



## KODAK EKTACHROME Professional Infrared EIR Film

### 1) Description

KODAK EKTACHROME Professional Infrared EIR Film is an infrared-sensitive, “false-color” reversal film produced on an ESTAR Base\*. It is intended for various photographic applications where infrared discriminations may yield useful results, such as: artistic, industrial, scientific, and aerial or technical ground photography. The amount of infrared reflectance present at any given time will affect the final color rendition. Exposure latitude is limited to +/- 1/2 stop.

KODAK EKTACHROME Professional Infrared EIR Film can be processed in Process AR-5 using KODAK EA-5 Chemicals or Process E-6 using KODAK EKTACHROME Chemicals. However, images run through Process E-6 will be higher in contrast and appear more saturated in color. In scientific and/or technical applications, Process AR-5 is recommended where comparisons to historical data are desired. While Process E-6 will provide meaningful results, the higher contrast and color saturation may affect interpretation as compared to this film’s predecessor.

**NOTE: Do not process infrared film in labs using equipment with infrared sensors. Exposure to any infrared sources (sensors, cameras, night vision goggles, etc.) will fog EIR Film.**

FEATURES	BENEFITS
Infrared sensitivity from 700 to 900 nm and normal (near ultraviolet and visible) sensitivity from 380 to 700 nm	Infrared sensitivity allows you to see color signatures between objects that are visually quite similar.
ESTAR Base*	Provides flexibility, moisture resistance, high tear resistance, excellent dimensional stability, and good optical properties.
Fine grain and medium sharpness	Meets a wide range of needs from artistic creativity to scientific and technical applications.
Push processing in Process E-6	Allows for increased shutter speeds under low-light situations or contrast adjustment.

Customer Code	ESTAR Base*	Size and CAT No.	Manufacturing Code
EIR	4-mil (0.101 mm) with a fast drying backing	135-36 cassettes 144 8406	2236

*\*This ESTAR Base is very strong, which may cause difficulties during slide mounting. Make your photofinisher aware of this when submitting film for processing, so they can either take precautions or provide you with a special hand-mounting service.*

## 2) Darkroom Recommendations

Do not use a safelight. Handle unprocessed film in total darkness.

## 3) Storage and Handling

Color infrared film, such as KODAK EKTACHROME Professional Infrared EIR Film, is usually more seriously affected by adverse storage conditions than natural color or black-and-white films. Color infrared film is extremely sensitive to variations in temperature and relative humidity. Storage conditions affect the three image-forming layers in different degrees, causing a change in color balance as well as a change in overall film speed and contrast. In the case of EIR Film, the infrared-sensitive layer is most affected, causing a loss in infrared sensitivity and a resultant color balance drift toward cyan.

### Unexposed Film

The keeping characteristics of unexposed color infrared films are such that they must be kept in a freezer or refrigerator. Unexposed film can tolerate up to one month at temperatures not exceeding 55°F (13°C), including no more than one week at room temperature (75°F/24°C). For best infrared sensitivity, store EIR film in a freezer at 0 to -10°F (-18 to -23°C), in the original package. To prevent moisture condensation on refrigerated or frozen film, allow it to reach room temperature before opening the package -- otherwise sticking or spotting may occur. Warm-up time from a refrigerator is about 1 hour and is about 2 hours from a freezer.

### Camera Loading and Unloading

Load and unload cassettes in total darkness to eliminate the possibility of fog exposure. If you must load or unload under subdued lighting conditions, you may want to advance the film several frames to allow for fog exposure.

Although unlikely, an infrared leak in your camera is possible. To check for a leak, load the camera and move a strong tungsten light in front of and around the back of the camera for approximately one minute with the shutter closed. If there are no streaks on the film when processed, the camera should be infrared-tight.

Some modern cameras incorporate infrared sensors that cause fog on infrared films. The sprocket hole area is most frequently affected, and this fog may extend into the image area. Preliminary testing may be advised.

After exposure, be sure to rewind the film leader back into the magazine. Unlike other 35 mm films, EIR Film does not contain a light piping dye, so visible light may pipe into the roll via the leader (or even through the velvet light trap). Limited amounts of exposure may result in only slight fog in the sprocket hole area of the first frame or two. Longer times will result in fogged images. Therefore, this film should always be returned to a black plastic canister (do not transfer to clear canister).

