Van Dommelen	Satlantic	Satlantic, Canada Sea Bird Scientific	<a href="mailto:ronnie@satlantic.com">ronnie@satlantic.com</a>
John Morrow	Biospherical	Biospherical Instruments Inc., US	<a href="mailto:morrow@biospherical.com">morrow@biospherical.com</a>
Stéphane Victori	Cimel	Cimel Electronique S.A.S, France	<a href="mailto:s-victori@cimel.fr">s-victori@cimel.fr</a>





### 3.3 OVERVIEW OF THE FORM OF COMPARISONS (SEE TR-3 FOR A FULL AND DETAILED DESCRIPTION OF PROTOCOLS AND PROCEDURES TO BE FOLLOWED)

LCE-1 covers two comparisons. Each comparison will have its own specific characteristics but will both in principle take the same form i.e. they will all seek to observe a common entity. In the case of the participant irradiance source comparison, traceability to SI will be established through the direct comparison against the NPL reference standard. At NPL the Spectral Radiance and Irradiance Primary Scales (Woolliams et al, 2006) facility is used to transfer the scale from the NPL primary reference standard, a high temperature blackbody, to lamp and integrating sphere sources. These sources are then used as secondary spectral radiance and irradiance standards further down the chain. The spectral radiance of the blackbody is derived from knowledge of its temperature and Planck's law. The temperature is measured by a filter radiometer that has been calibrated in terms of its spectral radiance using a trap detector (a photodiode based standard or spectral responsivity). The trap detector being calibrated against the overall primary standard a cryogenic radiometer, which underpins the SI traceability of all of NPL's optical radiation measurements...

The radiance comparison will involve transfer radiometers that will be absolutely calibrated at NPL against a reference radiance source. The absolutely calibrated transfer radiometers will then be sent to each participant to perform radiance measurements using in house facilities and thus the SI traceability chain from the NPL scale will be extended to these radiometers and via the radiometer to each participant laboratory.

The inter-comparisons will be carried out to the highest possible SI-traceable standards with full uncertainty characterisation using the NPL state of the art radiometric laboratories. FRM4SOC LCE-1 will use the NPL Spectral Radiance and Irradiance Primary Scales (SRIPS) facility & Reference Spectroradiometer System (RefSpec).

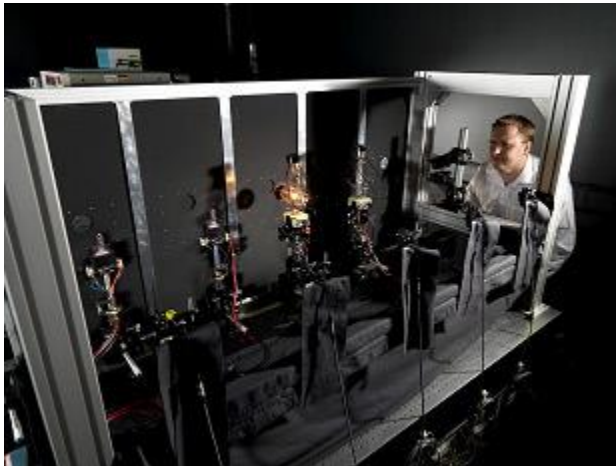
### 3.4 COMPARISON OVERVIEW

The laboratory calibration comparison exercise consists of two separate comparisons. The following sections outline the principle scope of each comparison.

#### 3.4.1 Comparison 1: Irradiance

In this comparison 1000 W lamps, so called FEL lamps according to ANSI (American National Standard Institute) designation, are considered as irradiance sources and will be used at the standard calibration distance of 500 mm measured from their reference plane. Having confirmed a list of participants, a review of their lamps will be performed, including information about in house power supplies, their most recent calibration certificates and number of burn out hours since the last calibration. For example, there are different types of mounts for 1000 W FEL lamps and these have different alignment procedures. It is also important to determine which types and which alignment procedures participants use. The stability and accuracy of each individual participant's power supply will also be important following the LCE-1 inter-comparisons when a verified irradiance source will go back to their home lab and be used as a working standard there. In addition the review will allow the preparation of the laboratory at NPL sufficiently in advance of LCE-1 to accommodate all identified lamps during the inter-comparison exercise. Training in absolute radiometric calibration and uncertainty evaluation will be given by NPL.

NPL will recommend hand carrying lamps to and from LCE-1 where participants are able to attend in person. This does not preclude remote participation, although it is possible that a lamp can change during transportation and therefore, if possible, 3 lamps from each participant should be transported with an appropriate means to and from the comparison.



