

# An Improved Professional 16mm Reversal Camera Film

By N. H. GROET, M. LIBERMAN and F. RICHEY

A 16mm subtractive reversal film with incorporated color couplers, designed to provide high-quality originals for the production of release prints, is described. From these camera originals, release prints onto Eastman Reversal Color Print Film, Type 5269, or release prints by way of Eastman Color Internegative Film, Type 7270, printed onto Eastman Color Print Film, Type 7382, can be produced. The film structure, sensitometric characteristics, exposure requirements, suggested filters and printing behavior of the new film are described.

THE PRODUCTION of professional-quality 16mm color motion pictures for educational, training, advertising and entertainment purposes was at first a by-product of the introduction in 1935 of practical color films for home movies. In the late 30's, professional use of the amateur films had caught on to such an extent that special-purpose print films were supplied in bulk form to make better and lower-cost prints from such originals. The availability of these materials gave impetus to the growth of the 16mm branch of the motion-picture industry.

As the producer of commercial 16mm films became more familiar with these materials, he found that the camera film designed for the amateur did not meet his requirements with respect to tone reproduction. For his purposes, the professional needed a camera film with characteristics designed to produce a large number of prints onto another film; good projection quality, essential for amateur films, was not a requirement. The processing service offered for the amateur film also posed a problem for the professional photographer. In order to keep the time schedule for a production to a minimum, the professional also found that it would be economically desirable to be able to process his own originals or to have the close cooperation of laboratories which could perform this service for him.

In view of the requirements for professional 16mm camera films as contrasted with amateur camera films, a modified film and process were made available to the professional cinematographer in 1947. This film, Kodachrome Commercial Safety Color Film, Type 5268, was designed to solve some of the professional's problems and has been used by many producers of 16mm film.

A system in general use for the pro-

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duction of 16mm motion-picture films involves the use of Kodachrome Commercial Film, Type 5268, in conjunction with a reversal duplicating material such as Eastman Reversal Color Print Film, Type 5269. When rush prints or a limited number of release prints are needed, these prints are made directly from the camera original. For lap dissolves and other effects, A&B roll printing is usually employed. In cases requiring high-volume release printing, and in the interest of protecting the "camera original," an intermediate reversal printing master is often prepared on the duplicating film; final prints are made by printing the intermediate printing master onto Eastman Reversal Color Print Film, Type 5269. These printing methods are shown schematically in Fig. 1.

Another possible method for the production of prints was presented to the Society in April, 1956, by Zwick, Bello and Osborne.<sup>1</sup> This system employs an intermediate color negative on Eastman Color Internegative Film, Type 7270, and is shown schematically in Fig. 2. Release prints are made by printing this intermediate negative onto a positive color film such as Eastman Color Print Film, Type 7382. It is also possible to prepare a 35mm internegative on Eastman Color Internegative Film, Type 5270, and a release print for theater use on Eastman Color Print Film, Type 5382.

Subsequent to the introduction of Kodachrome Commercial Film, Type 5268, improved photographic emulsions, new couplers for the production of dye

images, and new processing formulas have made possible the introduction at this time of an improved color camera film for the professional 16mm cinematographer. This film is Ektachrome Commercial Film, Type 7255. In designing this film, emphasis has been placed on obtaining improved speed, graininess, sharpness, latitude, curve shape and color quality.

This paper describes the new camera film which can be used in place of the Kodachrome Commercial Film in the duplicating systems as just outlined.

