

## Two High-Speed Color Films and a Reversal Print Film for Motion-Picture Use

Eastman (or Kodak) Ektachrome ER Daylight and Type B Films are high-speed color reversal camera films designed for 35mm and 16mm motion-picture photography. Ektachrome Reversal Print Film, designed for the same process as the camera films, may be used for making high-quality prints from camera originals. Film structure, sensitometric characteristics, exposure requirements, suggested filters, and printing behavior of the new films are discussed.

THE PRACTICE of motion-picture photography in color has experienced a succession of many new and improved color films. The manufacturers of photographic materials, recognizing that improved films would reflect both a reduction in production costs and improved quality to the producer, have incorporated the results of research and technological progress in these new color films. In view of the cost of stage lighting and the degree of magnification employed in modern projection systems, particular emphasis has been placed on the development of higher-speed and finer-grained motion-picture color films.

Typical of these photographic materials are Ektachrome Commercial

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Film, Type 7255, described by Groet, Liberman and Richey to the Society in April, 1958,<sup>1</sup> and Eastman Color Negative Film, Type 5250, described by Dundon and Zwick to the Society in May, 1959.<sup>2</sup> These color films were designed to have the maximum speed commensurate with the medium- to fine-grain characteristics required for excellent picture quality. However, these films, with rated exposure indices of 25 and 50, respectively, are frequently too low in speed for sport, available-light, high-speed and data-recording types of photography.

Recent improvements in photographic emulsions, sensitization, and dye-forming materials now make it possible to manufacture color reversal films with markedly higher film speed without the large losses in quality formerly attendant upon such attempts. As a result of these technological gains and in consideration of speed requirements placed on films used under conditions when inadequate

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lighting is a problem, two new, high-speed, reversal color films are being manufactured for motion-picture use. These films are Eastman (or Kodak) Ektachrome ER Film, Types 5257 (35mm) and 7257 (16mm) for use with daylight illumination, and Eastman (or Kodak) Ektachrome ER Film, Types 5258 (35mm) and 7258 (16mm) for use with tungsten illumination. The purpose of Part I of this paper is to discuss the characteristics and usage of these films.

Several methods for making color prints from reversal camera originals are discussed in the literature. In many cases these systems require different chemicals and modified equipment for processing the print film as compared to the processing requirements of the camera original. As a result, various operations, such as processing the original camera film, printing the camera film and processing the color prints, are frequently carried out in different laboratories.

Many operations involve security regulations or time considerations, and a print film is required which can be processed in the same chemicals and equipment used for processing the camera film. Hence, a new print film which fulfills these requirements is being introduced, along with the two new

camera films. This film is Ektachrome Reversal Print Film, Type 5386 (35mm) and Type 7386 (16mm). It is the purpose of Part II of this paper to discuss the characteristics and usage of the new reversal print film.

### PART I. CAMERA FILMS

Ektachrome ER Film, Type 5257 (35mm) and Type 7257 (16mm), is a high-speed, moderate-grain, camera film designed for use under daylight conditions. It is especially intended for situations in which the illumination level is low or for high-speed photography when sufficient exposure cannot be obtained with slower-speed color reversal films.

For daylight illumination, the exposure index of this film is 160. With a shutter speed of approximately  $\frac{1}{50}$  sec (24 frames/sec), the basic exposure is 14 ft-c at  $f/1.4$ . In terms of high-speed photography under average sunlight conditions, an aperture of  $f/4.0$  would be required for a rate of 1000 frames/sec. Except in an emergency, it is not desirable to use this film with tungsten light sources because of the color correction required and the attendant sacrifice in film speed. However, the daylight-balanced Type 5257 may be preferable in many existing light situations where fluorescent or fluorescent plus daylight lighting exists. Suggested filters for exposing the daylight film are shown in Table I.

Ektachrome ER Film, Type 5258 (35mm) and Type 7258 (16mm), is a high-speed camera material intended for use under difficult tungsten lighting conditions where sufficient exposure cannot be obtained with slower-speed color reversal films. It can be used in a number of applications, including the filming of industrial pictures under existing plant illumination, photography of various nighttime sporting events, high-speed photography, and color-newsreel work.