### Exposed Film

Keep exposed film cool and dry. Process the film as soon as possible after exposure to avoid undesirable changes in the latent image. If it is necessary to hold exposed but unprocessed film for several days (such as over a weekend), it should be resealed and refrigerated at 55°F (13°C) or lower. Keep room temperature storage to a minimum - preferably no more than two days. Before unsealing and processing exposed film that has been held in cold storage, follow the warm-up procedures described above for unexposed film.

### Processed Film

For best keeping, store slides in a dark, dust-free area at 50 to 70°F (10 to 21°C) and 30 to 50 percent relative humidity. High relative humidity promotes the growth of mold and causes ferrotyping. Very low relative humidity causes excessive curl and brittleness. Avoid storage temperatures over 80°F (27°C).

## 4) Color Formation with Color Infrared Film

### Visible and Invisible Radiation

This film has been designed to record radiation in and outside the visible range. Figure 1 shows the spectral range which can be photographed, with radiation wavelength increasing to the right side of the page. Beyond the visible region, the

radiation merges into heat waves, and finally into radar and radio waves. As you see in Figure 1, infrared films are sensitive to radiation up to 900 nm. There are too many thermal sources beyond this point which could unintentionally fog (accidentally sensitize) the film.

**Figure 1: Spectral Range of Radiation Recording Methods**

<-----increasing-----Color Temperature of Source-----decreasing----->	
<--- ultraviolet ---><----- VISIBLE LIGHT -----><----- near-infrared ----->	
<- 200 ----- 400 ----- wavelength (nm) ----- 700 ----- 900 ----- 1200 --->	
<----- Panchromatic Films ----->	
<----- EIR Film ----->	
1	2

- <sup>1</sup> Limit of transmission by gelatin (about 250 nm)
- <sup>2</sup> Limit of transmission by glass lenses (about 320 nm)

Materials have their own infrared signatures, and may look similar visually but different when photographed with an infrared sensitive recording material. The next sections compare the sensitivities and processed results using both normal color and infrared color films.

**Normal Color Films**

Color films have essentially three photo-sensitive layers. In a normal color film, such as KODAK EKTACHROME Professional E100SW Film, the layers are sensitized to the three primary spectral regions -- blue, green, and red -- during processing; each layer produces a dye of a complementary color -- yellow, magenta, and cyan, respectively. The amount of colorant, or dye, produced in any area is inversely related to the intensity of the radiation from the original scene. Thus, each layer is a separate record of the brightness in a single primary color. When visible light is passed through the combinations of the three dyes, a close visual reproduction of the color of the original scene is formed. With a color negative film, the colors of the combined dye images will be complementary to those of the original scene.

**Color Infrared-Sensitive Films**

Any portion of the spectrum to which photographic materials are sensitive can be recorded in a color film if the individual emulsion layer is correspondingly sensitized. Furthermore, the color of the dye formed in a particular layer need bear no relationship to the color of light to which the layer is sensitive. If the relationship is not complementary, the resulting colors are false. False-color films can be used to emphasize differences between objects that are visually quite similar. Color infrared-sensitized films emphasize differences in infrared reflectance. Figure 2 is a simplified diagram that demonstrates graphically how the colors of the terrain are reproduced differently on KODAK EKTACHROME Professional Infrared EIR Film, Process AR-5.

**NOTE:** Resulting colors will differ due to exposure, Process E-6 vs. AR-5, push processing of Process E-6, the amount of infrared reflectance present, and storage conditions.

