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New 16-mm Fujicolor Reversal Films RT500 and RT125

By TAKASHI HORIGUCHI

The two new 16-mm Fujicolor reversal films RT500, Type 8428, and RT125, Type 8427, are intended for professional motion picture and television use. They have exposure indices of 500 and 125 E.I. respectively under tungsten illumination. Even though their speed has been increased in comparison to earlier Fujicolor reversal materials, their granularity has been reduced, resulting in better image definition. The structure of the films is described, and data are given of filters to be used under normal and divers specific lighting conditions. Also, data on grain quality, definition (contrast transfer function), spectral sensitivity, and spectral density are provided. These films can be treated in various processes formulated by Fuji Photo Film Co., and they are compatible with processing by the Eastman Kodak VNF-1 and RVNP processes. The RT500 film, Type 8428, can be force-processed, doubling its exposure index, or even quadrupling it for special assignments. The new films offer the professional a wide field and ample range of applications.

In 1974 Fuji Photo Film Co. presented the 16-mm high-speed Fujicolor reversal TV film RT400, Type 8425, and the Fujicolor reversal TV film RT100, Type 8426. These films were much appreciated by professional users. As is well understood, these films incorporate an ultra-hardening technology in their emulsion, thus allowing for the elimination of the prehardening steps from the processing sequence. This, for the first time, made it possible to take advantage of hot-process reversal laboratory technology which does not require the prehardener and the neutralizer stages.

Research at Fuji Film is committed to continual development of upgraded quality, increased film speed, shorter development times, use of noncyanide bleaches, decreased resources consumption, and other such basic research in the design of new film types. As a result, two new 16-mm Fujicolor reversal films — RT500, Type 8428, and RT125, Type 8427 — have now been brought out. These films have been especially designed for use in television newsgathering, but they are also very useful for general cinematography, industrial applications, scientific research recording, and in many other fields suitable for these types of film.

Structure of the New Films

Figures 1 and 2 show the structure of the RT500 and RT125 films. Both, like the earlier RT400 and RT100 films, carry an antihalation layer on the front side of the base followed by the red-sensitive emulsion (incorporating the cyan coupler), an interlayer, the green-sensitive emulsion (incorporating the magenta coupler), a yellow filter layer, the blue-sensitive emulsion (incorporating the yellow coupler), and atop all these layers a protective coating. In the RT500 film, there are two layers to the red-sensitive emulsion, three layers to the green-sensitive emulsion, and only one layer to the blue-sensitive emulsion. In the RT125 film each of the three light-sensitive emulsion coatings is composed of two layers.

Film Speed

Tungsten and Daylight Exposure

The film speeds for RT500 and RT125 are indicated in Table I. Both films are balanced for 3200 K tungsten light and require no filter when exposed to this type of light. For daylight exposure the same filters as for the earlier films should be used: Fuji Filter LBA-12 or Kodak Daylight Filter No. 85B. The RT500 film is an ultra-high-speed film, but the protective properties of the film preventing edge fogging have been reinforced, and the daylight loading procedures — with regard to time and ambient brightness — are the same as for the RT125 film.

Exposure under Artificial Light Sources other than Tungsten

In various types of indoor and outdoor environments a variety of lighting situations may be present in which light sources other than tungsten light may be in use. In actual practice, a considerable amount of photographic work may have to be carried out under these different lighting conditions. When this is the case, use of the high-speed RT500 film is recommended in conjunction with a color compensating filter. In these situations, a variety of light sources may be found, such as the various types of fluorescent lamps, mercury discharge lamps, as well as the more recently introduced metal halide lamps, which are coming into ever greater service. Taking into account all these conditions, Table II indicates the filters that may be used with certain of today's representative light sources, as well as the effective exposure indices for each specific case.

Gradation and Color Balance

Figure 3 shows the difference in gradation between the new RT500 film and the earlier RT400 film. Figure 4 shows the characteristic curves for the RT125 film in comparison with the earlier RT100 film. The respective red, green, and blue color curves for both pairs of compared films were obtained under standard processing conditions and have been superimposed so as to intersect at the D = 1.0 density point. Because of differences in the spectral density curves of the RT500 and RT400 films, it is difficult to make precise comparisons based on the curves obtained from densitometric measurements. However, comparison of the RT500 and the RT400 film indicates that the blue gradation is somewhat softer, and that the shadow density in the three layers has been slightly increased, especially in the red (the cyan dye) layer, which also shows some softening of the highlight gradation. These characteristics of the RT500 film account for some reduction in gradation differential relative to the RT125 film.

