EVALUATING COLOR NEGATIVES

Kodak

COLOR DATA

Hugo A. Tarif

CONTENTS

An accurate, quick method of determining the printing characteristics of color negatives is necessary in order to print them economically on a production basis. However the evaluation is accomplished, and the methods are numerous, the results of such a study of a color negative must yield the practical information needed to prepare a satisfactory color print.

In black-and-white printing, a simple exposure series or a trial exposure, based on visual evaluation of the negative density, can be made. Black-and-white prints can be made quickly and cheaply, and viewed to determine the exposure adjustment necessary for the final print. But the exposure required to print a color negative is far more difficult to determine by merely viewing the negative or making an exposure series. The old black-and-white way of working may become a time-consuming and costly procedure when applied to color printing. So, color-negative evaluation methods have been developed to determine quickly and economically the exposure conditions for a color negative.

The negative-evaluation technique must provide the exposure time and the specific printing filter pack required. The filter pack may consist of either KODAK Color Compensating (CC) Filters or KODAK Color Printing (CP) Filters; however, CP Filters must be placed between the enlarger light source and the negative and never between the negative and the printing material.

Essentially, color-negative evaluation methods measure light transmitted by the three dye layers that comprise the color negative to determine the amount of exposure needed to record each layer satisfactorily on the printing material, such as KODAK EKTACOLOR Professional Paper or KODAK EKTACOLOR Print Film.

STANDARD NEGATIVE

Most color-negative-evaluation procedures are based on the use of a standard negative. Briefly, a standard negative is an average, normal negative that has been properly exposed and processed under known conditions and that is known, from actual trial, to make an excellent print. For a complete discussion

of the standard negative in color printing and processing, see the KODAK Data Book Printing Color Negatives, sold by photo dealers.

The proper filter pack should be known for the standard negative. Red, green, and blue densities of the unknown, or production, negatives are measured directly or indirectly to determine the filters that should be added or subtracted from the standard-negative filter pack so that the relative amounts of red, green, and blue light transmitted by the production negative and its filter pack are the same as those transmitted by the standard negative and its filter pack.

Before a negative-evaluation procedure is put into operation, therefore, a standard negative should be made. You should have a separate standard negative on each color-negative film that you use regularly. The standard negative should be as representative as possible of the negatives to be printed. To determine practical exposure and filter data for this standard negative, print it by trial and error until a color print of optimum quality is produced. Record the paper emulsion number, filter pack, exposure time, lens aperture, and magnification that were used to make the good print.

The kind of standard negative you select depends on the kind of photographs you make regularly. Preferably, the standard negative and production negatives should contain the image of a KODAK Neutral Test Card or KODAK Gray Scale placed in the scene, because its image lends itself to exact and reproducible measurement. Portrait photographers often use an average head-and-shoulders portrait as the standard negative. In photographic studios where the nature of the work varies, several standard negatives of typical subjects encountered can be used. Or, a single negative containing all the typical subjects — flesh tones, gray cards, neutral areas, etc — is satisfactory.

REFERENCE AREAS IN NEGATIVES

For successful negative evaluation, the area of the color negative that is evaluated must be basically the same subject matter in all the negatives. As mentioned previously, a gray card included in the picture, a flesh tone, or a neutral area such as

concrete provides a suitable reference area. In portraiture, a medium flesh tone is often selected. In commercial photography — and for that matter, all other fields of photography — it is helpful either to include a gray card in the scene or to expose an additional negative with the gray card in a prominent location. In the latter case, the negative with the gray card is used only for evaluation purposes; it is replaced by the negative without the card when the print is made.

When a flesh tone is used instead of a gray card in portrait negatives, the evaluation results will tend to reproduce all flesh tones alike, regardless of individual variations in skin color or in the character of the lighting falling on the original scene. Similarly, all images of a gray card tend to be printed alike, regardless of the position of the card relative to the main light and other such considerations. Therefore, if a skin tone, the lighting, etc, vary significantly from average, any negative-evaluation method can give printing information of limited accuracy.