For tungsten illumination, the exposure index of the film is 125 and is equivalent to 18 ft-c at  $f/1.4$  for  $\frac{1}{50}$  sec. For daylight illumination with a Kodak Wratten Filter No. 85B over the lens, the exposure index is 80. Suggested filters for exposing the tungsten film are shown in Table II.

For most subject matter, where even higher film speeds are required, the effective speed of both films can be doubled by increasing the time of development in the first developer. The increase in speed is accompanied by a slight loss in both maximum density and latitude. A slight increase in graininess also results from the modified processing.

#### General Description

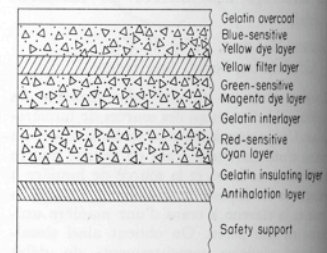
Both Ektachrome ER Films are multi-layer three-color reversal films with in-

**Table I. Filters Required With Various Light Sources for Exposure of Ektachrome ER Film, Type 5257.**

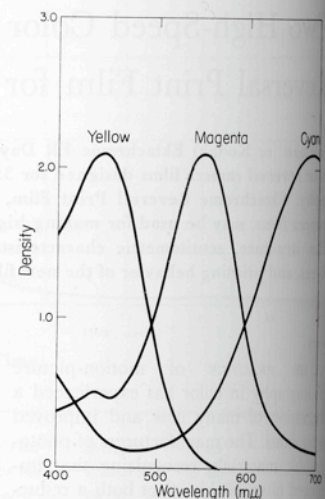
Light source	Camera filter	Exposure index
Daylight (sunlight plus some skylight)	None	160
3200 K Tungsten Lamps	Kodak Wratten Filter No. 78A plus Kodak Light Balancing Filter No. 82A	20
"CP" lamps (approximately 3350 K) or Photofloods	Kodak Wratten Filter No. 78A	32

corporated dye-forming couplers. The structure of the films is shown schematically in Fig. 1. 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 against abrasion. A yellow-filter layer between the blue- and 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 red-sensitive layers. The antihalation layer, which is coated directly on the support, is separated from the red-sensitive layer by a clear gelatin interlayer. The emulsion layers, in addition to the silver halide, contain 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 a 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. 2, where density is plotted against wavelength. The low unwanted absorptions of the dyes in the new films contribute to the good color quality obtained with these films.

The characteristic curves for the reproduction of a scale of neutrals, obtained by exposing each film to its own illuminant, are shown in Fig. 3. The curves are plotted in equivalent neutral density and approximate the appearance



**Fig. 1. Schematic cross-section of Ektachrome ER Film, Types 5257 and 5258.**



**Fig. 2. Spectrophotometric curves of three dyes in Ektachrome ER Films.**

**Table II. Filters Required With Various Light Sources for Exposure of Ektachrome ER Film, Type 5258.**

Light source	Light source filter	Camera filter	Exposure index
3200 K Tungsten Lamps	None	None	125
Photoflood Lamps	None	Kodak Wratten No. 81A	100
3350 K Tungsten Lamps	None	Kodak Wratten No. 81A	100
(Carbon arcs)	Straw-colored gel filter such as Brigham Y-1 over source	Kodak Wratten No. 85B	80
M-R Type 170 150-Amp. H.I. arc	Florentine Glass Filter over source	Kodak Wratten No. 85B	80
M-R Type 40 40-Amp. Duarc	None	Kodak Wratten No. 85B	80
Daylight (mixture of sunlight and skylight)	None	Kodak Wratten No. 85B	80

of this sensitometric exposure to the eye as well as the printing density of the processed camera film to currently available color print films.

Both films show little reciprocity failure for exposures made at high intensity and extremely short times; therefore, it is unnecessary to use compensating filters for high-speed photography.

With these characteristics, both Type 7257 and 7258 originals are suitable for direct projection, or, where needed, color prints can be made by several currently available methods. For example, prints may be made from the originals by printing onto Eastman Reversal Color Print Film, Type 5269, or prints may be made by a release printing system described before this Society by Zwick, Bello and Osborne in April, 1956.<sup>3</sup> This latter system employs the use of a color internegative on Eastman Color Internegative Film,

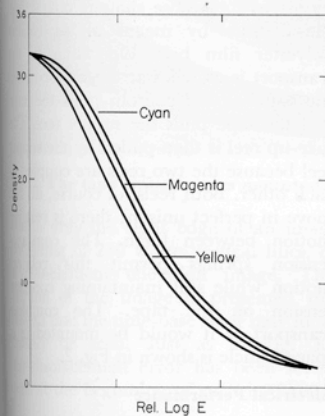


Fig. 3. Characteristic curves for Ektachrome ER Films, Types 5257 and 5258.

