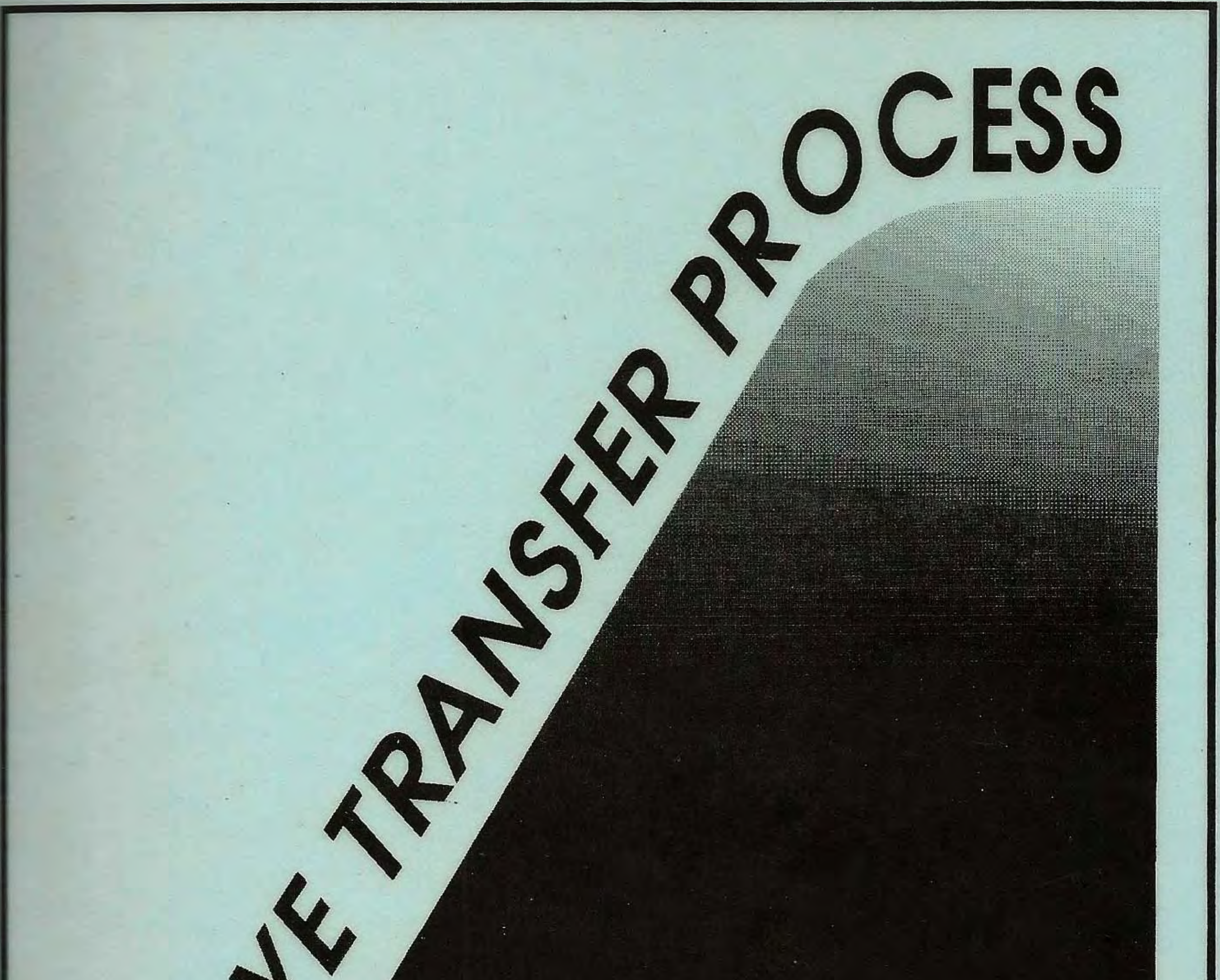
THE DYE TRANSFER PROCESS



BY DAVID DOUBLEY

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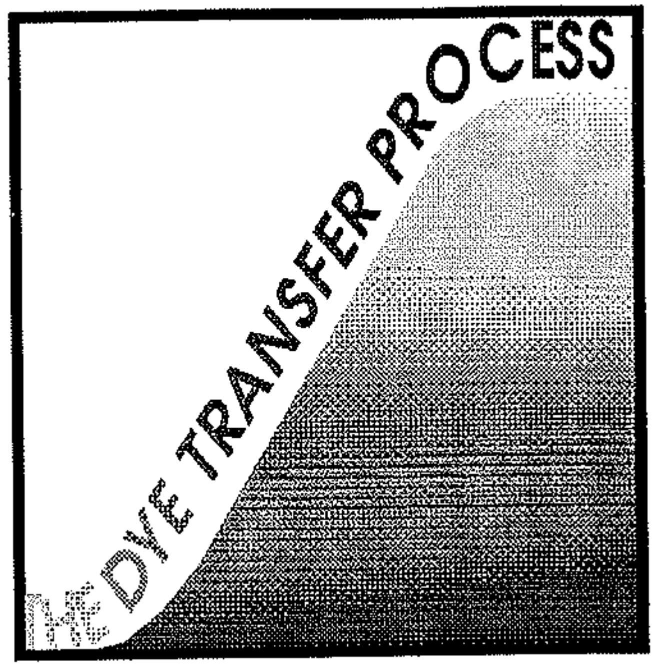
THE DYE TRANSFER PROCESS

EDITION 14



Hello.

This text is updated periodically to keep abreast of new developments, to correct mistakes, and to present new approaches to dye transfer. To keep your book up to date for the next year I will need your name, address, and book serial number. Just fill out the form below and mail it to:

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THE DYE TRANSFER PROCESS

(FOURTEENTH EDITION)

by

David Doubley

PREFACE

This manuscript was written to make dye transfer accessible to the amateur photographer. The techniques used are designed with the amateur in mind, yet offers enough technical background to satisfy the most advanced user. For me, dye transfer is not static, instead I see it as a dynamic and flexible system of color reproduction that has many untapped and creative avenues. The methods and techniques in this manuscript are by no means the only way to do things. I hope that the reader will utilize this text as a springboard to develop his or her own methods of working with dye transfer.

It is my intent to update the text periodically to inform you of changes in materials and approaches to dye transfer. If you have any ideas that you'd like to share with others or would like to see in the book, let me know. Send me your book's serial number and I will try to answer any questions you may have to the best of my knowledge. I will also try to send out errata sheets to help keep your book up to date for the first year you have it. Send your inquiries to:

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I will be glad to hear from you.

ACKNOWLEDGEMENTS

I would like to acknowledge every one who helped inspire this effort, but there are so many that it is impossible to include them all. There are, however, a few people who, because of their special help, I am compelled to mention; without them I would not have had the drive to take on such a project. My special thanks go to Frank McLaughlin, of Kodak, for his friendliness and his willingness to share ideas and information. Thanks also to Cathy Rose of the Martha's Vineyard School of Photography, John Ganis of the Center for Creative Studies, and the guys at Color Perfect Labs for their openness and patience.

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***** = FOR SEPARATIONS ONLY**

SOME PRELIMINARIES...

BEFORE YOU START.

I SOME PRELIMINARIES

CHAPTER 1 SOME PRELIMINARIES [1-1]

1.1 WHAT IS COLOR?

Color is a manifestation of light. Light is the aspect of a whole spectrum of electromagnetic waves (such as radio, heat, x-rays, etc.) of which a human observer is aware through the visual sensation which arises from the stimulation of the eye (refer to figure 1.1.1). Light oscillates at extremely fast rates; it can oscillate almost 1 quadrillion (1,000,000,000,000,000) times in a second. Each color has a specific oscillation rate. The word "frequency" is used to describe oscillation rates. Red has the lowest frequency and violet the highest frequency. All the other colors have frequencies between these two colors.

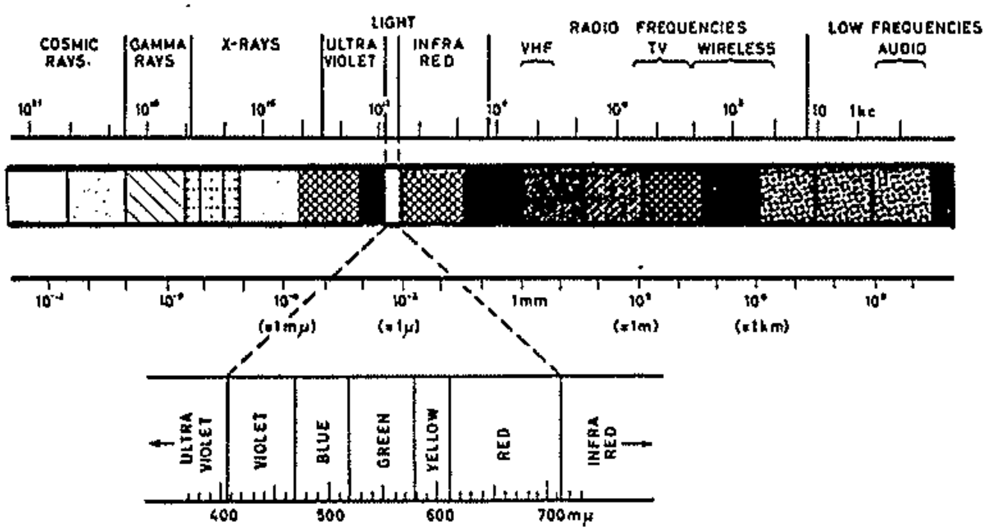


FIGURE 1.1.1

An equally valid way to characterize colors is by something called wave length. Each frequency has a specific wave length associated with it. The lower the frequency, the longer the wave length. Red has the longest wave length (about 700 billionths of a meter) and violet has the shortest (300 billionths of a meter). White light is often characterized as consisting of "primary" colors such as, red, orange, yellow, green, blue-green, blue, and violet.

Scientists have said, "The sensation of color is dependent on the spectral distribution of the illuminant, the ability of a particular colorant in an object to absorb portions of the blue, green, and red light, the spectral sensitivity of the human eye, and the psychological effect that is caused when the brain is stimulated by these variables in a given situation." In layman's terms this means that color is dependent on:

1. The color content of the illuminating light source. For example, daylight is more bluish than incandescent light which is reddish by comparison.

2. The color absorption and reflecting quality of the color in an object.

3. The color sensitivity of the eye. An extreme example of this would be color blindness.

4. The effects of the human brain's interpretation of what it sees.

CHAPTER 1 SOME PRELIMINARIES [1-2]

In the early 19th century, Thomas Young theorized that the eye contained a set of three color receptors known as rods and cones. Over 100 million are contained in the retina of the eye. They respond to the red, green, and blue regions of visible light and to varying light intensity. Red, green, and blue are known as the additive primary colors. Young said that these additive primary colors, when added in different proportions, would produce the visual sensation of all natural colors. The idea of separating light into its primary colors, in order to make color photographs, is based on Young's theory.

It is important to realize that color vision is not something totally objective. The idea of the eye as a model for the camera has been proven to be a fallacy. For a given scene, the camera adjusts the aperture and time so the film matches the scene. The eye on the otherhand adapts itself to the scene. A philosopher once said, "Beauty is a relative thing, neither independent nor absolute." The same can be said for color vision. Research done by Edwin Land (inventor of the Polaroid Land camera system) proved that our perception of color is quite subjective. He demonstrated that, contrary to Young's theory, under the right circumstances two different and not necessarily primary colors could create the sensation of fully colored vision. In a paper published in Scientific American magazine, Dr. Land demonstrated that colors change if the light and surrounding colored environment vary. For instance, if a red object were viewed under red light it might appear to the eye to be white or light pink.

There is a limit to the number of colors we can distinguish. There are millions of discrete colors in the visible light spectrum, yet we perceive only a small number of them. Scientists say that a human can distinguish over 100 "pure" colors in the visible light spectrum. There is, however, a tremendous variation in the ability to perceive differences in color; women generally are better at it than men, while some people are partially blind to some colors and others are completely color blind.

There are three important color attributes. They are hue, saturation, and luminosity. Together these attributes determine all distinguishable colors. By varying any or all of these three factors, it is possible to expand the hundred or so "pure" colors of the light spectrum into an inexhaustible variety of colors.

1.2 A SHORT HISTORY OF COLOR PROCESSES.

Thomas Young's three-color theory was proposed in 1802, many years before photography of any kind had been conceived. In fact, Fox Talbot, the inventor of the first reproducible techniques in monochromatic (non-color) photography, was not born until 1804. It was not until 1860 that a method was developed to demonstrate Young's theory. By that time monochromatic photography had reached a high degree of development. Plate glass negatives and plate glass positives (lantern slides) were common place.

In 1861 James Clerc-Maxwell demonstrated the three-color process to the Royal Institution in England. With the help of Thomas Sutton, a protege of Blanquart-Evard (inventor of the albumen printing technique), Maxwell made three identical glass negatives of a striped colored ribbon. Each negative was photographed through a different colored filter. The filters were made of glass cells filled with liquid dyes which approximated the three additive primary colors (red, green, and blue). Three corresponding positive lantern slides were made from these "separation negatives". Maxwell astounded members of the Institute when he created a full colored image by superimposing the projected lantern slides through the same red, green, and blue filters onto a screen.

Interestingly enough, it was also known that the three complementary colors of cyan, magenta, and yellow could produce the sensation of color in the eye. Subtracting additive colors from white light is results in complementary colors. These complementary colors are also called the subtractive colors. For instance, if red light is removed from white light, the remaining blue and green light combines to create the sensation of cyan in the eye. The eye perceives magenta when green light is subtracted and yellow when blue light is subtracted. If Maxwell could have found a way to dye each glass slide with the appropriate subtractive colors, he could have stacked his lantern slides in register and projected them as one to produce a color image. Later, Maxwell did in fact suggest the use of the subtractive colors in making color images. In fact, Louis du

CHAPTER 1 SOME PRELIMINARIES [1-3]

Ducas Hauron patented a three color assembly process based on this idea in 1869, but unfortunately the technology was not available to make his idea viable.

In the foregoing years an amazing number of color photographic techniques were invented. Basically, the techniques were of three types:

> 1.)Additive Screen Processes - in which the image is created by incorporating three additive colors into a single medium.
>
> 2.)Assembly Processes - which require the separation of an image into the subtractive colors and the reassembly of these colors on another medium.
>
> 3.)Multilayered Processes - in which the image is incorporated into a single tri-level emulsion consisting of the three subtractive colors.

The first commercially available processes were additive screen processes. One of the best known processes of this type was called the Autochrome process. This process was marketed by the Lumiere brothers around 1903. In this technique, a glass plate was coated on one side with a homogeneous emulsion of red, green, and blue dyed starch grains and the other side with black and white film emulsion. The starch grains acted as thousands of little separation filters during exposure for the black and white emulsion behind them. The plates were processed, without disturbing the dyed starch emulsion, as positive images. The Autochrome was viewed like a transparency with the starch grains acting as color filters. Believe it or not Steichen, Frank Eugene, and Steiglitz exhibited Autochrome prints in New York City at the Little Galleries of Photo Succession in 1907. Another technique similar to the Autochrome process was called Dufaycolor. It was also developed in France about the same time. It used a three color screen in a similar manner. These additive screen processes were limited in color reproduction and were soon replaced by assembly processes because they produced better color.

Assembly processes were the next step in the history of color. Although there were numerous techniques, many disappeared from the market as quickly as they appeared. Carbro Printing and Dye Transfer are the most well known of this type. All of the assembly processes used red, green, and blue filters to separate the color image into its constituent primary colors (a brief discussion of how filters work is given in section 1.4). Exposures were made on black and white panchromatic emulsions, i.e., emulsions which were sensitive to all colors. These "separation negatives" were then used to prepare magenta, cyan, and yellow positives which would be assembled together in register to create an image. The separations could be produced directly by making three successive exposures of a stationary subject, or by using any of a number of ingenious cameras which made the separations simultaneously in one exposure.

The most important and successful assembly methods relied on an effect described by Mongo Ponton in a paper in 1839. He discovered that paper coated with potassium dichromate (or bichromate) was sensitive to light. Later in 1852, Fox Talbot discovered that gelatin or gum arabic (soluble colloids), which would normally dissolve in hot water, were insoluble when it was mixed with potassium dichromate, coated on paper and exposed to light. This hardening process is called "tanning".

Alphonse Louis Poitevin patented a process called carbon printing in 1855. Poitevin added carbon black pigment to a colloid-bichromate mixture and applied it to paper. To make a print the carbon paper is placed in contact with a negative and exposed to sunlight. Washing the exposed carbon paper in hot water would dissolve the gelatin in proportion to the amount of light exposure, thereby creating a fully tonal positive image. Later, in 1899, Thomas Manley invented carbro printing (carbro is an acronym of the words "carbon" and "bromide"). Carbro printing is similar to carbon printing except a black and white chlorobromide print of the negative is used to transfer the tanned emulsion to a final backing paper. Carbro printing made it possible to make enlargements from any size negative and made it possible to correct problems with the original negative on the print. By using magenta, cyan, and yellow pigments instead of carbon black in the carbon and carbro processes, it was possible to make color prints. Color prints of this type were known as trichrome or tricolor carbon and carbro prints. Another color technique called Duxochrome used an unhardened silver-halide emulsion which was hardened and transferred like tricolor carbro. Other assembly techniques like Chromotone and Tri-tone were invented in the early 1900's, but did not reach the popularity of tricolor carbro and soon vanished.

The final stage in the history of color is the multilayered processes. All modern films and papers fit into this category except Dye Transfer.

It wasn't until the 1930's that a practical multilayered film was developed by Leopold Mannes and Leopold Godowsky. This color transparency process was purchased by Eastman Kodak Company and marketed as Kodachrome Transparency Film. Kodachrome required precise processing, critical temperatures and elaborate equipment. By 1936 a German company called Agfa Company developed the first easy-to-process transparency film called Agfacolor. Kodak soon followed with its version of Agfa's film which they called Ektachrome. Color negative films and color papers were not perfected until the early 1950's.

1.3 A HISTORY OF DYE TRANSFER.

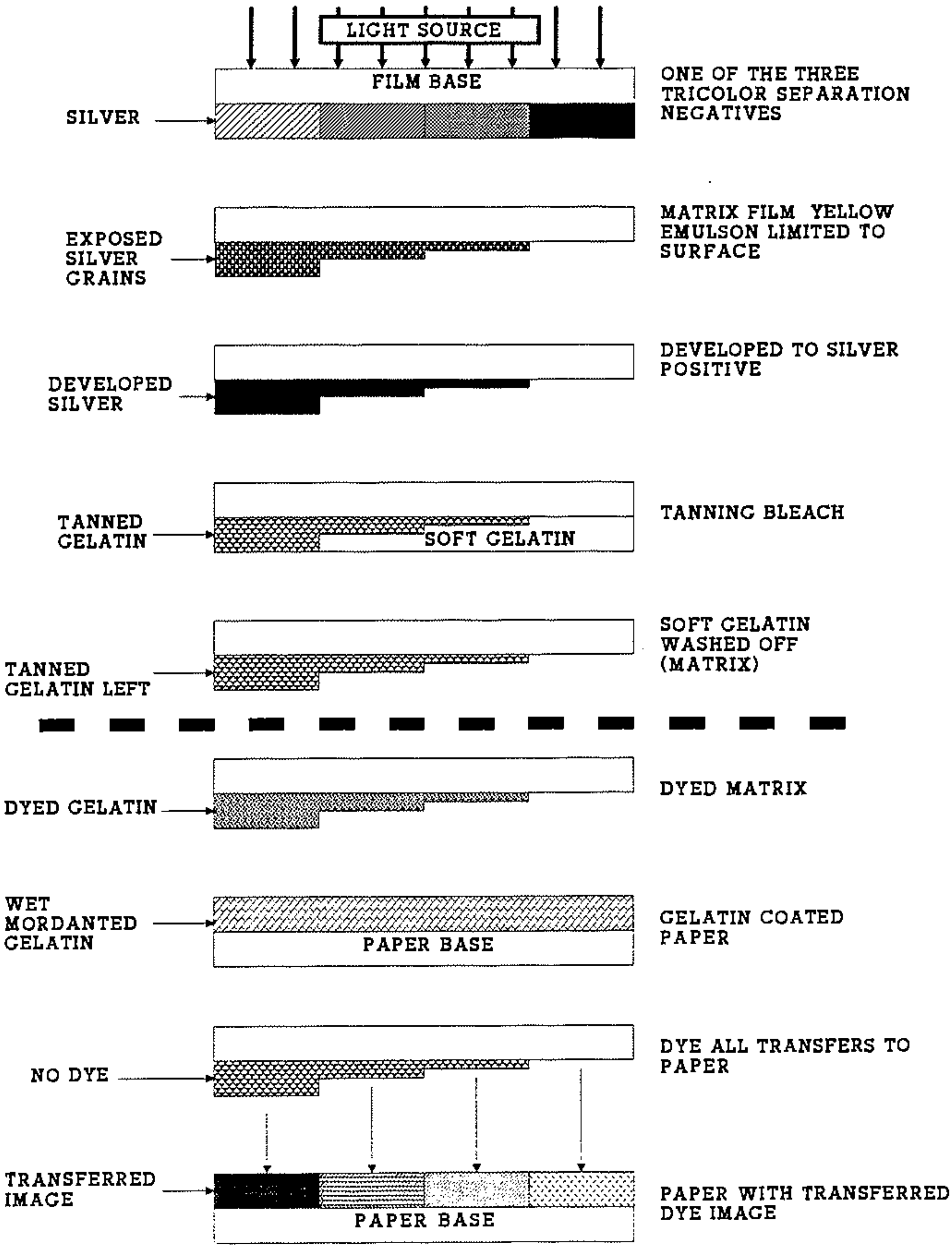
The major drawbacks of these early assembly processes were that only a single image could be obtained, the processes were slow, and the complexity of the procedures made the processes expensive. Despite these handicaps tricolor carbro labs flourished until the early 1950's.

In 1925 Jos Pe'(inventor of the "one-shot" color separation camera which bears his name) developed a method called the dye-imbibition process. This technique used a thick unhardened silver-halide emulsion, similar to Duxochrome, which was permanently attached to a thin film base. This material, when exposed and processed, formed a relief image. Relief images (or matrixes) were made for the magenta, cyan, and yellow colors of the original image and soaked in dyes of those colors. The dye soaked matrixes were drained and placed on a paper support, one at a time, where the dyes transferred from the matrix to the paper.

Eastman Kodak Company took this process and improved it substantially and marketed it as the Wash-off Relief Process in 1936. The Wash-off Relief Process employed a potassium dichromate solution and DK-50 film developer to tan (or harden) the matrix film. This was in many ways similar to the tricolor carbro process. However, there were a number of technical problems with the Wash-off Relief Process. Two Philadelphia photographer-inventors, Louis Condax and Robert Speck, solved many of these problems by using a pyrogallol developer instead of the dichromate film developer method to process the matrix film emulsion. Interestingly enough, pyrogallol was introduced as a film developer in 1851 by Regnault but was first observed to harden (tan) gelatin in 1881 by Leon Warnerke. Condax and Speck marketed their process for awhile but sold their technique to Eastman Kodak in 1946. Kodak marketed the process as the Dye-transfer Process.

The matrix film requires separation negatives to be made either from color transparencies or in the camera. It is an orthochromatic film, i.e., it can be used under a red safelight; this makes it easy to process. The relative simplicity of dye transfer made carbro printing uneconomical as a technique for making good color prints. In 1949 Kodak also developed Pan Matrix Film, a panchromatic version of regular matrix film, for their newly developed Kodacolor negative film. Color paper was not marketed until the early 1950's. Oddly, Kodak did not market Pan Matrix until 1954.

Pan Matrix Film dye transfer prints were much easier to make than those from the regular matrix film because no color separations were required. Most of the drudgery and difficulty in the dye transfer process is the result of having to make separation negatives. However, the regular matrix film remains the more popular of the two for dye transfer prints because of its importance in the Advertising and Graphic Arts fields where image manipulation techniques, such as stripping and color enhancement, are needed and more easily accomplished with dye transfer. In addition, color negative films were inferior to transparency film until recently. Pan Matrix Film also is more difficult to handle because it must be kept in total darkness for exposure and processing.



WASHOFF RELIEF
FIGURE 1.3.1

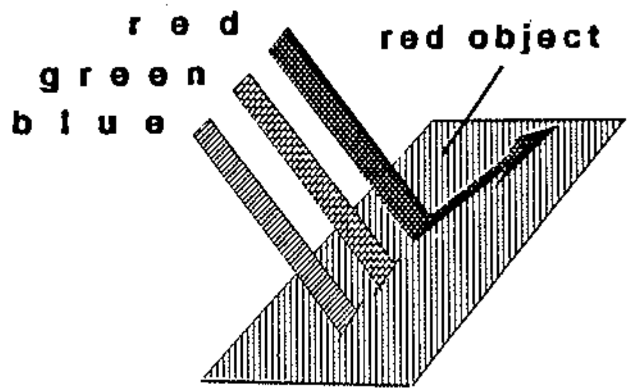
1.4 HOW COLOR FILTERS WORK.

Filters are available in glass or plastic. Most of the filters used with color processes are plastic. There are two types of plastic filters. Those used in color printing are called "color printing" or CP filters. They are made of plastic acetate and are the least expensive because they don't need to be optically flat, since they are used above the enlarging lens. Generally, they come only in magenta, yellow, and cyan, although some are available in red, green, and blue. All are supplied in density increments of 0.05 up to 0.50.

The other type of plastic filter is called a "color compensating" or CC filter. These filters are generally plastic gelatin and are used in front of the lens. They are optically flat to prevent image distortion. This, of course, makes them more expensive to make. These filters are usually available in many variations of red, green, and blue as well as magenta, cyan, and yellow. Their main use is to alter the film in someway, such as changing contrast or adding color for various purposes. The magenta, cyan, and yellow filters are used mainly for color printing.

Color filters are required in all of the color assembly processes to separate the image into its red, blue, and green components. It is imperative that the user have a good understanding of how filters work.

There are two ways that we see color. The first way is by reflected light (refer to figure 1.4.1).



An colored object will reflect its own color and absorb all other colors.

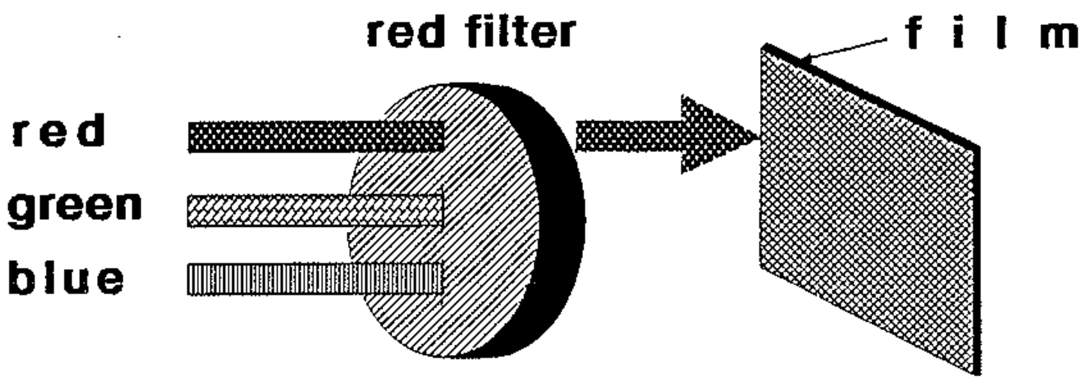
FIGURE 1.4.1

White light can be thought of as containing equal amounts of red, green, and blue light. Light bounces off an object and is seen by the eye. The color of the object determines what colors we see. It reflects its own color and absorbs all other colors. A red object, for instance, absorbs the green and blue component of light and reflects the red component of light back to the eye. Conversely, a cyan object absorbs red light and reflects green and blue light, which combine to make cyan. The same is true for all primary colors or any combination of primary colors. The following list shows the color absorption for additive and subtractive primary colors:

COLOR	ABSORBED COLOR
Red	Green + Blue (cyan)
Green	Red + Blue (magenta)
Blue	Red + Green (yellow)
Cyan(grn+blu)	Red
Magenta(red+blu)	Green
Yellow(red+grn)	Blue

The second way of seeing color is through transparent colored materials which transmit only their color and absorb all others. These filters can be made of glass or plastic materials. A red filter, for example, absorbs the green and blue component of light and transmits the red component of white light.

If panchromatic film (film that is sensitive to all colors) is placed behind a filter, the film will only be exposed to that component of light (refer to figure 1.4.2).



A filter will transmitt its own color and absorb all other colors

FIGURE 1.4.2

This is how separation negatives are produced. The filters used to make separations must divide the three primary colors very precisely. The word "sharp cutting" is used to describe such filters. Any contamination of color will cause the printed image to have dull, flat colors. Figure 1.4.3 shows a typical light sensitivity graph of the color response of three typical tricolor filters used in making separations. The graph shows very little contamination of color.

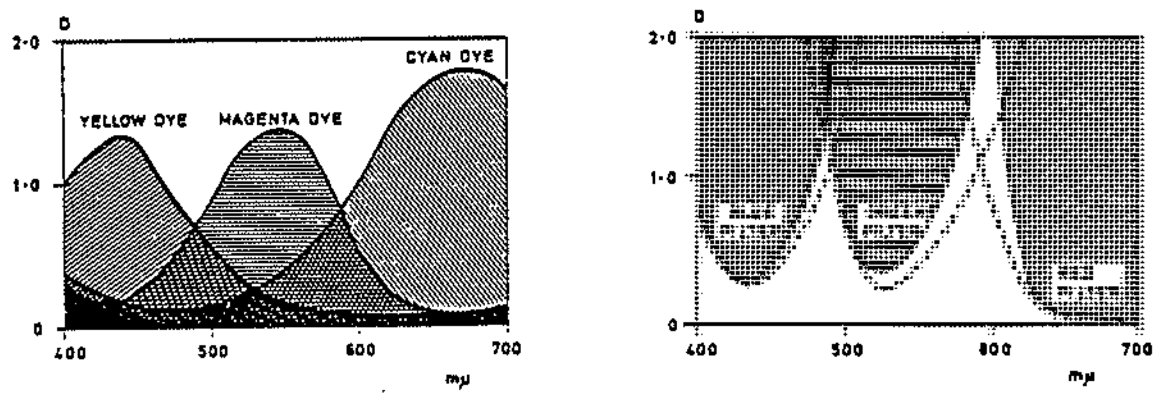


FIGURE 1.4.3

Listed below are the Kodak Wratten Filter descriptions of several tricolor filters which are commonly used to make separation negatives.

REDS

#24..... Red. Formerly used for "two-color photography" (for daylight with green No. 57; for tungsten with green No. 40 or 60). Used also for white-flame-arc tricolor projection.

#25..... Red Tricolor. Used for color separation work and tricolor printing. Two-color general viewing. Contrast effects in commercial and outdoor black and white photography. Haze penetration in aerial work and removes blue in infrared photography.

#29..... Deep Red Tricolor. Used for color separation and tricolor printing work. Tricolor projection (tungsten) with No. 47B and 61.

GREENS

#61..... Deep Green Tricolor. Used with No. 29 and 47B for tricolor projection (tungsten) and for color separation and tricolor printing work.

#99..... Green. Equivalent to No. 61 plus No. 16 (orange). Used for making separation positives from color negative films. Also for three-color printing on color papers.

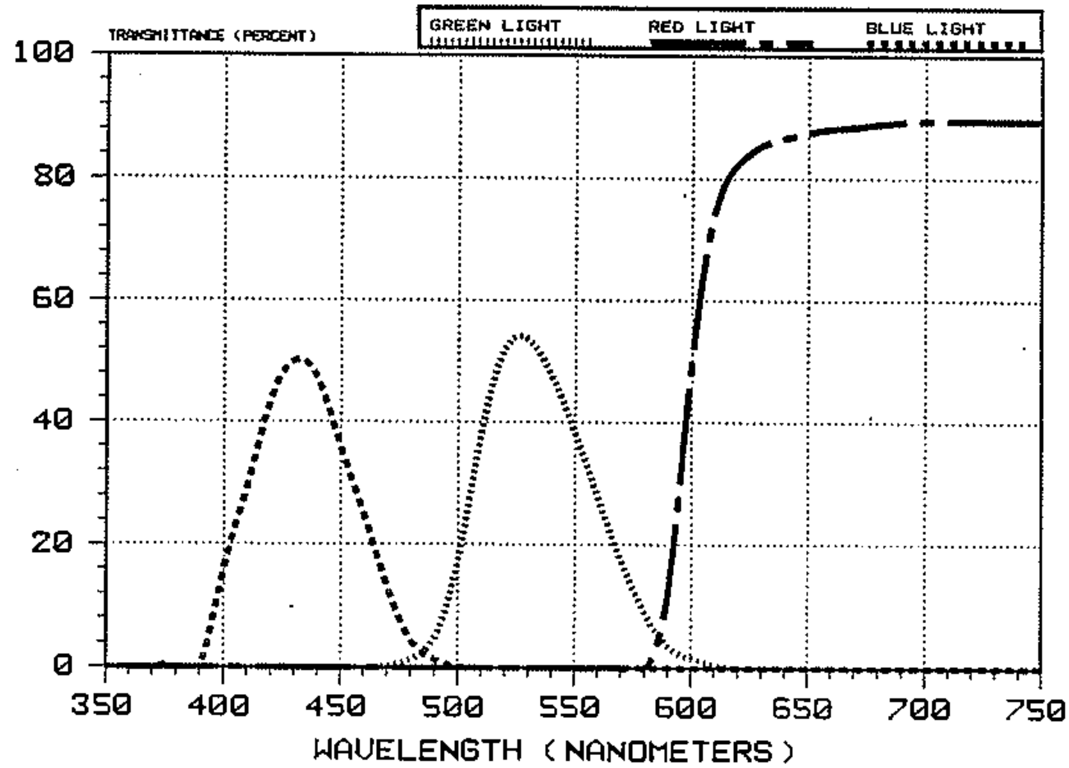
BLUES

#47B..... Deep Blue Tricolor. Used for color separation and tricolor printing work.