## General Description

Ektachrome Commercial Film, Type 7255, is a multilayer, three-color subtractive film, with incorporated dye-forming couplers. The structure is shown schematically in Fig. 3. The three-color records are provided by emulsion layers sensitized to blue, green and red light, respectively, coated on a safety-film support. A clear gelatin overcoat is provided for protection against abrasion. A yellow-filter layer between the blue- and the green-sensitive layers prevents blue light from reaching the bottom two emulsion layers, and a clear gelatin interlayer is provided for the prevention of color contamination between the green- and the red-sensitive layers. A removable, black antihalation layer is coated on the back side of the support. The emulsion layers contain, in addition to the silver halide, coupler dispersions from which a yellow dye is produced, during processing, in the blue-sensitive layer, a magenta dye in the green-sensitive layer and cyan dye in the red-sensitive layer. The proper choice of developing agent and of the three color-forming couplers results in dye-absorption curves shown in Fig. 4, where density is plotted against wavelength; for reference, the Kodachrome Commercial, Type 5268, dyes are shown in dashed lines. The reduction in the unwanted absorptions of the dyes in the new film is one of the important factors

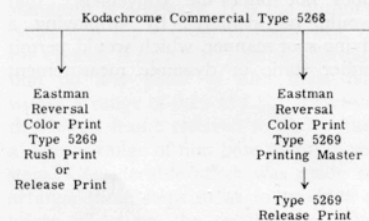


Fig. 1. A professional 16mm color-film duplicating system.

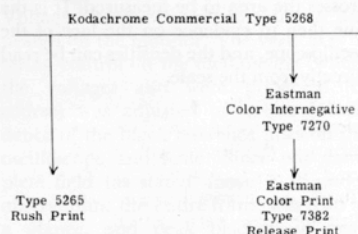


Fig. 2. A professional color-film duplicating system.

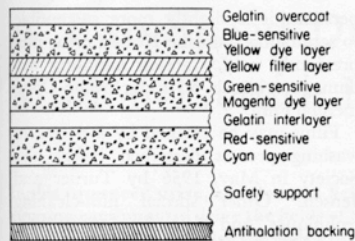


Fig. 3. Schematic cross section of Ektachrome Commercial Film, Type 7255.

contributing to the improved color reproduction.

#### Film Characteristics

Ektachrome Commercial Film, Type 7255, is a medium-speed, fine-grain, long-latitude, color reversal film balanced for 3200 K illumination as commonly used in the industry. The characteristic curves for the reproduction of a scale of neutrals are shown in Fig. 5. The three curves represent the densities of the neutral scale to red, green and blue light, as plotted against relative log exposure, and were measured on the Eastman Electronic Densitometer, Type 31A, with Eastman Status K Filters. The Eastman Status K Filters very nearly predict the printing densities of the camera film to Eastman Reversal Color Print Film, Type 5269. Low contrast scales of approximately 1.10 gamma with uniformly long straight-line characteristic curves are obtained.

The emulsions are coated on a safety support with good dimensional stability. The film is perforated according to American Standard PH22.5-1953, except dimension B, which is 0.2994 in., and dimension L, which is 29.94 in. The antihalation backing of this film is of the same type as that used with Eastman Color Negative and Eastman Color Print films and requires the same care in removal.

The individual emulsion layers of the new film have keeping properties similar to those of other multilayer camera films. For extended periods of storage, the unexposed film should be kept at a temperature not exceeding 55 F, in order to minimize color-balance changes. Latent-image keeping properties are also similar to those of other color camera films and it is desirable to process film as soon as possible after exposure.

Although materials such as Ektachrome Commercial Film do not have colored couplers for color-correction purposes, the interimage effects which occur in such reversal materials contribute to improved color quality. To illustrate one such effect, the solid H&D curve in Fig. 6 shows the amounts of magenta dye present in the neutral scale. The density of magenta dye is

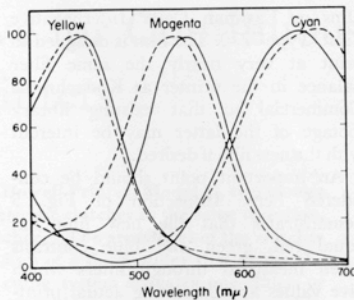


Fig. 4. Spectrophotometric curves of Ektachrome (solid lines) and Kodachrome (dashed lines) dyes.

expressed in equivalent neutral density units plotted against log exposure. As the blue exposure is decreased to the point where the scale receives no blue exposure, yellow dye (shown as blue density by the horizontal dashed line) is added; a decrease in magenta dye is evident, as shown by the dashed-line H&D curve. As cyan dye is added by decreasing the red exposure (shown as red density by horizontal dotted line), a further decrease in magenta dye, as shown by the dotted H&D curve, is observed.