In the RT125 film, a slight softness of the mid part and high-density portions of the red layer that was present in the earlier RT100 type has been corrected. Also, a minute adjustment of the blue toe portion has been made, resulting in a more balanced gradation for the three layers but retaining the overall contrast of the earlier type of film.

As a result of these gradation adjustments, the photographic subject luminance ranges which correspond to the upper and lower density limits recommended by the SMPTE for television use of color film are 1:50 for RT125, and 1:40 for RT500. This will provide appropriate contrast in televi-

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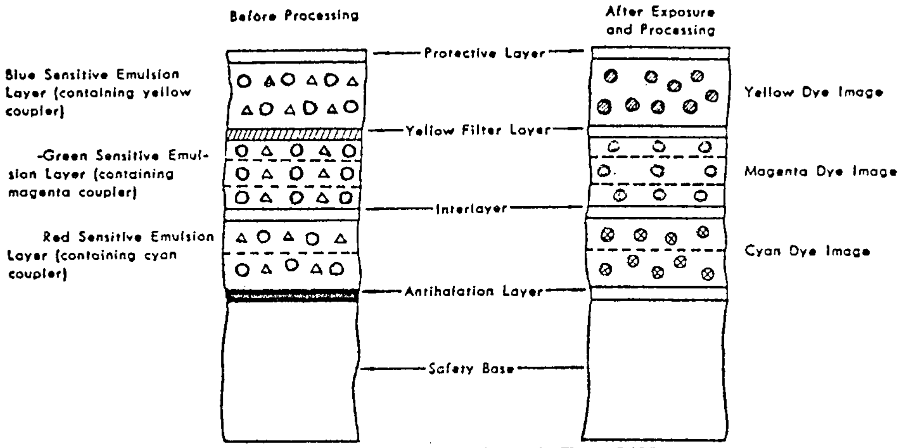

Fig. 1. Structure of 16-mm Fujicolor reversal film RT500, Type 8428.

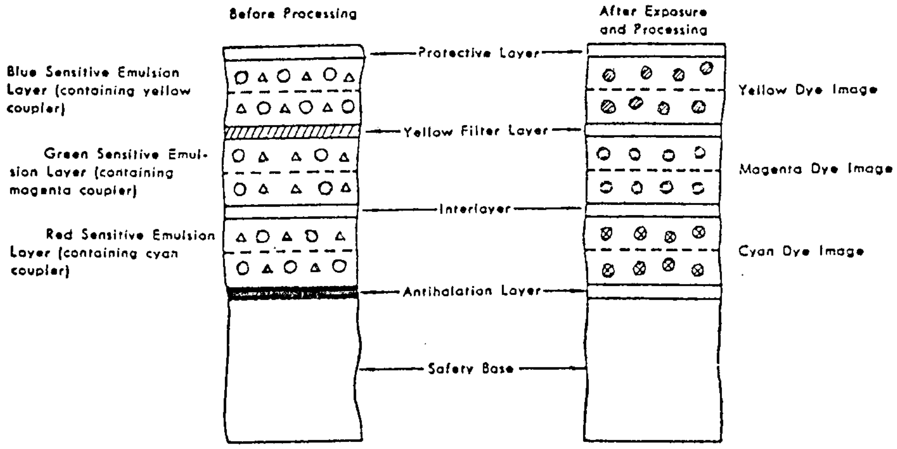

Fig. 2. Structure of 16-mm Fujicolor reversal film RT125, Type 8427.

Table I. Exposure index ratings and recommended filters.

Type of film	Type of lighting	Exposure index	Recommended filter
RT500	3200 K Tungsten	500	None
RT500	Daylight	320	Fuji light-balancing filter LBA-12 or Kodak daylight filter No. 85B
RT125	3200 K Tungsten	125	None
RT125	Daylight	80	Fuji light-balancing filter LBA-12 or Kodak daylight filter No. 85B

Table II. Filters and exposure index ratings recommended for 16-mm Fujicolor Reversal Film RT500, Type 8428, for various types of illumination.