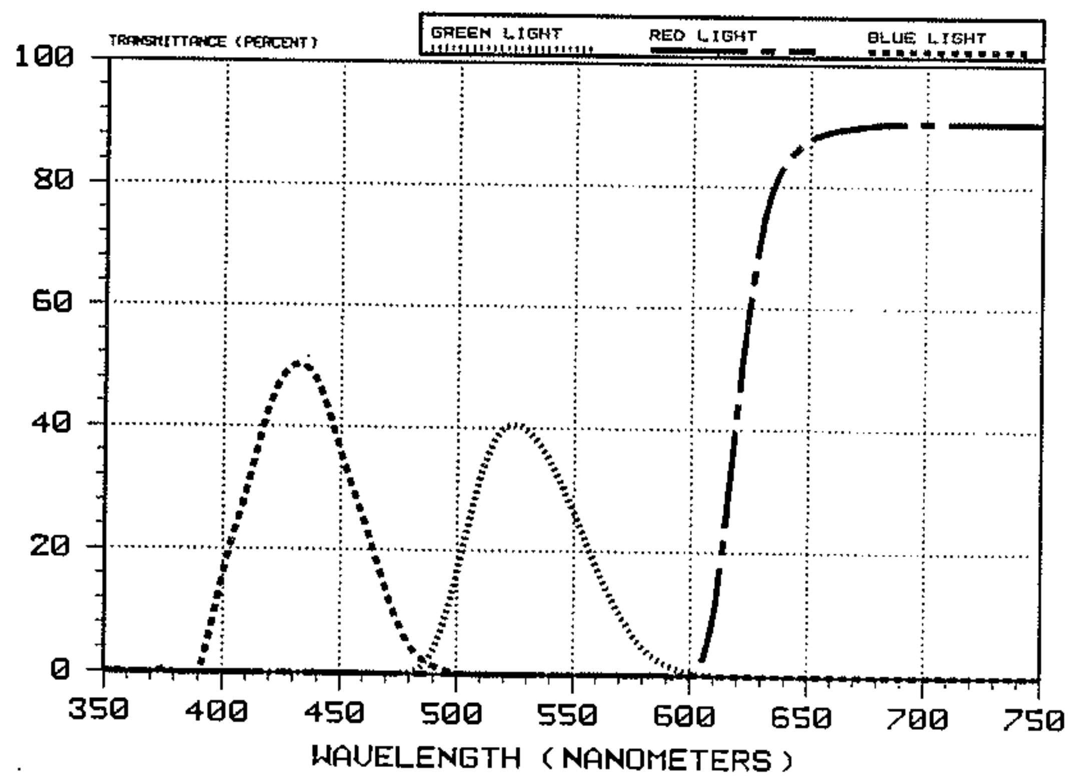
#98..... Blue. Equivalent to No. 47B plus 2B filter. Used for making separation positives from color negative films. Also used for three-color printing on color papers.

Different combinations of filters are used for different purposes. Some of these filter combinations and their uses are listed below.

SPECTROGRAPHIC CURVE FOR KODAK FILTERS
NO. 25 RED, NO. 58 GREEN, NO. 47B BLUE



SPECTROGRAPHIC CURVE FOR KODAK FILTERS
NO. 29 RED, NO. 61 GREEN, NO. 47B BLUE



#29,61,47B FILTERS
Used for making separation negatives from color transparencies (except Kodachrome). Used for making direct separation negatives with tungsten light source. Can be used to make matrixes (Pan Matrix Film) from color negatives.

#24,61,47B FILTERS
Used for making separation negatives from Kodachrome transparency film.

#29,99,98 FILTERS
Used for making Pan Matrixes from color negatives. Recommended by Kodak. A #47B filter may be substituted for the #98 filter if exposures are too long.

#25,47B,58 FILTERS
Used for making direct separation negatives with daylight. Also used to make red, green, and blue masks for photomechanical printing (a CC50G filter is used for black mask).

#24, #40, or #57 FILTERS
Interesting experiment, two-color separations. For tungsten use the #40 green and for daylight use the #57 green in combination with the #24 red. Works best with two basic colors, preferably complementary. Results vary.

1.5 A BRIEF COLOR SENSITOMETRY-DENSITOMETRY PRIMER.

Sensitometry is a study of photographic films and how they react to light. Densitometry deals with the measurement of film density to determine a film's characteristics. Densitometry requires the use of a film density measuring device called a densitometer. A little knowledge about these subjects is necessary in order to make good dye transfer prints. This section will give a brief overview of this subject. Included in the discussion is an explanation of density, brightness range, density range, and the concept of matching subject brightness range and film density range to obtain the best possible photographs. Kodak publication #E-59 is an excellent source of information on densitometry and is highly recommended for the beginner.

When black and white film is exposed to light it causes a reaction which results in a silver deposit on the film base when the film is processed. The density of the silver deposit varies in direct proportion to the amount of light which strikes the film. In essence, the same is true for color films before they processed. During processing the silver halide emulsion layers are chemically converted into dye stuffs. Color films are composed of a complex strata of multiple dye layers. Basically, a color film emulsion may be thought of as an arrangement of superimposed cyan, magenta, and yellow dye layers. These dyes act together to create color and density, passing and absorbing colors in proportion to the dye density of each layer.

Figure 1.5.1 shows a simplified view of the dye layers in color film.

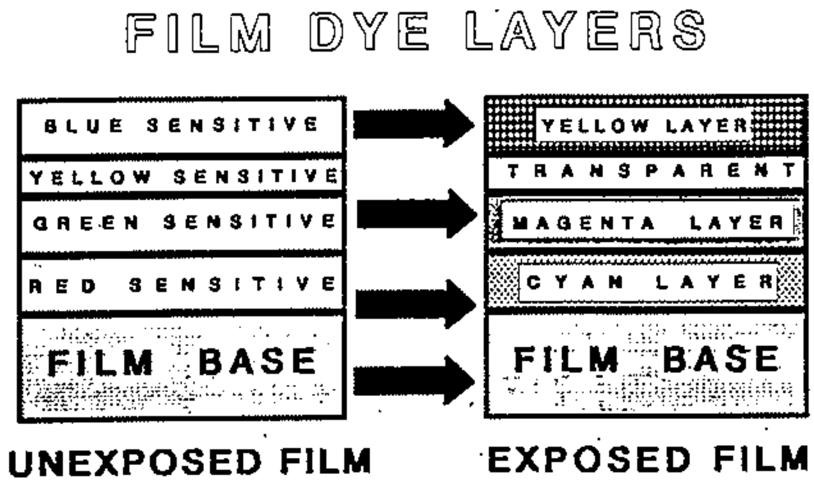


FIGURE 1.5.1

In the diagram you will see that, in addition to the red, blue, and green sensitive layers, a yellow filter layer exists to prevent blue light from reaching the lower layers during exposure. This yellow layer dissolves away when the film is processed. Modern color films actually have many other layers, such as interlayers, antihalation coatings, duo-sensitivity color layers, and anti-curl coatings.

1.5.1 Density. To understand a film's photographic characteristics, it is necessary to make densitometric measurements. Film density can best be understood by observing the effect it has on transmitted light. A piece of exposed film will allow some light to reach your eye but will reflect and absorb the remainder. One way to measure density is to describe it by the percentage of the transmitted light it passes or absorbs. For instance, film with a density of 50% will absorb 1/2 the transmitted light and pass 1/2 the transmitted light (assuming no transmitted light is reflected).

Expressing film density as a percentage of absorbed or passed light is a perfectly valid approach. Unfortunately, this method of measuring density is cumbersome because observable light can vary as much as 1000:1 from light to dark. A mathematical system which uses logarithmic values is used instead. The ability to pass light is defined as the transmission of light and the tendency to absorb or stop light is called opacity. Strictly speaking, density is defined as the common logarithm of the opacity (reciprocal of transmitted light). This formula shown below:

$$\text{Density}=\log_{10}(1/T)$$

where T=(light passed)/(total light)

Fortunately, you don't need to know this formula to understand density values Following is a table showing percentage of transmitted light, its equivalent density, and opacity.

PERCENTAGE	DENSITY	OPACITY
100%	0.0	
80	0.1	1.25:1
63	0.2	1.60:1
50	0.3	2.00:1
40	0.4	2.50:1
25	0.6	4.0 :1
10	1.0	10.00:1
2	1.7	50.00:1
0.01	2.0	100.00:1
0.001	3.0	1000.00:1

As you can see, film that transmits 100% of the light has a density of 0 and film which transmits .001% light has a density of 3.0. It is useful to remember that a density of 0.3 transmits 50% of the incident light and is equivalent to stopping down one f-stop. By using appropriate filters with a densitometer, it is also possible to measure the density of color materials. Density can be measured two ways: with transmitted light or reflected light. A transmission densitometer is used to measure film density and a reflection densitometer is used to measure density in prints.

1.5.2 Brightness Range. Knowledge of film density helps to make good photographs. Good prints are obtained by knowing the brightness range of the subject and matching it to the photographic material's density range. Brightness range is a measure of luminance difference between the highlights and the deepest shadow in a scene. Density range is a measure of density difference between the recorded deep shadow and the diffuse highlight (textured) of a scene in a negative. While brightness range can be expressed as a difference in f-stops, generally it is expressed as a logarithmic difference; density, as previously stated is also a logarithmic value. If everything were perfect, the density of the film would be directly proportional to the amount of light which strikes it. This ideal theoretical relationship can be expressed by the formula:

$$D = K \times \log_{10}(E)$$

where:

D=film density
E=light exposure
K=proportionality constant

The formula simply says that if you double the exposure, then the film density will double; if you triple the exposure, the film density will triple; and so on. This relationship is not true in reality that is why film and subject brightness range are difficult to match. For this discussion, brightness range and density range will be in logarithmic values. This sounds difficult but you'll find the concept fairly easy to grasp as you read on.

The normal brightness range of a sunny day, from deepest shadow to specular highlight (non textured), is about 3.0 (equivalent to a 1000:1 ratio of light to dark or 10 f-stops). However, if the specular highlights are taken to be diffused white and the deepest shadows to be black, then the brightness range is really about 2.2 (equivalent to a 160:1 ratio of seven f-stops). Fortunately, the human eye cannot easily discern the difference between a brightness range of 3.0 and that of 2.2. The reason for this is the human eye's inability to separate very dark and very bright tonalities. The limiting factors on film are the perceptible shadows and the textured highlights that our eyes see. The chart below lists the ranges for several photographic media as compared to a typical scene.

	Light Ratio	Density Rang e	f-stops
Bright Day	1000:1	3.0	10
Normal Day	100:1	2.0	6-2/3
B&W Neg	11:1	1.05	3-1/2
B&W Paper	60:1	1.8	6
Color Paper	30:1	1.5	5
Matrix Film	250:1	2.4	8
Dye Print	160:1	2.2	7

These ratios are even smaller when the the type of lens is taken into consideration. The flare in a lens sometimes has a dramatic effect of subject brightness range.

1.5.3 Density Curve & Range. The density values of a negative versus the logarithm of exposure can be plotted on a curve to see how the film responds to different brightnesses of light. As we stated in the previous section, the negative density should be directly proportional to the amount of light which strikes it; if this were true, then such a curve would be a straight line.

In actuality, the curve takes on a rather curious "S" shape (refer to Figure 1.5.2).

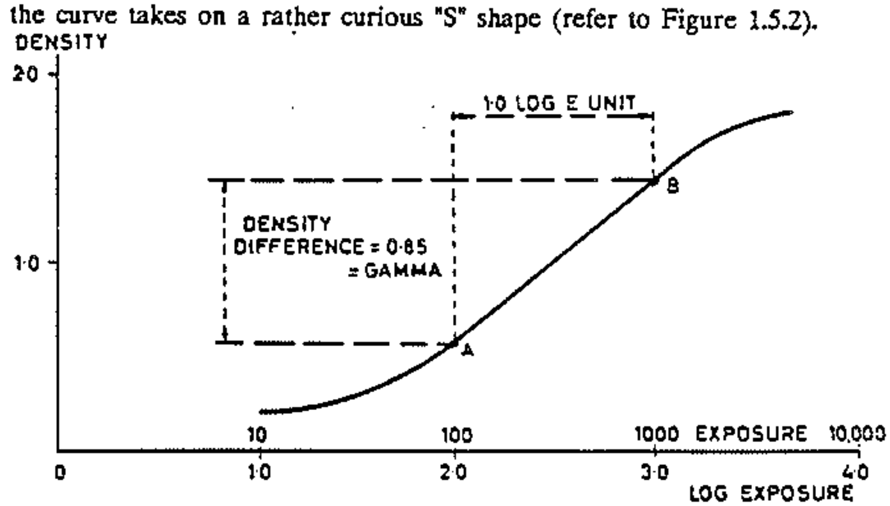


FIGURE 1.5.2

The reason for the curve distortion is that the deep shadows and diffused highlights at some exposure levels do not reproduce on the film in direct proportion to exposure.

This S-shaped curve is called a characteristic curve or an H-D curve, so named because of the pioneering work on this subject done by Dr. Ferdinand Hurter and Vero C. Driffield (1890). A different characteristic curve exists for every type of photographic material. The major factors that influence the curved shape are type of developer, development time, and temperature.

The "distortion" in a characteristic curve causes loss of shadow and highlight detail If the shadows and highlights are not at the proper locations on the curve then the subsequent prints will either have excessive contrast or not enough. Generally, it would be ideal to have the meaningful shadows and highlights fall on the straight line portion of the characteristic curve. The photographer's task is to place the exposure range of the subject at the extreme points on the curve's straight line portion. This is accomplished by varying the exposure and the development of the photographic material. In other words, the film's density range and the brightness range have to be aligned for best results.

The procedure is to expose the film so the shadow values lie at the desired location near the bottom of the curve (the "toe"); this sets the exposure time. After the exposure time is determined, the curve's slope is varied by finding the development time that will place the highlight exposure at the desired location at the top of the curve (the "shoulder"). This process of exposure and development to achieve predetermined film characteristics is often described as the "Zone System".

The slope of the curve is called its gamma. It should be noted that the curve in Figure 1.5.2 is an ideal curve. Actually, most characteristic curves exhibit much more curvature, which sometimes makes gamma difficult to determine. Something called contrast index is used to express density curve slope instead of gamma to make development times easier to determine. Lots of literature is available on this subject Kodak's pamphlet #F-5, "Kodak Professional Black-and-White Films", is an excellent source of information on this subject.

1.5.4 Color Density Curves. The question of density in color films seems difficult to grasp at first but is only slightly more involved. As we have mentioned, color films have three dye layers. The dye layers work together to create color densities. By using red, green, or blue filters with a densitometer it is possible to measure color densities of the film layers. The cyan, magenta, and yellow color layers of a color film can be measured and plotted as three curves on a single graph. Refer to Figure 1.5.3.

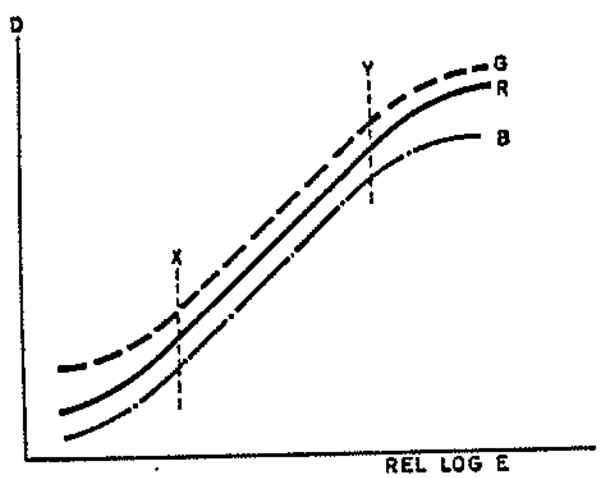
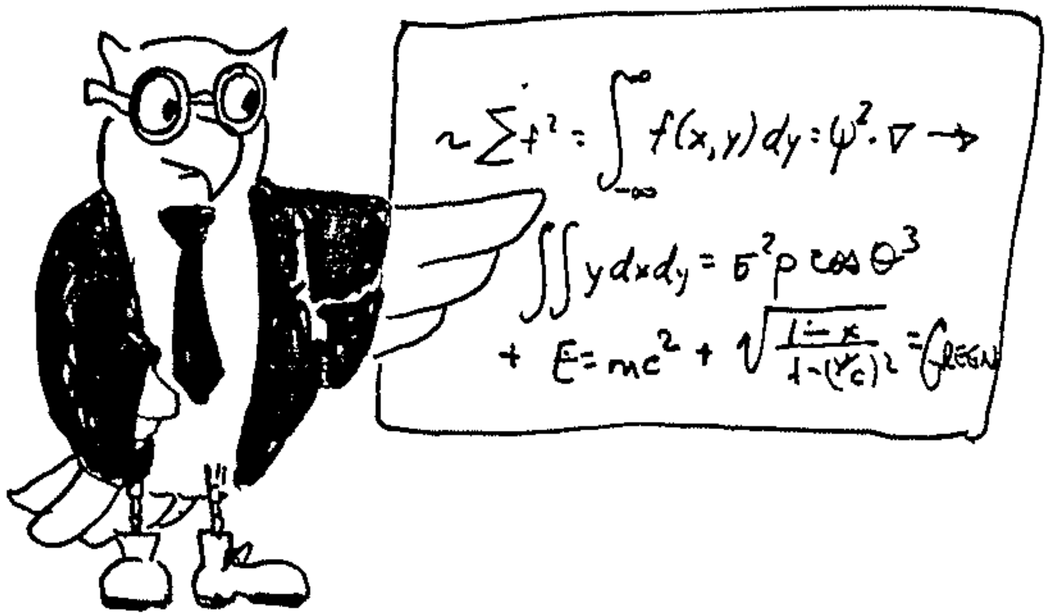


FIGURE 1.5.3

The curves are marked with the color filter through which each is measured with the densitometer. Notice that properly exposed and developed color film has three parallel and similarly shaped curves that are almost superimposed.

1.6 CONCLUSION

With these preliminaries complete, we will proceed to Chapter 2. In that chapter we will discuss how matrix film works and how and why it is capable of producing such wonderful color imagery. There will also be a discussion on masking of separation negatives. In later chapters we will show how to make separation negatives and their use with regular matrix film and techniques for using Pan Matrix film.



. . . and thats the <u>easy</u> stuff?

DYE TRANSFER THEORY

II DYE TRANSFER THEORY

CHAPTER 2 DYE TRANSFER THEORY [2-1]

2.1 AN OVERVIEW.

The purpose of this chapter is to help you understand how the dye transfer process works. It is important to understand how dye films and processes work if you are to make high quality dye transfer prints. In the dye transfer process, separate cyan, magenta, and yellow dyes are used to produce a color image. Since the dyes are separate they don't have the liabilities of dyes in modern three-color emulsion film. Dye transfer dyes can be made to be more permanent and purer in color.

Images are produced by separately transferring each dye to a paper support with a special film called matrix film. Each matrix is a separate primary color constituent of the original image. Each matrix film sheet (or 'mat') is soaked in the appropriate dye then individually rolled in register onto the paper support.

Matrix film is a gelatinous silver halide coated film which reacts to light when it is developed by hardening in proportion to the amount of light which strikes it. The developer for matrix film is called tanning developer. After the matrix film is developed it is fixed in a non-hardening fixer. Next, the matrix is washed in a hot water rinse bath at approximately 120 degrees Fahrenheit. The hot water dissolves any unhardened gelatin leaving a relief image of the subject. Finally, the matrix must be dried before it can be used. The finished matrixes are presoaked in hot water, then immersed in the appropriate dyes and readied for transfer to the paper support. The paper support is a specially prepared photographic paper that is presoaked in a special conditioning bath before it is readied for transfer. Refer to Figure 2.1.1.

2.2 MATRIX FILM.

There are two types of matrix film. The most often used version is called Kodak Matrix Film 4150. It is designed to be used with separation negatives. This film is orthochromatic and can be handled safely under a red safelight (Kodak Safelight Filter No. 1 or 1A). Refer to Figure 2.2.1.

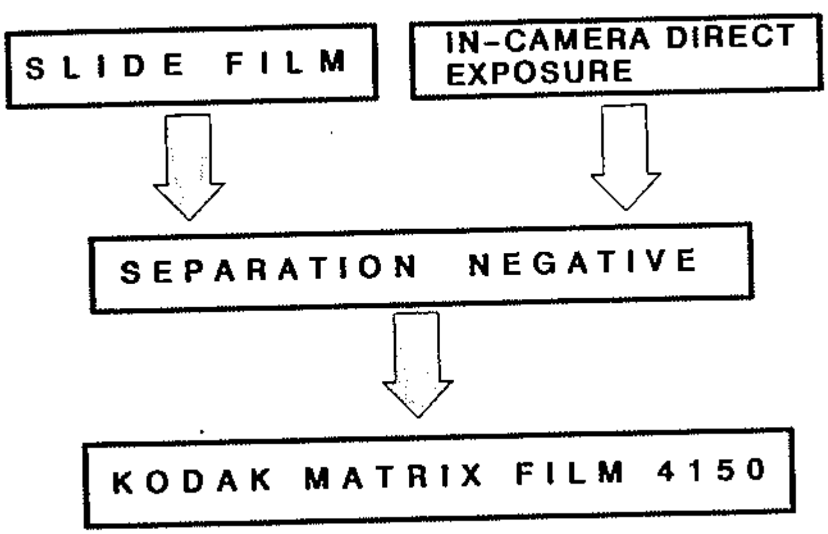


FIGURE 2.2.1

The second type of matrix film is called Kodak Pan Matrix Film 4149. Pan Matrix 4149 is designed to be used with color negative films. This film is panchromatic and cannot be used with a safelight. Refer to Figure 2.2.2.

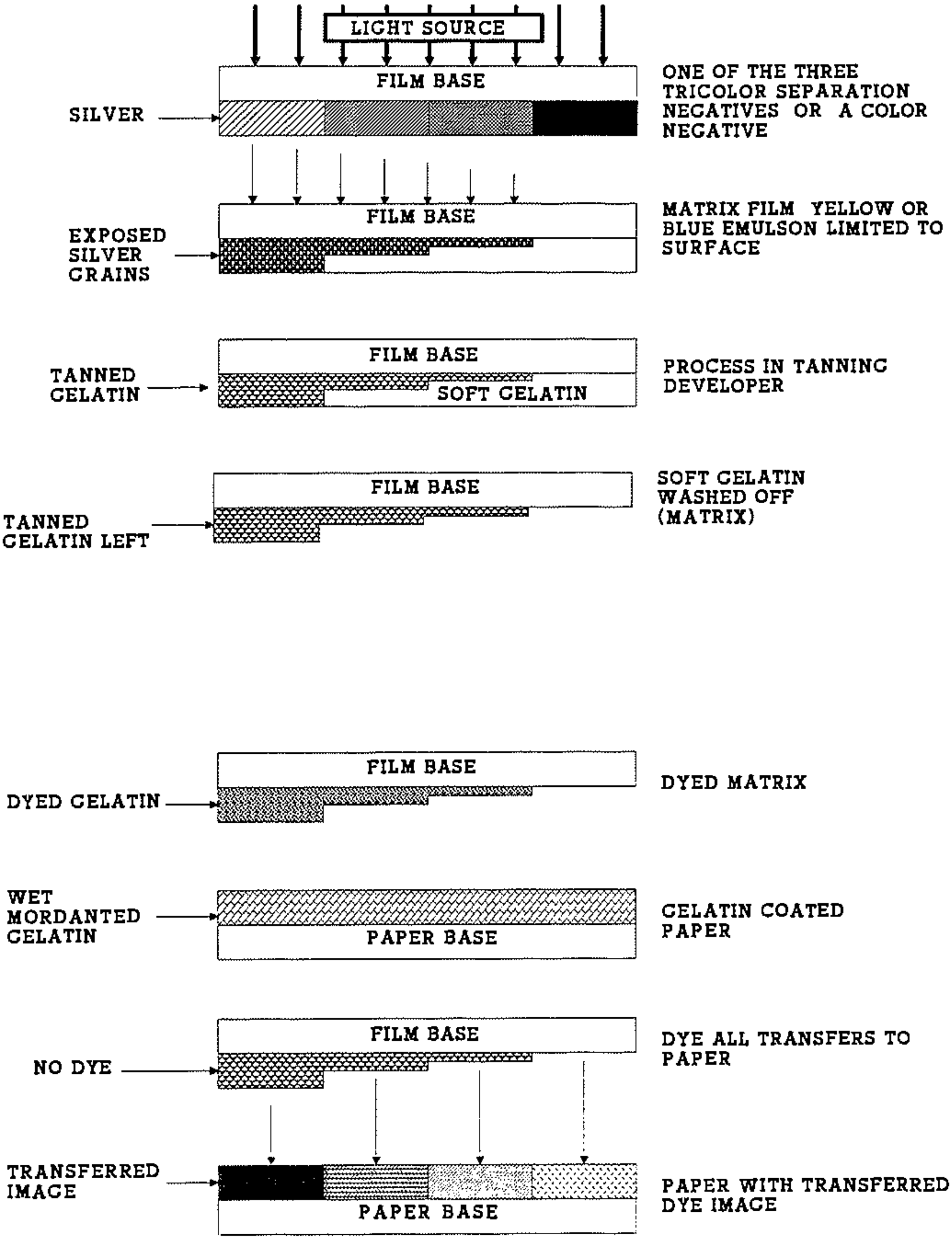

LIGHT SOURCE
FILM BASE
SILVER
ONE OF THE THREE TRICOLOR SEPARATION NEGATIVES OR A COLOR NEGATIVE
FILM BASE
EXPOSED SILVER GRAINS
MATRIX FILM YELLOW OR BLUE EMULSON LIMITED TO SURFACE
FILM BASE
TANNED GELATIN
SOFT GELATIN
PROCESS IN TANNING DEVELOPER
FILM BASE
TANNED GELATIN LEFT
SOFT GELATIN WASHED OFF (MATRIX)
FILM BASE
DYED GELATIN
DYED MATRIX
WET MORDANTED GELATIN
PAPER BASE
GELATIN COATED PAPER
FILM BASE
NO DYE
DYE ALL TRANSFERS TO PAPER
TRANSFERRED IMAGE
PAPER BASE
PAPER WITH TRANSFERRED DYE IMAGE

FIGURE 2.1.1

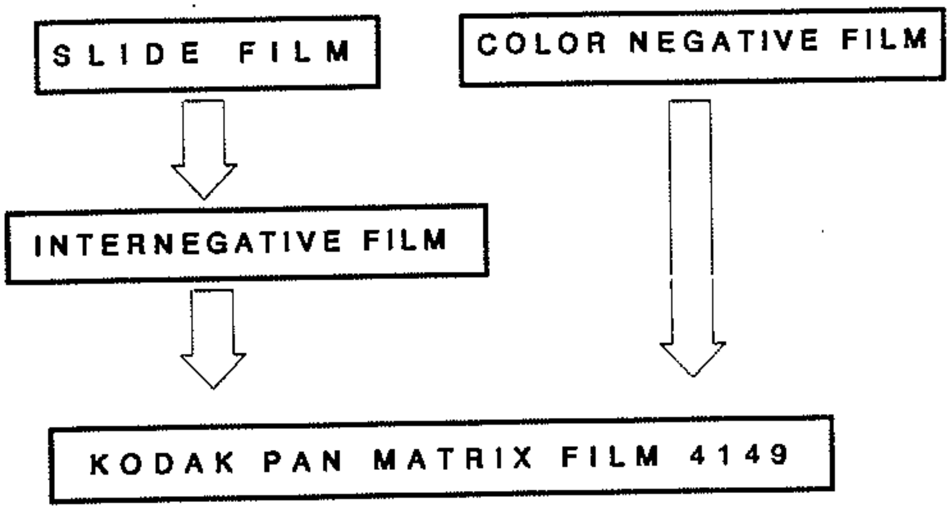


FIGURE 2.2.2

There are some minor differences between the two films. For instance, the films are colored with water soluble dyes to control the light penetration into the film emulsion during exposure. Matrix Film 4150 is yellow and Pan Matrix 4149 is blue-black in color. The light sensitivity of Pan Matrix 4149 is about the same as color printing paper and is approximately eight times more sensitive than Matrix Film 4150. Other than these differences, Pan Matrix 4149 and Matrix 4150 Film are essentially the same. In the following discussion the word "matrix film" will mean both Matrix Film 4140 and Pan Matrix Film 4149 unless either film is mentioned specifically.

Matrix film consists of thick silver-halide gelatin emulsion on a 0.007 inch thick polyester plastic film base. This film base is dimensionally stable and undergoes very little shrinkage or expansion whether wet or dry. The gelatin emulsion contains a light absorbing dye (yellow for 4150 film and blue-black for 4149 film) to limit light penetration through the emulsion during exposure.

Although generally not available, a dye transfer material called Kodak Dye Transfer Film 4151 was manufactured by Kodak. This film is not a matrix film, it is really a frosted plastic medium on which dyed images are transferred. Prints made on Dye Transfer Film 4151, sometimes called "day night" prints, can be viewed with reflected light or a combination of transmitted and reflected light. There will be no discussion of this material since it is not available.

A normal subject, as we have discussed in section 1.5, has a brightness range of about 160:1 (7-1/2 stops) from deep shadow to diffuse highlight (textured white). When that subject is recorded on film, the brightness range is compressed down 11:1 (3-2/3 stops) and re-expanded to a theoretical range of 100:1 (6-2/3 stops). Actually, a subject's practical range is about 30:1 (5 stops) on color photographic paper. Transparency film has a brightness range of 120:1 (7 stops), that's why color prints made from slides never seem to have the brilliance or snap of the original. Matrix film has the largest brightness range, it is about 250:1 (8 stops). This extended brightness range is one of the chief advantages of dye transfer printing. Refer to Figure 2.2.3.

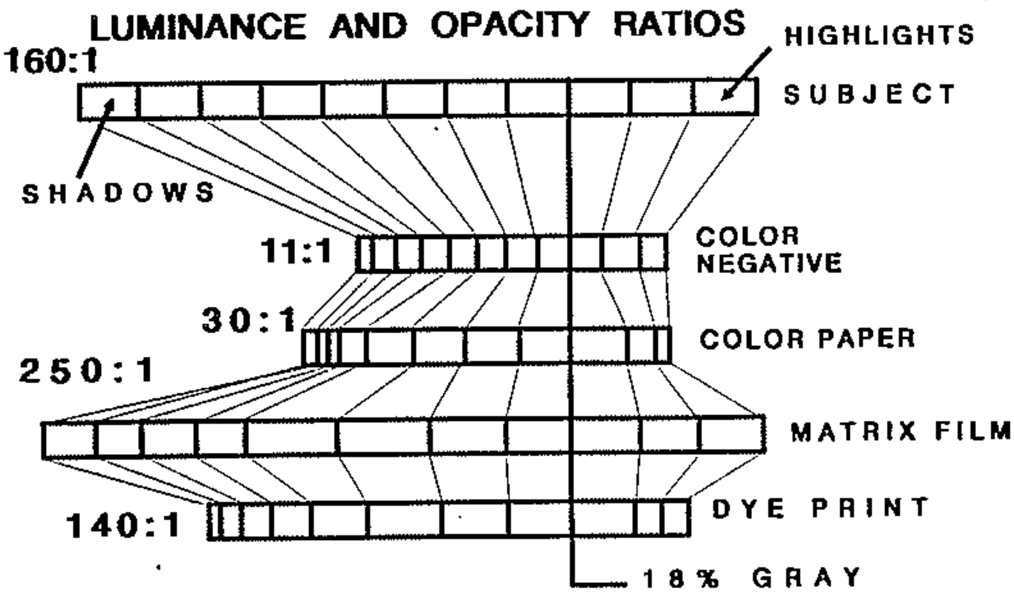
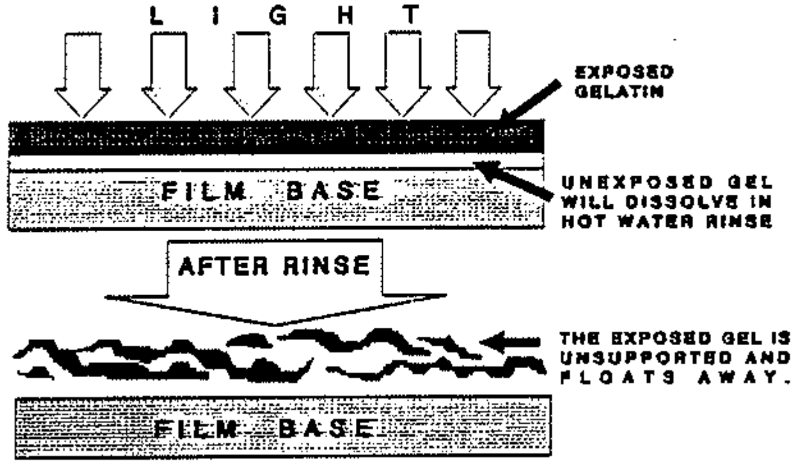


FIGURE 2.2.3

In Figure 2.2.3 we see that most of the tonal compression in photographic materials take place in the dark tones or shadows, less compression occurs in the highlights (above 18% gray) and almost none in the middle grays (around 18% gray). Notice that matrix film has far more shadow detail than color paper. In fact, the darker tones near pure black are not easily discernable under normal lighting in a dye print. This excess dark tonality gives dye prints deep saturated colors that visually surpass regular color papers. The invisible dark tones in a dye print also make it possible to control the contrast of dye prints, something almost impossible to do with regular color prints. In many ways dye print controllability is analogous to that of black and white printing papers.