Negative-evaluation procedures that utilize only a small area of the negative are called "spot readings." In the absence of a gray card, flesh tone, or neutral area in a negative, the entire area (or a large percentage of the area) of a negative can be measured, and integrated densities used to determine the exposure. Such methods are called "large-area readings," and require an integrating device as described on page 20.

NEGATIVE VARIATIONS

Few characteristics are exactly the same in two color negatives. Even when the subject matter is the same, differences can be produced by normal manufacturing variations from one emulsion coating to another, adverse storage conditions before exposure, illumination of different color quality, differences in sensitivity with changes in illumination level and exposure time (reciprocity effect), adverse storage conditions between exposure and processing (latent image keeping), and nonstandard processing conditions.

In those situations, such as school photography, in which the exposure and processing of film and paper are standardized and paper having the same emulsion number is used for printing a

roll of negatives, all the negatives can usually be printed as indicated by a satisfactory test print from one negative.

However, negative evaluation is necessary when negatives of varying characteristics must be printed on a production basis. Of course, certain matters, such as the storage and processing of the photographic materials, should be standardized. It may also be convenient to compensate for differences in the color quality of the scene illumination. Compensating for the differences in scene illumination with the use of filters suggested in the film instructions will make the printing filter pack much the same for all negatives and will eliminate the large variations in filter-pack requirements that often occur otherwise.

EXPOSING THREE LAYERS

It is helpful to think of KODAK EKTACOLOR Professional Paper in terms of its three separate emulsion layers. Each layer is sensitive to light of a particular color (red, green, or blue), and each layer must receive the correct exposure in order to yield a print of satisfactory density and color balance. A change in the overall exposure time affects all three dye images, while color-compensating filters of one color affect the exposure of one or two emulsion layers, depending on the color of the filter. For instance, a yellow filter affects only the blue-sensitive layer, while a red filter affects both the blue- and green- sensitive layers. By manipulating the variables — overall exposure time and the density and color of the filters placed in the light beam — you can obtain the proper exposure in each of the three emulsion layers.

Familiarity with this color-printing concept will help you understand better how negative evaluation works. Basically, these evaluation techniques provide a method of reading the red, green, and blue densities of the negative. These values provide the information needed to adjust the densities of the color-compensating filters so that, when the EKTACOLOR Professional Paper or EKTACOLOR Print Film is exposed, the red-, green-, and blue-sensitive layers of the printing material each receive the proper exposure.

THE NEGATIVE-EVALUATION METHOD TO SELECT

The particular negative-evaluation technique that you select will depend on the volume of work and on the equipment available. Representative approaches to color-negative evaluation are mentioned in the chart on page 8.