Type of illumination	Camera filter	Exposure index
Fluorescent lamps:		
Daylight (D)	LBA-12 + CC-40R	160
White (W)	CC-50R	200
White Deluxe (W-SDL)	LBA-8	400
Clear Mercury lamp:	Not recommended	
Fluorescent mercury lamps:		
White (HFX.W)	CC-70R	125
Soft (HFX.S)	CC-50R	200
Metal halide lamp	LBA-12	320

sion use as well as excellent picture quality for screen projection.

With regard to color balance, the earlier RT400 film had a somewhat yellowish tendency, but the RT500 has been corrected to give a good color balance from the uppermost highlights to the deepest shadows. In the RT125 film, correction has been made of the reddish balance in the halftone and shadow areas that was present in the ealier type RT100 film as a consequence of the softness of tone in the red high-density areas.

Color reproduction for a number of selected color patches is shown for both films, RT500 and RT125, in the chromaticity diagram in Fig. 5. Color reproduction has been improved with regard to the earlier two types of films, with especial improvement in the reproduction of gray. In comparing the RT500 film with the RT125, some loss of chroma can be seen, strictly speaking, but in comparison to the earlier RT400 type the chroma of the RT500 is better.

Grain Quality and Definition

The granularity of the two earlier and the two new films is compared in Fig. 6. Over and above the fact that the RT500 film has been designed to obtain the highest possible film speed its granularity has been improved, in addition, over that of the less sensitive RT400 film. Also, in the RT125 film, granularity has been improved over the RT100 type along with an increase in film speed.

Figure 7 compares the contrast transfer function (CTF) curves of the new and the earlier films. They are a measure of the definition capability of these films. It can be seen that definition of the RT500 film is about the same as that of the RT400 film but the definition of the RT125 film is somewhat improved over the earlier RT100.

Spectral Sensitivity and Spectral Density

The spectral sensitivities of the two new film types are shown in Fig. 8. It can be seen that the spectral sensitivity of the blue emulsion layer of the RT500 film has its peak just a little bit more toward the longer wavelength region than the RT125 film. In all other respects the spectral sensitivities of the two films are just about the same.

Figure 9 shows the spectral density curves for both the new films. Comparing the RT500 film to the RT125, it is evident that its magenta spectral density curve falls a little bit more to the left, that is, into a slightly shorter wavelength region (having greater blue absorption and more yellow transmission). For this reason, when the same neutral gray is exposed with both films, the RT500 reversal film will have a somewhat lower yellow density and a somewhat heightened cyan density than the RT125 film when measurement is carried out with a normal densitometer incorporating status AA filters.

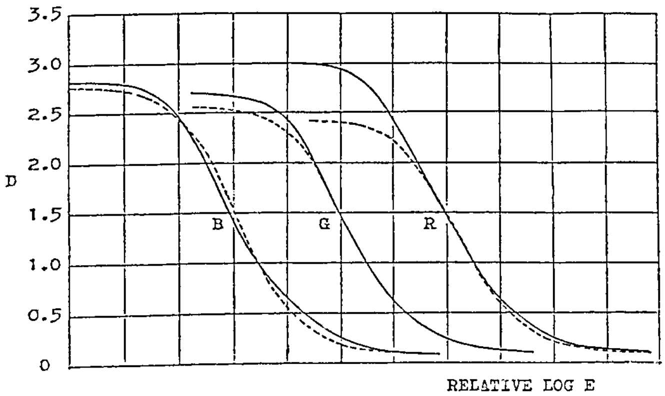

Fig. 3. Comparison of the sensitometric curves of the new RT500, Type 8428, Fujicolor reversal film (process VNF-1) and the earlier RT400, Type 8425 (modified ME-4 process).

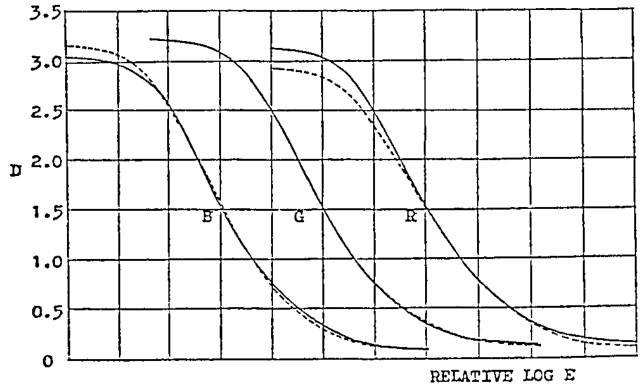

Fig. 4. Comparison of the sensitometric curves of the new RT125, Type 8427, Fujicolor reversal film (process VNF-1) and the earlier RT100, Type 8426, (modified ME-4 process).