Unlike most films, matrix film is always exposed through the film base rather than the emulsion. Exposing the gelatin emulsion to light will cause the silver-halide in the emulsion to be converted to molecules of silver. The number of silver molecules produced in the emulsion depends solely on the amount of light it's exposed to. The greater the exposure, the greater the depth of light penetration into the film emulsion. This means that more silver molecules are created at greater depths in the emulsion. After processing, the gelatin hardens in proportion to the amount of silver molecules produced by exposure. Refer to Figure 2.1.1. Matrix film must be exposed through the film base because it is impossible to expose it through the emulsion. If matrix film is mistakenly exposed through the emulsion side, the exposure light will not penetrate to the film base as it should. This would leave a zone of unexposed gelatin where the emulsion is attached to the film base. As a result, the entire emulsion would peel off the film base in the hot water rinse after processing. Refer to Figure 2.2.4. It's also incorrect to overexpose matrix film because it will result in hard crusty patches in the denser areas of the matrix which will not dissolve in the hot water rinse.



RESULTS OF IMPROPER EXPOSURE

FIGURE 2.2.4

2.3 TANNING DEVELOPER.

Matrix film developer is a two part developer. Parts A and B are mixed and stored separately prior to use. Part A contains the developing agent and Part B the contrast control agent. The major developing agent in Part A is a chemical called pyrogallol or "pyro" for short. Pyrogallol is a very active developing agent and has several drawbacks. Its useful life is very short, in fact it oxidizes so fast that once Part A and B are mixed, it must be used almost at once. This developer has a useful life of only five to six minutes after it is mixed. The normal development time for tanning developer is only two minutes. Such a short development time can cause uneven development if care is not taken to agitate carefully. This potent developing agent is rather abusive to sensitive skin (See Appendix A), so exercise some care when handling tanning developer.

Two formulas which are similar to the Kodak tanning developer are listed below. Kodak does not publish the formula that they use but it must be very similar:

Formula 1		
A.	Pyrogallol	15 g
	Citric Acid	2 g
	Ammonium Bromide	4 g
	Water to	1 liter
B.	Sodium Carbonate(anhyd.)	200 g
	Sodium Salicylate	4 g
	Water to	1 liter

Mix one part A to two parts B.

Formula 2		
A.	Pyrogallol	20 g
	Sodium Bisulphite	7.5 g
	Sodium Thiocyanate	25 g
	Potassium Bromide	10 g
	Water to	1 liter
B.	Sodium Carbonate	50 g
	Water to	1 liter

Mix one part A to one part B to six parts water.

Kodak's tanning developer is mixed one part A to two parts B for normal contrast matrixes. By mixing different ratios of part A and part B it is possible to vary the contrast of matrix film. The higher the concentration of part B the greater the contrast. A mixture of one part A to four parts B will produce a high contrast matrix. Changing contrast in prints by varying the developer A and B concentrations is one of several ways to changing contrast in the dye transfer process.

The hardening action of the "pyro" type developer was first observed in 1881 by Leon Warnerke. He theorized that the developer somehow causes the gelatinous silver-halide emulsion to harden around the silver molecules created by light exposure. Since stronger light penetrates the emulsion more, the developer will harden at greater depths. Matrix film in effect converts light exposure into an equivalent emulsion thickness on the matrix film base.

Some people still use the old Wash-off Relief system to develop Matrix Film 4150. The hardening process is accomplished in a different way than with tanning developer. The film is first developed in a standard black and white film developer. Kodak recommended that the film be developed five minutes at 70 degrees Fahrenheit in undiluted DK-50 (1:4 HC-110 is equivalent). The film is then bleached-tanned in what Kodak called R-10a solution. For those who are interested, the formula for the R-10a solution is given below.

A.	Ammonium dichromate	20 g
	Sulphuric acid	4 ml
	Water to	1 liter
B.	Sodium chloride (salt)	45 g
	Water to	1 liter

The purpose of the developer is to fully develop the exposed emulsion to silver. The R-10a solution converts the silver molecules produced by light exposure into silver chloride which is hardened by the ammonium bichromate. The bleached image is then rinsed in a hot water bath at 125 degrees Fahrenheit to dissolve any unhardened areas. The resulting relief image is fixed in a hardening fixing bath. Because the image will be difficult to see, it is often soaked in the appropriate dye and dried so it can be examined. The dye also helped make registering the processed matrixes by eye easier when punching registration holes. The processing steps are summarized below:

OLD WASH-OFF RELIEF SYSTEM

1) Develop in DK-50 for 5 minutes at 70^{O} F.

2) Wash for 10 minutes at 70^{O} F or less.

3) Bleach in R-10a for 4 minutes at 65^{O} F.

4) Rinse in hot water at 125^{O} F until water is clear.

LIGHTS MAY BE TURNED ON

5) Fix for 1 minute at room temperature.

6) Dry.

The matrixes obtained from this technique are lower in contrast than those obtained from the recommended tanning developer. This can be remedied by using HC-110, instead of DK-50, at a more concentrated dilution than the equivalent 1:4 dilution. The longer development times prevent uneven development problems that might be encountered with the tanning developer. Users of this process often employ a 2% acid rinse instead of the normal 1% acid rinse (acid rinse will be discussed later). Kodak now suggests an improved variation to the old original Washoff Relief method that seems to work quite well with Pan Matrix film. It is worth trying with both films. It is listed below:

NEW VARIATION OF WASH-OFF RELIEF SYSTEM

1) Develop in HC-110 dilution "C"(1:19) for 5 minutes at 68^{O} F.

2) Fix in non-hardened fixer for 5 minutes at 68^{O} F.

LIGHTS MAY BE TURNED ON

3) Wash for 10 minutes at 68^{O} F.

4) Bleach in R-10a for 5 minutes at 68^{O} F.

5) Rinse in hot water at 125^{O} F. until water is clear.

6) Dry.

2.4 THE DYES.

The essential components of the dye transfer process are the yellow, magenta, and cyan dyes. The dyes are sold by Kodak in a three dye set to make one gallon or as individual dye concentrates to make 25 gallons. The dyes are water soluble organic dye stuffs mixed with buffers to obtain and maintain certain PH values. Some typical dyes that might be used in making dye transfer baths are:

CYAN. Anthrazine Blue AB or
Solway Celestol B200.

MAGENTA. Alizarine Astrol B or
Solway Rubinol RS.

YELLOW. Tartrazine or Chlorazol
Brilliant Yellow 3G 200 with
Chlorazol Fast Orange ER180.

These dyes would be mixed with dye buffer solutions consisting of monosodium phosphate and borax. I think the modern dye buffer consists of acetic acid and triethanolamine. The following formulas are similar to those which Kodak may have used at one time.

Yellow dye	2.0 g
Monosodium Phosphate	20.0 g
Borax	2.2 g
Distilled water to	1.0 liter
Magenta dye	3.0 g
Monosodium Phosphate	12.5 g
Borax	5.0 g
Distilled water to	1.0 liter
Cyan dye	1.3 g
Monosodium Phosphate	7.5 g
Borax	7.5 g
Distilled water to	1.0 liter

These formulas are not recommended because of the difficulty in obtaining proper acidity. The Kodak dyes vary in PH from about 3.3 to 4.8 with the yellow dye having the highest acidity. If you have access to a PH meter it's possible to compare the homemade dye bath's PH with Kodak's and match them by adding acetic acid to increase acidity or triethanolamine to decrease acidity but it is not worth the effort. According to Kodak the PH values of cyan, magenta, and yellow are 4.35, 4.78, and 3.97 respectively.

In addition, the Kodak dye solutions have undergone many improvements since these formulas were published. Additional chemicals have been added to the dyes to maintain the shadow and highlight color balance between dyes. The Kodak dyes are now even more permanent and future dyes are planned which will be more permanent than today's. The Kodak dyes are also more resistant to biological growth. Yes, that's right, biological growth (mold). Because of their organic composition, dyes can easily become infected with fungus and mold spores contained in the air and water. This particulate matter (mold) must be strained out of the dye solution before it can be used again. If you have problems such as this, simply add a drop of formaldehyde to the dye; it has no effect on the dye whatsoever yet prevents mold.

An explanation of how dyes are absorbed by matrix film emulsion and transferred into dye transfer paper is too complex to be explained here in detail. What is apparent, however, is that matrix film absorbs dye in direct proportion to the depth of its emulsion. After a certain volume of dye is absorbed in the matrix emulsion it will absorb no more. The matrix film is like a sponge. The thicker the emulsion the greater the amount of liquid it will absorb. After the emulsion becomes saturated it will not absorb up any additional liquid. Dye absorption can only be increased by increasing dye acidity or decreased by decreasing dye acidity. This is important to know because this is one way print contrast and density can be varied.

A dye of ideal hue should completely absorb its complementary primary color and reflect the other two primary colors. None of the dyes used in the dye transfer process do this; each dye also reflects some of the other two colors. Cyan is the least pure of the three dyes; it reflects quite a bit of magenta and yellow. Magenta reflects quite a bit of yellow and a negligible amount of cyan. Yellow is the purest dye but even it reflects some magenta and a negligible amount of cyan. Section 2.7 discusses the dye impurity problem in greater detail.

2.5 DYE TRANSFER PAPER.

Dye transfer paper is essentially the same gelatin-coated paper used in paper-based black and white enlarging. It is a double weight paper with a smooth surface which is similar to glossy F surfaced black and white paper. Unlike B&W photographic paper emulsion, which is a gelatin substrate containing silver-halides, dye transfer paper emulsion is a gelatin substrate which contains an aluminum salt. This aluminum salt combines with the dye to make it insoluble. Such metallic compounds are called mordants. Mordants are commonly used in the textile industry to prevent dye from washing out of the fabrics. In dye transfer paper the mordant acts to hold the dye on the paper and prevents the dye from bleeding (called lateral migration). Since mordants are not light sensitive, mordanted dye transfer paper is not light sensitive and can be handled in normal light.

It is possible to use any smooth surfaced black and white enlarging paper instead of manufactured dye transfer paper. The old method, as recommended for the Wash-off Relief Process, proceeds as described. First the silver halide must be removed from the paper. This can be done by simply fixing the paper and washing it thoroughly. The paper is then mordanted in the following mordant solution (Kodak formula M-1):

1.	A.	Aluminum sulphate Water to	200 g 1 liter
	B.	Sodium carbonate Water to	40 g 500 ml
		Mix 1 part B to 1 part A. Add B to A. Filter out any undissolved precipitate. Soak paper in mixture for 5 minutes. Wash 5 minutes. Then immerse in 5% sodium acetate solution (below) for 5 minutes. Dry paper or immerse in paper conditioner	
2.		5% Sodium Acetate Sol. Water to	50 g 1 liter

A better technique uses any fixer with a potassium alum or similar aluminum salt hardener. The fixer fixes and mordants the paper simultaneously. This method is not only easier but also more economical than the old method. Care must be taken in selecting a fixer since not all fixers contain an aluminum salt hardener. Two suitable F-5 type fixers are "Kodak Fixer", a powder, for general use with films, plates, and papers and "Kodak Photo-fix", a powder, designed for papers. Different papers will yield different results usually in the form of slight cyan or blue shifts in the dye prints. This color shift is easy to correct on the printing process. I recommend papers like Kodabromide or Medalist. The papers need not be fresh; outdated papers work just as well.

2.6 PAPER CONDITIONER.

Before a dyed image is transferred to dye transfer paper it must be soaked in a paper conditioner. The paper conditioner is a base and the dye is an acid. These terms should be familiar to anyone who has had secondary school chemistry. An acid is a corrosive solution such as sulfuric acid, hydrochloric acid, acetic acid, and lemon juice. Bases are substances like sodium hydroxide (lye), ammonium hydroxide (ammonia), sodium acetate, and baking soda. When a base and an acid are combined they neutralize each other and form what is called a salt. For example, you can neutralize lemon juice by adding baking soda to it. The result is a fizzling, bubbling neutralized liquid.

The affinity between the acidic dyes and the "basic" paper is what causes the withdrawal of the dye from the matrix into the emulsion of the paper. If the paper is not conditioned in paper conditioner, little or no dye will be transferred to the paper. The dye molecules contained in the dye soaked matrix film migrate to the paper emulsion in order to reach a more neutral state on the paper.

Commercially prepared paper conditioner is very inexpensive and has a very long shelf life. However, a substitute paper conditioner can be made. The formula for the substitute paper conditioner comes from the old Wash-off Relief Method. It uses a 5% dilution of sodium acetate as the paper conditioner. The formula is given below.

Sodium acetate	50 g
Distilled water	1 liter

Kodak's conditioner has a PH of 6.5 and this formula has PH around 8.0 or 9.0. So, figure on adding more water than is shown. A PH meter would be invaluable for this purpose. This is very important because a high PH can cause mottling and other problems. Use this formulation as a last resort.

Kodak's paper conditioner has a very different formulation than that shown above. I suspect that the major component of Kodak's conditioner is ethylene glycol, the same stuff used to make automobile anti-freeze. If you can get some pure ethylene glycol and a hydrometer, capable of measuring 0 to 10 Baume', you can make an excellent substitute paper conditioner. The hydrometer is used to determine the concentration of "glycol" required when mixed with water. Use distilled water. The best way to determine the concentration is to measure the Baume' of Kodak's conditioner with the hydrometer. Make your solution in the same concentration. A typical stock solution has a concentration near 20 Baume'. All things considered, it's better to use Kodak's paper conditioner.

2.7 COLOR MASKING.

In general, a mask is a photographic image that is registered with another photographic image in order to c hange or modify reproduction characteristics of that image. If the mask of an image is a reversal of the original image then the contrast of the reproduction, made from the masked original, will be lower than the reproduction made from an unmasked original. A negative superimposed with its positive mask will produce lower contrast; the same is true for a positive original having a negative mask. If a negative is masked with a positive mask of equal but negative contrast, the result will be a negative with one uniform density, i.e., the reproduction has no contrast at all. There is no contrast because low densities in the negative will be cancelled by the high densities of the mask and vice versa, so the sum of densities at any point on the negative will be the same. You might want to try an experiment by taking a negative and making a positive of approximately the same contrast. If you were to superimpose the positive and negative you will see how the image is cancelled. Clear areas in the negative are covered by the reverse image in the positive and vice versa. This is an extreme case of masking; generally, masks will have gamma values which are a small percentage of the original.

A negative superimposed with a negative mask will have higher contrast. This principle, of course, holds for positives as well. Masking to increase contrast will not be discussed in this section since it is seldom necessary in the dye transfer process.

Masking is used primarily in color photography, especially where separation negatives are required to:

1. improve color saturation
2. reduce color contrast
3. correct hue shifts due to dye imperfections.

Color masking is necessary when making separation negatives from transparencies for the dye transfer process.

There are three types of color masks; those made from black and white film, called silver masks; those which are colored or dyed film materials; and those incorporated in the film emulsion. Most masking is done with silver masks made from a special black and white film designed expressly for that purpose, called pan masking film. Masking film does not have an antihalation backing; consequently, it produces an image which is soft and fuzzy.

A film called "Tri-mask" film is an example of the second type of masking. It actually incorporates three dyed layer masks in one film, one dye mask for each separation negative. It was developed mainly for photomechanical reproduction use. Its advantages are obvious, but it is difficult to use and does not always work well. Tri-mask should not be used for making separations for dye transfer work. Interestingly enough, Kodak recommended dyed masks for the old Wash-off Relief dye transfer technique. In that technique, low contrast, positive contact masks were made on matrix film from the separation negatives. The matrix film masks were dyed and registered with the separation negatives to make the final dye matrixes.

The third type of mask is the most familiar. It accounts for the orange coloring which is integrated into the emulsion of color negative film. Actually, the orange coloring is produced by two color masks. There is a reddish mask for the cyan dye layer of the film and a yellow mask for the magenta dye layer.

Masks are generally made by contact printing masking film with the original. The contact masks can be used in any of four ways depending on how they are made. These methods are to:

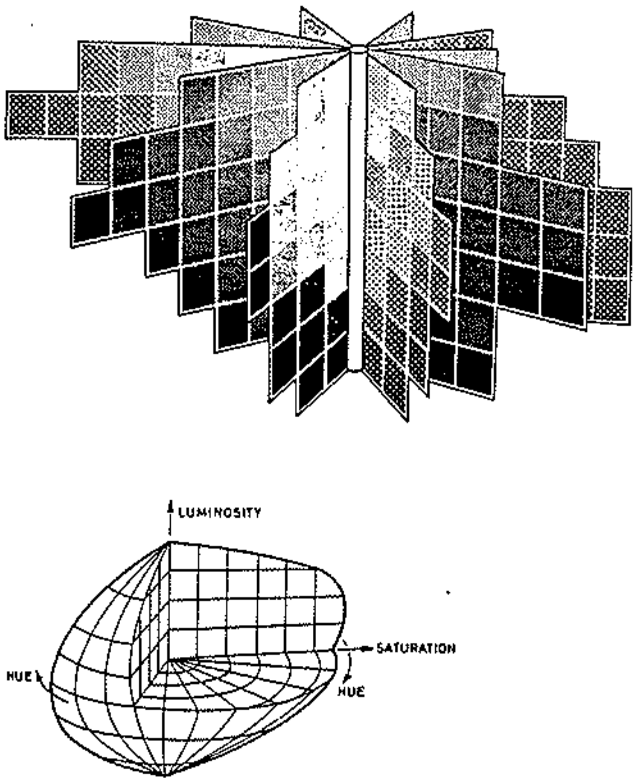
1. Combine a negative silver mask with transparency when making the separation negative.

2. Combine a positive silver mask with separation negative when making the reproduction (dye transfer).

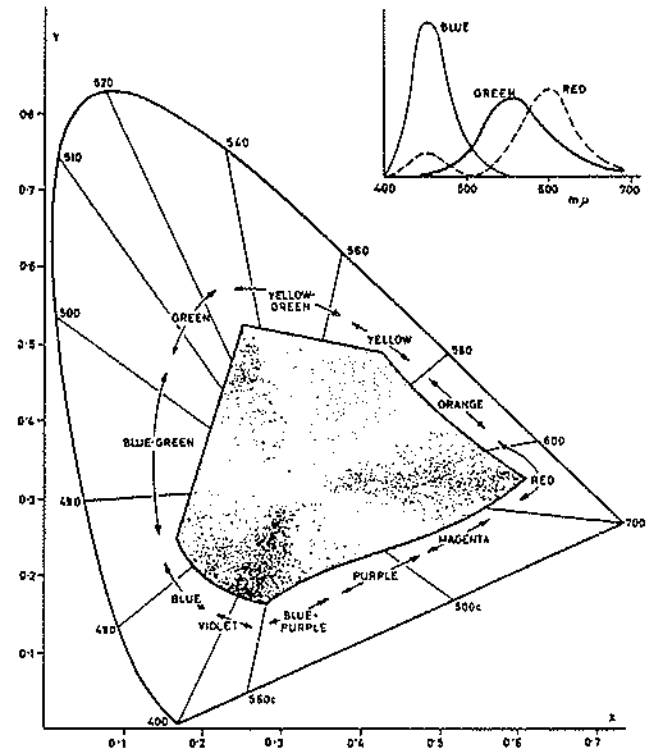
3. Combine a dyed negative mask with transparency when making separations.

4. Combine a special positive mask made with a subtractive color filter with transparency when making the separation negative.

Methods one and two are the most often used so the discussion will center on them. Methods three and four are almost never used today, so there will be no discussion about them. The first method is most often used in dye transfer printing because both color and contrast can be controlled. The second method



MUNSELL SYSTEM OF COLOR CLASSIFICATION



CIE CHROMATICITY DIAGRAM

Munsell System. Colors are charted in planes symmetrical about a central axis representing neutral tones from black to white. The chart forms a 3-dimensional solid whose 3 axises are luminosity (vertical), saturation (radiating from the center) and hue (around the circumference). The curve is lop-sided because the color are pigment colors rather than theoretical colors.

CIE diagram. The letters CIE stand for Commission Internationale d'Eclairage (International Commission of Illumination). The numbers around the U-shaped curve are wavelengths of pure spectrum colors in millimicrons. The line from 700 to 400 locates purples and magenta. The shaded area are colors which can be produced by dyes and pigments. The white center of the shaded area represents a standard daylight light source or reflected light from neutral gray by the standard light source.

FIGURE 2.7.1.1

corrects for color only, but is ideal for color correction of dye transfer prints made from direct separations. These masking techniques will be discussed later in section 2.7.4.

2.7.1 Color Attributes. Before continuing the discussion about color dyes and masking, important attributes of color such as hue, saturation (chroma), and luminosity (value) must be understood. The most well known system of color categorization is the Munsell system. The Munsell system assigns numerical values for each color's hue, chroma, and luminosity value.

Hue is that sensation that the mind calls color. Scientists measure color in wavelengths and define hue as a "dominant wave length". The Munsell system breaks color into ten principle hues of light:

1.red	6.blue-green
2.yellow-red	7.blue
3.yellow	8.purple-blue
4.green-yellow	9.purple
5.green	10.red-purple

Saturation (chroma) is the alteration of hues with white or gray. Because white and gray are neutral, altering the saturation of a color does not change its hue. Instead, what is obtained is a tint or shade of that color. Another way of thinking of this concept is to think of saturation as a measure of color's purity.

Luminosity (value) is the attribute of color that reflects or transmits light. Sometimes luminosity is also called the brightness of a color. Luminosity and saturation are two distinct color attributes which must not be confused; two colors can have the same hue and saturation, yet have different luminosities. Another way of thinking of luminosity is to relate it to the lightness or darkness of hue.

2.7.2 The Dye Color Problem. The major concern in dye transfer work is the elimination of the unwanted color absorption of the dye layers in the color transparency. If masking is not used, the unwanted color absorption of the dyes in the transparency cause color shifts and unacceptable contrast in the dye print. The chief concern of this section is to examine the mechanism of color absorption in transparency film.

As we know, color films, color papers, and dye transfer prints are comprised of superimposed transparent magenta, cyan, and yellow dye layers. Each layer reacts to its complementary color by absorbing it. Magenta absorbs green, cyan absorbs red, and yellow absorbs blue. Colors are created when each dye layer reacts to the red, blue, or green color components of the light. For instance, red results when equal amounts of magenta and yellow dye combine to absorb the green and blue components of light, thereby leaving red light as the only visually perceived light. Theoretically, each dye should only absorb its complement; in reality this is not the case.

Each additive color lies in particular wave length bands. Blue lies in the 400 to 500 nanometer (nm) band, green from 500 to 600, and red from 600 to 700. Figures 2.7.1, 2.7.2, and 2.7.3 show the color absorption curve (or spectral density curve) for each dye over the complete color spectrum from red to blue. The graphs show that each dye curve crosses over into the red, green, and blue band widths. This means that each dye absorbs some of the other two colors in addition to its complementary color. Figure 2.7.4 shows each dye curve in relation to the others. In Figures 2.7.5, 2.7.6, 2.7.7 the unwanted color absorption areas for each dye have been shaded. Figure 2.7.5 indicates that cyan dye absorbs significant amounts of blue and green light. Magenta also absorbs a significant quantity of blue and red light (see Figure 2.7.6). Even yellow, the purest of the dyes, absorbs some green and some insignificant quantities of red light as shown by Figure 2.7.7.

2.7.3 Color Absorption of Dye Layers. The color content of an ideal transparency and typical transparency, with a neutral gray, and having a density of 1.00, is shown below.

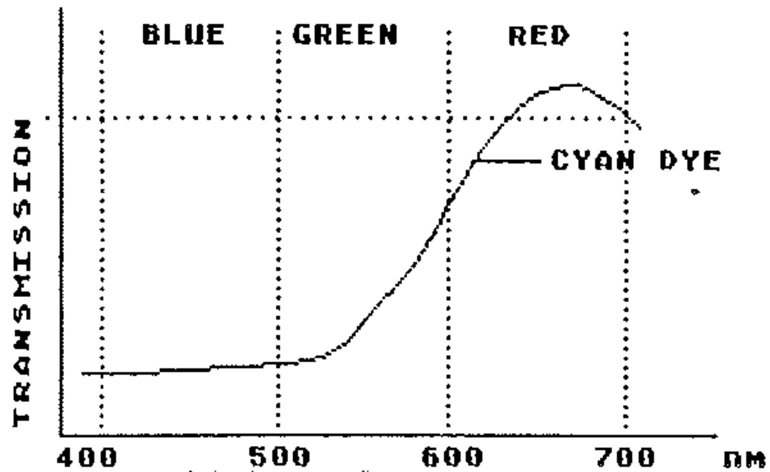


FIGURE 2.7.1

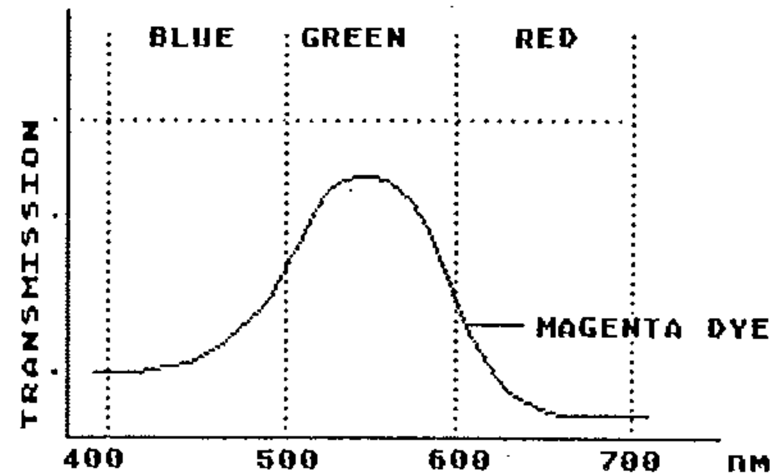


FIGURE 2.7.2

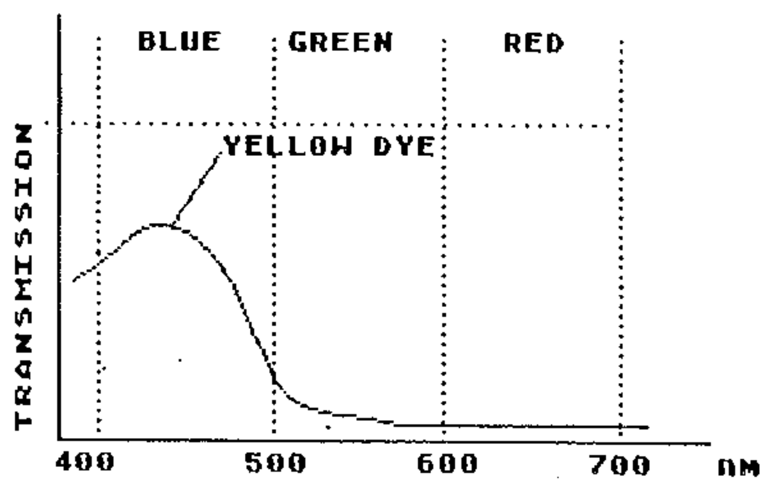


FIGURE 2.7.3

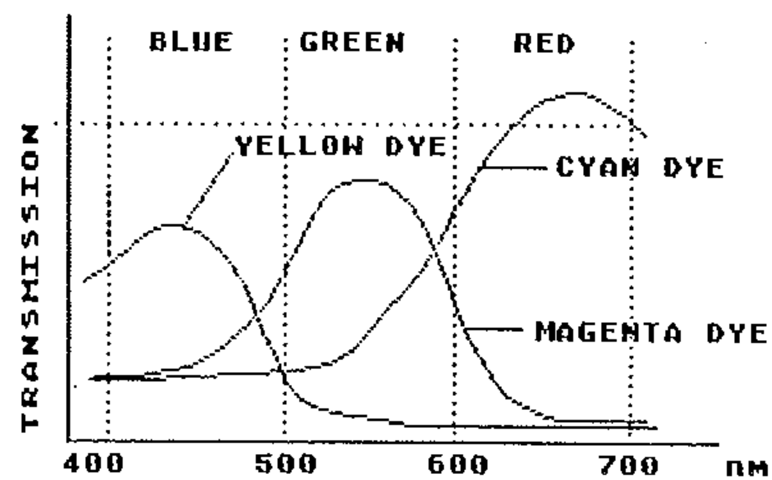


FIGURE 2.7.4

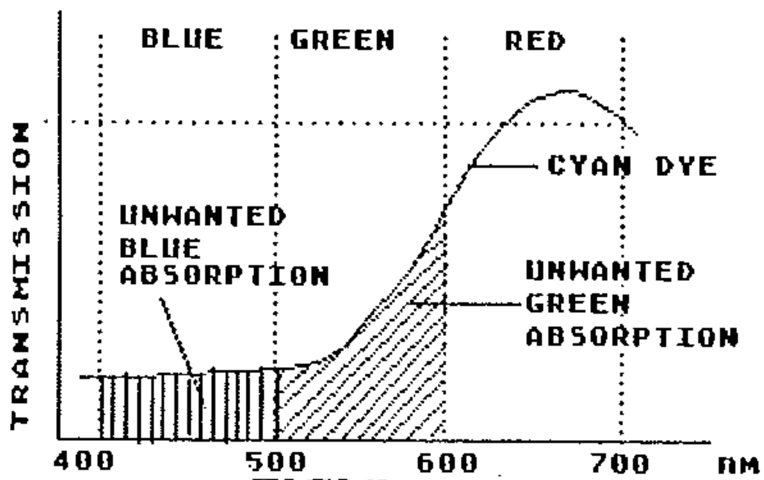


FIGURE 2.7.5

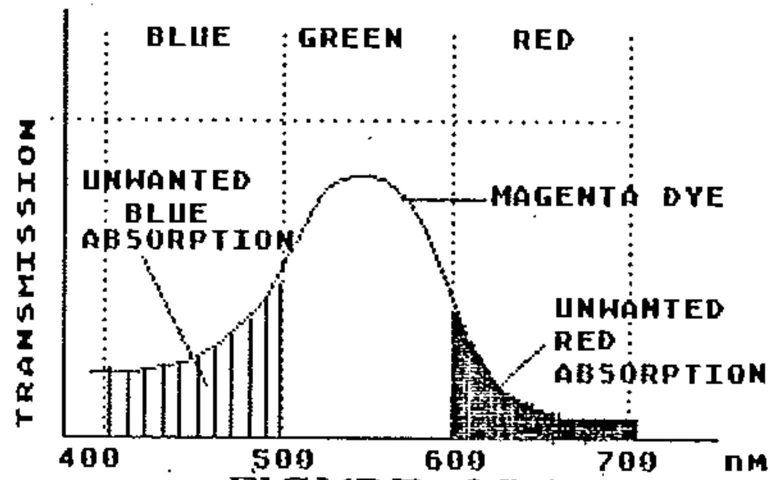


FIGURE 2.7.6

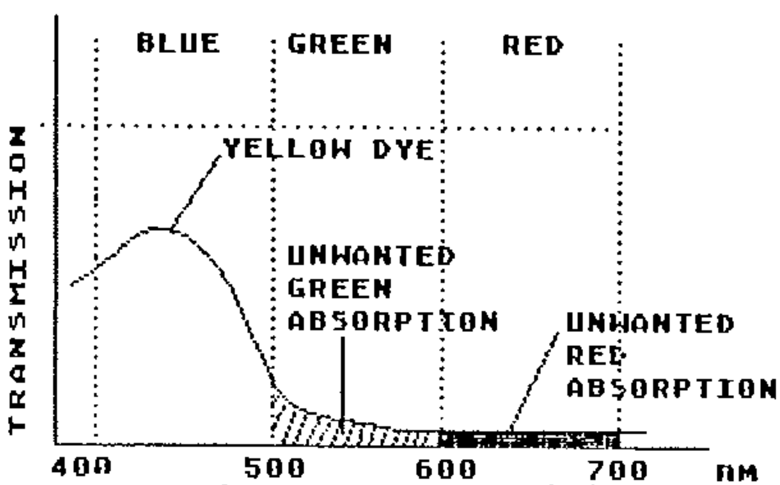


FIGURE 2.7.7

IDEAL TRANSPARENCY.

Dye	Blue	Green	Red
Cyan	...	...	1.00
Magenta	...	1.00	...
Yellow	1.00	...	...
Total	1.00	1.00	1.00

TYPICAL TRANSPARENCY.

Dye	Blue	Green	Red
Cyan	0.13	0.30	0.95
Magenta	0.30	0.57	0.03
Yellow	0.57	0.13	0.02
Total	1.00	1.00	1.00

It is interesting to note that although both charts show a total gray density of 1.00, the typical transparency film accomplishes this by taking advantage of the unwanted absorption of dye layers that should not contribute at all. Furthermore, only cyan does its job efficiently. The magenta and yellow only have densities of 0.57 as compared to an ideal value of 1.00. This is 57% (0.57/1.00) of ideal color absorption.

Typical neutral gray dye schematics for Kodachrome and Ektachrome are listed below. The values shown are for illustrative purposes only. Normally these values are compiled as gamma or densities, but to simplify the explanation the dye contamination is shown as the percentage of primary color absorption. The values have been rounded off for illustrative purposes and small values have been neglected.

KODACHROME.

Dye	Blue	Green	Red
Cyan	30%	30%	100%
Magenta	30%	60%	...
Yellow	40%	10%	...
Total	100%	100%	100%

EKTACHROME.

Dye	Blue	Green	Red
Cyan	15%	30%	100%
Magenta	30%	55%	...
Yellow	55%	15%	...
Total	100%	100%	100%

As an illustration, the percentages for Kodachrome are shown in bar graphic form in Figure 2.7.8.

