



APLAC T088

APLAC Proficiency Testing Program

Photometric Measurement of Solid State Lighting Products

Final Report

Organising Accreditation Body: China National Accreditation Service for Conformity Assessment (CNAS)

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Proficiency Testing Provider: National Lighting Test Centre (NLTC)

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Summary of Results

1. This program “APLAC T088 - Photometric measurement of Solid State Lighting Products” is intended to make an investigation on the lighting products measurement capabilities of the laboratories in different countries and regions, to understand the differences between the different laboratories, help the specific laboratories to make improvements, and try to establish a kind of equivalence. This program also cooperates with International Energy Agency (IEA) 4E SSL Annex so that the results of this program can be linked to the Interlaboratory Comparison 2013 (IC 2013) [1] run by IEA 4E SSL Annex, whereby the results of this PT program may be recognized internationally.

This program was organized by China National Accreditation Service for Conformity Assessment (CNAS), with National Lighting Test Centre (NLTC) as the collaborator and the Proficiency Testing Provider, under the auspices of Asia Pacific Laboratory Accreditation Cooperation (APLAC).

2. A total of 29 laboratories from 19 accreditation bodies enrolled in the program and 28 laboratories from 18 accreditation bodies returned results to the Proficiency Testing Provider (NLTC). One participant quit the comparison participation after receiving the testing artefacts.
3. In this comparison, five types of artefacts were compared: incandescent artefact (NLTC-IDC), omni-directional LED artefact (NLTC-OD), directional LED artefact (NLTC-D), high CCT LED artefact (NLTC-HCCT) and low power-factor LED artefact (NLTC-LPF). The electrical parameters (voltage, current, active power and power factor), photometric parameters (luminous flux and luminous efficacy) and colorimetric parameters (chromaticity x and y, CCT, CRI) were measured in this PT programme.
4. Some participants returned results of only some of the parameters specified. Lab P516 submitted results of only the electrical parameters (voltage, current, active power and power factor), lab P342 submitted results of the electrical parameters (voltage, current, active power and power factor) and luminous parameters (luminous flux and luminous efficacy) but not color quantities, and the lab P185 submitted results of only incandescent artefact (NLTC-IDC). Other laboratories submitted results of all artefacts.
5. The Assigned value(s) were average values of the twice measurement results by NLTC before and after delivery. The En number(s) were used as numerical indicators

to show participants' performance with respect to the Assigned value(s) in this programme.

6. The En number(s) of the participants are summarized as follows:

Table I-V show the summaries of En number(s) for each type of artefact and Table VI shows the summaries of En number(s) for each testing parameter for all artefacts.

(1) For different types of artefacts used in this comparison, the En number(s) are listed as follows:

Table I Summary of En number(s) of participant on NLTC- IDC artefact results

En number(s)	Number of Participants (Percentage)							
NLTC- IDC	Luminous flux	Active power	Luminous efficacy	x	y	CCT	Ra	Power factor
$ E_n \leq 1.0$	24 (89%)	19 (68%)	21 (78%)	22 (85%)	23 (88%)	23 (88%)	23 (96%)	28 (100%)
$ E_n > 1.0$	3 (11%)	9 (32%)	6 (22%)	4 (15%)	3 (12%)	3 (12%)	1 (4%)	0 (0%)
Total	27 (100%)	28 (100%)	27 (100%)	26 (100%)	26 (100%)	26 (100%)	24 (100%)	28 (100%)

Table II Summary of En number(s) of participant on NLTC- OD artefact results

En number(s)	Number of Participants (Percentage)								
NLTC- OD	Luminous flux	Current	Active power	Luminous efficacy	x	y	CCT	Ra	Power factor
$ E_n \leq 1.0$	24 (92%)	21 (78%)	27 (100%)	25 (96%)	24 (96%)	25 (100%)	25 (100%)	25 (100%)	21 (78%)
$ E_n > 1.0$	2 (8%)	6 (12%)	0 (0%)	1 (4%)	1 (4%)	0 (0%)	0 (0%)	0 (0%)	6 (22%)
Total	26 (100%)	27 (100%)	27 (100%)	26 (100%)	25 (100%)	25 (100%)	25 (100%)	25 (100%)	27 (100%)

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Table III Summary of En number(s) of participant on NLTC- D artefact results

En number(s)	Number of Participants (Percentage)								
NLTC- D	Luminous flux	Current	Active power	Luminous efficacy	x	y	CCT	Ra	Power factor
$ E_n \leq 1.0$	21 (81%)	22 (81%)	26 (96%)	21 (81%)	25 (100%)	24 (96%)	25 (100%)	23 (96%)	25 (93%)
$ E_n > 1.0$	5 (19%)	5 (19%)	1 (4%)	5 (19%)	0 (0%)	1 (4%)	0 (0%)	1 (4%)	2 (7%)
Total	26 (100%)	27 (100%)	27 (100%)	26 (100%)	25 (100%)	25 (100%)	25 (100%)	24 (100%)	27 (100%)

Table IV Summary of En number(s) of participant on NLTC-HCCT artefact results

En number(s)	Number of Participants (Percentage)								
NLTC- HCCT	Luminous flux	Current	Active power	Luminous efficacy	x	y	CCT	Ra	Power factor
$ E_n \leq 1.0$	22 (85%)	20 (74%)	27 (100%)	24 (92%)	23 (92%)	23 (92%)	23 (92%)	22 (92%)	23 (85%)
$ E_n > 1.0$	4 (15%)	7 (26%)	0 (0%)	2 (8%)	2 (8%)	2 (8%)	2 (8%)	2 (8%)	4 (15%)
Total	26 (100%)	27 (100%)	27 (100%)	26 (100%)	25 (100%)	25 (100%)	25 (100%)	24 (100%)	27 (100%)

Table V Summary of En number(s) of participant on NLTC-LPF artefact results

En number(s)	Number of Participants (Percentage)								
NLTC- LPF	Luminous flux	Current	Active power	Luminous efficacy	x	y	CCT	Ra	Power factor
$ E_n \leq 1.0$	23 (88%)	19 (70%)	23 (85%)	24 (92%)	23 (92%)	25 (100%)	25 (100%)	24 (100%)	23 (85%)
$ E_n > 1.0$	3 (12%)	8 (30%)	4 (15%)	2 (8%)	2 (8%)	0 (0%)	0 (0%)	0 (0%)	4 (15%)
Total	26 (100%)	27 (100%)	27 (100%)	26 (100%)	25 (100%)	25 (100%)	25 (100%)	24 (100%)	27 (100%)

(2) For all artefacts used in this comparison, the En number(s) are listed as follows:

Table VI Summary of En number(s) of participant on all parameters

En number(s)	Number of Participants (Percentage)								
All type artefact	Luminous flux	Current	Active power	Luminous efficacy	x	y	CCT	Ra	Power factor
$ E_n \leq 1.0$	114 (87%)	82 (76%)	122 (90%)	115 (88%)	117 (93%)	120 (95%)	121 (96%)	117 (97%)	120 (88%)
$ E_n > 1.0$	17 (13%)	26 (24%)	14 (10%)	16 (12%)	9 (7%)	6 (5%)	5 (4%)	4 (3%)	16 (12%)
Total	131 (100%)	108 (100%)	136 (100%)	131 (100%)	126 (100%)	126 (100%)	126 (100%)	121 (100%)	136 (100%)

Note:

- ① For NLTC-IDC artefacts, the current is a controlled quantity as an input parameter, it is not an assessment quantity in this PT programme.
- ② For LED artefacts, the voltage is a controlled quantity as an input parameter, so it is not an assessment quantity in this PT programme.

1. Introduction

1.1 The purpose of the Asia Pacific Laboratory Accreditation Cooperation (APLAC) is to build up and maintain mutual confidence between national calibration and testing services in order to reach a state of mutual agreement on the equivalence of the operation of the accreditation bodies and of the certificates issued by their accredited laboratories. This supports the removal of technical barriers to trade related to calibration activities which underpin all testing and measurement activities.

APLAC testing interlaboratory comparisons provide a forum for the comparability of testing in the Asia-Pacific region. They also provide confidence in the accreditation process of the APLAC members and also in their ability to take the appropriate corrective actions where an interlaboratory comparison reveals testing deficiencies. APLAC interlaboratory comparisons also result in a flow of know-how between the participating accreditation bodies and help establish a common high level of testing performance within the region.

1.2 This program APLAC T088 “Photometric measurement of Solid State Lighting Products” is intended to make an investigation on the lighting products measurement capabilities of the laboratories in different countries and regions, to understand the differences between the different laboratories, help the specific laboratories to make improvements, and try to establish a kind of equivalence. This program was organized by China National Accreditation Service for Conformity Assessment (CNAS), with National Lighting Test Centre (NLTC) as the collaborator, under the auspices of Asia Pacific Laboratory Accreditation Cooperation (APLAC).

1.3 National Lighting Test Centre (NLTC) is accredited by China National Accreditation Service for Conformity Assessment (CNAS) and NVLAP in the field of SSL testing activities against ISO/IEC 17025. NLTC, as the nucleus laboratory, has organized the IEA 4E SSL Annex Interlaboratory Comparison (IC 2013) [1] for the Asia area for the measurement of solid state lighting (SSL) products to investigate the PT and accreditation issues.

1.4 28 laboratories from 18 accreditation bodies returned results to the Proficiency Testing Provider (NLTC). The results of the testing for light artefacts are presented in this report. This report gives an indication of each participating laboratory's performance in terms of their agreement with the assigned value(s). Participants were confidentially assigned with unique laboratory codes (Pxxx) and the codes were used throughout the programme.

2. Measurands

2.1 The following properties / quantities have been measured and compared in this proficiency testing for all the five kinds of artefacts. The testing of these properties / quantities are required to be performed according to the specified measurement method (see Annex E-1).

- (a) Total luminous flux (lm);
- (b) Current (A) for LED artefacts;
- (c) Active power (W);
- (d) Luminous efficacy (lm/W);
- (e) Chromaticity coordinates x, y;
- (f) Correlated Colour Temperature (K);
- (g) Colour Rendering Index (CRI) Ra;
- (h) Power factor (PF).

2.2 Uncertainties are required to be reported by the participating laboratories, and the ISO Guide [2] and CIE 198: 2011[3] should be followed. The total uncertainty of each measured quantity shall be expressed in expanded uncertainty with a confidence interval of 95 % or a coverage factor $k=2$.

2.3 All results are required to be in at least four significant digits. The uncertainty should have two significant digits.

3. Objectives

The main objective is intended to make an investigation on the lighting products measurement capabilities of the laboratories in different countries and regions, understand the differences between the different laboratories, help the specific laboratories to make improvements, and try to establish a kind of equivalence.

The design of the proficiency test followed the requirements in ISO/IEC 17043:2010 Conformity Assessment – General Requirements for Proficiency Testing [4] and the test results submitted by participants were processed in accordance with the statistical technique outlined in ISO 13528:2005 Statistical Methods for Use in Proficiency Testing by Inter-laboratory Comparisons[5].

4. Proficiency Test Artefacts

4.1 The proficiency test artefacts were prepared by NLTC. In this comparison programme, 5 types of artefacts are chosen as the Proficiency Testing Items (PTIs):

- Incandescent artefact (NLTC-IDC)
Generally, stable incandescent artefact has often been used as reference artefact to compare and calibrate photometric laboratories. In this comparison test, the artefact was operated with constant DC 3.9500 A.
- Omni-directional LED artefact (NLTC-OD)
Omni-directional LED artefact works as similar to the standard artefact, and is expected to check the traceability of laboratories.
- Directional LED artefact (NLTC-D)
Directional LED artefact was used in the test, because it has high requirements of the reflection uniformity of the integrating sphere.
- High CCT LED artefact (NLTC-HCCT)
High CCT LED artefact challenges the color measurement proficiency of the laboratory.
- Low power-factor LED artefact (NLTC-LPF)
Low power-factor LED artefact in the test sample set was chosen to challenges the electrical measurement proficiency of the laboratory.

Table 4.1 Artefacts information

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Identifier	Artefact Type	Rated Voltage	Rated Power	Nominal CCT	Other Conditions
NLTC-IDC	Incandescent artefact	12 V DC	50 W	2800 K	Constant current: DC 3.9500 A.
NLTC-OD	Omni-directional LED artefact	220 V AC	5 W	2700 K	AC frequency: 50 Hz; Operating position: base up.
NLTC-D	Directional LED artefact	220 V AC	8 W	3000 K	
NLTC-HCCT	High CCT LED artefact	220 V AC	6 W	5000 K	
NLTC-LPF	Low power-factor LED artefact	220 V AC	6 W	3000 K	

4.2 Initially, about 1000 artefacts were purchased from the local market in China. After aging and stability checks from March to May 2013, NLTC finally prepared 30 sets of artefacts, total 150 artefacts for this PT programme.

4.3 Before and after delivery, two measurements were carried out by NLTC. In order to control the stability of the artefacts in the PT process, the deviations of all the artefacts in all parameters should be no more than $0.8\hat{S}$ [6].

Table 4.2 $\hat{S}$ value

$\hat{S}$ value	Generic standard uncertainties								
All type artefact	Luminous flux (%)	Current (%)	Active power (%)	Luminous efficacy (%)	x	y	CCT (3000K)	CCT (6000K)	Ra
$\hat{S}$	1.2	0.35	0.45	1.3	0.0010	0.0011	15	43	0.3

Note:

$\hat{S}$ is referred to IEA SSL Annex Interlaboratory Comparison Protocol for NLTC issued by NLTC on 2012.10.22.

The comparison results before and after delivery demonstrate that the artefacts were stable enough. More details see Annex D: Stability of artefacts.

4.4 All artefacts were tested under the required environmental conditions in Annex E-1.

All artefacts were stored under the room temperature between 15 °C and 35 °C and relative humidity less than 75 %. In the delivery process, the protector cases were used to insure the safety of the comparison artefacts.

4.5 In this comparison, NLTC sent 21 sets of artefacts which were totally 111 artefacts consist of 27 incandescent artefacts, 21 omni-directional LED artefacts, 21 directional LED artefacts, 21 high CCT LED artefacts, and 21 low power-factor LED artefacts.

Upon receipt of the test artefacts, organizing accreditation bodies and participants were requested to check the physical conditions of artefacts and promptly acknowledge the NLTC (PTP) by returning the “Receipt Form for Accreditation Body” and “Receipt Form for Participants” (see Annex E-4) to NLTC. Replacement would be arranged if any defect was detected.

All samples were received by the participants in good conditions. Due to the mis-operation of some participating laboratories, 6 IDC artefacts were damaged during the test, and NLTC sent them replacement artefacts “IDC-21, IDC-24, IDC-R12, IDC-R13, IDC-R14, and IDC-R19”.

Only 1 lab quit the comparison test after receiving the artefacts, so there are 20 sets of artefacts to be used in the comparison test finally.

The relationship between the lab codes and No. of artefacts is demonstrated in Table 4.3.

Table 4.3 The distribution of artefacts

No.	Artefacts	Lab codes
1	NLTC-IDC-21, NLTC-OD1-2, NLTC-D-3, NLTC-HCCT-4, NLTC-LPF-5	P011, P097
2	NLTC-IDC-30, NLTC-OD1-30, NLTC-D-30, NLTC-HCCT-30, NLTC-LPF-30	P108
3	NLTC-IDC-2, NLTC-OD1-3, NLTC-D-4, NLTC-HCCT-5, NLTC-LPF-6	P142, P146
4	NLTC-IDC-3, NLTC-OD1-4, NLTC-D-5, NLTC-HCCT-6, NLTC-LPF-7	P149
5	NLTC-IDC-24, NLTC-OD1-6, NLTC-D-7, NLTC-HCCT-8, NLTC-LPF-9	P152
6	NLTC-IDC-6, NLTC-OD1-7, NLTC-D-8, NLTC-HCCT-9, NLTC-LPF-10	P153, P158
7	NLTC-IDC-7	P185
8	NLTC-IDC-8, NLTC-OD1-9, NLTC-D-10, NLTC-HCCT-11, NLTC-LPF-12	P189
9	NLTC-IDC-9, NLTC-OD1-10, NLTC-D-11, NLTC-HCCT-12, NLTC-LPF-13	P294, P342
10	NLTC-IDC-10, NLTC-OD1-11, NLTC-D-12, NLTC-HCCT-13, NLTC-LPF-14	P416, P424
11	NLTC-IDC-11, NLTC-OD1-12, NLTC-D-13, NLTC-HCCT-14, NLTC-LPF-1	P446
12	NLTC-IDC-R12, NLTC-OD1-13, NLTC-D-14, NLTC-HCCT-1, NLTC-LPF-2	P516, P533
13	NLTC-IDC-R13, NLTC-OD1-14, NLTC-D-1, NLTC-HCCT-2, NLTC-LPF-3	P600
14*	NLTC-IDC-14, NLTC-OD1-1, NLTC-D-2, NLTC-HCCT-3, NLTC-LPF-4	P630
15*	NLTC-IDC-R14, NLTC-OD1-1, NLTC-D-2, NLTC-HCCT-3, NLTC-LPF-4	P639
16	NLTC-IDC-15, NLTC-OD1-16, NLTC-D-17, NLTC-HCCT-18,	P693

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	NLTC-LPF-19	
17	NLTC-IDC-20, NLTC-OD1-15, NLTC-D-16, NLTC-HCCT-17, NLTC-LPF-18	P725
18	NLTC-IDC-16, NLTC-OD1-17, NLTC-D-18, NLTC-HCCT-19, NLTC-LPF-20	P774, P850
19	NLTC-IDC-17, NLTC-OD1-18, NLTC-D-19, NLTC-HCCT-20, NLTC-LPF-15	P891
20	NLTC-IDC-18, NLTC-OD1-19, NLTC-D-20, NLTC-HCCT-15, NLTC-LPF-16	P895
21	NLTC-IDC-R19, NLTC-OD1-20, NLTC-D-15, NLTC-HCCT-16, NLTC-LPF-17	P920

***Note:**

Except for NLTC-IDC-14 and replacement artefact NLTC-IDC-R14, P630 and P639 use the same set of artefacts.

5. Assigned Value(s) and Uncertainty Budget

5.1 Assigned Value(s)

This testing scheme was designed as a star-type format, so NLTC only need to consider and test the stability without the homogeneity of the artefacts. 21 sets of test artefacts were measured by NLTC and sent to each of the 19 accreditation bodies, and then the accreditation bodies sent the artefacts to their nominated laboratories. The test artefacts were measured by the participating laboratories and then returned to NLTC who then conducted a second measurement on each test set. The second test by NLTC marked the end of the testing cycle and the start of the data analysis phase. All participants were required to return the test results followed the “Measurement Results Report Form” after end of their measurements, see Annex E-2.

The assigned value(s) X are determined by the twice measurement results by NLTC.

$$X = \frac{X_1 + X_2}{2} \text{ ----- (F1)}$$

X_1 is the value tested by NLTC before delivering artefacts;

X_2 is the value tested by NLTC after receiving artefacts.

Assigned value(s) reported by PTP for all quantities of all artefacts are given in Annex A: Assigned value(s).

5.2 Uncertainty Budget of the Assigned Value(s)

For photometric and colorimetric quantity measurement uncertainty evaluation, many affecting factors and their uncertainty contributions were considered by NLTC. For instance, the uncertainty budget for NLTC-D artefact is listed in Table 5.1 and Table 5.2.

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Table 5.1 Generic standard uncertainty budget for luminous flux of NLTC-D

Factors considered	Uncertainty contribution
Standard artefact calibration data	0.25%
Current control for standard artefact	0.16%
Aging of the standard artefact	0.1%
Response of spectrometer, random noise, etc.	0.23%
Position and direction of sample in sphere	0.1%
Auxiliary artefact (state shift between self-absorption tests)	0.1%
Spatial non-uniformity of sphere	0.5%
Ambient temperature influence on the sample	0.1%
System repeatability	0.46%
Relative combined standard uncertainty	0.8%
Total relative expanded uncertainty (k=2)	1.6%

Table 5.2 Generic standard uncertainty budget for colorimetric parameters x of NLTC-D

Factors considered	Uncertainty contribution
System repeatability	0.0006
Standard artefact calibration data	0.0005
Response of spectrometer (nonlinearity, stray light, noise, etc.)	0.0006
Wavelength error of spectrometer	0.0008
Combined standard uncertainty	0.00127
Total expanded uncertainty (k=2)	0.0025

The (relative) expanded uncertainties of all parameters provided by NLTC are listed in Table 5.3 as follows.

Table 5.3 (Relative) expanded uncertainties of NLTC

Identifier	(Relative) Expanded Uncertainty								
	Luminous flux (%)	Current (%)	Active power (%)	Luminous efficacy (%)	x	y	CCT (K)	Ra	Power factor
NLTC-IDC	1.4	0.30	0.78	1.6	0.0006	0.0006	10	0.23	0.0010
NLTC-OD1	2.5	2.2	1.8	3.1	0.0025	0.0025	60	0.38	0.013
NLTC-D	1.6	0.85	0.88	1.9	0.0025	0.0025	60	0.39	0.011
NLTC-HCCT	1.6	0.58	1.6	2.2	0.0025	0.0025	111	0.68	0.0060
NLTC-LPF	2.5	1.1	0.56	2.7	0.0025	0.0025	60	0.49	0.0040

Note:

“%” demonstrates that the expanded uncertainty of the parameter is relative.

6. Performance Assessment

Participants' performance was assessed using the En number(s), which is calculated as following:

$$E_n = \frac{x - X}{\sqrt{U_{lab}^2 + U_{ref}^2}} \quad (F2)$$

Where

x is the participant result;

X is the assigned value from NTLC;

U_{lab} is the expanded uncertainty ($k=2$) of a participant's result;

U_{ref} is the expanded uncertainty ($k=2$) of the assigned value.

For the value of chromaticity coordinate (x, y), correlated color temperature, color rendering index and power factor, the En number(s) could be calculated directly by formula F2.

However, for the value of current, active power assumption, total luminous flux and luminous efficacy, the relative differences of the results from each laboratory and the assigned value(s) of the same test artefact are given by:

$$\Delta X_{relative} \frac{x - X}{X} \quad (F3)$$

Therefore, the formula F2 could be changed by:

$$E_n = \frac{\Delta X_{relative}}{\sqrt{(U_{lab,rel} \cdot x / X)^2 + (U_{ref,rel})^2}} \quad (F4)$$

Where

$U_{lab,rel}$ is the relative expanded uncertainty of x ;

$U_{ref,rel}$ is the relative expanded uncertainty of X .

The value x/X is very close to 1, for simplified calculation, the F4 could be replaced by:

$$E_n = \frac{\Delta X_{relative}}{\sqrt{U_{lab,rel}^2 + U_{ref,rel}^2}} \quad (F5)$$

With ISO 13528[5] in reference, En number(s) will be applied to evaluate the test results that given by the participants.

Criteria are as following:

$|E_n| \leq 1.0$ is considered to be satisfactory;

$|E_n| > 1.0$ is considered to be unsatisfactory.

7 Results and Discussions

7.1 Test Results by Participants

Reported test results by participants are presented in Annex B: Results Presentations of Participants, also in Annex C: Interim Report. Comparing with the Annex C, the (relative) differences of results between the participants and NLTC for all quantities, all artefacts, and for all participants in graphic forms, are presented in Annex B: Results Presentations of Participants.

7.2 Discussions

During this PT programme, besides the test results and uncertainty, some information as for equipments, standard artefact, amounting status are also required. Some laboratory provides the information, and some are still missing. The analysis is based on the information that NLTC have got from the participants.

7.2.1 Uncertainty Estimation

The (relative) expanded uncertainties of the average of the reported results were provided by the participants. According to the uncertainties provided by the participants (seen from Annex B), too small or too large values were observed.

(1) Overestimate

For the luminous efficacy of NLTC-IDC and NLTC-OD artefact, such as lab P146, the uncertainty range from 9.2%-14.7% is too large. Therefore, the En number(s) are small.

For the current of NLTC-D artefact, such as the lab P142, the estimated uncertainty is 14.74%.

For the color coordinate x and y, such as the lab P158, the estimated uncertainty is 1.05, which is beyond the normal range of x or y (less than 1.0000).

For the CCT, such as the lab P149, the estimated uncertainty is 365 for HCCT artefact, which beyond the normal range. Maybe it is due to calculation mistake.

(2) Underestimate

Although P158 underestimated the uncertainties (the uncertainty is 0.05% for electrical parameters, about dozens of times smaller than the normal range), but reported good results (the test results are very close to assigned value(s)). Therefore, the En number(s) are small.

For the color coordinate x and y, such as the lab P142, the estimated uncertainty is 0.0000.

In addition, some labs such as P774 and P850 could not calculate the uncertainty propagation from the active power and total luminous flux for calculation of luminous efficacy uncertainty.

Comprehensively speaking, it could be concluded that not all laboratories could estimate their uncertainties very reasonably and proficiently, especially for LED artefacts. Therefore, more corresponding practices and trainings on uncertainties estimation should be carried out in future for some test laboratories.

7.2.2 Significant Digits

In this PT programme, the requirements of significant digits for test results are as follows in the “Measurement Results Report Form”(see Annex E-2):

“All measured values in at least four significant digits”.

A few laboratories provided the test results with 2 digits after the decimal point on current, such as lab P774 which lead to larger deviations from assigned value(s) for four LED artefacts. So the significant digits are also important for the test results, especially for the small current artefacts.

7.2.3 Deviation from Protocol

In this PT programme, the voltage of all LED artefacts is 220V AC. But Lab P189 used the 230V AC instead, so the deviations of electrical parameters from assigned value(s) are large and most En number(s) for current are outside ± 1.0 range (negative deviation).

7.2.4 Misoperation in PT Process

Some laboratories have also not noticed the burning condition for the NLTC-IDC artefacts, and burned them with 220V AC, which led to the damage of the artefacts. The new alternative artefacts have been transported to the participating laboratories and it delayed some time for this PT programme.

7.2.5 Photometric Quantities Measurements

As shown in Annex B.2.1, some laboratories reported very close values to the assigned value(s), but there are also some labs with large difference as more than 10%, with the maximum deviation 23.11%.

- Test procedures

During the testing, detailed operation steps will directly affect the testing results. For burning position, Lab P600 burned the NLTC-D, NLTC-HCCT and NLTC-LPF in horizontal position (in the protocol, the burning position of all artefacts are base up), which may lead to larger deviations from assigned value(s).

- Traceability of the standard artefact

Some laboratories calibrated their standard artefacts 2-5 years before this PT testing, which may affect the test results of luminous flux even if the standard artefact has changed very little. Therefore, the laboratories should check the validity of the traceability of the standard artefacts before testing.

- Difference for two test systems

According to the equipment information from 28 participating laboratories, 20 laboratories used sphere system for luminous flux measurements, 5 laboratories used Gonios, 2 laboratories used both Gonios and sphere system, and 1 laboratory has not tested the luminous flux.

From the test results, it could be found that there is no obvious difference between these two different systems.

7.2.6 Colorimetric Quantities Measurements

For colorimetric quantities measurements, most laboratories used sphere-spectrometer system, only 2 laboratories used gonio-spectrometer system, 1 laboratory used colorimeter (direct measurement emitted light), and 1 laboratory used double monochromator.

From the test results, it could be seen that all laboratories using Gonio-spectrometer system, colorimeter and double monochromator have small deviations from assigned value(s) in color measurements. So we might say that different color test equipments (spectrometer, colorimeter, double monochromator) would not affect the measurement accuracy if the laboratories use the correct method for color measurements. Detailed deviation information could be found in the Annex B.2.6, B.2.7, and B.2.8.

7.2.7 Electrical Quantities Measurements

The En number(s) of electrical quantities measurements in this programme have more unsatisfactory values than that of photometric and colorimetric quantities, especially for the LED artefacts.

The current measurements for each kind of LED artefacts have 5-8 unsatisfactory values in each figure (see Annex Figure B-11 to B-14). However, the En number(s) of active power for NLTC-OD, NLTC-D (except for P149) and NLTC-HCCT are most within ± 1.0 range. But the En number(s) of active power for NLTC-LPF has 6 unsatisfactory values.

It could be concluded that for active power measurements of NLTC-OD, NLTC-D and NLTC-HCCT are relative easier than that of NLTC-LPF. It verifies the initial assumption of this PT programme that the NLTC-LPF artefact has specific characteristics and would challenge the abilities of electrical measurements, including the equipments compatibility, wiring method, and test method.

Another important factor is the consistency confirmation between the first measurement and second measurement. From the test results provided by some participants, the difference in between two current measurements is 23% (NLTC-D artefact, for instance lab P108).

Although the active power are not calculated by some laboratories, but the logic relationship does not exist in the test results of artefacts. That is to say, the formular $P=U*I*PF$ is not valid in their measurements (for instance P149).

Detailed deviation information could be seen in the Annex B.2.3, B.2.4 and B.2.5.

8 Remarks

8.1 The PT tasks and corresponding responsible persons are presented in Table 8.1.

Table 8.1 Division of task table

Name	Unit	Duty
Professor Yoshi Ohno	NIST	Consultant of this PT programme
Mr. HUA Shuming	NLTC	Technical expert
Mr. HE Ping	CNAS	Coordinator of this PT programme
Dr. ZHANG Wei	NLTC	Coordinator of NLTC
Dr. WU Yang	NLTC	Vice-coordinator of NLTC
Professor TIAN Ling	CNAS	Report review
Mr. WANG Zhong	CNAS	Data analysis
Mr. XIN Hongzheng	NLTC	Test supervisor
Mr. WANG Lin	NLTC	Test engineer
Miss ZHANG Ting	NLTC	Dispatch artefacts

8.2 Further comments on the report should be promptly forwarded by email to CNAS or the PTP (NLTC), as follows:

CNAS: heping@cnas.org.cn; heping.peking@gmail.com;

NLTC: wuyang@nltc.cn; zhangwei@nltc.cn.

8.3 This final Report may be submitted to accreditation bodies, by the participants or by the reference laboratory, with a permission of the participating laboratory. Otherwise, this report is kept confidential and will not be disclosed by the participating laboratories. This report may be disclosed by the reference laboratory to an interested party, in which case the reference laboratory will ensure the anonymity of data.

9. Reference

- [1] IEA SSL Annex Interlaboratory Comparison 2013,
<http://ssl.iea-4e.org/task-2-ssl-testing/2013-ic>
- [2] ISO, Guide to the Expression of Uncertainty in Measurement, 1st Edition,
1993
- [3] CIE 198:2011: Determination of Measurement Uncertainties in Photometry.
- [4] ISO/IEC 17043:2010, Conformity assessment - General requirements for
proficiency testing.
- [5] ISO 13528:2005, Statistical methods for use in proficiency testing by
interlaboratory comparisons.
- [6] IEA SSL Annex Interlaboratory Comparison Protocol for NLTC.

Annex A: Assigned Value(s)

Table A.1 Assigned value(s) for Lab P011 and P097

Identifier	Measurement results																	
	Total luminous flux (lm)		Current (A)		Active power (W)		Luminous efficacy		x		y		CCT (K)		Ra		Power factor	
	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)
NLTC-IDC-21	614.9	1.4	3.950 ⁽¹⁾	0.30	42.98	0.78	14.30	1.6	0.4526	0.0006	0.4092	0.0006	2794	10	99.85	0.23	1.000	0.0010
NLTC-OD1-2	240.5	2.5	0.03068	2.2	4.877	1.8	49.31	3.1	0.4492	0.0025	0.4053	0.0025	2812	60	83.40	0.38	0.7226	0.013
NLTC-D-3	509.0	1.6	0.03680	0.85	7.086	0.88	71.82	1.9	0.4438	0.0025	0.4085	0.0025	2922	60	81.90	0.39	0.8752	0.011
NLTC-HCCT-4	537.5	1.6	0.03290	0.58	5.885	1.6	91.34	2.2	0.3304	0.0025	0.3430	0.0025	5592	111	79.62	0.68	0.8132	0.0060
NLTC-LPF-5	441.4	2.5	0.04850	1.1	5.266	0.56	83.80	2.7	0.4242	0.0025	0.3948	0.0025	3150	60	83.50	0.49	0.4938	0.0040

Note:

- (1) For NLTC-IDC artefacts, the current is a controlled quantity as an input parameter, it is not an assessment quantity in this PT programme. In this table, it is an input value, not assigned value.
- (2) For LED artefacts, the voltage is a controlled quantity as an input parameter, so it is not an assessment quantity in this PT programme. In this table, it is an input value, not assigned value.
- (3) The above two notes apply to the following tables from Table A.2 to Table A.21.