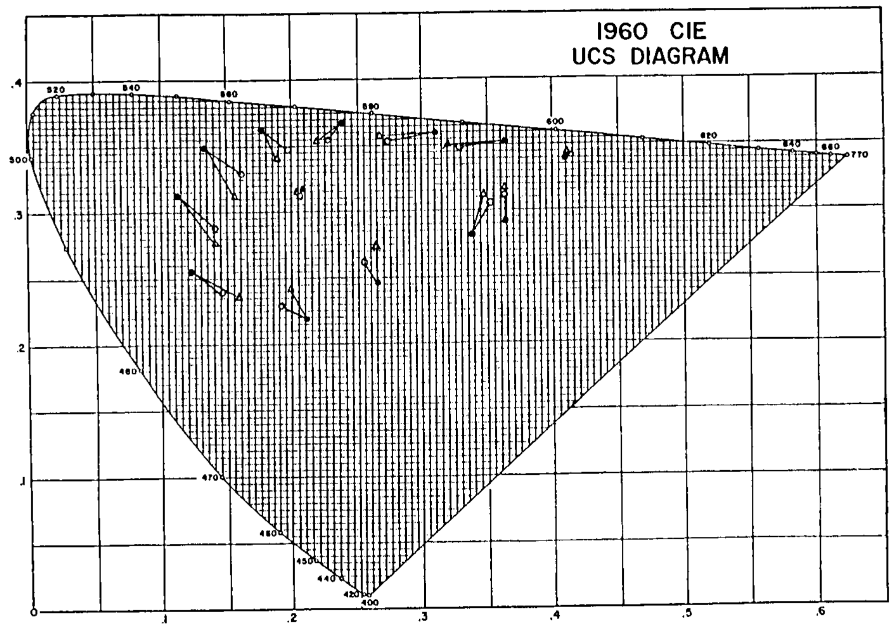

Fig. 5. Chromaticity loci for selected color patches reproduced with the new RT500 and RT125 Fujicolor films; (●) original color patch, (△) RT500 reproduction, (○) RT125 reproduction.

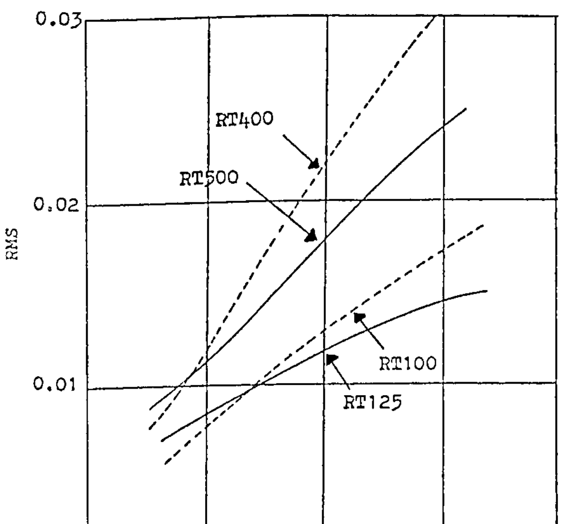

Fig. 6. Comparison of the RMS granularity of the new films (solid lines) and the earlier films (dashed lines). Aperture: 40 × 40 μm.