**Figure 2. Color reproduction of typical terrain with EKTACHROME Infrared Film, Process AR-5.**

REFLECTANCE OF ORIGINAL SUBJECT (terrain)					
	Blue	Green	Red	Infrared	
YELLOW FILTER (minus blue)	=====	=====	=====	=====	
LAYER SENSITIVITY	EXPOSURE				
Infrared & Blue Green & Blue Red & Blue		XXXXXXXX	XXXXXXXX	XXXXXXXX	EXPOSED UNPROCESSED FILM
DYES FORMED IN FILM LAYERS: REVERSAL PROCESSING					
Cyan Yellow Magenta	///////// ///////// /////////	///////// ///////// /////////	///////// ///////// /////////	///////// ///////// /////////	REVERSAL-PROCESSED FILM
	Black	Blue	Green	Red	
	Color Reproduction of Infrared Film				

As indicated in Figure 2, all three layers are inherently sensitive to blue radiation. Therefore, to limit the exposure of each layer of color infrared film to only its intended spectral region, a yellow filter (minus blue), such as a KODAK PROFESSIONAL WRATTEN Gelatin Filter No. 12 (or equivalent), is always used over the camera lens. It can be seen that with the yellow filter in place, the layers act as though they were sensitive only to green, red, and infrared (as all blue radiation is absorbed by the filter). The “XXX” areas in the top portion of Figure 2 illustrate exposed areas of silver halide in the various layers from each of the spectral bands reflected from the original scene. Thus, three separate negative silver records are formed.

Where there is no exposure, the recommended reversal processing will yield cyan dye in the infrared-sensitive layer, yellow dye in the green-sensitive layer, and magenta dye in the red-sensitive layer. When an image is exposed, the amount of dye formed is inversely proportional to the exposure. The bottom portion of Figure 1 illustrates the dye formation and resulting colors after exposure and processing. Infrared radiation appears as red, which is the result of yellow dye formation in one layer, magenta dye formation in a second layer, and the absence of cyan dye. Green reproduces as blue -- the result of cyan dye formation in one layer, magenta dye formation in a second layer, and the absence of yellow dye. Red reproduces as green -- the result of cyan dye formation in one layer, yellow dye formation in a second layer, and the absence of magenta dye.

Blue in the original subject has not been recorded because of the filter, and is therefore rendered as black. Numerous other colors will be formed, depending on the proportions of green, red, and infrared reflected or transmitted by the original subject.

## 5) Applications

The advantages of color infrared-sensitive films for most applications are well documented in published literature and are summarized below.

### Artistic Applications

KODAK EKTACHROME Professional Infrared EIR Film can be used to create striking pictorial effects due to the false color response. Color rendition is dependent upon exposure, Processes E-6 or AR-5, push processing of Process E-6, and the amount of infrared reflectance present. Results in Process E-6 will be higher in contrast and more saturated (see Processing).

In conventional AR-5 processing, a color infrared transparency of a red barn with green foliage in the background will result in a pastel-green barn, red foliage, and blue-green sky. The reproduction is bizarre, yet beautiful. In Process E-6, flesh tone has a more sallow appearance with yellow lips which provides a unique look or special effect to the fashion or commercial photographer without software enhancement of the image. Filtration with different filters or combinations of filters can be used to extend the possibilities of this new medium. You can underexpose and push process this film to take advantage of contrast adjustment or low light levels. Recommendations for push process adjustments are located in the processing section.

### Photomicrography

Color infrared film can be used under the microscope to provide another possibility for clarification of areas which may appear the same visually. The KODAK PROFESSIONAL WRATTEN Gelatin Filter No. 12 is placed in the beam, and any heat-absorbing glass should also remain in position. After a test roll is exposed, the most common goal is to neutralize the background for normal exposures. The exposure guidelines in the exposure section should provide good starting points for this branch of photography.

### Documents or Paintings

Inks, pigments, and other materials that appear visually similar can appear differently in an infrared photograph. Underlying inks or different inks can be distinguished which may be helpful in investigative work. Paintings or other similar works of art can be examined to see if there has been overpainting or other alterations. Results could be very helpful and are non-destructive test methods.

### Electronic Thermography

Infrared-sensitive materials can be used to study the distribution of objects that are just below red heat levels such as stoves, engine parts, high pressure boilers, etc. The range of temperature which can be recorded is from 250 to 500°C (482 to 932°F). Longer exposure times would be necessary to characterize the cooler parts, with shorter times for the hotter parts.