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Table A.2 Assigned value(s) for Lab P108

Identifier	Measurement results																	
	Total luminous flux (lm)		Current (A)		Active power (W)		Luminous efficacy		x		y		CCT (K)		Ra		Power factor	
	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty
NLTC-IDC-30	568.7	1.4	3.950	0.30	41.87	0.78	13.58	1.6	0.4544	0.0006	0.4098	0.0006	2771	10	99.80	0.23	1.000	0.0010
NLTC-OD1-30	216.8	2.5	0.03133	2.2	4.795	1.8	45.22	3.1	0.4508	0.0025	0.4076	0.0025	2808	60	84.60	0.38	0.6955	0.013
NLTC-D-30	501.6	1.6	0.03758	0.85	6.941	0.88	72.27	1.9	0.4422	0.0025	0.4058	0.0025	2927	60	81.90	0.39	0.8393	0.011
NLTC-HCCT-30	543.0	1.6	0.0330	0.58	5.895	1.6	92.10	2.2	0.3274	0.0025	0.3356	0.0025	5732	111	78.98	0.68	0.8120	0.0060
NLTC-LPF-30	462.4	2.5	0.05020	1.1	5.503	0.56	84.02	2.7	0.4262	0.0025	0.3962	0.0025	3124	60	83.55	0.49	0.4983	0.0040

Table A.3 Assigned value(s) for Lab P142 and P146

Identifier	Measurement results																	
	Total luminous flux (lm)		Current (A)		Active power (W)		Luminous efficacy		x		y		CCT (K)		Ra		Power factor	
	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty
NLTC-IDC-2	596.6	1.4	3.950	0.30	42.28	0.78	14.11	1.6	0.4534	0.0006	0.4095	0.0006	2783	10	99.84	0.23	1.000	0.0010
NLTC-OD1-3	222.4	2.5	0.03077	2.2	4.858	1.8	45.78	3.1	0.4526	0.0025	0.4102	0.0025	2800	60	83.95	0.38	0.7177	0.013
NLTC-D-4	521.9	1.6	0.03836	0.85	7.148	0.88	73.00	1.9	0.4432	0.0025	0.4090	0.0025	2936	60	82.35	0.39	0.8466	0.011
NLTC-HCCT-5	540.2	1.6	0.03379	0.58	6.019	1.6	89.76	2.2	0.3282	0.0025	0.3382	0.0025	5690	111	79.20	0.68	0.8096	0.0060
NLTC-LPF-6	441.4	2.5	0.04868	1.1	5.286	0.56	83.50	2.7	0.4375	0.0025	0.4052	0.0025	2998	60	82.30	0.49	0.4938	0.0040

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Table A.4 Assigned value(s) for Lab P149

Identifier	Measurement results																	
	Total luminous flux (lm)		Current (A)		Active power (W)		Luminous efficacy		x		y		CCT (K)		Ra		Power factor	
	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)
NLTC-IDC-3	600.9	1.4	3.950	0.30	42.52	0.78	14.13	1.6	0.4528	0.0006	0.4092	0.0006	2790	10	99.85	0.23	1.000	0.0010
NLTC-OD1-4	229.8	2.5	0.03117	2.2	4.763	1.8	48.26	3.1	0.4511	0.0025	0.4080	0.0025	2806	60	82.92	0.38	0.6945	0.013
NLTC-D-5	500.0	1.6	0.03828	0.85	6.948	0.88	71.96	1.9	0.4420	0.0025	0.4075	0.0025	2944	60	81.95	0.39	0.8270	0.011
NLTC-HCCT-6	540.6	1.6	0.03293	0.58	5.871	1.6	92.08	2.2	0.3298	0.0025	0.3399	0.0025	5618	111	79.16	0.68	0.8104	0.0060
NLTC-LPF-7	438.0	2.5	0.04788	1.1	5.194	0.56	84.32	2.7	0.4310	0.0025	0.4030	0.0025	3094	60	83.10	0.49	0.4931	0.0040

Table A.5 Assigned value(s) for Lab P152

Identifier	Measurement results																	
	Total luminous flux (lm)		Current (A)		Active power (W)		Luminous efficacy		x		y		CCT (K)		Ra		Power factor	
	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)
NLTC-IDC-24	625.9	1.4	3.950	0.30	46.29	0.78	13.52	1.6	0.4516	0.0006	0.4088	0.0006	2804	10	99.88	0.23	1.000	0.0010
NLTC-OD1-6	220.7	2.5	0.02984	2.2	4.690	1.8	47.05	3.1	0.4517	0.0025	0.4090	0.0025	2806	60	84.75	0.38	0.7145	0.013
NLTC-D-7	519.6	1.6	0.03750	0.85	7.184	0.88	72.34	1.9	0.4415	0.0025	0.4104	0.0025	2974	60	82.34	0.39	0.8709	0.011
NLTC-HCCT-8	541.8	1.6	0.03323	0.58	5.940	1.6	91.20	2.2	0.3282	0.0025	0.3371	0.0025	5694	111	79.08	0.68	0.8123	0.0060
NLTC-LPF-9	424.8	2.5	0.05022	1.1	5.566	0.56	77.04	2.7	0.4395	0.0025	0.4084	0.0025	2992	60	82.10	0.49	0.5037	0.0040

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Table A.6 Assigned value(s) for Lab P153 and P158

Identifier	Measurement results																	
	Total luminous flux (lm)		Current (A)		Active power (W)		Luminous efficacy		x		y		CCT (K)		Ra		Power factor	
	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty
NLTC-IDC-6	628.8	1.4	3.950	0.30	43.70	0.78	14.38	1.6	0.4520	0.0006	0.4091	0.0006	2800	10	99.80	0.23	1.000	0.0010
NLTC-OD1-7	224.6	2.5	0.02948	2.2	4.697	1.8	47.82	3.1	0.4510	0.0025	0.4094	0.0025	2818	60	84.80	0.38	0.7244	0.013
NLTC-D-8	513.4	1.6	0.03508	0.85	7.086	0.88	72.44	1.9	0.4429	0.0025	0.4082	0.0025	2936	60	81.88	0.39	0.9182	0.011
NLTC-HCCT-9	542.7	1.6	0.03302	0.58	5.898	1.6	92.02	2.2	0.3294	0.0025	0.3404	0.0025	5636	111	78.90	0.68	0.8118	0.0060
NLTC-LPF-10	452.8	2.5	0.04988	1.1	5.464	0.56	82.88	2.7	0.4394	0.0025	0.4065	0.0025	2978	60	82.20	0.49	0.4980	0.0040

Table A.7 Assigned value(s) for Lab P185

Identifier	Measurement results																	
	Total luminous flux (lm)		Current (A)		Active power (W)		Luminous efficacy		x		y		CCT (K)		Ra		Power factor	
	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty
NLTC-IDC-7	619.5	1.4	3.950	0.30	43.25	0.78	14.32	1.6	0.4500	0.0006	0.4087	0.0006	2828	10	99.82	0.23	1.000	0.0010

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Table A.8 Assigned value(s) for Lab P189

Identifier	Measurement results																	
	Total luminous flux (lm)		Current (A)		Active power (W)		Luminous efficacy		x		y		CCT (K)		Ra		Power factor	
	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)
NLTC-IDC-8	594.6	1.4	3.950	0.30	43.43	0.78	13.70	1.6	0.4534	0.0006	0.4093	0.0006	2784	10	99.85	0.23	1.000	0.0010
NLTC-OD1-9	238.7	2.5	0.03020	2.2	4.826	1.8	49.46	3.1	0.4514	0.0025	0.4066	0.0025	2790	60	82.10	0.38	0.7265	0.013
NLTC-D-10	534.6	1.6	0.03822	0.85	7.332	0.88	72.92	1.9	0.4436	0.0025	0.4093	0.0025	2933	60	81.85	0.39	0.8720	0.011
NLTC-HCCT-11	529.2	1.6	0.03324	0.58	5.936	1.6	89.14	2.2	0.3236	0.0025	0.3309	0.0025	5930	111	79.86	0.68	0.8116	0.0060
NLTC-LPF-12	431.0	2.5	0.04719	1.1	5.113	0.56	84.30	2.7	0.4403	0.0025	0.4098	0.0025	2990	60	82.10	0.49	0.4926	0.0040

Table A.9 Assigned value(s) for Lab P294 and P342

Identifier	Measurement results																	
	Total luminous flux (lm)		Current (A)		Active power (W)		Luminous efficacy		x		y		CCT (K)		Ra		Power factor	
	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)
NLTC-IDC-9	604.0	1.4	3.950	0.30	43.73	0.78	13.81	1.6	0.4538	0.0006	0.4108	0.0006	2788	10	99.85	0.23	1.000	0.0010
NLTC-OD1-10	233.6	2.5	0.03150	2.2	4.853	1.8	48.14	3.1	0.4514	0.0025	0.4077	0.0025	2801	60	82.68	0.38	0.7000	0.013
NLTC-D-11	510.4	1.6	0.03716	0.85	7.062	0.88	72.28	1.9	0.4451	0.0025	0.4135	0.0025	2942	60	81.68	0.39	0.8639	0.011
NLTC-HCCT-12	523.1	1.6	0.03397	0.58	5.966	1.6	87.66	2.2	0.3234	0.0025	0.3318	0.0025	5936	111	79.66	0.68	0.7990	0.0060
NLTC-LPF-13	448.8	2.5	0.04872	1.1	5.373	0.56	83.53	2.7	0.4300	0.0025	0.4027	0.0025	3110	60	82.74	0.49	0.5013	0.0040

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Table A.10 Assigned value(s) for Lab P416 and P424

Identifier	Measurement results																	
	Total luminous flux (lm)		Current (A)		Active power (W)		Luminous efficacy		x		y		CCT (K)		Ra		Power factor	
	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty
NLTC-IDC-10	594.7	1.4	3.950	0.30	43.17	0.78	13.78	1.6	0.4536	0.0006	0.4096	0.0006	2780	10	99.80	0.23	1.000	0.0010
NLTC-OD1-11	214.4	2.5	0.02977	2.2	4.675	1.8	45.86	3.1	0.4510	0.0025	0.4076	0.0025	2805	60	84.64	0.38	0.7152	0.013
NLTC-D-12	515.4	1.6	0.03505	0.85	7.143	0.88	72.16	1.9	0.4436	0.0025	0.4092	0.0025	2931	60	81.80	0.39	0.9263	0.011
NLTC-HCCT-13	539.4	1.6	0.03343	0.58	5.956	1.6	90.56	2.2	0.3304	0.0025	0.3436	0.0025	5588	111	79.96	0.68	0.8098	0.0060
NLTC-LPF-14	462.8	2.5	0.05025	1.1	5.504	0.56	84.10	2.7	0.4261	0.0025	0.3960	0.0025	3125	60	83.55	0.49	0.4979	0.0040

Table A.11 Assigned value(s) for Lab P446

Identifier	Measurement results																	
	Total luminous flux (lm)		Current (A)		Active power (W)		Luminous efficacy		x		y		CCT (K)		Ra		Power factor	
	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty
NLTC-IDC-11	568.5	1.4	3.950	0.30	42.15	0.78	13.49	1.6	0.4548	0.0006	0.4098	0.0006	2766	10	99.80	0.23	1.000	0.0010
NLTC-OD1-12	249.4	2.5	0.03039	2.2	4.837	1.8	51.55	3.1	0.4512	0.0025	0.4077	0.0025	2800	60	82.10	0.38	0.7235	0.013
NLTC-D-13	529.8	1.6	0.03985	0.85	7.252	0.88	73.06	1.9	0.4424	0.0025	0.4098	0.0025	2954	60	81.95	0.39	0.8272	0.011
NLTC-HCCT-14	544.1	1.6	0.03349	0.58	5.954	1.6	91.38	2.2	0.3306	0.0025	0.3435	0.0025	5580	111	79.50	0.68	0.8082	0.0060
NLTC-LPF-1	463.6	2.5	0.05036	1.1	5.573	0.56	83.19	2.7	0.4316	0.0025	0.4034	0.0025	3087	60	82.80	0.49	0.5030	0.0040

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Table A.12 Assigned value(s) for Lab P516 and P533

Identifier	Measurement results																	
	Total luminous flux (lm)		Current (A)		Active power (W)		Luminous efficacy		x		y		CCT (K)		Ra		Power factor	
	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty
NLTC-IDC-R12	588.5	1.4	3.95	0.30	43.02	0.78	13.69	1.6	0.4542	0.0006	0.4098	0.0006	2774	10	99.80	0.23	1.000	0.0010
NLTC-OD1-13	240.4	2.5	0.03051	2.2	4.800	1.8	50.08	3.1	0.4493	0.0025	0.4050	0.0025	2810	60	82.76	0.38	0.7152	0.013
NLTC-D-14	528.8	1.6	0.03658	0.85	7.002	0.88	75.53	1.9	0.4414	0.0025	0.4077	0.0025	2954	60	82.00	0.39	0.8700	0.011
NLTC-HCCT-1	545.7	1.6	0.03410	0.58	5.982	1.6	91.23	2.2	0.3288	0.0025	0.3382	0.0025	5666	111	78.95	0.68	0.7976	0.0060
NLTC-LPF-2	436.2	2.5	0.04950	1.1	5.109	0.56	85.39	2.7	0.4380	0.0025	0.4061	0.0025	2998	60	82.20	0.49	0.4691	0.0040

Table A.13 Assigned value(s) for Lab P600

Identifier	Measurement results																	
	Total luminous flux (lm)		Current (A)		Active power (W)		Luminous efficacy		x		y		CCT (K)		Ra		Power factor	
	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty
NLTC-IDC-R13	608.3	1.4	3.950	0.30	42.42	0.78	14.34	1.6	0.4526	0.0006	0.4094	0.0006	2794	10	99.80	0.23	1.000	0.0010
NLTC-OD1-14	235.4	2.5	0.03048	2.2	4.854	1.8	48.49	3.1	0.4517	0.0025	0.4069	0.0025	2788	60	83.18	0.38	0.7240	0.013
NLTC-D-1	529.0	1.6	0.03864	0.85	7.212	0.88	73.34	1.9	0.4438	0.0025	0.4096	0.0025	2932	60	82.05	0.39	0.8484	0.011
NLTC-HCCT-2	521.1	1.6	0.03324	0.58	5.916	1.6	88.08	2.2	0.3286	0.0025	0.3380	0.0025	5672	111	79.32	0.68	0.8091	0.0060
NLTC-LPF-3	464.6	2.5	0.05091	1.1	5.583	0.56	83.22	2.7	0.4310	0.0025	0.4043	0.0025	3105	60	82.60	0.49	0.4985	0.0040

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Table A.14 Assigned value(s) for Lab P630

Identifier	Measurement results																	
	Total luminous flux (lm)		Current (A)		Active power (W)		Luminous efficacy		x		y		CCT (K)		Ra		Power factor	
	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty
NLTC-IDC-14	583.2	1.4	3.950	0.30	43.23	0.78	13.49	1.6	0.4535	0.0006	0.4096	0.0006	2784	10	99.80	0.23	1.000	0.0010
NLTC-OD1-1	222.1	2.5	0.0299	2.2	4.772	1.8	46.54	3.1	0.4523	0.0025	0.4116	0.0025	2817	60	84.80	0.38	0.7254	0.013
NLTC-D-2	524.8	1.6	0.03692	0.85	7.076	0.88	74.18	1.9	0.4422	0.0025	0.4074	0.0025	2941	60	82.50	0.39	0.8712	0.011
NLTC-HCCT-3	522.1	1.6	0.03352	0.58	6.009	1.6	86.88	2.2	0.3284	0.0025	0.3373	0.0025	5686	111	79.45	0.68	0.8146	0.0060
NLTC-LPF-4	440.2	2.5	0.04824	1.1	5.230	0.56	84.18	2.7	0.4396	0.0025	0.4078	0.0025	2985	60	82.20	0.49	0.4928	0.0040

Table A.15 Assigned value(s) for Lab P639

Identifier	Measurement results																	
	Total luminous flux (lm)		Current (A)		Active power (W)		Luminous efficacy		x		y		CCT (K)		Ra		Power factor	
	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty
NLTC-IDC-R14	584.6	1.4	3.950	0.30	43.08	0.78	13.57	1.6	0.4541	0.0006	0.4096	0.0006	2775	10	99.80	0.23	1.000	0.0010
NLTC-OD1-1	222.1	2.5	0.02990	2.2	4.772	1.8	46.54	3.1	0.4523	0.0025	0.4116	0.0025	2817	60	84.80	0.38	0.7254	0.013
NLTC-D-2	524.8	1.6	0.03692	0.85	7.076	0.88	74.18	1.9	0.4422	0.0025	0.4074	0.0025	2941	60	82.50	0.39	0.8712	0.011
NLTC-HCCT-3	522.1	1.6	0.03352	0.58	6.009	1.6	86.88	2.2	0.3284	0.0025	0.3373	0.0025	5686	111	79.45	0.68	0.8146	0.0060
NLTC-LPF-4	440.2	2.5	0.04824	1.1	5.230	0.56	84.18	2.7	0.4396	0.0025	0.4078	0.0025	2985	60	82.20	0.49	0.4928	0.0040

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Table A.16 Assigned value(s) for Lab P693

Identifier	Measurement results																	
	Total luminous flux (lm)		Current (A)		Active power (W)		Luminous efficacy		x		y		CCT (K)		Ra		Power factor	
	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty
NLTC-IDC-15	577.7	1.4	3.950	0.30	42.24	0.78	13.68	1.6	0.4542	0.0006	0.4096	0.0006	2772	10	99.84	0.23	1.000	0.0010
NLTC-OD1-16	248.7	2.5	0.03200	2.2	4.947	1.8	50.28	3.1	0.4532	0.0025	0.4094	0.0025	2786	60	82.55	0.38	0.7026	0.013
NLTC-D-17	528.8	1.6	0.03869	0.85	7.362	0.88	71.82	1.9	0.4434	0.0025	0.4100	0.0025	2942	60	81.90	0.39	0.8650	0.011
NLTC-HCCT-18	513.5	1.6	0.03315	0.58	5.914	1.6	86.84	2.2	0.3274	0.0025	0.3414	0.0025	5727	111	79.27	0.68	0.8094	0.0060
NLTC-LPF-19	466.4	2.5	0.05115	1.1	5.630	0.56	82.84	2.7	0.4384	0.0025	0.4060	0.0025	2990	60	82.06	0.49	0.5003	0.0040

Table A.17 Assigned value(s) for Lab P725

Identifier	Measurement results																	
	Total luminous flux (lm)		Current (A)		Active power (W)		Luminous efficacy		x		y		CCT (K)		Ra		Power factor	
	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty
NLTC-IDC-20	596.3	1.4	3.950	0.30	43.44	0.78	13.73	1.6	0.4536	0.0006	0.4094	0.0006	2782	10	99.85	0.23	1.000	0.0010
NLTC-OD1-15	229.8	2.5	0.03102	2.2	4.812	1.8	47.74	3.1	0.4506	0.0025	0.4049	0.0025	2788	60	82.75	0.38	0.7053	0.013
NLTC-D-16	526.1	1.6	0.03888	0.85	7.180	0.88	73.26	1.9	0.4406	0.0025	0.4071	0.0025	2964	60	82.15	0.39	0.8395	0.011
NLTC-HCCT-17	535.4	1.6	0.03315	0.58	5.883	1.6	91.00	2.2	0.3288	0.0025	0.3387	0.0025	5662	111	79.20	0.68	0.8059	0.0060
NLTC-LPF-18	456.9	2.5	0.04930	1.1	5.492	0.56	83.20	2.7	0.4300	0.0025	0.4014	0.0025	3097	60	83.00	0.49	0.5064	0.0040

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Table A.18 Assigned value(s) for Lab P774 and P850

Identifier	Measurement results																	
	Total luminous flux (lm)		Current (A)		Active power (W)		Luminous efficacy		x		y		CCT (K)		Ra		Power factor	
	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty
NLTC-IDC-16	585.2	1.4	3.950	0.30	46.93	0.78	12.47	1.6	0.4552	0.0006	0.4100	0.0006	2762	10	99.82	0.23	1.000	0.0010
NLTC-OD1-17	245.0	2.5	0.03007	2.2	4.788	1.8	51.17	3.1	0.4506	0.0025	0.4080	0.0025	2814	60	82.32	0.38	0.7237	0.013
NLTC-D-18	531.8	1.6	0.03596	0.85	7.122	0.88	74.68	1.9	0.4414	0.0025	0.4080	0.0025	2956	60	82.14	0.39	0.9001	0.011
NLTC-HCCT-19	518.6	1.6	0.03310	0.58	5.916	1.6	87.67	2.2	0.3239	0.0025	0.3317	0.0025	5914	111	79.40	0.68	0.8124	0.0060
NLTC-LPF-20	452.8	2.5	0.04988	1.1	5.497	0.56	82.38	2.7	0.4380	0.0025	0.4092	0.0025	3023	60	82.10	0.49	0.5011	0.0040

Table A.19 Assigned value(s) for Lab P891

Identifier	Measurement results																	
	Total luminous flux (lm)		Current (A)		Active power (W)		Luminous efficacy		x		y		CCT (K)		Ra		Power factor	
	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty
NLTC-IDC-17	591.3	1.4	3.950	0.30	46.87	0.78	12.62	1.6	0.4534	0.0006	0.4094	0.0006	2784	10	99.85	0.23	1.000	0.0010
NLTC-OD1-18	228.6	2.5	0.02910	2.2	4.670	1.8	48.94	3.1	0.4516	0.0025	0.4102	0.0025	2815	60	84.15	0.38	0.7294	0.013
NLTC-D-19	525.4	1.6	0.03634	0.85	7.100	0.88	74.00	1.9	0.4416	0.0025	0.4082	0.0025	2956	60	82.05	0.39	0.8881	0.011
NLTC-HCCT-20	514.2	1.6	0.03312	0.58	5.940	1.6	86.55	2.2	0.3239	0.0025	0.3324	0.0025	5905	111	79.88	0.68	0.8150	0.0060
NLTC-LPF-15	466.5	2.5	0.05001	1.1	5.593	0.56	83.40	2.7	0.4386	0.0025	0.4061	0.0025	2987	60	82.00	0.49	0.5084	0.0040

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Table A.20 Assigned value(s) for Lab P895

Identifier	Measurement results																	
	Total luminous flux (lm)		Current (A)		Active power (W)		Luminous efficacy		x		y		CCT (K)		Ra		Power factor	
	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty
NLTC-IDC-18	601.5	1.4	3.950	0.30	46.81	0.78	12.85	1.6	0.4512	0.0006	0.4092	0.0006	2814	10	99.90	0.23	1	0.0010
NLTC-OD1-19	224.8	2.5	0.03024	2.2	4.846	1.8	46.40	3.1	0.4510	0.0025	0.4077	0.0025	2806	60	83.80	0.38	0.7280	0.013
NLTC-D-20	523.0	1.6	0.03709	0.85	7.142	0.88	73.22	1.9	0.4404	0.0025	0.4068	0.0025	2963	60	82.20	0.39	0.8754	0.011
NLTC-HCCT-15	534.5	1.6	0.03368	0.58	6.004	1.6	89.02	2.2	0.3309	0.0025	0.3434	0.0025	5568	111	79.70	0.68	0.8103	0.0060
NLTC-LPF-16	445.5	2.5	0.04933	1.1	5.360	0.56	82.12	2.7	0.4383	0.0025	0.4058	0.0025	2990	60	82.16	0.49	0.4938	0.0040

Table A.21 Assigned value(s) for Lab P920

Identifier	Measurement results																	
	Total luminous flux (lm)		Current (A)		Active power (W)		Luminous efficacy		x		y		CCT (K)		Ra		Power factor	
	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty
NLTC-IDC-R19	565.8	1.4	3.950	0.30	42.07	0.78	13.44	1.6	0.4548	0.0006	0.4098	0.0006	2766	10	99.60	0.23	1.000	0.0010
NLTC-OD1-20	229.8	2.5	0.03072	2.2	4.620	1.8	49.76	3.1	0.4524	0.0025	0.4096	0.0025	2800	60	83.70	0.38	0.6836	0.013
NLTC-D-15	502.5	1.6	0.04039	0.85	6.977	0.88	72.02	1.9	0.4421	0.0025	0.4076	0.0025	2942	60	81.85	0.39	0.7852	0.011
NLTC-HCCT-16	517.8	1.6	0.03257	0.58	5.804	1.6	89.22	2.2	0.3254	0.0025	0.3395	0.0025	5818	111	79.04	0.68	0.8102	0.0060
NLTC-LPF-17	451.2	2.5	0.04934	1.1	5.390	0.56	83.71	2.7	0.4383	0.0025	0.4056	0.0025	2990	60	82.30	0.49	0.4966	0.0040

Annex B: Results Presentations of Participants

In this section, testing results, the (relative) differences between the participant's measurement values and the Assigned value(s), participants' reported uncertainties, the En number(s), for all participants, for all or part of artefacts and quantities, are presented in the following sections. Please note that if the drifts of some artefacts before and after delivery affect the evaluation of the reference uncertainty, see Annex D.

B.1 Test Results of Participants

Photometric measurement of Solid State Lighting Program
APLAC T088

B.1.1 Test Results of Lab P011

Table B.1 Test results of Lab P011

Identifier		Measurement results																	
		Total luminous flux (lm)		Current (A)		Active power (W)		Luminous efficacy		x		y		CCT (K)		Ra		Power factor	
		Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)
NLTC-IDC-21	1	615.2573		3.9500		49.4698		12.4370		0.4520		0.4090		2801.3000		99.8445		/	
	2	616.0263		3.9500		49.8372		12.3608		0.4521		0.4090		2799.6000		99.8202		/	
	Avg.	615.6418	1.00	3.9500	0.35	49.6535	0.50	12.3989	1.30	0.4520	0.0008	0.409	0.0004	2800.45	7.00	99.8324	0.50	/	/
NLTC-OD1-2	1	241.2690		0.0300		4.8810		49.4302		0.4492		0.4049		2809.7000		83.6909		0.7400	
	2	241.5227		0.0310		4.8710		49.5838		0.4492		0.4048		2809.6000		83.7157		0.7380	
	Avg.	241.3959	1.00	0.0305	0.35	4.8760	0.50	49.5070	1.30	0.4492	0.0008	0.4048	0.0004	2809.65	7.00	83.7033	0.50	0.7390	0.03
NLTC-D-3	1	494.2031		0.0370		7.1310		69.3035		0.4435		0.4083		2925.9526		82.3477		0.8760	
	2	491.6524		0.0370		7.1630		68.6378		0.4431		0.4083		2932.3000		82.2742		0.8800	
	Avg.	492.9278	1.00	0.0370	0.35	7.1470	0.50	68.9706	1.30	0.4433	0.0008	0.4083	0.0004	2929.126	7.00	82.3110	0.50	0.8780	0.03
NLTC-HCCT-4	1	531.2076		0.0330		5.9480		89.3086		0.3304		0.3437		5591.0000		79.6653		0.8190	
	2	530.4318		0.0330		5.9610		88.9837		0.3303		0.3436		5594.2000		79.7142		0.8210	
	Avg.	530.8197	1.00	0.0330	0.35	5.9545	0.50	89.1462	1.30	0.3304	0.0008	0.3436	0.0004	5592.6	7.00	79.6898	0.50	0.8200	0.03
NLTC-LPF-5	1	434.6273		0.0490		5.3530		81.1932		0.4241		0.3950		3152.6000		83.7280		0.4950	
	2	433.6631		0.0490		5.3360		81.2712		0.4241		0.3950		3153.4000		83.7358		0.4950	
	Avg.	434.1452	1.00	0.0490	0.35	5.3445	0.50	81.2322	1.30	0.4241	0.0008	0.3950	0.0004	3153	7.00	83.7319	0.50	0.4950	0.03

Photometric measurement of Solid State Lighting Program
APLAC T088

Table B.2 En number(s) for Lab P011

Identifier	Measurement results								
	Total luminous flux	Current	Active power	Luminous efficacy	x	y	CCT	Ra	Power factor
NLTC-IDC-21	0.1	N/A	16.8	-6.4	-0.6	-0.3	0.5	0.0	/
NLTC-OD1-2	0.1	-0.3	0.0	0.1	0.0	-0.2	0.0	0.5	0.5
NLTC-D-3	-1.7	0.6	0.8	-1.7	-0.2	-0.1	0.1	0.6	0.1
NLTC-HCCT-4	-0.7	0.4	0.7	-0.9	0.0	0.2	0.0	0.1	0.2
NLTC-LPF-5	-0.6	0.9	2.0	-1.0	0.0	0.1	0.0	0.3	0.0

Photometric measurement of Solid State Lighting Program
APLAC T088

B.1.2 Test Results of Lab P097

Table B.3 Test results of Lab P097

Identifier		Measurement results																	
		Total luminous flux (lm)		Current (A)		Active power (W)		Luminous efficacy		x		y		CCT (K)		Ra		Power factor	
		Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)
NLTC-IDC-21	1	611		3.950		43.1		14.2		0.4518		0.4087		2802		100		1.00	
	2	611		3.950		43.1		14.2		0.4516		0.4086		2804		100		1.00	
	Avg.	611	2.1	3.950	0.12	43.1	0.35	14.2	2.6	0.4517	0.003	0.4086	0.003	2803	50	100	2	1.00	0.02
NLTC-OD1-2	1	238		0.031		4.84		49.2		0.4505		0.4048		2791		84		0.72	
	2	239		0.031		4.84		49.4		0.4501		0.4047		2795		84		0.72	
	Avg.	238	2.1	0.031	0.12	4.84	0.35	49.3	2.6	0.4503	0.003	0.4048	0.003	2793	50	84	2	0.72	0.02
NLTC-D-3	1	501		0.037		7.08		70.8		0.4429		0.4047		2908		83		0.87	
	2	501		0.037		7.08		70.8		0.4427		0.4046		2910		83		0.87	
	Avg.	501	2.1	0.037	0.12	7.08	0.35	70.8	2.6	0.4428	0.003	0.4046	0.003	2909	50	83	2	0.87	0.02
NLTC-HCCT-4	1	529		0.033		5.90		89.7		0.3307		0.3422		5580		79		0.81	
	2	529		0.033		5.90		89.7		0.3304		0.342		5590		79		0.81	
	Avg.	529	2.1	0.033	0.12	5.90	0.35	89.7	2.6	0.3306	0.003	0.3421	0.003	5585	250	79	2	0.81	0.02
NLTC-LPF-5	1	433		0.048		5.27		82.2		0.4236		0.3934		3150		84		0.50	
	2	433		0.048		5.26		82.3		0.4246		0.3939		3134		84		0.50	
	Avg.	433	2.1	0.048	0.12	5.26	0.35	82.2	2.6	0.4241	0.003	0.3936	0.003	3142	50	84	2	0.50	0.02

Photometric measurement of Solid State Lighting Program
APLAC T088

Table B.4 En number(s) for Lab P097

Identifier	Measurement results								
	Total luminous flux	Current	Active power	Luminous efficacy	x	y	CCT	Ra	Power factor
NLTC-IDC-21	-0.2	N/A	0.3	-0.2	-0.3	-0.2	0.2	0.1	/
NLTC-OD1-2	-0.3	0.5	-0.4	0.0	0.3	-0.1	-0.2	0.3	-0.1
NLTC-D-3	-0.6	0.6	-0.1	-0.4	-0.3	-1.0	-0.2	0.5	-0.2
NLTC-HCCT-4	-0.6	0.5	0.2	-0.5	0.1	-0.2	0.0	-0.3	-0.2
NLTC-LPF-5	-0.6	-0.9	-0.2	-0.5	0.0	-0.3	-0.1	0.2	0.3

Photometric measurement of Solid State Lighting Program
APLAC T088

B.1.3 Test Results of Lab P108

Table B.5 Test results of Lab P108

Identifier		Measurement results																	
		Total luminous		Current		Active power		Luminous		x		y		CCT		Ra		Power factor	
		flux (lm)		(A)		(W)		efficacy						(K)					
Result	Uncertai	Result	Uncertai	Result	Uncertai	Result	Uncertai	Result	Uncertai	Result	Uncertai	Result	Uncertai	Result	Uncert-a	Result	Uncertai	Result	Uncertai
		-nty(%)	-nty(%)												inty				
NLTC-IDC-30	1	567.8		3.9500		41.82		13.58		0.4546		0.4096		2767		100		1	
	2	567.9		3.9500		41.78		13.59		0.4547		0.4096		2766		100		1	
	Avg.	567.8	0.72	3.9500	0.013	41.80	0.017	13.58	0.72	0.4546	0.00051	0.4096	0.00040	2766	7.5	100	0.088	1	/
NLTC-OD1-30	1	218.1		0.0464		4.72		46.21		0.4512		0.4066		2794		85		0.4624	
	2	217.4		0.0462		4.72		46.05		0.4510		0.4064		2795		85		0.4644	
	Avg.	217.8	0.80	0.0463	0.78	4.72	3.0	46.13	3.1	0.4511	0.00066	0.4065	0.00051	2794	10	85	0.16	0.4634	0.014
NLTC-D-30	1	497.6		0.0503		6.92		71.90		0.4408		0.4048		2941		83		0.6252	
	2	496.0		0.0621		6.92		71.68		0.4408		0.4047		2941		83		0.5066	
	Avg.	496.8	0.82	0.0562	0.59	6.92	2.0	71.79	2.2	0.4408	0.00066	0.4048	0.00055	2941	12	83	0.17	0.5659	0.011
NLTC-HCCT-30	1	542.4		0.0334		5.91		91.78		0.3272		0.3350		5741		79		0.8044	
	2	544.9		0.0334		5.90		92.36		0.3271		0.3351		5749		79		0.8030	
	Avg.	543.6	0.88	0.0334	1.1	5.90	2.4	92.07	2.6	0.3272	0.00058	0.3350	0.00047	5745	18	79	0.18	0.8037	0.021
NLTC-LPF-30	1	458.4		0.0505		5.50		83.35		0.4259		0.3944		3115		84		0.4951	
	2	461.8		0.0505		5.50		83.97		0.4255		0.3944		3121		84		0.4951	
	Avg.	460.1	1.0	0.0505	0.72	5.50	2.6	83.66	2.8	0.4257	0.00071	0.3944	0.00044	3118	13	84	0.15	0.4951	0.013

Photometric measurement of Solid State Lighting Program
APLAC T088

Table B.6 En number(s) for Lab P108

Identifier	Measurement results								
	Total luminous flux	Current	Active power	Luminous efficacy	x	y	CCT	Ra	Power factor
NLTC-IDC-30	-0.1	N/A	-0.2	0.0	0.3	-0.3	-0.4	0.9	/
NLTC-OD1-30	0.2	20.5	-0.4	0.5	0.1	-0.4	-0.2	1.0	-12.1
NLTC-D-30	-0.5	47.9	-0.1	-0.2	-0.5	-0.4	0.2	2.6	-17.6
NLTC-HCCT-30	0.1	1.0	0.0	0.0	-0.1	-0.2	0.1	0.0	-0.4
NLTC-LPF-30	-0.2	0.5	0.0	-0.1	-0.2	-0.7	-0.1	0.9	-0.2

Photometric measurement of Solid State Lighting Program
APLAC T088

B.1.4 Test Results of Lab P142

Table B.7 Test results of Lab P142

Identifier		Measurement results																	
		Total luminous flux (lm)		Current (A)		Active power (W)		Luminous efficacy		x		y		CCT (K)		Ra		Power factor	
		Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty
NLTC-IDC-2	1	599.42		3.95		46.31		12.94		0.4526		0.4089		2791		99.9		1	
	2	594.56		3.95		46.09		12.99		0.4525		0.4089		2793		99.9		1	
	Avg.	598.99	4.09	3.95	0.15	46.20	4.09	12.96	5.78	0.4526	0.0000453	0.4089	0.0000286	2792	0.726	99.9	0.290	1	0.0849
NLTC-OD1-3	1	227.36		0.031		4.9		46.4		0.4534		0.4092		2782		84.2		0.71	
	2	236.33		0.032		5		47.27		0.4535		0.4097		2785		84		0.71	
	Avg.	231.84	4.09	0.032	4.09	5.0	2.67	46.84	4.88	0.4534	0.0000453	0.4094	0.0000287	2784	0.724	84.1	0.244	0.71	0.060279
NLTC-D-4	1	506.15		0.04		7.2		70.3		0.4432		0.4068		2919		82.8		0.83	
	2	507.25		0.04		7.2		70.45		0.4435		0.4067		2915		82.9		0.83	
	Avg.	506.70	4.09	0.04	14.74	7.2	2.15	70.38	4.62	0.4434	0.0000443	0.4068	0.0000285	2917	0.758	82.8	0.240	0.83	0.060258
NLTC-HCCT-5	1	552.18		0.037		6.1		90.52		0.328		0.3369		5700		79.2		0.75	
	2	550.25		0.037		6.1		90.2		0.328		0.3368		5700		79.3		0.75	
	Avg.	551.22	4.09	0.037	3.38	6.1	2.21	90.36	4.65	0.3280	0.0000328	0.3368	0.0000236	5700	1.48	79.2	0.230	0.75	0.0603
NLTC-LPF-6	1	442.81		0.042		5.4		82		0.4381		0.4046		2984		82.6		0.58	
	2	440.77		0.042		5.4		81.62		0.4381		0.4044		2983		82.6		0.57	
	Avg.	441.79	4.09	0.042	3.30	5.4	2.27	81.81	4.68	0.4381	0.0000438	0.4045	0.0000283	2984	0.776	82.6	0.240	0.58	0.060835