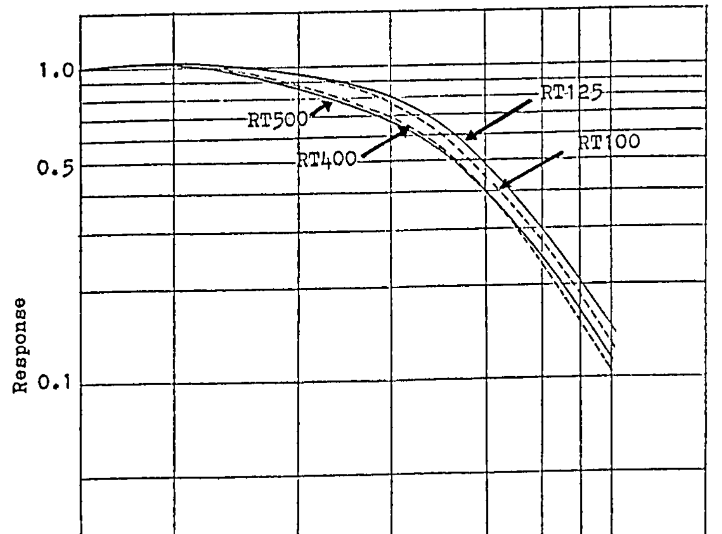

Fig. 7. Comparison of the contrast transfer function curves of the new films (solid lines) with the earlier films (dashed lines) for a visual density $D = 1.0$, obtained with white-light exposure.

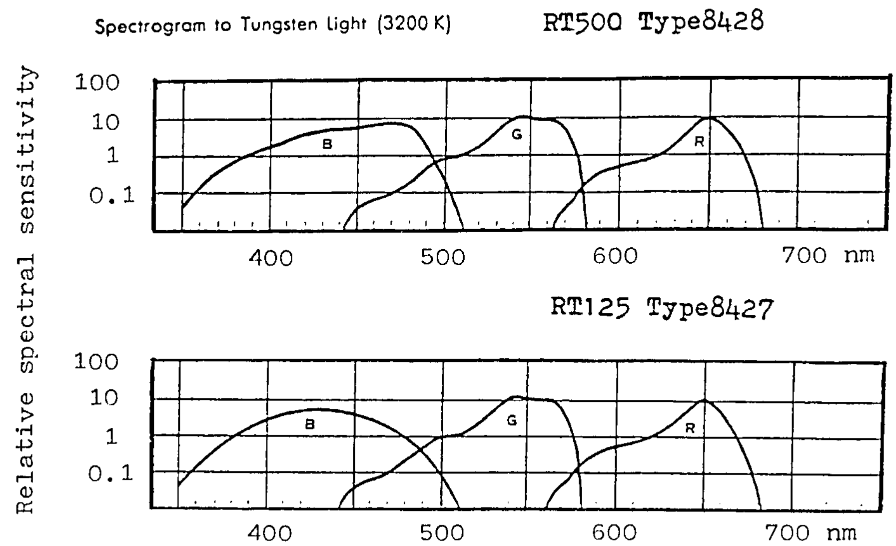

Fig. 8. Spectral sensitivity curves of the two new types of reversal film.

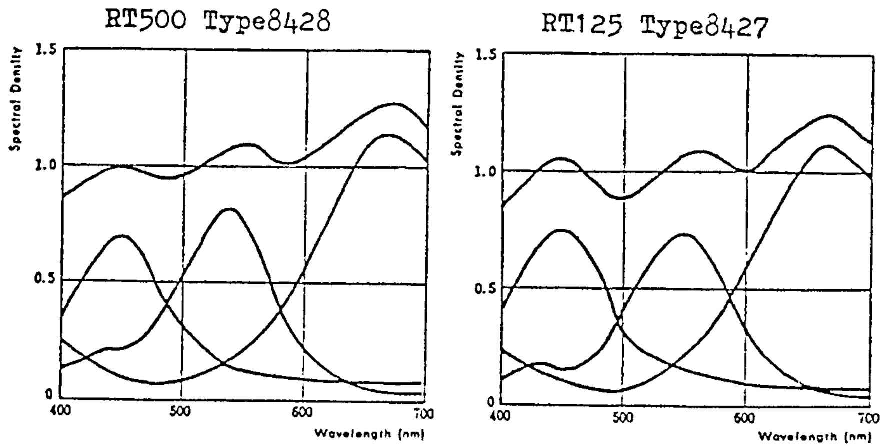

Fig. 9. Spectral density curves of the two new types of reversal film.

Table III. Temperature and time specifications for three different processes suitable for the treatment of RT500 and RT125 Fujicolor reversal films.