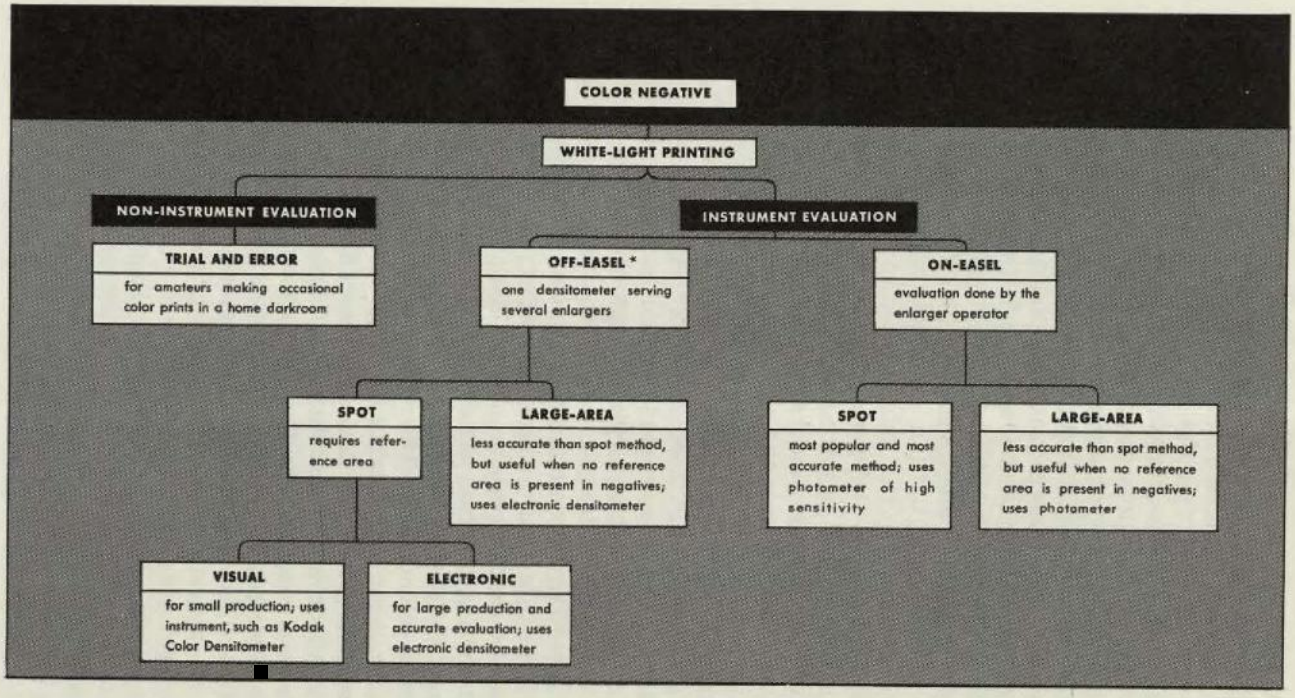
An amateur who makes occasional color prints in a home darkroom may find trial-and-error printing, the only non-instrument evaluation method, the best procedure. The first print made by this method is judged, and changes in exposure and filters are made until a satisfactory print is produced. For large operations, the trial-and-error technique is time consuming and costly. However, the method is suitable where time is not of prime importance and equipment is minimal. For a complete discussion of this printing technique, as well as suggested filter packs and exposure times, see the KODAK Data Book Printing Color Negatives, sold by photo dealers.

All other negative-evaluation techniques are based on the use of a densitometer, either visual or electronic, or an easel photometer. For the advanced amateur and the professional who cannot justify larger expenditures for electronic equipment, a technique utilizing a visual densitometer, such as the KODAK Color Densitometer, Model 1, can be used.

Negative-evaluation techniques using electronic instruments can be performed on or off the enlarger easel. They can be based on reading the densities either in a small part of a negative (spot readings) or over a large percentage of the negative area (large-area readings). Experienced workers can usually make the density readings for a negative in less than a minute. These methods are generally capable of producing satisfactory prints on the first try. Procedures based on large-area readings are less accurate than those involving spot readings, but large-area readings are widely and satisfactorily used in photofinishing operations.

Off-easel evaluation methods are particularly useful where enlarging is a production operation and time cannot be spared from actual enlarging activities to perform the evaluation on the enlarger easel, or where it is uneconomical to purchase a sufficient number of photometers to service all the enlargers.

In such cases, color-negative evaluation can be set up on a production basis outside the darkroom. By using an off-easel



*Off-easel evaluation methods determine color balance only; the exposure must be determined as a separate procedure.

method, a densitometer operator can furnish darkroom technicians with filter-pack information for each color negative. Then, the darkroom technician need determine only the lens opening and exposure time for the size of the enlargement to be made.

Off-easel evaluation is well suited to professional continuous printing and processing systems utilizing equipment, such as the KODAK Roll Paper Printer, Type IVB-3, for single or multiple prints up to 5 x 7 inches, and the KODAK Master Roll Paper Holder, Model 11-K, used in conjunction with an enlarger for prints up to 11 x 14 inches. In such operations, off-easel evaluation at once provides the filter-pack requirements for printing on any or all of the equipment available.

On-easel evaluation is suited to operations in which the enlarger operator can perform economically the evaluation as well as the printing. If there are several enlargers in constant operation, each enlarger can be furnished with a photometer, and each technician can be taught the negative-evaluation procedure to be used. If all enlargers are identical, one can be furnished with a photometer and used exclusively for negative evaluation.

