With our Society in excellent condition from every standpoint, we think the future should find each member of the Society concentrating upon three questions: (1) How can I best serve and improve my profession? (2) How can I enlighten and improve myself as a chemist? (3) How can I best serve my employer and humanity? In such times of economical and social unrest as the present, we should not lose sight of either of these questions and we should do our utmost to arrive at the correct answers. If we find the correct answers and strive to reach the goal, we will have done our duty toward our profession, our Society, humanity and ourselves.

May I personally thank all of the active members of the Society for their support which I deeply and sincerely appreciate.

THE ADJUSTMENT OF LOVIBOND RED GLASSES*

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Introduction

The Lovibond color system consists of red, yellow and blue sets of colored glass slides of standard size and color. These glasses are graded and numbered in terms of the intensity or depth of color on the three scales. The first scientific description of this system was published by the U. S. Bureau of Standards.[1]

Certain yellow and red glasses can be combined to produce amber colors which closely match the colors of vegetable oils. It so happens that in matching oil colors the match is much less affected by the choice of the yellow component than it is by the red. In fact for most purposes the single yellow glass designated "35-Y" is sufficient. The match is so sensitive to small differences in red, however, that the manufacturer's designations on the red glasses are not accurate enough to facilitate the precise grading of oils which this American industry requires.

In response to this need, the U. S. Bureau of Standards has revised the scale for numbering Lovibond red glasses and has regraded many glasses on the new scale. The regrade numerals for each glass usually consist of an integral part and a fractional part expressed to one, two or three decimal places. The Electrical Testing Laboratories has developed a procedure for altering the color of a Lovibond glass just enough to eliminate the decimal part of the regrade designation and produce a glass having an integral grade on the new and more accurate scale.

[1]Gibson, Harris and Priest. B. S. Sci. Pap. No. 547, 22, 1 (1927).

The Priest-Gibson N″ Scale

The following discussion is limited to the consideration of the grading and adjusting of Lovibond red glasses when combined with a "35-yellow" glass. The effect of deviating from the 35-point on the yellow scale has been discussed previously by the Bureau of Standards.[2]

The Priest-Gibson N″ scale[3] for Lovibond red glasses was developed at the U. S. Bureau of Standards in response to the needs of the vegetable oil industry for a more accurate scale than that supplied by the maker of the Lovibond glasses. It is well-known that the American Oil Chemists' Society has been influential in bringing about this development. The new scale has two essential advantages not possessed by the old. It is truly additive and it is based on fundamental measurements independent of the choice of observer or the permanence of a particular set of colored standards.[1]

Lovibond glasses regraded by the Bureau of Standards have received grades on the N″ scale which differ from the nominal Lovibond assignment by the amounts shown in Fig.

[2]Priest, Judd, Gibson and Walker. B. S. J. R. 2, (R. P. 58) 793 (1929).

[3]In the publications of the U. S. Bureau of Standards (which comprise the bulk of the literature in this field), the manufacturer's color scale is designated by N. The Bureau then developed a revised scale which they called N′. This scale was not completely satisfactory and after receiving further revision has been designated N″.

