Fiducial Reference Measurements for validation of Surface Temperature from Satellites (FRM4STS): Laboratory Calibration of Participants Radiometers and Blackbodies

D-90A: Implementation plan for the FRM4STS LCE (LCE-IP)

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D90A: Implementation plan for the FRM4STS LCE (LCE-IP)

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1	2	01.10.2015	Complete draft submitted for review
1	3	04.07.2018	Revised draft submitted for review
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DOCUMENT APPROVAL

Contractor Approval

Name	Role in Project	Signature & Date (dd/mm/yyyy)
Dr Nigel Fox	Technical Leader	
Dr Andrew Brown	Project Manager	 Andrew Brown, NPL 22 August 2018

CUSTOMER APPROVAL

Name	Role in Project	Signature	Date (dd/mm/yyyy)
C Donlon	ESA Technical Officer		

APPLICABLE DOCUMENTS

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EOP-SM/2642	1	Fiducial Reference Measurements for Thermal Infrared Satellite Validation (FRM4STS) Statement of Work

ACRONYMS AND ABBREVIATIONS

CEOS	Committee on Earth Observation Satellites
DMI	Danish Meteorological Institute
FRM4STS	Fiducial Reference Measurements for
GOTA	Grupo de Observacion de la Tierra y la Atmosfera
IPL	Imaging Processing Laboratory
IR	Infra-Red
ISO	International Organization for Standardization
JPL	Jet Propulsion Laboratory
KIT	Karlsruhe Institute of Meteorology
LST	Land Surface Temperature
NMI	National Measurement Institute
NPL	National Physical Laboratory
OUC	Ocean University of China
PTB	Physikalisch-Technische Bundesanstalt
SST	Sea Surface Temperature
SI	Système Internationale
UK	United Kingdom
WGCV	Working Group for Calibration and Validation
WST	Water Surface Temperature

1. INTRODUCTION

The measurement of the Earth's surface temperature is a critical product for meteorology and an essential parameter/indicator for climate monitoring. Satellites have been monitoring global surface temperature for some time, and have established sufficient consistency and accuracy between in-flight sensors to claim that it is of "climate quality". However, it is essential that such measurements are fully anchored to SI units and that there is a direct correlation with "true" surface/in-situ based measurements.

The most accurate of these surface based measurements (used for validation) are derived from field deployed IR radiometers. These are in principle calibrated traceably to SI units, generally through a reference radiance blackbody. Such instrumentation is of varying design, operated by different teams in different parts of the globe. It is essential for the integrity of their use, to provide validation data for satellites both in-flight and to provide the link to future sensors, that any differences in the results obtained between them are understood. This knowledge will allow any potential biases to be removed and not transferred to satellite sensors. This knowledge can only be determined through formal comparison, of the instrumentation, both in terms of its primary "lab based" calibration and its use in the field. The provision of a fully traceable link to SI ensures that the data are robust and can claim its status as a "climate data record".

The Earth Observation "IR Cal/Val community" is well versed in the need and value of such comparisons having held highly successful exercises in Miami and at NPL in 2001 and 2009 [1, 2]. However, six years will have passed since the last comparison and it is considered timely to repeat/update the process. This Implementation Plan describes the set of comparison activities that will be carried out as part of this exercise in the lab at NPL.

2. OBJECTIVES

The overarching objective of this comparison is "*To establish the "degree of equivalence" between surface based IR Cal/Val measurements made in support of satellite observations of the Earth's surface temperature and to establish their traceability to SI units through the participation of national standards laboratories".*

The objective can be sub-divided into the following:

1) Evaluation of the differences in IR radiometer primary calibrations (laboratory based)

   a. Reference standards used (blackbodies) and traceability
   b. Radiometers response to common blackbody target
   c. Evaluation of differences in radiometer response when viewing water/Land surface targets in particular the effects of external environmental conditions such as sky brightness.

2) Establishment of formal traceability for participant blackbodies and radiometers

The purpose of this document is to describe the implementation plan for the laboratory calibration of the radiometers and reference standard blackbodies.

3. ORGANIZATION

3.1 COORDINATOR

NPL, the UK national metrology institute (NMI) will coordinate this comparison supported by the PTB, the NMI of Germany. NPL, the coordinator, will be responsible for inviting participants and for the analysis of data, following appropriate processing by individual participants. NPL, as the coordinator, 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 that 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 through CEOS and other relevant bodies will be carried out in October 2015 to ensure full opportunity and encouragement is provided to all. All participants should be able to demonstrate independent traceability to SI of the instrumentation that they use, or make clear the route of traceability via another named laboratory before the start of the comparison activities. The traceability of a radiometer can be demonstrated for example by indicating the calibration route (back to SI primary standards i.e. nature of any certificate) of their thermometer which is used to measure the temperature of the blackbody cavity which is used to calibrate the radiometer, along with calculation of the emittance of the same blackbody, or by direct traceable measurement of its radiance.