**Figure 1. SRIPS/RefSpec in action**

For the irradiance source intercomparisons all FEL lamps submitted to the LCE-1 exercise will be measured at NPL against NPL primary standards. The participants will be shown the NPL Spectral Radiance and Irradiance Primary Scales (SRIPS) facility (please see below) and this will include training on the alignment process. The actual measurements of each of the participant's irradiance sources will then be run on SRIPS. As a result of this comparison, irradiance values will be obtained from each lamp as measured under the carefully controlled conditions of SRIPS at NPL and these will be compared with their certificate values.

If participants wish to take advantage of the calibration/comparison process and formally update the certification of their lamps this will be made possible. However, due to the additional activities that need to take place as part of the NPL formal quality management system this will require an additional fee to obtain a calibration certification.



SRIPS will be the main facility used at NPL for LCE-1 of FRM4SOC. It is based around a double grating monochromator that defines the wavelength for the comparison. In front of this monochromator input optics collect the light and, after the monochromator, detectors measure that light. Figure 2 presents a schematic diagram of the SRIPS. The monochromator is operated in turn with each of three different gratings and there are four different detectors used to cover the full spectral region. Lamps are usually calibrated directly against the UHTBB (ultra-high temperature black body or against another standard lamp or source if required).

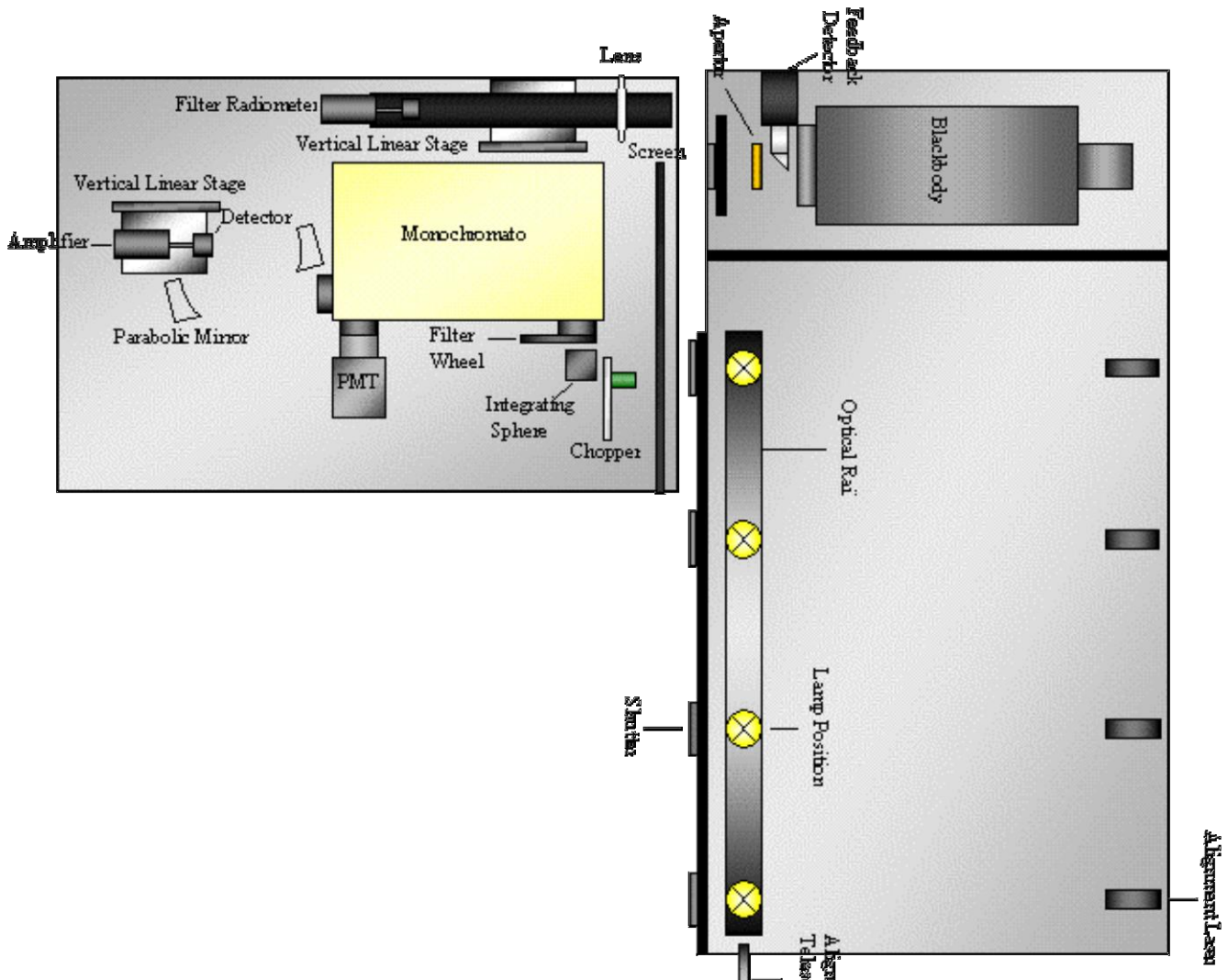


Figure 2. Diagram of the NPL SRIPS facility layout

### 3.4.2 Comparison 2: Radiance

For this comparison radiance sources are considered as an FEL lamp and a reference reflectance panel (such as Spectralon) set. If any of the participants want to use other radiance sources they need to discuss further details individually with the pilot. Following the irradiance and power supply review, similar information on the partners' radiance source set ups (e.g. shield position and laboratory stray light estimation) will be detailed by each participant and supplied to the pilot prior to LCE-1.

The second active phase of LCE-1 concerns the inter-comparison of radiance sources for OCRs. As a radiance source is formed by combining an FEL lamp and a diffuser panel, comparing several reflectance panels using one lamp provides only a partial solution for the comparisons. The most



appropriate method for carrying out a complete radiance source comparison between labs is using an NPL fully characterised transfer radiometer. This will involve an NPL calibrated transfer radiometer sent back and forth in turn to each participant to perform radiance measurements. The transfer radiometer in this configuration will be used to compare the participant's in-house radiance sources with the NPL derived radiance scale. As NPL do not own an OCR we have arranged with an external collaborator (JRC) to use two of their stable OC filter radiometers as the transfer radiometers for the radiance source comparisons.