Photometric measurement of Solid State Lighting Program
APLAC T088

Table B.8 En number(s) for Lab P142

Identifier	Measurement results								
	Total luminous flux	Current	Active power	Luminous efficacy	x	y	CCT	Ra	Power factor
NLTC-IDC-2	0.1	N/A	2.2	-1.4	-1.3	-1.0	0.9	0.2	/
NLTC-OD1-3	0.9	0.9	0.9	0.4	0.3	-0.3	-0.3	0.3	-0.1
NLTC-D-4	-0.7	0.3	0.3	-0.7	0.1	-0.9	-0.3	1.0	-0.3
NLTC-HCCT-5	0.5	2.8	0.5	0.1	-0.1	-0.6	0.1	0.0	-1.0
NLTC-LPF-6	0.0	-3.9	0.9	-0.4	0.2	-0.3	-0.2	0.5	1.4

Photometric measurement of Solid State Lighting Program
APLAC T088

B.1.5 Test Results of Lab P146

Table B.9 Test results of Lab P146

Identifier		Measurement results																	
		Total luminous flux (lm)		Current (A)		Active power (W)		Luminous efficacy		x		y		CCT (K)		Ra		Power factor	
		Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)
NLTC-IDC-2	1	590.37		3.9500		42.07		14.03		0.4531		0.4093		2787		99.8		1	
	2	590.56		3.9500		42.02		14.05		0.4534		0.4093		2782		99.9		1	
	Avg.	590.46	1.50	3.9500	0.10	42.04	0.10	14.04	14.67	0.4532	0.0009	0.4093	0.0009	2784	15	99.8	1.70	1	/
NLTC-OD1-3	1	225.49		0.0305		4.86		46.35		0.4533		0.4101		2790		84.2		0.7240	
	2	222.05		0.0305		4.84		45.38		0.4531		0.41		2792		84.2		0.7230	
	Avg.	223.77	1.50	0.0305	0.22	4.85	0.34	45.86	9.18	0.4532	0.0009	0.4100	0.0009	2791	15	84.2	1.70	0.7235	0.012
NLTC-D-4	1	519.11		0.0381		7.120		72.86		0.4407		0.4071		2961		82.4		0.8495	
	2	519.73		0.0381		7.119		73.00		0.441		0.4069		2956		82.5		0.8491	
	Avg.	519.42	1.50	0.0381	0.22	7.120	0.34	72.93	5.84	0.4408	0.0009	0.4070	0.0009	2958	15	82.4	1.70	0.8493	0.008
NLTC-HCCT-5	1	540.07		0.0336		6.03		89.43		0.3270		0.3364		5748		79.2		0.8147	
	2	538.14		0.0337		6.04		89.09		0.3271		0.3363		5755		79.4		0.8145	
	Avg.	539.10	1.50	0.0336	0.22	6.04	0.34	89.26	4.77	0.3270	0.0009	0.3364	0.0009	5752	15	79.3	1.70	0.8146	0.010
NLTC-LPF-6	1	438.15		0.0482		5.26		83.30		0.4370		0.4044		3002		82.4		0.4959	
	2	442.17		0.0481		5.26		84.06		0.4368		0.4047		3007		82.5		0.4962	
	Avg.	440.16	1.50	0.0482	0.22	5.26	0.34	83.68	5.09	0.4369	0.0009	0.4046	0.0009	3004	15	82.4	1.70	0.4960	0.018

Photometric measurement of Solid State Lighting Program
APLAC T088

Table B.10 En number(s) for Lab P146

Identifier	Measurement results								
	Total luminous flux	Current	Active power	Luminous efficacy	x	y	CCT	Ra	Power factor
NLTC-IDC-2	-0.5	N/A	-0.7	0.0	-0.2	-0.2	0.1	0.0	/
NLTC-OD1-3	0.2	-0.4	-0.1	0.0	0.2	-0.1	-0.1	0.1	0.3
NLTC-D-4	-0.2	-0.8	-0.4	0.0	-0.9	-0.8	0.4	0.0	0.2
NLTC-HCCT-5	-0.1	-0.9	0.2	-0.1	-0.5	-0.7	0.6	0.1	0.4
NLTC-LPF-6	-0.1	-0.9	-0.7	0.0	-0.2	-0.2	0.1	0.1	0.1

Photometric measurement of Solid State Lighting Program
APLAC T088

B.1.6 Test Results of Lab P149

Table B.11 Test results of Lab P149

Identifier		Measurement results																	
		Total luminous flux (lm)		Current (A)		Active power (W)		Luminous efficacy		x		y		CCT (K)		Ra		Power factor	
		Result	Uncertai nty(%)	Result	Uncertai nty(%)	Result	Uncertai nty(%)	Result	Uncertai nty(%)	Result	Uncertai nty	Result	Uncertai nty	Result	Uncert-a inty	Result	Uncertai nty	Result	Uncertai nty
NLTC-IDC-3	1	553.32		3.95		42.99		12.87		0.4701		0.4175		2610		98.9		1	
	2	553.32		3.9501		42.98		/		0.4702		0.4174		2609		98.9		1	
	Avg.	553.32	6.00	3.9500	1.10	42.98	1.60	12.87	6.20	0.4702	0.0065	0.4174	0.0065	2610	165	98.9	2.60	1	0.01
NLTC-OD1-4	1	208.08		0.03115		4.7		44.27		0.4553		0.4075		2739		82.8		0.78	
	2	207.6		0.03115		4.7		44.17		0.4556		0.4074		2733		82.8		0.78	
	Avg.	207.84	6.00	0.03115	1.10	4.7	1.60	44.22	6.20	0.4554	0.0065	0.4074	0.0065	2736	165	82.8	2.60	0.78	0.01
NLTC-D-5	1	630.61		0.03969		7.3		86.38		0.4482		0.4087		2857.62		81.3		0.87	
	2	600.48		0.03961		7.3		82.26		0.4481		0.4087		2858.82		81.3		0.87	
	Avg.	615.54	3.00	0.03965	1.10	7.3	1.60	84.32	3.40	0.4482	0.0065	0.4087	0.0065	2854.22	165	81.3	2.60	0.87	0.01
NLTC-HCCT-6	1	500.44		0.03476		5.9		84.82		0.3411		0.3496		5151.23		78.2		0.87	
	2	500.44		0.0348		5.9		84.82		0.3412		0.3496		5149.83		78.2		0.87	
	Avg.	500.44	6.00	0.03478	1.10	5.9	1.60	84.82	6.20	0.3412	0.0065	0.3496	0.0065	5150.53	360	78.2	2.60	0.87	0.01
NLTC-LPF-7	1	402.03		0.04474		5.2		77.31		0.4401		0.4082		2985.62		82.8		0.54	
	2	402.03		0.04486		5.2		77.36		0.4399		0.4082		2987.59		82.8		0.54	
	Avg.	402.03	6.00	0.04480	1.10	5.2	1.60	77.34	6.20	0.4400	0.0065	0.4082	0.0065	2986.60	165	82.8	2.60	0.54	0.01

Photometric measurement of Solid State Lighting Program
APLAC T088

Table B.12 En number(s) for Lab P149

Identifier	Measurement results								
	Total luminous flux	Current	Active power	Luminous efficacy	x	y	CCT	Ra	Power factor
NLTC-IDC-3	-1.3	N/A	0.6	-1.4	2.7	1.3	-1.1	-0.4	/
NLTC-OD1-4	-1.5	0.0	-0.5	-1.2	0.6	-0.1	-0.4	0.0	5.2
NLTC-D-5	6.8	2.6	2.8	4.4	0.9	0.2	-0.5	-0.2	2.9
NLTC-HCCT-6	-1.2	4.5	0.2	-1.2	1.6	1.4	-1.2	-0.4	5.1
NLTC-LPF-7	-1.3	-4.1	0.1	-1.2	1.3	0.7	-0.6	-0.1	4.4

Photometric measurement of Solid State Lighting Program
APLAC T088

B.1.7 Test Results of Lab P152

Table B.13 Test results of Lab P152

Identifier		Measurement results																	
		Total luminous flux (lm)		Current (A)		Active power (W)		Luminous efficacy		x		y		CCT (K)		Ra		Power factor	
		Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)
NLTC-IDC-24	1	625.2		3.9491		46.40		13.47		0.4517		0.4084		2800		99.0		/	
	2	622.4		3.9500		46.77		13.31		0.4518		0.4084		2798		100.0		/	
	Avg.	623.8	1.11	3.9496	0.51	46.58	0.97	13.39	1.48	0.4518	0.0007	0.4084	0.0006	2799	9.7	99.5	1.1	/	/
NLTC-OD1-6	1	219.7		0.0299		4.73		46.45		0.4520		0.4082		2794		85.3		0.7194	
	2	219.5		0.0299		4.73		46.41		0.4520		0.4082		2793		85.3		0.7194	
	Avg.	219.6	1.02	0.0299	0.36	4.73	0.39	46.43	1.10	0.4520	0.0013	0.4082	0.0010	2794	4.7	85.3	0.94	0.7194	0.0013
NLTC-D-7	1	517.2		0.0378		7.19		71.93		0.4410		0.4081		2965		82.8		0.8646	
	2	517.7		0.0378		7.19		72.00		0.4410		0.4081		2964		82.8		0.8650	
	Avg.	517.4	1.02	0.0378	0.36	7.19	0.39	71.96	1.10	0.4410	0.0011	0.4081	0.0010	2964	9.2	82.8	0.92	0.8648	0.0016
NLTC-HCCT-8	1	542.9		0.0333		5.95		91.24		0.3288		0.3367		5664		79.8		0.8122	
	2	543.6		0.0333		5.95		91.36		0.3289		0.3368		5660		79.9		0.8126	
	Avg.	543.2	1.02	0.0333	0.36	5.95	0.39	91.30	1.10	0.3288	0.0008	0.3368	0.0008	5662	17.6	79.8	0.89	0.8124	0.0015
NLTC-LPF-9	1	432.9		0.0508		5.60		77.30		0.4397		0.4072		2978		82.9		0.5011	
	2	432.2		0.0508		5.60		77.19		0.4395		0.4072		2980		82.9		0.5010	
	Avg.	432.6	1.02	0.0508	0.36	5.60	0.39	77.24	1.10	0.4396	0.0011	0.4072	0.0010	2979	9.2	82.9	0.92	0.5010	0.0009

Photometric measurement of Solid State Lighting Program
APLAC T088

Table B.14 En number(s) for Lab P152

Identifier	Measurement results								
	Total luminous flux	Current	Active power	Luminous efficacy	x	y	CCT	Ra	Power factor
NLTC-IDC-24	-0.2	N/A	0.5	-0.5	0.2	-0.5	-0.4	-0.3	/
NLTC-OD1-6	-0.2	0.1	0.5	-0.4	0.1	-0.3	-0.2	0.5	0.4
NLTC-D-7	-0.2	0.9	0.1	-0.2	-0.2	-0.9	-0.2	0.5	-0.5
NLTC-HCCT-8	0.1	0.3	0.1	0.0	0.2	-0.1	-0.3	0.6	0.0
NLTC-LPF-9	0.3	1.0	0.9	0.1	0.0	-0.4	-0.2	0.8	-0.7

Photometric measurement of Solid State Lighting Program
APLAC T088

B.1.8 Test Results of Lab P153

Table B.15 Test results of Lab P153

Identifier		Measurement results																	
		Total luminous		Current		Active power		Luminous		x		y		CCT		Ra		Power factor	
		flux (lm)	Uncertai-nty(%)	Result	Uncertai-nty(%)	Result	Uncertai-nty(%)	Result	Uncertai-nty(%)	Result	Uncertai-nty	Result	Uncertai-nty	Result	Uncert-a-inty	Result	Uncertai-nty	Result	Uncertai-nty
NLTC-IDC-6	1	637.2		3.950		44.583		14.29		0.4518		0.4087		2799.9		99.80		/	
	2	632.7		3.950		44.823		14.11		0.4517		0.4087		2801.8		99.80		/	
	Avg.	635.0	1.7	3.950	0.45	44.703	0.92	14.20	1.9	0.4518	0.0014	0.4087	0.0013	2800.8	10	99.80	1.8	/	/
NLTC-OD1-7	1	224.4		0.0320		4.605		48.7296		0.4520		0.4088		2797.2		85.00		0.6500	
	2	224.2		0.0320		4.716		47.5403		0.4521		0.4088		2795.9		84.90		0.6450	
	Avg.	224.3	2.0	0.0320	0.26	4.660	0.50	48.1350	2.1	0.4520	0.0015	0.4088	0.0013	2796.6	11	84.95	1.5	0.6475	0.15
NLTC-D-8	1	504.2		0.0350		7.091		71.1042		0.4433		0.4071		2918.5		82.00		0.9110	
	2	511.8		0.0350		7.097		72.1150		0.4431		0.4068		2919.8		82.10		0.9110	
	Avg.	508.0	2.0	0.0350	0.24	7.094	0.40	71.6096	2.0	0.4432	0.0015	0.4070	0.0013	2919.2	11	82.05	1.5	0.9110	0.091
NLTC-HCCT-9	1	540.9		0.0330		5.903		91.63		0.3307		0.3396		5575.4		79.90		0.8040	
	2	536.8		0.0330		5.906		90.89		0.3308		0.3396		5571.0		79.90		0.8050	
	Avg.	538.8	2.0	0.0330	0.25	5.904	0.50	91.26	2.1	0.3308	0.0011	0.3396	0.0011	5573.2	21	79.90	1.5	0.8045	0.15
NLTC-LPF-10	1	455.8		0.0490		5.452		83.602		0.4401		0.4062		2961.9		82.20		0.5010	
	2	454.1		0.0490		5.438		83.505		0.4401		0.4060		2961.5		82.20		0.5010	
	Avg.	455.0	2.0	0.0490	0.20	5.445	0.72	83.554	2.1	0.4401	0.0015	0.4061	0.0013	2961.7	11	82.20	1.5	0.5010	0.35

Photometric measurement of Solid State Lighting Program
APLAC T088

Table B.16 En number(s) for Lab P153

Identifier	Measurement results								
	Total luminous flux	Current	Active power	Luminous efficacy	x	y	CCT	Ra	Power factor
NLTC-IDC-6	0.4	N/A	1.9	-0.5	-0.1	-0.3	0.1	0.0	/
NLTC-OD1-7	0.0	3.9	-0.4	0.2	0.3	-0.2	-0.3	0.1	-0.5
NLTC-D-8	-0.4	-0.3	0.1	-0.4	0.1	-0.4	-0.3	0.1	-0.1
NLTC-HCCT-9	-0.3	-0.1	0.1	-0.3	0.5	-0.3	-0.6	0.6	0.0
NLTC-LPF-10	0.2	-1.6	-0.4	0.2	0.2	-0.1	-0.3	0.0	0.0

Photometric measurement of Solid State Lighting Program
APLAC T088

B.1.9 Test Results of Lab P158

Table B.17 Test results of Lab P158

Identifier		Measurement results																	
		Total luminous flux (lm)		Current (A)		Active power (W)		Luminous efficacy		x		y		CCT (K)		Ra		Power factor	
		Result	Uncertai- nty(%)	Result	Uncertai- nty(%)	Result	Uncertai- nty(%)	Result	Uncertai- nty(%)	Result	Uncertai- nty	Result	Uncertai- nty	Result	Uncert-a inty	Result	Uncertai- nty	Result	Uncertai- nty
NLTC-IDC-6	1	619.50		3.95		43.43		14.26		0.4521		0.409		2797		99.7		1	
	2	620.1		3.95		43.48		14.2		0.4521		0.409		2798		99.8		1	
	Avg.	619.80	1.05	3.95	0.05	43.46	0.05	14.23	1.10	0.4521	1.05	0.4090	1.05	2798	1.05	99.8	1.05	1	0.0485
NLTC-OD1-7	1	222.20		0.029278		4.718		47.1		0.451		0.4091		2815		84.7		0.732	
	2	222.2		0.029318		4.723		47		0.451		0.4091		2815		84.7		0.732	
	Avg.	222.20	1.05	0.029298	0.05	4.720	0.05	47.0	1.10	0.4510	1.05	0.4091	1.05	2815	1.05	84.7	1.05	0.732	0.0485
NLTC-D-8	1	503.30		0.03511		7.118		70.7		0.4423		0.4074		2935		81.9		0.921	
	2	503.8		0.03512		7.118		70.8		0.4424		0.4074		2935		81.9		0.921	
	Avg.	503.55	1.05	0.03512	0.05	7.118	0.05	70.8	1.10	0.4424	1.05	0.4074	1.05	2935	1.05	81.9	1.05	0.921	0.0485
NLTC-HCCT-9	1	537.80		0.03319		5.933		90.6		0.328		0.3378		5697		78.7		0.812	
	2	537.8		0.03315		5.931		90.6		0.3281		0.3378		5695		78.7		0.813	
	Avg.	537.80	1.05	0.03317	0.05	5.932	0.05	90.6	1.10	0.3280	1.05	0.3378	1.05	5696	1.05	78.7	1.05	0.812	0.0485
NLTC-LPF-10	1	447.90		0.04954		5.478		81.8		0.439		0.4063		2981		82.1		0.499	
	2	447.9		0.04989		5.488		81.6		0.439		0.4063		2981		82.1		0.499	
	Avg.	447.90	1.05	0.04972	0.05	5.483	0.05	81.7	1.10	0.4390	1.05	0.4063	1.05	2981	1.05	82.1	1.05	0.499	0.0485

Photometric measurement of Solid State Lighting Program
APLAC T088

Table B.18 En number(s) for Lab P158

Identifier	Measurement results								
	Total luminous flux	Current	Active power	Luminous efficacy	x	y	CCT	Ra	Power factor
NLTC-IDC-6	-0.8	N/A	-0.7	-0.5	0.0	0.0	-0.2	0.0	/
NLTC-OD1-7	-0.4	-0.3	0.3	-0.5	0.0	0.0	0.0	-0.1	0.2
NLTC-D-8	-1.0	0.1	0.5	-1.0	0.0	0.0	0.0	0.0	0.1
NLTC-HCCT-9	-0.5	0.8	0.4	-0.6	0.0	0.0	0.5	-0.2	0.0
NLTC-LPF-10	-0.4	-0.3	0.6	-0.5	0.0	0.0	0.0	-0.1	0.0

Photometric measurement of Solid State Lighting Program
APLAC T088

B.1.10 Test Results of Lab P185

Table B.19 Test results of Lab P185

Identifier		Measurement results																	
		Total luminous flux (lm)		Current (A)		Active power (W)		Luminous efficacy		x		y		CCT (K)		Ra		Power factor	
		Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)
NLTC-IDC-7	1	628.9		3.950		43.45		14.474		0.4489		0.4117		2867		/	/	/	/
	2	629.7		3.950		43.45		14.492		0.4496		0.4112		2851		/	/	/	/
	Avg.	629.3	5	3.950	0.10	43.45	0.201	14.483	0.201	0.4492	0.0050	0.4114	0.0050	2859	28.6	/	/	/	/

Table B.20 En number(s) for Lab P185

Identifier		Measurement results							
		Total luminous flux	Current	Active power	Luminous efficacy	x	y	CCT	Ra
NLTC-IDC-7		0.3	N/A	0.6	0.7	-0.2	0.5	1.0	/

Photometric measurement of Solid State Lighting Program
APLAC T088

B.1.11 Test Results of Lab P189

Table B.21 Test results of Lab P189

Identifier		Measurement results																	
		Total luminous flux (lm)		Current (A)		Active power (W)		Luminous efficacy		x		y		CCT (K)		Ra		Power factor	
		Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)
NLTC-IDC-8	1	597		3.950		42.67		13.98		0.4555		0.4115		2769		99.3		1	
	2	/		/		/		/		/		/		/		/		/	
	Avg.	597	1.6	3.950	0.23	42.67	0.45	13.98	1.7	0.4555	0.0013	0.4115	0.0006	2769	30	99.3	1.0	1	0.020
NLTC-OD1-9	1	240		0.0262		4.86		49.4		0.4541		0.4089		2769		81.5		0.81	
	2	/		/		/		/		/		/		/		/		/	
	Avg.	240	2.0	0.0262	0.29	4.86	0.72	49.4	2.1	0.4541	0.0030	0.4089	0.0015	2769	61	81.5	2	0.81	0.02
NLTC-D-10	1	534		0.0373		7.40		72.3		0.4473		0.4123		2899		81.3		0.86	
	2	/		/		/		/		/		/		/		/		/	
	Avg.	534	2.2	0.0373	0.23	7.40	0.51	72.3	2.3	0.4473	0.0030	0.4123	0.0015	2899	64	81.3	2	0.86	0.02
NLTC-HCCT-11	1	523.4		0.0299		6.003		87.19		0.3279		0.3383		5706		78.7		0.8736	
	2	/		/		/		/		/		/		/		/		/	
	Avg.	523.4	2.2	0.0299	0.27	6.003	0.60	87.19	2.3	0.3279	0.0030	0.3383	0.0015	5706	126	78.7	2.0	0.8736	0.02
NLTC-LPF-12	1	433.5		0.0394		5.234		82.82		0.4427		0.4108		2959		81.54		0.5777	
	2	/		/		/		/		/		/		/		/		/	
	Avg.	433.5	2.2	0.0394	0.23	5.234	0.67	82.82	2.3	0.4427	0.0030	0.4108	0.0015	2959	65	81.54	2.0	0.5777	0.02

Photometric measurement of Solid State Lighting Program
APLAC T088

Table B.22 En number(s) for Lab P189

Identifier	Measurement results								
	Total luminous flux	Current	Active power	Luminous efficacy	x	y	CCT	Ra	Power factor
NLTC-IDC-8	0.2	N/A	-1.9	0.9	1.5	2.6	-0.5	-0.5	/
NLTC-OD1-9	0.2	-6.0	0.4	0.0	0.7	0.8	-0.2	-0.3	3.5
NLTC-D-10	0.0	-2.7	0.9	-0.3	0.9	1.0	-0.4	-0.3	-0.5
NLTC-HCCT-11	-0.4	-15.7	0.7	-0.7	1.1	2.5	-1.3	-0.5	3.0
NLTC-LPF-12	0.2	-14.7	2.7	-0.5	0.6	0.3	-0.4	-0.3	4.2

Photometric measurement of Solid State Lighting Program
APLAC T088

B.1.12 Test Results of Lab P294

Table B.23 Test results of Lab P294

Identifier		Measurement results																	
		Total luminous flux (lm)		Current (A)		Active power (W)		Luminous efficacy		x		y		CCT (K)		Ra		Power factor	
		Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)
NLTC-IDC-9	1	578.8		3.950		44.30		13.07		0.45352		0.4114		2797.1		99.20		1.000	
	2	588.4		3.950		44.10		13.34		0.45352		0.4114		2797.1		99.20		1.000	
	Avg.	583.6	0.98	3.950	0.5	44.20	1.7	13.20	3	0.4535	0.00002	0.4114	0.0002	2797.1	0.9	99.20	0.03	1.000	0.001
NLTC-OD1-10	1	223.4		0.0266		4.765		46.9		0.4505		0.4085		2819.9		82.60		0.8143	
	2	223.0		0.0266		4.760		46.8		0.4505		0.4085		2819.9		82.60		0.8145	
	Avg.	223.2	1.4	0.0266	0.6	4.762	1.7	46.8	3.4	0.4505	0.0014	0.4085	0.0014	2819.9	9.6	82.60	0.22	0.8144	0.0057
NLTC-D-11	1	498.3		0.0369		7.0675		70.5		0.4427		0.4122		2969.7		81.88		0.8711	
	2	493.2		0.0369		7.060		69.8		0.4427		0.4122		2969.7		81.88		0.8707	
	Avg.	495.8	1.3	0.0369	0.6	7.0638	1.7	70.2	3.3	0.4427	0.0006	0.4122	0.0008	2969.7	3.1	81.88	0.07	0.8709	0.0061
NLTC-HCCT-12	1	502.8		0.0304		5.895		85.1		0.3232		0.3345		5935.0		79.24		0.8808	
	2	502.4		0.0304		5.89		85.3		0.3232		0.3345		5935.0		79.24		0.8810	
	Avg.	502.6	1.3	0.0304	0.6	5.892	1.7	85.2	3.3	0.3232	0.0005	0.3345	0.0009	5935.0	23.4	79.24	0.09	0.8809	0.0062
NLTC-LPF-13	1	427.1		0.0413		5.294		80.7		0.4260		0.4009		3165.6		83.03		0.5839	
	2	426.5		0.0414		5.30		80.5		0.4260		0.4009		3165.6		83.03		0.5818	
	Avg.	426.8	1.3	0.0414	0.6	5.297	1.7	80.6	3.3	0.4260	0.0008	0.4009	0.0010	3165.6	5.8	83.03	0.10	0.5828	0.0041

Photometric measurement of Solid State Lighting Program
APLAC T088

Table B.24 En number(s) for Lab P294

Identifier	Measurement results								
	Total luminous flux	Current	Active power	Luminous efficacy	x	y	CCT	Ra	Power factor
NLTC-IDC-9	-1.9	N/A	0.6	-1.3	-0.5	0.9	0.9	-3.2	/
NLTC-OD1-10	-1.6	-6.8	-0.8	-0.6	-0.3	0.3	0.3	-0.2	8.1
NLTC-D-11	-1.4	-0.7	0.0	-0.8	-0.9	-0.5	0.5	0.5	0.6
NLTC-HCCT-12	-1.9	-12.6	-0.5	-0.7	-0.1	1.0	0.0	-0.6	9.5
NLTC-LPF-13	-1.7	-12.0	-0.8	-0.8	-1.5	-0.7	0.9	0.6	14.2

Photometric measurement of Solid State Lighting Program
APLAC T088

B.1.13 Test Results of Lab P342

Table B.25 Test results of Lab P342

Identifier		Measurement results																	
		Total luminous flux (lm)		Current (A)		Active power (W)		Luminous efficacy		x		y		CCT (K)		Ra		Power factor	
		Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)
NLTC-IDC-9	1	603.50		3.95		43.43		13.896		/	/	/	/	/	/	/	/	/	
	2	607.94		3.950009		43.52		13.969		/	/	/	/	/	/	/	/	/	
	Avg.	605.72	2.10	3.950004	0.01	43.48	0.02	13.932	2.10	/	/	/	/	/	/	/	/	/	/
NLTC-OD1-10	1	232.60		0.0311		4.827		48.187		/	/	/	/	/	/	/	/	-0.713	
	2	234.06		0.0313		4.855		48.21		/	/	/	/	/	/	/	/	-0.705	
	Avg.	233.33	2.10	0.0312	0.14	4.841	0.19	48.198	2.20	/	/	/	/	/	/	/	/	-0.709	0.005
NLTC-D-11	1	508.20		0.0369		7.1		71.58		/	/	/	/	/	/	/	/	-0.87	
	2	507.9		0.0379		7.134		71.19		/	/	/	/	/	/	/	/	-0.856	
	Avg.	508.05	2.50	0.0374	0.14	7.117	0.19	71.38	2.60	/	/	/	/	/	/	/	/	-0.863	0.005
NLTC-HCCT-12	1	517.80		0.0343		5.947		87.07		/	/	/	/	/	/	/	/	-0.8	
	2	525.4		0.0338		5.99		87.72		/	/	/	/	/	/	/	/	-0.805	
	Avg.	521.60	2.30	0.0340	0.14	5.968	0.19	87.40	2.40	/	/	/	/	/	/	/	/	-0.8025	0.005
NLTC-LPF-13	1	440.30		0.0473		5.367		82.04		/	/	/	/	/	/	/	/	-0.492	
	2	446.3		0.0492		5.43		82.19		/	/	/	/	/	/	/	/	-0.5	
	Avg.	443.30	2.30	0.0482	0.14	5.398	0.19	82.12	2.40	/	/	/	/	/	/	/	/	-0.496	0.005

Photometric measurement of Solid State Lighting Program
APLAC T088

Table B.26 En number(s) for Lab P342

Identifier	Measurement results								
	Total luminous flux	Current	Active power	Luminous efficacy	x	y	CCT	Ra	Power factor
NLTC-IDC-9	0.1	N/A	-0.7	0.3	/	/	/	/	/
NLTC-OD1-10	0.0	-0.4	-0.1	0.0	/	/	/	/	0.6
NLTC-D-11	-0.2	0.8	0.9	-0.4	/	/	/	/	-0.1
NLTC-HCCT-12	-0.1	0.2	0.0	0.0	/	/	/	/	0.4
NLTC-LPF-13	-0.4	-1.0	0.8	-0.5	/	/	/	/	-0.8

Photometric measurement of Solid State Lighting Program
APLAC T088

B.1.14 Test Results of Lab P416

Table B.27 Test results of Lab P416

Identifier		Measurement results																	
		Total luminous flux (lm)		Current (A)		Active power (W)		Luminous efficacy		x		y		CCT (K)		Ra		Power factor	
		Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)
NLTC-IDC-10	1	606.35		3.9513		43.412		13.967		0.4526		0.4074		2783		99.51		1.0000	
	2	605.40		3.9510		43.592		13.888		0.4527		0.4074		2784		99.50		1.0000	
	Avg.	605.88	1.8	3.9512	0.38	43.502	0.66	13.928	2.1	0.4526	0.0095	0.4074	0.0089	2784	86	99.50	0.72	1.0000	0.002
NLTC-OD1-11	1	220.29		0.0299		4.730		46.573		0.4505		0.4053		2797		85.06		0.7189	
	2	220.36		0.0299		4.734		46.548		0.4506		0.4054		2797		85.11		0.7194	
	Avg.	220.32	2.9	0.0299	0.63	4.732	0.80	46.560	3.1	0.4506	0.0095	0.4054	0.009	2797	88	85.08	0.62	0.7192	0.0052
NLTC-D-12	1	495.81		0.0354		7.148		69.363		0.444		0.4076		2902		82.06		0.9174	
	2	499.59		0.0354		7.149		69.883		0.444		0.4077		2902		82.07		0.9180	
	Avg.	497.70	2.9	0.0354	0.63	7.148	0.80	69.623	3.1	0.4440	0.0094	0.4076	0.009	2902	90	82.06	0.59	0.9177	0.0066
NLTC-HCCT-13	1	538.85		0.0337		5.994		89.898		0.3312		0.3433		5552		79.6		0.8083	
	2	538.41		0.0337		5.982		90.005		0.3312		0.3433		5550		79.60		0.8067	
	Avg.	538.63	2.9	0.0337	0.63	5.988	0.80	89.952	3.1	0.3312	0.007	0.3433	0.0076	5551	173	79.60	0.58	0.8075	0.0059
NLTC-LPF-14	1	462.37		0.0497		5.494		84.159		0.426		0.3947		3092		83.63		0.5023	
	2	464.20		0.0499		5.489		84.569		0.4263		0.3948		3089		83.61		0.4999	
	Avg.	463.28	2.9	0.0498	0.63	5.492	0.80	84.364	3.1	0.4262	0.009	0.3948	0.0087	3090	96	83.62	0.61	0.5011	0.0037

Photometric measurement of Solid State Lighting Program
APLAC T088

Table B.28 En number(s) for Lab P416

Identifier	Measurement results								
	Total luminous flux	Current	Active power	Luminous efficacy	x	y	CCT	Ra	Power factor
NLTC-IDC-10	0.8	N/A	0.8	0.4	-0.1	-0.2	0.0	-0.4	/
NLTC-OD1-11	0.7	0.2	0.6	0.3	0.0	-0.2	-0.1	0.6	0.3
NLTC-D-12	-1.0	0.9	0.1	-1.0	0.0	-0.2	-0.3	0.4	-0.7
NLTC-HCCT-13	0.0	0.9	0.3	-0.2	0.1	0.0	-0.2	-0.4	-0.3
NLTC-LPF-14	0.0	-0.7	-0.2	0.1	0.0	-0.1	-0.3	0.1	0.6

Photometric measurement of Solid State Lighting Program
APLAC T088

B.1.15 Test Results of Lab P424

Table B.29 Test results of Lab P424

Identifier		Measurement results																	
		Total luminous flux (lm)		Current (A)		Active power (W)		Luminous efficacy		x		y		CCT (K)		Ra		Power factor	
		Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)
NLTC-IDC-10	1	599.2		3.950		42.56		14.08		0.4538		0.4092		2776		100		1.000	
	2	598.8		3.950		42.55		14.07		0.4538		0.4093		2776		100		1.000	
	Avg.	599.0	2.50	3.950	0.05	42.56	0.40	14.08	2.53	0.4538	0.00068	0.4092	0.00057	2776	18.40	100	0.59	1.000	0.00057
NLTC-OD1-11	1	218.0		0.030		4.699		46.39		0.4510		0.4069		2799		84.8		0.722	
	2	217.4		0.030		4.699		46.27		0.4510		0.4069		2799		84.8		0.722	
	Avg.	217.7	2.50	0.030	0.04	4.699	0.06	46.33	2.50	0.4510	0.00068	0.4069	0.00057	2799	18.40	84.8	0.59	0.722	0.00057
NLTC-D-12	1	527.7		0.035		7.132		73.99		0.4423		0.4070		2936		81.9		0.915	
	2	529.0		0.035		7.131		74.18		0.4422		0.4069		2936		81.9		0.915	
	Avg.	528.4	2.50	0.035	0.04	7.132	0.06	74.08	2.50	0.4422	0.00068	0.4070	0.00057	2936	18.40	81.9	0.59	0.915	0.00057
NLTC-HCCT-13	1	538.9		0.033		5.972		90.24		0.3295		0.342		5632		79.5		0.812	
	2	539.2		0.033		5.975		90.23		0.3295		0.342		5631		79.5		0.812	
	Avg.	539.0	2.50	0.033	0.04	5.974	0.06	90.24	2.50	0.3295	0.00068	0.3420	0.00057	5632	18.40	79.5	0.59	0.812	0.00057
NLTC-LPF-14	1	463.9		0.050		5.496		84.41		0.4257		0.3951		3123		83.7		0.498	
	2	462.9		0.050		5.498		84.19		0.4257		0.3950		3123		83.8		0.499	
	Avg.	463.4	2.50	0.050	0.04	5.497	0.06	84.30	2.50	0.4257	0.00068	0.3950	0.00057	3123	18.40	83.8	0.59	0.498	0.00057

Photometric measurement of Solid State Lighting Program
APLAC T088

Table B.30 En number(s) for Lab P424

Identifier	Measurement results								
	Total luminous flux	Current	Active power	Luminous efficacy	x	y	CCT	Ra	Power factor
NLTC-IDC-10	0.2	N/A	-1.6	0.7	0.2	-0.5	-0.2	0.3	/
NLTC-OD1-11	0.4	0.3	0.3	0.3	0.0	-0.3	-0.1	0.2	0.5
NLTC-D-12	0.8	-0.2	-0.2	0.8	-0.5	-0.9	0.1	0.1	-1.0
NLTC-HCCT-13	0.0	-2.2	0.2	-0.1	-0.3	-0.6	0.4	-0.5	0.4
NLTC-LPF-14	0.0	-0.5	-0.2	0.1	-0.2	-0.4	0.0	0.3	0.0