**NOTE:** *A great deal of confusion continues to arise concerning infrared photography and the measurement of infrared energy (heat waves). This confusion often leads to futile attempts to detect thermal patterns through the use of infrared photography in cases where this technique does not apply. Contrary to what many people believe, the infrared record in a photograph is not a measure of ambient temperature variation. Thermal photography cannot be done with infrared-sensitive film because it is not a thermal or heat detector, being only sensitive to the near-infrared spectral region. (Infrared Film is sensitive to approximately 900 nm -- see the spectral sensitivity curve in this publication.) Thermal recording usually involves obtaining a visual display of longer wavelength (3 to 5 and 8 to 12 microns) radiation, such as on a cathode-ray tube, and then photographing these thermographic displays by conventional means using standard black-and-white and color films. A four-page pamphlet, "Thermal Recording and Infrared Photography of Hot Objects," KODAK Publication No. P-570, is available upon request.*

### Surveillance / Night Photography

Human behavior can be recorded by pre-set cameras in areas which might be logical to view potential activity, but remote from the anticipated position to minimize detection. An infrared filter, such as a KODAK PROFESSIONAL WRATTEN Gelatin Filter No. 12, is not required over the lens for this application. To restrict illumination visibility by the subject, either cover the flash with a KODAK WRATTEN PROFESSIONAL Gelatin Filter No. 87 or 87C or use infrared coated lamps; however, a dull red glow may still be visible.

**Aerial / Technical Ground Photography**

KODAK EKTACHROME Professional Infrared EIR Film is suitable in agriculture and forest surveys for the detection of crop yields, crop and tree diseases, insect infestations, and identification of tree species. Photographs of foliage made with color infrared-sensitive films often show great variations in infrared reflectivity when leaves visually show just small variations in shades of green. Healthy trees have a much higher infrared reflectance than diseased trees, so infrared results can distinguish between them. Healthy deciduous trees photograph magenta or red in spring and summer, while diseased trees may photograph from dark red to green or even yellow. In any given vegetation, the season, water or mineral content of the soil, or age may affect the results.

EKTACHROME Infrared Film is used in pollution monitoring applications. The film probably will not detect thermal effects but may image chemicals dissolved in gaseous or aqueous effluents, since water or water vapor do not have strong infrared reflectance.

Infrared film can be effective for reconnaissance and detecting camouflage when photographing objects painted to simulate foliage. Although some paints have been developed to simulate the spectral properties of foliage, camouflage detection may still be possible by directly comparing a transparency on normal color film with an infrared image of the same objects.

For additional information on aerial applications see Kodak Publication AS-69 or contact Aerial Systems, Eastman Kodak Company, Rochester, New York 14653-7128.

**6) Exposure**

**Speed and Filter - Non-Aerial Use**

Use the exposure index (EI) numbers below with meters and cameras marked for ISO, ASA, or DIN speeds as a starting-point. Do not change the film-speed setting when metering through a filter. Metering through filters may affect light meter accuracy; see your meter or camera manual for specific information. For critical work, make a series of test exposures. Exposure latitude is limited to +/- 1/2 stop.

A KODAK PROFESSIONAL WRATTEN Gelatin Filter No. 12 (or equivalent) is required over the camera lens to prevent blue radiation from exposing the inherent blue sensitivities of all three emulsion layers. Similar filters may provide satisfactory or preferred results. Experiment to determine your personal preference in your application.

Light Source	KODAK PROFESSIONAL WRATTEN Gelatin Filter + KODAK Color Compensating Filter	Exposure Index	
		Arithmetic / Logarithmic	
		Process AR-5	Process E-6
Daylight or Electronic Flash	No. 12	100 / 21	200 / 24
Tungsten (3200 K)	No. 12 + CC20C + Corning Glass Filter CS No. 1-59 3966 or No. 12 + CC50C	50 / 18	100 / 21

### Color Balance Shift

Color Shift Desired		KODAK Color Compensating Filter
from	to more	
green	magenta	Cyan
yellow	blue	Cyan
cyan	red	Blue
blue	yellow	Magenta

### Aerial Exposure Data

Aerial Film Speeds (EAFS or ISO A equivalent) should not be confused with conventional film speeds, which are designed for roll and sheet films used in pictorial photography. The characteristics of aerial scenes differ markedly from those of ordinary pictorial or ground scenes because of the smaller range in subject luminance, atmospheric haze conditions, and other factors. Therefore, different film-speed characteristics are used to relate aerial-scene characteristics to practical exposure recommendations.