### 3.5 TIMETABLE

There are three main phases to the comparison activity, shown in Table 2. The first phase prepares for the measurements; the second phase is the measurements themselves and the third phase the analysis and report writing.

**Table 2. Comparison activity- Phases**

<b>PHASE 1: PREPARATION</b>	
Release of international invitation to participate	October, 2016
Preparation and formal agreement of protocol	September to December, 2016
Participants send details of their irradiance sources and radiance measurement setup in their calibration labs to pilot	December, 2016 to March 2017
Receipt of transfer radiometers at NPL and their preparation for use in LCE-1	December, 2016 to March 2017
<b>PHASE 2: MEASUREMENTS &amp; TRAINING</b>	
Comparison of participant's irradiance sources & LCE-1 training	April 03-07, 2017
Circulation of transfer radiometers and comparison of participants radiance sources	April 2017 to December, 2017
<b>PHASE 3: ANALYSIS AND REPORTS</b>	
Pilot sends quality checked irradiance calibration data to individual participants and begins process of data base compilation and inter-comparison analysis	May, 2017
Participants send preliminary report of radiance measurements and uncertainty to pilot	April, 2017 to December, 2017
Draft A (results circulated to participants)	May, 2018
Final draft report circulated to participants	June, 2018
Draft B submitted to CEOS WGCV	July, 2018
Final Report published	August, 2018

Table 3 below shows the top-level plan for the comparison activity. The first week starting on Monday 3rd April 2017 has been allocated to laboratory measurements of the participants' irradiance sources on the NPL SRIPS/RefSpec facility. These measurements are expected to last all of that week and may possibly need some of the following week. It is not necessary for participants to be present during the measurements but nevertheless each participant will have the opportunity of hands-on experience of SRIPS/RefSpec and of the SI-traceable measurement and calibration of their irradiance sources. Furthermore, every effort will be made to finish the irradiance measurements by Friday 07 April 2017 to allow participants to be able to hand-carry their irradiance sources back to their respective laboratories.

The other days of the week of the irradiance source measurements have been allocated to training in uncertainty and absolute radiometric calibration. Particular attention will be paid to training that ensures that each participant follows the same methodology in radiance source measurement and evaluation of uncertainty at each stage of that process, in preparation for receipt of the transfer radiometers from NPL and the appropriate measurements at their home laboratories.