This is essential to have a good set of protocols have been agreed by all participants before the start of the comparison. The pilot laboratory will prepare a set of procedures and protocols which will be passed to participants. Participants shall be given the opportunity to discuss and review these procedures and protocols with the coordinator lab before they agree to participate. Once the protocol (described in TR-1) and list of participants has been reviewed and agreed, no change to the protocol may be made without prior agreement of all participants. By their declared intention to participate in this key comparison, the participants accept the general instructions and the technical protocols written down in this document and commit themselves to follow the procedures strictly.

Where required, demonstrable traceability to SI will be obtained through participation of PTB and NPL as coordinator.

3.3 PARTICIPANTS' DETAILS

Table 1. Participants' Contact Details

Contact person	Short version	Institute	Contact details
Nigel Fox	NPL	National Physical Laboratory	email: nigel.fox@npl.co.uk; Tel: +44 20 8943 6825
Carol Anne Clayson	Woods Hole Oceanographic Institution	266 Woods Hole Road, Woods Hole, MA 02543-1050 U.S.A	email: cclayson@whoi.edu; Tel: +1 508 289 3626
Jacob Høyer	DMI	Danish Meteorological Institute (DMI), Centre for Ocean and Ice, Lyngbyvej 100, 2100 København Ø	email: jlh@dmi.dk; Tel: +4539157203
Frank Goettsche	KIT	Institute for Meterology and Climate Research (IMK-AF), Kaiserstr. 12, 76131, Karlsruhe, Germany	email: frank.goettsche@kit.edu; +49 721 608-23821
Helen Beggs	Bureau of Meteorology, Australian Govt.	Ocean Modelling Research Team Research and Development Branch Bureau of Meteorology	email: h.beggs@bom.gov.au;

		GPO Box 1289 Melbourne VIC 3001 Level 11, 700 Collins Street, Docklands VIC 3008	Tel: +61 3 9669 4394; Fax: +613 9669 4660
Nicole Morgan	CSIRO	Seagoing Instrumentation Team, Oceans and Atmosphere Flagship, CSIRO, GPO Box 1538, Hobart, TAS, 7001, AUSTRALIA	email: Nicole.Morgan@csiro.au; Ph: +613 6232 5222
Leiguan Ouc	OUC-CN	Ocean Remote Sensing Institute Ocean University of China 5 Yushan Road,Qingdao, 266003 China	email: leiguan@ouc.edu.cn

Contact person	Short version	Institute	Contact details
Manuel Arbelo	GOTA	Grupo de Observacion de la Tierra y la Atmosfera (GOTA), ULL, Spain	email.: marbelo@ull.es
Simon Hook	JPL-NASA	Carbon Cycle and Ecosystems MS 183-501, Jet Propulsion Laboratory 4800 Oak Grove Drive, Pasadena, CA 91109 USA	email: simon.j.hook@jpl.nasa.gov
J. A. Sobrino	IPL	Imaging Processing Laboratory (IPL) Parque Científico,Universitat de Valencia Poligono La Coma s/n, 46980 Paterna Spain	Tel: +34 96 354 3115; email: sobrino@UV.es
Raquel Niclos			email.: Raquel.Niclos@uv.es
Tim Nightingale	STFC	STFC Rutherford Appleton Laboratory Chilton, Didcot,Oxon OX11 0QX United Kingdom	Tel: +44 1235445914; Tim.Nightingale@stfc.ac.uk
Werenfrid Wimmer	Soton	National Oceanography Centre, Southampton,European Way, Southampton, SO19 9TX, United Kingdom	email: w.wimmer@soton.ac.uk
Willem Vreeling	DLR	DLR, Remote Sensing Technology Institute, Oberpfaffenhofen, D-82234 Wessling, Germany	email: willem.vreeling@dlr.de
Caroline Sloan	MOD, NAVY SHIPS-HM FEIO	Fleet Environmental Information Officer NAVY SHIPS-HM FEIO | Navy Command Headquarters, MP 2.3, Leach Building, Whale Island, Portsmouth, Hampshire, PO2 8B	Tel: 023 9262 5958 | Mil: 93832 5958; NAVYSHIPS-HMFEIO@mod.uk; caroline.sloan104@mod.uk
Ian Barton	CSIRO Australia	Head office, PO Box 225,Dickson ACT 2602 Australia www.csiro.au	Tel: +61 3 9545 2176; email: Ian Barton@csiro.au
Dr. César Coll	UV-ES	Dept. of Earth Physics and Thermodynamics Faculty of Physics, University of Valencia Dr. Moliner, 50. 46100 Burjassot Spain	email: Cesar.Coll@uv.es
Raju Datla	NIST	100 Bureau Drive, Gaithersburg, MD 20899 USA	email: rdatla@nist.gov
William (Bill) Emery	EDU-USA	Univ of Colorado, Aerospace Eng. Sci. Dept CB 431, Boulder,CO, 80309-0431 USA	email: emery@colorado.edu