Process step	Process MCR-42		Process MCR-45		Process VNF-1	
	°C	min : s	°C	min : s	°C	min : s
First developer	40±0.3	2 : 40	42±0.3	2 : 05	37.8±0.3	3 : 10
Stop bath	36±3	25	38±3	20	35±3	30
Wash	39±1	50	40±1	40	38±1	1 : 00
Color developer	45±0.6	2 : 55	46±0.6	2 : 20	43.3±0.6	3 : 35
Stop bath	36±3	25	38±3	20	35±3	30
Wash	39±1	50	40±1	40	38±1	1 : 00
Bleach	36±3	1 : 15	38±3	1 : 00	35±3	1 : 30
Fixing bath	36±3	1 : 15	38±3	1 : 00	35±3	1 : 30
Wash	39±1	50	40±1	40	38±1	1 : 00
Stabilizer	36±3	25	38±3	20	35±3	30
Total time		11 : 50		9 : 25		14 : 15

Processing

Processing Conditions

Both films, the RT500 as well as the RT125, are designed for treatment in either the Fuji Film MCR-42 or MCR-45 process. Process steps for both processes and for the Eastman VNF-1 process are given in Table III. Processing times and temperatures differ somewhat from those recommended for the earlier film types, but there is no change in the formulation of the processing solutions.

Figure 10 shows the characteristic curves for the RT500 film obtained in both processes, MCR-42 and MCR-45. Figure 11 shows comparative equivalent data for the RT125 film. Both films may also be processed without modification in the Eastman Kodak processes VNF-1 or RVNP.

First Developer Replenishment

The processing procedures are as previously indicated for both films. However, with regard to replenishment of the first developer an important modification has been introduced. The amount of replenisher needed in the first developer has been reduced to only 700 mL for every 100 ft (30.5 m) of film processed. For the earlier films RT400 and RT100, 1100 mL of replenisher were needed for the same amount of processed film. The reduction in replenisher is thus about 34% and will contribute to lowering the operating costs. Furthermore, less processing effluent will have to be disposed of. No replenishment should take place while leader is running through the developer.

Forced Processing

The 500 E.I. value of the exposure index of the RT500 film makes this an ultra-high-speed material, usable in a very wide range of difficult and demanding photographic assignments. However, when photography must be carried out under exceptionally low lighting conditions, forced processing can be used. When applying forced processing to the RT500 film, either the temperature of, or the development time in, the first developer can be adjusted (Table IV). The resulting photographic quality would seem to be better with an increase in temperature than with an increase in development time. Forced processing with a temperature increase will yield an exposure index of 1000 — doubling the original exposure index value — and will produce little change in color balance, nor will it compromise the grain quality. Reduction of the density in the deep shadows will be relatively limited, and good image quality will be retained.

Forced processing based on an increase in first developer immersion time with the intent of doubling the exposure index will result in some degree of color balance loss tending to an overall magenta cast. Furthermore, increasing the development time will result in slowing down the overall speed of the processor, lengthening not only the first developer time but also that of all the other processing steps.

It is not recommended to apply temperature increase for a fourfold increase in exposure index. A decrease in deep shadow densities and a visibly affected grain quality would produce an adverse effect in image quality. However, when photographic work must forcibly be carried out under excessively low lighting conditions, or when high-speed cinematography for industrial and scientific research purposes is to be undertaken, this type of forced processing can be very useful in extending the range of applications of the RT500 film.

Storage of Rawstock and Processed Film

The shelf life of the rawstock for both the RT500 and the RT125 has been improved over the earlier types of film. It is recommended, however, that for long-term storage both new materials be stored under

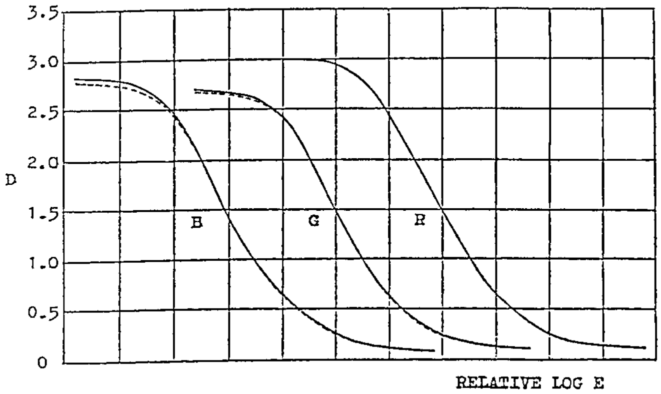

Fig. 10. **Comparison of the sensitometric curves obtained on RT500 reversal film with process MCR-42 (solid lines) and process MCR-45 (dashed lines).**