Special high-speed equipment is available for photofinishers engaged in large-production color printing. This equipment performs the color-negative evaluation semiautomatically as part of the printing process. Such equipment includes the KODAK Enlarging Color Printer, Model 8S-2-K, and KODAK Roll Paper Color Printers, Type IVC and Type IVS, and Model 5S-2-K.

The order in which negative-evaluation procedures are presented on the following pages generally follows the chart on page 8 from left to right and from simplest to most elaborate. If you are in doubt as to which technique to use, consider electronic instrument evaluation with spot readings made on the enlarger easel, page 16. This method is generally the most accurate and furnishes the most consistent results. However, it also requires the most sensitive photometer.

OFF-EASEL SPOT EVALUATION WITH THE *KODAK* COLOR DENSITOMETER

The KODAK Color Densitometer, Model 1, can be used to determine a trial filter pack and exposure time which should produce a color print that is within a range that can be judged visually for the final filter and exposure-time refinements.

	Cyan Value *Red Reading*	Magenta Value *Green Reading*	Yellow Value *Blue Reading*
1. Measure the red, green, and blue densities of the gray-card image (or medium-tone flesh image, etc) in the standard negative. Round off the readings to the nearest 0.05 and record the red reading under Cyan Value, the green reading under Magenta Value, and the blue reading under Yellow Value, as shown in the example at right:	0.95	1.00	1.20
2. In the appropriate columns, record the values of the filters used to make the best print from the standard negative (in the example, 65M + 80Y):	0	0.65	0.80
3. Add the columns of figures: (These figures represent the total amount of cyan, magenta, and yellow in the standard negative plus its filter pack.)	0.95	1.65	2.00
4. Measure the red, green, and blue densities of the production negative and enter these figures in the cyan, magenta, and yellow columns, respectively:	1.10	0.95	1.10

	Cyan Value	Magenta Value	Yellow Value
5. Subtract the figures in Step 4 from those in Step 3:	−0.15	0.70	0.90
6. Add or subtract equal amounts to each column to make the cyan value zero, thus eliminating neutral density:	+0.15	+0.15	+0.15
	0	0.85	1.05

The trial filter pack for the production negative is 85M + 105Y

The 0.15 neutral density canceled out represents the amount by which the production negative is denser than the standard negative. Of course, the production negative could be lighter than the standard negative, in which case, the cyan value in Step 5 would be a plus number. When this occurs, subtract values in Step 6 to eliminate the neutral density.

To determine the trial exposure time for the production negative, find, in the table below, the nearest plus or minus number that corresponds to the amount of neutral density eliminated in Step 6. Multiply the exposure time for the standard negative by the factor given in the table.

Figure Appearing in Step 6:	Multiply Standard-Negative Exposure Time by:
+0.40	2.6
+0.30	2.0
+0.20	1.6
+0.10	1.25
0	1
−0.10	0.8
−0.20	0.65
−0.30	0.5
−0.40	0.4

Of course, any electronic densitometer can be used to make the red, green, and blue density measurements that are made visually with the KODAK Color Densitometer. So, in the procedure just described, an electronic densitometer can be substituted for the visual densitometer. Actually, the procedure described on the following pages is very similar to the one outlined on the previous pages. However, one bit of drudgery, the mathematical computation, has been removed in this method. Instead, the electronic densitometer is set up to read directly the filter pack required.

EQUIPMENT AND MATERIALS

For off-easel evaluation, an electronic instrument of generally lower sensitivity than that required for on-easel evaluation can be used. Instead of using an enlarger as the light source for measuring negative densities, another light source is used. This removes negative-evaluation activities from the darkroom and frees the enlarger for printing work. Suitable electronic equipment is manufactured by Macbeth Instrument Corporation, P.O. Box 950, Newburgh, New York 12553, and by the Welch Scientific Company, 1515 Sedgwick Street, Chicago, Illinois 60610.