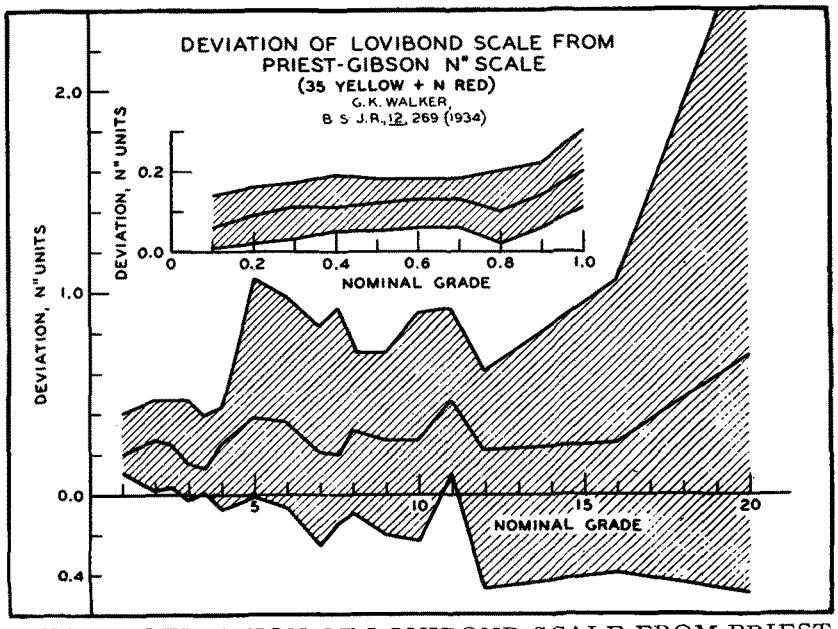

FIG. 1. DEVIATION OF LOVIBOND SCALE FROM PRIEST-GIBSON N″ SCALE.

*A paper presented at the 26th annual meeting of the American Oil Chemists' Society at Memphis, Tenn., May 23-24, 1935.

1.[4] The upper and lower curves show the maximum and minimum grades in a group of one thousand glasses. The intermediate curve passes through the average values. Notice that the spread in the grades of these glasses greatly exceeds the experimental errors associated with typical oil measurements and that even the average grades deviate by considerable amounts from the Priest-Gibson scale. A study of this chart shows the futility of attempting accurate color grading with glasses which have not been calibrated on the N″ scale. The regrading of over two thousand red glasses by the Bureau of Standards has completely proved out the N″ scale and the demand for this regrading has demonstrated the importance of accurately calibrated glasses to American industry.

The importance of basing all measurements on the N″ scale needs no argument. It is accepted as standard in this country. It has smoothed out gross irregularities in the manufacturer's scale. It permits finer grading because of the higher accuracy embodied in the regraded glasses.

The improvement in the scale, unless carried a step further, leads to the use of glasses graded to fractional values. The three digit numbers (two digits for N″ less than one) representing these fractional grades are much less convenient, more time-consuming and more prone to mistakes in recording data than are the integral values (or exact decimal values for N″ less than 1.0) assigned to glasses which have been suitably adjusted. Unless adjusted, glasses of identical nominal grade show significant differences in N″. Thus glasses of identical N″ value cannot be obtained from the makers to replace broken specimens, glasses exactly defining standard points are unavailable and the sets of glasses of various laboratories although identical in nominal grade are non-uniform in N″ grade.

Lovibond Glasses Can Be Adjusted

Adjustment to exact unit values on the N″ scale is a natural extention of the establishment of the new scale. At the request of the Color Glass Development Committee, Dr. Judd of the Bureau of Standards, demonstrated that the grade of a glass could be reduced by hand-polishing with cloth and rouge. An improved mechanical polishing method has been developed and glasses can now be reduced in grade by controlled amounts on a *commercial* basis.

By adjusting glasses to exact integral and decimal fractional values, equivalent specimens are available to all users. Glasses adjusted exactly to the principal test points 2.5, 7.6, 12, 16 and 20 are available. Formerly glasses representing these points could only be obtained by combining two or three regraded glasses selected from a large and complete set. Broken glasses can be replaced by adjusting a new glass to the non-integral value of the old if desired. If the central portion of the old glass remained unbroken a duplicate could be prepared even if the regrade numeral of the old glass had not been previously determined.

E. T. L. Adjusts and Grades Lovibond Red Glasses

Realizing the great benefits and conveniences which Lovibond users would receive if adjusted glasses were commercially available, the Color Glass Development Committee, through Mr. L. M. Gill, chairman, has requested Electrical Testing Laboratories to supply this service. In response to this request, E. T. L. has prepared to adjust and grade these glasses.

E. T. L. since its organization in 1896 has been continuously engaged in the measurement of light and color. At the present time this work is carried on in the Photometric Department under the direction of the department head, Mr. William F. Little. [Dr. Estey is Mr. Little's assistant and in direct charge of the work on Lovibond glasses.—Ed.] For many years the laboratories has made spectro-photometric measurements first with a Lummer-Brodhun visual instrument and now by means of the more modern photoelectric spectrophotometer shown in Fig. 2. This sort of work forms an excellent background against which to study the problems involved in grading Lovibond glasses.