Type 7270, which is in turn, printed onto a positive color film such as Eastman Color Print Film, Type 7383. A third method for making release prints on a new print film will be discussed in Part II of this paper.

The new camera films differ from Ektachrome Commercial Film in that the high-speed emulsions cause some loss in quality owing to increased graininess and a loss in picture definition. The high-speed Ektachrome films are not suggested as replacements for such quality films as Ektachrome Commercial Film, but are designed to supplement the use of these high-quality films in situations where unfavorable lighting conditions are encountered.

## Processing

Detailed information on processing and manuals covering specific steps and equipment are available from the Motion Picture Film Dept. of Eastman Kodak Co. A license to process these films is available at a moderate charge; information relative to the license may be obtained from Eastman Kodak Co. In general, it can be stated that these films require specific formula changes in the first and color developers and time and temperature adjustments from the Ektachrome Commercial Film process. However, the new films can be processed in the equipment which was designed for processing the Ektachrome Commercial Film.

## PART II. The Print Film

### General Description

Ektachrome Reversal Print Film, Type 5386 (35mm) and Type 7386 (16mm), is a fine-grain, high-definition film intended for making quality prints from reversal camera originals. The new film is especially designed for processing in the same solutions and equipment as are employed for the high-speed camera films described in Part I. Since the Ektachrome ER Films and the Ektachrome Reversal Print Film are compatible from a processing viewpoint, this combination of camera and print film satisfies the needs of those users requiring security precautions or where the elapsed time between original photography and the production of a color print must be held to a minimum.

The structure of the print film is similar to that of the camera film with two important exceptions: The emulsions used are finer-grained and absorbing dyes are distributed throughout the film for the purpose of preventing scattered light from traveling significant distances in the emulsion layers. As a result, the film is very fine in grain and high in definition; prints made on this film compare favorably with the original in these respects. The contrast of the print film is lower than that of the camera film; lower contrast is required in order that the tonal qualities of the original may be preserved.

### Printing

The use of Ektachrome Reversal Color Print Film, Type 7386, is not restricted to making color prints from Ektachrome ER originals; as in the case of Eastman Reversal Color Print Film, Type 5269, the new print film may be used for making release prints from any color

reversal original. In the case of release prints from Ektachrome ER Films, the new film does have the advantage that the print film may be processed in the same process as that required for the original camera film. Detailed instructions for printing will be supplied by the Motion Picture Film Dept. of Eastman Kodak Co. For the purpose of this paper, it is sufficient to state that the speed and contrast of the new film are similar to those of Eastman Reversal Color Print Film, Type 5269, and that the same printing equipment may be used for both films.

### Intercut Originals

An important point should be mentioned here. Release prints from Ektachrome ER Films will appear somewhat higher in contrast than prints from Ektachrome Commercial Film, Type 7255. The difference in contrast results from the fact that Ektachrome ER films are designed for direct projection and are higher in contrast than Ektachrome Commercial Film, which is designed to have lower contrast and is better suited for printing onto a reversal print film.

Therefore, in a production requiring the use of the two camera films, the slower reversal film for scenes having adequate illumination and the high-speed film for "hard-to-get" scenes, it is advisable to intercut only at obvious scene changes.

### Processing

As in the case of the Ektachrome ER Films, information on processing and manuals covering detailed characteristics of the process steps and equipment are available from the Motion Picture Film Dept. of Eastman Kodak Co. The Motion Picture Film Dept. can also supply information about a license to process the film; the license is available at a moderate charge. Instructions for printing a soundtrack on the print film will also be available.

At the Convention, a demonstration reel was projected to show various applications of the Ektachrome ER Films and the quality of color prints made onto the Ektachrome Reversal Print Film.

### References

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2. M. L. Dundon and D. M. Zwick, "A high-speed color negative film," *Jour. SMPTE*, 68: 735-738, Nov. 1959.
3. 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.