NATIONAL BUREAU OF STANDARDS REPORT

6234

RECHECK OF LAMPS USED IN INTERCOMPARISONS

OF

STANDARDS OF LUMINOUS INTENSITY AT 2042°K

MADE AT

BUREAU INTERNATIONAL DES POIDS ET MESURES

by

Ray P. Teele

Velma I. Burns

U. S. DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

THE NATIONAL BUREAU OF STANDARDS

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Photometry and Colorimetry Section
Optics and Metrology Division

(File Reference 1100)

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Recheck of Lamps Used in Intercomparisons of Standards of Luminous Intensity at 2042°K Made at Bureau International des Poids et Mesures

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In "Lettre-circulaire du Bureau International aux Laboratoires Nationaux", dated October 28, 1957, the first two lines of Table A indicate that our 1956 candela is larger by 0.8 percent at 2042°K and larger by 1.3 percent at 2353°K than our 1952 candela. Since we have attempted to maintain these units constant, a study was made to determine whether these indicated changes were spurious or real. The candela at 2353°K was studied first because it had the greater indicated change and the results were reported in NBS Report 5959, dated July 10, 1958. It is the purpose of the present report to give new data and analyses bearing on the candela at 2042°K.

Table A herein lists the groups of lamps sent to the BIPM for the 1952 and 1956 intercomparisons and of similar lamps retained here, the standards used for their evaluation, and the equipment used. In this table, as in Table A of NBS Report 5959, "209" and "Balcony" refer to laboratory locations, "exposed" refers to the fact that the light baffles that were used exposed the entire lamp to the receiver, and "Kohlrausch" and "Balance" refer to the photometric equipment used.

Table B gives the results for the lamps used in the 1956 intercomparisons before and after being sent to the BIPM as well as the results of the present investigation; in this report these results will be designated "Before", "After", and "Present", respectively.

The lamps used in the 1952 intercomparison are still available and they were remeasured. Table C summarizes the results.

The estimated uncertainties listed in Tables B and C for the individual lamps were calculated at the 0.1 percent confidence level as 4.9 times the probable error of the corresponding mean intensity. The estimated uncertainties listed in these tables for the averages of the lamps in the Before, After, and Present runs (3rd line from bottom of tables) were, in the same manner, calculated from the averages of the individual runs. For the purpose of estimating the uncertainties (shown in the last two lines of Tables B and C) of the average of the Before and After results, as well as of the (1956-Present) and (1952-Present) differences, an analysis of variance was made, taking into account "between years" and "within year" components.

It was found that the difference between the Before and After average and the Present value was not significant (at the 5% level) in either the 1952 or 1956 lamps.

Table A - Summary of the comparisons at NBS relating to the lamps sent for the 1952 and 1956 BIPM intercomparisons of the candela at 2042°K

Date	NBS report	Lamps measured	Standards used	Equipment used	Number of runs
9/48	118,363	5292B* 5293B* 3844* 3855*	5492 5493 5495 5496 5497 5499	209 Exposed Kohlrausch	3
3/52	1526	5292B* 5293B* 3844* 3855*	801 802 804 810 824 825	209 Exposed Kohlrausch	3
10/55	4341	3757* 3758 3759* 3760* 3761 3762*	2395 2398 2399 2400 2401 2402 2407 2270	209 Exposed Kohlrausch	3
6/57	5317	3757* 3758 3759* 3760* 3761 3762*	2395 2398 2399 2400 2401 2402 2407 2270	Balcony Exposed Balance	3
2/58	Present	5292B* 5293B* 3844* 3855* 3757* 3758 3759* 3760* 3761 3762*	2395 2398 2399 2400 2401 2402 2407 2270	Balcony Exposed Balance and 209 Exposed Kohlrausch	3 3

* Lamps sent to BIPM

Table B. Summary of Results on 1956 Candela at 2042°K

Lamp No.	Before Candela	Before Uncertainty	After Candela	After Uncertainty	Present Candela	Present Uncertainty
NBS3757	11.85	±.08	11.67	±.05	11.82	±.03
NBS3759	11.84	±.09	11.99	±.04	11.87	±.06
NBS3760	11.88	±.14	11.90	±.00	11.92	±.11
NBS3762	12.14	±.12	11.96	±.08	12.05	±.02
Average	11.93	±.02	11.88	±.01	11.91_5	±.05

Average of "Before" and "After" (1956) = $11.90_5 \pm .07_1$

1956 - Present = $-.01_2 \pm .09_1$

Table C. Summary of Results on 1952 Candela at 2042°K

Lamp No.	Before Candela	Before Uncertainty	After Candela	After Uncertainty	Present Candela	Present Uncertainty
BS5292B	13.67	±.05	13.63	±.11	13.64	±.05
BS5293B	14.23	±.10	14.18	±.07	14.11	±.02
BS3855	13.25	±.05	13.37	±.07	13.28	±.06
Average	13.72	±.05	13.73	±.09	13.68	±.01

Average of "Before" and "After" (1952) = $13.72_2 \pm .05_1$

1952 - Present = $0.04_5 \pm .10_7$

In the "Lettre-circulaire du Bureau International aux Laboratoires Nationaux" dated October 28, 1957 the ratio of candelas assigned to lamps on the basis of the 1956 lamp standards to those assigned on the basis of the 1952 lamp standards, according to measurements made at the BIPM, is 0.992. The Present values in Tables B and C show that we would increase the 1956 assigned values by a factor of 1.001 (i.e. 11.91/11.90) and decrease the 1952 assigned values by a factor of .997 (i.e. 13.68/13.72). Accordingly, the use of the Present values in lieu of the originally reported values would result in the BIPM obtaining a ratio of assigned values of .996 (i.e. 11.90/11.91 x 13.68/13.72) instead of .992. Thus although our Present assignments would reduce the apparent discrepancy by one-half, the magnitude of the uncertainties involved indicates that no change in our 1952 values should be made.

The important conclusion to be drawn from this report is that photometric standards and techniques must be improved so as to decrease the uncertainties in the values assigned to lamp standards if the international intercomparisons are to serve the purpose of showing significantly differences of the magnitude that currently exists between the photometric units as they are maintained by the participating laboratories.

U. S. DEPARTMENT OF COMMERCE
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THE NATIONAL BUREAU OF STANDARDS

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- Office of Basic Instrumentation.
- Office of Weights and Measures.

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NBS