**Table 3. Comparison Activity- Plan**

Activity No.	Start Date	End Date	Experiment/Training	Venue
1a	03 April 2017	07 April 2017	LCE-1 Intercomparison of OCR Irradiance Sources	NPL
1b	04 April 2017	04 April 2017	Uncertainty in measurement training	NPL
1c	05 April 2017	06 April 2017	Absolute radiometric calibration with uncertainty training	NPL
1d	05 April 2017	06 April 2017	Cryogenic Radiometer and SRIPS/RefSpec Lab Tour	NPL
2	17 April 2017	31 December 2017?	Circulation of transfer radiometers and LCE-1 round-robin intercomparison of participants radiance sources	LCE-1 Participants Laboratories

### 3.6 TRANSPORTATION OF INSTRUMENTATION

It is the responsibility of all participants to ensure that any instrumentation required by them is shipped with sufficient time to clear any customs requirements of the host country, in this case the UK. This includes transportation from any port of entry to the site of the comparison and any delay could result in them being excluded from the comparison. For this part of the comparison, participants should send their equipment to:

Dr. Andrew Clive Banks  
Room F4-A10  
National Physical Laboratory (NPL)  
Hampton Road  
Teddington  
Middlesex  
UK  
TW11 0LW

Any queries can be directed to Andrew on [andrew.banks@npl.co.uk](mailto:andrew.banks@npl.co.uk) or by phone on +44 (0)20 8943 6081. As is stipulated on the application / expression of interest form for LCE-1, it is not obligatory for participants to be present at the comparisons and any form of irradiance source that is used for OCR calibration is acceptable.

However, **IT IS HIGHLY RECOMMENDED THAT, WHERE POSSIBLE, IRRADIANCE SOURCES ARE HAND CARRIED** to and from the comparisons to avoid the risk of damage. Please note that the coordinator and host laboratory have no insurance for any loss or damage of the equipment during transportation or whilst in use during the comparison, however all reasonable efforts will be made to aid participants in any security. Equipment that is sent to NPL will be stored until Monday 03 April 2017, when their owners can unpack them and assemble them for the lab comparisons.

Irradiance source power supplies are not needed as SRIPS/RefSpec has a carefully controlled and monitored power supply for the measurements. Nevertheless, electrical power (220 V AC) will be available to all participants, with a local UK plug fitting for the duration of the comparisons at NPL. Participants whose equipment require 110 V AC supplies should provide their own transformers. The area of NPL where participants will be located for the comparisons and training offers Wi-Fi reception.





Participants can stay in a number of hotels located around NPL during the duration of this Workshop. A list of local hotels is provided in Appendix 1.

All subsistence and hotel costs will be at the expense of the participants. Participants can have lunch at the NPL main restaurant during the week of LCE-1. A selection of hot dishes, as well as salads and sandwiches are available throughout the day. Free tea and coffee will be available to all participants throughout the day. A wide choice of food and restaurants can also be found in Teddington town centre, a short walk from NPL.

Please note that visitors to the UK from some countries require entry visas. Please check and if you are coming from such a country, you should apply for the visa well ahead of the start of LCE-1. You may require supporting documents for your visa application. Please contact the UK Embassy/Visa facilitation centre in your country to find out what you require for your visa application. Alternatively you can find more information and potentially apply for a UK visa on <https://www.gov.uk/apply-uk-visa>. If you require supporting documents or invitation to LCE-1, please contact Andrew Banks at NPL (see details above) stating what documents you require. Please note that the Visa processing time may vary depending on your country of application, so please allow sufficient time for the application to be processed.

### 3.7 FLIGHTS TO THE UK & DIRECTIONS TO NPL

Heathrow airport is the nearest airport to NPL, being about 10 miles away. There is good public transport linking Heathrow airport and NPL. For example, No 285 bus starts from Heathrow Central Bus Station and passes outside the NPL main reception. The X26 bus provides a faster service from Heathrow airport but stops in Broad Street in Teddington, a five minute walk from NPL. Taxis can be used but they are expensive (about £50). It is cheaper to book a minicab to collect you from Heathrow and bring you to NPL or to your chosen hotel. The cost of a minicab to take you from Heathrow airport to Teddington would be around £25.

Flights are also available to other UK airports but the only other airport which could be considered is Gatwick airport, being some 35 miles away from NPL. However, public transport from Gatwick airport is not as good as from Heathrow. Visitors have to travel from Gatwick airport to Teddington by train, via Clapham Junction. This takes longer, it is more complicated and it is more expensive. A minicab can be booked to bring you to Teddington but the costs is likely to be just over £50.