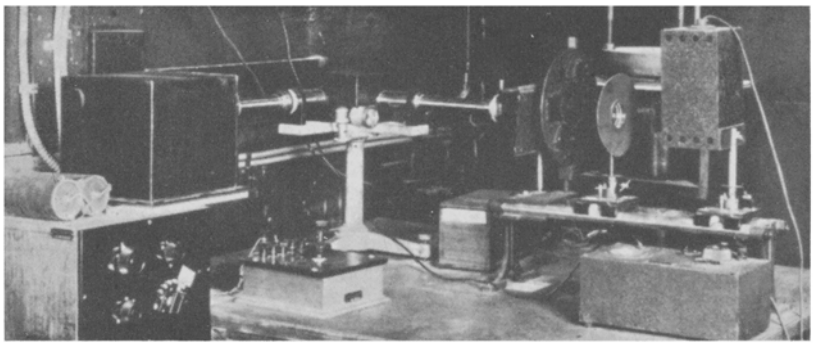

FIG. 2. PHOTOELECTRIC SPECTROPHOTOMETER IN USE AT ELECTRICAL TESTING LABORATORIES.

When Mr. Gill first interested E. T. L. in this project the available literature was studied, largely in the form of a set of reprints supplied by Dr. Gibson. This led to a visit in company with Mr. Gill to Dr. Gibson at the bureau. A careful study was made of both apparatus and technique. On our return a comparator was built similar to that employed by the bureau.[5] This instrument is shown in Fig. 3. The illuminating unit at the right is provided with a 200-watt projection lamp which illuminates the two ground glasses which act as a broad secondary source. From this surface the light traverses a Davis and Gibson[6] filter, a condensing lens, the samples and enters the Martens polarization photometer shown at the left. The eyepiece is covered with a 35-Y glass. In use the current is adjusted to operate the lamp at 2848°K and the light after passing through the filter is at the color temperature 4800°K. This instru-

[4]Fig. 1 is based on data in a paper by G. K. Walker. B. S. J. R. 12, (R. P. 653) 269 (1934).

[5]Walker, B. S. J. R. 12 (R. P. 653) 269 (1934).

[6]Davis and Gibson. Misc. Pub. B. S., No. 114, Jan. 1931.

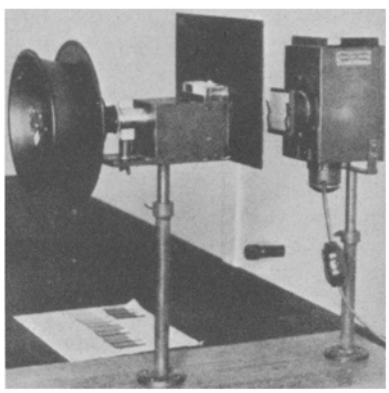

FIG. 3. VISUAL COMPARATOR USED FOR GRADING LOVIBOND GLASSES.

ment is almost an exact copy of the bureau apparatus; the small differences in design have no effect on the accuracy of its performance.

E. T. L. purchased a set of standards from the bureau which have the values shown in Table I.

TABLE No. I

E.T.L. Standard Lovibond Red Glasses
Graded by the National Bureau of Standards

B.S. No.	N	N″	B.S. No.	N	N″
74170-A	.10	.16	74170-L	3.0	3.20
B	.20	.34	M	4.0	4.38
C	.30	.40	N	5.0	5.38
D	.40	.52	O	6.0	6.46
E	.50	.65	P	7.0	7.30
F	.60	.73	Q	8.0	8.22
G	.70	.85	R	9.0	9.63
H	.80	.91	S	10.0	10.09
I	.90	1.08	T	12.0	12.2
J	1.0	1.21	U	15.0	15.3
K	2.0	2.35	V	20.0	21.1

Realizing that these glasses would be used for regrading other glasses, this set received special attention and care at the hands of Mrs. Haupt and Dr. Gibson at the bureau. Repeated measurements were made by them over a period of a month. These calibrated glasses can be combined in pairs so as to obtain a set of nearly integral values as shown in part in Table II.