Dr. Frank-M. Goettsche	IMK-FZK	Forschungszentrum Karlsruhe Institute of Meteorology and Climate Research, Atmospheric Trace Gases and Remote Sensing, Meteorological Satellite-Data Analysis, Hermann-von-Helmholtz-Platz 1, 76344 Eggenstein-Leopoldshafen Germany	email: frank.goettsche@imk.fzk.de; Tel: +49-(0)7247-82-3821
Peter J Minnett	RSMAS	University of Miami, 4600 Rickenbacker Causeway, Miami, FL 33149 USA	email: pminnett@rsmas.miami.edu

3.4 OVERVIEW OF THE FORM OF COMPARISONS

The Workshop covers a number of individual comparisons. Full and detailed descriptions of the protocols and procedures which will be followed during the Workshop can be found in TR-1, Each comparison will have its own specific characteristics but will all in principle take the same form i.e. they will all seek to observe a common entity. In the case of the participant blackbody comparison, traceability to SI will be established through the direct participation of standards provided by two national standards laboratories. The radiometer comparison will involve the participant radiometers viewing a reference radiance blackbody which will allow that traceability to be extended to these radiometers.

3.5 COMPARISON OVERVIEW

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

3.5.1 Comparison 1: Blackbodies

In this comparison, any portable blackbodies provided by participants will be compared relative to reference radiance blackbodies using well-characterised transfer standard radiometers. The transfer radiometers used will be the NPL AMBER facility which will be used to measure the radiance temperature of the blackbodies for a wavelength of 10.1 μm and the PTB infrared radiometer which will be used to measure the radiance temperature of the blackbodies in the 8 μm to 14 μm wavelength range.

The blackbodies which are used to support sea/water surface temperature measurements will be compared at nominal temperatures of 283 K, 293 K and 303 K. For blackbodies which are used to support land surface temperature measurements, the comparison will be extended down to 273 K and up to 323 K, whereas blackbodies which are used to support ice surface temperature measurements, the comparison will be over the 253 K to 323 K temperature range.

3.5.2 Comparison 2: Radiometers (laboratory)

For this comparison all participant radiometers will be compared to a reference blackbody calibrated traceable to SI. The reference black body will be variable in temperature, have a well-characterised and high spectral emissivity and have an aperture sufficiently large to accommodate the field of view of any participant radiometer.

The reference blackbody will be set to a fixed known temperature and then viewed by all radiometers. Radiometers which are used to measure sea/water surface temperature will perform measurements at nominal temperatures of 278 K, 283 K, 293 K and 303 K. Radiometers which are used to measure land

surface temperatures will perform measurements down to 273 K and up to 323 K, whereas radiometers which are used to measure ice surface temperatures will perform measurements down to 253 K and up to 293 K.

3.6 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

PHASE 1: PREPARATION	
Invitation to participate	October 2015
Preparation and formal agreement of protocol	Jan - March 2016
PHASE 2: MEASUREMENTS	
Comparison of participants' Radiometers	June 2016
Comparison of participants' Blackbodies	June 2016
Participants send all data and reports to pilot	July 2016
PHASE 3: ANALYSIS AND REPORTS	
Participants send preliminary report of measurement system and uncertainty to pilot and forwarded to all	April 2016
Receipt of comments from participants	May 2016
Draft A (results circulated to participants)	July 2016
Final draft report circulated to participants	August 2016
Draft B submitted to CEOS WGCV	September 2016
Final Report published	October 2016

Table 3 below shows the top-level plan for the comparison activity. The first week starting on Monday 20th June 2016 has been allocated to laboratory measurements of the reference blackbody using the participants' radiometers as well as the measurement of the participants' blackbodies using the reference radiometers of NPL and PTB. These measurements are expected to last most of that week. If these measurements finish earlier than the end of the week, some field measurements of Land Surface Temperature (LST) can be done on the NPL site. However, the plan is to start the LST measurements on Monday 4th July 2016 at a site on the NPL campus. The LST measurements can continue to the end of that week, if necessary, but they are expected to finish by Wednesday 6th July.