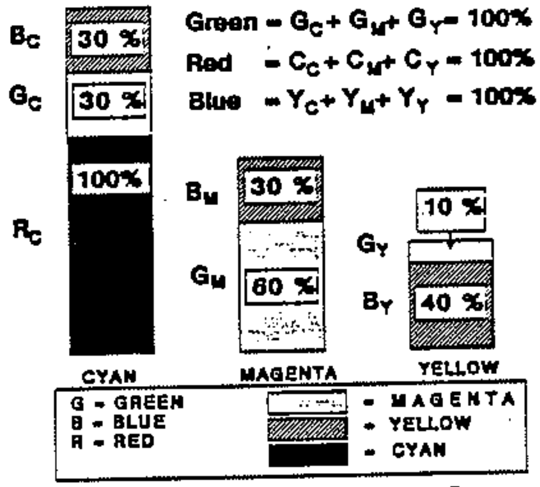


FIGURE 2.7.8

As you can see, cyan dye absorbs the largest proportion of the total light absorbed (about 53%). Magenta dye absorbs about 30% and yellow dye absorbs only 17% of the total light. Ideal dyes should absorb one-third (33%) of the total light. The assumption that perfect dyes will appear as a neutral gray if combined in equal layers on transparency is not strictly true. Actually, the color sensitivity of the human eye is a little different for each color.

The cyan dye in Kodachrome film absorbs 30% green and 30% blue. This is equivalent to saying that there is about 30% red in the cyan dye since red is the color which absorbs green and blue.

The extra red in the cyan dye acts to neutralize some of the cyan which is equivalent to adding gray to cyan. Consequently, the cyan dye in Kodachrome is darker than it should be, in other words the cyan is less saturated.

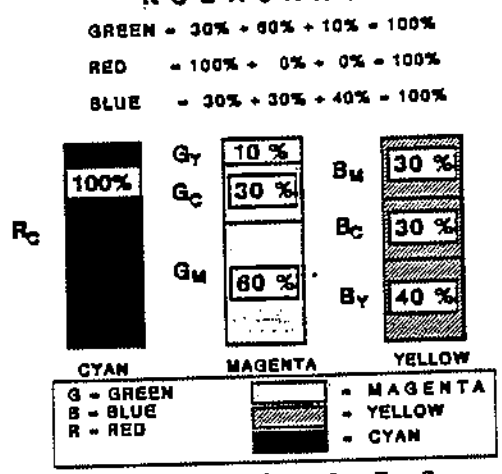


FIGURE 2.7.9

The magenta dye in Kodachrome absorbs 30% unwanted blue light and a negligible quantity of red light. This unwanted blue absorption adds yellow to the magenta hue thus making it more reddish than it should be. Rather than a change in saturation as in the case of cyan, magenta has a reddish hue shift.

The yellow dye in Kodachrome absorbs only 10% unwanted green light and an imperceptible quantity of red light. The unwanted green absorption causes the addition of magenta to the yellow dye hue which makes it slightly orange in hue.

The failure of magenta and yellow to absorb anything close to 100% of their complementary colors is even more disturbing than the fact that they absorb unwanted colors of light.

The dye layers in color materials are only able to produce a neutral color by cleverly taking advantage of the imperfections in each dye. In order to get a neutral gray equal amounts of red, green, and blue light absorption have to occur. The film accomplishes this by utilizing the multiple color absorption in each dye layer. For instance with Kodachrome, 100% blue light absorption is obtained by adding the 30% blue absorption of cyan dye and the 30% blue absorption of magenta dye to the 40% absorption of yellow dye. Similarly, 100% green light absorption is obtained when he 30% green absorption of cyan dye and the 10% green light absorption of yellow are combined with the 60% absorption of magenta. The graph in Figure 2.7.9 demonstrates this by rearranging the graph in Figure 2.7.8.

2.7.4 Masking to Solve Reproduction Problems. The delicate balance of dye layers on color transparency film is upset whenever we try to make copies or duplicates of it. Anyone who has ever tried to make slide duplicates on ordinary transparency film has noticed the increased contrast and color shifts. The same thing happens whenever dye transfer prints are made from transparencies, if the masking technique is not used. Let's assume the dyes in the dye transfer process have the same light absorption characteristics as Kodachrome film shown below.

KODACHROME AND DYE TRANSFER DYES

Dye	Blue	Green	Red
Cyan	30%	30%	100%
Magenta	30%	60%	...
Yellow	40%	10%	...
Total	100%	100%	100%

If a dye transfer print is made from a transparency without masking, the color contrast (or gamma) of the print is high and the absorption values of the dyes are changed. Rather than go through the mathematics, let's look at the effect of copying a neutral gray from Kodachrome onto dye transfer paper. The dye absorption percentages for dye transfer print would be:

DYE TRANSFER.

Dye	Blue	Green	Red
Cyan	51%	51%	100%
Magenta	30%	39%	...
Yellow	19%	10%	...
Total	100%	100%	100%

If you compare these values to those above with the original Kodachrome, you will see some disturbing problems. The cyan dye now absorbs about 51% of the green and blue light resulting in much darker cyan. The magenta dye only absorbs 39% of the green light and almost 30% of the blue light. This means magenta will be more reddish in hue and have lower saturation in the dye transfer print. Yellow dye will be reddish and substantially lower in saturation. In fact, most of the colors will show some deterioration. A summary of the effects on additive and subtractive colors in the dye transfer print, if masking is omitted, are listed below.

1.Red almost unchanged.
2.Green is darker and slightly bluish.
3.Blue is darker and greenish.
4.Yellow is desaturated and reddish.
5.Magenta is desaturated and reddish.
6.Cyan is darker.

The use of masking will allow the unwanted color absorptions to be eliminated and lower the contrast a bit. Generally, masks are made to correct the dye imperfections in the original transparency even though it's also possible to correct the dyes in the dye transfer print. This is almost never done since very little is gained from attempting to rectify color absorption problems in both the transparency and dye transfer dyes.

The masking technique used in dye transfer printing to compensate for unwanted dye absorption in the transparency attempts to lighten the magenta and yellow dyes where cyan is also present. This is accomplished by adding density, in the right proportions, to the transparency where cyan and magenta or cyan and yellow dye occur simultaneously. The same is true for the magenta and yellow dyes. Masks for magenta lighten the cyan and yellow dyes and masks for yellow lighten cyan and magenta dyes. This means it's possible to have up to six masks, i.e., one for each unwanted absorption per separation negative. This would require the transparency to be registered with two masks simultaneously for each separation negative. Thankfully, excellent results can be obtained with two or even one color masks.

Let's examine this technique in more detail. As mentioned earlier, the color absorption percentages for the cyan dye layer in Kodachrome are:

LIGHT ABSORPTION

Dye	Blue	Green	Red
Cyan	30%	30%	100%

In a sense, the cyan dye is really three dyes in one. It is a normal contrast cyan dye and two low contrast dyes, magenta and yellow.

In fact, the density curves for red, green, and blue can be plotted and the gammas for each curve can be determined (see Figure 2.7.10).

GAMMA VALUES

RED = − 0.20
GREEN = − 0.90
BLUE = − 0.30
MASK = + 0.30

BLUE + MASK = 0.0

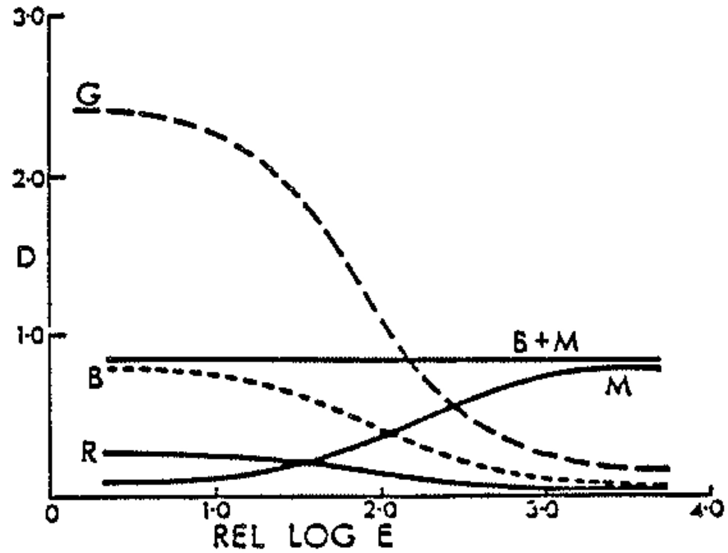


FIGURE 2.7.10

As stated in the beginning of this section, if a mask of equal but negative gamma is registered with the original, the net effect is to neutralize the tones so the combination yields uniform density, i.e., the gamma will be zero. This is how the mask eliminates the yellow and magenta components of the cyan dye. A typical Kodachrome cyan dye would have gammas for its color components like those listed below.

GAMMA VALUES

Dye	Blue	Green	Red
Cyan	-.30	-.28	-.90

Two masks, which are a record of the cyan parts of the transparency, are made by exposing masking film through a red filter. These masks are called red principal masks. The red principal masks add the required density to the transparency when the green and blue separation negatives are made to make the magenta and yellow less dense in the required areas on dye print.

The contrast of one red principal mask must be equal and opposite the contrast of blue, and the other equal and opposite the contrast of green. For the gamma in the example above, the red principal for green would have a gamma of +0.30 and that for blue would have a gamma of +0.28. In addition to altering the density of each mask in the proper areas, the masks lower the overall contrast a bit.

2.7.5 Practical Masking. Theoretically, two masks are required for each separation: a green and blue mask for red, a red and blue for green, and a red and green for blue separation negatives. Fortunately, there are a number of practical concessions which can reduce six masks down to two.

Since the red principal masks for the blue and green separations are so close in contrast, it is possible to use just one red principal mask for both of them with no noticeable effect in the final print. Since magenta and yellow dye absorb so little red light, the green and blue masks for the red separation can be omitted without any adverse effects. Finally, since the green absorption of yellow dye is barely noticeable to the eye, the blue principle mask is rarely used for the green separation. As a consequence of these practical concessions, it is possible to get extraordinary color with only one red and one green principal mask. Incidently, the red mask is used with the red separation, not as a color mask but to reduce the separation's contrast.

It is even possible to get by with only one color mask for all three separation negatives if a transparency has a dominant color. The primary function of a single mask is to improve relative color luminosity (brightness) and saturation. A single mask is usually made with a red filter; yet, sometimes a magenta filter is used instead of red. The single magenta mask lightens only the greens in the dye print but a red mask lightens greens and blues (cyan). Unfortunately, a single mask cannot correct hue shifts. Most hue shifts occur in the warmer colors, so if the transparency has a predominance of reds, magentas, and yellows a single mask will be insufficient.

Two color masks must be used to correct saturation, brightness and hue shifts in dye transfer prints. For Ektachrome and Kodachrome transparency film, red and green principal masks are sufficient to yield excellent results. For Ektachrome film, the red mask is used with the red and green separation and the green mask is used with the blue separation. For Kodachrome, the red mask is used with the red separation and the green mask is used with the green and blue separations.

Another way to understand masks is to know their effect on the cyan, magenta, and yellow dyes in the final print. The red mask serves to lower the contrast of the cyan dye for Ektachrome and Kodachrome. In the case of Ektachrome, the red mask also removes magenta dye where cyan and magenta dye occur together, and the green mask removes yellow dye where yellow and magenta dye occur together in the print. For Kodachrome, green principal masks lower the contrast of the magenta dye and it also removes yellow dye where magenta and yellow dye occur together in the print.

2.7.6 Diffusion of Masks. Masks are exposed through diffusion material to make them very soft and fuzzy. This diffusion serves two purposes. First, it makes registration of the transparency much easier and prevents the relief effects which might occur if any minute mis-registration occurs. Second, the diffusion, strangely enough, helps improve the sharpness of the final image. The diffusion accomplishes this because the smooth and uniform silver emulsion helps to maintain the contrast of minute detail in the original while it lowers the contrast of major areas of the transparency. In fact, the more diffused a mask is the sharper the image.

2.8 HIGHLIGHT MASKING.

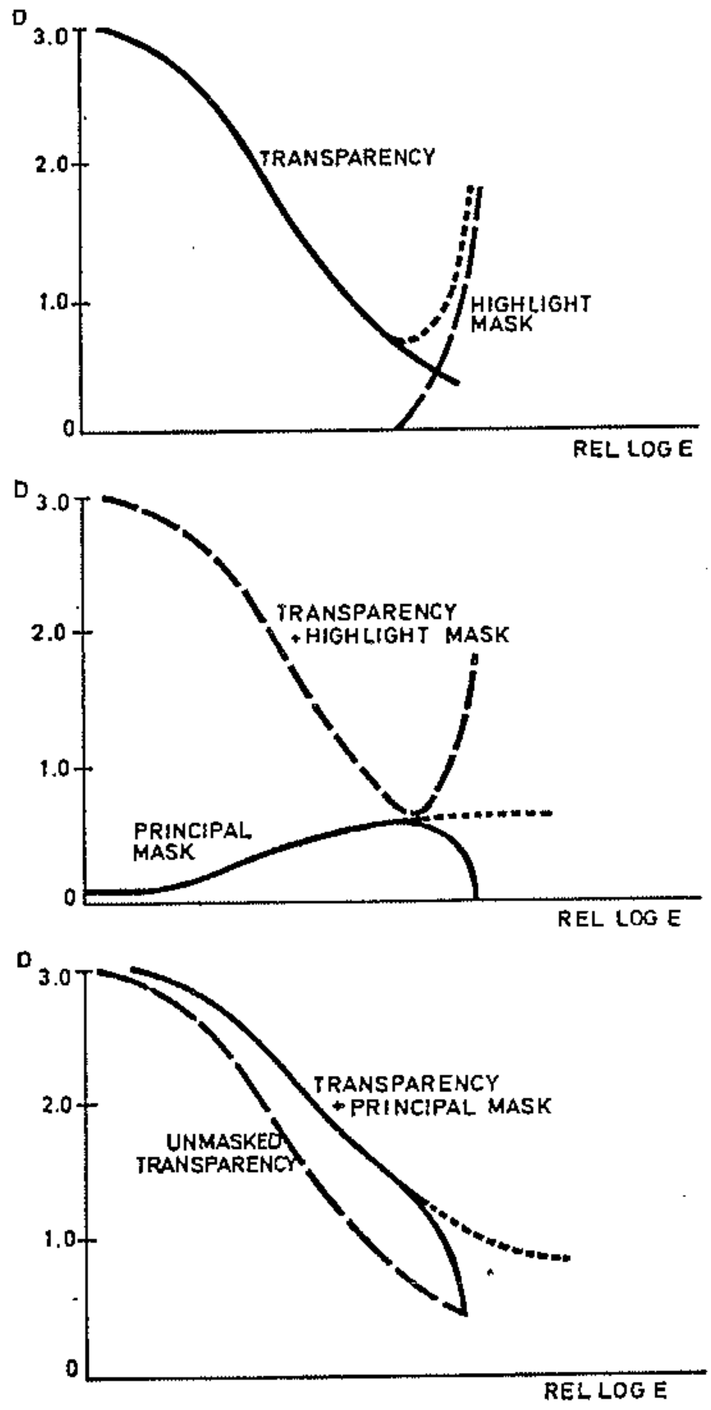
The diffuse highlight values in most transparencies show a loss of detail and contrast because they are on the non-straight line portion of the characteristic curve called the shoulder. The net result of this problem on dye transfer prints is a loss of contrast and overall color saturation. The lowered contrast results from an absence of any clear whites in the print. Transparencies with important highlight values require highlight masking for the best possible reproduction of these areas in the dye transfer print. The highlight masks also compensate for the long toe in the matrix film.

A high contrast film such as Kodalith is used to make highlight masks. The highlight mask is usually made by exposing the transparency and film in register with white light. The resulting image after development is record of just the highlights in the transparency. The mask is used in either of two places in the separation negative making process.

1. It can be registered with the transparency when making the principal masks, then it's discarded.

2. It can be registered with final separation negatives when making dye transfer matrixes.

Either of the two techniques works well. The first technique is the easiest of the two. It is the technique Kodak recommends in their dye transfer manual (E-80). The major drawback of the first technique



HIGHLIGHT MASKING

FIGURE 2.8.1

is its inflexibility. Because the principal mask is diffused, the highlight mask is also diffused. Sometimes this causes a halo effect in the highlights. In addition, since the highlight masking is incorporated in the principal masking and consequently, the separation negatives any problems created by the highlight masking requires that the masks and the separation negatives be remade.

The second technique is used by most professional labs, mainly because of its flexibility. The highlight masks can be remade, if problems occur, without requiring the remake of masks and separations. This flexibility allows for other more subtle changes which are of great value to the skilled craftsman. For most work done by amateurs, the first technique is usually adequate but the latter method is preferred.

Highlight masks are usually made on ortho high contrast film such as Kodak's Ortho Film 2556, Type 3. This allows the exposures to be made under a red safelight and allows the film to be developed by inspection. The one highlight mask is used when making each principal color mask.

The problem with either of the single highlight masking techniques mentioned is that it defeats the color correction of the principal masks. The principal masks lower the contrast of the separation negative for color correction. Since the highlight mask increases the contrast of the highlights in the separation, the color correction of the principal mask in the highlights is lost. This means that delicately colored highlights might show color shifts.

If a highlight has a predominant color then a filter of opposite color is used when exposing the highlight mask. The best way to counteract color shifts in the highlights is to make a highlight mask for each color. The use of filters, however, requires that panchromatic high contrast film be used. The red highlight mask is used with the red separation, the green with the green separation, and the blue highlight mask with the blue separation. This technique guarantees that highlight masking will not produce any color shifts.

Finally, as was mentioned earlier, highlight masks are required only when important highlight detail is present in the transparency. Use of highlight masking on transparencies that have good tonal ranges increase contrast at the expense of the lower tones, if care is not taken.

2.9 MISCELLANEOUS MASKING.

There are a number of special masking techniques used mostly in photomechanical reproduction. Techniques like shadow masking, area masking, and magenta masking are just a few of the numerous special masking techniques that can and have been used with dye transfer.

Shadow masking is used to provide shadow tone separation in black printer separation negatives. There is little or no use of this masking technique in dye transfer.

Area masking is a technique that is used to create the effect of "burning-in" or "dodging" in a separation. It is not a good technique, in general, for color work but can used when all else fails.

Magenta masking is another photomechanical masking technique when in-camera reflection copies are made. The magenta dyed masks can be used to correct some color problems.

An excellent source of information on various techniques for masking can be found in the following book:

Title:Color Photography in Practice.
Author: D.A. Spencer
Publisher: Focal Press, New York, London.

Equipment and Supplies

III EQUIPMENT & SUPPLIES

*** = FOR SEPARATIONS ONLY

*** = FOR SEPARATIONS ONLY

*** = FOR SEPARATIONS ONLY

CHAPTER 3 EQUIPMENT AND SUPPLIES [3-1]

3.0 INTRODUCTION

This chapter will deal with the equipment and hardware needed for the dye transfer process. Included in each segment will be information on how to build much of the equipment yourself. When something cannot be built, you will be told where to get it. In some cases you may be able to acquire certain items elsewhere. Feel free to do so anytime, unless otherwise mentioned. Some of the hardware can be purchased from Kodak, however most of it cannot. Catalog numbers will be given whenever possible. Some of the specialized equipment is available only from a company called Condit Manufacturing. Write for any catalog information at this address:

Condit Manufacturing Co.
Philo Curtis Road
Sandy Hook, Connecticut 06482

In many cases you may have a better design than the one shown for a homemade item; if so, by all means use it. Some of the section numbers will be preceded by three asterisks (***), these sections are for those making matrixes with separation negatives. Sections marked by asterisks may be ignored by those working with Pan Matrix Film.

3.1 ENLARGERS.

The choice of enlarger to use is important to anyone who will be doing dye transfer printing. The first thing to decide is whether you will be making dye prints from color negatives or transparencies. If you plan to make dye prints from transparencies then you will have to make exposures through separation negatives. In choosing an enlarger for separation work your choice must be very careful since special equipment is required and is available for only a few models. The best model for both types of dye work is the Omega brand 4x5 enlarger, since a great deal of equipment is available for it, new and used. Other alternative enlargers are Beseler and Durst 4x5 enlargers. The 4x5 format enlargers are necessary because most separation work will be done with 4x5 sheet film. For those planning only to make dye prints from color negatives any number of good medium priced enlarger models will suffice. Remember, you get what you pay for.

The essential requirement in an enlarger is stability. Although some enlargers are more stable than others, all are unstable to some degree. Some additional support should be used to insure that any unsuspected movement will not cause matrixes to be unsharp or mis-registered. The top of the enlarger should be braced against the wall. One suggestion is to use picture wire and miniature turnbuckles to guy the enlarger to the wall. For those who are all thumbs, commercially available braces can be purchased. The Condit Company makes a telescoping brace but it is expensive.

A suggestion that will help minimize stray light that could possibly fog the matrix film is to make a "dark bag". This is a black bag which is used to cover the enlarger head to prevent light leaks from around the negative carrier and lamp housing from fogging the matrixes. It can be made of black felt or any opaque black cloth. Rather than construct a bag which has to slide over the enlarger, make a split bag which can be wrapped around the enlarger head and tied closed. Another simple solution is to use a view camera focusing cloth to wrap the entire enlarger head to prevent light leaks. In all cases, check for stray light by darkening the room, waiting a few minutes to get your eyes accustomed to the dark, then check for light leaks. You will be amazed. **USE THE DARKBAG ONLY DURING EXPOSURES TO PREVENT EXCESSIVE HEAT BUILDUP!!, REMOVE IT WHEN EXPOSURE IS COMPLETED!!!!!.**

Enlargers (4x5 size).

1. Omega model D5VXL
2. Beseler model 45MXII
3. Durst model L1200

*****3.1.1 Enlarger Light Source.** For those who are making dye prints from color negatives, the standard condenser type light source or dichroic color head is more than satisfactory. If you plan to make matrix exposures from separation negatives there is some controversy about what is the best type of light source to use. Most believe that a condenser type light source is not the best light source for exposing matrixes from separations because of its tendency to block highlight detail and increase the contrast of prints. This is not a problem with color negatives because the emulsion contains dye pigment, not silver. The increased contrast creates a number of headaches in the print that cannot be rectified with highlight masking or print controls. The remedy for these potential problems is a diffusion light source of some kind. Diffusion light sources tend to minimize imperfections in the separation negative, provide good highlight detail, and tonality. All of Kodak's exposure recommendations for its masking and separation films are based on the use of a diffusion light source. If your light source is a dichroic color head that does not use a condenser then you have no problems. For all others, a cold light source is an excellent alternative. The Aristo Company makes an excellent diffusion light source which fits a number of popular enlargers. The bluish color of the Aristo head is excellent for matrix film because of its sensitivity to actinic light (ultra violet), however, the bluish color will cause some slight loss of contrast print when compared to the 3200K light sources. This is a very minor problem which is easily remedied in the process. Owners of Omega enlargers may be able to buy a used Omega diffusion light source for a reasonable price since Omega no longer manufactures diffusion light sources.

A novel idea is to purchase an additive color head for your enlarger. This greatly simplifies the exposure of color negatives onto Pan matrix film. Some professional labs also use it to make separation negatives. This type of enlarger head contains red, green, blue light sources. The chief advantage of this color head is that there is no exposure compensation needed as compared to using the standard gelatin filters, i.e., the exposure is the same for each color. In addition, sharpness is improved because the filtration is above the enlarging lens. The Phillips model PCS 150 is one brand of tricolor light source currently available. This model is made for the Phillips enlarger but can be adapted for Omega and Beseler enlargers. Phillips recommends that the filtration should be set to 50 red, 50 green, 50 blue for this type work. Another tricolor light source is the Beseler-Minolta 45A electronic colorhead. This unit uses color filtered flashtubes controlled by a computerized sensor. The advertisements say the 45A can be used to make color separations. Buy this unit at you own risk; there are rumors that the 45A is prone to overheating.

If you plan on making enlarged separation negatives from 35mm transparencies, then you might also want to have a "point light source". A point light source will produce enlarged separations of optimum quality. I have seen satisfactory prints made without a point light source, but if you have the money get a point light source. These light sources are available for both the Omega and Beseler 4x5 enlargers. The Condit Company makes a special point light source head for the Omega 4x5 enlarger that is designed for enlarged separation work. It has a bulb support which allows it to be raised and lowered for focusing, a variable light illumination control, variable condensers and six filter holders in the housing.

If you can't afford a point light source for enlarged separation work, you can make a crude facsimile that does a better job than the standard opal enlarging bulb supplied with enlargers like the Omega 4x5. You will need a bayonet- to-screw base light adapter. Such adapters were made for miniature flash bulbs. Condit sells the adapter for a modest price. Other sources for this adapter are the Frank Morse Company or possibly through your local photo supplier as a #455-flash lamp socket. The address of the Morse Company is listed in the last section of this chapter. You will also need a General Electric No. PH111A, 75watt, 120V enlarging bulb. These bulbs are small 1-1/2 inch diameter opal bulbs with a bayonet base. The bulbs can be obtained from your local photo dealer since it is used in such enlargers as the Beseler 23C enlarger or from Condit.

The bulb is installed in the adapter and this assembly is inserted in the head. Be sure your enlarger has at least five inches of clearance for this assembly. If you don't, this idea should not be attempted because the bulb operates at high temperature and may damage your condenser.

Cold Light Source.
1. Aristo Co. model D-2 (Omega & Beseler 4x5)
   model available for Testrite, Printex, Sunray, etc.
2. Mervap Co.

Point Light Source.
1. Omega Microfilm Lamp Type DM
2. Beseler Point Source Illuminating
   System #8135

Substitute Light Source.
1. Bayonet-screw base adapter
   K&M or F. Morse Company.
2. 75 watt, 120v Enlarger bulb.
   G.E.#111A

3.2 VOLTAGE REGULATORS.

A voltage regulator is a necessity for any kind of color printing. A regulated voltage source is needed because the operation of washers, electric ranges, or similar heavy electric equipment in the home can cause voltage fluctuations. Even a neighbor, if he is on the same transformer, can cause voltage fluctuations. Variations in voltage of only a few volts can result in noticeable color shifts. A change of five volts will reduce the light output of a incandescent tungsten bulb about 15% resulting in a color change equivalent to 10CC filtration. An increase in voltage will increase the blue content of the light source and a decrease in voltage will increase the red content. If the light source in your enlarger is a tungsten-halogen bulb (often used in color heads), which uses a step-down transformer, then you may not need a voltage regulator because the transformer will act as a one. Light sources with cold light heads also don't require voltage regulation.

There are two types of voltage regulators. The most common is the transformer type, technically called constant voltage transformers. Although these regulators are quite heavy and bulky, they are capable of handling large wattages. Two companies which make this type of regulator are Sola Electric Division and Raytheon Company. Every time the voltage changes the constant voltage regulator automatically readjusts the line current to keep the voltage constant.

The second type of voltage regulator is the solid state type. These devices use electronics to control voltage fluctuations. They are extremely light, often weighing only a few ounces, and are considerably smaller than the transformer type of regulator. An excellent solid state regulator is manufactured by Vivek Company but other brands are also available. The Vivek regulator is available from Condit.

If you are careful you can get by without a voltage regulator by being discrete about the times you use your enlarger. Avoid times when people are active around the house such as mealtimes, mornings or early evenings. If heavy industry is nearby, find out when they shutdown and startup for the day. This leaves late nights as the only time to do any kind of color exposing. Obviously, it is much easier to make an investment in a voltage regulator as soon as your budget will allow.

Voltage Regulators.

1. Sola 20-13-112.(transformer)
2. Raytheon #VR-6113.(transformer)
3. Vivek model 110 (solid state)
4. Unicolor model 750 (solid state)

***3.3 SAFELIGHT FILTERS.

Safelights cannot be used when making exposures on Pan Matrix Film 4149 from color negatives. Those making matrixes from separation negatives can use a safelight because Matrix Film 4150 is orthochromatic. A No. 1 red safelight is recommended by Kodak, but a No. 1A safelight filter is also acceptable and is considerably brighter.

Safelight

1. Kodak. No. 1 or No. 1A

3.4 TRAYS.

A number of processing trays are necessary for the dye transfer process. We will be working only with 10x12 or smaller matrix films so the tray sizes reflect this approach. You will need seven 11x14 trays. Three of these trays will be used for matrix film processing and for rinsing the matrixes during the transfer process. The other four are for the dye baths and the paper conditioner. If possible, you should get three flat bottomed trays to process your matrix film in, although flat bottomed trays are sometimes hard to obtain and more expensive. The flat bottomed trays will protect your film from scratches and require less chemistry because there are no grooves or dimples. The dimples and grooves may also cause variable density areas on film if it is left stationary in the fixer. The remaining six may have dimples or grooves but make sure they are the depressed kind to protect the delicate matrixes.

In addition to the 11x14 trays, you should purchase three 5x7 trays. They will be used to process matrix test strips and separation negatives. Try to get trays with either flat bottoms, depressed grooves, or dimples for the same reasons mentioned above.

```
Trays (flat bottomed).
1.  11x14 tray.  VWR Scientific catalog no.  TR71707-20
    or Kodak catalog no.  EK# 150-6633

2.  5x7 tray.  Cesco-lite or Kodak
```

*****3.4.1 Drum Processing.** An interesting alternative to tray processing of matrix film is to use a color paper drum processor and a motorized drum roller. Drum users say they get very good results with drum processors. There are two notable advantages to this technique. First, the convenience of working in room light. Second, the motorized roller provides added consistency to development. This helps maintain the predictability necessary for good mats. Although I have experienced problems when processing Pan Matrix with a drum, others have had no problems, especially those using the JOBO type drums; test your drum, it may work.

There are a few things you should remember if you are going to purchase a drum. First, get an 11x14 drum for 10x12 matrix film, preferably one that will accommodate a number of film sizes. For instance, some drums will allow you to process a number of 4x5 test sheets simultaneously. Since matrix film is not a standard size, be sure the drum can accommodate the 10x12 film with no trouble. I suggest you take a 10x12 sheet of paper with you when you go to purchase a drum to verify it can hold 10x12 film. This way you can be sure that you will have no problems. Each sheet of matrix film must be processed in at least a specified minimum volume of chemistry. You should not use less than 5 ounces of tanning developer part A for each sheet of 10x12 matrix film (1 ounce for 4x5 film). That works out to approximately 0.04 ounces per square inch. You should also remember that if you develop a 4x5 sheet of matrix film in a large 11x14 drum, you will have to use at least the minimum recommended volume of developer for that drum. For example, only 3 ounces (1 ounce part A and 2 ounces part B) of developer is necessary to process a 4x5 sheet of film but you'll have to use 6 ounces in a typical 11x14 drum. Make sure you wash the drum thoroughly after each use or you can create some bad contamination problems.

```
Color Processing Drum.
1.11x14 drum.  Beseler, Unicolor,
  Cibachrome, JOBO.
2.Motorized Drum Roller.  Beseler,
  Unicolor, Cibachrome.
```

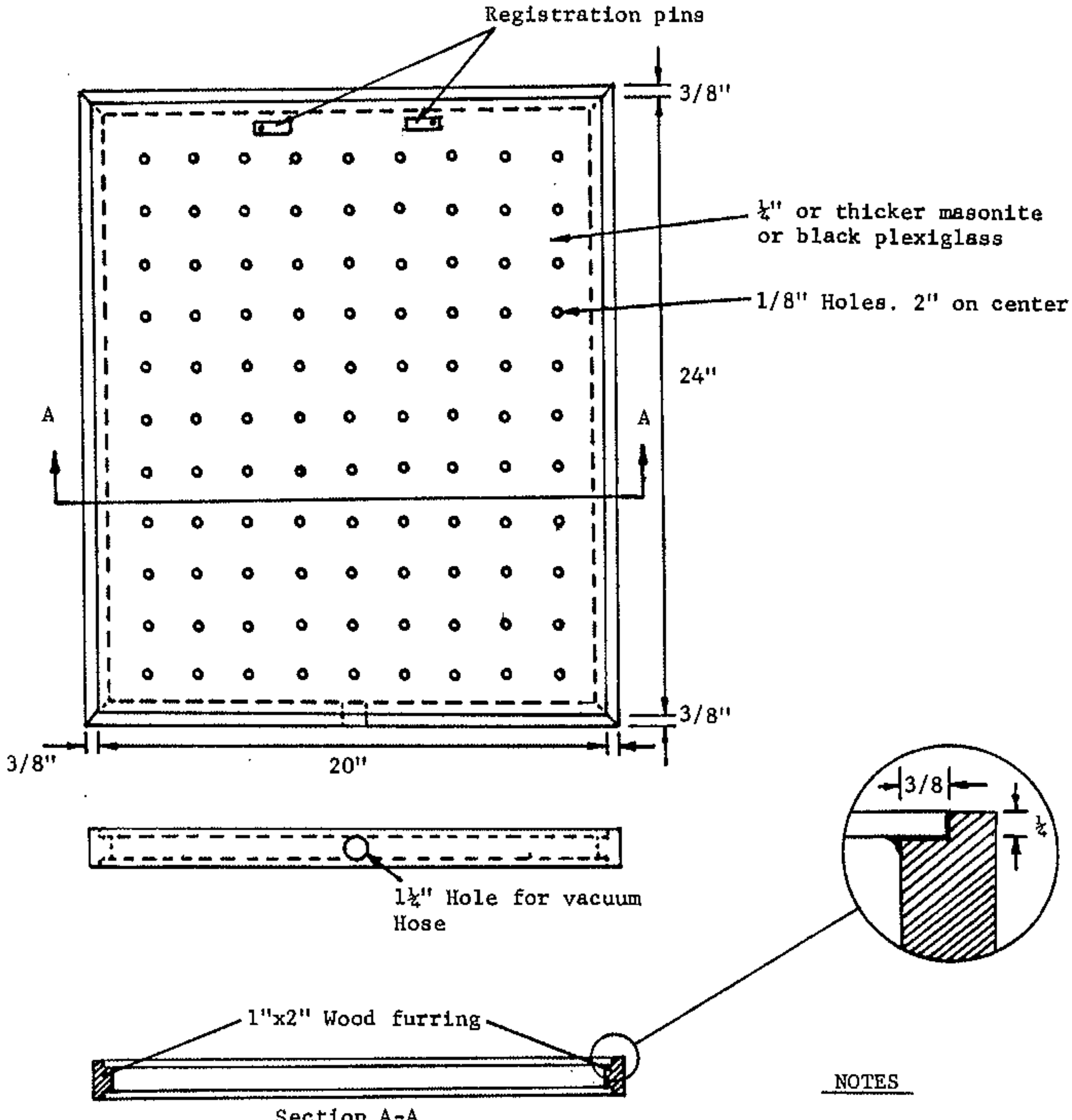
3.5 VACUUM EASEL.

