

A Review of Commercial Light Meter Calibration Pitfalls and Inadequacies

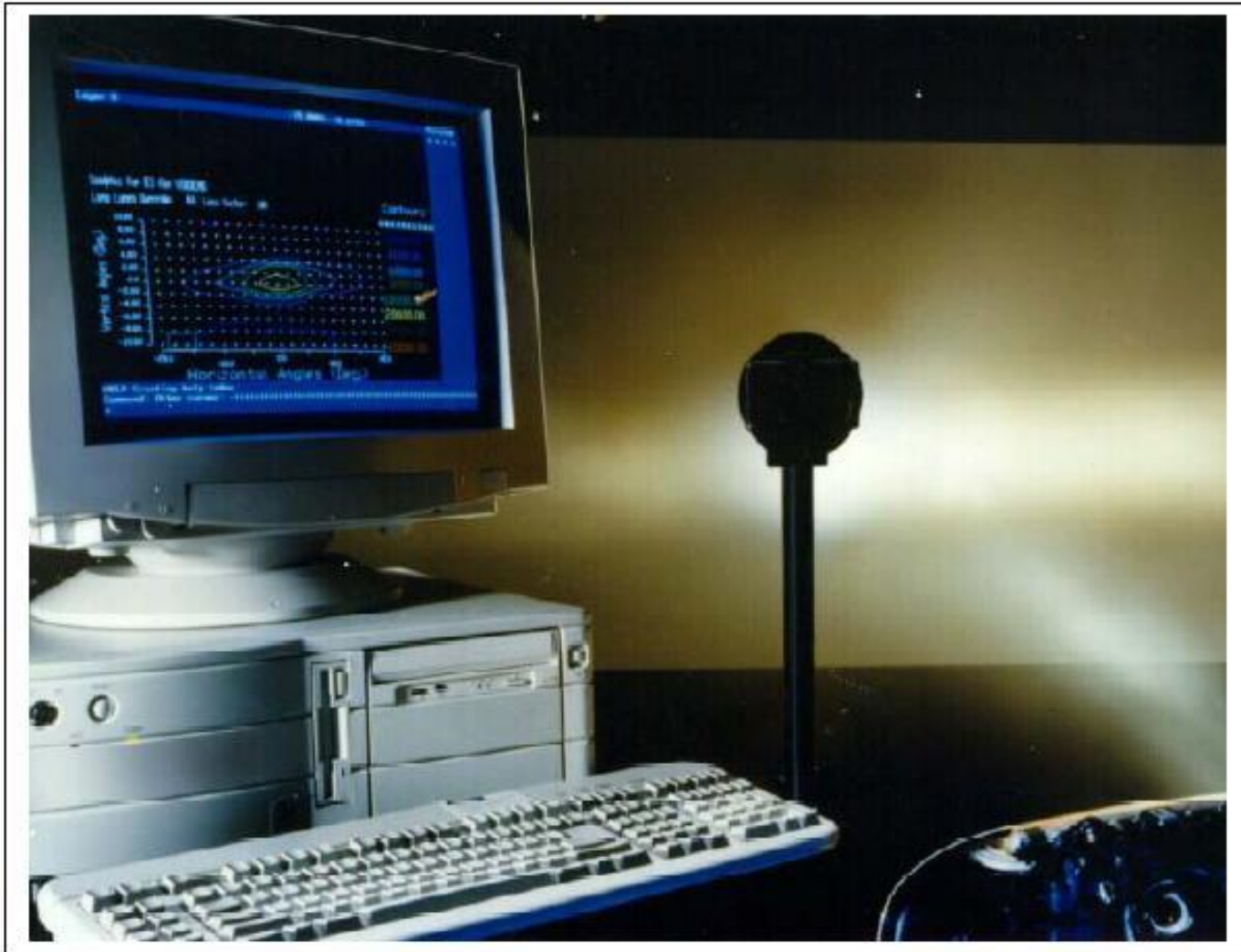