The second week starting on Monday 27th June 2016 has been allocated to field measurement of the water surface temperature of the large water reservoir at Wraysbury, near NPL. Measurements will be done from the platform located in the middle of the reservoir. These measurements are expected to finish by the end of that week (Friday 1st July 2016).

Table 3. Comparison Activity- Plan

Week No.	Experiment No.	Start Date	End Date	Experiment	Venue
1	1	20 JUNE 2016	24 JUNE 2016	Laboratory calibration of participants' radiometers against reference blackbody. Simultaneously, laboratory calibration of participants' blackbodies using the NPL	NPL, UK

				AMBER facility and PTB's IR radiometer.	
2	2	27 JUNE 2016	1 JULY 2016	Water surface temperature measurement inter-comparison of participants' radiometers.	Wraysbury reservoir, near NPL, UK
3	3	04 JULY 2016	08 JULY 2016	Land Surface Temperature measurements inter-comparison of radiometers	On NPL campus.

3.7 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:

Evangelos "Theo" Theocharous,
Room F4-A1,
NPL,
Hampton Road
Teddington
TW11 0LW

Any queries can be directed to Theo on e.theo@npl.co.uk or by phone on +44 208 943 6977.

It is recommended that where possible any fragile components should be hand carried to avoid the risk of damage. Equipment which will be sent to NPL will be stored until Monday 20th June 2016, when their owners can unpack them and assemble them for the lab comparisons. It is expected that the equipment will be re-packed in the afternoon of Friday 24th June, for transport to the Wraysbury reservoir platform. A van will be provided to transport the equipment to the Wraysbury reservoir site, early on Monday 27th June. Equipment which is not required for the WST field comparison can be left in Lab F4-L1 at NPL. Participants can arrange their own way to Wraysbury (using their own car or a taxi), but transport will be provided to take participants free of charge from NPL to Wraysbury reservoir every day of that week, departing promptly at 9:00 AM from the NPL main reception. Participants who miss this transport will have to make their own way to Wraysbury by taxi at their own cost. Similarly, transport will also be provided to return participants from Wraysbury to NPL every day of that week, departing at 5:00 PM from the car-park at Wraysbury reservoir. Equipment can be left unattended on the platform at Wraysbury reservoir for the evenings of Monday to Thursday of that week. Participants are expected to pack their equipment on the afternoon of Friday 24th June so they can be collected by a van from the Wraysbury reservoir car-park at 4:45 PM and returned to NPL.

LST measurements are due to take place on the NPL site during the last week of the Workshop, so participants can walk from NPL main building to the venue. NPL will again organise the transport of equipment and participants between NPL and the location selected for the LST comparison.

Please note that the coordinator and host laboratory have no insurance for any loss or damage of the instrumentation during transportation or whilst in use during the comparison, however all reasonable efforts will be made to aid participants in any security.

Electrical power (220 V ac) will be available to all participants, with a local UK plug fitting for the comparisons at NPL and during the water surface temperature measurements at the Wraysbury reservoir. Participants whose equipment requires 110 V ac supplies must provide their own transformers.

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. Information on hotels in the vicinity of Wraysbury can also be provided on request, in case some participants wish to move to hotels in the vicinity of Wraysbury during the WST field comparison (second week of the Workshop). However, transport to and from hotels near Wraysbury to the reservoir where the comparison will be taking place will be their responsibility.

All subsistence and hotel stay costs will be at the expense of the participants. Participants can have lunch at the NPL main restaurant during the first week of the Workshop. 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. Participants can also use these facilities during the third week of the Workshop (LST measurements at NPL), as well as the bar/restaurant at the NPL Social Club.

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 the Workshop. 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. If you require supporting documents or invitation to the Workshop, please contact Theo Theocharous at NPL stating what documents you require. Please note that the Visa processing time may vary depending on your country of application, so please allow sufficed time for the application to be processed.

3.8 FLIGHTS TO THE UK

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 likely is Gatwick airport, but is 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 are likely to be just over £50.

You can find directions to NPL for different modes of transport (own 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.

3.9 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 under both laboratory and field conditions. 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.

4.0 REFERENCES

1. Barton, I. J., Minnett, P. J., Maillet K. A., Donlon, C. J., Hook, S. J., Jessup, A. T. and Nightingale, T. J., 2004," The Miami 2001 infrared radiometer calibration and intercomparison: Part II Shipboard results", *Journal of Atmospheric and Oceanic Technology*, 21, 268-283.