When exposures are made on matrix film it is imperative that the film be flat to insure good registration. This is usually accomplished with a vacuum easel. A vacuum easel secures film by creating suction underneath the film to hold it in place.

Commercially sold vacuum easels are available to handle film sizes up to 20x24. For most dye transfer work these easels come with registration pins, some have retractable pins. Registration holes are punched in the matrix film, then it is placed on the easel's registration pins. Obviously, if you buy a commercially made easel you will also need a punch to go with it. Those who will be making matrixes from color negatives have a distinct advantage over others because Pan Matrix film is prepunched. Pan Matrix users should make sure their commercial vacuum easel has the proper pins for Pan Matrix film. In either case, a vacuum pump of some sort is also required. Make sure your vacuum easel has vacuum channels for 10x12 matrix film. Easels are available from Condit Company and from Kodak. Unfortunately, the cost of this equipment starts at several hundred dollars and approaches almost a thousand.

The alternative is to build your own vacuum easel. This is not as difficult as it seems. The only special items you'll have to purchase are registration pins. Condit makes pins that can be glued to the surface of the easel and pins with threaded ends with nuts which can be attached to the surface of the easel. Your source of vacuum will be a common vacuum cleaner. Two different designs are shown in this section. The difference between the designs is mainly a matter of preference and willingness to invest time to do a good job.

The first design is shown in Figure 3.5.1. The material is listed below:

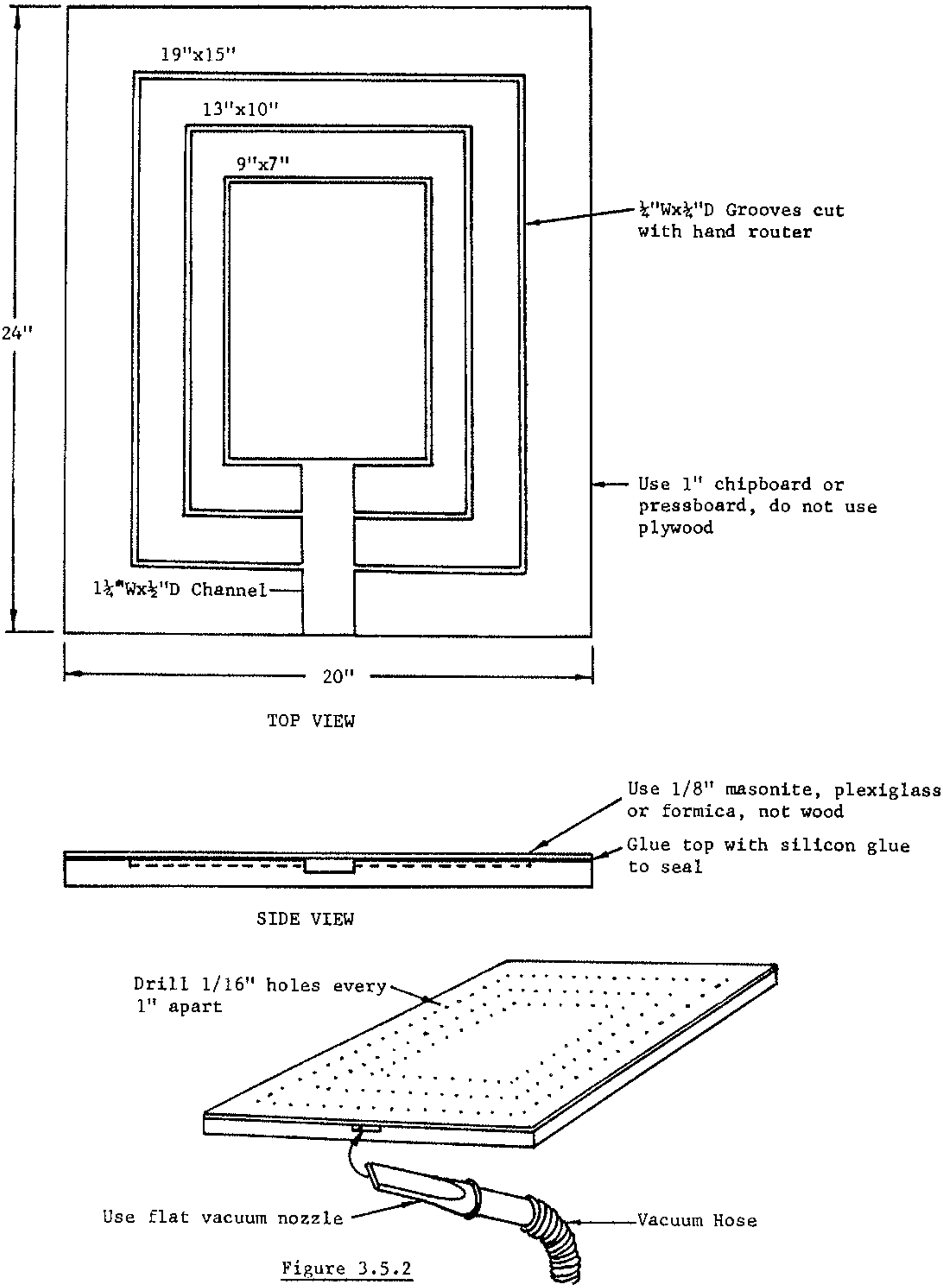


NOTES

1. Paint all surfaces flat black.

2. Seal all joints with silicon rubber glue.

Figure 3.5.1



19"x15"
13"x10"
9"x7"
¼"Wx¼"D Grooves cut with hand router
24"
Use 1" chipboard or pressboard, do not use plywood
1¼"Wx½"D Channel
20"
TOP VIEW
Use 1/8" masonite, plexiglass or formica, not wood
Glue top with silicon glue to seal
SIDE VIEW
Drill 1/16" holes every 1" apart
Use flat vacuum nozzle
Vacuum Hose

Figure 3.5.2

Quantity	Description
1 sheet	20x24x1/4 in. Masonite or black plexiglass (top)
1 sheet	20x24x1/4 in. Masonite or plywood (bottom)
2 pcs.	24x1x2 in. pine (#1 grade) (side)
2 pcs.	20x1x2 in. pine (#1 grade) (side)
1 tube	Silicone rubber glue
1 box	1-1/4 in. finishing nails or wood screws
1 quart	Flat black paint
1	6-1/2 in. regist. pin strip or set of pins (Condit Co.)

Do not use plywood for the top since its surface is too rough for this application. If you buy masonite, make sure it is the tempered kind, which has a hard, smooth surface on one side. The black plexiglass is much nicer but 1/4 inch plexiglass is rather expensive. Be sure to seal all of the joints with the silicone glue. This design will accommodate film up to 16x20 easily. If you prefer, you can reduce the overall size to 14x16 inches if you are planning to use only 10x12 film. The design shows fancy miter joints and dado cuts, however they can be omitted in favor of simpler methods of joining wood. Be sure to sand down any burrs created by drilling the 1/8 inch holes.

The second design is much more compact than the previous design. If you have access to a router this design is easy to build and requires no screws or nails. See Figure 3.5.2. The materials are listed below:

Quantity	Description
1 sheet	20x24x1/8 in. black plexiglass, masonite, or formica
1 piece	20x24x3/4 in. chipboard
1 pint	contact cement or silicon rubber glue
1	6-1/2 in. regist. pin strip or pin set

The slots are 1/4 inch deep grooves and the main channel is 1/2 inch deep. The smaller size is possible because a flat corner vacuum cleaning accessory eliminates the necessity for a 1-1/4 inch hole. For convenience an auxiliary channel can be added on the longer side of the easel for horizontal use of the easel. The auxiliary channel can be sealed with a rubber plug which can be removed and inserted in the other channel whenever it's to be used. The holes in the top are located over the slots as shown in the diagram. Use an over sized drill to deburr all drilled holes.

The vacuum easel should not move when you are making exposures, so devise a way to anchor the easel to the enlarging table. I use C-clamps but this may not be practical for your enlarging set up. Condit Company makes easel clamping bars in various sizes from 14 to 48 inches in length tracks. The bars bolt to the table and the easel is anchored by "spin-tite" locking devices. A design for a homemade easel clamping system is shown in Fig 3.5.3. and 3.5.4. With the easel shown in figure 3.5.1 there is a limitation to its size. Too much vacuum can cause the easel to sag in the middle for larger sizes. This problem can be solved by putting a support in

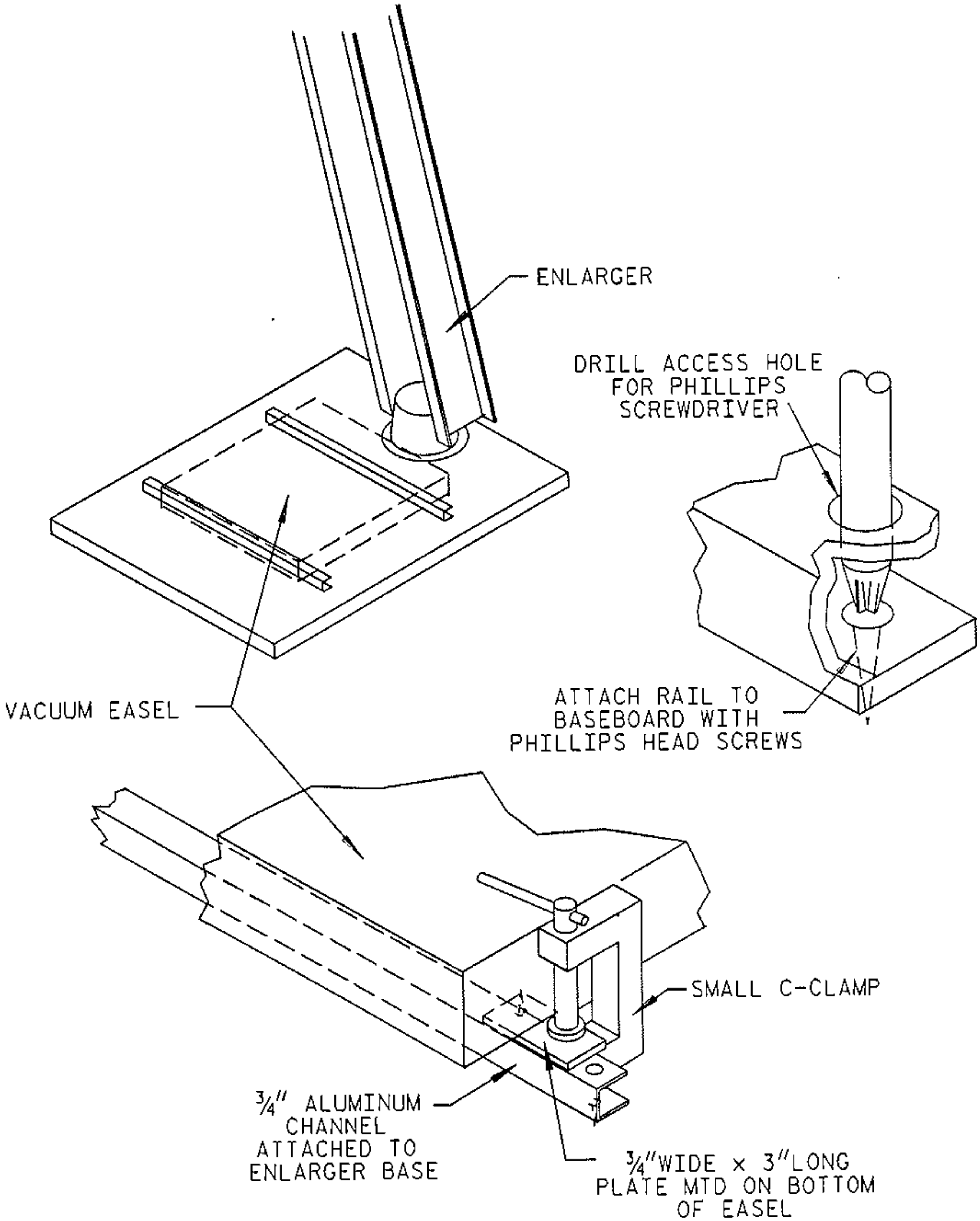

ENLARGER
DRILL ACCESS HOLE
FOR PHILLIPS
SCREWDRIVER
VACUUM EASEL
ATTACH RAIL TO
BASEBOARD WITH
PHILLIPS HEAD SCREWS
SMALL C-CLAMP
¾" ALUMINUM
CHANNEL
ATTACHED TO
ENLARGER BASE
¾"WIDE x 3"LONG
PLATE MTD ON BOTTOM
OF EASEL

FIGURE 3.5.3

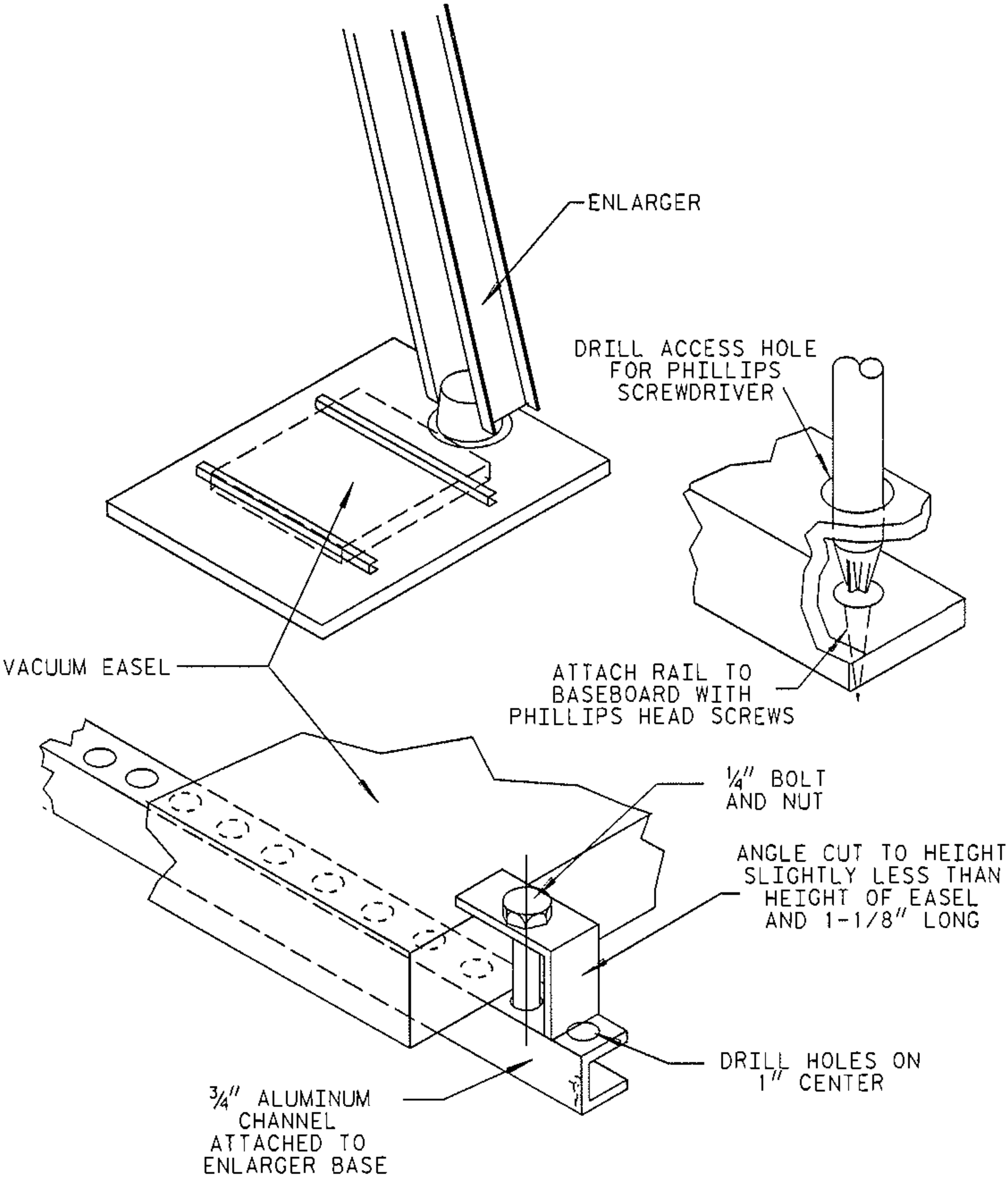
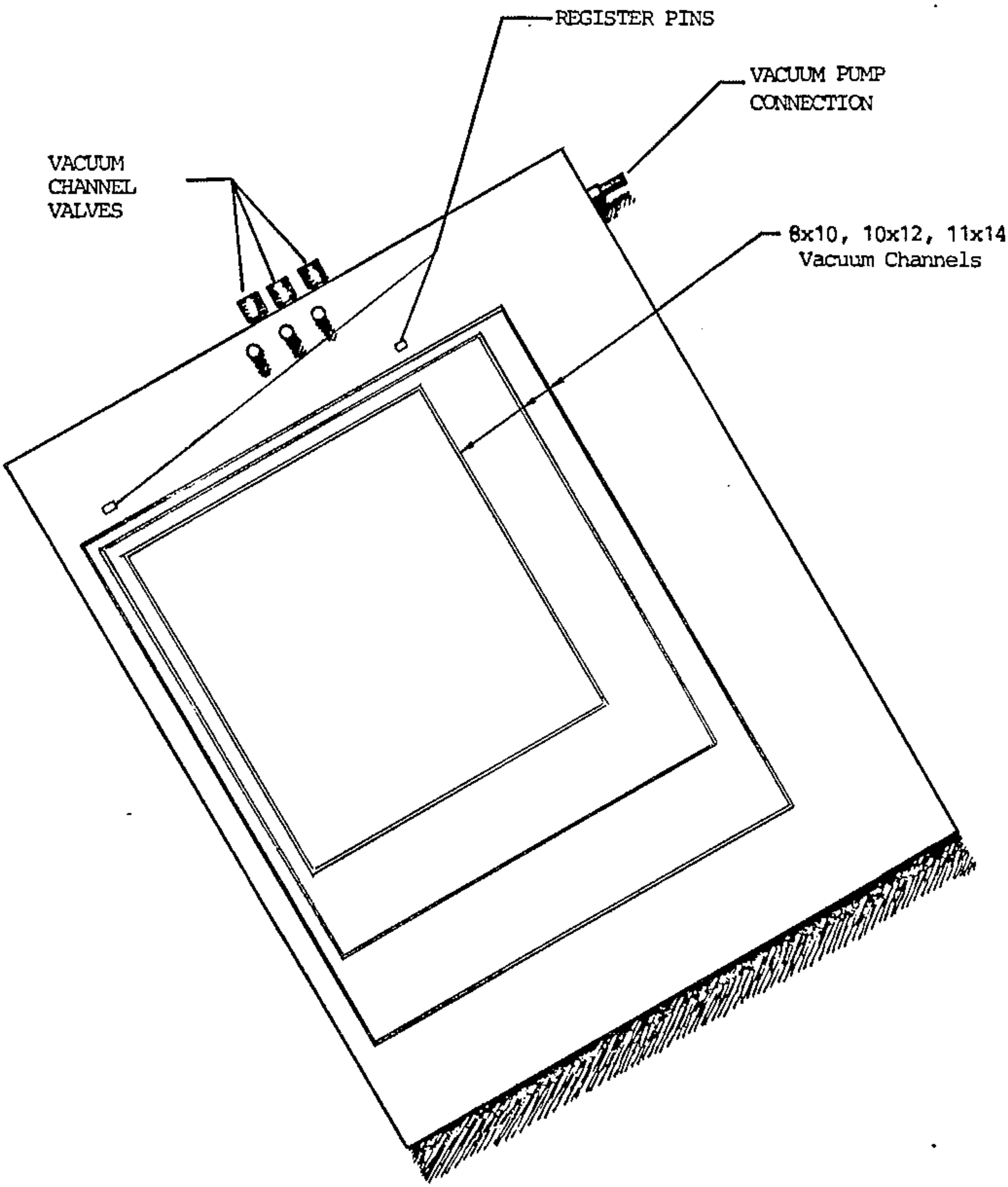
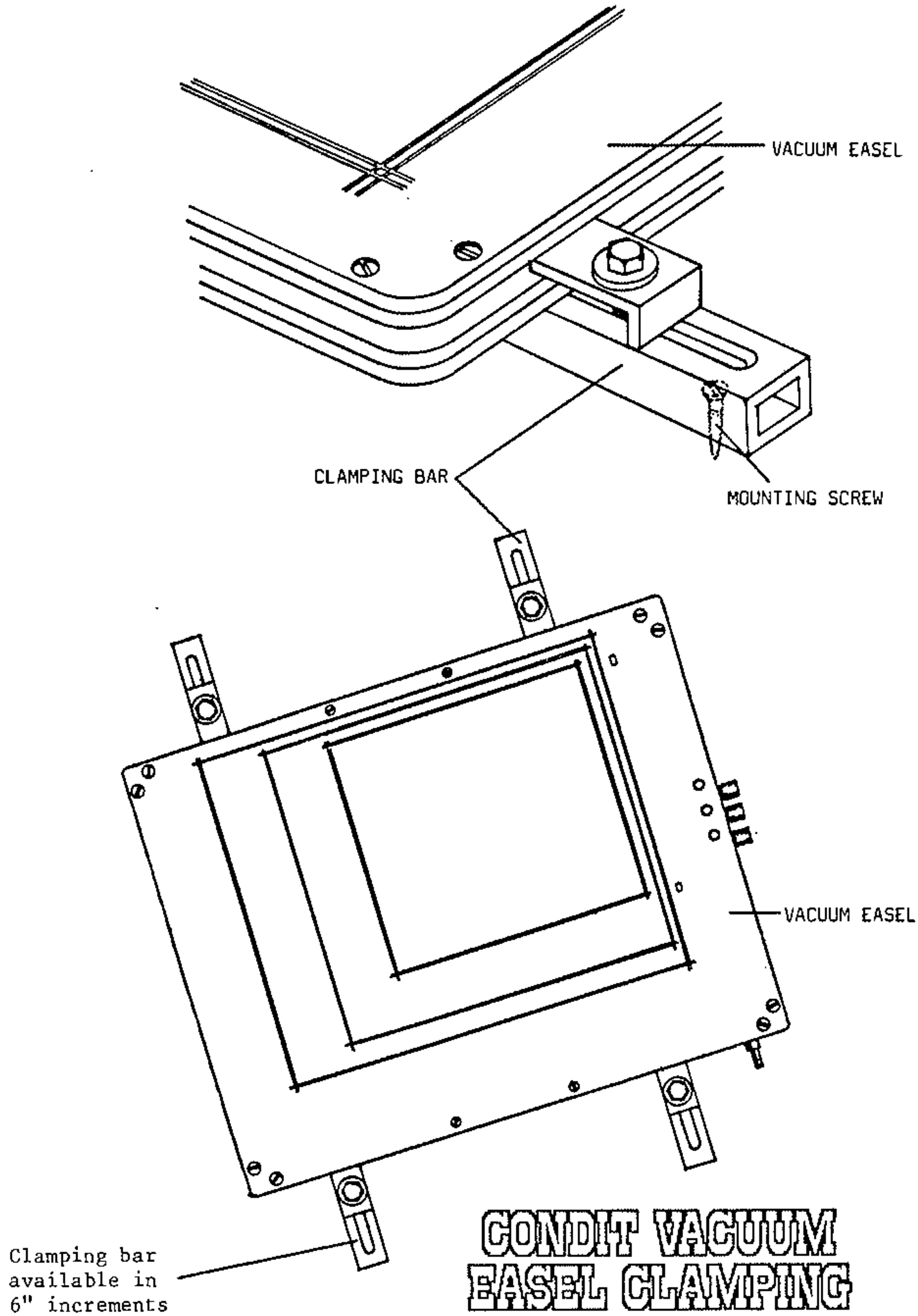

ENLARGER
DRILL ACCESS HOLE
FOR PHILLIPS
SCREWDRIVER
VACUUM EASEL
ATTACH RAIL TO
BASEBOARD WITH
PHILLIPS HEAD SCREWS
1/4" BOLT
AND NUT
ANGLE CUT TO HEIGHT
SLIGHTLY LESS THAN
HEIGHT OF EASEL
AND 1-1/8" LONG
DRILL HOLES ON
1" CENTER
3/4" ALUMINUM
CHANNEL
ATTACHED TO
ENLARGER BASE

FIGURE 3.5.4



CONDIT COMMERCIAL FIXED PIN VACUUM EASEL



CONDIT VACUUM EASEL CLAMPING BAR

the center of easel, especially for easels 16x20 and larger. Remember, to keep the vacuum low, use just enough to secure the film to the easel. Too much vacuum can cause dimpling of the film.

```
Vacuum Easel
1.  10x12 fixed pin vacuum easels.
Available from Condit Co.  (many sizes)
```

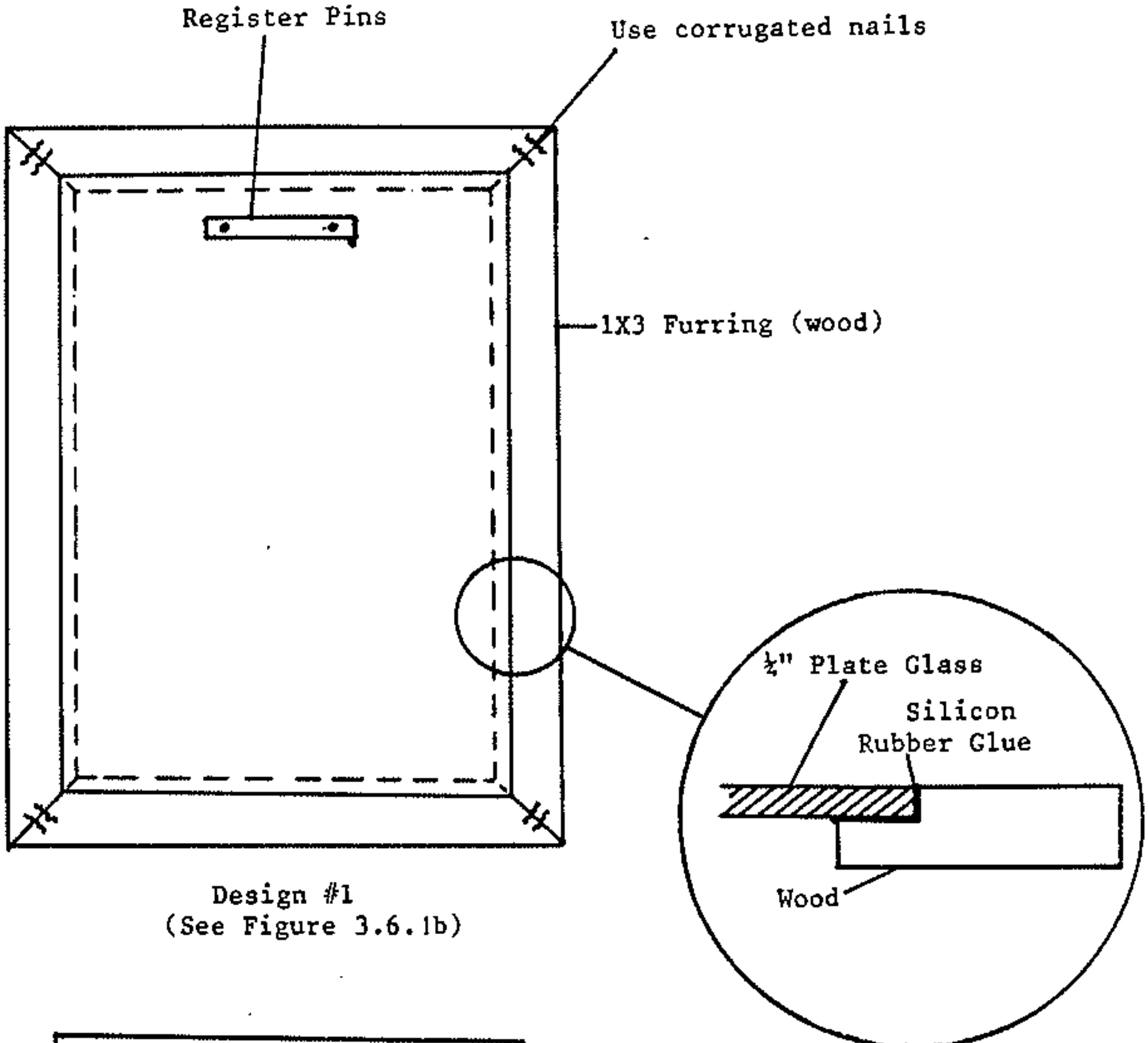
3.6 TRANSFER EASEL.

Dyes are transferred to the support paper on a transfer easel. Many professional dye labs use a transfer easel made of granite. The granite slab has a porous texture which helps keep the dye transfer paper moist and prevents slippage when matrixes are rolled onto the paper. The loss of moisture will cause the transfer paper to buckle and curl resulting in mis-registration. Granite is also impervious to corrosion, which means it will last a life time. Condit Company use to sell a granite slab with registration pins but it is no longer sold by them.

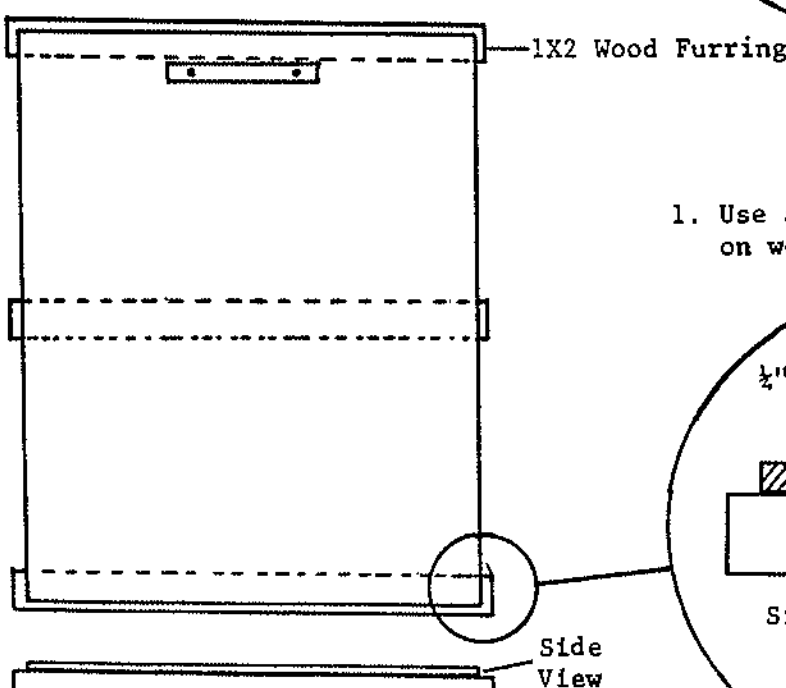
One can be make a granite easel by "epoxying" commercially made pins in a slab of granite purchased from a monument dealer. Drill the holes with a masonry bit. Exact placement is accomplished with a template made from cardboard which has be punched with a registration punch.

Condit now makes glass transfer boards in two sizes. For 10x12 and 11x14 film a 1/4"x15"x18" model is available. For film sizes from 10x12 to 16x20, a model measuring 1/4"x18"x26" is available. The larger models has two sets of pins to accommodate the two sizes of registration holes. These boards are designed to be used on the darkroom sink duckboards.