The KODAK Aerial Exposure Computer, KODAK Publication No. AS-10, has been published based on the Aerial Film Speed criterion.

A KODAK PROFESSIONAL WRATTEN Gelatin Filter No. 12 (or equivalent) is required over the camera lens to prevent blue radiation from exposing the inherent blue sensitivities of all three emulsion layers.

Nominal EAFS or ISO A equivalent, daylight: 40

(based on exposure through a KODAK PROFESSIONAL WRATTEN Gelatin Filter No. 12 (deep yellow) and processing in KODAK EA-5 Chemicals, Process AR-5)

**NOTE:** The Aerial Film Speed given in this publication is rounded to the nearest cube root of 2 step (equivalent to 1/3 stop).

### Typical Aerial Camera Exposure:

A typical exposure for these films is approximately 1/300 second at f/5.6 with a KODAK PROFESSIONAL WRATTEN Gelatin Filter No. 12 (deep yellow). This exposure is based on a solar altitude of 40 degrees, a clear day, and an aircraft altitude of 10,000 feet.

## 7) Reciprocity Characteristics

No filter correction or exposure adjustment is required for exposure times from 1/1,000 second to 1/100 second. At 1/10 second, increase the lens aperture by 1 stop and add a CC20B filter for scientific or technical measurements.

**NOTE:** This information applies only when the film is exposed to daylight. The data are based on average emulsions rounded to the nearest 1/3 stop and assume normal recommended processing. The adjustments are subject to change due to normal manufacturing variations or film-storage conditions after the film leaves the factory. For critical applications, make tests under your conditions.

## 8) Processing

**NOTE: Do not process infrared film in labs using equipment with infrared sensors. The infrared sources used by photofinishers, such as night vision goggles, infrared cameras (used mostly on rack-and-tank machines), or infrared replenishment sensors (used on some roller-transport, continuous and minilab machines), will fog EIR Film. The photofinisher must be willing to turn off their infrared cameras and not use infrared goggles while this film is out of its magazine. Labs using roller-transport processors should first verify the presence of infrared sensors, which detect the length and width of the film for replenishment calculations. Many of these processors have a manual replenishment mode, which will turn off the sensors. Film fogged by infrared radiation in the lab will have an overall crimson red appearance. (It completely fogs the infrared layer, leaving only an image from the red and green sensitive layers.) Labs receiving film for processing with the leader protruding from the magazine should rewind it into the magazine or keep it in a black plastic can until it can be opened in the dark. Some labs' equipment will not operate if all infrared emitters are disengaged.**

KODAK EKTACHROME Professional Infrared EIR Film is designed for processing in KODAK EA-5 Chemicals, Process AR-5. If higher contrast and color saturation are desired, process the film in KODAK Chemicals, Process E-6 (see Description regarding the use of Process E-6 for scientific and technical applications). Color rendition differs due to exposure, Process E-6 vs. AR-5, push processing of Process E-6, the amount of infrared reflectance present, and storage conditions.

Follow these procedures when processing infrared film:

- Process in TOTAL darkness
- Do not process in equipment using infrared film scanning for replenishment rates
- Turn off all sensors
- Turn off or cover any LED displays
- Do not use temperature probes
- Turn off all infrared camera-to-light sources

### **Push Processing**

EIR Film has an effective speed of EI 320 for push 1 with no filter change.

### **Automated Slide Mounting**

Due to the strength of its ESTAR Base, EIR Film may require special handling to avoid the possibility of crinkling during the cutting operation. If your photofinisher has not had experience with this film, you may want to request hand mounting.

## 9) Printing Transparencies

### **Duplicate Color Transparencies**

To make duplicate color slides or transparencies by direct printing or enlarging, use KODAK EKTACHROME Duplicating Films or KODAK EKTACHROME RADIANCE Overhead Material. Or, make internegatives on KODAK Commercial Internegative Film, and print them on KODAK VERICOLOR Print Film, KODAK VERICOLOR Slide Film, KODAK DURATRANS® RA Display Material, or KODAK DURACLEAR™ RA Display Material.