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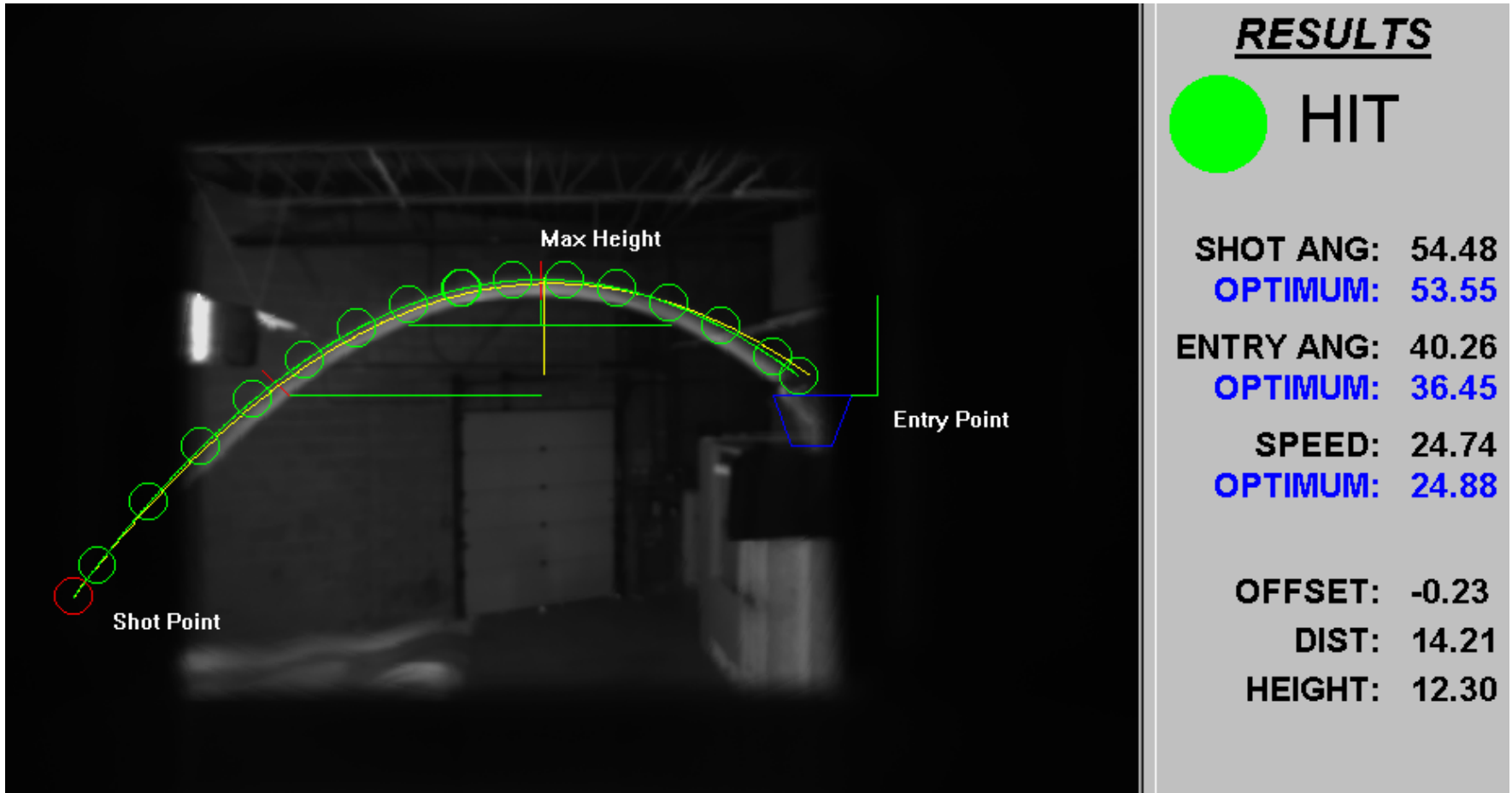
President