Many dye transfer enthusiasts use plate glass as an alternative. It is extremely flat and smooth by comparison to granite, but it works almost as well. The plate glass should be at least 1/4 inch thick. Do not use ordinary glass because it is not as flat as plate window glass and is more prone to breakage and scratches. To protect plate glass from breakage, glue wood strips underneath it with a waterproof glue such as silicon rubber glue. Be sure to give the wood strips several coats of varnish to protect them from moisture. Two possible designs for a plate glass easel are shown in Figure 3.6.1. When you buy the plate glass be sure to have the glazier round off the edges of the glass. For 10x12 matrix film buy 14x16 inch plate glass. The materials for Design #1 are listed below:

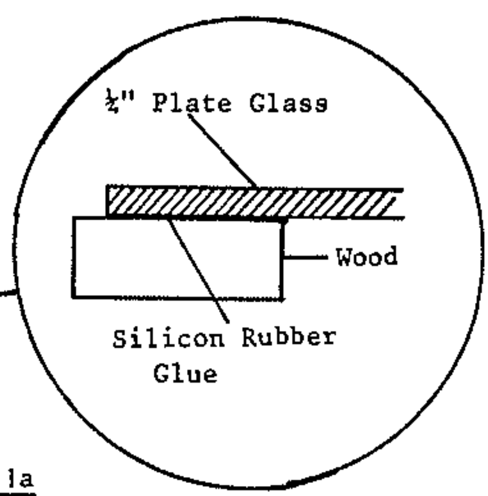


Design #1
(See Figure 3.6.1b)



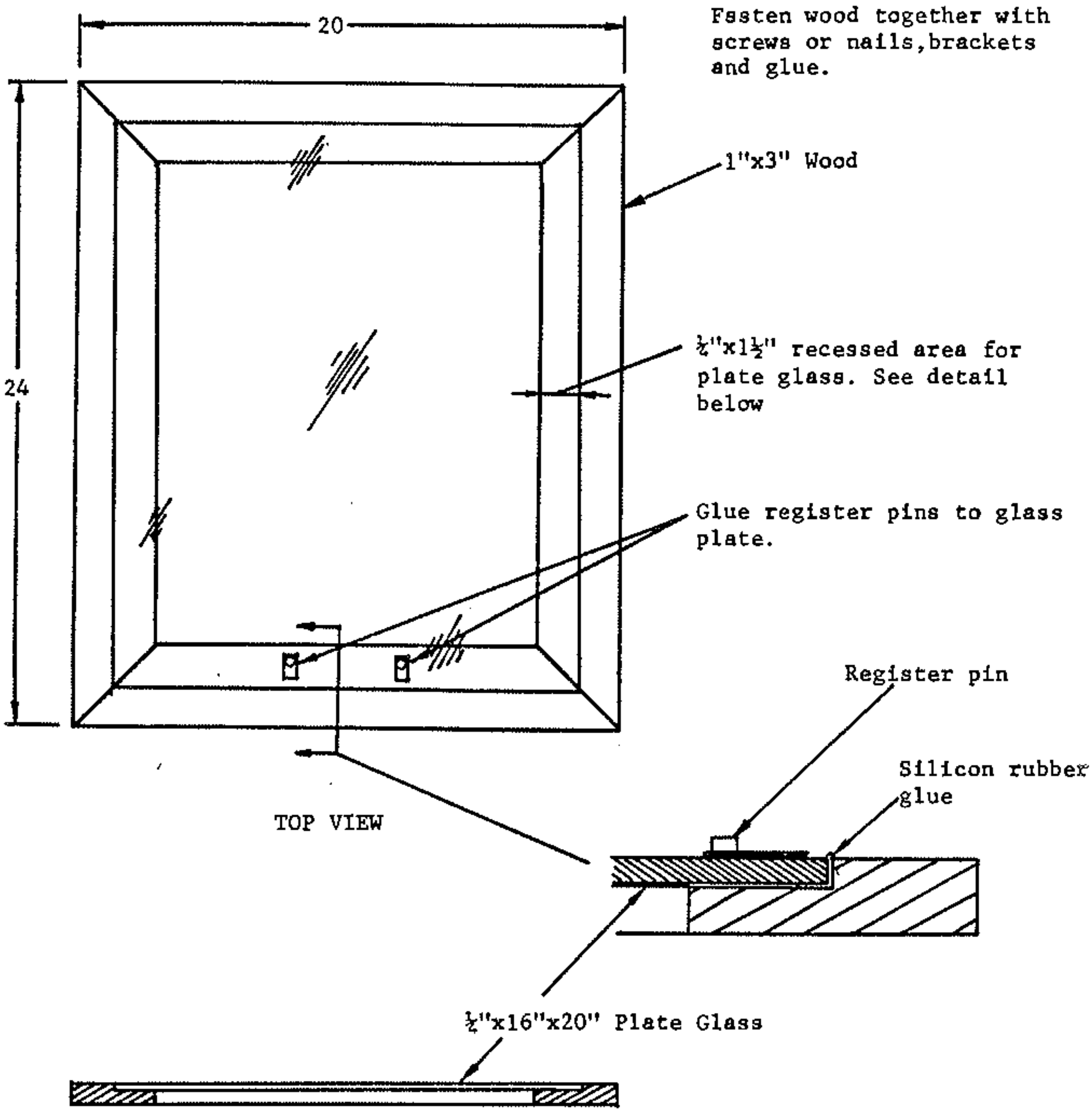
NOTES

1. Use at least 2 coats of varnish on wood before glueing.



Design #2

Figure 3.6.1a



Notes

1. Seal all crevises with silicon rubber glue.
2. Cover wood with at least 2 coats of varnish or equivalent finish.

Figure 3.6.1b

Quantity	Description
1 sheet	14x16x1/4 in. Plate glass
2 pcs.	20x3x1 in. pine (#1 grade)
2 pcs.	18x3x1 in. pine (#1 grade)
1 dozen	corrugated nails (L-brackets may be used instead)
1 tube	Silicone rubber glue
1 quart	Spar varnish
1	6-1/2 in. regist. pin strip or pin set

The materials for Design #2 follow:

Quantity	Description
1 sheet	14x16x1/4 in. Plate glass
3 pcs.	15x2x1 pine in. (#1 grade)
1 tube	Silicone rubber glue
1 quart	Spar varnish
1	6-1/2 in. regist. pin strip or pin set

These designs can easily be modified to accommodate larger glass for larger prints.

3.7 PRINT ROLLER.

A print roller is used to roll the matrix film onto the dye transfer paper. The roller must travel smoothly and uniformly contact the film surface. Get the best roller you can afford. Without complete contact between paper and matrix film all your work can go down the drain. Get a good roller such as Kodak's or Condit's 17". Condit also makes a 22" roller for larger film sizes and makes a lower cost 13" aluminum roller for smaller film sizes. All of these rollers cost well over a hundred dollars but you will never regret spending the money. What makes these rollers so good is their weight, smooth rolling action and the soft rubber rollers which are precision made to close tolerances. You might find some graphic arts rollers or brayers that are less expensive but not by much.

Some people use a rubber squeegee instead of a roller. I do not recommend them because they wear out and sometimes apply unequal pressure. If you're short of funds, however, they're a good substitute until you can get a decent roller. Get a squeegee with a soft rubber blade that is at least 14 inches wide. Condit sells a 14 rubber squeegee. You may have to squeegee the matrix film two or three times with light pressure to get good results.

```
Print Rollers.
1.  17" Kodak Master Print Roller EK# 147-7249
2.  22" Stainless steel roller by Condit Company
```

3.8 GELATIN FILTERS.

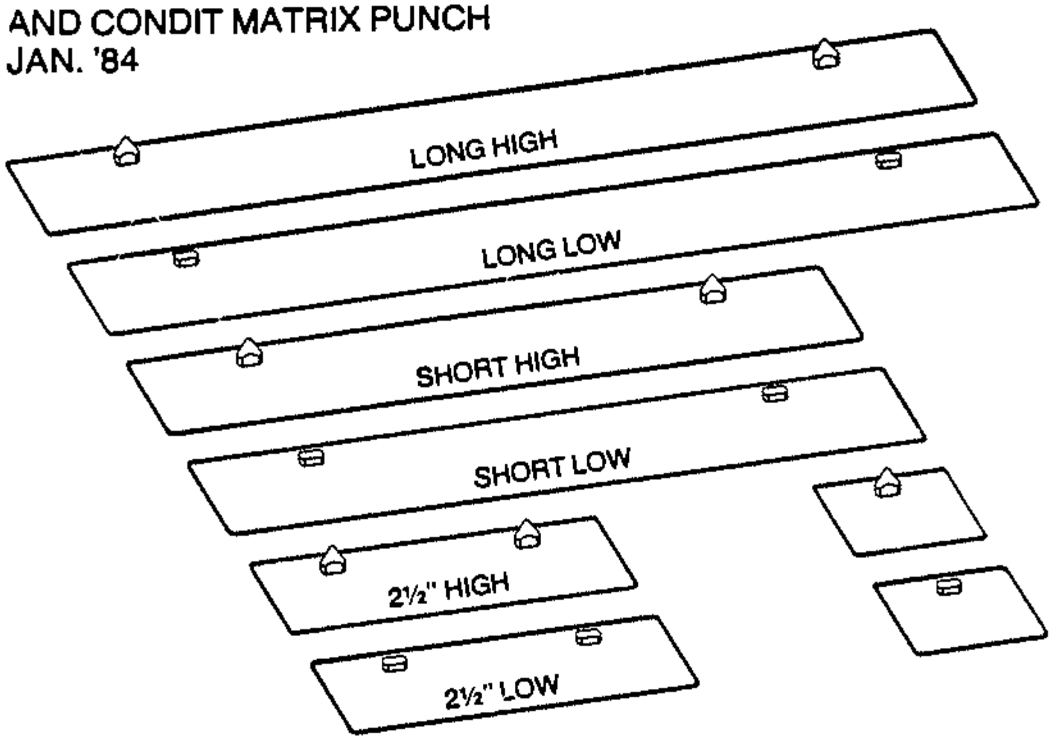
Red, green, and blue filters are needed to make tricolor exposures, but different filters are recommended for different films. See section 1.4 for a more thorough explanation of filters. Use either a 2 or 3 inch filters. It's possible to buy 5 inch filters for use above the enlarging lens but they are expensive. Putting the filter above the enlarging lens has one distinct advantage, scratches are not a problem. If your exposures are made in front of the lens, care must be taken not to scratch the filters since scratches will seriously degrade the sharpness of the dye print. Eventually, the filters will have to be replaced regardless of how careful you are because the filters will begin to fade due to constant exposure to light. To help protect your filters you should put them into a filter frame. Kodak makes metal filter frames in 2, 3, and 5 inch sizes. Another alternative is to buy low cost cardboard filter frames from Calumet Company (see listing at end of this chapter) in packages of 24. The Calumet frames are held together with self-sticking adhesive and come in a number of sizes. You can save a little money by making your own filter frames out of cardboard. Just cut a circular hole, larger than the diameter of the enlarging lens, into two pieces of thin cardboard, place the filter between them and glue the pieces together.

3.8.1 Filters for Color Negatives. If you will be making matrixes from color negatives, either of two combinations of filters are recommended. Kodak recommends the Wratten filter number 29(red), number 99(green), and number 98(blue). Kodak says the 47B(blue) filter can be used in lieu of the 98 filter if your exposure times are too long. If you use the 47B filter also use a 2B filter to limit unwanted UV light. The other filter combination which will also work well are the number 29(red), number 61(green), and the 47B(blue) filters. The only reason you might want to use the second combination is that they can also be used for making separation negatives. Sometimes the 29, 61, and 47B are easier to obtain than the first combination. I recommend the 29, 99, and 98 as the best combination if you are only working with Pan Matrix film, although you can interchange any of the filters to suit your needs.

*****3.8.2 Filters for Separations.** As we have already mentioned the filter combination recommended for separation work are Wratten filter numbers 29(red), 61(green), and 47B(blue). This combination should not be altered because most exposure and development information assumes you are using these filters. In addition, a number 24(red) filter is needed if you ever plan to make separations from Kodachrome transparencies. The number 24 (red) filter is used instead of the 29 (red) filter when making Kodachrome separations because of the emulsion differences between Kodachrome and Ektachrome film. The red and green filters are also used to make the principal color masks. If you have the inclination to try making a single mask, you will need a Wratten filter number 33(magenta). For highlight masking Kodak recommends a 2.4 Neutral Density filter assembled from a 2.0 and 0.4ND filter. Get 0.3, 0.6, and 0.9ND filters to help make exposure times for each filter nearly the same. This helps to alleviate reciprocity problems.

STAINLESS STEEL REGISTER STRIPS

FOR EASTMAN KODAK PUNCH
AND CONDIT MATRIX PUNCH
JAN. '84



.015 SPRING TEMPER STAINLESS BASE

STRIPS TO MATCH CONDIT MATRIX PUNCH

- 3 Pins
- 4 Pins
- 5 Pins
- 6 Pins

HIGH AND LOW PINS

ROUND PINS 1/16 - 1/8 - 3/16 - 1/4

- Single pin strip
- Two pin strips

NEED NUMBER OF CONDIT PUNCH TO MATCH

- Special two pin strips

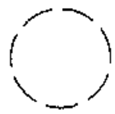
REGISTER PINS AVAILABLE SEPARATELY

CONDIT MANUFACTURING CO., INC.
Philo Curtis Road
Sandy Hook, CT 06482
U.S.A.

BREGMAN COMPANY

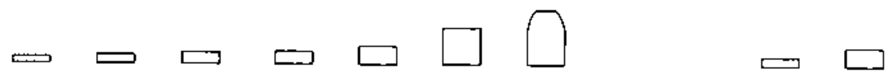
PINS

¼″ ROUND



3/16″ X ¼″ OBLONG
-or-
¼″ X 5/16″ OBLONG

CODE LETTER	M	N	T	R	O	Q	P	V	Y
HEIGHT	3/64	1/16	5/64	3/32	1/8	1/4	3/8	1/16	1/8



BASES

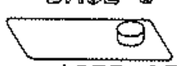
BASE 1

(SET OF 6)

BASE 2

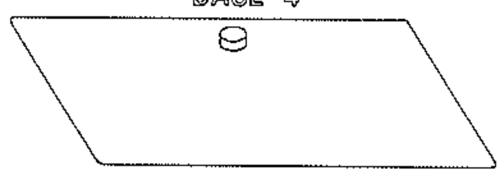
(SET OF 8)

BASE 3



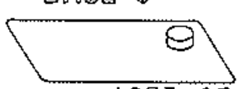
(SET OF 6)

BASE 4



(SET OF 3)

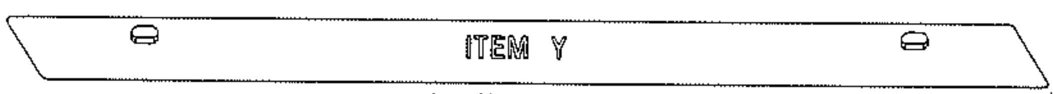
BASE 5



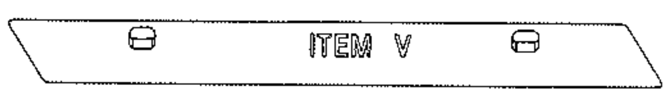
(SET OF 5)

PIN BARS

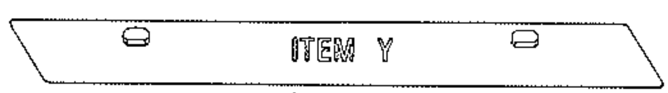
(9 INCH SPACING)



(9 INCH SPACING)



(6½INCH SPACING)



(6½INCH SPACING)

MILTON BREGMAN MFG.
2933 VAUXHALL RD.
VAUXHALL, N.J. 07088
201-851-0500

```
 Filters (2"(50mm) or 3"(75mm)).
   1.   #29 red
   2.   #99 green
   3.   #98 blue
   4.   #47B blue(optional) + 2B filter

***1.   #61 green
***2.   #47B blue
***3.   #29 red
***4.   #24 red(Kodachrome only)
***5.   #33 magenta(optional)
***6.   #96 neutral density

*** = for separation negatives.

 Filter Frames.
   1.   2"(50mm) filter frame.  Kodak #EK 148-6620
   2.   3"(75mm) filter frame.  Kodak #EK 148-6638
```

3.9 REGISTRATION PINS & PUNCHES.

Those doing dye prints from color negatives need registration pin strips for the prepunched Pan Matrix film. Two pin strips are needed; one for the vacuum easel, as mentioned in section 3.5, and one for the transfer easel, mentioned in section 3.6. For 10x12 Pan Matrix Film, purchase two 6-1/2 inch pin strips from Condit or Bregman Company.

The pin strips match holes produced by the Kodak Matrix film punch. If you plan to make 16x20 dye prints also purchase two 9 inch pin strips. Register pins come in two heights, low (1/16 in.) and high (1/8 in.), so get one of each (some intermediate heights are available from manufacturers). The low pin strip is to be used on the transfer easel and the high pin strip on the vacuum easel. Do not use the low pin strips on the vacuum easel because the low pins are hard to find in the dark.

You can substitute single register pins for the pin strip, but be sure you get the oblong type register pins. If you plan on making a registration negative carrier and/or a registration contact frame then be sure to purchase four additional low single register pins. The register pins for the carrier and contact frame can be round or oblong because either will work with the two hole punch you will use. Single register pins can be purchased from Condit, VWR Scientific or the Bregman Company.

You will have to locate the single pins on the easels by cutting off the top portion of a sheet of Pan Matrix film (the remainder of the sheet will be used for test strips) and using it as a template for gluing the single pins. Catalog pages for Condit and Bregman pins are included on the following pages.

*****3.9.1 Matrix Film Punch.** Unlike Pan Matrix Film 4149, regular Matrix Film 4150 has to be punched. The commercial register punch produces three oblong holes. The center to outside hole distance is 6-1/2 inches and the distance between the two outside holes is 9 inches. The 6-1/2 inch distance is used for films 11x14 and smaller and the 9 inch holes (or all three holes) for larger matrix films. One of the outside holes is a little longer than the other two oblong holes. This feature allows for any dimensional expansion or contraction the matrix film may undergo due to humidity or temperature changes. Registration punches are available from Kodak or Condit Company. Condit manufactures a matrix film punch which is compatible with the Kodak punch as well as a four hole punch with a span of 19" between the outside holes.

There is no rule which says the Kodak type punches must be used. Condit, for instance, sells a low cost paper punch and matching register pin kit which sells for about $35.00. Punches, used for graphic arts applications, will also do the job very well. If you use an alternate punch, make sure you get the proper registration pins to go with it. Register pins for these punches are usually 1/4 inch round pins. VWR Scientific sells a number of register punches and the register pins to go with them.

*****3.9.2 Separation Film Punches.** To keep the various masks in register it is necessary to have a film punch. Since most people use 4x5 separation and masking films, a special punch is required to punch holes along the edge of the film. Condit makes film punches just for this purpose. The Condit film punch is designed to punch two 1/16 inch holes in the margin of film. They also make a matching contact printing frame and a special glass negative carrier with 1/16 register pins built into them. These items will be discussed later in this chapter.

*****3.9.3 Homemade Punches.** The cost of register punches for matrix film, 4x5 separation, and masking films is quite expensive. An adequate substitute of a matrix film punch is an ordinary three hole paper punch. The paper punch you purchase should be of good quality to insure ease in punching holes. An expensive paper punch costs much less than a commercial film punch. The only drawback in using such punches is the fact that they cannot compensate for dimensional changes in film size. Be certain that the punch hole sizes are 1/4 inch. Many paper punches have 5/16 inch holes, so be careful when you buy. The pins for the paper punch are the graphic arts 1/4 inch round type but the oblong type will also work. The round pins can be purchased from Bregman and VWR Scientific. The oblong pins can be purchased from Condit or Bregman.

An ordinary two hole paper punch can be used for separation and masking film. It is best to buy a good quality punch for the same reasons mentioned before. Make sure it is a 1/4" hole punch. Later in this chapter, a design for making a contact printing frame and a registration carrier will be discussed for use with this 2 hole punch.

Register Pin Strip (6-1/2 in.)
1. Condit Company
2. Bregman Company. 6-1/2 pin bar, item V.

Single Register Pin
1. Condit Company. Oblong pins
2. Bregman Company. Oblong pins, item V.

*****Matrix Film Punch**
1. Kodak #EK 147-6969
2. Condit Co. 3 hole model

*****Separation Film Punch**
1. Condit Company.

*****Homemade Punch and Pins**
1. Three hole paper punch.
2. Two hole paper punch.
3. Single 1/4 in. round register pins. Bregman code letter O or VWR Scientific Cat.#TR71750-00.

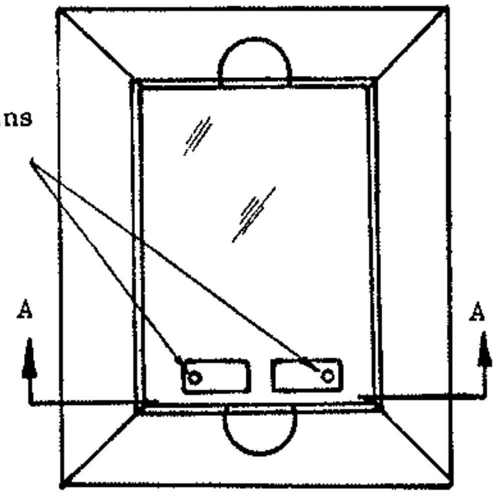
*** = for separation negatives

***3.10 REGISTRATION PRINTING FRAME.

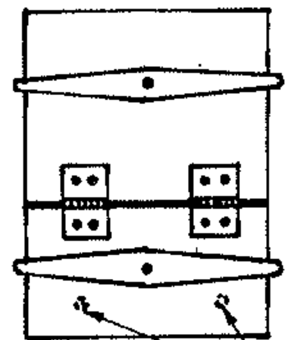
A registration printing frame is used to make contact masks and contact separation negatives. Making contact separations is easier than making enlarged separations and also much cheaper. Basically, the register frame is just a contact print frame with register pins. Kodak makes an 11x14 printing frame but nothing for 4x5 separation work. The Condit Company, however, makes 5x7 and 8x10 register frames, all of which use 1/16" pins. The 5x7 print frame accommodates both 4x5 and 5x7 film sizes. The price includes the frame, register pin glass, and the hole punch. Naturally, you will also have to purchase the register carrier which Condit calls a Precision Negative Carrier. A design for a homemade register carrier that can be made to accommodate either 1/16" or 1/4" pins is shown in section 3.11. It is primitive by comparison to Condit's precision carrier but it is functional non-the-less.

You can make a register printing frame out of an ordinary 5x7 contact print frame. In fact, you can make a print frame from wooden molding available from any lumber yard and ordinary picture glass. The register pins can be 1/4" or 1/16" pins. The 1/16" single pins can be purchased from Condit. With some simple modifications, you can have a very good printing frame. The hole punch, as mentioned in section 3.9.3, is an ordinary two hole paper punch or the 1/16" commercial film punch made by Condit. The design is shown in Figure 3.10.1 and the material is listed below:

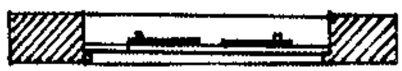
Glue register pins
to glass.
Location of pins
to match 2 hole
punch.



Homemade or commercial 5x7 printing
Frame



Drill holes for
register pin
clearance

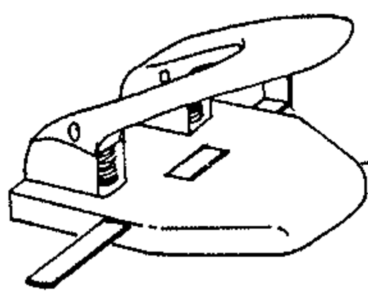


Section A-A

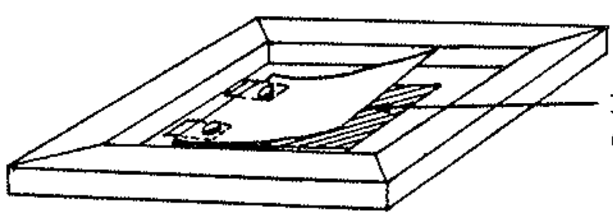
Side View

NOTE:

1. Be sure that punched
   holes match diameter
   of register pins.

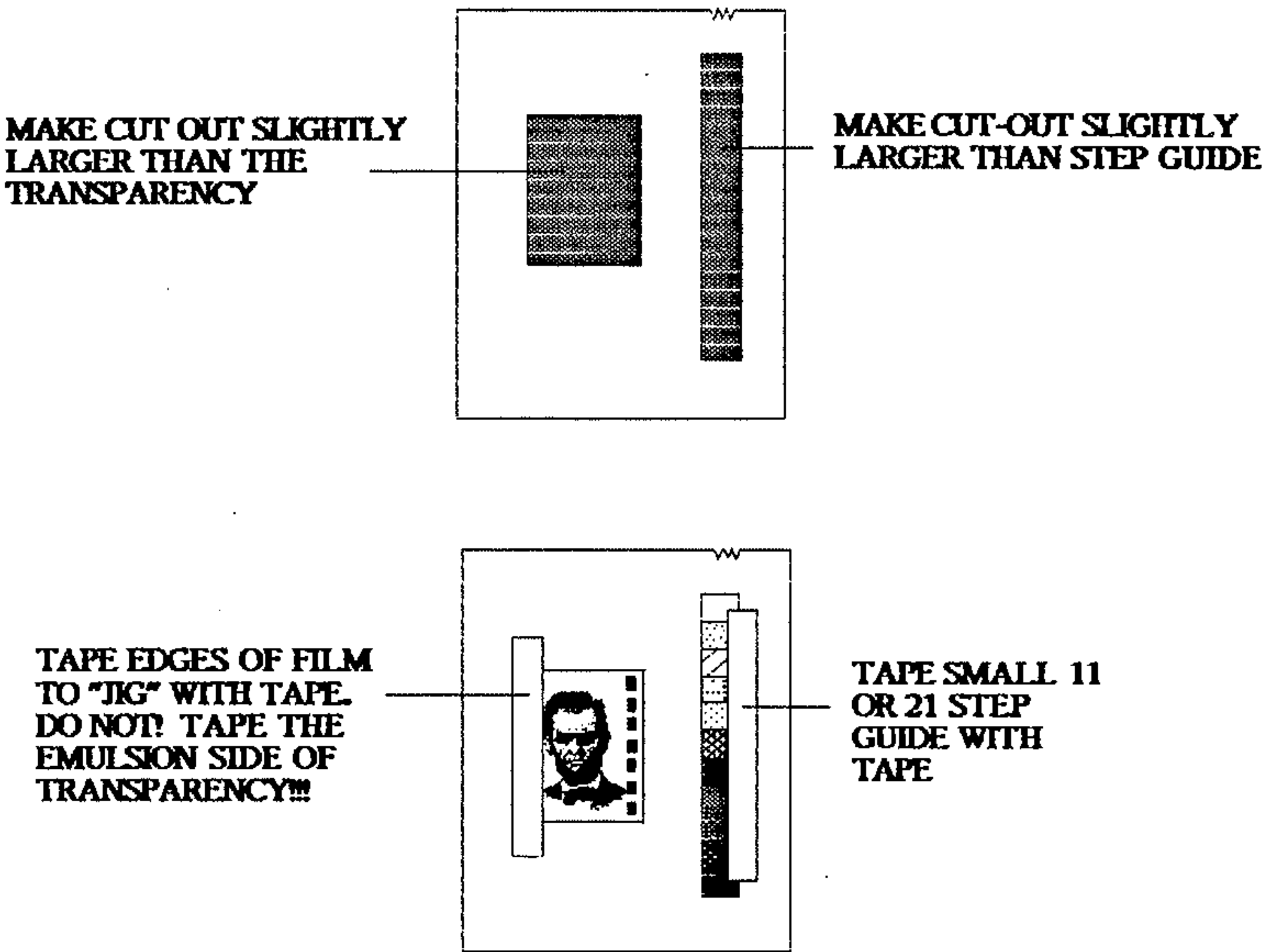


Commercial 2 hole punch



Install punched negatives,
etcetera, as shown

Figure 3.10.1



1. SET ENLARGER FOR ILLUMINATION OF 3 FOOTCANDLES. CLOSE DOWN LENS APERATURE 4 STOPS OR USE NEUTRAL DENSITY FILTERS EQUIVALENT TO 1.2 DENSITY.

2. EXPOSE 4X5 KODALITH ORTHO FILM 2556 FOR 5 SECONDS.

3. DEVELOP FILM FOR 1-1/2 MINUTES IN DEKTOL 1:1 AT 68 DEGREES F.

4. YOU SHOULD OBTAIN A BACKGROUND DENSITY WHICH LOOKS LIKE 18% GRAY. IF THE EXPOSURE TIMES ARE NOT CORRECT THEN MAKE A TEST STRIP TO OBTAIN THE CORRECT EXPOSURE.

5. ASSEMBLE JIG BY TAPING TRANSPARENCY AND STEP GUIDE INTO IT. PUNCH HOLES .

FIGURE 3.10.2

Quantity	Description
1	5x7 wooden print frame (Premier Photo Materials Co., equivalent, or homemade
2	1/4 in. low, register pins (1/16" pins) (Bregman, VWR Sci. or Condit)
1 tube	Silicone rubber glue
1	Two-hole paper punch (1/4" or 1/16" holes)

For small film such as 35mm film, a 4x5 holding jig can be made from a 4x5 sheet of Kodalith film. Figure 3.10.2 illustrates how a "jig" is made. The next section will discuss the construction of the registration carrier you will need. The pins can be located by making a gluing jig from cardboard. Simply punch holes into a piece of cardboard with the two-hole punch, insert the pins in the hole, apply glue to the pins and install this assembly on the surface.

One of the problems you will encounter when the glass and the smooth film backing come in contact is Newton rings. Newton rings are tiny circular interference fringes caused by light diffraction when two smooth surfaces come in contact. This happens because either the surfaces are not completely flat or there is uneven pressure between them which creates microscopic air wedges. These air wedges, due to their shape, bend light beams unevenly causing interference fringes.

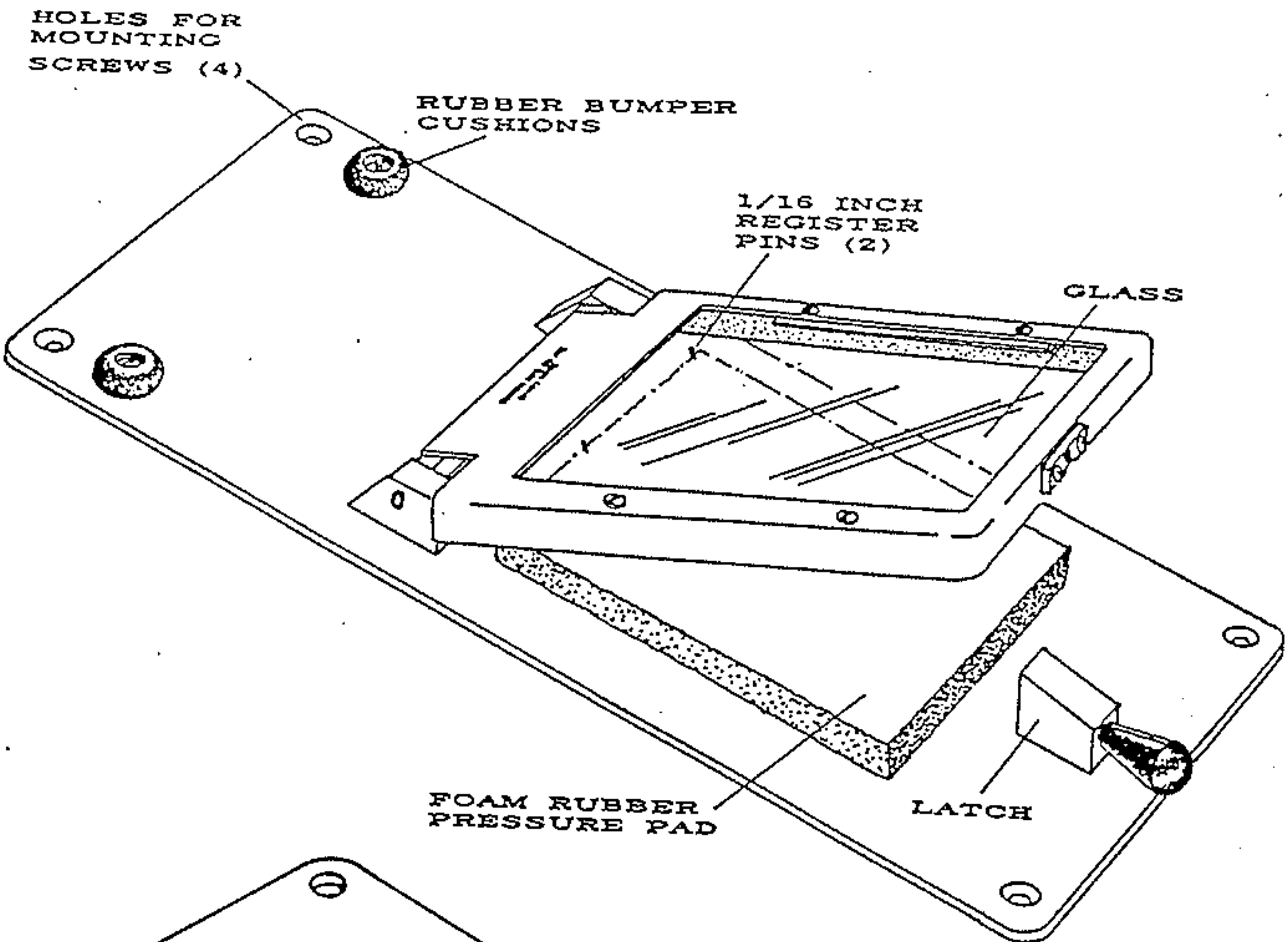
One solution was blowing a micro fine powder, called offset powder, over one of the surfaces. Although this technique is still done it must be done with extreme care to avoid degrading the image.

A second solution is to replace the 5x7 glass in the printing frame with anti-Newton ring glass which has an extremely fine textured surface. This special glass can be purchased from Condit Company for about one dollar a square inch.A third solution is to insert a finely textured film between the glass and film backing. Two such films are Kodak Translite #5561 and Kodak Roller Transport Cleaning Film #4955. The Translite film is a photosensitive and translucent material which must be fixed out. Obviously, if you are using a point light source for contact printing the Translite film would be impractical. Transport film is a clear material which is not photosensitive and can be used straight from the box.