### **Color Prints**

To make color prints from slides or transparencies, print directly to KODAK EKTACHROME RADIANCE Papers or KODAK EKTACHROME RADIANCE III SELECT Material. Or, make internegatives on KODAK Commercial Internegative Film, and print them on KODAK EKTACOLOR Papers or KODAK DURAFLEX® Print Material.

## 10) Scanning Transparencies

The KODAK EKTACHROME Film family is characterized by sets of image dyes which perform similarly when scanned. The scanner operator can set up one basic tone scale and color-correction channel for all EKTACHROME Films, and then optimize the tone scale and gray balance for the requirements of individual images.

For best results, use the KODAK Q-60 Color Input Target / Q-60E1 or Q-60E3 to establish the setup for KODAK EKTACHROME Films on all scanners. These targets are manufactured to ANSI standards and represent the dye sets for all EKTACHROME Films. Setups determined for EKTACHROME Films without using a Q-60 Color Input Target will also apply to all EKTACHROME Films.

### Scanning for PHOTO CD Applications

Use the Universal E-6 Film Term to scan all KODAK EKTACHROME Films for Photo CD Imaging Workstation applications.

For Output to a Photo CD Player: Using the Universal E-6 Film Term should result in an image that closely matches your original transparency in density, tone scale, and overall color balance when viewed on a player.

For Output to Devices Other than Photo CD Players: The YCC data that results when using the Universal E-6 Film Term is capable of producing a high-quality duplicate of your original transparency in terms of density, tone scale, and color reproduction. Final quality of your reproduced image depends on the capabilities of your output device, the viewing environment, and the rendering path that is used.

## 11) Image Structure

(Based on processing in KODAK EA-5 Chemicals, Process AR-5.)

### Diffuse rms Granularity: 17 Fine

Read at a gross diffuse visual density of 1.0, 48-micrometre aperture.

## 12) Graphs<sup>1</sup>

Process AR-5

### Characteristic:

b) (10-96)

### Spectral Sensitivity:

c) (9-94)

### Spectral Dye Density:

d) (9-94)

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Kodak Professional Division  
EASTMAN KODAK COMPANY - Rochester, NY 14650

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<sup>1</sup>NOTICE: While the data presented are typical of production coatings, they do not represent standards that must be met by Kodak. Varying storage, exposure, and processing conditions will affect results. The company reserves the right to change and improve product characteristics at any time.