Photometric measurement of Solid State Lighting Program
APLAC T088

B.1.16 Test Results of Lab P446

Table B.31 Test results of Lab P446

Identifier		Measurement results																	
		Total luminous		Current		Active power		Luminous		x		y		CCT		Ra		Power factor	
		flux (lm)		(A)		(W)		efficacy							(K)				
		Result	Uncertai-nty(%)	Result	Uncertai-nty(%)	Result	Uncertai-nty(%)	Result	Uncertai-nty(%)	Result	Uncertai-nty	Result	Uncertai-nty	Result	Uncert-a-inty	Result	Uncertai-nty	Result	Uncertai-nty
NLTC-IDC-11	1	561.58		3.95		42.49		13.22		0.4547		0.4101		2770		99.8		1.000	
	2	561.06		3.95		42.16		13.31		0.4545		0.4102		2773		99.8		1.000	
	Avg.	561.32	1.30	3.95	0.20	42.32	0.05	13.26	1.30	0.4546	0.003	0.41015	0.003	2772	14	99.8	0.50	1.000	0.0002
NLTC-OD1-12	1	244.99		0.03026		4.815		50.88		0.4514		0.4073		2797		82.0		0.724	
	2	244.63		0.03031		4.817		50.79		0.4510		0.4071		2800		82.1		0.723	
	Avg.	244.81	1.30	0.03028	0.02	4.816	0.05	50.84	1.30	0.4512	0.003	0.4072	0.003	2798	14	82.0	0.50	0.724	0.0002
NLTC-D-13	1	523.48		0.0402		7.218		72.52		0.4415		0.4085		2960		82.0		0.8164	
	2	524.24		0.0402		7.216		72.65		0.4415		0.4085		2959		82.1		0.8170	
	Avg.	523.86	1.30	0.0402	0.02	7.217	0.05	72.58	1.30	0.4415	0.003	0.4085	0.003	2960	14	82.0	0.50	0.8167	0.0002
NLTC-HCCT-14	1	534.41		0.03365		5.997		89.78		0.3305		0.3437		5585		78.8		0.81	
	2	534.99		0.03371		5.97		89.61		0.3301		0.3433		5602		78.8		0.805	
	Avg.	536.70	1.30	0.03368	0.02	5.984	0.05	89.70	1.30	0.3303	0.003	0.3435	0.003	5594	14	78.8	0.50	0.808	0.0002
NLTC-LPF-1	1	460.72		0.05		5.571		82.7		0.4312		0.4033		3092		82.8		0.507	
	2	459.91		0.05009		5.579		82.43		0.4313		0.4031		3090		82.8		0.507	
	Avg.	460.32	1.30	0.05004	0.02	5.575	0.05	82.56	1.30	0.4312	0.003	0.4032	0.003	3091	14	82.8	0.50	0.507	0.0002

Photometric measurement of Solid State Lighting Program
APLAC T088

Table B.32 En number(s) for Lab P446

Identifier	Measurement results								
	Total luminous flux	Current	Active power	Luminous efficacy	x	y	CCT	Ra	Power factor
NLTC-IDC-11	-0.6	N/A	0.5	-0.8	-0.1	0.1	0.3	0.0	/
NLTC-OD1-12	-0.7	-0.2	-0.2	-0.4	0.0	-0.1	0.0	-0.2	0.0
NLTC-D-13	-0.5	1.0	-0.5	-0.3	-0.2	-0.3	0.1	0.1	-1.0
NLTC-HCCT-14	-0.7	1.0	0.3	-0.7	-0.1	0.0	0.1	-0.8	0.0
NLTC-LPF-1	-0.3	-0.6	0.1	-0.3	-0.1	-0.1	0.1	0.0	1.0

Photometric measurement of Solid State Lighting Program
APLAC T088

B.1.17 Test Results of Lab P516

Table B.33 Test results of Lab P516

Identifier		Measurement results																	
		Total luminous flux (lm)		Current (A)		Active power (W)		Luminous efficacy		x		y		CCT (K)		Ra		Power factor	
		Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty
NLTC-IDC-R12	1	/	/	3.896		41.5		/	/	/	/	/	/	/	/	/	/	/	
	2	/	/	3.897		41.5		/	/	/	/	/	/	/	/	/	/	/	
	Avg.	/	/	3.896	0.33	41.5	1.40	/	/	/	/	/	/	/	/	/	/	/	/
NLTC-OD1-13	1	/	/	0.0317		4.93		/	/	/	/	/	/	/	/	/	/	0.748	
	2	/	/	0.0297		4.83		/	/	/	/	/	/	/	/	/	/	0.745	
	Avg.	/	/	0.0307	3.10	4.88	3.70	/	/	/	/	/	/	/	/	/	/	0.746	0.0091
NLTC-D-14	1	/	/	0.0367		7.03		/	/	/	/	/	/	/	/	/	/	0.871	
	2	/	/	0.0367		6.93		/	/	/	/	/	/	/	/	/	/	0.861	
	Avg.	/	/	0.0367	3.10	6.98	3.70	/	/	/	/	/	/	/	/	/	/	0.866	0.0091
NLTC-HCCT-1	1	/	/	0.0357		6.03		/	/	/	/	/	/	/	/	/	/	0.81	
	2	/	/	0.0347		5.93		/	/	/	/	/	/	/	/	/	/	0.802	
	Avg.	/	/	0.0352	3.10	5.98	3.70	/	/	/	/	/	/	/	/	/	/	0.806	0.0091
NLTC-LPF-2	1	/	/	0.0377		4.93		/	/	/	/	/	/	/	/	/	/	0.604	
	2	/	/	0.0387		4.93		/	/	/	/	/	/	/	/	/	/	0.593	
	Avg.	/	/	0.0382	3.10	4.93	3.70	/	/	/	/	/	/	/	/	/	/	0.598	0.0097

Photometric measurement of Solid State Lighting Program
APLAC T088

Table B.34 En number(s) for Lab P516

Identifier	Measurement results								
	Total luminous flux	Current	Active power	Luminous efficacy	x	y	CCT	Ra	Power factor
NLTC-IDC-R12	/	N/A	-2.2	/	/	/	/	/	/
NLTC-OD1-13	/	0.2	0.4	/	/	/	/	/	1.9
NLTC-D-14	/	0.1	-0.1	/	/	/	/	/	-0.3
NLTC-HCCT-1	/	1.0	0.0	/	/	/	/	/	0.8
NLTC-LPF-2	/	-6.9	-0.9	/	/	/	/	/	0.0

Photometric measurement of Solid State Lighting Program
APLAC T088

B.1.18 Test Results of Lab P533

Table B.35 Test results of Lab P533

Identifier		Measurement results																	
		Total luminous		Current		Active power		Luminous		x		y		CCT		Ra		Power factor	
		flux (lm)		(A)		(W)		efficacy					(K)						
		Result	Uncertai-nty(%)	Result	Uncertai-nty(%)	Result	Uncertai-nty(%)	Result	Uncertai-nty(%)	Result	Uncertai-nty	Result	Uncertai-nty	Result	Uncert-ainty	Result	Uncertai-nty	Result	Uncertai-nty
NLTC-IDC-R12	1	594.4		3.948		42.552		13.97		0.4545		0.4093		2767		99.77		1	
	2	594.2		3.948		42.553		13.96		0.4543		0.4092		2769		99.83		1	
	Avg.	594.3	3	3.948	1.11	42.552	1.61	13.96	3.41	0.4544	0.002	0.4092	0.002	2768	20	99.80	1.50	1	/
NLTC-OD1-13	1	242.0		0.0305		4.824		50.17		0.4487		0.4033		2804		82.66		0.7179	
	2	242.4		0.0312		4.825		50.24		0.4497		0.4042		2797		82.27		0.7021	
	Avg.	242.2	4	0.0308	0.63	4.824	3.53	50.20	5.34	0.4492	0.002	0.4038	0.002	2800	20	82.46	1.50	0.71	0.026
NLTC-D-14	1	522.0		0.0367		7.005		74.52		0.4406		0.4049		2946		82.33		0.8663	
	2	522.3		0.0368		7.003		74.58		0.4404		0.4049		2949		82.36		0.8663	
	Avg.	522.2	4	0.0368	0.58	7.004	2.60	74.55	4.77	0.4405	0.002	0.4049	0.002	2948	20	82.34	1.50	0.8663	0.024
NLTC-HCCT-1	1	543.0		0.0338		5.941		91.40		0.3296		0.3386		5629		78.76		0.7972	
	2	543.5		0.0342		5.940		91.50		0.3295		0.3385		5634		78.83		0.7897	
	Avg.	543.2	4	0.0340	0.60	5.940	3.06	91.45	5.04	0.3296	0.002	0.3386	0.002	5632	200	78.80	1.50	0.7934	0.025
NLTC-LPF-2	1	435.7		0.0498		5.107		85.31		0.4390		0.4057		2979		82.27		0.4657	
	2	435.8		0.0493		5.101		85.43		0.4389		0.4059		2981		82.3		0.4670	
	Avg.	435.8	4	0.0496	0.50	5.104	9.23	85.37	10.10	0.4390	0.002	0.4058	0.002	2980	20	82.28	1.50	0.4664	0.043

Photometric measurement of Solid State Lighting Program
APLAC T088

Table B.36 En number(s) for Lab P533

Identifier	Measurement results								
	Total luminous flux	Current	Active power	Luminous efficacy	x	y	CCT	Ra	Power factor
NLTC-IDC-R12	0.3	N/A	-0.6	0.5	0.1	-0.3	-0.3	0.0	/
NLTC-OD1-13	0.2	0.4	0.1	0.0	0.0	-0.4	-0.2	-0.2	-0.2
NLTC-D-14	-0.3	0.6	0.0	-0.3	-0.3	-0.9	-0.1	0.2	-0.1
NLTC-HCCT-1	-0.1	-0.3	-0.2	0.0	0.2	0.1	-0.1	-0.1	-0.2
NLTC-LPF-2	0.0	0.2	0.0	0.0	0.3	-0.1	-0.3	0.1	-0.1

Photometric measurement of Solid State Lighting Program
APLAC T088

B.1.19 Test Results of Lab P600

Table B.37 Test results of Lab P600

Identifier		Measurement results																	
		Total luminous		Current		Active power		Luminous		x		y		CCT		Ra		Power factor	
		flux (lm)	Uncertai-nty(%)	Result	Uncertai-nty(%)	Result	Uncertai-nty(%)	Result	Uncertai-nty(%)	Result	Uncertai-nty	Result	Uncertai-nty	Result	Uncert-a-inty	Result	Uncertai-nty	Result	Uncertai-nty
NLTC-IDC-R13	1	611.2		3.95		42.24		14.47		0.4473		0.4073		2859		99.80		1	
	2	610.9		3.95		42.24		14.46		0.4474		0.4075		2859		99.75		1	
	Avg.	611.0	1.7	3.95	0.15	42.24	0.3	14.46	1.73	0.4474	0.0002	0.4074	0.0002	2859	15	99.78	1.00	1	0.0035
NLTC-OD1-14	1	236.9		0.03031		4.797		49.39		0.4487		0.4064		2830		82.93		0.7194	
	2	239.1		0.03053		4.8		49.83		0.449		0.4069		2829		82.87		0.7147	
	Avg.	238.0	1.7	0.03042	0.2	4.798	0.3	49.61	1.73	0.4488	0.0005	0.4066	0.0005	2830	25	82.90	1.00	0.7170	0.0030
NLTC-D-1	1	459.2		0.03843		7.199		63.79		0.4426		0.4053		2916		81.94		0.8515	
	2	457.7		0.03843		7.199		63.58		0.4428		0.4053		2912		81.95		0.8515	
	Avg.	458.4	1.7	0.03843	0.2	7.199	0.3	63.68	1.73	0.4427	0.0002	0.4053	0.0002	2914	15	81.94	1.00	0.8515	0.0035
NLTC-HCCT-2	1	488		0.03341		5.996		81.39		0.3292		0.3405		5643		77.58		0.8158	
	2	487.1		0.0334		5.995		81.25		0.3294		0.3407		5637		77.47		0.8158	
	Avg.	487.6	1.7	0.033405	0.2	5.996	0.3	81.32	1.73	0.3293	0.0002	0.3406	0.0002	5640	15	77.52	1.00	0.8158	0.0034
NLTC-LPF-3	1	439.6		0.05112		5.647		77.85		0.4308		0.4055		3118		82.01		0.5021	
	2	439.7		0.0511		5.645		77.88		0.4308		0.4055		3118		82.04		0.5021	
	Avg.	439.6	1.7	0.05111	0.2	5.646	0.3	77.86	1.73	0.4308	0.0002	0.4055	0.0002	3118	15	82.02	1.00	0.5021	0.0021

Photometric measurement of Solid State Lighting Program
APLAC T088

Table B.38 En number(s) for Lab P600

Identifier	Measurement results								
	Total luminous flux	Current	Active power	Luminous efficacy	x	y	CCT	Ra	Power factor
NLTC-IDC-R13	0.2	N/A	-0.5	0.4	-8.2	-3.2	3.6	0.0	/
NLTC-OD1-14	0.4	-0.1	-0.6	0.7	-1.1	-0.1	0.6	-0.3	-0.5
NLTC-D-1	-5.7	-0.6	-0.2	-5.1	-0.4	-1.7	-0.3	-0.1	0.3
NLTC-HCCT-2	-2.8	0.8	0.8	-2.7	0.3	1.0	-0.3	-1.5	1.0
NLTC-LPF-3	-1.8	0.3	1.8	-2.0	-0.1	0.5	0.2	-0.5	0.8

Photometric measurement of Solid State Lighting Program
APLAC T088

B.1.20 Test Results of Lab P630

Table B.39 Test results of Lab P630

Identifier		Measurement results																	
		Total luminous		Current		Active power		Luminous		x		y		CCT		Ra		Power factor	
		flux (lm)		(A)		(W)		efficacy					(K)						
		Result	Uncertai-nty(%)	Result	Uncertai-nty(%)	Result	Uncertai-nty(%)	Result	Uncertai-nty(%)	Result	Uncertai-nty	Result	Uncertai-nty	Result	Uncert-a-inty	Result	Uncertai-nty	Result	Uncertai-nty
NLTC-IDC-14	1	576.72		3.9500		43.213		13.346		0.4523		0.4091		2796		99.9		1.0000	
	2	576.88		3.9500		43.252		13.338		0.4523		0.4090		2798		99.9		1.0000	
	Avg.	576.80	1.80	3.9500	0.20	43.232	0.50	13.342	1.87	0.4523	0.001	0.4090	0.001	2797	18	99.9	0.1	1.0000	0.001
NLTC-OD1-1	1	222.61		0.0299		4.8453		45.943		0.4525		0.4104		2804		85.2		0.7366	
	2	222.40		0.0298		4.8284		46.061		0.4526		0.4104		2803		85.2		0.7365	
	Avg.	222.50	1.80	0.0298	0.20	4.8368	0.50	46.002	1.87	0.4526	0.001	0.4104	0.001	2803	18	85.2	0.1	0.7366	0.001
NLTC-D-2	1	515.20		0.0366		7.0414		73.167		0.4421		0.4047		2920		82.9		0.8745	
	2	515.63		0.0366		7.0438		73.203		0.4419		0.4047		2922		82.9		0.8748	
	Avg.	515.42	1.80	0.0366	0.20	7.0426	0.50	73.185	1.87	0.4420	0.001	0.4047	0.001	2921	45	82.9	0.1	0.8746	0.001
NLTC-HCCT-3	1	520.42		0.0337		6.0224		86.414		0.3276		0.3348		5720		80.1		0.8123	
	2	520.68		0.0337		6.0231		86.447		0.3277		0.3349		5718		80.1		0.8124	
	Avg.	520.55	1.80	0.0337	0.20	6.0228	0.50	86.430	1.87	0.3276	0.001	0.3348	0.001	5719	18	80.1	0.1	0.8124	0.001
NLTC-LPF-4	1	441.65		0.0479		5.2208		84.594		0.4399		0.4059		2966		82.7		0.4954	
	2	442.08		0.0480		5.2293		84.539		0.4398		0.4058		2968		82.7		0.4952	
	Avg.	441.86	2.0	0.0480	0.20	5.2250	0.72	84.566	2.1	0.4398	0.0015	0.4058	0.0013	2967	11	82.7	1.5	0.4953	0.001

Photometric measurement of Solid State Lighting Program
APLAC T088

Table B.40 En number(s) for Lab P630

Identifier	Measurement results								
	Total luminous flux	Current	Active power	Luminous efficacy	x	y	CCT	Ra	Power factor
NLTC-IDC-14	-0.5	N/A	0.0	-0.5	-1.0	-0.5	0.6	0.4	/
NLTC-OD1-1	0.1	-0.1	0.7	-0.3	0.1	-0.4	-0.2	1.0	0.9
NLTC-D-2	-0.7	-1.0	-0.5	-0.5	-0.1	-1.0	-0.3	1.0	0.3
NLTC-HCCT-3	-0.1	0.9	0.1	-0.2	-0.3	-0.9	0.3	0.9	-0.4
NLTC-LPF-4	0.1	-0.4	-0.1	0.1	0.1	-0.7	-0.3	1.0	0.6

Photometric measurement of Solid State Lighting Program
APLAC T088

B.1.21 Test Results of Lab P639

Table B.41 Test results of Lab P639

Identifier		Measurement results																	
		Total luminous		Current		Active power		Luminous		x		y		CCT		Ra		Power factor	
		flux (lm)		(A)		(W)		efficacy							(K)				
		Result	Uncertai-nty(%)	Result	Uncertai-nty(%)	Result	Uncertai-nty(%)	Result	Uncertai-nty(%)	Result	Uncertai-nty	Result	Uncertai-nty	Result	Uncert-a-inty	Result	Uncertai-nty	Result	Uncertai-nty
NLTC-IDC-R14	1	593.40		3.95031		44.475		13.34		0.4532		0.4089		2783		99.4		/	
	2	593.5		3.95029		44.473		13.35		0.4531		0.4088		2783		99.4		/	
	Avg.	593.45	2.20	3.95030	0.02	44.474	0.02	13.34	2.20	0.4532	0.0015	0.4088	0.0015	2783	38	99.4	/	/	/
NLTC-OD1-1	1	224.60		0.0299		4.71		47.69		0.4521		0.4108		2813		84.6		0.71558	
	2	224.6		0.0299		4.711		47.68		0.4522		0.4108		2813		84.6		0.71574	
	Avg.	224.60	2.20	0.0299	0.02	4.710	0.02	47.68	2.20	0.4522	0.0015	0.4108	0.0015	2813	38	84.6	/	0.71566	0.0000715
NLTC-D-2	1	527.90		0.0367		7.062		74.75		0.4415		0.4058		2938		82.5		0.87517	
	2	527.9		0.0367		7.061		74.76		0.4415		0.4058		2938		82.5		0.875	
	Avg.	527.90	2.20	0.0367	0.02	7.062	0.02	74.76	2.20	0.4415	0.0015	0.4058	0.0015	2938	38	82.5	/	0.87508	0.0000875
NLTC-HCCT-3	1	531.90		0.0336		6.0164		88.41		0.3273		0.3358		5738		79.4		0.81338	
	2	531.4		0.0336		6.0162		88.33		0.3273		0.3357		5739		79.4		0.81334	
	Avg.	531.65	2.20	0.0336	0.02	6.0163	0.02	88.37	2.20	0.3273	0.0015	0.3358	0.0015	5738	38	79.4	/	0.81336	0.0000813
NLTC-LPF-4	1	449.30		0.0485		5.2197		86.08		0.4391		0.4067		2985		82.5		0.48934	
	2	449.2		0.0488		5.2208		86.04		0.4391		0.4067		2985		82.5		0.48959	
	Avg.	449.25	2.20	0.0486	0.02	5.2202	0.02	86.06	2.20	0.4391	0.0015	0.4067	0.0015	2985	38	82.5	/	0.48946	0.0000489

Photometric measurement of Solid State Lighting Program
APLAC T088

Table B.42 En number(s) for Lab P639

Identifier	Measurement results								
	Total luminous flux	Current	Active power	Luminous efficacy	x	y	CCT	Ra	Power factor
NLTC-IDC-R14	0.6	N/A	4.2	-0.6	-0.6	-0.5	0.2	/	/
NLTC-OD1-1	0.3	0.0	-0.7	0.6	0.0	-0.3	-0.1	/	-0.7
NLTC-D-2	0.2	-0.7	-0.2	0.3	-0.2	-0.5	0.0	/	0.4
NLTC-HCCT-3	0.7	0.4	0.1	0.6	-0.4	-0.5	0.4	/	-0.2
NLTC-LPF-4	0.6	0.7	-0.3	0.6	-0.2	-0.4	0.0	/	-0.8

Photometric measurement of Solid State Lighting Program
APLAC T088

B.1.22 Test Results of Lab P693

Table B.43 Test results of Lab P693

Identifier		Measurement results																	
		Total luminous		Current		Active power		Luminous		x		y		CCT		Ra		Power factor	
		flux (lm)		(A)		(W)		efficacy					(K)						
		Result	Uncertai-nty(%)	Result	Uncertai-nty(%)	Result	Uncertai-nty(%)	Result	Uncertai-nty(%)	Result	Uncertai-nty	Result	Uncertai-nty	Result	Uncert-a-inty	Result	Uncertai-nty	Result	Uncertai-nty
NLTC-IDC-15	1	560.9		3.95		44.30		12.66		0.4522		0.4084		2794		99.91		1.000	
	2	557.8		3.95		44.31		12.59		0.4525		0.4089		2792		99.91		1.000	
	Avg.	559.4	0.86	3.95	0.12	44.30	0.13	12.62	0.88	0.4524	0.018	0.4086	0.018	2793	0.96	99.91	0.21	1.000	0.036
NLTC-OD1-16	1	253.9		0.033		4.825		50.67		0.4548		0.4079		2805		82.8		0.6750	
	2	254.0		0.033		4.915		49.36		0.4508		0.4081		2811		82.7		0.6810	
	Avg.	254.0	2.8	0.033	0.30	4.870	0.90	50.02	2.9	0.4528	0.020	0.408	0.020	2808	2.8	82.8	0.26	0.6780	0.0072
NLTC-D-17	1	519.1		0.039		7.369		68.52		0.4414		0.4067		2948		82.10		0.8680	
	2	514.7		0.039		7.343		68.38		0.4414		0.4069		2949		82.00		0.8730	
	Avg.	516.9	2.8	0.039	0.38	7.356	0.84	68.45	2.9	0.4414	0.0208	0.4068	0.0208	2948	0.53	82.05	0.26	0.8705	0.0071
NLTC-HCCT-18	1	516.3		0.038		5.987		85.62		0.3263		0.3414		5776		78.20		0.7190	
	2	517.4		0.037		5.873		85.69		0.3259		0.3410		5794		78.40		0.7210	
	Avg.	516.8	2.8	0.038	0.39	5.930	0.92	85.66	2.9	0.3261	0.0208	0.3412	0.0208	5785	8.5	78.30	0.27	0.7200	0.0067
NLTC-LPF-19	1	467.9		0.058		5.688		83.53		0.4402		0.4054		3013		82.40		0.4480	
	2	461.6		0.058		5.775		82.72		0.4360		0.4058		3019		82.00		0.4520	
	Avg.	464.8	2.7	0.058	0.31	5.732	0.74	83.12	2.9	0.4381	0.0209	0.4056	0.0209	3016	2.84	82.20	0.32	0.4500	0.0069

Photometric measurement of Solid State Lighting Program
APLAC T088

Table B.44 En number(s) for Lab P693

Identifier	Measurement results								
	Total luminous flux	Current	Active power	Luminous efficacy	x	y	CCT	Ra	Power factor
NLTC-IDC-15	-1.9	N/A	6.2	-4.2	-0.1	-0.1	2.1	0.2	/
NLTC-OD1-16	0.6	1.4	-0.8	-0.1	0.0	-0.1	0.4	0.5	-1.7
NLTC-D-17	-0.7	0.9	-0.1	-1.4	-0.1	-0.2	0.1	0.3	0.4
NLTC-HCCT-18	0.2	20.9	0.1	-0.4	-0.1	0.0	0.5	-1.3	-9.9
NLTC-LPF-19	-0.1	11.7	1.9	0.1	0.0	0.0	0.4	0.2	-6.3

Photometric measurement of Solid State Lighting Program
APLAC T088

B.1.23 Test Results of Lab P725

Table B.45 Test results of Lab P725

Identifier		Measurement results																	
		Total luminous flux (lm)		Current (A)		Active power (W)		Luminous efficacy		x		y		CCT (K)		Ra		Power factor	
		Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)
NLTC-IDC-20	1	593		3.949		43.1		13.7		0.4537		0.4094		2780		99.5		1	
	2	595		3.951		43.2		13.8		/		/		/		/		1	
	Avg.	594	3.7	3.950	0.02	43.2	0.03	13.8	3.7	0.4537	0.0015	0.4094	0.0015	2780	30	99.5	0.5	1	/
NLTC-OD1-15	1	229.7		0.03066		4.74		48.5		0.4514		0.4037		2768		83.2		0.702	
	2	230.0		0.03072		4.75		48.4		0.4514		0.4037		2767		83.2		0.702	
	Avg.	229.8	3.8	0.03069	0.05	4.74	2.0	48.4	4.3	0.4514	0.0015	0.4037	0.0015	2768	40	83.2	0.5	0.702	0.014
NLTC-D-16	1	522		0.03923		7.19		72.7		0.4414		0.4062		2943		82.7		0.832	
	2	521		0.03922		7.18		72.6		0.4411		0.4057		2944		82.8		0.832	
	Avg.	522	3.8	0.03922	0.05	7.18	2.0	72.6	4.3	0.4412	0.0020	0.4060	0.0020	2944	50	82.8	0.5	0.832	0.017
NLTC-HCCT-17	1	533		0.03330		5.94		89.8		0.3289		0.3380		5662		79.1		0.809	
	2	532		0.03330		5.94		89.6		0.3290		0.3386		5654		79.0		0.809	
	Avg.	532	3.8	0.03330	0.05	5.94	2.0	89.7	4.3	0.3290	0.0015	0.3383	0.0015	5658	70	79.0	0.5	0.809	0.016
NLTC-LPF-18	1	456		0.04874		5.50		82.9		0.4315		0.4016		3074		83.3		0.512	
	2	454		0.04876		5.51		82.6		0.4315		0.4016		3073		83.3		0.513	
	Avg.	455	3.8	0.04875	0.05	5.50	2	82.8	4.3	0.4315	0.0015	0.4016	0.0015	3074	40	83.3	0.5	0.5125	0.012

Photometric measurement of Solid State Lighting Program
APLAC T088

Table B.46 En number(s) for Lab P725

Identifier	Measurement results								
	Total luminous flux	Current	Active power	Luminous efficacy	x	y	CCT	Ra	Power factor
NLTC-IDC-20	-0.1	N/A	-0.7	0.1	0.1	0.0	-0.1	-0.6	/
NLTC-OD1-15	0.0	-0.5	-0.6	0.3	0.3	-0.4	-0.3	0.7	-0.2
NLTC-D-16	-0.2	1.0	0.0	-0.2	0.2	-0.3	-0.3	1.0	-0.4
NLTC-HCCT-17	-0.2	0.8	0.4	-0.3	0.1	-0.1	0.0	-0.2	0.2
NLTC-LPF-18	-0.1	-1.0	0.1	-0.1	0.5	0.1	-0.3	0.4	0.5

Photometric measurement of Solid State Lighting Program
APLAC T088

B.1.24 Test Results of Lab P774

Table B.47 Test results of Lab P774

Identifier		Measurement results																	
		Total luminous		Current		Active power		Luminous		x		y		CCT		Ra		Power factor	
		flux (lm)		(A)		(W)		efficacy						(K)					
Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)
NLTC-IDC-16	1	587.00		3.95		52.8		11.11		0.4538		0.4089		2771		99.7999		/	
	2	590.5		3.95		52.8		11.18		0.4539		0.4089		2771		99.8055		/	
	Avg.	588.75	4.00	3.95	3	52.8	3	11.14	4.00	0.4538	0.01	0.4089	0.01	2771	69.00	99.8027	3.00	/	/
NLTC-OD1-17	1	244.40		0.02		4.9		49.87		0.4508		0.4066		2798		82.4216		0.82	
	2	244		0.02		4.9		49.79		0.4508		0.4066		2798		82.4473		0.82	
	Avg.	244.20	4.00	0.02	3	4.9	3	49.83	4.00	0.4508	0.01	0.4066	0.01	2798	70.00	82.4344	2.50	0.82	0.50
NLTC-D-18	1	529.10		0.03		7.2		73.58		0.4404		0.4054		2952		82.5104		0.95	
	2	527.9		0.03		7.2		73.42		0.4403		0.4054		2953		82.4916		0.95	
	Avg.	528.50	4.00	0.03	3	7.2	3	73.50	4.00	0.4404	0.01	0.4054	0.01	2952	74.00	82.5010	2.50	0.95	0.50
NLTC-HCCT-19	1	526.10		0.03		6		87.71		0.3241		0.3309		5899		79.6743		0.85	
	2	530		0.03		6		88.34		0.3240		0.3309		5901		79.6857		0.85	
	Avg.	528.05	4.00	0.03	3	6	3	88.02	4.00	0.3240	0.01	0.3309	0.01	5900	147.50	79.6800	2.50	0.85	0.50
NLTC-LPF-20	1	455.90		0.04		5.6		81.44		0.4375		0.4076		3017		82.3348		0.506	
	2	454.4		0.04		5.6		81.16		0.4374		0.4075		3018		82.3479		0.508	
	Avg.	455.15	4.0	0.04	3	5.6	3	81.30	4.00	0.4374	0.01	0.4076	0.01	3018	75.50	82.3414	2.50	0.507	0.50

Photometric measurement of Solid State Lighting Program
APLAC T088

Table B.48 En number(s) for Lab P774

Identifier	Measurement results								
	Total luminous flux	Current	Active power	Luminous efficacy	x	y	CCT	Ra	Power factor
NLTC-IDC-16	0.1	N/A	4.0	-2.5	-0.1	-0.1	0.1	0.0	/
NLTC-OD1-17	-0.1	-9.0	0.7	-0.5	0.0	-0.1	-0.2	0.0	0.2
NLTC-D-18	-0.1	-5.3	0.4	-0.4	-0.1	-0.3	0.0	0.1	0.1
NLTC-HCCT-19	0.4	-3.1	0.4	0.1	0.0	-0.1	-0.1	0.1	0.1
NLTC-LPF-20	0.1	-6.2	0.6	-0.3	-0.1	-0.2	-0.1	0.1	0.0

Photometric measurement of Solid State Lighting Program
APLAC T088

B.1.25 Test Results of Lab P850

Table B.49 Test results of Lab P850

Identifier		Measurement results																	
		Total luminous flux (lm)		Current (A)		Active power (W)		Luminous efficacy		x		y		CCT (K)		Ra		Power factor	
		Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)
NLTC-IDC-16	1	587.605		3.9497		46.205		12.717		0.4537		0.4095		2780		99.9		1.000	
	2	591.975		3.9503		46.092		12.843		0.4528		0.4091		2790		99.9		1.000	
	Avg.	589.790	2.30	3.9500	0.70	46.148	2.40	12.780	2.30	0.4532	0.007	0.4093	0.007	2785	45	99.9	1.6	1.000	/
NLTC-OD1-17	1	247.927		0.030		4.772		51.955		0.4489		0.4063		2826		82.4		0.722	
	2	251.908		0.0301		4.796		52.525		0.4485		0.4063		2832		82.4		0.725	
	Avg.	249.918	2.20	0.03005	0.80	4.784	1.50	52.240	2.20	0.4487	0.007	0.4063	0.007	2829	50	82.4	1.5	0.724	0.011
NLTC-D-18	1	528.908		0.0358		7.117		74.316		0.4395		0.4065		2977		82.2		0.904	
	2	532.413		0.0358		7.132		74.651		0.4393		0.4061		2977		82.3		0.905	
	Avg.	530.660	2.20	0.0358	0.80	7.124	1.50	74.484	2.20	0.4394	0.007	0.4063	0.007	2977	52	82.2	1.4	0.904	0.014
NLTC-HCCT-19	1	518.434		0.0332		5.922		87.544		0.3234		0.3315		5936		79.4		0.811	
	2	524.474		0.0332		5.916		88.653		0.3226		0.3304		5980		79.4		0.811	
	Avg.	521.454	2.20	0.0332	0.80	5.919	1.50	88.098	2.20	0.3230	0.006	0.3310	0.006	5958	105	79.4	1.4	0.811	0.012
NLTC-LPF-20	1	454.389		0.0498		5.504		82.556		0.4369		0.4083		3036		82.1		0.502	
	2	460.372		0.0497		5.502		83.674		0.4365		0.4081		3041		82.1		0.503	
	Avg.	457.380	2.20	0.0498	0.80	5.503	1.50	83.115	2.20	0.4367	0.007	0.4082	0.007	3038	55	82.1	1.5	0.502	0.008

Photometric measurement of Solid State Lighting Program
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Table B.50 En number(s) for Lab P850

Identifier	Measurement results								
	Total luminous flux	Current	Active power	Luminous efficacy	x	y	CCT	Ra	Power factor
NLTC-IDC-16	0.3	N/A	-0.7	0.9	-0.3	-0.1	0.5	0.0	/
NLTC-OD1-17	0.6	0.0	0.0	0.5	-0.3	-0.2	0.2	0.1	0.0
NLTC-D-18	-0.1	-0.4	0.0	-0.1	-0.3	-0.2	0.3	0.0	0.2
NLTC-HCCT-19	0.2	0.3	0.0	0.2	-0.1	-0.1	0.3	0.0	-0.1
NLTC-LPF-20	0.3	-0.1	0.1	0.3	-0.2	-0.1	0.2	0.0	0.1

Photometric measurement of Solid State Lighting Program
APLAC T088

B.1.26 Test Results of Lab P891

Table B.51 Test results of Lab P891

Identifier		Measurement results																	
		Total luminous flux (lm)		Current (A)		Active power (W)		Luminous efficacy		x		y		CCT (K)		Ra		Power factor	
		Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)	Result	Uncertainty(%)
NLTC-IDC-17	1	583.70		3.95		47.03		12.41		0.4536		0.4088		2774		99.77		DC	
	2	583.7		3.95		47.19		12.37		0.4535		0.4089		2775		99.79		DC	
	Avg.	583.7	1.00	3.95	0.02	47.11	0.02	12.39	1.00	0.4536	0.006	0.4088	0.005	2774	7	99.78	1.60	DC	/
NLTC-OD1-18	1	230.30		0.0288		4.625		49.79		0.4524		0.4085		2788		83.9		0.7294	
	2	230.9		0.02881		4.627		49.9		0.4525		0.4083		2786		83.91		0.7296	
	Avg.	230.6	1.00	0.02880	0.02	4.626	0.02	49.84	1.00	0.4524	0.006	0.4084	0.005	2787	7	83.90	1.60	0.7295	0.03
NLTC-D-19	1	524.40		0.036246		7.039		74.51		0.4418		0.4066		2938		82.33		0.8821	
	2	522.2		0.03625		7.04		74.18		0.4417		0.4064		2938		82.36		0.88225	
	Avg.	523.3	1.00	0.036248	0.02	7.040	0.02	74.34	1.00	0.4418	0.006	0.4065	0.005	2938	7	82.34	1.60	0.88218	0.03
NLTC-HCCT-20	1	519.80		0.032988		5.919		87.82		0.3251		0.3337		5842		79.97		0.815	
	2	517.9		0.03298		5.919		87.48		0.3254		0.3338		5828		80.06		0.81505	
	Avg.	518.8	1.00	0.032984	0.02	5.919	0.02	87.65	1.00	0.3252	0.006	0.3338	0.005	5835	7	80.02	1.60	0.81502	0.03
NLTC-LPF-15	1	462.30		0.04989		5.57		83		0.4399		0.4059		2963		82.16		0.5072	
	2	459.6		0.04998		5.571		82.5		0.4399		0.4063		2966		81.97		0.5064	
	Avg.	460.95	1.00	0.04994	0.02	5.570	0.02	82.75	1.00	0.4399	0.006	0.4061	0.005	2964	7	82.06	1.60	0.5068	0.03

