HFL:WDA:RCM
VII-2

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS
Washington 25, D. C.

Letter
Circular
LC785

March 31, 1945

CALIBRATION OF ARC LAMPS FOR TESTING COLORFASTNESS TO LIGHT

INTRODUCTION. Work has been in progress at the National Bureau of Standards for several years on a reference standard lamp for testing colorfastness to light of textiles, paper, and similar materials, and on means for calibrating the lamps used for testing colorfastness to light in laboratories throughout the country in terms of this standard. The purpose is to provide a reliable method for expressing colorfastness to light in "standard fading hours." Since the beginning of the work the project has been discussed at intervals with members of the Lightfastness Committee of the American Association of Textile Chemists and Colorists which has played a leading part in the development of methods for testing colorfastness to light.

Recently the Bureau made a survey of the relative fading abilities of some 46 lamps in 21 different laboratories in order to arrive at an average value and to demonstrate the need for calibration. The standard lamp and proposed method of calibration are described briefly in this letter circular and the results of the survey are given.

STANDARD LAMP. The reference standard lamp is the result of considerable effort to develop a unit in which fading is reproducible at all times. It is a carbon arc housed in a special room. The temperature and relative humidity of the air in the room, the line voltage, and arc current are automatically controlled and their values recorded. The radiant output of the arc throughout the visible and ultraviolet regions of the spectrum is recorded by an instrument specially built for the purpose. A 10-years' supply of carbon electrodes manufactured for the lamp from one batch of raw materials to meet very close tolerances is on hand. The lamp has been adjusted to produce fading at a rate equal to that of the average of the lamps included in the survey.

SURVEY OF FADING LAMPS. The survey was made by distributing test strips of paper dyed with Victoria Blue for exposure for exactly 20 hours in each unit. The change in reflectance at a suitable wave length, 578 millimicrons, was obtained by measuring photometrically the reflectance of each strip before and after exposure. This change in reflectance was taken to be indicative of the fading ability of the lamp for textiles since the paper had been found to be as responsive to differences in relative humidity and type and make of arc lamp as some 60 textile dyeings exposed simultaneously. Because of this and because the extensive fading made a rather high precision possible, the strips were especially suited for the survey.

The results of the survey are given in Table 1. The change in reflectance varied from 0.405 for the most powerful lamp to 0.092 for the least. Omitting the two very low values in the table, which are definitely out of line, the average value for the other lamps was 0.327.

CALIBRATION. To be generally acceptable, a method of calibration should require no special equipment and no special skill on the part of the operator. This is true of the proposed method. A strip of calibration paper is exposed in the lamp for a suitable period of time, say for 20 hours. The strip is then compared visually with a strip of the same calibration paper which has been exposed in the reference standard lamp in steps of 16, 18, 20, and 22 standard fading hours. The time of exposure in the lamp being calibrated which is equivalent to one of the steps of exposure in the reference standard lamp can be determined in this simple manner within 10 percent or possibly better. Thus the lamp can be calibrated in terms of the reference standard lamp and therefore in terms of any other similarly calibrated lamp. The calibration can be repeated as often as the particular installation requires.

The requirements for such a calibration paper are: (1) the differences in the fading in the 16, 18, 20, and 22-hour steps of exposure in the standard lamp shall be visually distinct; (2) the rate of fading shall be affected to approximately the same extent by changes in humidity, type and make of arc lamp as the rate of fading of the material to be tested; (3) the color of the paper before and after exposure shall not change when the paper is stored in the dark; and (4) the color and colorfastness of the paper shall be uniform.

Forty-seven representative dyes in a series of concentrations on two kinds of paper were tried in searching for such a calibration paper. The majority failed to meet the first two requirements and only a few met all four. Benzoazurine G (Colour Index No. 502) on a special paper made from purified sulfite pulp appeared to be the most satisfactory for the calibration of lamps for testing textiles. Accordingly a large quantity of this paper has been prepared in the paper mill of the Bureau and is available for general distribution. Laboratories desiring to try the paper will be supplied with unexposed test strips and with a book of strips which have been exposed in the reference standard lamp for 16, 18, 20, and 22 hours. They will be asked to comment on their experience with the paper to guide any further work that seems necessary. Requests for the paper should be addressed to the National Bureau of Standards, VII-2, Washington 25, D. C.

Table 1. Results of survey of relative fading of Victoria Blue paper exposed for 20 hours in arc lamps in various laboratories (Values given are the change in absolute diffuse reflectance (measured at 45° from normal incidence) for wave length 578 millimicrons. FDA and FDA-R are Atlas Electric Devices Co. Fade-Ometers, NCC-X20 and NCC-XV are National Carbon Co. accelerated testing machines.)

Change in reflectance at 578 mμ	Type of lamp	Current	Code designation
0.405	FDA-R	ac	6G
.401	NCC-X20	ac	7F
.395	FDA	ac	5E
.393	FDA-R	ac	8F
.387	FDA-R	ac	7I
.387	FDA	ac	3E
.386	FDA-R	ac	5G
.380	FDA-R	ac	8B
.380	FDA-R	ac	9F
.379	FDA-R	ac	5I
.379	FDA-R	-	5F
.376	FDA-R	ac	1G
.372	FDA-R	ac	4B
.370	FDA-R	ac	2B
.365	FDA	dc	9I
.363	FDA-R	ac	3I
.361	FDA	ac	4F
.340	NCC-XV	ac	4F
.336	FDA-R	ac	7H
.327	FDA-R	ac	1I
.319	(Atlas)	dc	6H
.318	FDA-R	-	2F
.314	FDA-R	ac	2D
.314	FDA-R	ac	1K
.310	FDA	ac	8H
.308	FDA-R	ac	1B
.306	FDA-R	ac	1A
.304	FDA-R	ac	5H
.303	FDA	dc	4I
.296	FDA	ac	1E
.289	FDA-R	ac	3F
.289	FDA-R	ac	7A
.288	FDA-R	-	2H
.281	FDA-R	ac	2E
.280	FDA-R	-	5A
.279	FDA-R	ac	6A
.276	-	-	3H
.271	FDA	ac	3G
.269	FDA-R	-	1H
.268	NCC-X20	ac	6F
.268	FDA-R	ac	3A
.260	FDA	dc	2K
.257	FDA-R	ac	2A
.254	-	-	9G
.220	FDA	ac	4G
.092	FDA	-	4A
0.327 - Mean (omitting last two)			