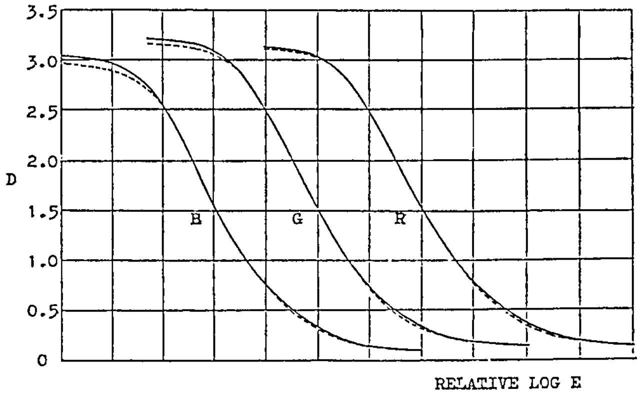

Fig. 11. Comparison of the sensitometric curves obtained on RT125 reversal film with process MCR-42 (solid lines) and process MCR-45 (dashed lines).

refrigeration at 10°C (50°F) or less, as was recommended for the earlier films.

The storage characteristics of the color images in the processed film exhibit retarded fading of the cyan image in both films RT500 and RT125, and provide a much longer storage durability. But, the previously recommended storage conditions of less than 20°C (68°F) at a relative humidity of 40 to 50% must still be observed.

Packaging

The packaging of the RT500 and RT125 films (Table V) has been completely redesigned. Film in the new packaging comes in three unit sizes with lengths of 30.5, 61, and 122 m. The old style of a round can in a paper box has changed and paper boxes are no longer used. Instead, a square container with rounded corners is now used. The label is attached over one of four side surfaces which have been sealed securely by adhesive tape. The label shows information as to film type, user orientation, emulsion number, and production number.

Control Strips

To facilitate photographic quality control in the processing of both films — RT500 as well as RT125 — preexposed control strips on RT125 material are available. Their use is the same as with the earlier types of color reversal films. They are packaged as a set containing a single reference strip and a roll of uncut control strips with a total length amounting to 60 control strips.

Table IV. Temperature and/or time recommendations for forced processing of 16-mm Fujicolor reversal film RT500, type 8428.

Process	Exposure index for tungsten	First developer	
		Option 1: Temperature increase	Option 2: Time increase
		°C	min:s
MCR-42	1000	40 + 6 = 46	2:40 + 2:00 = 4:40
	2000	Not recommended	2:40 + 3:50 = 6:30
MCR-45	1000	42 + 6 = 48	2:05 + 1:30 = 3:35
	2000	Not recommended	2:05 + 2:40 = 4:45
VNF-1	1000	37.8 + 6.2 = 44	3:10 + 2:00 = 5:10
	2000	37.8 + 10.7 = 48.5	3:10 + 3:20 = 6:30
RVNP	1000	43 + 5.5 = 48.5	2:00 + 1:20 = 3:20
	2000	Not recommended	2:00 + 2:30 = 4:30

Note: The first value in each equation is the recommended standard temperature or time; the second is the increase for forced processing; and the last value is the resulting temperature or development time for forced processing.

Table V. Packaging formats of the new 16-mm Fujicolor reversal films RT500, Type 8428, and RT 125, Type 8427.

Film length	Camera spool or 16P2 core	Perforation (7.605 mm)	Winding	Magnetic stripe	For loading in:
100	Spool	1R	Winding B		Daylight
100	Spool	2R			Daylight
200	Spool	1R	Winding B		Daylight
200	Spool	2R			Daylight
400	Core	1R	Winding B		Darkroom
400	Core	2R			Darkroom
400	Spool	2R			Daylight
1200 (×2)	Core	1R	Winding B		Darkroom
1200 (×2)	Core	2R			Darkroom
100	Spool	1R	Winding B	Yes	Daylight
200	Spool	1R	Winding B	Yes	Daylight
360	Spool	1R	Winding B	Yes	Daylight
400	Core	1R	Winding B	Yes	Darkroom
1200 (×2)	Core	1R	Winding B	Yes	Darkroom