Green colors are generally reproduced too dark as a result of the unwanted green absorption of the cyan and yellow dyes produced in color films. The reduction in magenta dye as a function of decreasing blue and red exposures has the net effect of compensating for the unwanted absorption of the yellow and cyan dyes and improves the brightness of green colors in the final reproduction.

#### Exposure of Film

Ektachrome Commercial Film is furnished in standard lengths for use in conventional 16mm motion-picture cameras. The film has an exposure index of 25 to tungsten, 3200 K illumination, and an index of 16 when filtered with a Kodak Wratten Filter No. 85 for daylight. Compared with Kodachrome Commercial Film, the film speed is more than double; in spite of the higher speed, prints from the Ektachrome Commercial are finer-grained and sharper compared with prints made from its predecessor.

Suggested filters for use in exposing the new film are shown in Table I.

Kodak Color Compensating Filters may also be used to correct for slight color-balance differences from one emulsion to another. This practice will minimize the changes required in the printer filter pack when the original consists of footages from different emulsion numbers. When a particular emulsion requires a compensating filter, only one filter will be necessary, and

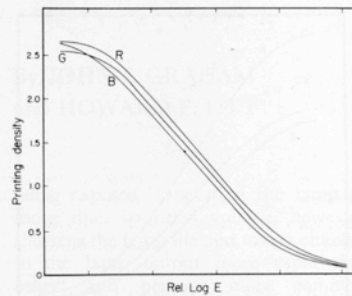


Fig. 5. Characteristic curves of Ektachrome Commercial Film, Type 7255. Densitometer: Eastman Electronic Color Densitometer, Type 31A, Status K Filters, which read printing density.

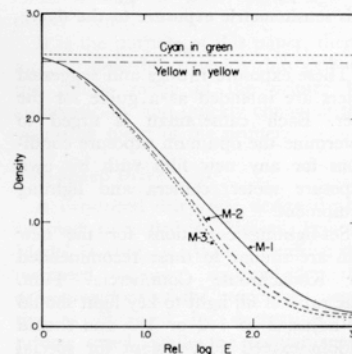


Fig. 6. Interimage effect in magenta layer of Ektachrome Commercial Film, Type 7255, as a function of exposure in yellow and cyan layers: M-1, Magenta in neutral; M-2, Magenta in yellow; M-3, Magenta in green.

this filter will be a 0.10 cyan, a 0.10 magenta or a 0.10 yellow. The appropriate filter for a particular emulsion will be indicated on the side of the film carton directly below the emulsion number.

Table I. Filters Required With Various Light Sources for Exposure of Ektachrome Commercial Film, Type 7255.

Light source	Light source filter required	Camera filter required
3200 K Tungsten lamps or "CP" lamps (approx. 3350 K)	None	None
Daylight (sunlight plus some skylight)	None	Kodak Wratten No. 85
M-R Type 170, 150-amp, high-intensity arc	Straw-colored gelatin filter such as Brigham Y-1	Kodak Wratten No. 85
M-R Type 40, 40-amp Duarc	Florentine Glass	Kodak Wratten No. 85
Daylight	None	Kodak Wratten No. 85

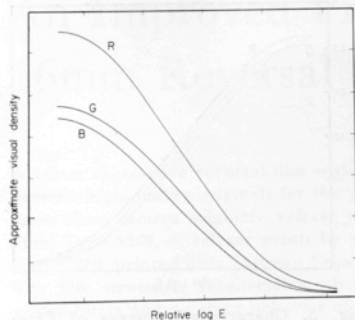


Fig. 7. Characteristic curves of Ektachrome Commercial Film, Type 7255. Densitometer: Eastman Electronic Color Densitometer, Type 31A, with filters which approximate the appearance of this sensitometric exposure to the dye.