Photometric measurement of Solid State Lighting Program
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Table B.52 En number(s) for Lab P891

Identifier	Measurement results								
	Total luminous flux	Current	Active power	Luminous efficacy	x	y	CCT	Ra	Power factor
NLTC-IDC-17	-0.7	N/A	0.7	-1.0	0.0	-0.1	-0.8	0.0	/
NLTC-OD1-18	0.3	-0.5	-0.5	0.6	0.1	-0.3	-0.5	-0.2	0.0
NLTC-D-19	-0.2	-0.3	-1.0	0.2	0.0	-0.3	-0.3	0.2	-0.2
NLTC-HCCT-20	0.5	-0.7	-0.2	0.5	0.2	0.3	-0.6	0.1	0.0
NLTC-LPF-15	-0.4	-0.1	-0.7	-0.3	0.2	0.0	-0.4	0.0	-0.1

Photometric measurement of Solid State Lighting Program
APLAC T088

B.1.27 Test Results of Lab P895

Table B.53 Test results of Lab P895

Identifier		Measurement results																	
		Total luminous flux (lm)		Current (A)		Active power (W)		Luminous efficacy		x		y		CCT (K)		Ra		Power factor	
		Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)
NLTC-IDC-18	1	604.23		3.950		46.96		12.80		0.4509		0.4089		2816		99.78		1.000	
	2	605.33		3.950		47.00		12.81		0.4510		0.4089		2816		99.74		1.000	
	Avg.	604.78	0.72	3.950	1.8	46.98	1.8	12.80	1.8	0.4510	0.0003	0.4089	0.0002	2816	9.772	99.76	0.3581	1.000	0.0006
NLTC-OD1-19	1	226.37		0.030		4.8		47.16		0.4488		0.4069		2832		83.93		0.737	
	2	226.63		0.030		4.8		47.21		0.4488		0.4069		2832		83.97		0.736	
	Avg.	226.50	0.64	0.030	2.1	4.8	1.3	47.19	1.8	0.4488	0.0002	0.4069	0.0002	2832	9.827	83.95	0.3056	0.737	0.0006
NLTC-D-20	1	498.23		0.036		7.1		70.17		0.4386		0.4045		2976		82.48		0.886	
	2	498.36		0.036		7.1		70.19		0.4386		0.4044		2975		82.50		0.886	
	Avg.	498.30	0.58	0.036	1.8	7.1	0.94	70.18	1.8	0.4386	0.0002	0.4045	0.0003	2976	10.59	82.49	0.2896	0.886	0.0006
NLTC-HCCT-15	1	513.25		0.033		5.9		86.99		0.3283		0.3408		5684		79.27		0.814	
	2	513.58		0.033		5.9		87.05		0.3285		0.3409		5679		79.25		0.814	
	Avg.	513.42	0.60	0.033	1.9	5.9	1.1	87.02	1.8	0.3284	0.0005	0.3409	0.0003	5682	22.91	79.26	0.2786	0.814	0.0006
NLTC-LPF-16	1	435.55		0.049		5.3		82.18		0.4358		0.4035		3015		82.33		0.498	
	2	435.62		0.049		5.3		82.19		0.4362		0.4034		3007		82.39		0.498	
	Avg.	435.58	0.58	0.049	1.3	5.3	1.2	82.19	1.8	0.4360	0.0010	0.4035	0.0003	3011	21.46	82.36	0.3181	0.498	0.0006

Photometric measurement of Solid State Lighting Program
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Table B.54 En number(s) for Lab P895

Identifier	Measurement results								
	Total luminous flux	Current	Active power	Luminous efficacy	x	y	CCT	Ra	Power factor
NLTC-IDC-18	0.3	N/A	0.2	-0.2	-0.3	-0.5	0.1	-0.3	/
NLTC-OD1-19	0.3	-0.3	-0.4	0.5	-0.9	-0.3	0.4	0.3	0.7
NLTC-D-20	-2.8	-1.5	-0.5	-1.6	-0.7	-0.9	0.2	0.6	1.0
NLTC-HCCT-15	-2.3	-1.0	-0.9	-0.8	-1.0	-1.0	1.0	-0.6	0.6
NLTC-LPF-16	-0.9	-0.4	-0.9	-0.3	-0.9	-0.9	0.3	0.3	1.0

Photometric measurement of Solid State Lighting Program
APLAC T088

B.1.28 Test Results of Lab P920

Table B.55 Test results of Lab P920

Identifier		Measurement results																	
		Total luminous flux (lm)		Current (A)		Active power (W)		Luminous efficacy		x		y		CCT (K)		Ra		Power factor	
		Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)	Result	Uncertainty (%)
NLTC-IDC-R19	1	565.007		3.9502		41.891		13.488		0.4548		0.4098		2764		99.4		1	
	2	564.284		3.9500		41.828		13.491		0.4549		0.4098		2763		99.5		1	
	Avg.	564.646	2.2	3.9501	0.12	41.860	0.16	13.490	2.2	0.4548	0.001	0.4098	0.001	2764	15	99.4	0.1	1	0
NLTC-OD1-20	1	224.400		0.030726		4.515		49.701		0.4533		0.4096		2785		83.9		0.6676	
	2	225.013		0.030989		4.611		48.799		0.4531		0.4094		2786		83.9		0.6761	
	Avg.	224.706	2.2	0.030858	0.12	4.563	0.16	49.250	2.2	0.4532	0.001	0.4095	0.001	2786	15	83.9	0.3	0.6718	0.0022
NLTC-D-15	1	487.909		0.040703		6.956		70.142		0.4431		0.4071		2921		81.6		0.7769	
	2	488.657		0.040802		6.956		70.250		0.4430		0.4070		2923		81.6		0.7747	
	Avg.	488.283	2.2	0.040753	0.12	6.956	0.16	70.196	2.2	0.4430	0.001	0.4070	0.001	2922	15	81.6	0.3	0.7758	0.0022
NLTC-HCCT-16	1	506.493		0.032811		5.813		87.131		0.3263		0.3379		5775		79.0		0.8050	
	2	506.802		0.032678		5.783		87.637		0.3262		0.3395		5780		79.0		0.8045	
	Avg.	506.648	2.2	0.032745	0.12	5.798	0.16	87.384	2.2	0.3262	0.0015	0.3387	0.0015	5778	30	79.0	0.3	0.8048	0.0022
NLTC-LPF-17	1	441.451		0.04946		5.398		81.780		0.4391		0.4056		2974		82.0		0.4961	
	2	441.356		0.04942		5.399		81.748		0.4388		0.4053		2977		82.6		0.4964	
	Avg.	441.404	2.2	0.04944	0.12	5.398	0.16	81.764	2.2	0.4390	0.001	0.4054	0.001	2976	15	82.3	0.3	0.4962	0.0022

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Table B.56 En number(s) for Lab P920

Identifier	Measurement results								
	Total luminous flux	Current	Active power	Luminous efficacy	x	y	CCT	Ra	Power factor
NLTC-IDC-R19	0.1	N/A	-0.6	0.1	0.0	0.0	-0.1	-0.9	/
NLTC-OD1-20	-0.7	0.2	-0.7	-0.3	0.3	0.0	-0.2	0.4	-0.9
NLTC-D-15	-1.0	1.0	-0.3	-0.9	0.3	-0.2	-0.3	-0.5	-0.8
NLTC-HCCT-16	-0.8	0.9	-0.1	-0.7	0.3	-0.3	-0.3	-0.1	-0.8
NLTC-LPF-17	-0.7	0.2	0.3	-0.7	0.3	-0.1	-0.2	0.0	-0.1

B.2 (Relative) differences in Measurement Results

The (relative) differences of results between the participants and NLTC for all quantities, all artefacts, and for all participants in graphic forms, are presented in the following subsections. The error bars in the graphs show the expanded uncertainties ($k=2$) of measurements reported by the participants. Dashed lines show (relative) expanded uncertainty ($k=2$) of the Assigned value(s). In the following figures, the deviations of the measurement results which are too large from NLTC were not listed in the following figures.

B.2.1 Total Luminous Flux

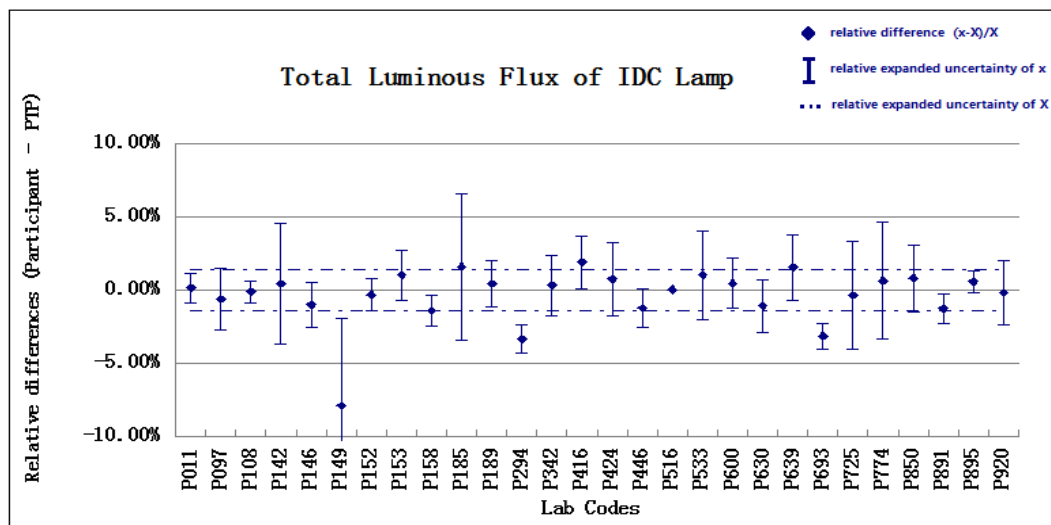


Figure B-1 Relative differences (Participant – PTP) of total luminous flux for NLTC-IDC

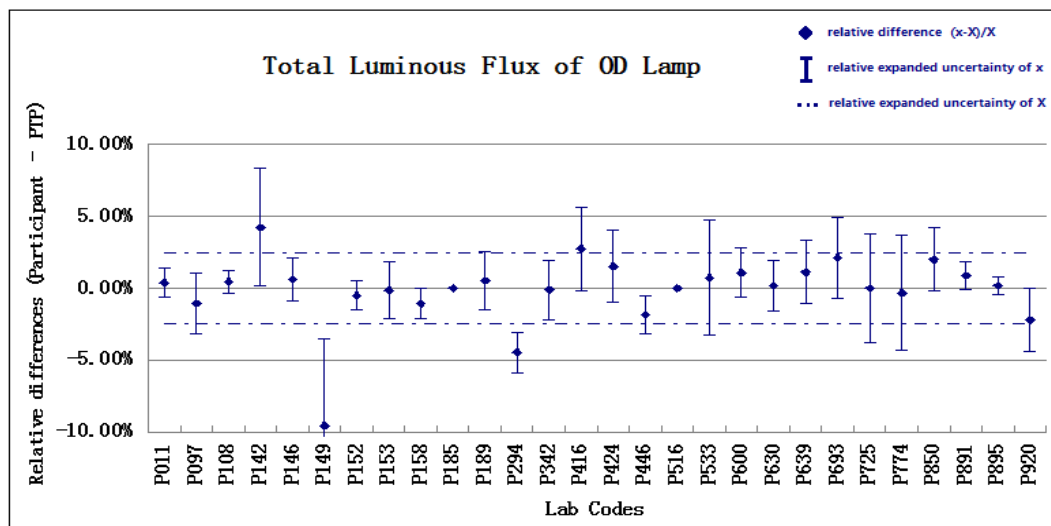


Figure B-2 Relative differences (Participant – PTP) of total luminous flux for NLTC-OD

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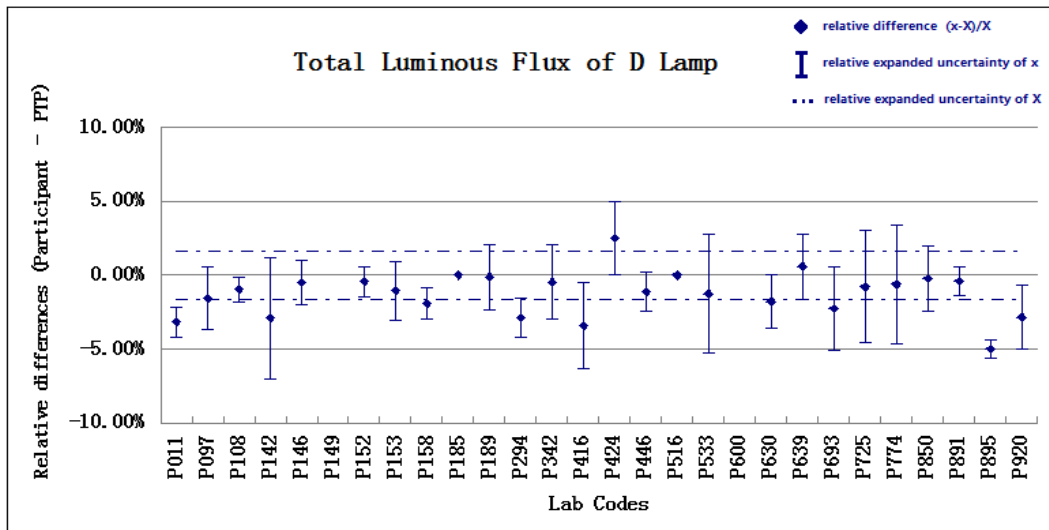


Figure B-3 Relative differences (Participant - PTP) of total luminous flux for NLTC-D

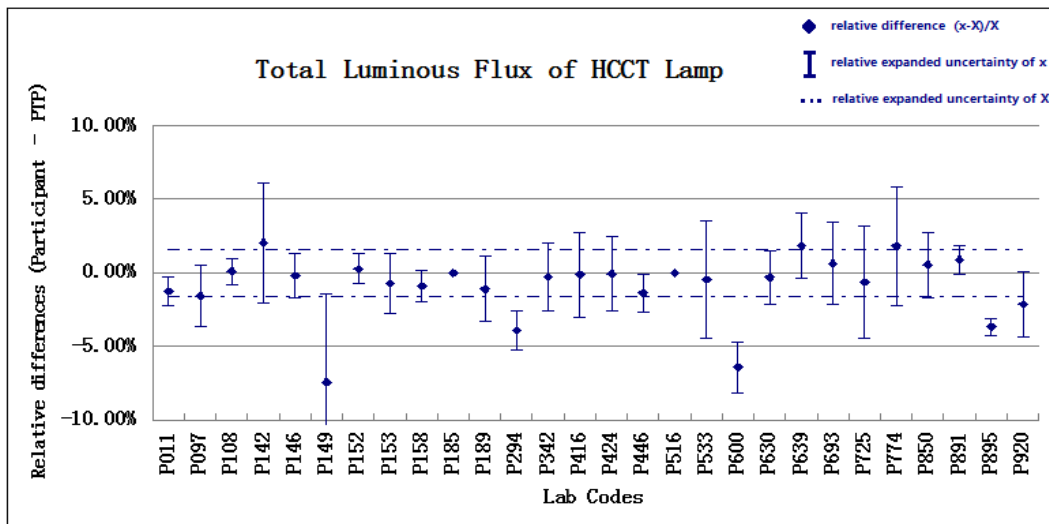


Figure B-4 Relative differences (Participant - PTP) of total luminous flux for NLTC-HCCT

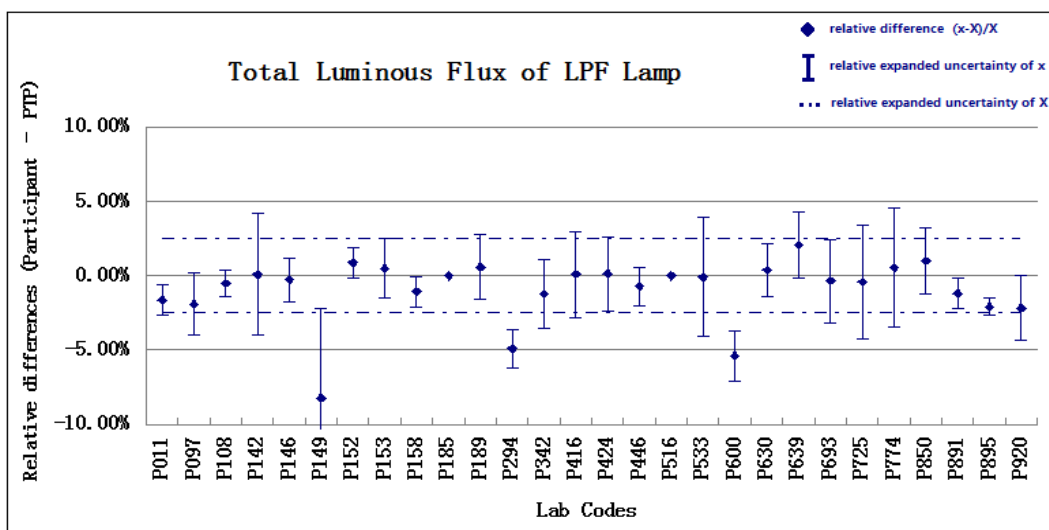


Figure B-5 Relative differences (Participant – PTP) of total luminous flux for NLTC-LPF

B.2.2 Luminous Efficacy

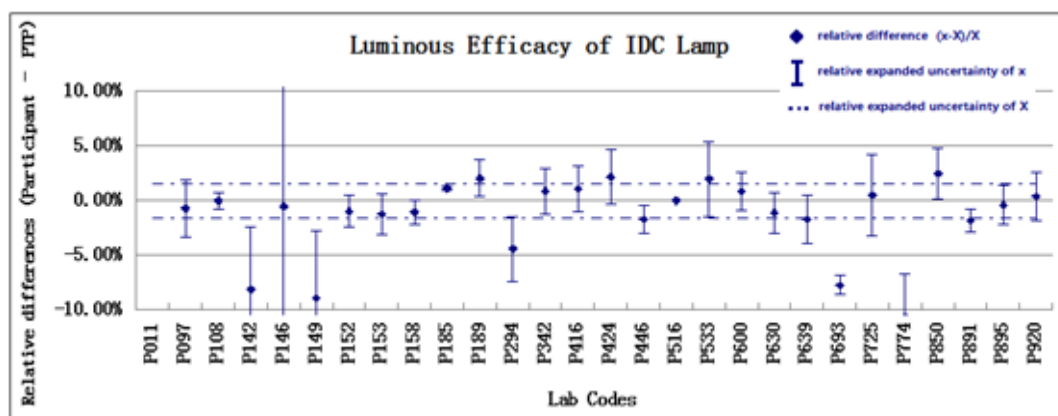


Figure B-6 Relative differences (Participant – PTP) of luminous efficacy for NLTC-IDC

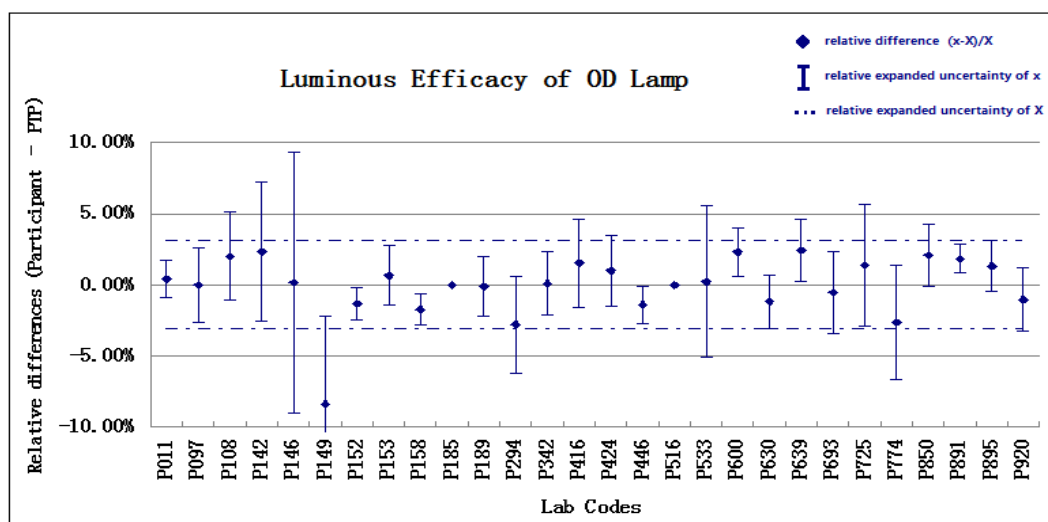


Figure B-7 Relative differences (Participant – PTP) of luminous efficacy for NLTC-OD

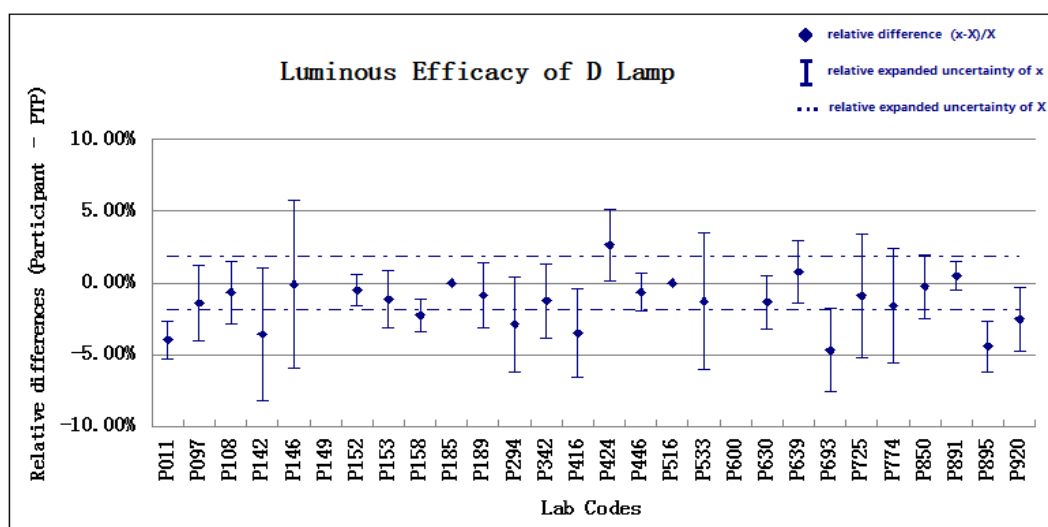


Figure B-8 Relative differences (Participant – PTP) of luminous efficacy for NLTC-D

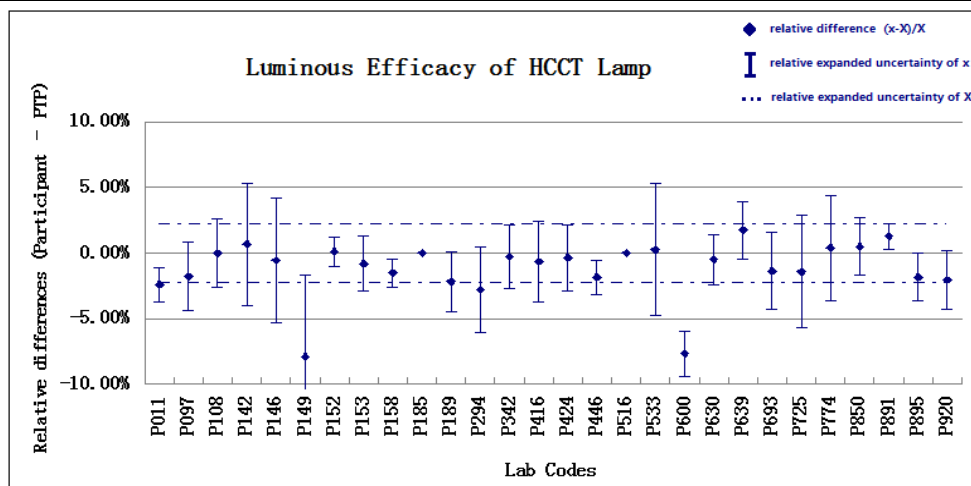


Figure B-9 Relative differences (Participant – PTP) of luminous efficacy for NLTC-HCCT

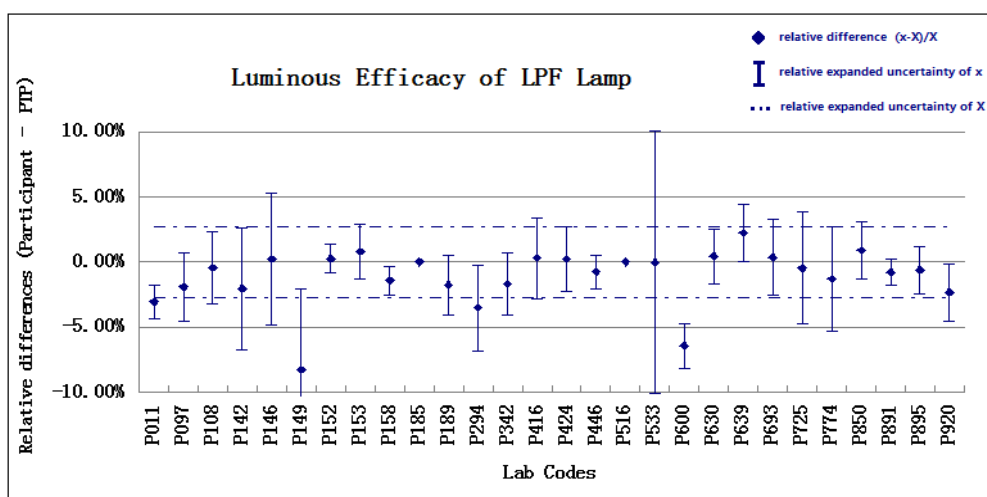


Figure B-10 Relative differences (Participant – PTP) of luminous efficacy for NLTC-LPF

B.2.3 Current

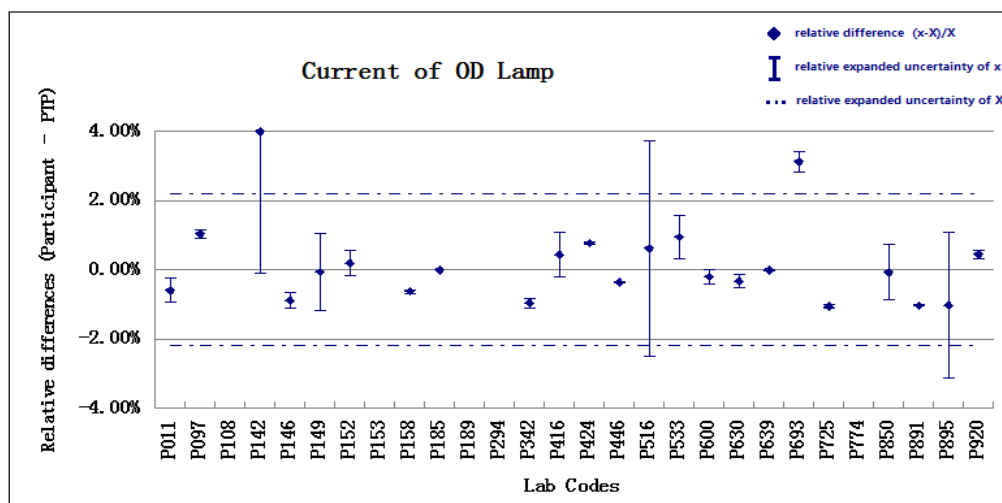


Figure B-11 Relative differences (Participant – PTP) of current for NLTC-OD

Photometric measurement of Solid State Lighting Program
APLAC T088

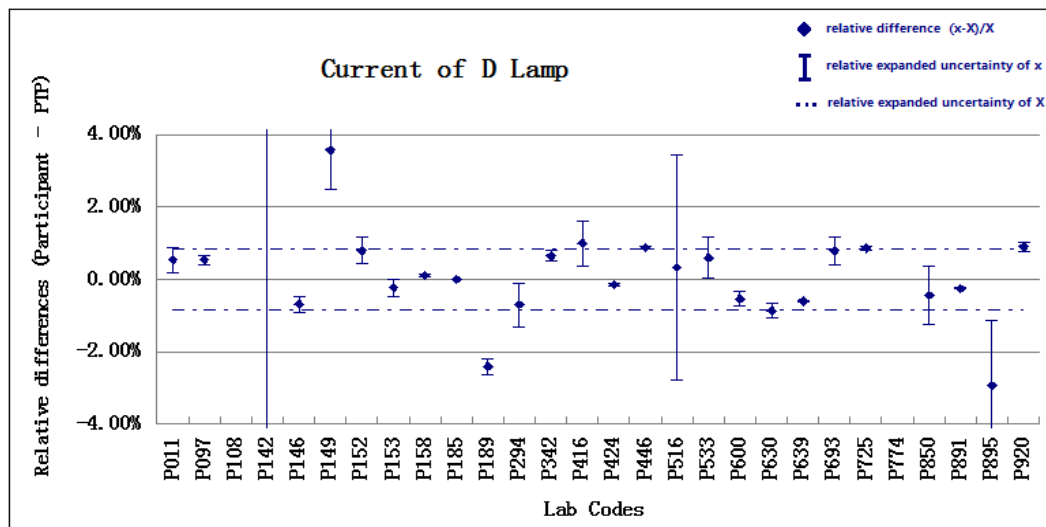


Figure B-12 Relative differences (Participant – PTP) of current for NLTC-D

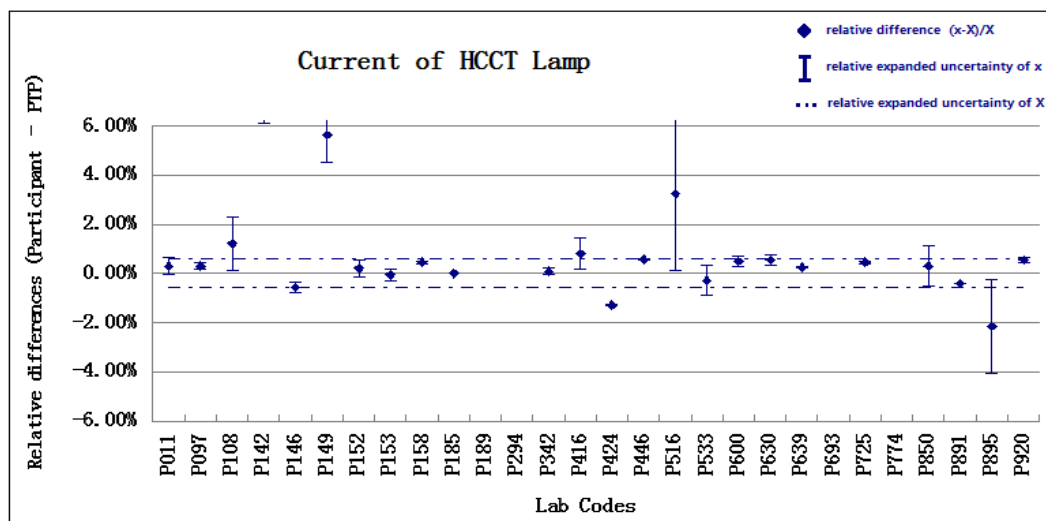


Figure B-13 Relative differences (Participant – PTP) of current for NLTC-HCCT

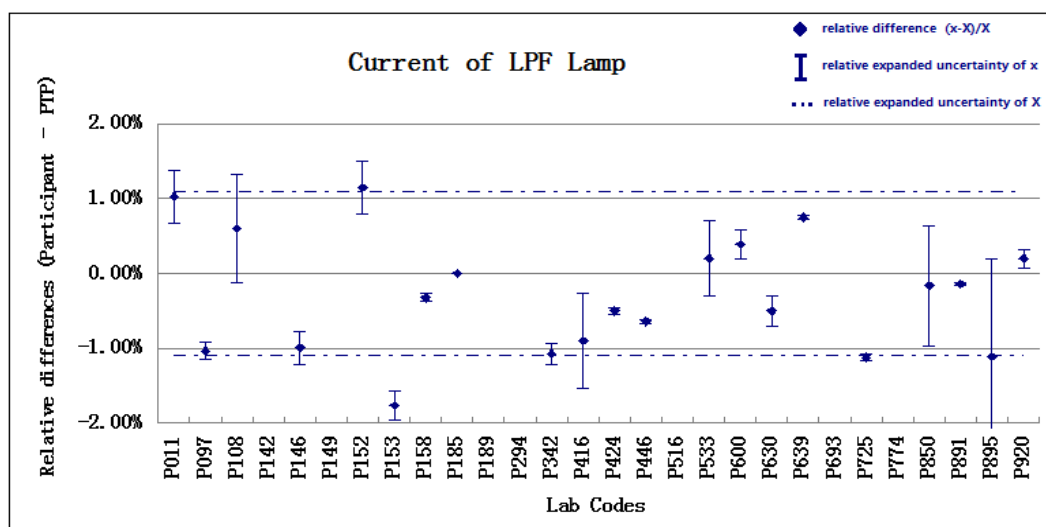


Figure B-14 Relative differences (Participant – PTP) of current for NLTC-LPF

B.2.4 Active Power

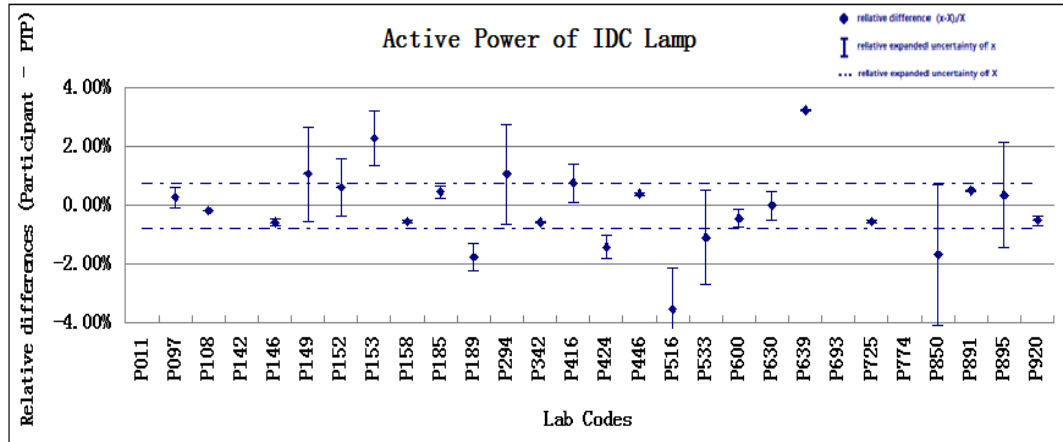


Figure B-15 Relative differences (Participant – PTP) of active power for NLTC-IDC