TABLE No. II

Combinations of Lovibond Red Set, B.S. Test No. 74170
to Obtain Unit Values from N″ = 0.1 to 1.0

Integral N″	Standards N″	Available N″
0.10	0.52 — 0.40	0.12
	0.73 — 0.65	0.08
0.20	0.85 — 0.65	0.20
0.30	0.65 — 0.34	0.31
0.40	0.40	0.40
0.50	0.52	0.52
	0.65 — 0.16	0.49
0.60	0.73 — 0.16	0.57
	0.65	0.65
0.70	0.52 + 0.16	0.68
	0.73	0.73
0.80	0.65 + 0.16	0.81
0.90	0.91	0.91
1.00	0.65 + 0.34	0.99

It is very desirable to have standards whose grades are nearly identical with those of the glasses one expects to measure. Over the range shown the greatest deviation from the desired unit value of any two-element combination is 0.03 N″ units.

The Technique of Adjustment

After seeing Dr. Judd polish a glass by hand E. T. L. experimented with various machine polishers and ultimately settled on the equipment shown in Fig. 4. A rapidly rotating iron disk carries a felt pad soaked with rouge and water. The glass is fastened with pitch on the face of a little block which is held against the felt lap and polishes the glass without scratching it. The glass must be unblocked for examination. The iron lap and the block are shown separately at the right of the figure.

The extreme delicacy of this process will be apparent when it is realized that on a 20-R glass the flashed surface of red coloring matter is only about twenty ten-thousandths of an inch thick. Assuming all glasses to have about the same concentration of color and to differ only in the thickness of the layer this means that one-tenth of an N″ unit corresponds to one hundred-thousandths of an inch and some of our adjustments are accurate to half of this thickness.

We adjust and grade, or merely grade, glasses supplied by the client. When desired, we will supply the glass in addition to the calibration. Glasses submitted to us need not be new. In fact, the adjusting process improves an old glass by renewing the polish and decreasing the scratches. Each glass is accurately graded when received and then carefully polished to decrease the grade to the desired value. The adjustment can only proceed in one direction, i. e., towards lower values of N″. After the glass is brought as nearly as possible to a unit value it is very carefully regraded and interchecked with other glasses.

When finished the glass is provided with a new paper label (the old one is destroyed in polishing) and the final regrade numeral is engraved on the glass together with an E. T. L. identification number and the word "ADJUSTED." A written report is also provided describing the work done on the glasses.

The Accuracy of Grading and Adjusting

Accuracy in the grading of Lovibond glasses depends on an observer with a sensitive color sense, suitable apparatus and reliable standards. While visiting the bureau, Mr. Gill and I went through the test for measuring our least detectable chromaticity differences.[7].

After reading differences of 0.5, 0.3, 0.2 and 0.1 N″ units at 7.6 red we made 20 observations at 0.05 units. Our scores at this difference corresponded to certainty for 0.06 units which is more than twice the sensitivity of a large group previously experimented on and is nearly twice the sensitivity required to stay within the tolerances set up by the bureau. These scores might be improved slightly with further experience.

The sensitivity of the apparatus depends on having two absolutely uniform and closely adjoining photometric fields with a dividing line that entirely disappears when there is a perfect brightness and color-match. The brightness must be independently variable. The illumination must be ample in quantity and standard in color. Our apparatus fulfills these requirements.

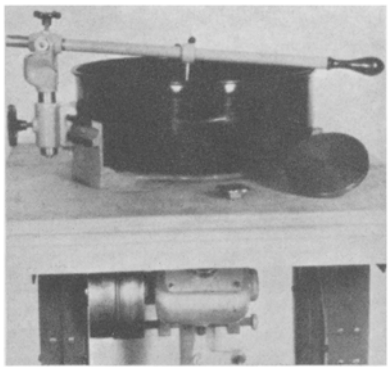

FIG. 4. OPTICAL SURFACING MACHINE USED TO ADJUST LOVIBOND GLASSES.