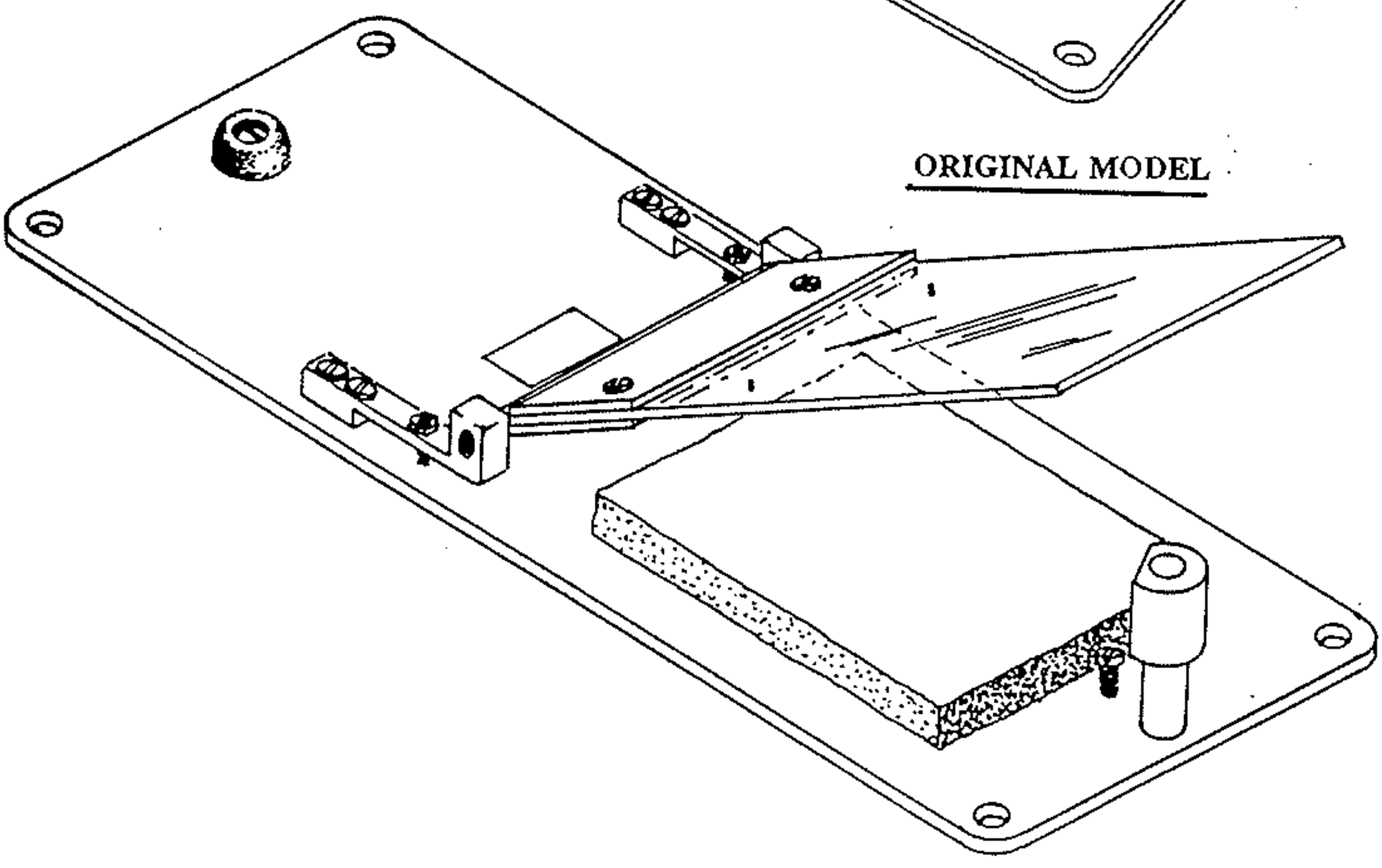
A fourth and final solution is to coat the glass surface with a gum arabic solution. It is made by mixing a 1/2 ounce of 14% gum arabic with 4 ounces of water. Since I have not used this method I do not know how well it works but it is worth a try.

Registration Printing Frame

1. Kodak #EK-147-5623.(11x14 size)
2. Condit. 5x7 Mask Register Frame (includes pin glass and punch.)



ORIGINAL MODEL



REVISED MODEL

FIGURE 3.10.3

***3.10.1 Mask Registration Printer.** If you are planning to make 4x5 or 5x7 enlarged masks and enlarged separations instead of contact masks and separations, then this is a nice item to have. This unit is a sort of registration print frame which fastens to the easel.

The mask registration printer consists of a hinged glass plate, with 1/16" register pins, 3 inches apart, cemented into it. The register pins match the Condit 1/16" film punch. The printer is opened, the film is installed on the glass plate with the emulsion towards the glass, and then closed and locked on top of a foam rubber pad.

The mask registration printer is fastened to the easel under the enlarging lens and the image is projected through the glass onto the film for exposures. Look out for Newton rings; the uneven pressure exerted by the glass makes this unit a good candidate for it.

The alternative method is to tape a set of register pins to the easel. The film is placed, emulsion up, on the easel and a piece of clean, unscratched plate glass is placed on top. The glass keeps the film flat. I would advise putting a sheet of black paper down first to prevent reflections.

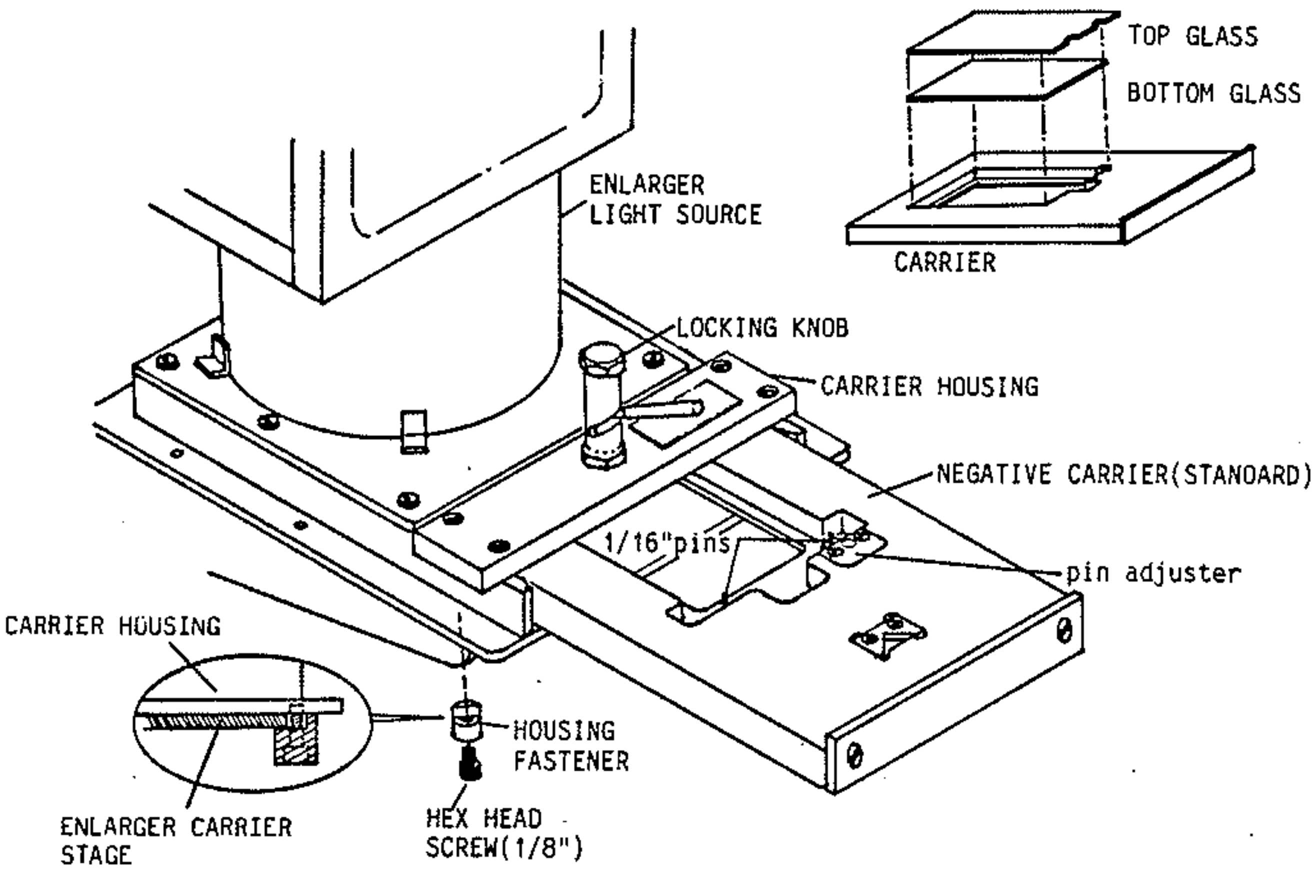
Mask Registration Printer
1. 4x5 size. Condit Co.

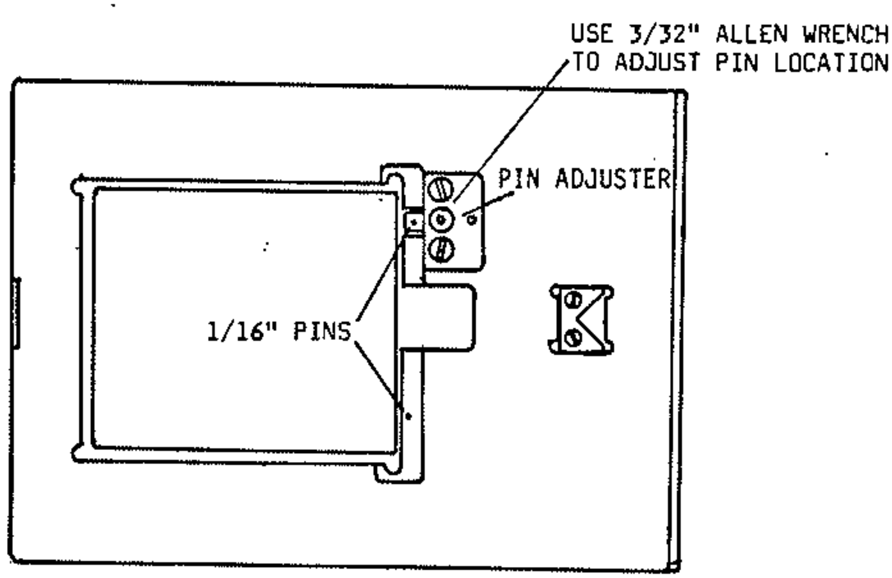
***3.11 REGISTER NEGATIVE CARRIER.

After the separations are made, each is projected from the enlarger. The carrier has to have registration pins to insure proper registration. This method is much easier than the old fashioned method of registering the matrixes after they are exposed and processed. Condit makes a special precision negative carrier for use with their equipment.

The precision carrier is a two part device consisting of a housing and removable glass carrier. The glass carrier has 1/16" register pins, which are 3 inches apart. The housing is mounted permanently on the carrier stage. The glass carrier slides into the housing and is fastened with a locking knob. The glass carrier is removed from the housing to change separations and replaced, without shifting registration.

The precision carrier housing will also accept a special oil immersion carrier for those planning to do enlarged separations from 35mm or 2-1/4 transparencies. Oil immersion is a system in which a 35mm or 2-1/4 transparency is floated in a special fluid and placed between glass inserts to minimize the effects of scratches, dust, and Newton rings. The oil immersion carrier is supplied with replaceable glass oil immersion inserts. An enlarger point light source is also required with the oil immersion system. Needless to say, the oil immersion technique is messy, time consuming, and an expensive way to go. The system produces the best separations possible from 35mm transparencies.

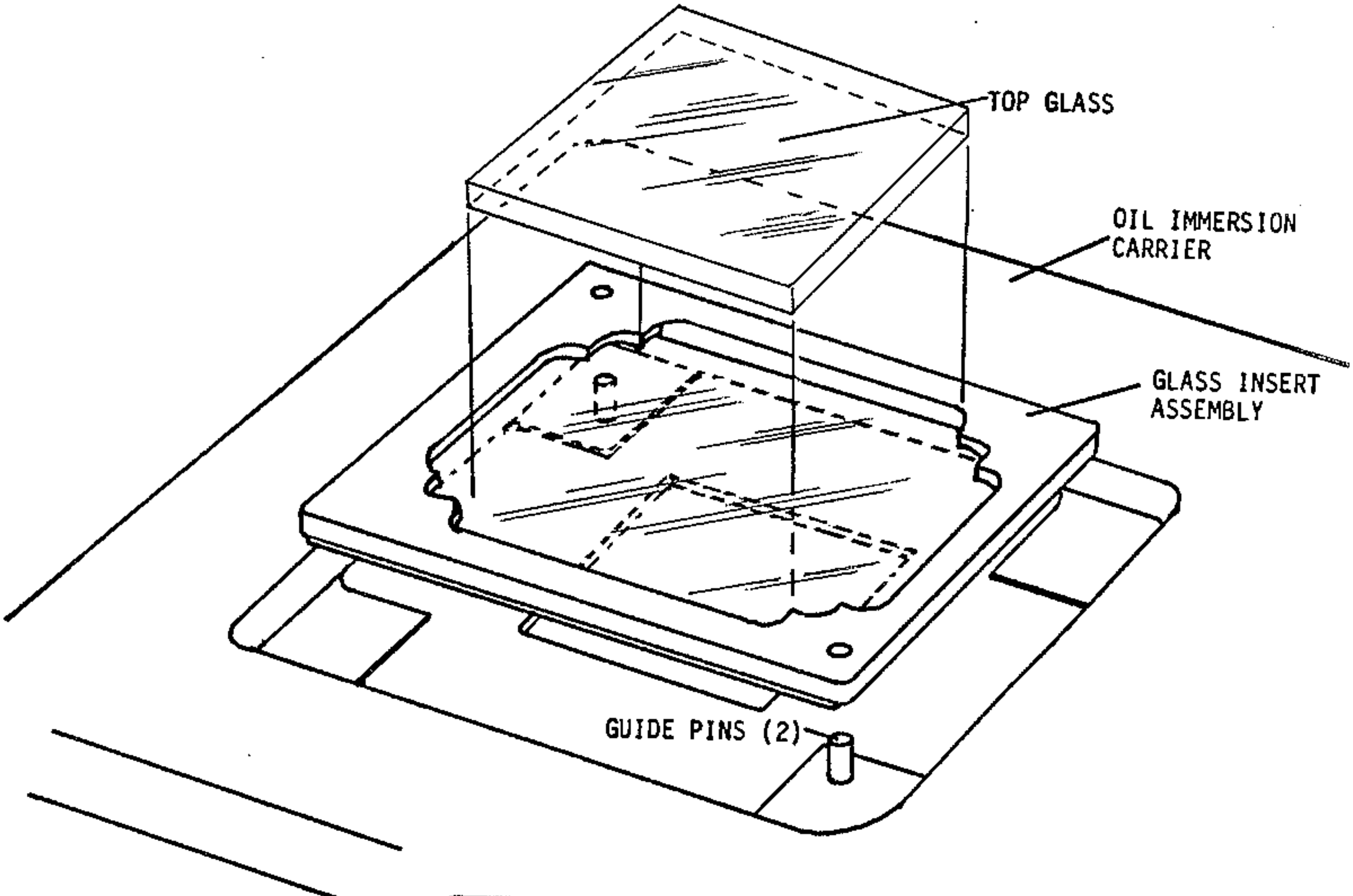


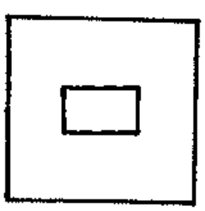


TOP VIEW OF STANDARD CARRIER

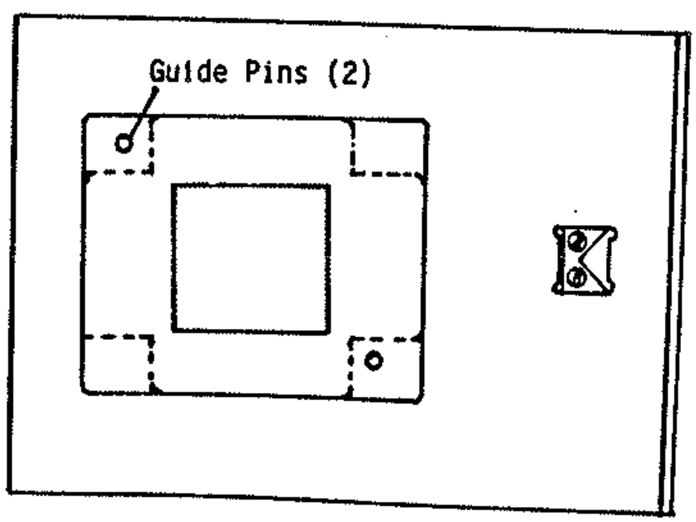
CONDIT PRECISION NEGATIVE CARRIER

(OMEGA D-2)

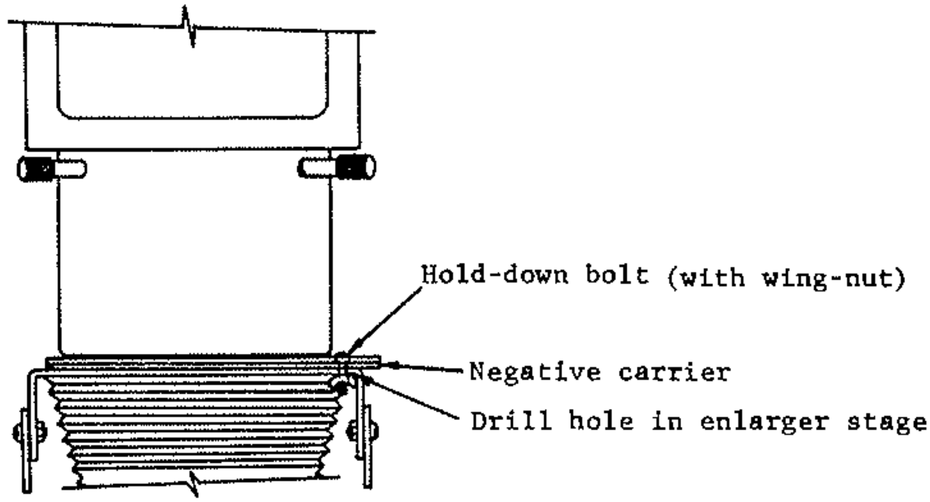




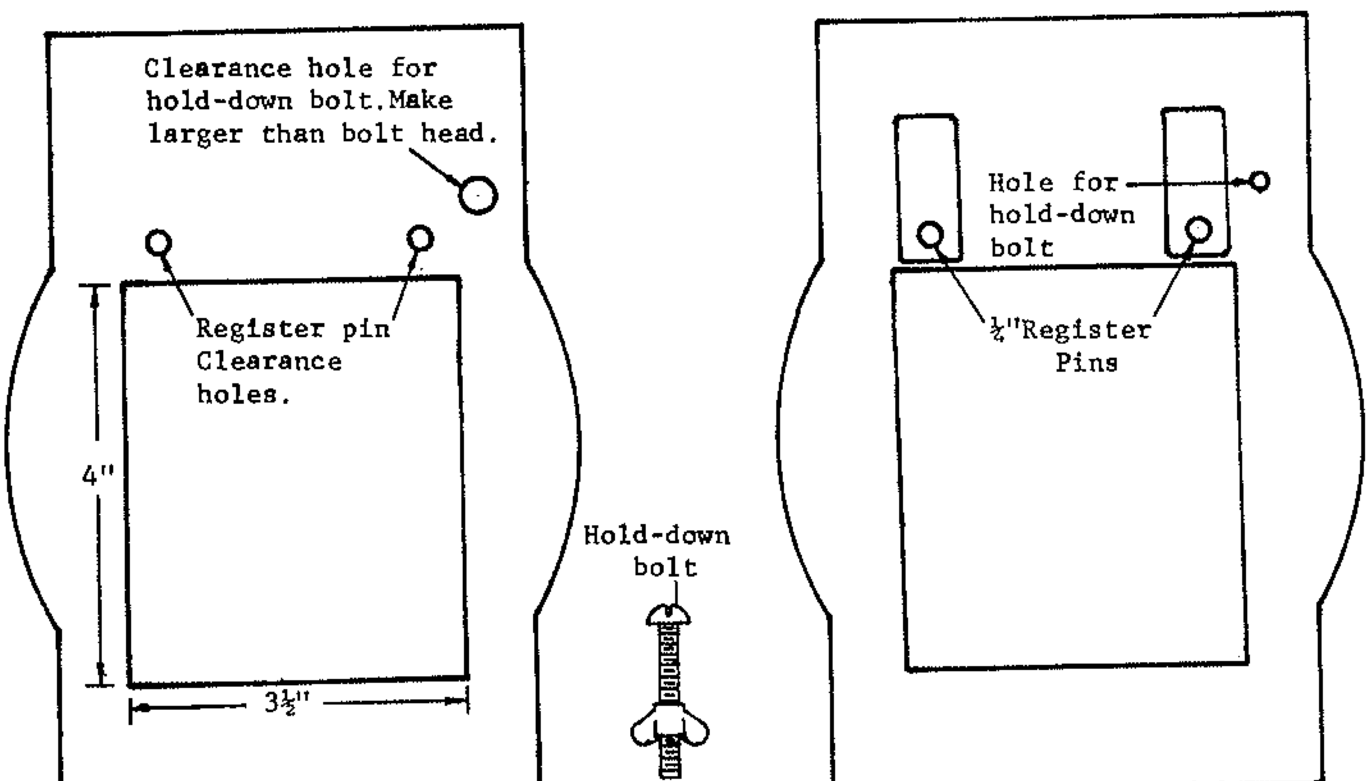
35mm Mask



OIL IMMERSION CARRIER
(Top View)



FRONT VIEW OF ENLARGER HEAD



TOP

BOTTOM

MODIFIED
'OMEGA' enlarger negative carrier

NOTE:

1. Drill hole in enlarger stage for hold-down bolt.

Figure 3.11.1

Unfortunately, Condit only makes the precision carrier for the 4x5 Omega, 4x5 Beseler, 5x7 Durst, 8x10 Elwood and 8x10 Saltzman enlargers. A few manufacturers like Omega make their own glass registration carrier, but make sure the printing frame is compatible with it and that you have a matching film punch.

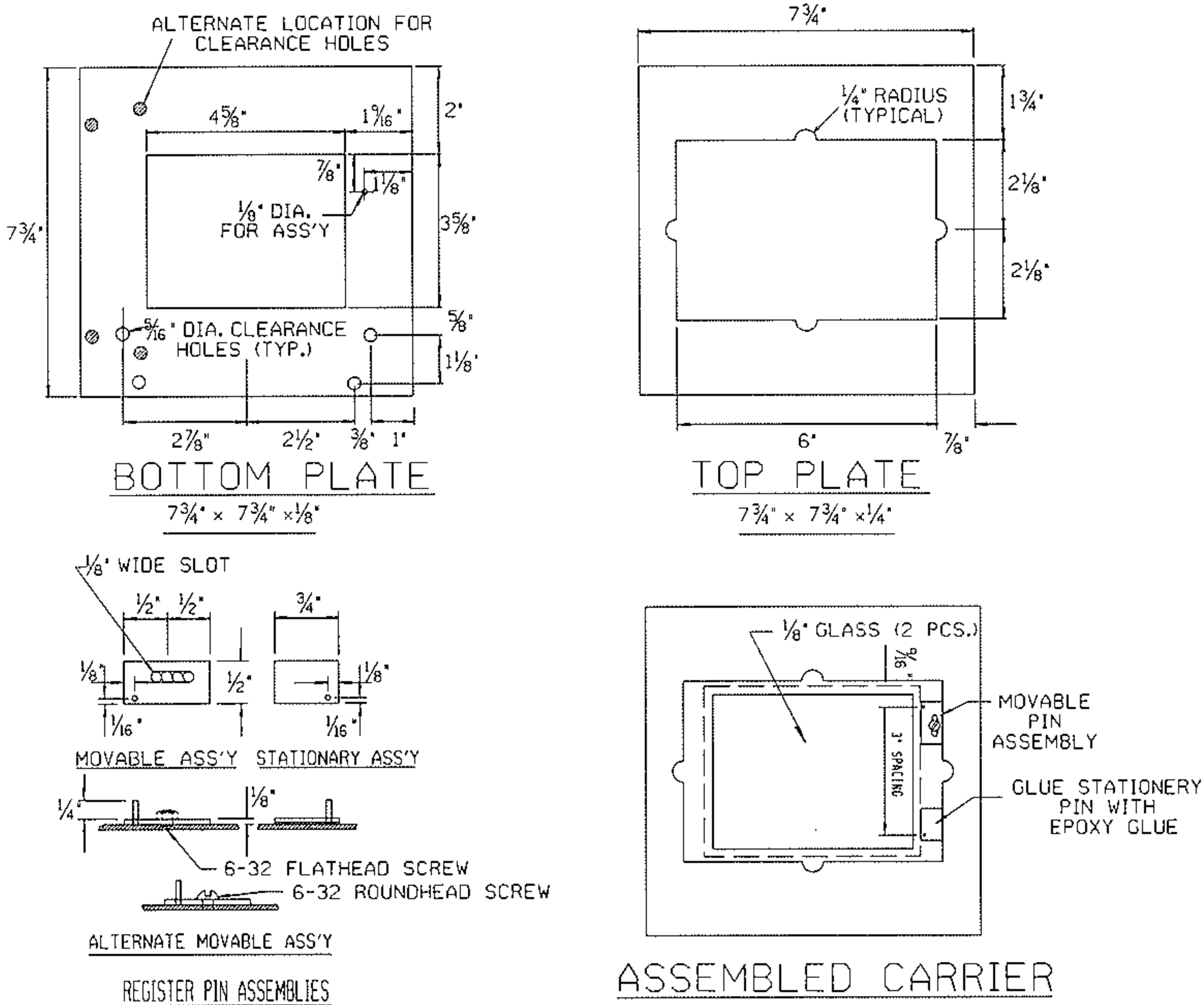
You can make your own negative glassless carrier by modifying a ready-made carrier. This carrier is strictly for small prints, 8x10 and smaller. The film's tendency to curl makes registration difficult. A design for a glassless register carrier, Omega enlarger is shown in Figure 3.11.1. The material is listed below:

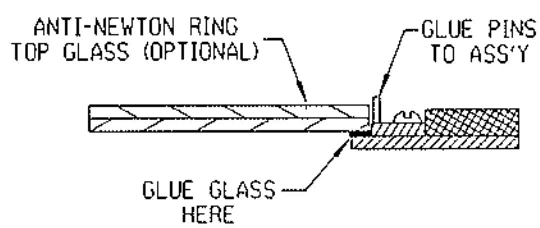
Quantity	Description
1	Negative carrier smaller than 4x5
2	1/4 in., low, round register pins (Bregman or VWR Scientific)
1	1/8x2 in. round head bolt and wing nut
1 tube	Epoxy or silicon rubber glue

Although this design is for an Omega enlarger, similar modifications are possible with other brands of carriers. The bottom plate has to be anchored to the enlarger stage. In the design shown a bolt is used; if this is not practical, use a small C-clamp or whatever you can think of. Make sure you get low register pins so the pins don't protrude through the top plate. The pins can be located by making a gluing jig from cardboard. Simply punch holes into a piece of cardboard with the two-hole punch, insert the pins in the hole, apply glue to the pins and install this assembly on the surface of the carrier's bottom plate. If you are using pre-made separations with 1/16" registration holes, then substitute Condit's 1/16 inch register pins.

A better and more sophisticated design is shown in Figure 3.11.2. It is designed for the Omega 4x5 enlarger. This design is a glass carrier with 1/16" pins. A glass carrier insures good registration. The register pin block with the slot is moveable to allow it to slide left or right. When the pin block is properly adjusted re-tighten the screw. This feature permits you to compensate any film contraction or expansion. A 1/16" inch punch can be purchased from Condit for under $100 dollars. The small 1/16" pins are necessary if you plan to use pre-made enlarged 4x5 separations or 4x5 contact separations from 4x5 transparencies because the 1/16" registration holes are punched in the film border. If your transparencies are 35mm or 2-1/4" then this design can be modified for 1/4 inch pins, simply glue the 1/4 inch pins to the bottom glass. The bottom glass is 1/8 inch high strength glass, purchase it from Condit or a glass dealer (make sure it has no scratches). If you can afford it, use anti-Newton ring glass for the top cover glass. This glass is available from Condit. If you can't get anti-Newton glass use the Translite film as described in section 3.22.13, but only if it is needed. Since the 4x5 negative is the same size as the cover glass and the cover glass just lays on top of the negative, you will seldom or never get Newton rings, since this ailment is usually caused by uneven pressure on the negative.

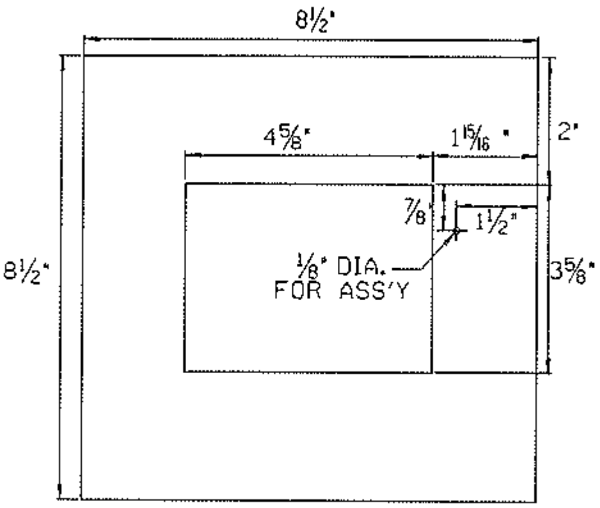
Use a small C-clamp to secure this unit to the enlarger's carrier stage. This carrier works best with an Aristo head because the light source must be lifted in order to change separations. This done is by removing the light source, removing the cover glass, and carefully lifting the separation off the pins. An easy way to do





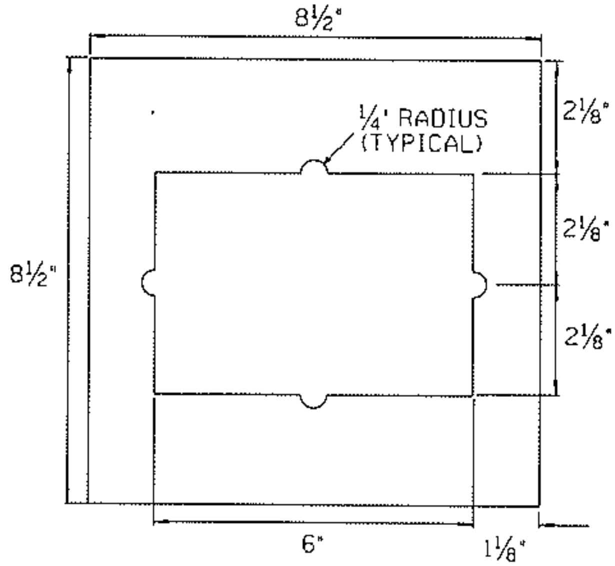
1. TOP PLATE TO BE 1/4" METAL OR PLASTIC.
2. BOTTOM PLATE TO BE 1/8" METAL OR PLASTIC.
3. 1/16" PINS TO BE MADE FROM 1/16" DRILL.
4. GLUE OR SCREW TOP AND BOTTOM PLATE TOGETHER.
5. GLASS TO BE 1/8" X 4" X 5" HIGH STRENGTH GLASS GLASS SHOULD HAVE NO SCRATHES.
6. FOR 1/4" PINS, GLUE PINS TO BOTTOM GLASS, WHICH IS 1/8" X 4" X 5 1/2".
7. PAINT THE CARRIER BLACK TO MINIMIZE REFLECTION.
8. 1/16" PINS SHOULD BE 3 " ON CENTER WHEN MOUNTED.
9. CLEARANCE HOLES MAY BE NEEDED IF 1/4" CARRIER CONTROL PINS ARE IN ENLARGER CARRIER STAGE. HOLES SHOULD BE INSTALLED TO ALLOW POSITIONING OF CARRIER.

FIGURE 3.11.2
OMEGA D-II ENLARGER



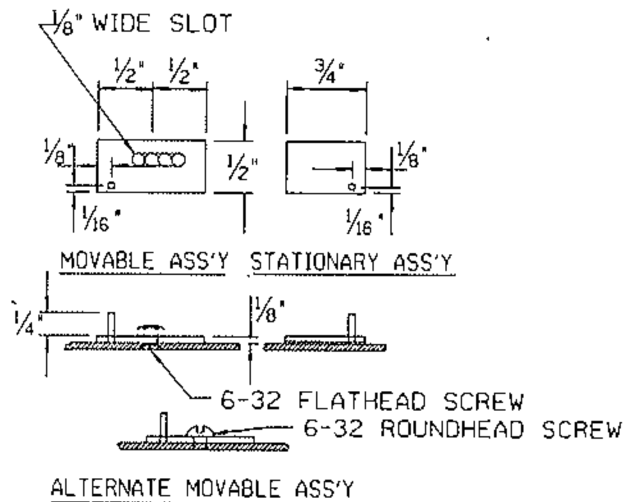
BOTTOM PLATE

8½" × 8½" ×⅛"

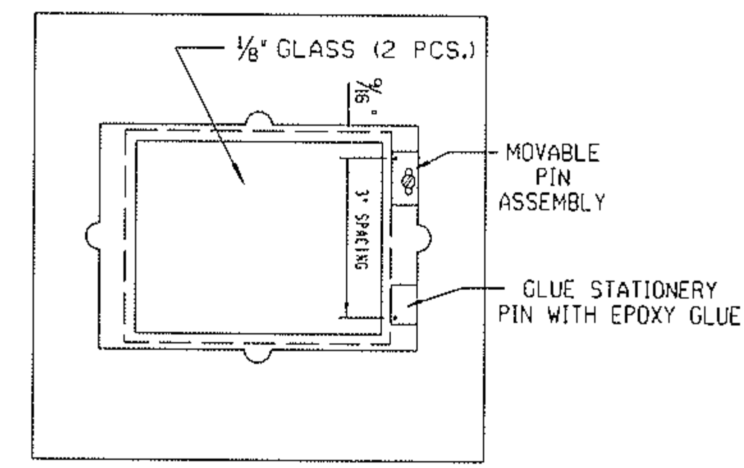


TOP PLATE

8½" × 8½" ×¼"



REGISTER PIN ASSEMBLIES



ASSEMBLED CARRIER

1. TOP PLATE TO BE 1/4" METAL OR PLASTIC.
2. BOTTOM PLATE TO BE 1/8" METAL OR PLASTIC.
3. 1/16" PINS TO BE MADE FROM 1/16" DRILL.
4. GLUE OR SCREW TOP AND BOTTOM PLATE TOGETHER.
5. GLASS TO BE 1/8" X 4" X 5" HIGH STRENGTH GLASS
   GLASS SHOULD HAVE NO SCRATHES.
6. FOR 1/4" PINS, GLUE PINS TO BOTTOM GLASS,
   WHICH IS 1/8" X 4" X 5 1/2".
7. PAINT THE CARRIER BLACK TO MINIMIZE REFLECTION.
8. 1/16" PINS SHOULD BE 3 " ON CENTER WHEN MOUNTED.
9. CLEARANCE HOLES MAY BE NEEDED IF 1/4" CARRIER
   CONTROL PINS ARE IN ENLARGER CARRIER STAGE. HOLES
   SHOULD BE INSTALLED TO ALLOW POSITIONING OF CARRIER.