Lighting Sciences Canada Ltd.

IES LM-77-09 Approved Method: Intensity Distribution of Luminaires and Lamps Using Digital Screen Imaging Photography



IES LM-77-09 Camera used to capture the trajectory of a basketball



Energy Efficiency

- Electric Power (Watts)
 - Straight forward
- Quantity of Light (Lumens)
 - Not as easy

Light Measurement Units

- Lumen
- Lux (Foot-candle)
- Candela
- Candela per square meter (Foot-lambert)
- “We live in a sea of photons” 2005

Light Measurement

- Derived from optical radiation measurements (since 1979)
- Requires spectral measurement 400nm to 800nm
- A present, no spectrometer is economical and convenient enough for routine field measurements

Light Meters

- Silicone photocell and filters
- Human spectral sensitivity curve (V_{λ})
- Real spectral response defines quality of the light meter
- Cosine correction and electronic resolution assumed adequate

Accuracy

- Laboratory calibration accuracy
 - Not the same as user measurement accuracy
- Instrument integrity
- User training and integrity

Calibration Process

- Incandescent filament lamp at 2856 K
- Calibration accuracy can carry over to measurement accuracy if used on light sources of same spectral content
- User measurement accuracy will degrade if spectral sensitivity not perfect when used on light sources of different spectral content
- Alternatively light meters can be calibrated for light sources to be used

CIE f1'

1. Less than 2% - Test Laboratory Grade
2. 2 to 4% - High accuracy Grade
3. 6 to 9% - Acceptable Grade
4. Greater than 10% - Non-technical Grade
5. No values available

Meter to Meter Calibration

- Should contribute no more than 0.3% extra inaccuracy
- Commercial companies provide transfer uncertainty of up to 4%. This needs clarification.
- Estimation of user measurement accuracy would be 3, 4, and 5% for grades 1, 2, and 3 sensors.

PHOTOMETRIC ERRORS WITH COMPACT FUORESCENT SOURCES

MICHAEL OUELLETTE 1992

Table I

PERCENT ERROR $f(Z, P_j)$ OF PHOTOMETERS P_j IN MEASURING DIFFERENT COMPACT FLUORESCENT AND INCANDESCENT LAMPS

Lamp Z	P1	P2	P3	P4
1	-2.2	-3.4	-4.5	-6.2
2	-5.9	-6.5	-8.8	-8.2
3	-7.8	-9.5	-7.8	-6.2
4	-1.8	-0.7	-3.3	-2.7
5	-6.9	-7.8	-10.2	-7.0
5*	-7.7	-8.6	-9.4	-9.8
6	-5.2	-6.1	-8.2	-8.6
6*	-5.0	-6.8	-7.7	-8.1
7	-7.9	-8.3	-10.0	-9.7
8	-8.4	-8.8	-10.6	-10.6
8*	-8.0	-8.7	-9.3	-9.7
9	-7.7	-8.0	-10.3	-10.0
10	-8.4	-7.7	-10.7	-7.7
11	-6.1	-7.5	-7.5	-6.8
12	-7.7	-8.6	-9.6	-9.1
13	-8.0	-8.9	-10.3	-9.7
13*	-8.8	-9.5	-11.0	-10.2
Q1105	-5.3	-5.6	-8.0	-6.7

* Repeated measure

Observations on Ouellette's Work

- All four meters show around 6% systemic errors
 - Accuracy of the standard lamps
 - Spectroradiometer calibration process
 - Meter calibration offset
- 6% high – for reference a recent comparison between NIST, COOKE, and a SWISS supplier
 - COOKE 1% lower than NIST
 - SWISS supplier 2.5% lower than NIST
- If systematic errors removed, revised errors would be consistent with grade 3 light meters

Calibration of a Mirror Goniophotometer

- 2010 IESNA Annual Meeting “Illuminance Meter Based Candlepower Calibration”
- Measure candlepower in all directions and integrate to yield total lumens
- More reliable and expensive than an integrating sphere
- IES Round-Robin tests have not produced a calibration factor to adjust calibration of mirror photometer
- Round-Robin test (6 month cycle) with stable light source and well calibrated light meter would reduce discrepancies between photometric laboratories to less than 2%

Commercial Lighting Testing Services

- For the past 25 years
 - Independent Testing Laboratories (ITL)
 - Lighting Sciences Inc. (LSI)
 - Lighting Sciences Canada (LSC)
- servicing lighting industry using IES LM procedures
- Market tested and accepted
- Produce more than 90% of independent photometric tests used in North America

Then came White LEDs

- A lot of people tried to position themselves as experts
- A lot of unreliable and inaccurate information provided in speech and print
- “We live in a sea of misinformation” 2011

Example 1

- Home expert columnist stated, “LED fixtures generate no heat.”
- Light beam has no heat but half to two-thirds of electrical energy still has to be dissipated as heat

Example 2

- May 2010 issue of Photonic Spectra, page 40, “LED Streetlights Shine in Cradle to Grave Study”
- Prepared by researchers from the University of Pittsburgh
- Claims:
 1. LED streetlights consume half the electricity and produce more light
 2. LED streetlight housings are composed mostly of plastic and wires

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