The accuracy of our standards has just been described.

The Bureau of Standards reports two decimal places where the nom-

[7]Priest. Oil and Fat Industries 5, 63 (1928).

inal grade is not greater than ten. For higher grades one decimal place is reported. Their tolerances which the reported grades do not exceed are 0.1 for nominal grades not greater than ten, 0.2 for nominal grades greater than ten and including sixteen and 0.4 for higher nominal grades. Electrical Testing Laboratories can report within these same tolerances. As far as possible glasses will be adjusted within half of these tolerances.

Conclusion

The N″ scale developed for increased accuracy led to glasses graded to uneven amounts. E. T. L., at the request of your committee, offers its services to make available glasses marked in even units but on the Priest-Gibson N″ scale. Their facilities and experience have been described.

Quoting from the 1935 report of the Color Glass Development Committee:

> "It is to be said in their favor that the Electrical Testing Laboratories have approached the problem with considerably less emphasis on the profit motive than would normally be expected."

The Laboratories' policy favors the establishment of new services not only with the hope that they will pay their own way but more especially with the desire to cooperate with and serve a new group of friends. At the present time money has been spent on experimental work and on the development of the project which cannot hope to be recovered immediately. Fees for these services are being set at the lowest possible figure for the purpose of promoting the widest possible use of adjusted or regraded glasses. We hope this service can be developed to such a volume as will permit it to pay its own way.

It is a pleasure to acknowledge appreciation to Mr. Gill for introducing E. T. L. to your society and to this project; to the bureau staff, particularly Dr. Gibson, Mrs. Haupt and Dr. Judd, for their very cordial cooperation, and to Mr. Trevithick for giving the first order for adjusting a set of glasses.

ELECTRICAL TESTING LABORATORIES
General Office and Laboratories
80th St. and East End Ave.
New York

May 21, 1935.

To the Members of the American Oil Chemists' Society:

Electrical Testing Laboratories has been requested by your Color Glass Development Committee to undertake the adjustment of Lovibond red glasses (when combined with 35 yellow) to exact integral values. The glasses are adjusted by polishing the colored side of the glass, thereby removing a minute layer from the surface and slightly lightening the color. Obviously the adjusting process always lowers the regrade numeral. Fortunately most glasses are higher on the N″ scale than their nominal grade indicates. Each glass is engraved with an identifying number and its regrade numeral. Adjusted glasses also carry the word "ADJUSTED." All glasses are returned accompanied by a suitable report.

Since adjusting is inextricably associated with regrading, we are also prepared to regrade glasses where adjusting is either undesired or unnecessary. For example, if a glass sent in for adjusting were found to be already within the Bureau of Standards' tolerances, the glass would be graded only and a corresponding lower fee would be charged.

Tentative Fee Schedule

Regrading and assigning N″ numeral, per glass.....$2.00
Adjusting and regrading, per glass.....$5.00
These prices are net irrespective of the number of samples submitted.

We are prepared to render this service at the lowest possible price for the immediate benefit of your industry. Our fees are set somewhat below the present cost of this work but we hope that as orders build up the work can be put on a routine basis with savings that will maintain low fees but still permit the project to pay its own way.

Please write us if you need additional information.

Yours very truly,
PHOTOMETRIC DEPARTMENT.
By: Roger S. Estey.

REPORT OF REVISIONS OF METHODS COMMITTEE: 1934

By W. H. IRWIN, Chairman

THE changes and additions to our oil and fat methods made it necessary to reprint ten pages of the methods. In addition, this year the committee reprinted the "Methods for the Analysis of Commercial Soaps and Soap Products" as tentative methods of the society. These methods increased the cost of the printing this year so that the total cost amounted to $130. However, we have reason to believe that the demand for the methods, due to the inclusion of soap methods, will more than offset the additional expense incurred this year.

Recently the writer has seen two inquiries in regard to the advisability of two separate scientific organizations developing and publishing methods covering soap and soap products and in each instance he has pointed out the fact that the methods of our society are in general use and have received wide acceptance in the trade.