If the equipment that you are using is not furnished with reading filters, use KODAK WRATTEN Filters No. 70 (red), 99 (green), and either 47B or 98 (blue). The KODAK WRATTEN Filter No. 92 can be substituted for the No. 70 (red), and the No. 61 for the No. 99 (green), if the particular instrument has relatively low red and green sensitivity. These substitutions result in some loss in accuracy. If neither the light source nor the densitometer that you are using has attenuators, KODAK WRATTEN Neutral Density Filters No. 96 are required to attenuate the light. The instruments made by the manufacturers listed above provide attenuators that can be adjusted instead of adding neutral density to the reading filters.

CALIBRATE READING FILTERS

1. Carefully read the instructions accompanying the particular densitometer you are using so that you become familiar with the mechanical controls provided to make the adjustments discussed here.

2. Place the standard negative over the aperture on the light box in such a way that the gray-card, flesh-tone or other reference area selected falls on the aperture of the densitometer probe unit.

3. With the blue reading filter in place, the blue circuit actuated, and the densitometer master control set to about medium sensitivity, adjust the blue light attenuator or blue circuit attenuator until the meter reads, on the filter-requirement scale, the value of the yellow filter used to print the standard negative. (Filter-requirement scales generally have divisions in units of 0.1; each such 0.1 division should be regarded as equivalent to a 10 filter, so, for example, 0.3 is 30 and 1.0 is 100. If the densitometer does not have a filter-requirement scale, add a new grease-pencil scale on the glass panel over the optical-density scale. See Figure 1.

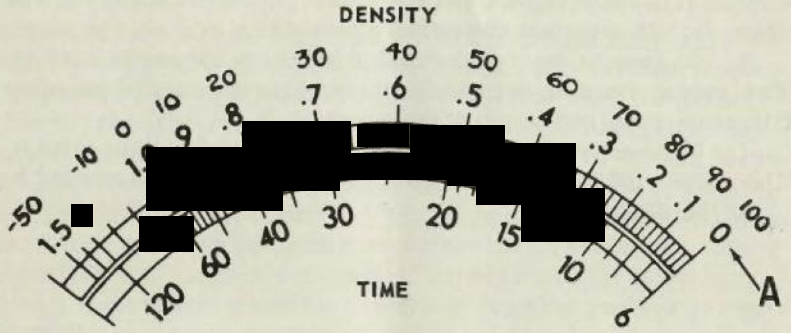


FIGURE 1

Many photometers have an optical-density scale like "A" above. Such a scale can be converted easily to read directly in CC or CP Filters by adding a grease-pencil scale to the glass panel as shown. Any convenient point can be selected for the zero position; here, 1.0 has been chosen. The use of the exposure-time scale is explained in the manufacturer's instructions.

4. Change to the green reading filter and the green circuit, and adjust the green light attenuator or the green circuit attenuator until the meter reads the value of the magenta filter used to print the standard negative.

5. Change to the red reading filter and the red circuit and adjust the red light attenuator or the red circuit attenuator until the meter reads zero. (This "zero" may be any convenient number on the dial.)

6. Recheck the above readings for accuracy. This calibration should be rechecked periodically during normal operation.

This completes the instrument calibration for the off-easel negative-evaluation technique. The filter pack for production negatives can now be determined.

DETERMINE THE FILTER PACK

1. Place the production negative over the light-box aperture in such a way that the gray-card or other reference area falls on the probe aperture.

2. With the red reading filter in place and the red circuit actuated, adjust the densitometer master control or the light-source iris diaphragm until the meter pointer rests at the red zero. Do not readjust the color attenuators.

3. Change to the green reading filter and the green circuit. The meter reading obtained indicates the amount of magenta filtration required to print the negative.*

4. Change to the blue reading filter and the blue circuit. The meter indicates the amount of yellow filtration needed to print the negative.*

---

*Occasionally, there may be a minus reading on the meter scale indicating that cyan filtration is required. Sometimes, the addition of an extra piece of heat-absorbing glass in the enlarger will return the reading to positive magenta and yellow values. Otherwise, CC Cyan-2 Filters can be placed below the enlarger lens (between the lens and the paper) to obtain positive readings. Be sure that the cyan KODAK Color Compensating Filters you use bear the suffix "–2."