You can find directions to NPL for different modes of transport (car, train etc.) on the NPL website: <http://www.npl.co.uk/location> . A map of the area around NPL can be found on <http://www.npl.co.uk/upload/pdf/npl-map-col.pdf> .

### 3.8 OTHER INFORMATION

Three months prior to the start of the comparison, participants will be required to supply to the pilot a description of the instrumentation that they will bring to the comparison. This will include any specific operational characteristics where heights/mountings may be critical as well as a full description of its characterisation, traceability and associated uncertainties. These uncertainties will be reviewed by NPL for consistency and circulated to all participants for comment and peer review. Submitted uncertainty budgets can be revised as part of this review process but only in the direction to increase the estimate in light of any comments.



#### 4 REFERENCES

BIPM, IEC, IFCC, ISO, IUPAC, IUPAP and OIML, 1995. *Guide to the Expression of Uncertainty in Measurement* (Geneva, Switzerland: International Organisation for Standardisation).

Goodman, T., Servantes, W., Woolliams, E., Sperfield, P., Simionescu, M., Blattner, P., Källberg, S., Khlevnoy, B., Dekker, P., 2015. *Final Report on the EURAMET.PR-K1.a-2009 Comparison of Spectral Irradiance 250 nm - 2500 nm* (NPL Report OP12, NPL, Teddington, UK).

JCGM, 2008a. *Evaluation of measurement data – Guide to the expression of uncertainty in measurement - GUM 1995 with minor corrections* (Joint Committee for Guides in Metrology (JCGM), [http://www.bipm.org/utis/common/documents/jcgm/JCGM\\_100\\_2008\\_E.pdf](http://www.bipm.org/utis/common/documents/jcgm/JCGM_100_2008_E.pdf) ).

JCGM, 2008b. *Evaluation of measurement data – Supplement 1 to the “Guide to the expression of uncertainty in measurement” – Propagation of distributions using a Monte Carlo method* (JCGM, [http://www.bipm.org/utis/common/documents/jcgm/JCGM\\_101\\_2008\\_E.pdf](http://www.bipm.org/utis/common/documents/jcgm/JCGM_101_2008_E.pdf) )

Woolliams, E.R., Fox, N.P., Cox, M.G., Harris, P.M. and Harrison, N.J., 2006. Final report on CCPR K1-a: Spectral Irradiance from 250 nm to 2500 nm, *Metrologia* 43 (1A Tech. Suppl.), (2006) S98-S104



## APPENDIX 1

### HOTELS AROUND NPL

HOTEL	COMMENTS / FACILITIES
<p><b>The Park Hotel</b> Park Road Teddington TW11 0AB T: 0843 357 5516</p>	<ul style="list-style-type: none"> <li>• 10 minute walk from NPL, close to Teddington railway station</li> <li>• Corporate rates: Standard Room (single occupancy): £107 Standard Double Room (double occupancy): £117</li> <li>• 43 standard bedrooms</li> <li>• 8 family rooms</li> <li>• Disabled bedrooms</li> <li>• Restaurant and bar facilities</li> </ul>
<p>NB: <b>The Park Hotel</b> has a corporate rate for NPL customers for which 'National Physical Laboratory' needs to be quoted when booking</p>	
<p><b>The Lensbury</b> Broom Road Teddington TW11 9NU Tel: 020 8614 6444 Email: accommodation@lensbury.com</p>	<ul style="list-style-type: none"> <li>• Early booking advised</li> <li>• Corporate rates: Standard Room (single occupancy): £135 Standard Double Room (double occupancy): £160</li> <li>• All rates are per room per night, inclusive of VAT, breakfast, use of leisure facilities, free Wi-Fi and shuttle bus* to and from Teddington railway station (NPL Reception is approx. 10 minutes' walk from the station)</li> </ul> <p>(* Check with Lensbury Reception for bus timings)</p>
<p>NB: <b>The Lensbury</b> has a corporate rate for NPL customers for which 'National Physical Laboratory' needs to be quoted when booking</p>	
<p><b>Travelodge Teddington</b> Park House Station Road Teddington TW11 9AD Tel: 0871 984 6231</p>	<ul style="list-style-type: none"> <li>• 10 minute walk from NPL</li> <li>• Close to Teddington railway station</li> <li>• Bar   café</li> <li>• Wi-Fi facilities</li> </ul>
<p><b>Travelodge Sunbury</b> Hanworth Road Sunbury on Thames TW16 5DJ Tel: 0871 984 6356</p>	<ul style="list-style-type: none"> <li>• 5 miles from NPL (appx. 20 mins drive by car)</li> <li>• Situated close to the M3 motorway</li> <li>• Bar   café</li> <li>• Wi-Fi facilities</li> </ul>
<p><b>Travelodge Kingston</b> 21-23 London Road Kingston upon Thames</p>	<ul style="list-style-type: none"> <li>• 15 minute taxi ride to NPL</li> <li>• 2 minute walk to Kingston railway station</li> <li>• 72 rooms (36 doubles and 36 family rooms)</li> </ul>