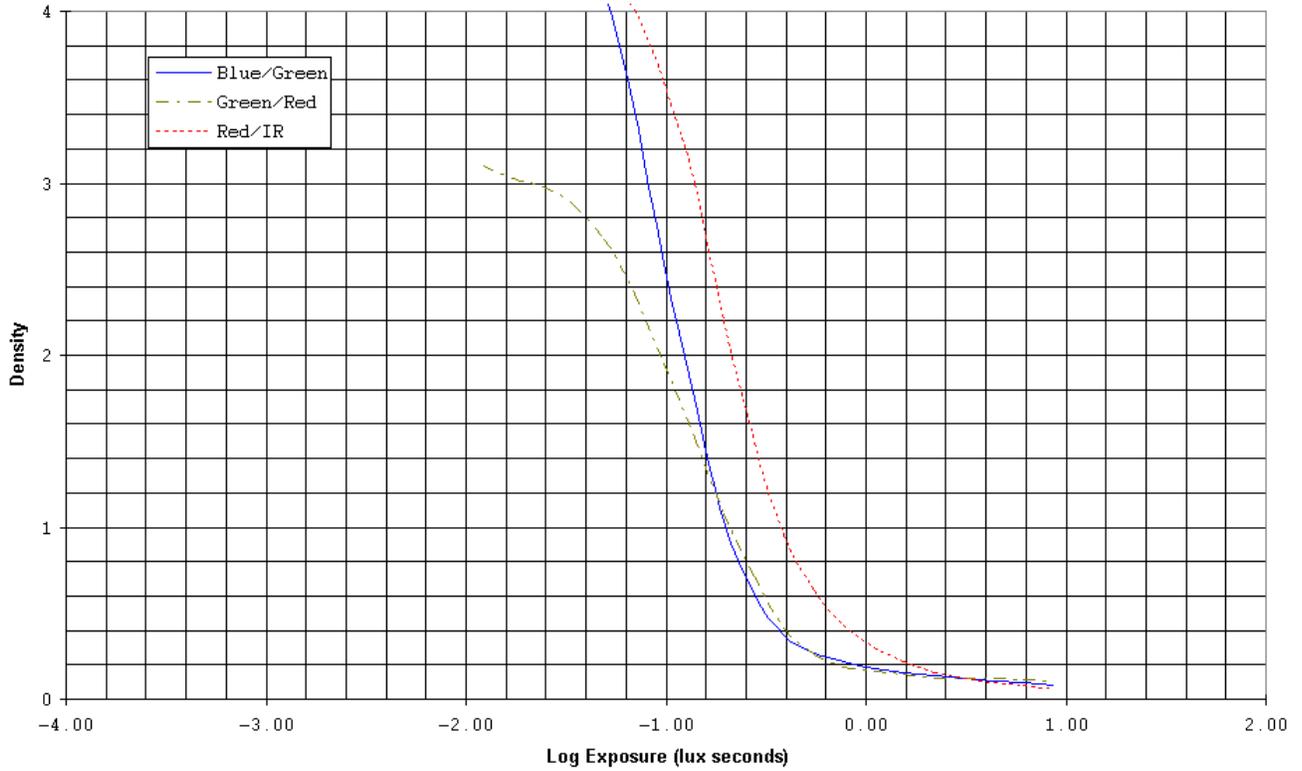
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**End of Data Sheet**

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**TI2323B 10-96**  
CHARACTERISTIC, For Publication

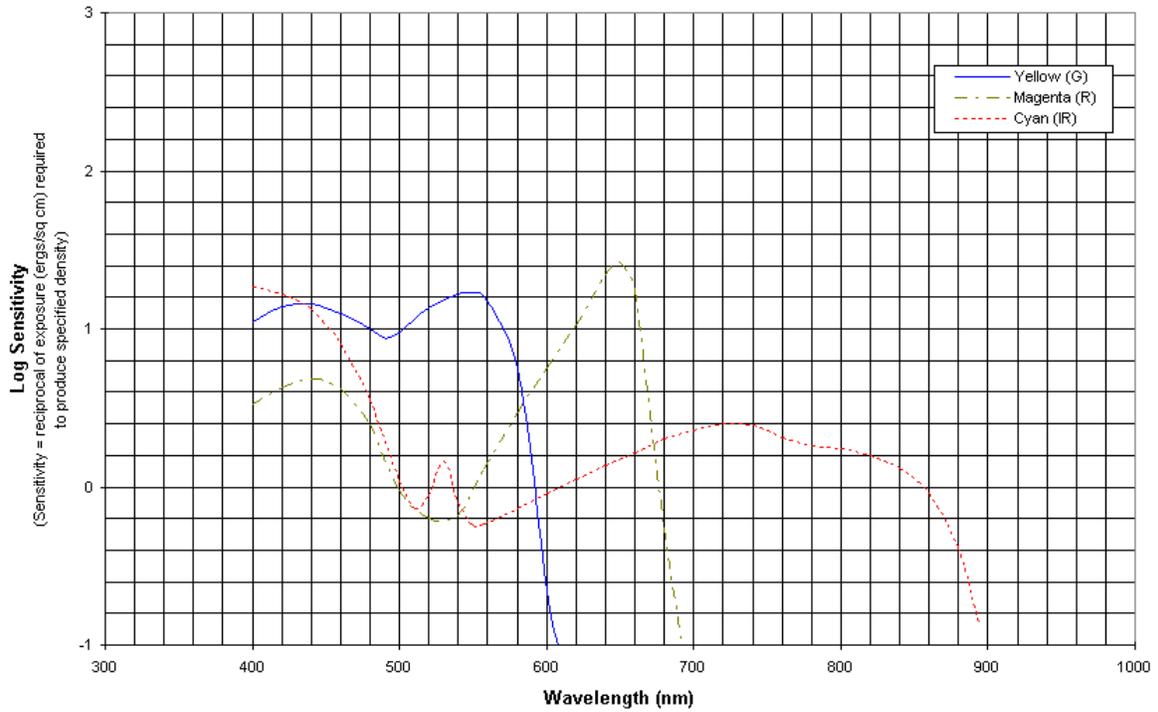
KODAK EKTACHROME Professional Infrared EIR Film/2236  
Daylight 1/50 sec; Process AR-5, KODAK EKTACHROME RT Processor, Model 1811, 5.4 fpm; Status A  
(Resulting colors in Transparency/Sensitivity to Original; see Figure 1)