DETERMINE EXPOSURE

One of several procedures for determining the lens opening and exposure time can be used in conjunction with the off-easel filter-pack determination. The method described on pages 18 and 19 can be used to determine the lens opening and exposure time at the enlarger easel. However, the photometer does not necessarily have to be sensitive enough for color-balance readings in order to make the simple density reading required to determine the exposure.

OFF-EASEL LARGE-AREA EVALUATION WITH AN ELECTRONIC DENSITOMETER

Although large-area readings are not so reliable as the previously discussed spot-reading technique, they are useful when the production negatives contain no reference area that is suitable for the spot-reading procedure. Whenever production negatives vary from the standard negative (e.g., by having large areas of one predominant color, etc), the technique of reading and integrating densities over the entire negative may provide incorrect printing information. Corrections for such unusual negatives are largely a matter of experience and judgment.

Equipment and materials required for this method are essentially the same as those used in off-easel spot evaluation with an electronic densitometer, page 12. However, the light box must be modified to illuminate the entire negative, or another one fabricated that will. Also, the densitometer probe unit must be situated where it will read the whole negative area or a large percentage of it simultaneously.

The procedure for this technique, otherwise, is exactly the same as that for off-easel spot evaluation on page 12.

Several methods of on-easel spot evaluation with a photometer are satisfactory. Basically they are all alike. They vary subtly in procedure and somewhat in accuracy. Perhaps the simplest of on-easel spot evaluation techniques is the one that has already been described as an off-easel spot evaluation method on page 12. That procedure can be adapted for on-easel work merely by substituting an enlarger for the transmission light source. The technique described on the following pages is a refinement of that procedure. Here, the filter pack is actually tested in the enlarger so that the filter pack determined will give more accurate results.

EQUIPMENT AND MATERIALS

1. A color photometer of high sensitivity and stability is needed for on-easel negative evaluation. Suitable instruments are manufactured by the following representative companies:

Lektra Laboratories, Inc., 154 Eleventh Avenue, New York, N.Y. 10011

Macbeth Instrument Corporation, P.O. Box 950, Newburgh, N.Y. 12553

Mornick Instrument Company, 4115 Weslow, Houston, Texas 77017

Welch Scientific Company, 1515 Sedgwick Street, Chicago, Illinois 60610

2. An enlarger suitable for color printing should be equipped with a tungsten lamp and heat-absorbing glass (such as Pittsburgh 2043).

3. KODAK WRATTEN Filters No. 92 (red), 99 (green), and 47B (blue) in the 2-inch-square size, only if the photometer probe unit is not equipped with red, green, and blue reading filters. A KODAK WRATTEN Filter No. 2B or KODAK Color Printing Filter CP2B should be permanently installed above the negative. In addition, KODAK Color Compensating (CC) Filters or KODAK Color Printing (CP) Filters are required.

CP Filters can be used only between the light source and the negative, but CC Filters can also be used between the negative and the paper, where they are in the path of image-forming light.

4. A standard negative made as described previously.

CALIBRATE READING FILTERS

1. To become familiar with the mechanical controls provided to make the adjustments discussed here, read carefully the instructions accompanying the particular photometer you are using. Most photometers are equipped with attenuators that can be adjusted as described below. If the photometer has no such attenuators, you can achieve the same effect by adding appropriate values of KODAK WRATTEN Neutral Density Filters No. 96 to the reading filter.

2. Place in the enlarger the standard negative and the filter pack that was used to make the good print. Place the photometer probe on the easel so that the gray-card or other reference area falls on the aperture of the probe.

3. With the blue reading filter in place, the blue circuit actuated, and the photometer master control and the blue attenuator set to give maximum sensitivity, adjust the enlarger lens opening until the meter reads zero on the filter-requirement scale. It may be necessary to decrease the magnification in order to bring the meter needle to the zero position. (Although it is easier to use the zero position provided on the scale, any convenient point on the scale can be used for calibrating the reading filters. On some photometers, there is only an optical-density scale, so a convenient zero position must be selected and a grease-pencil scale added to the glass panel. See Figure 1.)