2. Theocharous, E., Usadi, E. and Fox, N. P., "CEOS comparison of IR brightness temperature measurements in support of satellite validation. Part I: Laboratory and ocean surface temperature comparison of radiation thermometers", NPL REPORT OP3, July 2010

Appendix 1

Hotels around NPL

NB: The Park Hotel has a corporate rate for NPL customers for which '**National Physical Laboratory**' needs to be quoted when booking	
The Park Hotel Park Road Teddington TW11 0AB T: 0843 357 5516	• 10 minute walk from NPL, close to Teddington railway station • Corporate rate: Standard Room (single occupancy): £107 Standard Double Room (double occupancy): £117 • 43 standard bedrooms • 8 family rooms • 4 disabled bedrooms • Restaurant and bar facilities
NB: Lensbury has a corporate rate for NPL customers for which '**National Physical Laboratory**' needs to be quoted when booking	
Lensbury Broom Road Teddington TW11 9NU T: 020 8614 6444 Email: accommodation@lensbury.com	• Early booking advised • Corporate rate: Standard Room (single occupancy): £135 Standard Double Room (double occupancy): £160 • 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) (* Check with Lensbury Reception for bus timings)
Travelodge Teddington Park House Station Road Teddington TW11 9AD T: 0871 984 6231	• 10 minute walk from NPL • Close to Teddington railway station • Bar | café • Wi-Fi facilities
Travelodge Sunbury Hanworth Road Sunbury on Thames TW16 5DJ T: 0871 984 6356	• 5 miles from NPL (approx 20 minutes drive by car) • Situated close to the M3 motorway • Bar | café • Wi-Fi facilities
Travelodge Kingston 21-23 London Road Kingston upon Thames KT2 6ND	• 15 minute taxi ride to NPL • 2 minute walk to Kingston railway station • 72 rooms (36 doubles and 36 family rooms)

Travelodge Feltham Res Centre High Street Feltham TW13 4EX	• 20 minute taxi ride (approx 6 miles) to NPL
Chase Lodge Hotel 10 Park Road Hampton Wick Kingston upon Thames KT1 4AS	• Located at the edge of Bushy Park • 20 minutes walk through the park to NPL and 5 minutes walk from Hampton Wick railway station • 12 bedrooms • Restaurant
The White Hart Hotel 1 High Street Hampton Wick Kingston upon Thames KT1 4DA	• Situated at the foot of Kingston Bridge • 5 minute taxi ride to NPL and 10-minute walk to Hampton Wick and Kingston railway stations • 37 bedrooms • Restaurant and bar facilities (also open to the public)
NB: Carlton Mitre Hotel has a corporate rate for NPL customers for which '**National Physical Laboratory**' needs to be quoted when booking	

Carlton Mitre Hotel
Hampton Court Road
Hampton Court
KT8 9BN
 	
T: 020 8783 3505
Email:
resmitre@carltonhotels.co.uk
	• 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
	• Corporate rate:
	  ○ Standard Room (single occupancy): £107.50
	  ○ Standard Double Room (double occupancy): £127.50
	• 36 bedrooms | wireless internet facilities | restaurant and bar facilities | coffee lounge

The Alexander Pope Hotel Cross Deep Twickenham TW1 4RB	• 5 minute taxi ride to NPL • Bus routes to Teddington High Street
Premier Inn Twickenham East Corner Sixth Cross Road / Staines Road Twickenham TW2 5PE	• 5 minute taxi ride to NPL • East access from A316 • Carvery restaurant and bar facilities in Beefeater Grill (The Fountain) next door
Premier Inn Twickenham Stadium Chertsey Road (A316) Whitton TW2 6LS	• 10 minute taxi ride to NPL • 31 bedrooms • Carvery restaurant and bar facilities in pub next door (The Winning Post)

Antoinette Hotel 26 Beaufort Road Kingston upon Thames KT1 2TQ	• 15 minute taxi ride to NPL | 10 minute walk to Surbiton railway station | 20 minute walk to Kingston railway station • 100 bedrooms • Private garden • Restaurant and bar facilities • Private function / meeting rooms
Firs Guest House 41 Hampton Road Teddington TW11 0LA Tel: 020 8977 6551	• 10 minute walk from NPL • Basic family-run guest house
Holiday Inn - Shepperton Felix Lane Shepperton TW17 8NP	• 30 minute taxi ride to NPL • 185 bedrooms • Leisure facilities (pool, gym, sauna) • Restaurant and bar facilities • Free parking