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**TI2323C 9-94**  
SPECTRAL SENSITIVITY, For Publication

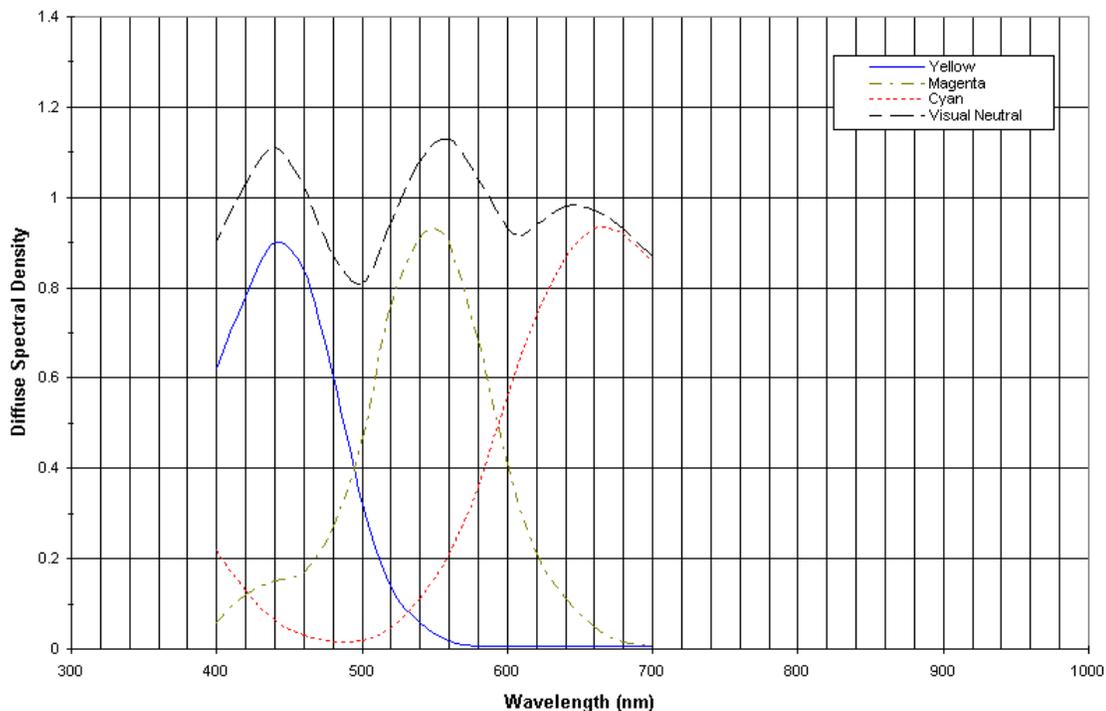
KODAK EKTACHROME Professional Infrared EIR Film/2236  
Normalized to 1/50 sec; Process AR-5; Density=1.0, Equivalent Neutral Density (END)  
(G = Green sensitive, R = Red sensitive, IR = Infrared Sensitive)



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**TI2323D 9-94**  
SPECTRAL DYE DENSITY, For Publication

KODAK EKTACHROME Professional Infrared EIR Film/2236  
Normalized dyes to form a visual neutral density of 1.0 for a viewing illuminant of D5000;  
Process AR-5



Notice: While the data presented are typical of production coatings, they do not represent standards which must be met by Eastman Kodak Company. Varying storage, exposure and processing conditions will affect results. The company reserves the right to change and improve product characteristics at any time.