KT2 6ND	
<b>Travelodge Feltham</b> Res Centre High Street Feltham TW13 4EX	<ul style="list-style-type: none"> <li>• 20 minute taxi ride (approx 6 miles) to NPL</li> </ul>
<b>Chase Lodge Hotel</b> 10 Park Road Hampton Wick Kingston upon Thames KT1 4AS	<ul style="list-style-type: none"> <li>• Located at the edge of Bushy Park</li> <li>• 20 minutes walk through the park to NPL and 5 minutes walk from Hampton Wick railway station</li> <li>• 12 bedrooms</li> <li>• Restaurant</li> </ul>
<b>The White Hart Hotel</b> 1 High Street Hampton Wick Kingston upon Thames KT1 4DA	<ul style="list-style-type: none"> <li>• Situated at the foot of Kingston Bridge</li> <li>• 5 minute taxi ride to NPL and 10-minute walk to Hampton Wick and Kingston railway stations</li> <li>• 37 bedrooms</li> <li>• Restaurant and bar facilities (also open to the public)</li> </ul>
<b>Carlton Mitre Hotel</b> Hampton Court Road Hampton Court KT8 9BN Tel: 020 8783 3505 Email: <a href="mailto:resmitre@carltonhotels.co.uk">resmitre@carltonhotels.co.uk</a>	<ul style="list-style-type: none"> <li>• Located 3 miles from NPL (10 minute taxi ride through Bushy Park) - historic location opposite Hampton Court Palace and located directly on the River Thames</li> <li>• Corporate rate: Standard room (single occupancy): £107.50 Standard double room (double occupancy): £127.50</li> <li>• 36 bedrooms   wireless internet facilities   restaurant and bar facilities   coffee lounge</li> </ul>
NB: <b>Carlton Mitre Hotel</b> has a corporate rate for NPL customers for which 'National Physical Laboratory' needs to be quoted when booking	
<b>The Alexander Pope Hotel</b> Cross Deep Twickenham TW1 4RB	<ul style="list-style-type: none"> <li>• 5 minute taxi ride to NPL</li> <li>• Bus routes to Teddington High Street</li> </ul>
<b>Premier Inn Twickenham East</b> Corner Sixth Cross Road / Staines Road Twickenham TW2 5PE	<ul style="list-style-type: none"> <li>• 5 minute taxi ride to NPL</li> <li>• Carvery restaurant and bar facilities in Beefeater Grill next door (The Fountain)</li> </ul>
<b>Premier Inn Twickenham Stadium</b>	<ul style="list-style-type: none"> <li>• 10 minute taxi ride to NPL</li> </ul>



Chertsey Road (A316) Whitton TW2 6LS	<ul style="list-style-type: none"><li>• 31 bedrooms</li><li>• Carvery restaurant and bar facilities in pub next door (The Winning Post)</li></ul>
<b>Antoinette Hotel</b> 26 Beaufort Road Kingston upon Thames KT1 2TQ	<ul style="list-style-type: none"><li>• 15 minute taxi ride to NPL   10 minute walk to Surbiton railway station   20 minute walk to Kingston railway station</li><li>• 100 bedrooms</li><li>• Private garden</li><li>• Restaurant and bar facilities</li><li>• Private function / meeting rooms</li></ul>
<b>Firs Guest House</b> 41 Hampton Road Teddington TW11 0LA Tel: 020 8977 6551	<ul style="list-style-type: none"><li>• 10 minute walk from NPL</li><li>• Basic family-run guest house</li></ul>
<b>Holiday Inn – Shepperton</b> Felix Lane Shepperton TW17 8NP	<ul style="list-style-type: none"><li>• 30 minute taxi ride to NPL</li><li>• 185 bedrooms</li><li>• Leisure facilities (pool, gym, sauna)</li><li>• Restaurant and bar facilities</li><li>• Free parking</li></ul>