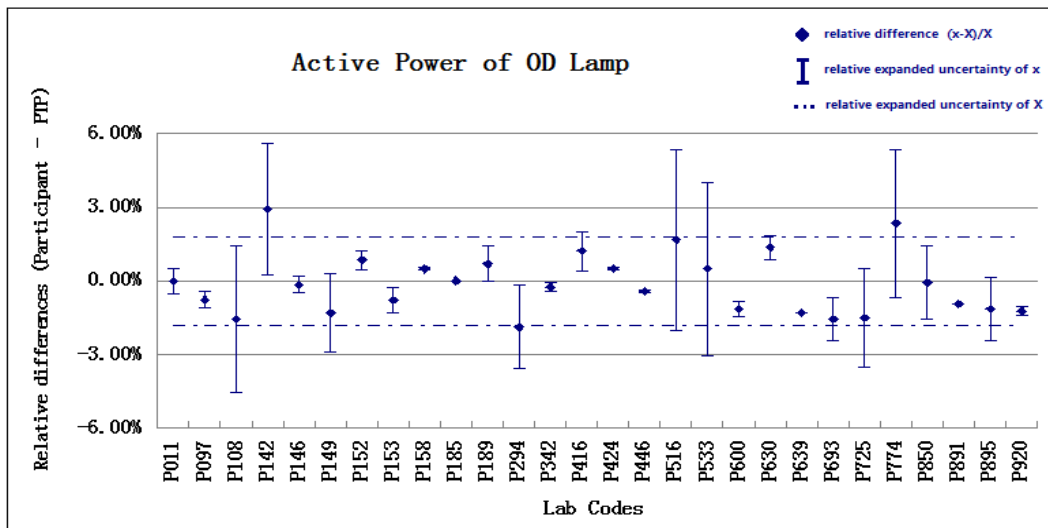


Figure B-16 Relative differences (Participant – PTP) of active power for NLTC-OD

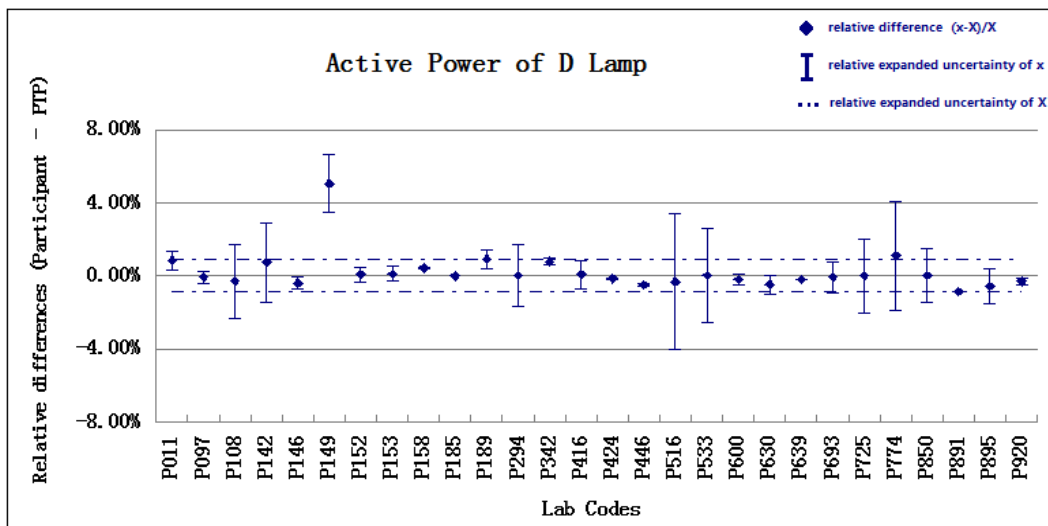


Figure B-17 Relative differences (Participant – PTP) of active power for NLTC-D

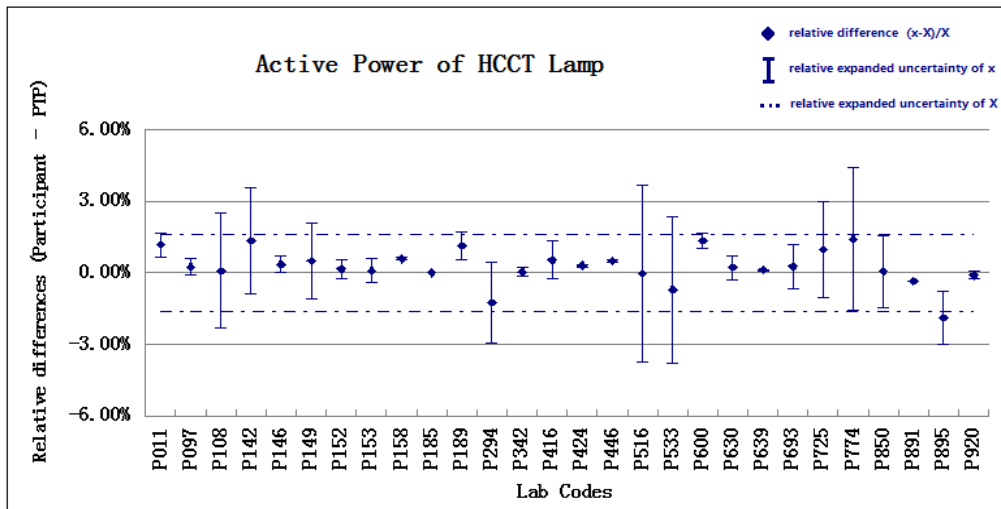


Figure B-18 Relative differences (Participant – PTP) of active power for NLTC-HCCT

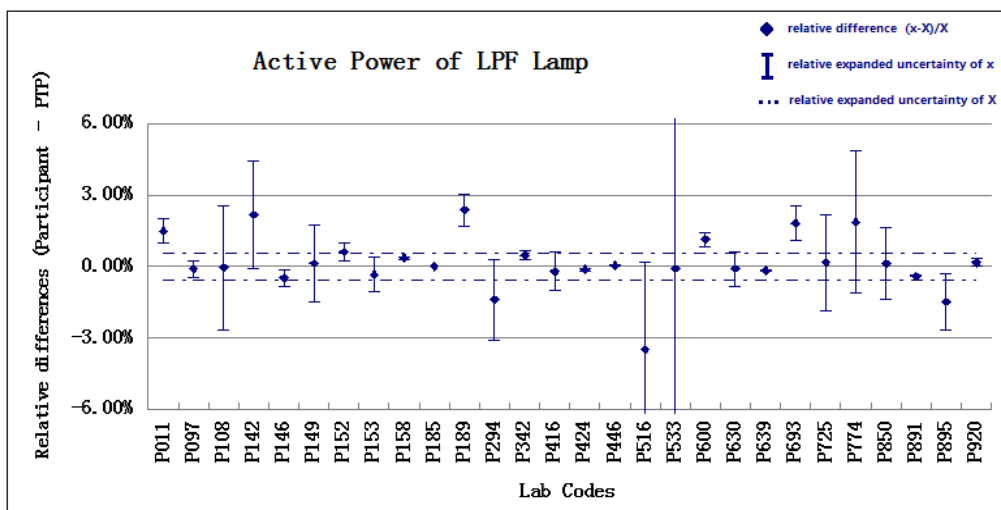


Figure B-19 Relative differences (Participant – PTP) of active power for NLTC-LPF

B.2.5 Power Factor

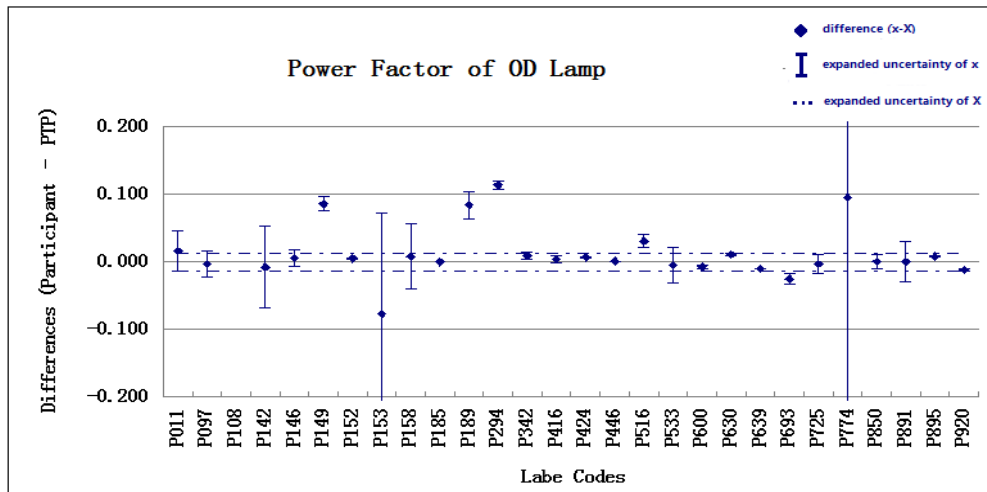


Figure B-20 Differences (Participant – PTP) of power factor for NLTC-OD

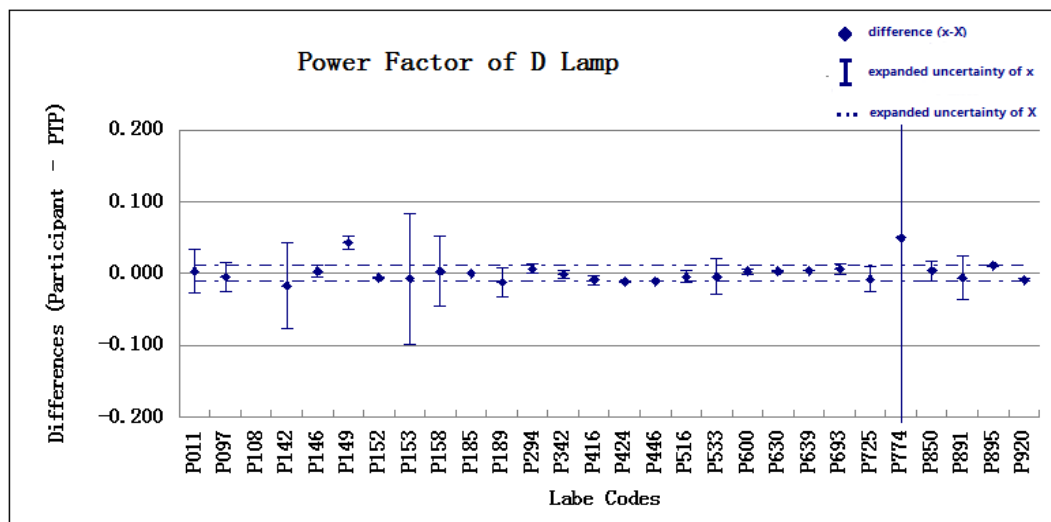


Figure B-21 Differences (Participant – PTP) of power factor for NLTC-D

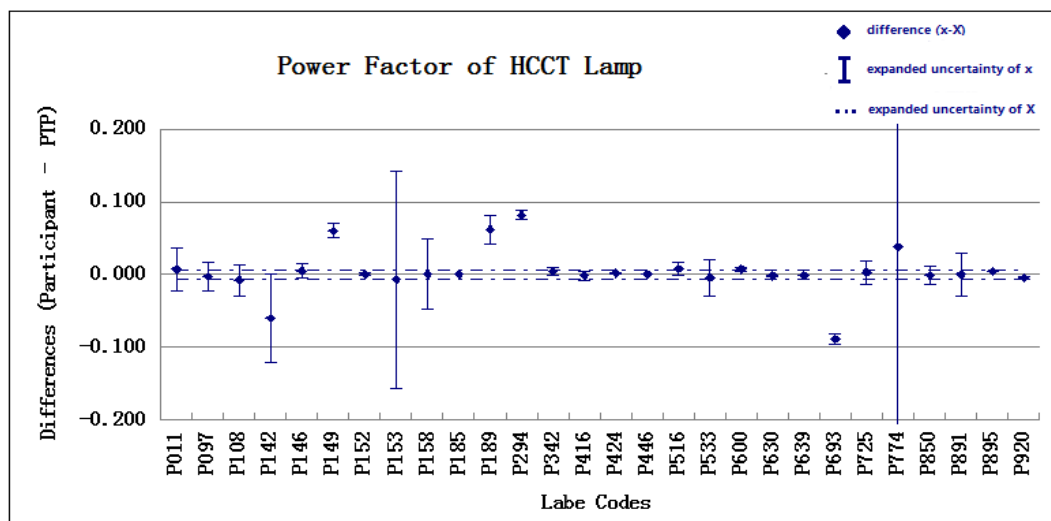


Figure B-22 Differences (Participant – PTP) of power factor for NLTC-HCCT

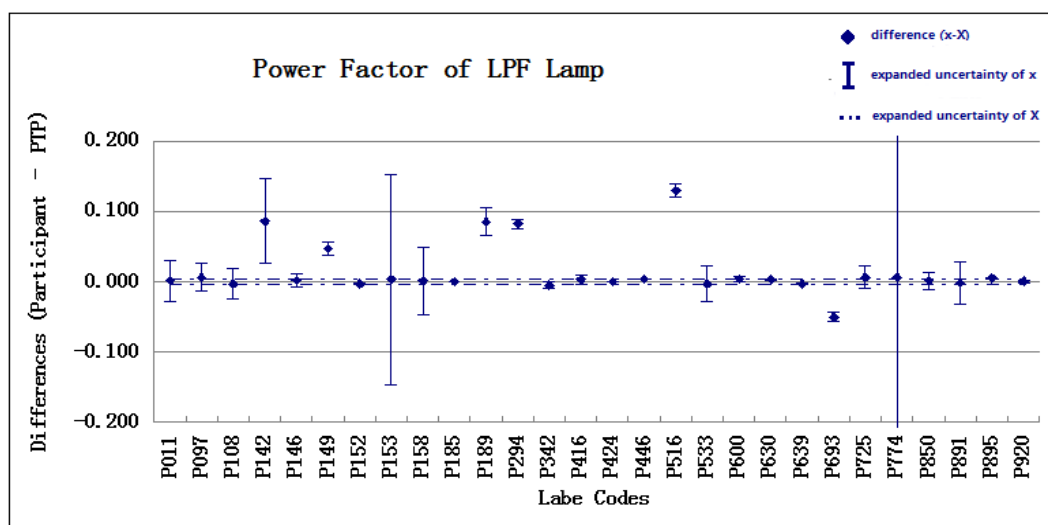


Figure B-23 Differences (Participant – PTP) of power factor for NLTC-LPF

B.2.6 Chromaticity x, y

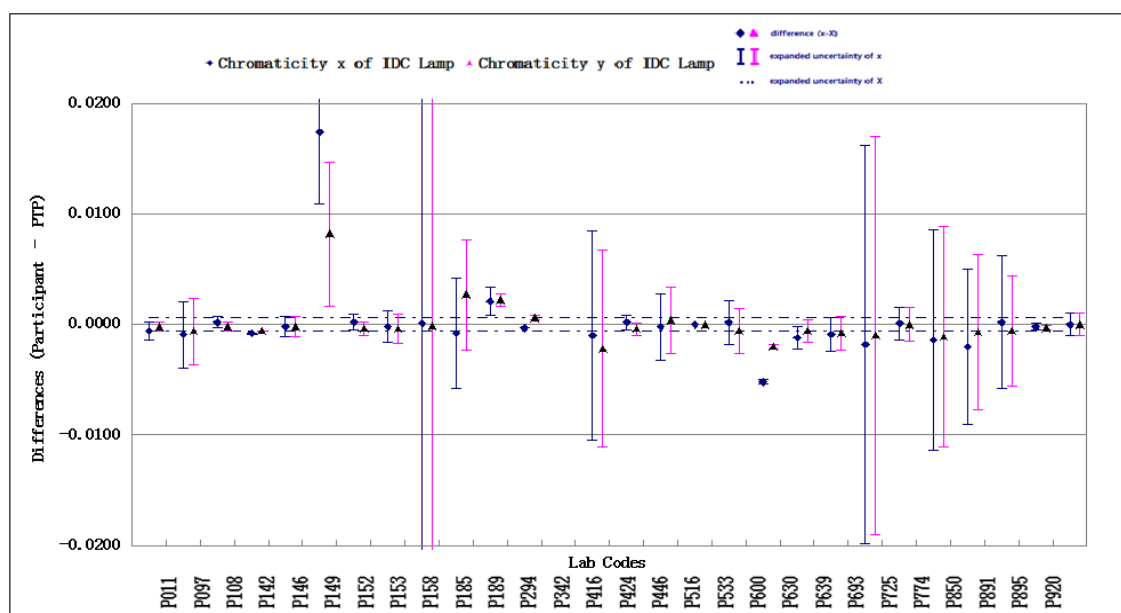


Figure B-24 Differences (Participant – PTP) of chromaticity x, y for NLTC-IDC

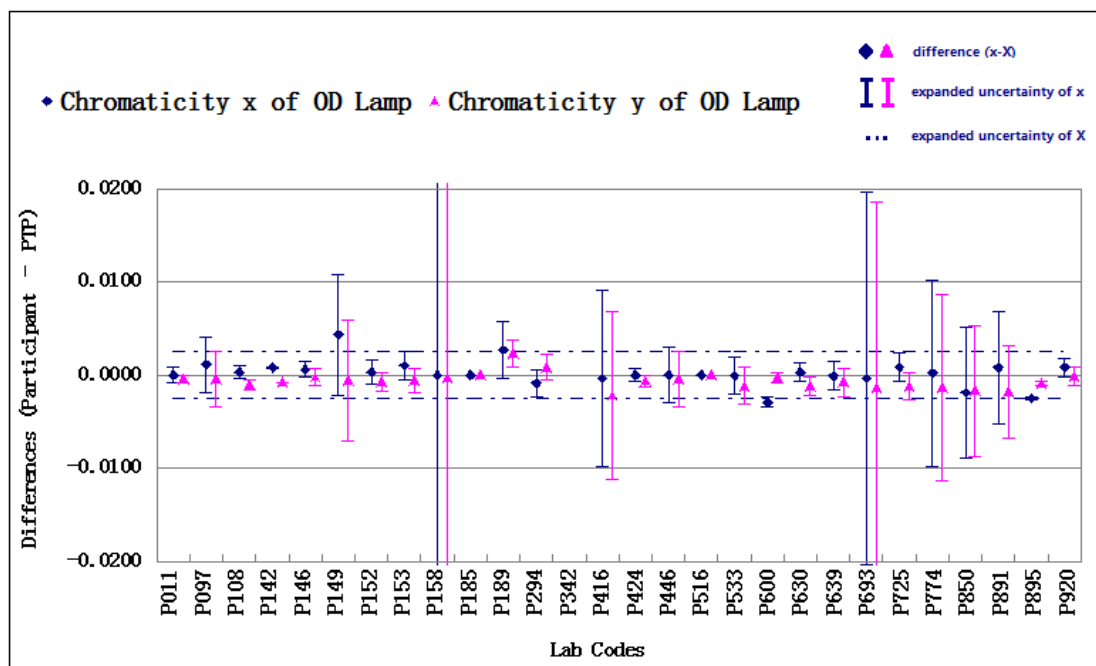


Figure B-25 Differences (Participant - PTP) of chromaticity x,y for NLTC-OD

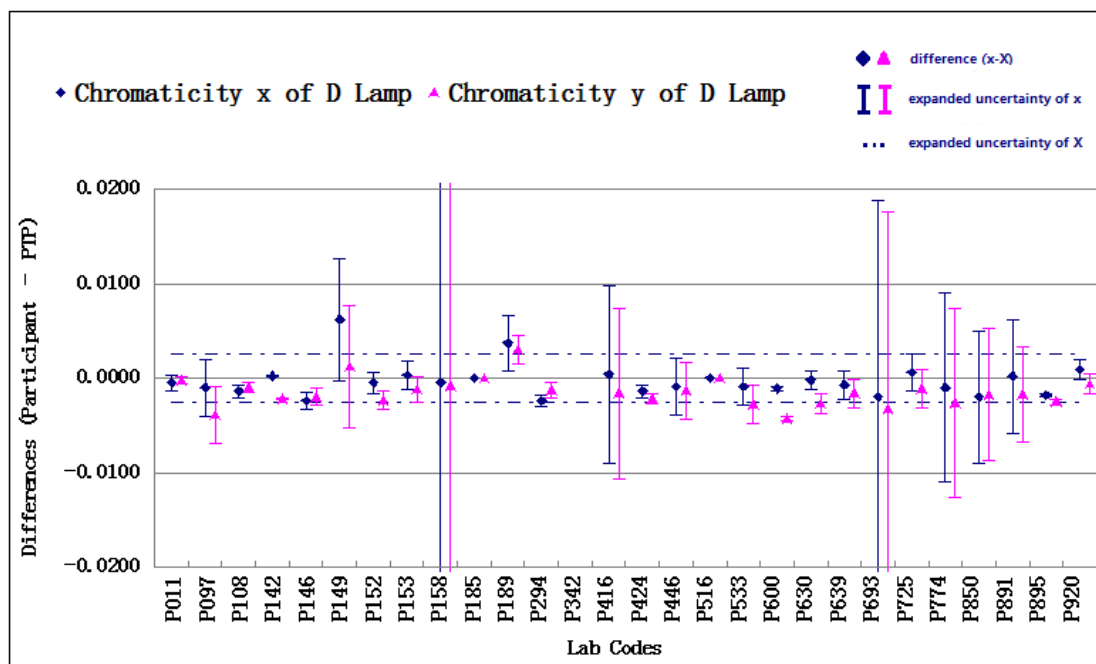


Figure B-26 Differences (Participant - PTP) of chromaticity x,y for NLTC-D

Photometric measurement of Solid State Lighting Program
APLAC T088

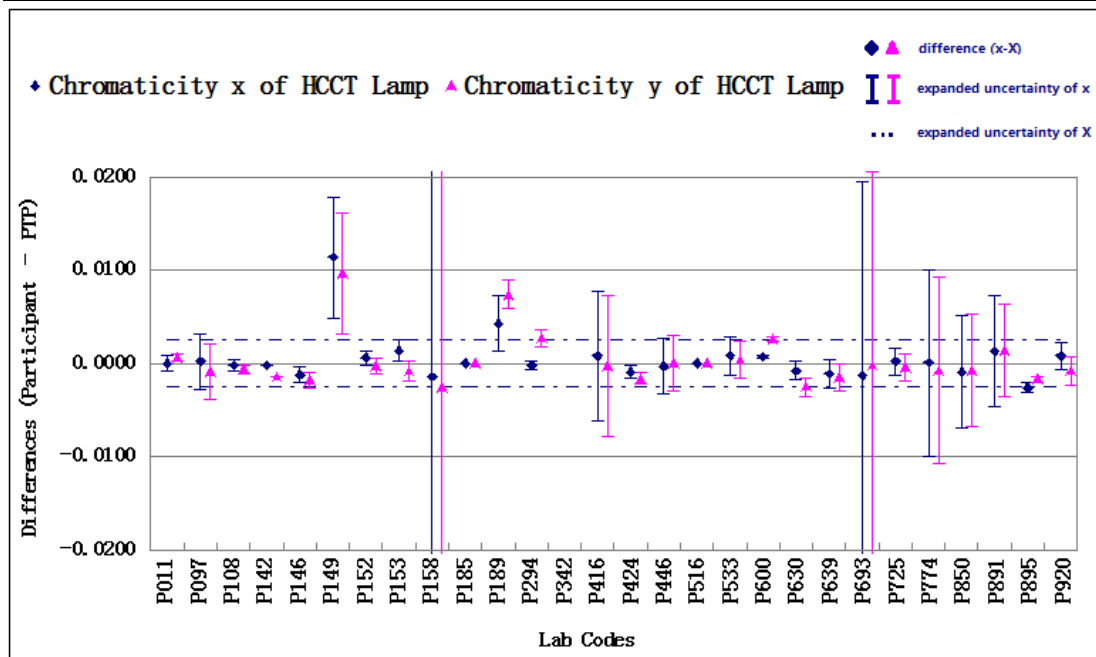


Figure B-27 Differences (Participant - PTP) of chromaticity x,y for NLTC-HCCT

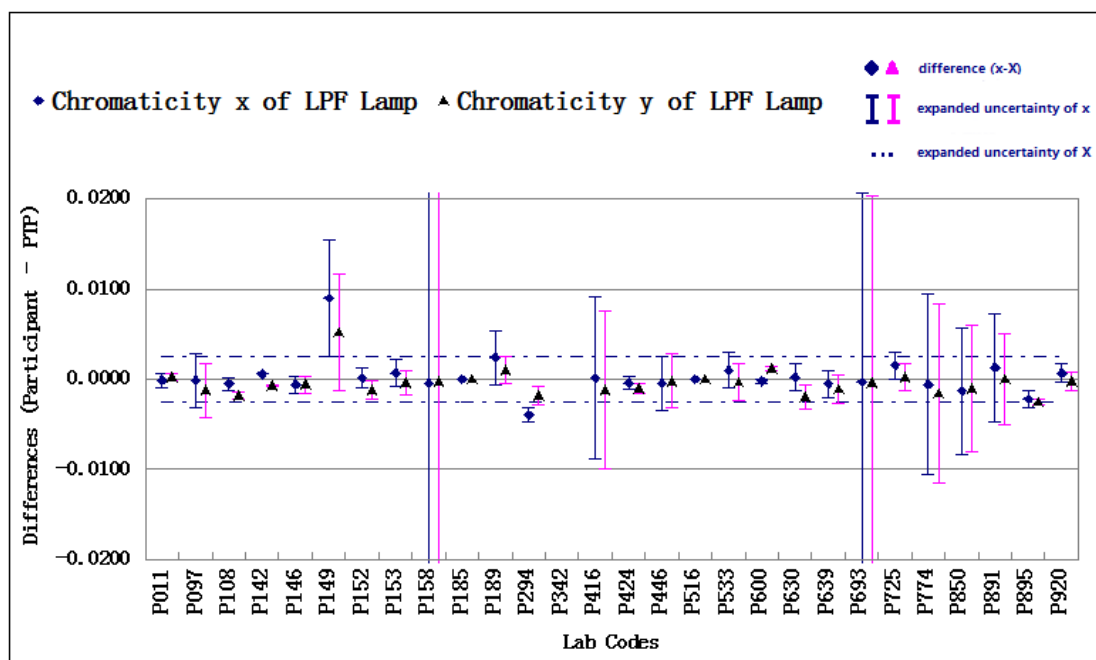


Figure B-28 Differences (Participant - PTP) of chromaticity x,y for NLTC-LPF

B.2.7 Correlated Color Temperature (CCT)