These exposure ratings and suggested filters are intended as a guide for the user. Each cameraman is urged to determine the optimum exposure conditions for any new film with his own exposure meter, camera and lighting equipment.

Set-lighting conditions for the new film are similar to those recommended for Kodachrome Commercial Film. The ratio of fill light to key light should be adjusted to 1:2 or 1:3 and should seldom exceed 1:4, except for special effects.

#### Choice of Colors for Costumes, Make-up, Set Properties, Artwork, etc.

Before actual production is started, it is desirable to make careful tests of various pigments, fabrics, make-up materials, etc., and to determine how these colors will be reproduced in the final print film, in the complete process intended for production. The results of these tests should be carefully evaluated and catalogued for future reference.

#### Printing Ektachrome Commercial Film

Ektachrome Commercial Film may be printed on either reversal color-print

films or Eastman Color Internegative Film, Type 7270. The film is designed to print at very nearly the same filter balance in the printer as Kodachrome Commercial so that existing library footage of the latter may be intercut with the new film if desired.

An important point should be considered here. Inspection of Fig. 5 demonstrates that the new film has equal red, green and blue contrasts when measured through filters which give values approximating actual printing densities. However, if the same dye scale is measured with filters which approximate the appearance of this sensitometric exposure to the eye, a high red density and contrast are seen, and the user would rightly conclude that the original itself would not be optimally balanced with respect to a visual match for the original silver step tablet (Fig. 7). This film is not suitable for direct projection and should not be judged on that basis, but rather, on the quality of the prints made from the camera original.

As a result of the discrepancy between visual and printing densities of Ektachrome Commercial Film, intercut Ektachrome and Kodachrome camera originals which print at the same printer balance will differ markedly in visual appearance. The Ektachrome camera original will appear cyan in balance by visual inspection as compared with the Kodachrome camera original.

#### Care of Film

Good practices of housekeeping in processing, editing and printing rooms, careful film-handling procedures and proper maintenance of printing equipment are essential for the production of satisfactory originals on Ektachrome Commercial Film. The incorporation of coupler dispersions softens the emulsion layers and this is detectable in the raw film stock and also in the processed film. Although this film has improved abrasion-resistance over other motion-picture films containing coupler dis-

persions, it is slightly more susceptible to scratching than the Kodachrome film previously used. Careless handling will damage originals on Ektachrome Commercial Film.

Films may be cleaned by a detergent washing process described before this Society in May, 1956 by Turner and Jensen.<sup>2</sup> Other special film-cleaning techniques and film-cleaning solvents should be tested before they are applied to valuable originals.

#### Sensitometric Exposures

Reproducible sensitometric strip exposures are required as a convenient monitor of film and process variations which aid in process control.<sup>3</sup> These exposures may be made on Ektachrome Commercial Film on any reliable sensitometer providing tungsten-quality illumination of approximately 3200 K color temperature. An exposure time of  $\frac{1}{25}$  or  $\frac{1}{50}$  sec is used to approximate the exposure time given in the camera. Slight variations in contrasts and in relative speeds of the three emulsion layers will result from either very long or very short exposure times.

#### Processing

At the Society's Convention the processing of Ektachrome Commercial Film, Type 7255, was covered in a companion paper by D. S. Thomas, H. Rees and H. Vogt of the Color Technology Division of Eastman Kodak Co. That paper will not be published in the *Journal*; manuals and other instructions for processing this film are available from the Eastman Kodak Co., Motion Picture Film Department.

#### References

1. D. M. Zwick, H. J. Bello and C. E. Osborne, "A 16mm color internegative film for use in color motion-picture photography," *Jour. SMPTE*, 65: 426-428, Aug. 1956.
2. J. R. Turner and E. W. Jensen, "Some principles of spray processing," *Jour. SMPTE*, 65: 92-96, Feb. 1956.
3. A. M. Koerner, "The problems of control of color photographic processes," *Jour. SMPTE*, 63: 225-230, Dec. 1954.