4. Without altering the enlarger settings, change to the green reading filter and the green circuit, and adjust the green attenuator until the meter again reads zero.

5. Without altering the enlarger settings, change to the red reading filter and the red circuit, and adjust the red attenuator until the meter again reads zero.

6. Recheck the above readings for accuracy. This calibration should be rechecked periodically during normal operation.

CALIBRATE FOR EXPOSURE LEVEL

1. With the standard negative and its filter pack in the enlarger, set the lens opening and magnification to the settings used to give the good print from the standard negative.
2. With no filter over the probe aperture, place the probe on the easel in such a location that the gray-card or other reference area falls on the aperture of the probe.
3. With the photometer master control set for maximum sensitivity, actuate the exposure circuit and adjust the exposure attenuator until the meter reading on the time scale is the exposure time that was used to print the standard negative.

This completes the instrument calibration for the on-easel negative-evaluation system. The filter packs and exposure times for production negatives can now be determined.

DETERMINE THE FILTER PACK

In this system it may be simpler to use only magenta and yellow filters for printing, provided the filters can be placed above the negative carrier where it is not necessary to reduce their number to a minimum. All filter adjustments can then be made by merely adding or subtracting yellow or magenta filters.

1. Insert the production negative in the enlarger. Place the photometer probe unit on the easel in such a location that the gray-card or other reference area falls on the probe aperture.
2. With the red reading filter in place and the red circuit actuated, adjust the enlarger lens opening or decrease the magnification, if necessary, until the meter pointer rests at zero. Do not readjust the color attenuators.
3. Change to the green reading filter and the green circuit. The meter reading obtained indicates the amount of magenta filtration required to print the negative.*
4. Change to the blue reading filter and the blue circuit. The meter reading indicates the amount of yellow filtration needed to print the negative.*

*See footnote on page 14.

5. Place in the enlarger the magenta and yellow filters determined above and repeat steps 2 through 4. The meter should read zero. If it doesn't, remake the adjustments in step 2 and readjust the filter pack by the amount of the meter reading in steps 3 and 4 until the meter reads zero on the red, green, and blue reading-filter settings. Use the final, adjusted filter pack to print the production negative.

DETERMINE EXPOSURE

With the production negative and the above-determined filter pack in the enlarger, adjust the magnification to the desired value. With no reading filter over the probe, place the photometer probe on the easel in such a location that the gray-card or other reference area falls on the aperture of the probe.

With the master control set for maximum sensitivity and the exposure circuit actuated, adjust the enlarger lens opening until the meter pointer rests at the same printing time as was used to make the good print from the standard negative. Print at this lens opening and exposure time, or adjust the lens opening to any desired f-stop and print at the time indicated on the meter. Large deviations in time from the standard exposure time may require an adjustment for the reciprocity characteristics of the color paper.

ON-EASEL LARGE-AREA EVALUATION WITH A PHOTOMETER

Although this technique is not so satisfactory as the one previously discussed, it is useful when the production negatives contain no reference area that is suitable for spot evaluation. Evaluation by large-area readings is subject to some failures, principally from negatives with large areas of one predominant color or large, intentional light or dark areas. Correcting the meter-indicated printing information for negatives that vary significantly from normal is largely a matter of experience and judgment.

The same equipment listed for on-easel spot evaluation should be used here. In addition, an integrating cone or an optical integrator is necessary to permit reading the entire area of the negative or a large portion of it.

The procedure for this technique is exactly the same as that for on-easel spot evaluation on page 16. When determining the exposure time and lens opening, be sure to use the same magnification as that used for making the good print from the standard negative.

Sales Service Division

EASTMAN KODAK COMPANY • ROCHESTER, N. Y. 14650

Evaluating Color Negatives

KODAK Sales Service Pamphlet No. E-52

11-64 Major Revision

279-L-KP-E

Printed in the United States of America