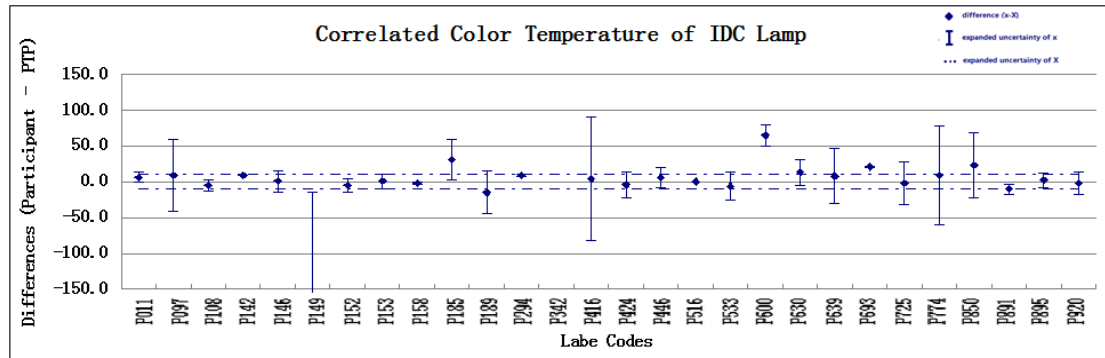


Figure B-29 Differences (Participant – PTP) of CCT for NLTC-IDC

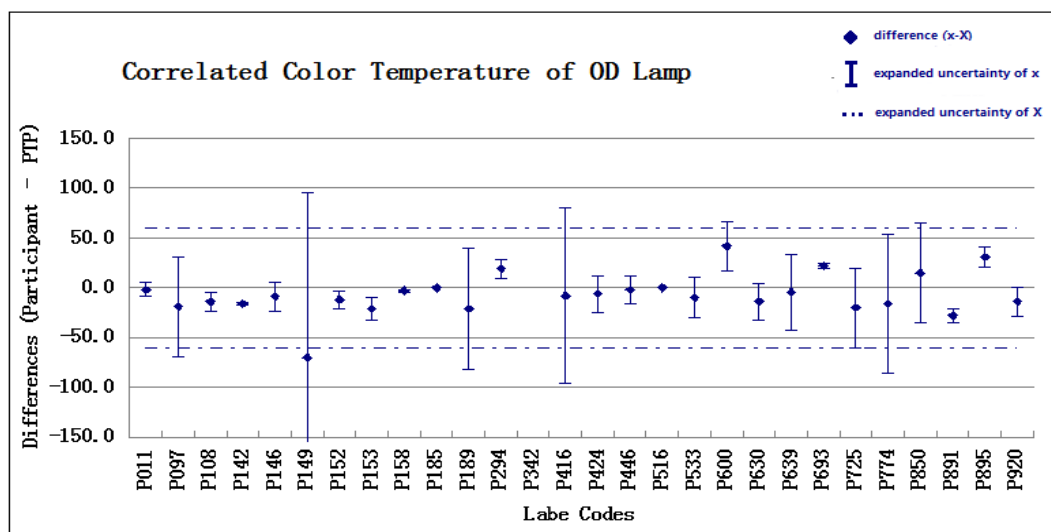


Figure B-30 Differences (Participant – PTP) of CCT for NLTC-OD

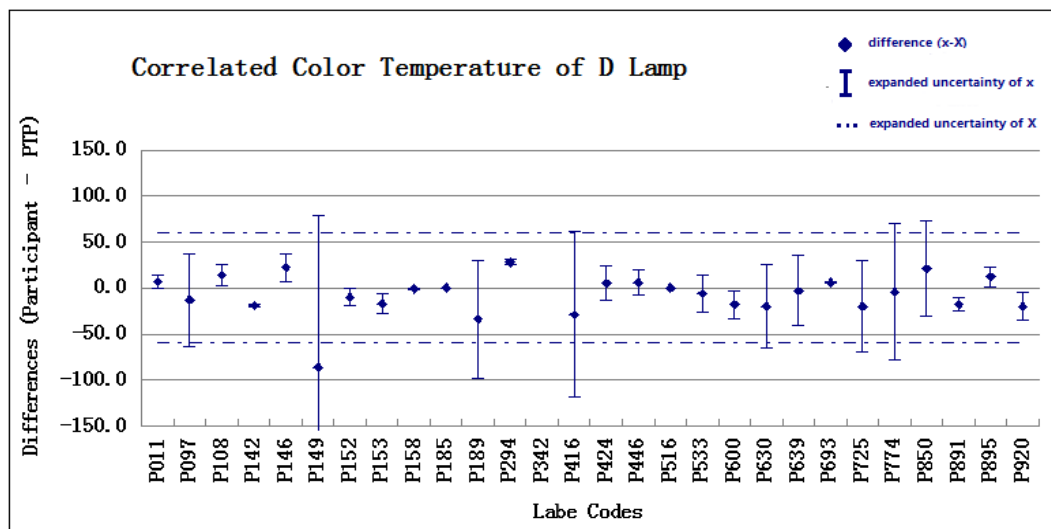


Figure B-31 Differences (Participant – PTP) of CCT for NLTC-D

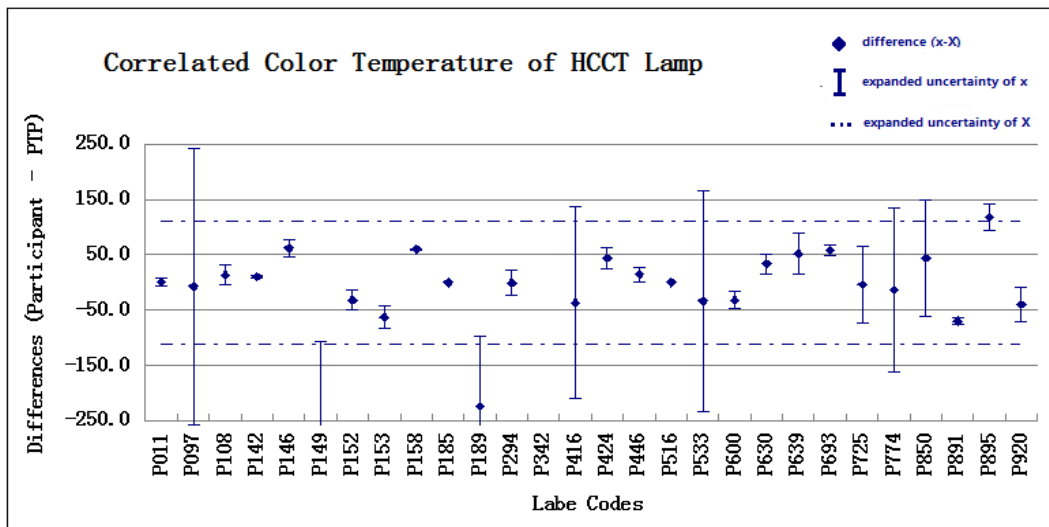


Figure B-32 Differences (Participant – PTP) of CCT for NLTC-HCCT

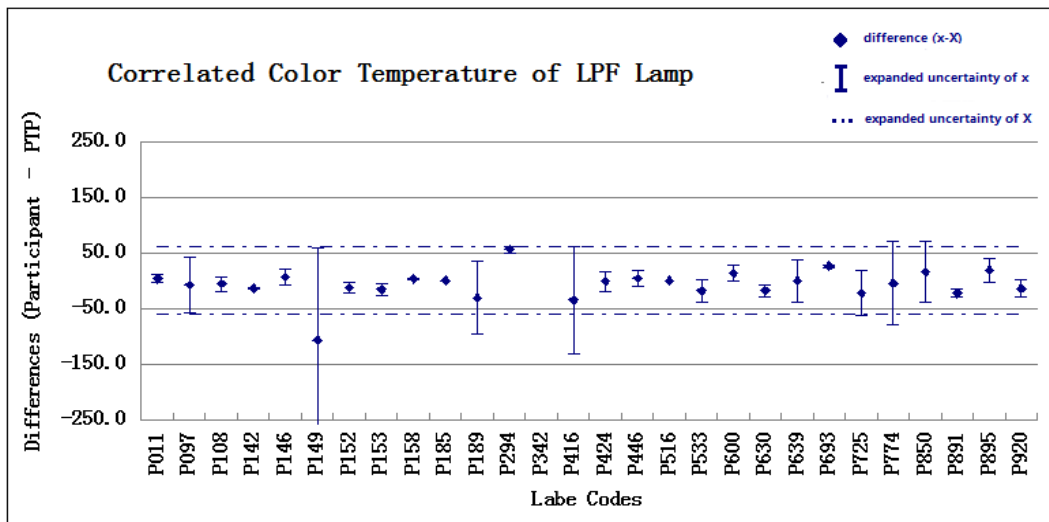


Figure B-33 Differences (Participant – PTP) of CCT for NLTC-LPF

B.2.8 CRI

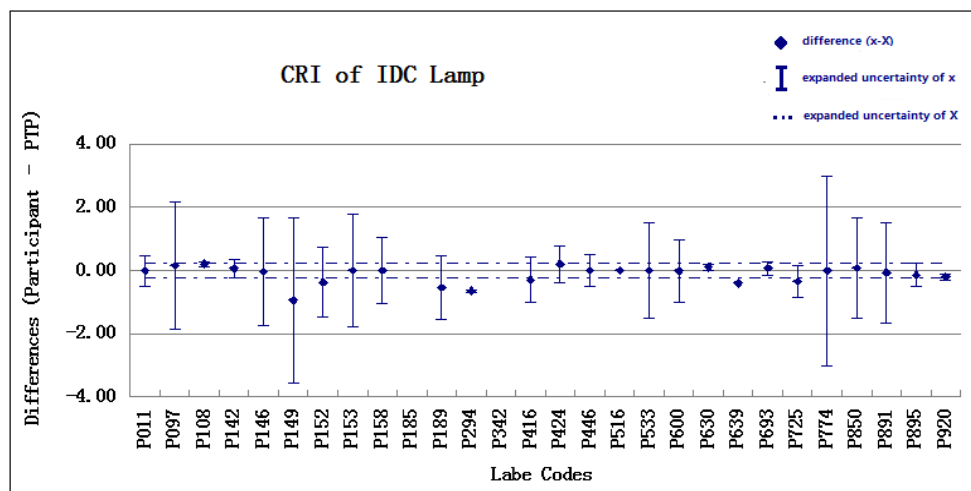


Figure B-34 Differences (Participant – PTP) of CRI Ra for NLTC-IDC

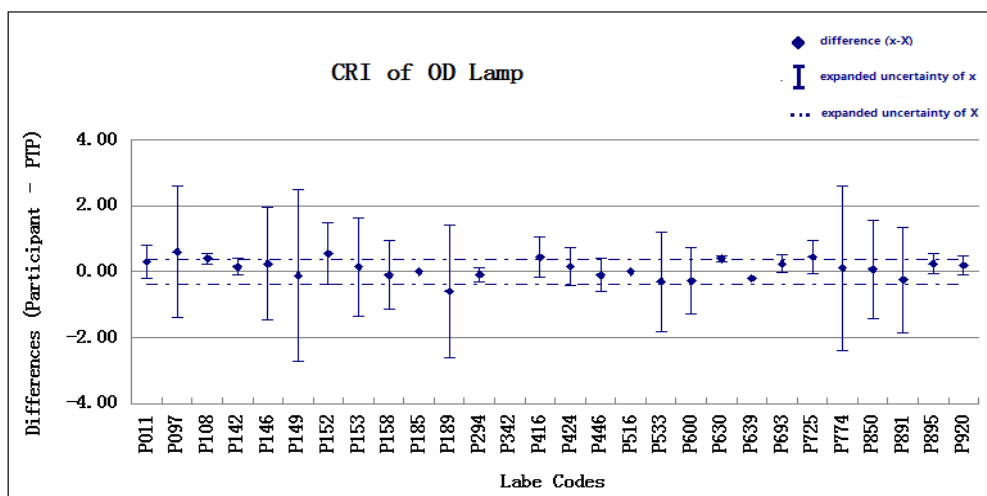


Figure B-35 Differences (Participant - PTP) of CRI Ra for NLTC-OD

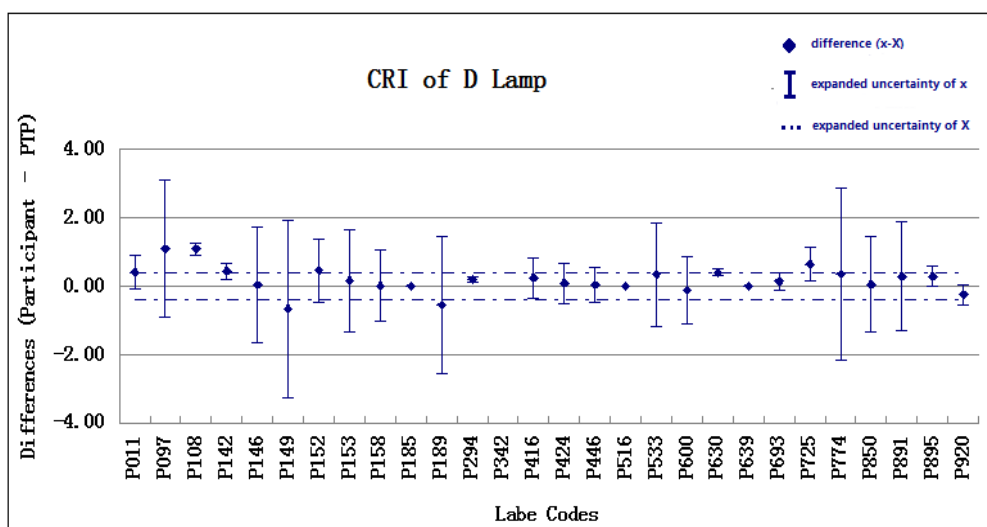


Figure B-36 Differences (Participant - PTP) of CRI Ra for NLTC-D

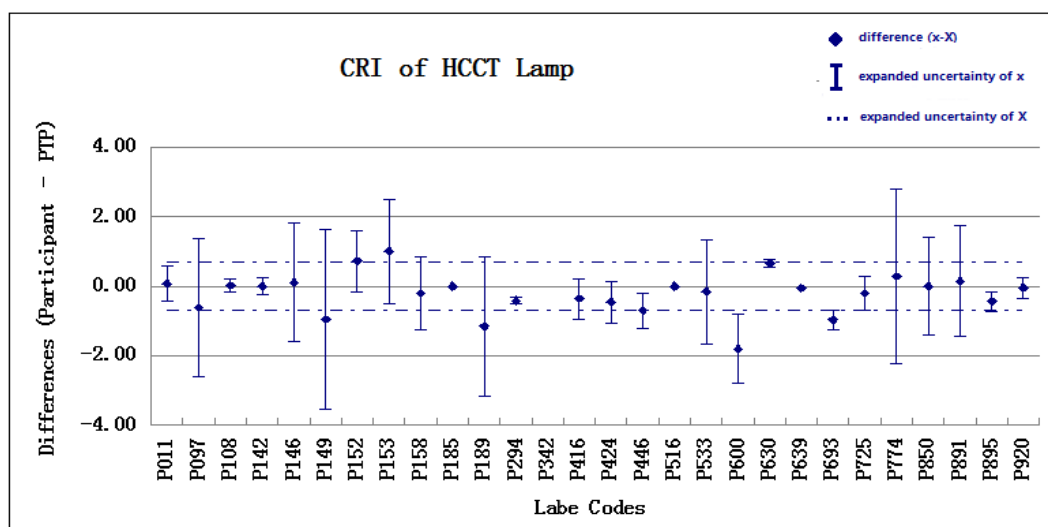


Figure B-37 Differences (Participant - PTP) of CRI Ra for NLTC-HCCT

Photometric measurement of Solid State Lighting Program
APLAC T088

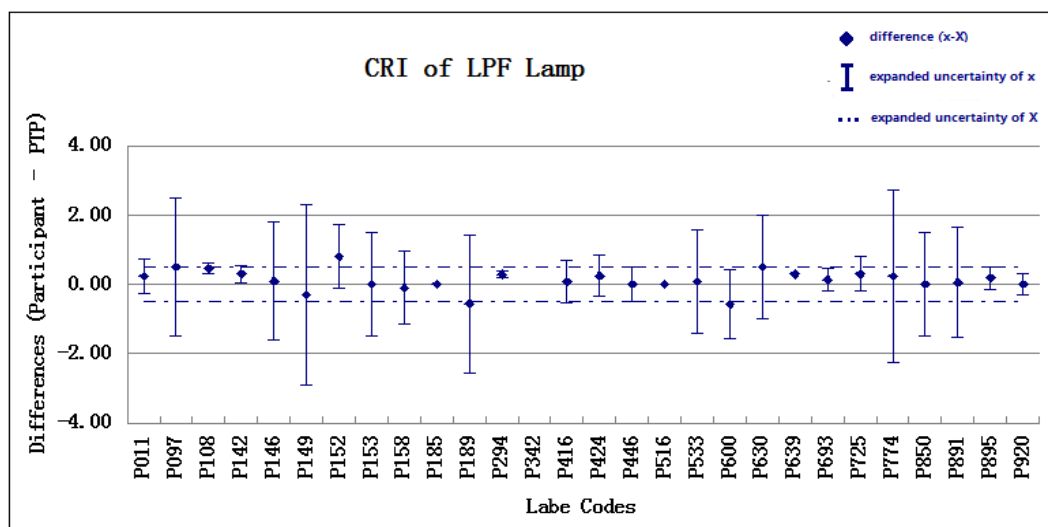


Figure B-38 Differences (Participant – PTP) of CRI Ra for NLTC-LPF

Annex C: Interim Report

Due to the limited pages, the interim report has been omitted here.

Annex D: Stability of Artefacts

Table D-1 Test results of 1st and 2nd measurements for NLTC-IDC artefacts by NLTC

Identifier		Measurement results		
		Total luminous flux (lm)	Active power (W)	CCT (K)
NLTC-IDC-2	1	596.4	42.27	2783
	2	596.8	42.30	2783
	(Relative) difference	0.07%	0.09%	0
NLTC-IDC-3	1	600.5	42.46	2791
	2	601.3	42.58	2790
	(Relative) difference	0.13%	0.28%	-1
NLTC-IDC-5	1	625.8	46.33	2807
	2	626.0	46.25	2802
	(Relative) difference	0.03%	-0.17%	-5
NLTC-IDC-6	1	627.6	43.76	2800
	2	629.9	43.65	2800
	(Relative) difference	0.37%	-0.25%	0
NLTC-IDC-7	1	619	43.25	2828
	2	620	43.25	2828
	(Relative) difference	0.16%	0.00%	0
NLTC-IDC-8	1	593.0	43.39	2784
	2	596.2	43.47	2783
	(Relative) difference	0.54%	0.18%	-1
NLTC-IDC-9	1	602.5	43.687	2788
	2	605.4	43.766	2788
	(Relative) difference	0.48%	0.18%	0
NLTC-IDC-10	1	594.7	43.13	2781
	2	594.7	43.21	2780
	(Relative) difference	0.00%	0.19%	-1
NLTC-IDC-11	1	568.8	42.24	2766
	2	568.1	42.06	2766
	(Relative) difference	-0.12%	-0.43%	0
NLTC-IDC-R12	1	588.2	43.02	2774
	2	588.8	43.02	2774
	(Relative) difference	0.10%	0.00%	0
NLTC-IDC-R13	1	607	42.46	2794
	2	609.6	42.38	2794

Photometric measurement of Solid State Lighting Program
APLAC T088

	(Relative) difference	0.43%	-0.19%	0
NLTC-IDC-14	1	584.5	43.22	2785
	2	581.8	43.23	2782
	(Relative) difference	-0.46%	0.02%	-3
NLTC-IDC-R14	1	584.5	43.09	2775
	2	584.6	43.08	2775
	(Relative) difference	0.02%	-0.02%	0
NLTC-IDC-15	1	577.6	42.28	2773
	2	577.7	42.2	2772
	(Relative) difference	0.02%	-0.19%	-1
NLTC-IDC-16	1	584.7	46.89	2762
	2	585.6	46.97	2763
	(Relative) difference	0.15%	0.17%	1
NLTC-IDC-17	1	591.9	46.89	2784
	2	590.7	46.85	2783
	(Relative) difference	-0.20%	-0.09%	-1
NLTC-IDC-18	1	600.9	46.81	2815
	2	602.0	46.81	2814
	(Relative) difference	0.18%	0.00%	-1
NLTC-IDC-R19	1	563.9	41.95	2767
	2	567.6	42.19	2766
	(Relative) difference	0.65%	0.57%	-1
NLTC-IDC-20	1	594.6	43.47	2781
	2	598.0	43.41	2782
	(Relative) difference	0.57%	-0.14%	1
NLTC-IDC-21	1	615.8	42.96	2796
	2	614.0	43.01	2792
	(Relative) difference	-0.29%	0.12%	-4
NLTC-IDC-30	1	568.6	41.83	2771
	2	568.7	41.91	2771
	(Relative) difference	0.02%	0.19%	0

Table D-2 Test results of 1st and 2nd measurements for NLTC-OD artefacts by NLTC

Identifier		Measurement results		
		Total luminous flux (lm)	Active power (W)	CCT (K)
NLTC-OD1-1	1	222.6	4.784	2816
	2	221.6	4.759	2818

Photometric measurement of Solid State Lighting Program
APLAC T088

	(Relative) difference	-0.45%	-0.52%	2
NLTC-OD1-2	1	240.9	4.898	2812
	2	240.1	4.856	2812
	(Relative) difference	-0.33%	-0.86%	0
NLTC-OD1-3	1	222.5	4.872	2800
	2	222.3	4.844	2800
	(Relative) difference	-0.09%	-0.58%	0
NLTC-OD1-4	1	229.8	4.754	2806
	2	229.8	4.771	2806
	(Relative) difference	0.00%	0.36%	0
NLTC-OD1-6	1	220.6	4.686	2806
	2	220.7	4.694	2805
	(Relative) difference	0.05%	0.17%	-1
NLTC-OD1-7	1	225.0	4.700	2818
	2	224.2	4.694	2817
	(Relative) difference	-0.36%	-0.13%	-1
NLTC-OD1-9	1	238.8	4.835	2790
	2	238.6	4.817	2789
	(Relative) difference	-0.08%	-0.37%	-1
NLTC-OD1-10	1	233.2	4.852	2804
	2	234.0	4.854	2798
	(Relative) difference	0.34%	0.04%	-6
NLTC-OD1-11	1	214.7	4.670	2806
	2	214.1	4.680	2804
	(Relative) difference	-0.28%	0.21%	-2
NLTC-OD1-12	1	250.2	4.852	2801
	2	248.5	4.822	2800
	(Relative) difference	-0.68%	-0.62%	-1
NLTC-OD1-13	1	240.9	4.797	2811
	2	239.8	4.802	2809
	(Relative) difference	-0.46%	0.10%	-2
NLTC-OD1-14	1	236.0	4.861	2790
	2	234.7	4.846	2787
	(Relative) difference	-0.55%	-0.31%	-3
NLTC-OD1-15	1	230.0	4.816	2789
	2	229.5	4.809	2788
	(Relative) difference	-0.22%	-0.15%	-1
NLTC-OD1-16	1	249.5	4.949	2787

Photometric measurement of Solid State Lighting Program
APLAC T088

	2	247.9	4.945	2786
	(Relative) difference	-0.64%	-0.08%	-1
NLTC-OD1-17	1	245.3	4.786	2815
	2	244.7	4.790	2813
	(Relative) difference	-0.24%	0.08%	-2
NLTC-OD1-18	1	229.2	4.666	2821
	2	227.9	4.675	2809
	(Relative) difference	-0.57%	0.19%	-12
NLTC-OD1-19	1	223.6	4.835	2811
	2	226.1	4.856	2801
	(Relative) difference	1.11%	0.43%	-10
NLTC-OD1-20	1	230.1	4.621	2800
	2	229.6	4.618	2801
	(Relative) difference	-0.22%	-0.06%	1
NLTC-OD1-30	1	217.0	4.795	2807
	2	216.6	4.795	2808
	(Relative) difference	-0.18%	0.00%	1

Table D-3 Test results of 1st and 2nd measurements for NLTC-D artefacts by NLTC

Identifier		Measurement results		
		Total luminous flux (lm)	Active power (W)	CCT (K)
NLTC-D-1	1	527.8	7.221	2931
	2	530.1	7.203	2932
	(Relative) difference	0.43%	-0.25%	1
NLTC-D-2	1	525.1	7.072	2944
	2	524.6	7.079	2938
	(Relative) difference	-0.10%	0.10%	-6
NLTC-D-3	1	509.3	7.096	2922
	2	508.6	7.076	2923
	(Relative) difference	-0.14%	-0.28%	1
NLTC-D-4	1	520.6	7.140	2938
	2	523.2	7.157	2934
	(Relative) difference	0.50%	0.24%	-4
NLTC-D-5	1	499.1	6.936	2944
	2	500.9	6.961	2943
	(Relative) difference	0.36%	0.36%	-1
NLTC-D-7	1	520.9	7.177	2977

Photometric measurement of Solid State Lighting Program
APLAC T088

	2	518.4	7.190	2972
	(Relative) difference	-0.48%	0.18%	-5
NLTC-D-8	1	513.7	7.079	2936
	2	513.0	7.094	2935
	(Relative) difference	-0.14%	0.21%	-1
NLTC-D-10	1	534.7	7.333	2936
	2	534.6	7.330	2930
	(Relative) difference	-0.02%	-0.04%	-6
NLTC-D-11	1	509.8	7.052	2943
	2	511.1	7.073	2940
	(Relative) difference	0.25%	0.30%	-3
NLTC-D-12	1	515.6	7.138	2935
	2	515.2	7.148	2927
	(Relative) difference	-0.08%	0.14%	-8
NLTC-D-13	1	530.0	7.244	2957
	2	529.6	7.260	2952
	(Relative) difference	-0.08%	0.22%	-5
NLTC-D-14	1	528.4	6.997	2955
	2	529.3	7.007	2952
	(Relative) difference	0.17%	0.14%	-3
NLTC-D-15	1	502.7	6.973	2943
	2	502.3	6.981	2941
	(Relative) difference	-0.08%	0.11%	-2
NLTC-D-16	1	524.1	7.181	2964
	2	528.1	7.180	2963
	(Relative) difference	0.76%	-0.01%	-1
NLTC-D-17	1	527.7	7.360	2941
	2	529.8	7.365	2942
	(Relative) difference	0.40%	0.07%	1
NLTC-D-18	1	529.8	7.110	2956
	2	533.9	7.133	2957
	(Relative) difference	0.77%	0.32%	1
NLTC-D-19	1	523.2	7.137	2957
	2	527.6	7.063	2956
	(Relative) difference	0.84%	-1.04%	-1
NLTC-D-20	1	521.5	7.143	2962
	2	524.4	7.141	2964
	(Relative) difference	0.55%	-0.03%	2

Photometric measurement of Solid State Lighting Program
APLAC T088

NLTC-D-30	1	500.9	6.922	2928
	2	502.4	6.960	2925
	(Relative) difference	0.30%	0.55%	-3

Table D-4 Test results of 1st and 2nd measurements for NLTC-HCCT artefacts by NLTC

Identifier		Measurement results		
		Total luminous flux (lm)	Active power (W)	CCT (K)
NLTC-HCCT-1	1	545.7	5.982	5666
	2	545.7	5.981	5666
	(Relative) difference	0.00%	-0.02%	0
NLTC-HCCT-2	1	521.8	5.917	5668
	2	520.3	5.915	5675
	(Relative) difference	-0.29%	-0.03%	7
NLTC-HCCT-3	1	519.7	6.022	5677
	2	524.5	5.996	5694
	(Relative) difference	0.92%	-0.43%	17
NLTC-HCCT-4	1	537.4	5.885	5577
	2	537.6	5.885	5607
	(Relative) difference	0.04%	0.00%	30
NLTC-HCCT-5	1	539.8	6.020	5685
	2	540.6	6.017	5694
	(Relative) difference	0.15%	-0.05%	9
NLTC-HCCT-6	1	541.8	5.869	5622
	2	539.4	5.873	5613
	(Relative) difference	-0.44%	0.07%	-9
NLTC-HCCT-8	1	542.5	5.940	5691
	2	541.0	5.941	5697
	(Relative) difference	-0.28%	0.02%	6
NLTC-HCCT-9	1	541.3	5.901	5640
	2	544.1	5.894	5631
	(Relative) difference	0.52%	-0.12%	-9
NLTC-HCCT-11	1	528.0	5.937	5928
	2	530.3	5.936	5933
	(Relative) difference	0.43%	-0.02%	5
NLTC-HCCT-12	1	520.6	5.968	5955
	2	525.5	5.965	5917

Photometric measurement of Solid State Lighting Program
APLAC T088

	(Relative) difference	0.94%	-0.05%	-38
NLTC-HCCT-13	1	539.2	5.97	5600
	2	539.6	5.943	5577
	(Relative) difference	0.07%	-0.45%	-23
NLTC-HCCT-14	1	545.2	5.954	5587
	2	542.9	5.954	5573
	(Relative) difference	-0.42%	0.00%	-14
NLTC-HCCT-15	1	536.0	5.996	5571
	2	533.0	6.013	5564
	(Relative) difference	-0.56%	0.28%	-7
NLTC-HCCT-16	1	519.0	5.804	5804
	2	516.6	5.804	5833
	(Relative) difference	-0.46%	0.00%	29
NLTC-HCCT-17	1	534.7	5.886	5660
	2	536.0	5.880	5665
	(Relative) difference	0.24%	-0.10%	5
NLTC-HCCT-18	1	511.6	5.914	5727
	2	515.4	5.913	5728
	(Relative) difference	0.74%	-0.02%	1
NLTC-HCCT-19	1	516.5	5.915	5960
	2	520.8	5.917	5868
	(Relative) difference	0.83%	0.03%	-92
NLTC-HCCT-20	1	516.1	5.941	5884
	2	512.4	5.940	5926
	(Relative) difference	-0.72%	-0.02%	42
NLTC-HCCT-30	1	544.1	5.894	5732
	2	541.8	5.896	5732
	(Relative) difference	-0.42%	0.03%	0

Table D-5 Test results of 1st and 2nd measurements for NLTC-LPF artefacts by NLTC

Identifier		Measurement results		
		Total luminous flux (lm)	Active power (W)	CCT (K)
NLTC-LPF-1	1	463.2	5.575	3087
	2	464.0	5.571	3087
	(Relative) difference	0.17%	-0.07%	0
NLTC-LPF-2	1	437.3	5.107	2999
	2	435.2	5.111	2997

Photometric measurement of Solid State Lighting Program
APLAC T088

	(Relative) difference	-0.48%	0.08%	-2
NLTC-LPF-3	1	464.8	5.579	3103
	2	464.4	5.586	3107
	(Relative) difference	-0.09%	0.13%	4
NLTC-LPF-4	1	438.9	5.226	2983
	2	441.6	5.234	2987
	(Relative) difference	0.61%	0.15%	4
NLTC-LPF-5	1	441.2	5.265	3149
	2	441.5	5.268	3151
	(Relative) difference	0.07%	0.06%	2
NLTC-LPF-6	1	441.8	5.287	2999
	2	441.0	5.286	2997
	(Relative) difference	-0.18%	-0.02%	-2
NLTC-LPF-7	1	437.8	5.189	3093
	2	438.1	5.198	3095
	(Relative) difference	0.07%	0.17%	2
NLTC-LPF-9	1	428.1	5.566	2992
	2	429.4	5.565	2993
	(Relative) difference	0.30%	-0.02%	1
NLTC-LPF-10	1	451.8	5.470	2977
	2	453.9	5.458	2979
	(Relative) difference	0.46%	-0.22%	2
NLTC-LPF-12	1	430.0	5.114	2990
	2	432.0	5.112	2990
	(Relative) difference	0.46%	-0.04%	0
NLTC-LPF-13	1	448.2	5.376	3110
	2	449.4	5.370	3110
	(Relative) difference	0.27%	-0.11%	0
NLTC-LPF-14	1	463.4	5.501	3127
	2	462.3	5.506	3123
	(Relative) difference	-0.24%	0.09%	-4
NLTC-LPF-15	1	467	5.592	2988
	2	466	5.594	2986
	(Relative) difference	-0.21%	0.04%	-2
NLTC-LPF-16	1	446.2	5.34	2989
	2	444.8	5.38	2992
	(Relative) difference	-0.31%	0.75%	3
NLTC-LPF-17	1	450.4	5.389	2988

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	2	452.0	5.391	2991
	(Relative) difference	0.35%	0.04%	3
NLTC-LPF-18	1	455.7	5.494	3102
	2	458.1	5.489	3092
	(Relative) difference	0.53%	-0.09%	-10
NLTC-LPF-19	1	466.7	5.629	2989
	2	466.1	5.631	2991
	(Relative) difference	-0.13%	0.04%	2
NLTC-LPF-20	1	451.7	5.496	3022
	2	453.9	5.498	3024
	(Relative) difference	0.49%	0.04%	2
NLTC-LPF-30	1	462.3	5.506	3123
	2	462.4	5.500	3124
	(Relative) difference	0.02%	-0.11%	1

Table D-1 to Table D-5 show the test results of 1st and 2nd measurements for all types of artefacts by NLTC. In addition, the (relative) changes of luminous flux, active power, and CCT are intuitively shown from Fig. D-1 to Fig. D-15. which proves that artefacts were stable enough in the whole PT process.

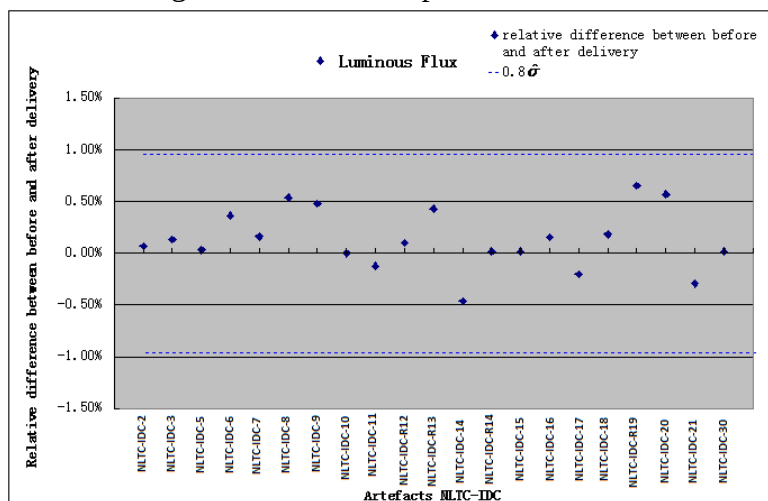


Figure D-1 Relative differences between two measurements by NLTC, before and after transportation, for luminous flux, for artefact NLTC-IDC

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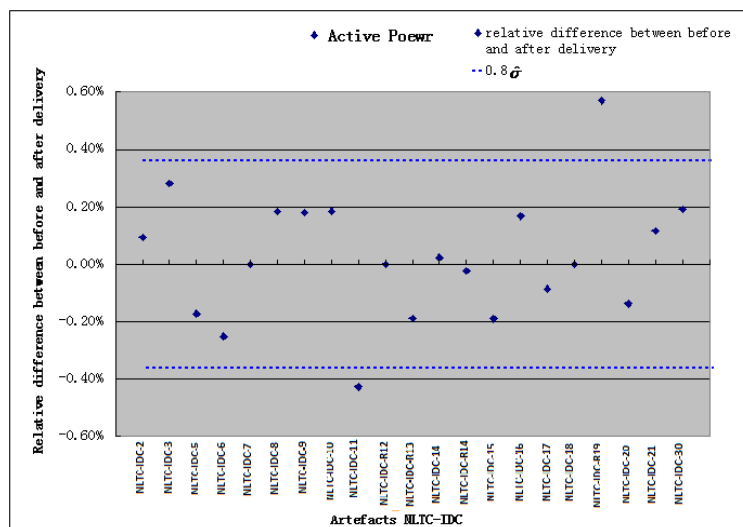


Figure D-2 Relative differences between two measurements by NLTC, before and after transportation, for active power, for artefact NLTC- IDC

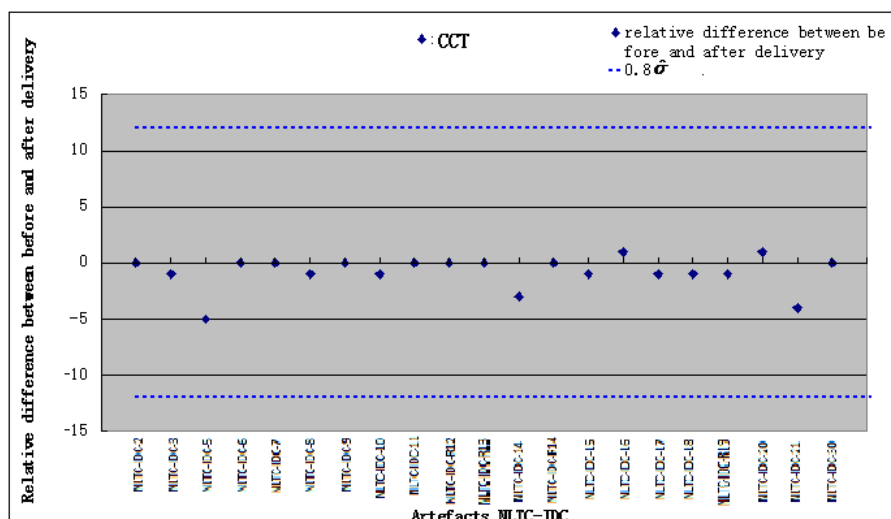


Figure D-3 Differences between two measurements by NLTC, before and after transportation, for CCT, for artefact NLTC- IDC

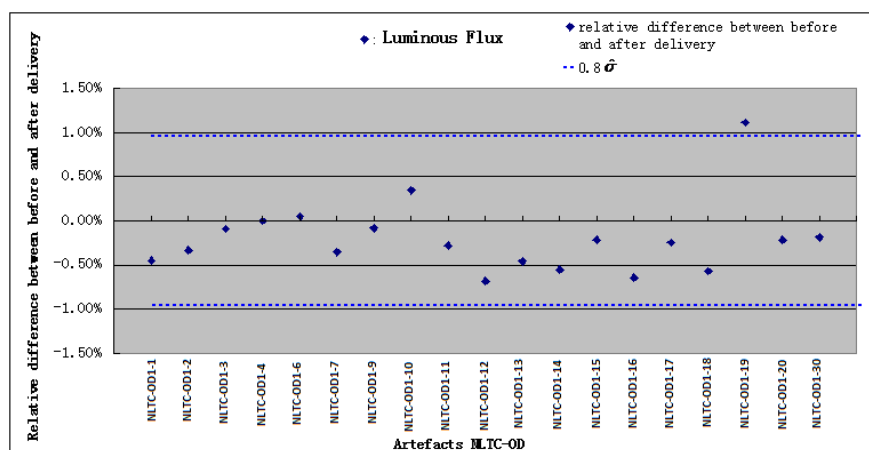


Figure D-4 Relative differences between two measurements by NLTC, before and after transportation, for luminous flux, for artefact NLTC-OD

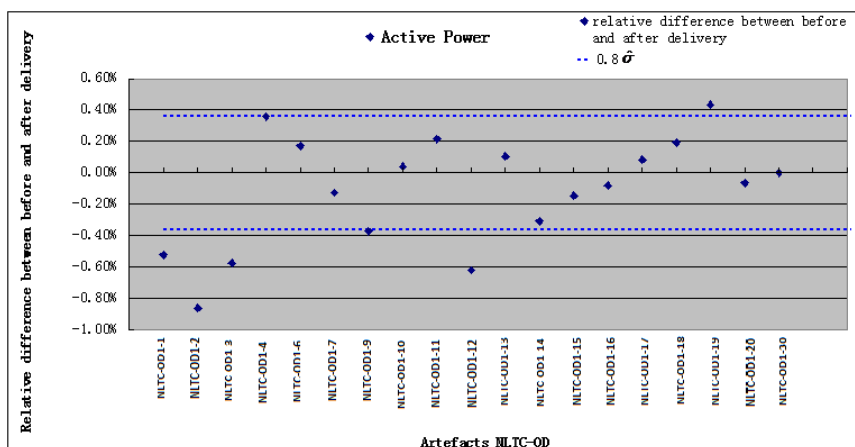


Figure D-5 Relative differences between two measurements by NLTC, before and after transportation, for active power, for artefact NLTC- OD

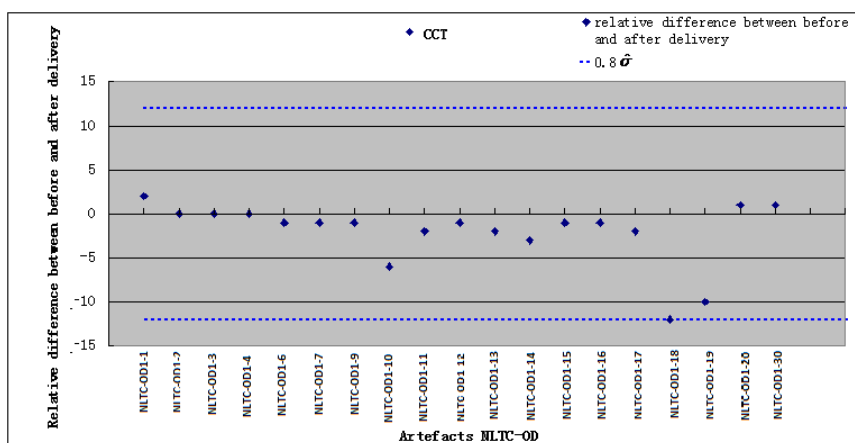


Figure D-6 Differences between two measurements by NLTC, before and after transportation, for CCT, for artefact NLTC- OD

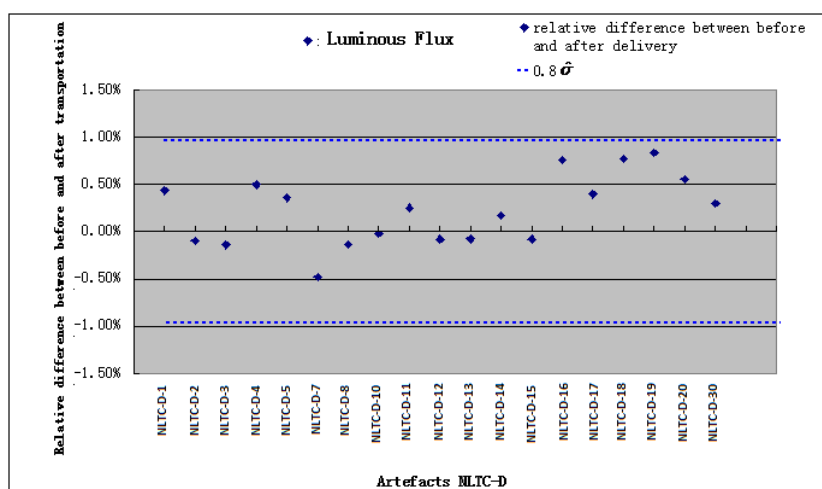


Figure D-7 Relative differences between two measurements by NLTC, before and after transportation, for luminous flux, for artefact NLTC-D

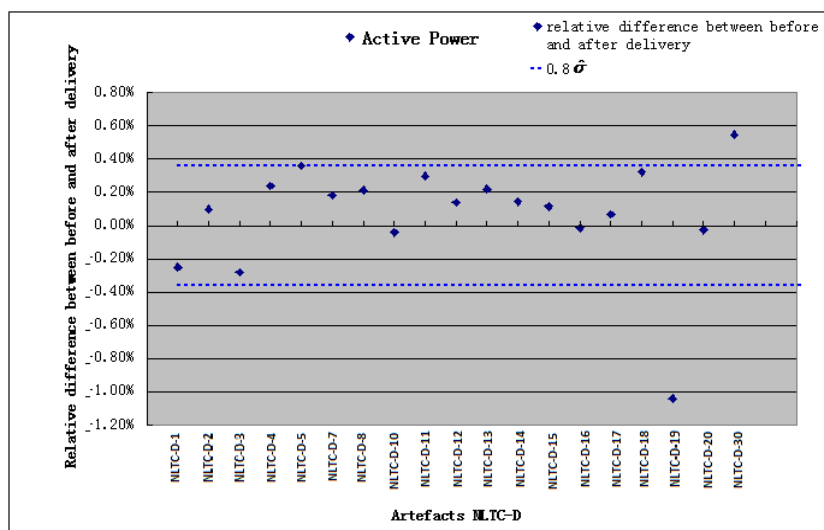


Figure D-8 Relative differences between two measurements by NLTC, before and after transportation, for active power, for artefact NLTC- D

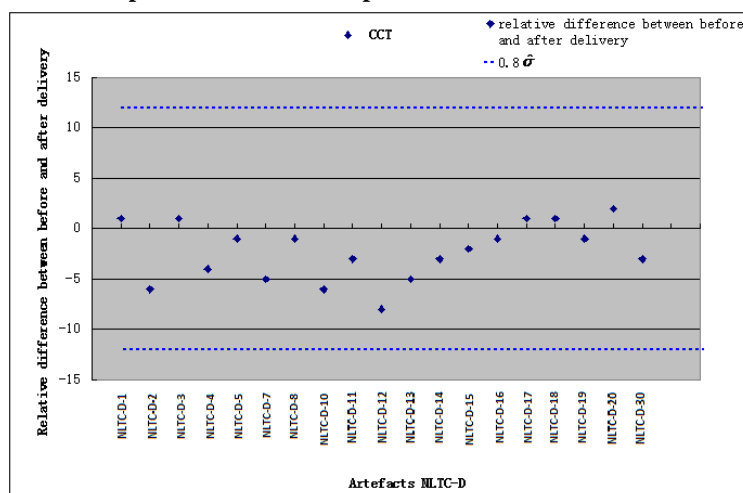


Figure D-9 Differences between two measurements by NLTC, before and after transportation, for CCT, for artefact NLTC- D

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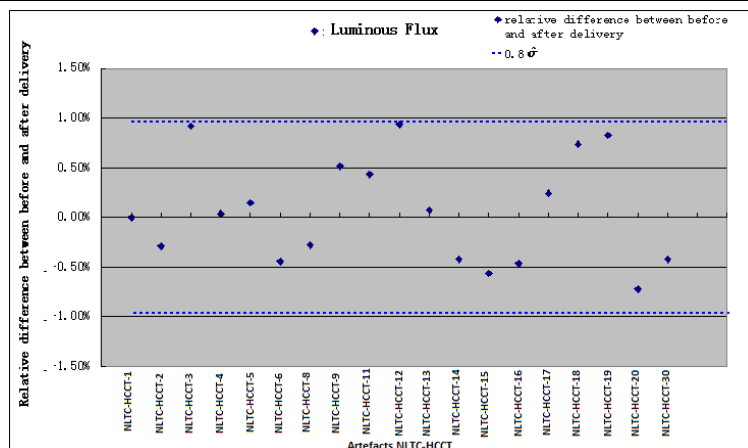


Figure D-10 Relative differences between two measurements by NLTC, before and after transportation, for luminous flux, for artefact NLTC-HCCT

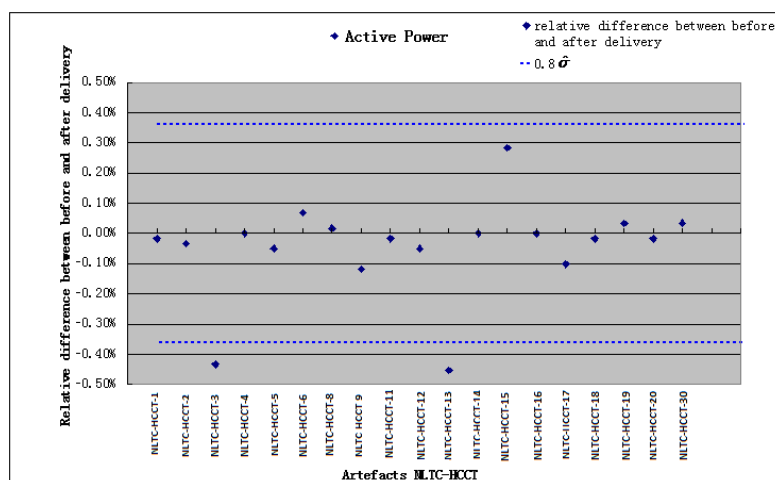


Figure D-11 Relative differences between two measurements by NLTC, before and after transportation, for active power, for artefact NLTC-HCCT

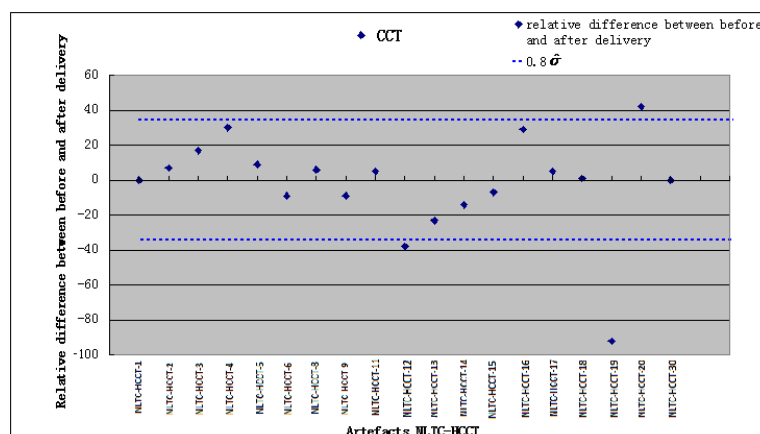


Figure D-12 Differences between two measurements by NLTC, before and after transportation, for CCT, for artefact NLTC-HCCT

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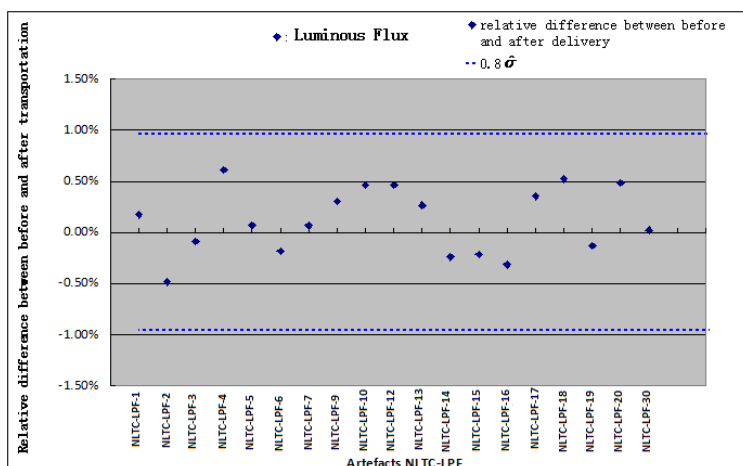


Figure D-13 Relative differences between two measurements by NLTC, before and after transportation, for luminous flux, for artefact NLTC-LPF

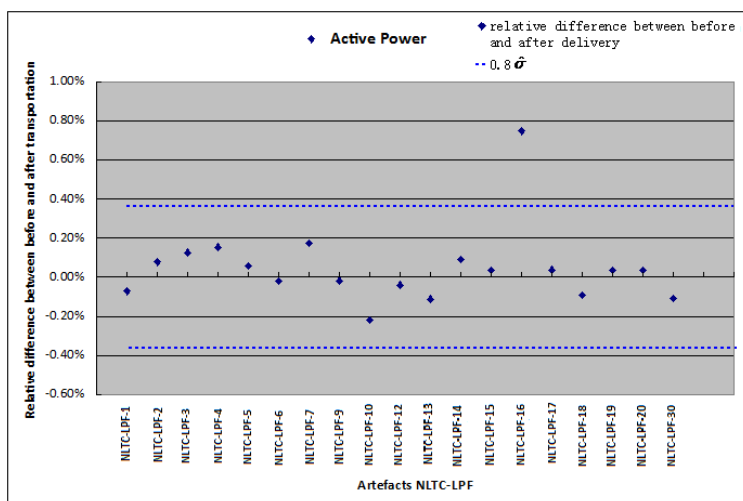


Figure D-14 Relative differences between two measurements by NLTC, before and after transportation, for active power, for artefact NLTC-LPF

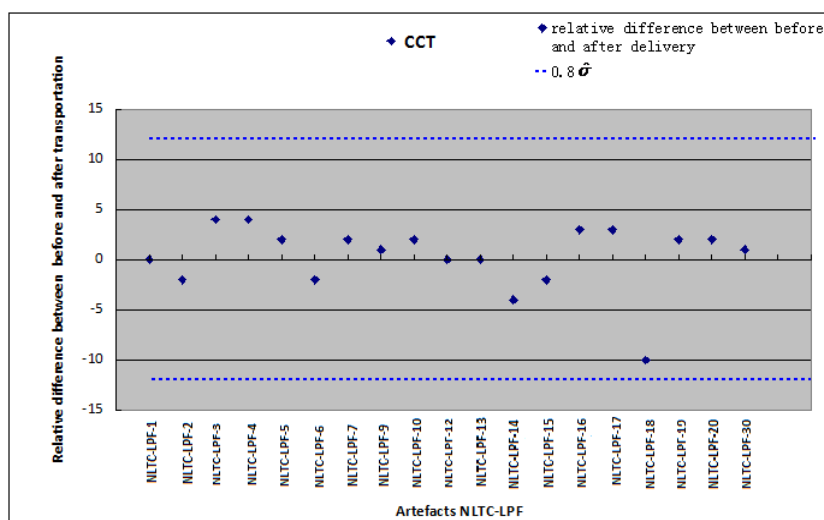


Figure D-15 Differences between two measurements by NLTC, before and after transportation, for CCT, for artefact NLTC- LPF

It demonstrates that the the deviations of all artefacts except for the artefacts listed in Table D-6 in all parameters are no more than $0.8\hat{s}$ which proves that they were very stable enough in the whole PT process.

In order to confirm that the drift of the artefacts listed in Table D-6 could not affect the evaluation of u_{ref} for the E_n number calculation, the following calculation has been made. The results could be reduced to two types of data as follows.

(1) $u_{\text{drift}} < (1/3) \cdot u_{\text{ref}}$

For these artefacts, the u_{drift} could not affect the evaluation of u_{ref} .

(2) $u_{\text{drift}} > (1/3) \cdot u_{\text{ref}}$

For these artefacts, the u_{ref} has been expanded with adding the u_{drift} as one of affecting factor. However, it could be seen that there is almost no change for the updated E_n value(s).

In conclusion, it demonstrates that all artefacts are stable during the PT process.

Table D-6 Comparison between artefacts drift and u_{ref} ⁽¹⁾

Artefacts	Measurands	(Relative) difference Δ	u_{drift} $(\Delta /2\sqrt{3})$	$(1/3)u_{\text{ref}}^*$	U_{ref} value after adding U_{drift}	E_n value before expanding U_{ref}	E_n value after expanding U_{ref}
NLTC-IDC-1 1	Active Power(%)	-0.43	0.12	0.13	/	/	/
NLTC-IDC-R 19	Active Power(%)	0.57	0.16	0.13	0.84	-0.6	-0.6
NLTC-OD1-1	Luminous flux	1.11	0.32	0.42	/	/	/

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9	(%)						
NLTC-OD1-1	Active Power(%)	-0.52	0.15	0.30	/	/	/
NLTC-OD1-2	Active Power(%)	-0.86	0.25	0.30	/	/	/
NLTC-OD1-3	Active Power(%)	-0.58	0.17	0.30	/	/	/
NLTC-OD1-4	Active Power(%)	0.36	0.10	0.30	/	/	/
NLTC-OD1-9	Active Power(%)	-0.37	0.11	0.30	/	/	/
NLTC-OD1-12	Active Power(%)	-0.62	0.18	0.30	/	/	/
NLTC-OD1-19	Active Power(%)	0.43	0.12	0.30	/	/	/
NLTC-OD1-18	CCT(K)	-12	3	10	/	/	/
NLTC-D-5	Active Power(%)	0.36	0.10	0.15	/	/	/
NLTC-D-19	Active Power(%)	-1.04	0.30	0.15	1.07	-1.0	-0.8
NLTC-D-30	Active Power(%)	0.55	0.16	0.15	1.09	-0.1	-0.1
NLTC-HCCT-3	Active Power(%)	-0.43	0.12	0.27	/	/	/
NLTC-HCCT-13	Active Power(%)	-0.45	0.13	0.27	/	/	/
NLTC-HCCT-12	CCT(K)	-38	11	18.5	/	/	/
NLTC-HCCT-19	CCT(K)	-92	27	18.5	123	P774: -0.1 P850: 0.3	P774: -0.1 P850: 0.3
NLTC-HCCT-20	CCT(K)	42	12	18.5	/	/	/
NLTC-LPF-16**	Active Power(%)	/	/	/	/	/	/

Note:

(1) $*u_{ref}$: Standard uncertainty of Assigned value(s).

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(2) ** LPF-16 was mistreated by the participant, which made larger drift. Thus it was precluded first.

Annex E: PT Protocol and Other Relative Documents

E-1: Measurement method for the proficiency testing program

Introductions

This measurement method is prepared for use by the APLAC Proficiency Testing Program – Photometric measurement of Solid State Lighting Program. As this APLAC PT Program cooperates with *IEA SSL Annex Interlaboratory Comparison 2013* [1], this measurement method follows the *IEA SSL Annex Interlaboratory Comparison Test Method* [2] and made basically compatible with the IEA's test method.

1. Environmental Conditions

A. Ambient temperature

- The ambient temperature during the measurement of the product shall be maintained at $(25 \pm 1) ^\circ\text{C}$. If a laboratory does not meet this requirement, outside the range $(25 \pm 1) ^\circ\text{C}$ and within $21 ^\circ\text{C}$ to $27 ^\circ\text{C}$ is allowed only if the results are corrected to the values for $25 ^\circ\text{C}$, using the ambient-temperature dependence data for the particular device under test for particular measurement quantities. In this case, the actual measured ambient temperature, method (formula) of correction, and temperature dependence data of the device shall be reported.
- The temperature sensor shall be placed at the same height and within 1 m for LED artefacts or luminaire under test.
- The temperature sensor shall be shielded from direct optical radiation from the SSL product and from any other light source. Environment of the temperature sensor and the artefact or luminaire should not be isolated.
- The thermometer shall have resolution of $0.1 ^\circ\text{C}$ or less.

Note: It is recommended that the thermometer has a calibration uncertainty of $0.2 ^\circ\text{C}$ or less.

B. Air movement

Air flow around the SSL product being tested should be such that normal convective air flow induced by device under test is not affected. The air flow shall be less than 0.2 m/s .

Note 1: Air flow in an integrating sphere (without forced air cooling system)

when closed is considered to be satisfying this requirement.

Note 2: Portable anemometers are commercially available with measurement uncertainty of 0.05 m/s.

Note 3: In case the light source is moved on the goniophotometer during measurements, the moving speed should be chosen adequately to meet the requirement above.

C. Laboratory humidity

Relative humidity of the laboratory should be 65 % or less.

2. Mounting Conditions

A. Operating position

The operating position of the artefacts used for the proficiency testing are specified in the program description. Measurement shall be made with the artefact operated accordingly.

B. Supporting objects

- SSL products with a screw base or bayonet shall be supported only by the socket.
- LED luminaires shall be mounted to the measuring instrument (integrating sphere or goniophotometer) so that heat conduction through supporting objects causes negligible temperature effects. (The product may be suspended in air by wire or held by support materials that have low heat conductivity, e.g., Teflon).
- If the SSL product under test is provided with a support structure that is designated to be used as a component of the luminaire thermal management system, the product shall be tested with the support structure attached.

3. Electrical conditions and measurement

A. Operation of SSL product

- The SSL product under test shall be operated at the rated voltage (AC or DC) and frequency (for AC operation, normally 50 Hz or 60 Hz) according to the specification of the product under test for its normal use.
- The tolerance of the test voltage is ± 0.2 % of the rated value and the tolerance of frequency is ± 0.2 %.

- The voltage shall be measured at the socket (for screw-base or bayonet-base artefacts), or at the power input line as close to the product as possible. The measurement position (length from the socket or the power input line) shall be reported.

Note: This is critical especially for low-voltage artefacts. For screw base artefacts, 4-pole socket is commercially available, which allows measurement of voltage directly across the cap with no effect of contact resistance.

- Care should be taken when applying the power to the product under test.

Note 1: When applying a constant DC voltage, the voltage should be ramped up slowly to protect the device. Large frame power supplies can apply a surge before recovering to an appropriate DC power.

Note 2: When applying AC voltage, the power supply should be set to come on at a zero degree phase. A few LED drivers that involve capacitors may have a large in-rush current if the AC voltage is applied at a non-zero degree phase.

- The voltage (V), current (A), power (W) (RMS for AC operation), and power factor for AC operation, shall be measured at the time photometric measurements are taken.

B. Electrical instrumentation

- The voltage of an AC power supply or DC power supply applied to the product under test shall be regulated to within ± 0.2 % (AC) or ± 0.1 % (DC) under load.
- AC voltage ripple of the DC power supply shall be 0.5 % or less.
- The AC power supply shall have a sinusoidal voltage waveshape at the prescribed frequency with the total harmonic distortion not exceeding 3 % under a resistive load.
- For AC-input SSL products, an AC power meter shall be connected between the AC power supply and the SSL product under test, and AC power as well as input voltage and current shall be measured.
- The AC power meter shall have the capability of measuring power factor.
- The AC power meter shall have a sampling rate that is capable of resolving the current wave for the SSL product. Many LED drivers based on capacitors and diode bridges have very sharp current waves

requiring a high sampling rate. Analogue AC power meters will not measure properly.

Note: IEC 61000-3-2 states that the electrical characteristics of lighting products should be analysed in a frequency range covering the fundamental (50 Hz or 60 Hz) and up to the 40th order (2 kHz or 2.4 kHz). IEC 61000-4-7 [14] indicates that power measurement equipment should be able to analyse components up to 9 kHz

- The calibration uncertainties (see the Note below) of the instruments for AC voltage and AC current shall be $\leq 0.2\%$. The calibration uncertainty of the AC power meter shall be $\leq 0.5\%$ and that for DC voltage and current shall be $\leq 0.1\%$.

Note: Uncertainty here, and throughout this document, refers to relative expanded uncertainty with a 95 % confidence interval, normally with a coverage factor $k=2$, as prescribed in ISO Guide for expression of uncertainties in measurement.

4. Stabilization

Prior to taking measurements, the product under test shall be operated at the rated condition to stabilize so that the changes of electrical power and total luminous flux (for integrating sphere) or luminous intensity (for a goniophotometer setup) in a fixed direction are less than 0.5 % over a 30 minute window by monitoring the signal every minute. The actual stabilization time shall be reported for each SSL product tested.

5. Photometric and colormetric measurement

The following instruments are used for the measurement quantities needed:

- Sphere-spectroradiometer (for total luminous flux, colour quantities, CRI)
- Sphere-photometer (for total luminous flux)
- Goniophotometer with a photometer head (luminous intensity distribution, total luminous flux (if configured for absolute photometry)).
- Gonio-spectroradiometer (luminous intensity distribution, total luminous flux, colour quantities, CRI, chromaticity spatial uniformity)
- Gonio-colorimeter (luminous intensity distribution, total luminous flux, chromaticity spatial uniformity)

A. Total luminous flux

- Total luminous flux of an SSL product shall be measured using an integrating sphere system (a sphere-spectroradiometer and/or a sphere-photometer) or a goniophotometer (configured for absolute photometry).

Integrating sphere systems

- A sphere-spectroradiometer shall be calibrated with a total spectral radiant flux standard traceable to an NMI.

Note 1: If total spectral radiant flux standard artefacts are not available from the local NMI, the standard may be derived by the user from spectral irradiance standard artefact(s) and total luminous flux standard artefact(s), both shall be traceable to an NMI. In this case, the derivation methods and related data (e.g., angular uniformity of spectrum or CCT of the standard artefact) shall be reported.

Note 2: It would not be acceptable if the spectroradiometer used with the integrating sphere is calibrated for spectral irradiance only without considering the relative spectral throughput of the integrating sphere. The integrating sphere and the spectroradiometer together shall be calibrated as one system for total spectral radiant flux.

- The spectroradiometer used for the sphere-spectroradiometer system shall cover the wavelength range of at least 380 nm to 780 nm, and the bandwidth (full width half maximum) and scanning interval to be no greater than 5 nm. Wavelength scale uncertainty shall be within 0.3 nm.
- A sphere-photometer system or sphere-spectroradiometer system shall be equipped with an auxiliary artefact and self-absorption measurement shall be carried out and correction made for each product under test.
- A sphere-photometer shall be calibrated with a total luminous flux standard traceable to an NMI.
- A sphere-photometer shall have a total relative spectral responsivity (sphere plus photometer head) that meets the f_1' value of 2% or less. If f_1' of the sphere-photometer exceeds 2%, then f_1' no greater than 6 % is acceptable if spectral mismatch correction is applied to each product tested. For this correction, the relative spectral distribution of the product and the relative spectral responsivity of the sphere-photometer is necessary. In this case, the correction factor and data for spectral mismatch correction shall be reported.

- A combination of a photometer head and a spectroradiometer may also be used, with the photometer head used for luminous flux measurement and the spectroradiometer used for spectral mismatch correction determinations and for measurement of colour quantities.

Note: In this case, the spectroradiometer measures only the relative total spectral radiant flux and needs to be calibrated only for relative total spectral radiant flux scale.

- The photometer head of a sphere-photometer and the spectroradiometer input optics at integrating sphere detector port (normally equipped with a diffuser) shall have approximate cosine correction, with the f_2 value of 15 % or less.

Goniophotometer

- The goniophotometer to be used shall be the type, in which the operating position of the SSL product under test with respect to gravity is not changed.

Note 1: Type C goniophotometers include the moving detector type for relatively short photometric distances (for smaller SSL products) and the moving mirror type for larger photometric distances (larger SSL products or having a narrow beam angle).

- For goniophotometers employing a photometer head, the relative spectral responsivity of the photometer head (plus mirror if used) shall have an f_1' value of 1.5 % or less. If the f_1' of the photometer head (or the Y channel of a colorimeter head) of a goniophotometer exceeds 1.5 % (but < 6 %), the spectral mismatch correction shall be applied to each product under test. For this correction, the relative spectral distribution of the product is necessary.
- Scanning resolution fine enough to accurately define the test sample shall be used. For typical wide-angle, smooth intensity distributions, a 22.5° lateral (horizontal) and 5° longitudinal (vertical) grid may be acceptable. For reflector artefacts, the longitudinal angle increments shall be 1/10 or less of the beam angle (diameter of the angular cone emitting more than 1/2 of the peak intensity) but not larger than 5°. Finer angle resolution (smaller test increments) shall be used where the luminous intensity from the SSL product is changing rapidly or is erratic, such as in beam forming sources.

Note: For SSL products having rapidly changing intensity distribution,

measurements may be repeated with another randomly selected vertical reference plane to ensure that results are within laboratory's uncertainty budget for the test.

- The goniophotometer used for total luminous flux measurement shall be calibrated for luminous intensity standard or illuminance standard traceable to an NMI, and measured total luminous flux value (lm) shall be verified by measuring a total luminous flux standard traceable to an NMI. Alternately, the goniophotometer system may be calibrated against a total luminous flux standard traceable to an NMI, if the dead angle of the Goniophotometer does not affect the measurement of the total luminous flux standard artefact.

Note 1: For mirror type goniophotometers, a luminous intensity standard artefact is normally used to calibrate the photometer head, in which case, the photometric distance and the reflectance of mirror are automatically included in the calibration.

Note 2: Illuminance (lx) integration method may be used only for a goniophotometer with the photometer head rotating (no mirror). In this case, the photometric distance needs to be determined accurately.

- Goniophotometers shall have an angular scan range covering the entire solid angle to which the SSL product emits light.

Note: Goniophotometers in general have some angular region (called dead angle) where emission from a light source is blocked by its mechanism, e.g., an arm to hold the light source. Goniophotometers having a large dead angle (exceeding $\pm 10^\circ$) should not be used to measure total luminous flux of omnidirectional artefacts or luminaires unless appropriate correction procedures are implemented.

- Care should be taken to minimize stray light errors.

Note 1: The goniophotometers should be installed in a dark room with low reflectance wall surfaces, and should preferably be equipped with a light trap or light absorbing surface on the opposite side of the mirror or detector on the rotating arm, so that the errors due to reflections and stray light from surrounding surfaces are minimized.

Note 2: The photometer head or spectroradiometer input should be equipped with a hood or aperture screens to receive the light only from the effective angle range of the SSL product under test.

B. Luminous intensity distribution

- Luminous intensity distribution of an SSL product shall be measured with a goniophotometer that fulfils requirements in 5.A. There is no need to calibrate the goniophotometer against absolute luminous intensity or illuminance standard, as luminous intensity distribution measurements can be done on a relative photometric scale.
- The coordinate system and geometry for mounting SSL products should follow the general practice used in traditional luminaire testing.
- A sufficient photometric distance should be used – generally, more than five times of the largest dimension of the test SSL product having broad angular distributions. A longer distance may be needed for narrow beam sources.

C. Centre-beam luminous intensity

The centre-beam luminous intensity is the luminous intensity along the centre axis of the SSL product. The centre axis is the axis defined by the SSL product mounting base and the intended direction of the light determined by the optical components built into the SSL product. For further details of measurement conditions, see IEC/TR 61341.

D. Luminous efficacy

- The electrical input power P_{TEST} (W) of the SSL product under test shall be measured according to section 3.
- The luminous flux F_{TEST} (lm) shall be measured according to section 5.A.
- The luminous efficacy h_v (lm/W) of the product under test shall be determined by

$$h_v = \frac{F_{\text{TEST}}}{P_{\text{TEST}}} \quad (1)$$

E. Colour quantities

- Colour quantities to be measured for SSL products include chromaticity coordinates (x, y) and/or (u', v'), correlated colour temperature (CCT), Duv, and general Colour Rendering Index (CRI Ra). Colour quantities are calculated from the measured relative spectral power distribution of

the SSL product according to the definitions given in CIE 13.3 and CIE 15.

- The colour quantities of SSL products shall be measured as spatially averaged values, with its value at each point weighted by the intensity and the solid angle, over the angular range where light is intentionally emitted from the SSL product.

Note 1: A sphere-spectroradiometer automatically measures the spatially averaged spectral power distribution, from which spatially averaged colour quantities can be calculated. The sphere-spectroradiometer to be used shall meet the requirements in section 5.A.

Note 2: Spatially averaged colour quantities can also be measured with a gonio-spectroradiometer or a gonio-colorimeter. In this case, the angular scan shall be made for at least two vertical planes at 90° apart (Φ angle), and at 10° increments for a vertical angle scan (θ angle) in each vertical plane. For reflector artefacts, the θ angle increments shall be $1/10$ or less of the beam angle (diameter of the angular cone emitting more than $1/2$ of the peak intensity) but no larger than 10° . The colour quantities and (relative) luminous intensity at each goniometer angle shall be recorded over the angle range where the luminous intensity is more than 10 % of the peak intensity, which are used for the calculation of spatially averaged colour quantities. The colour quantity values are weighted by the solid angle (represented by the angle) and the luminous intensity of the point.

- If a gonio-colorimeter is used, the chromaticity at one of the angular points shall be measured with a spectroradiometer to calibrate the colorimeter head, and all measured results by the colorimeter shall be corrected based on the spectroradiometer reading.

6. Measurement Uncertainty

The uncertainties should be reported for all measurement results. In reporting uncertainties, the international recommendation, ISO GUM (Guide to the Expression of Uncertainty in Measurement), should be followed to evaluate and express uncertainties of measurement. For all measurements covered in this document, a coverage factor of $k=2$ (generally corresponding to a confidence interval of 95 %) shall be used. Guidance on evaluation of uncertainty in photometry is available in CIE 198.

References

- [1] IEA SSL Annex: Interlaboratory Comparison 2013,
<http://ssl.iea-4e.org/task-2-ssl-testing/2013-ic>
- [2] IEA SSL Annex: Interlaboratory Comparison Test Method, Version 1.0,
http://ssl.iea-4e.org/files/otherfiles/0000/0051/SSL_Annex_2013_IC_Test_Method_v.1.0.pdf

E-2: Measurement Results Report Form

Laboratory Information

Laboratory Name and Address

Name of Person Conducting Test

Contact details – email:

Contact details – phone:

Date of Test

Signature of Supervisor or

Reviewer

Did the Supervisor monitor the
tests / data analysis?

Is it normal for the supervisor to
monitor tests / data analysis?

Test Method

If your measurement conditions or instrument specifications deviate from any requirements in measurement procedure for the proficiency testing program, please report the section (phrase) numbers of the Test Method where your measurement is not compliant, and describe your actual measurement conditions.

Description of the Calibration of your Photometric Measurement System:

1. artefact Standard Type
2. artefact Standard Volts
3. artefact Standard Amps
4. artefact Standard Watts
5. artefact Standard Output
(Lumens)
6. Calibration date of primary
standard (by calibration
laboratory)
7. Name of calibration lab

Your Electrical Instruments and Measurement

a) Electrical Power Measurements:

Are watts measured or calculated?

Measured

☐

Calculated

☐

A few of the comparison artefacts have significant current wave harmonic distortion. Current and power measurements require AC power meters with a suitable sampling rate. For calculated, the expectation is that the laboratory has measured the voltage and current waveforms and calculated the power.

b) Describe the electrical instrumentation.

Besides the actual hardware details, if an artificial network (AMN) or line impedance stabilization network (LISN) is in the artefact power circuit, please provide the resistance and inductance. If you use an AC power supply with programmable output impedance, please provide the resistance and inductance. If no LISN or programmable AC power supply is present and you have measured

the mains impedance, please provide.

Please provide the highest harmonic component measure or measurement bandwidth for the AC power measurement.

Please provide the copy of measurement circuit diagram.

Your Photometric Instruments and Measurement

c) Total Luminous Flux Measurements: Please provide the information below.

Measurement Equipment – Goniophotometer
or Sphere

Goniophotometer type and angle step?
(if applicable)

Sphere diameter and surface reflectance?
(if applicable)

Photodetector type (photometer /
spectroradiometer, etc.)

Describe correction factors applied (spectral
mismatch, self-absorption, spatial
nonuniformity of the sphere, stray light,
dead-angle of goniophotometer, etc.) as
applicable

d) Colour Measurements: Colour measurements are made at the electrical values above; report the results in the appropriate Excel form and related information below.

Measurement procedure?

Instrument type (sphere-spectroradiometer /
goniospectroradiometer / gonio-colorimeter,
etc.)

Describe correction methods and factors for
colour measurements if any

Please provide any additional information that can provide insight into the measurements results.

Please provide the digital photos that show the comparison artefacts mounted in the test instrument.

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Measurement Results and some information for reference

Report your measurement results using the table below .

Measurement	NLTC-XX											
	Measurement results									Information for reference		
	Current (A)	Active Power (W)	Power Factor	Total luminous flux (lm)	Luminous efficacy (lm/W)	x	y	CCT (K)	CRI Ra	Ambient Temp (℃)	Relative Humidity (%)	Stabilization time (min)
1 st measurement												
2 nd measurement												
(Relative) expanded uncertainty (k=2) (%)	%	%		%	%					/	/	/
Total operating time of this artefact												

Note:

- (1) All measured values in at least four significant digits.
- (2) The uncertainty values should be given in two significant digits.

Electronically submit the data sheets to Nucleus Lab Contact (heping@cnas.org.cn; zhangwei@nltc.cn; wuyang@nltc.cn).

E-3: Receipt Form (for Accreditation bodies)

In order to monitor the progress of this proficiency testing program, we kindly ask each participating accreditation body, on receipt of the artefacts, to fill out this Receipt Form, and sent it to heping@cnas.org.cn and zhangwei@nltc.cn electronically.

Thank you in advance for your cooperation.

_____ (how many) packages were received on _____ (date).

Comments

Participating Accreditation Body: _____

Contact Person: _____

Email: _____

Phone: _____

Fax: _____

E-4: Receipt Form (for Participants)

In order to monitor the progress of this proficiency testing program, we kindly ask each participating laboratory, on receipt of the artefacts, to fill out this Receipt Form, and sent it to your accreditation body, heping@cnas.org.cn and zhangwei@nltc.cn electronically.

Thank you in advance for your cooperation.

Participating Accreditation Body: _____

Contact Person: _____

Email: _____

Phone: _____

Fax: _____

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Artefacts checking feedback table

Lab for Receiving		Recipient	(please show the name clearly)
Date and time	(MM:DD:YYYY), (HH:MM)		
Package check	☐ Normal		
	☐ Abnormal, Description and picture:		
Artifact check (appearance)	☐ Normal		
	☐ Abnormal, Description and picture:		
Artifact check (lighting)	☐ Normal		
	☐ Abnormal, Description and picture:		

Comments

Annex F: Geographical Distribution of Participants

Table F-1 Geographical distribution of participants

No.	Economies	Participants Enrolled
1	USA	7
2	Colombia	2
3	Austria	2
4	Hong Kong	1
5	Finland	1
6	Sweden	1
7	Chinese Taipei	2
8	Australia	2
9	India	2
10	Chile	1
11	China	2
12	Romania	1
13	France	2
14	Bulgaria	1
15	Poland	1
Total		28

Annex G: Timetable of this PT

Table G-1 Timetable of PT

Item	Date
Registration	March 20, 2013-May 29, 2013
Testing by PTP(first round)	March to May 2013
Delivery date of artefacts	21 June 2013
Arriving Date of artefacts	24 June 2013——27 June 2013
Testing by laboratories	July 2013-November 2013
Return date of artefacts	22 July 2013——13 November 2013
Testing by PTP(second round)	October-November 2013
Interim report	10 March 2014
Distribution of draft final report	13 June 2014

End of report.

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