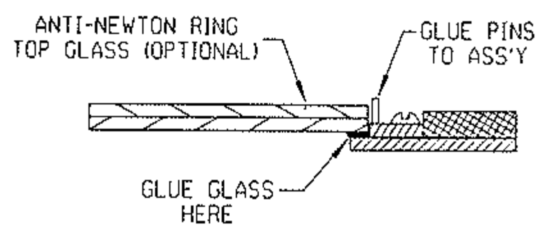


FIGURE 3.11.2A

BESELER ENLARGER (CB7 OR 45M)

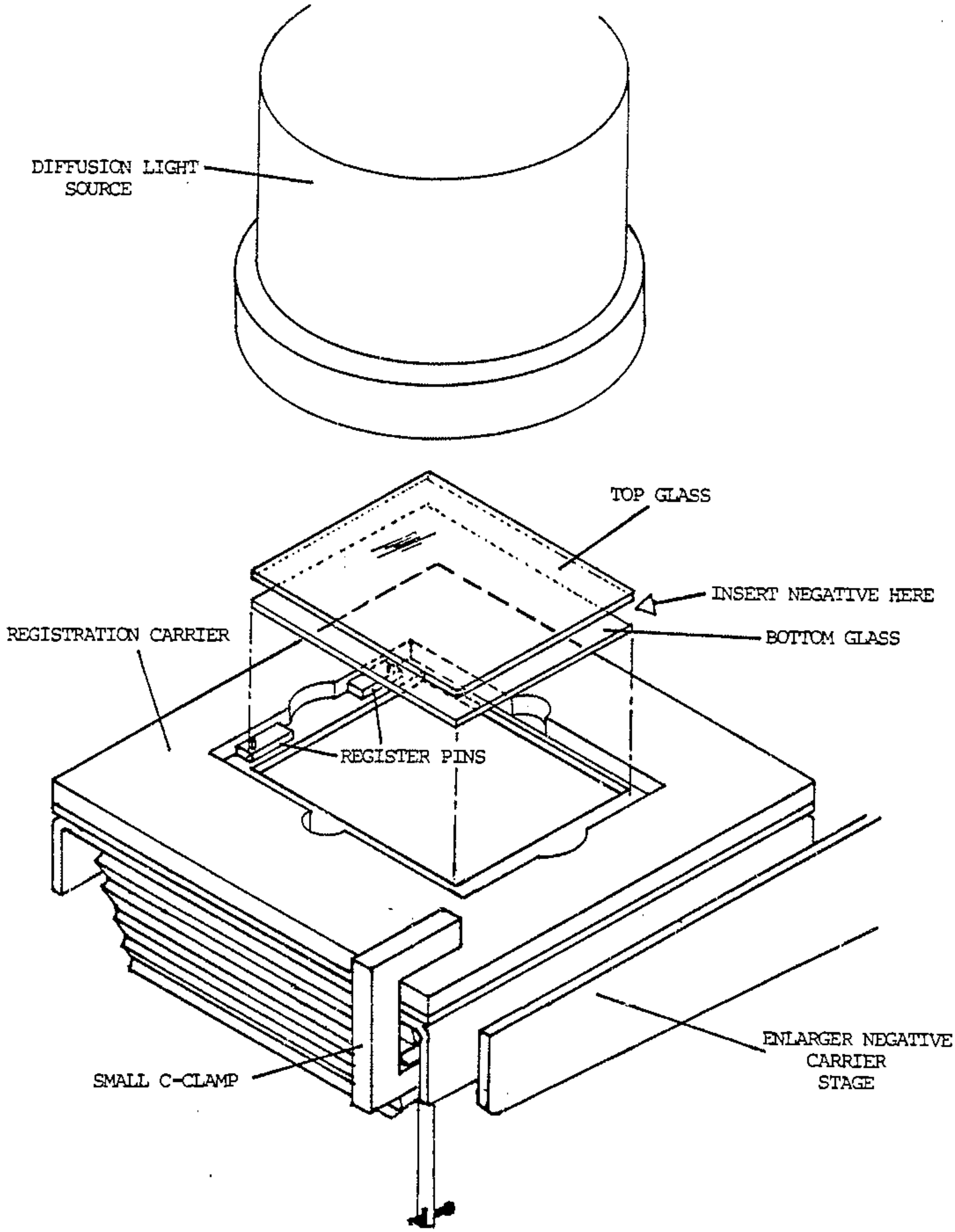


Figure 3.11.2b

this is to slide the tip of a small spatula under the negative near the pin and twist the spatula to pop the negative off. Remember to keep the glass surfaces as clean as possible. Blow any accumulated dust away with compressed air and use a small sable brush to remove large pieces of dust. Check and recheck, try turning the room lights off, then turn on the enlarger light source, you'll be amazed how much dust and lint you'll see.

Registration Negative Carrier
1. Condit. 4x5 Precision negative carrier (for Omega D series enlarger only).
2. Omega. Glass type.

Immersion Oils
1. Cargille oil. Low viscosity. 16 oz. VWR cat #48216-122
2. Castor oil.
3. Silicone oil. Dow Corning #200

***3.12 DENSITOMETER.

An essential tool to have if you are making separations is a transmission densitometer to read negative densities. Separation negatives have to be nearly identical in contrast and density values to make good dye prints. Proper development and exposure times can only be determined with a densitometer. Densitometers are quite expensive; they can range in price from $600 up to $2000. VWR Scientific sells a number of densitometers but most start at $1000.

If you are a bargain hunter and you want a good densitometer then you might try Condit Manufacturing. Occasionally, they have a few reconditioned transmission densitometers priced in the $600 range. Most are the well known Macbeth brand, analog densitometer, i.e, the kind with the indicating needle. Calumet Company sells a low cost black and white densitometer for under $250. Although its accuracy is only plus or minus 5%, it is close enough for separation work. Their address is:

Calumet Photographic Inc.
890 Supreme Drive
Bensenville, Illinois 60160
1-800-323-2849
1-312-860-7447

An inexpensive alternative is to buy a used densitometer, but make sure it is accurate. It's possible to save quite a bit of money if you can find a Kodak Model 1 Visual Densitometer at a good used photo equipment dealer like Lens and Repro, in New York City, or Photographers Place, in Chicago. These Kodak visual densitometers can be purchased for as little as $50. They are accurate to within + or - .05 density, which is more than adequate for separation work. Since the Model 1 densitometer has no electronic parts, little can go wrong with it and it can even be used to measure color density.

A final alternative when all else fails, is to make your own densitometer from a spotmeter or the Luna-Pro lightmeter. Details for such a meter can be found in the workbook supplement to "Beyond the Zone System" by Phil Davis. This two book set can be found at any good photography bookstore or ordered from Light Impressions in Rochester, New York, 1-800-828-6216. A number of photo magazines have also given designs for homemade densitometers.

Transmission Densitometer
1. Calumet Company. "Photron Delta-1" Catalog #AA1300.
2. Kodak. Model 1 Visual type.
3. Professional models.

***3.13 STEP GUIDE.

Along with the densitometer it is necessary to get a special test strip called a 21 step guide. This is a small negative strip with 21 density steps which vary in density from 0.05 to 3.05, in 0.15 density increments. An 11 step guide is also available. Its steps vary in increments of 0.30 up to 3.05. Either step guide is satisfactory for separation negative calibration. Usually the step guide is taped along side the transparency (see Figure 3.10.2). This is done so the separation negative contrast and relative density can be obtained by plotting the steps on a density graph. Kodak and VWR Scientific make these guides. If you purchase the Kodak step guides take a quill pen and india ink, number each step with the least dense step being numbered 1. Get the small 21 step guide by VWR or the 11 step guide Kodak No. 1A if you plan to make contact masks and/or separations. Although these scales are uncalibrated, they are fairly accurate. Kodak does sell calibrated scales but they are much more expensive. Listed below are the density values you should assume for the 21 step guide.

STEP	DENSITY
1	0.05
2	0.20
3	0.35
4	0.50
5	0.65
6	0.80
7	0.95
8	1.10
9	1.25
10	1.40
11	1.55

STEP	DENSITY
12	1.70
13	1.85
14	2.00
15	2.15
16	2.30
17	2.45
18	2.60
19	2.75
20	2.90
21	3.05

The density values for an 11 step guide follow:

STEP	DENSITY
1	0.05
2	0.35
3	0.65
4	0.95
5	1.25
6	1.55

STEP	DENSITY
7	1.85
8	2.15
9	2.45
10	2.75
11	3.05

The uncalibrated scales are quite close to these values.

21 Step Guide
1. Kodak. Step Tablet No. 2. (152-3398)
2. VWR. Platemaker's Sensitivity Guide. Cat. #TR70281-50
3. Stouffers. 21 step transmission guide

11 Step Guide
1. Kodak. Step Tablet No.1A (152-3380).

***3.14 CONTACT PRINTING LAMP.

If you are planning to do contact separations this is a useful item to have. Although an enlarger makes a fine light source for contact printing, a point light source contact printing lamp offers the ultimate in image sharpness. Contact printing lamps vary in design and sophistication. VWR Scientific and many graphic arts suppliers sell this type of light source.

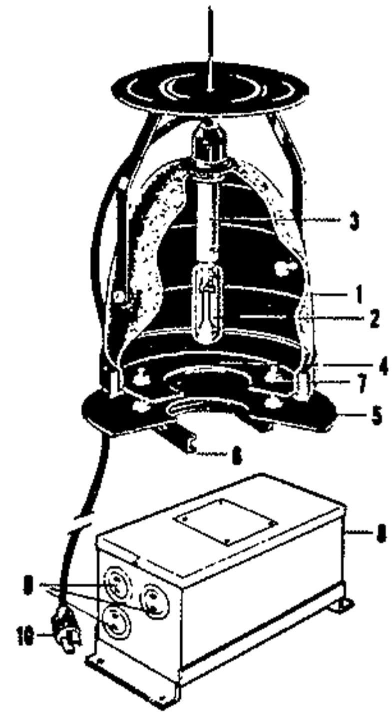
Kodak publication Q-80 has a design for a contact printing lamp which you can build. This design is included in this section. The material required is listed below:

Quantity	Description
1	Kodak Adjustable Safelight, Model B, Kodak #EK 141-2212
1	100W, 20 volt lamp General Elect. #100 T8/1SC-20V (type BZA) VWR CAt# GE100T8-1SC
1	Photoflash Lamp Socket Adapter. No. 455
1	5-1/2 in. metal disk w/ 2-5/8" hole in center.
1	7-1/2 in. metal disk w/ 2-5/8" hole in center.
3	#8 machine screws with three nuts each
1	100 Volt-amp step down transformer 115v primary and 5 amp secondary w/ 4,8,12,16,20,24 volt taps. Edwards Co. Signal transformer or equivalent
3	"midget" twist-lock receptacles and matching plug.

Normally, the 16 volt tap is used but you might want to use the 12, and 20 volt taps as a way to vary the illumination. The chart below gives the illumination levels of the different voltages.

CONTACT PRINTING LAMP FOR PHOTOMECHANICAL WORK

Three of the requirements that contact printing lamps for photomechanical work must fulfill are: (1) the illumination must be uniform over the printing plane; (2) the light source must be small in size; and (3) the lamphouse must accommodate filters. These requirements are met with a modification of the KODAK Adjustable Safelight Lamp. This modification is pictured at the right, with call-out numbers corresponding to numbered descriptions with the text.*



Using a KODAK Adjustable Safelight Lamp ①

When modified, this lamp will provide a light source of excellent uniformity and high intensity. The bulb to use for the modification is a General Electric 100 T8/1SC-20V ②; it has a small filament and clear-glass end, and *MUST* be burned base-end up. This bulb can be ordered from the General Electric Company or from one of its branches through your dealer for Kodak graphic arts materials.

Because the bulb has a bayonet-type base, an adapter of the type used for miniature photographic flash lamps is necessary. Use of an adapter that is 3 1/2 inches long places the bulb near the aperture plate and creates a cone of light broad enough to easily cover an average-sized printing frame. An adapter matching this description is manufactured by Frank W. Morse Company, 44 Lincoln, Saco, Maine 04072. Order it through your photo dealer using the designation "No. 455—Photoflash Lamp Socket Adapter." ③

The safelight filter is replaced by a metal disk 5 1/2 inches in diameter ④, which has a 2 5/8-inch round hole cut in the center. Below this metal plate is a second disk of metal with an outside diameter of 7 1/2 inches ⑤ and a 2 5/8-inch hole in the center. On the underside of this hole is soldered a KODAK Gelatin Filter Frame Holder, Series VIII ⑥. The lower disk is spaced 1/2 inch below the upper disk by means of three 3/4-inch machine screws ⑦. Extra nuts on each screw will hold the plates at the desired separation. This space allows excess heat to escape and keeps the gelatin filter cooler. The entire disk assembly and the inside of the lamp should be painted with KODAK Brushing Lacquer, No. 4 Dull Black.

The transformer ⑧ is a 100-watt, step-down type with a 115-volt primary and a 5-ampere tapped secondary having taps for 4, 8, 12, 16, 20, and 24 volts. An example is the Edwards Signalling Transformer, manufactured by the Edwards Company, Inc., Clock & Program Systems, 90 Connecticut Avenue, Norwalk, Connecticut 06852. This transformer, or one similar to it, is generally available through electrical supply stores. Only three of the taps are used—8, 16, and 20 volts. Each is connected to a separate female receptacle ⑨ installed in the end of the transformer case. (Use "midget twist-lock, female, flush motor base" receptacles, obtainable from electrical supply dealers. These fittings are used to prevent the accidental insertion of the lamp cord into a 110-volt service outlet.) A corresponding midget twist-lock cord plug ("cap") ⑩ is attached to the lamp cord, replacing the standard cord plug. This plug can then be inserted in any one of the outlets to obtain different light intensities.

*A ready-made lamp similar to this is the K&M Tri-Level Point Source Light, made by the K&M Manufacturing Company, 4931 73rd Avenue North, Pinellas Park, Florida 33565.

In order to make exposures repeatable, we recommend the addition of a constant voltage transformer. It is not generally realized that a drop in line voltage of only 10 percent will decrease the exposure of an orthochromatic material by almost 40 percent because the color of the light source changes with the applied voltage. This problem is especially troublesome in many printing plants where large press motors, exposing lamps, and other heavy power equipment constantly vary the load on the power lines.

Manually variable controls are available, but a much more satisfactory arrangement is to use a constant-voltage transformer between the line and the step-down transformer described above. Among the suitable constant-voltage transformers are the Raytheon VR-6113† and the Sola 20-13-112‡. Both are rated at 120 watts and will handle fluctuations over the range of 95 to 130 volts while holding the secondary voltage to within 1 percent.

†Raytheon Company, Sorenson Product Supplies Department, 676 Island Pond Road, Manchester, New Hampshire 03103.

‡Sola Electric Division, Sola Basic Industries, 1701 Busse Road, Elk Grove Village, Illinois 60007.

Graphics Markets Division

EASTMAN KODAK COMPANY • ROCHESTER, N.Y. 14650

Contact Printing Lamp for Photomechanical Work

9-74-E-Reprint

Kodak Publication No. Q-80

Printed in the United States of America

VOLTAGE	LIGHT INTENSITY RATIO	LUMENS
8	2	117
12	8	436
16	21	1223
20	45	2600

I would suggest that you use only one twist-lock plug and a three position switch as an alternate approach. The 4 and 8 volt taps are too low in illumination and tend to diminish the blue content of the light source too much. If you have too much trouble finding the recommended transformer, you might try any 12 to 20 volt transformer rated at 100 volt-amps or higher.

Contact Printing Lamp
1. K & M Tri-level Point Source Light.
2. VWR. Cat. #NRCP25 or Cat. #KM72451-00

3.15 DYE TRANSFER MATRIX FILMS.

Matrix films come in a variety of sizes, however for beginners I suggest the 10x12 size. Matrix films are sold in 25 sheet boxes. While matrix film has good keeping properties, it is best to refrigerate it when you are not using it. When you take it out of the refrigerator, allow it to warm for a couple of hours to avoid condensation.

3.15.1 Pan Matrix Film. Pan Matrix Film 4149 is for color negatives. **AS OF JANUARY 1991, THIS FILM IS NO LONGER BEING MADE BY KODAK. ANY MENTION OF THIS FILM IN THE MANUAL IS FOR REFERENCE ONLY.** It came only in 10x12 and 16-1/2 x 21-1/4 sizes. The film is panchromatic so it must be used in total darkness only. Pan Matrix is prepunched at the factory.

*****3.15.2** Ortho Matrix Film. Matrix Film 4150 is designed for use with separation negatives. Unlike Pan Matrix, film this film comes in a number of sizes. The sizes available are 8x10, 10x12, 11-1/2x15-1/4, 14-1/2x18-1/4, 16-1/2x21-1/4, 20x24, and 20-1/2x25-1/4. Beginners should start with 8x10 or 10x12 film. This film is orthochromatic so it can be used with a red safelight.

AMT.	TYPE	DESCRIPTION
1	box	Kodak Matrix Film 4150. 10x12 size. 25 sheets. Kodak #140-4433

***3.16 SEPARATION NEGATIVE FILMS.

There are three film types required to make color separation negatives. First, a highlight masking film is needed; second, pan masking film; and finally, a separation negative film is needed. Each film will be discussed in detail in the following subsections.

*****3.16.1 Highlight Masking Film.** If your transparency has important highlight detail then you must first make a highlight mask. This mask is either registered with the original transparency when making the color masks (principal masks) or registered with the separations when exposing matrix film.

Very high contrast negative film is required for highlight masking. The film Kodak recommends for this purpose is Kodalith Ortho Film 2556. It is easy to use because it can be used with a red safelight.

If you plan to do any three color highlight masking then you will need a panchromatic high contrast film. The best film for this purpose is Kodalith Pan Film 2568. This film is used when subtle highlight color fidelity has to be maintained. This film is available but may soon be removed from the market because of environmental problems. Try one of the substitutes listed below.

Another excellent film for three color highlight masking in Technical Pan film. Although it is a bit more sensitive to red, it none-the-less suitable for three color highlight masking. It is especially suitable when the image has flat, long scaled highlights. It must be developed to higher contrasts by using the appropriate dilution of HC-110 developer.

Single Highlight Masking Film.
1. Kodalith Ortho Film 2556.
   Type 3. 4x5, 50 sheets.
   Kodak catalog# 165-2965.

Three Color Highlight Masking.
1. Kodalith Pan Film 2568.
   4x5, 50 sheets.
   Kodak catalog# 153-4252

2. Agfa Litex Pan Halftone P911P
   8x10.
   Agfa catalog # 2GJQ7.

3. Fugi HP100 Lith Film
   8x10.
   Fugi catalog # 55-22-7007.

4. Kodalith MPII SO-479.
   8x10.

5. Technical Pan Film 4415 (with 50CC Cyan Filter)
   4x5, 25 sheets.
   Kodak catalog # 800-4640

*****3.16.2 Pan Masking Film.** A special film called Pan Masking film is required to make color principal masks. This film is designed to produce a soft, fuzzy image. Kodak's version is called Pan Masking Film 4570. Masking film comes is 4x5, 5x7 and larger sizes. Normally 4x5 film is used for amateur work, if you can only get 8x10 film then you must cut the film to size.

An interesting alternative to pan masking films is Plus-X film. Some people say that the results are comparable to pan masking films. I think you may have trouble getting the low contrast you need for masking. If you decide to try this alternative be sure to use two diffusion sheets rather than one as suggested for pan masking film. I don't recommend this film for beginners.

```
Pan Masking Film.
1.  Kodak Pan Masking Film 4570.
    50 sheets.  4x5, #153-4304 or
    8x10, #153-4528

2.  OPTIONAL.  Kodak Plus-X Pan
    Professional Film 4147.  4x5,
    100 sheets.  Kodak #144-3423.
```

*** **3.16.3 Separation Negative Films.** There are a variety of films which can be used for separation negatives. The old standby for color separation negatives is Kodak Super XX Pan Film 4142. I recommend it because of its exceptional color response and because of the abundance of development information available. Super XX does have some drawbacks. It has medium grain structure, which means it cannot be enlarged too much without producing grainy dye prints. This means that if you make 35mm contact separations don't try to make dye prints larger than 8x10. For larger films, i.e., 2-1/4 inch and larger, contact separation prints up to 11x14 show few ill effects. 4x5 enlarged separations from 35mm also work quite well.

A good alternative is Kodak Separation Negative Film 4131, Type 1. Separation Negative Film, Type 1 has more inherent contrast and a finer grain structure than Super XX. Its major drawback is its curve shape. Although its color response is good, it does not come close to the linear response of Super-XX. This film was designed for enlarged separation work so it's available in sizes up to 20x24. Unfortunately, this film is not available in 4x5 size. You will have to cut it down. If you decide to use it, be sure you don't get Separation Negative Film, Type 2 which is for copy work. Rumors have it that Separation Negative Film, Type 1 film may be discontinued in the future, since Kodak has at times threatened to discontinue its manufacture; only time will tell.

Recently, some dye labs have used T-Max 100 film for separations with good success. Like Separation Negative film, the curve shape of this film cannot match Super-XX, but its superior grain structure makes it very good for large sized dye prints. Do not use the T-Max 400 film because it has very bad color response for separation work.Another possibility is to use Plus-X film for separation negatives. It also has finer grain and higher contrast than Super-XX . The color response of is not as good as Super-XX, never-the-less it worth trying. Some experimenters have gotten some interesting results using Tri-X but I would not recommend it for normal dye printing.

Separation Negative Films.

1. Kodak Super-XX Pan Film 4142. 4x5, 25 sheets. Kodak catalog #147-1614.

2. Kodak Separation Negative Film 4131, Type 1. 8x10, 50 sheets, #153-9071.

3. T-Max 100 Film 4x5, 25 sheets. Kodak catalog #802-0737.

4. OPTIONAL. Kodak Plus-X Pan Professional Film 4147. 4x5, 100 sheets. Kodak #144-3423.

3.17 PROCESSING CHEMICALS.

This section gives an overview of the chemicals required to process the films and produce dye transfer prints. The quantities given will be sufficient for the beginner to make dozens of 10x12 prints.

3.17.1 Tanning Developer. The tanning developer comes in two parts, A and B, both of which are dry powders. Tanning Developer A comes in one quart packets and Developer B comes in one gallon packages. The A developer is only sold in boxes of 10, one quart packets, so be sure to get five, one gallon packages of B of each 10 packet box of A developer. Both A and B also come in five gallon sizes but I don't recommend mixing five gallons of chemistry unless you plan to use it within a month due to the developer's short life. **DO NOT MIX PART A AND B TOGETHER. THEY ARE MIXED A FEW SECONDS BEFORE USE ONLY!!! THE DEVELOPER OXIDIZES IN 5 MINUTES.**

An alternative developer to Kodak's Tanning Developer is discussed in section 2.4. First, you will need either DK-50 or HC-110 developer. Second, you will need ammonium dichromate, sulfuric acid and sodium chloride (salt), to make a special tanning solution called R-10a. The sulfuric acid may be hard to obtain. Extreme care should be used when handling this acid (see the chemical safety section in the appendix). For beginners I would suggest you do not try this developer until you have gained experience with the Kodak Tanning Developer.

AMT.	TYPE	DESCRIPTION
1	box	Tanning Dev. A. Ten 1 qt. packets. Kodak #169-1971.
10	pkgs	Tanning Dev. B. One gallon pkgs. Kodak #146-8571.
		- OPTIONAL-
1	btl.	HC-110 developer. 16 oz. Kodak #140-8988. (or DK-50)
1	btl.	Sulfuric Acid. 16 oz. VWR Sci. #JT9685-2
1	btl.	Ammonium Dichromate. 1 lb. VWR #JT0688-1.
1	btl.	Sodium Chloride. 1 lb. VWR #VW6430-1.

3.17.2 Fixer for Matrix Film. Any non-hardening fixer will work when processing matrix film. Kodak recommends their C-41 Flexicolor Chemistry Fixer. You can also use sodium thiosulphate although it requires more work because it is a dry powder. Another good choice is ammonium thiosulphate; it comes in liquid form. Any of these will work equally well but I prefer the liquids because they are easy to mix. Unlike the developers, the fixer can be reused. I would discard it after every three full sized sheets. If you are willing to risk it, the fixer can be used until the matrix fails to clear after one minute.

AMT.	TYPE	DESCRIPTION
1	btl.	Kodak Flexicolor Fixer & Replenish. 1 gallon. Kodak #169-3837.
1	btl.	Ammonium Thiosulphate.
1	lb.	Sodium Thiosulphate Kodak #146-3587.

3.17.3 Dye Set. The dyes can be purchased in one and five gallon sizes. For amateur work the one gallon size is more than sufficient. One quart is enough for normal use with 10x12 film. The remainder can be used to make high contrast dye, low contrast dye, and for dye replenishment.

AMT	TYPE	DESCRIPTION
1	box	Kodak Dye and Dye Buffer Set. 1 gallon size. Kodak #190-0042

3.17.4 Acetic Acid. Acetic acid is the most used chemical in the dye transfer process. Get more than you think you will need. Get Glacial Acetic Acid rather than 28% Acetic Acid. This way you will get more for you money. Don't store this acid below 62 degrees Fahrenheit because Glacial Acetic Acid freezes into hard lumps at that temperature.

AMT.	TYPE	DESCRIPTION
2	btls	Kodak Glacial Acetic Acid. 16 oz bottle. Kodak #146-2836

3.17.5 Paper Conditioner. Paper conditioner lasts a long time and is relatively inexpensive. Although section 2.6 shows how to make a substitute paper conditioner, I strongly suggest you do not. Paper conditioner can be used until it looks like strong tea.

AMT.	TYPE	DESCRIPTION
1	btl.	Kodak Dye Transfer. Paper Conditioner. 1 qt. Kodak #146-5814

*****3.17.6 Masking and Separation Developers.** Highlightmasks are developed in Kodak D-11 developer. This developer is a dry powder that has good keeping properties when mixed.HC-110 is used to process both pan masking film and separation films. It comes as a liquid concentrate which is diluted to make a stock solution. Some people mix the small quantities of developer by using a hypodermic needle todraw the concentrate directly from the bottle. Generally, this is not a good idea unless the hypodermic is extremely accurate.

AMT.	TYPE	DESCRIPTION
1	pkg.	Kodak D-11 developer. To make one gallon. Kodak #146-4569.
1	btl.	Kodak HC-110 develop. 16 Oz. Kodak #140-8988.

3.18 CHEMICALS FOR PRINT COLOR ADJUSTMENT.

To make really good prints there are a number of "fine tuning" solutions that are required. The uses for these chemicals are given in the chapter on fine tuning dye prints. The chemicals and quantities are listed as follow:

AMT.	DESCRIPTION
8 oz.	Triethanolamine
1 lb.	Sodium Acetate
8 oz.	Sodium Hexametaphosphate (Calgon)
1 qt.	Ammonium Hydroxide (Clear Ammonia)
8 oz.	Potassium Permanganate
8 oz.	Sodium Bisulfite
8 oz.	Sodium Hypochlorite (Clear Bleach)
8 oz.	Kodak Photo-Flo

Most of these chemicals can be purchased from the chemical suppliers listed in the last section of this chapter.

3.19 DYE TRANSFER PAPER.

Dye transfer paper is a glossy (F surface) double weight paper which has been premordanted for use in the dye transfer process. Dye transfer paper can also be special ordered in G surface, which is a fine grain, cream colored double weight paper stock. Dye transfer paper is available in 8x10, 10x12, 11x14, 14x17, 16x20, 16-1/2x20-1/4, 20x24, 20-1/2x25-1/4, and in a 40in x 30ft roll. Get 11x14 paper for 10x12 film. The precut paper is currently available only in 100 sheet boxes.

Because dye transfer paper is expensive and difficult to obtain, mordanting black and white paper for use in dye transfer is worth the effort. A complete explanation of how this is done is discussed in section 2.5. Two good choices of paper for this purpose are Medalist or Kodabromide, F surface, double weight. Any black and white paper will work but each produces a slightly different coloration. If Kodak Ektalure paper. Regardless of what paper you choose, be sure to get a double weight paper, because single weight paper has a tendency to wrinkle.

AMT.	TYPE	DESCRIPTION
1	box	Dye Transfer Paper. F Surface. 11x14, 100shts. Kodak #189 0268. -or- Medalist or Kodabromide Paper. (to be mordanted)

3.20 PROJECTION PRINT SCALE.

A projection scale consists of numbered step wedges of varying densities on a plastic base. It is used to make a test strip with only a single predetermined exposure. The numbers in each wedge tell the user the exposure for that wedge. If you are exposing Pan Matrix film I strongly recommend that you get one. This scale is the best way to make test strips and it will also be used to test the dyes in the forthcoming chapters.

Projection Print Scale.

1. Projection print scale. Kodak catalog #155-7248 (Code #R-26), "Pro" Co.

3.21 TRAY ROCKER.

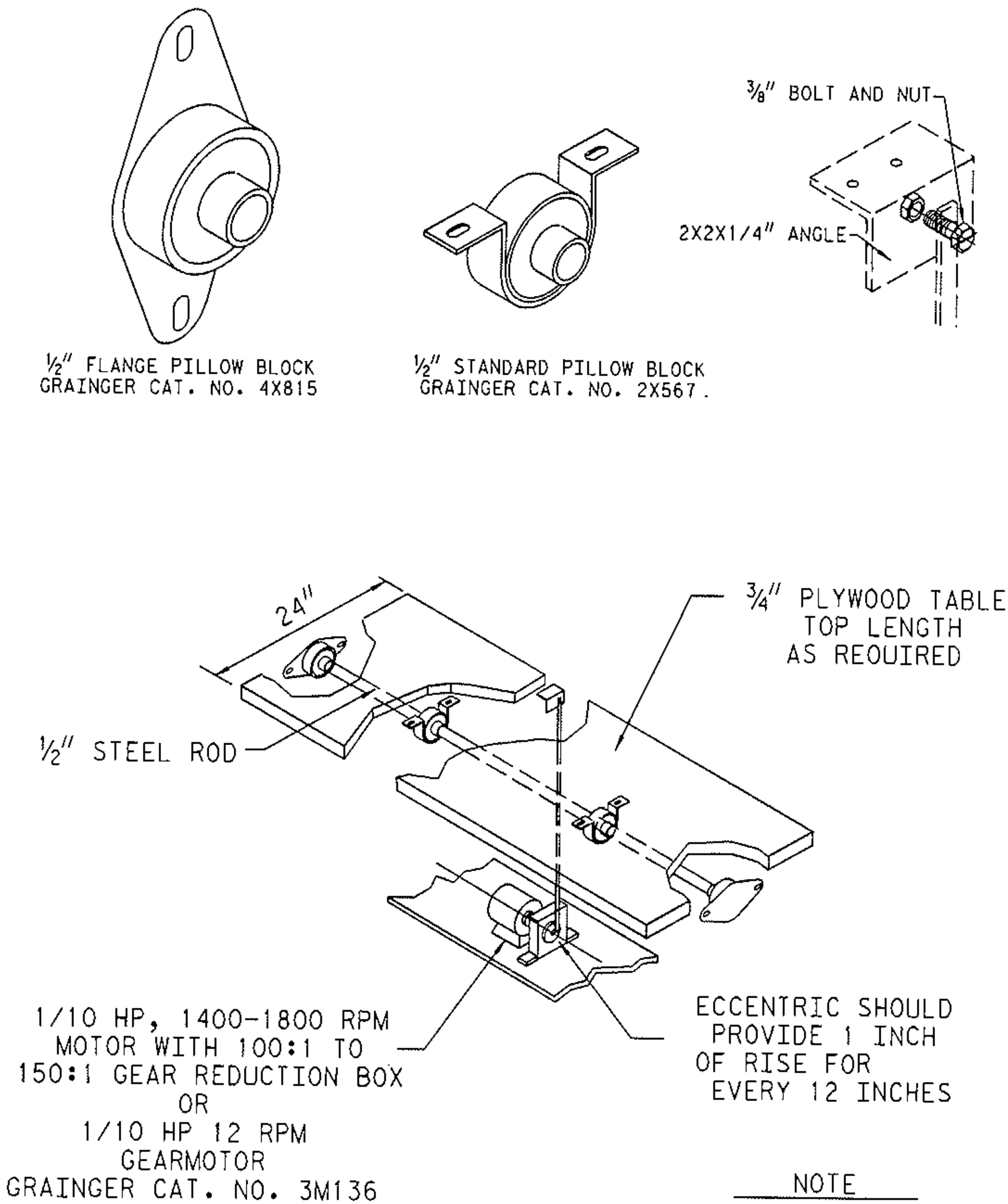
If you plan to do a large number of dye transfer prints then you might eventually want an automatic tray rocker. Though not essential, a tray rocker is a nice luxury if you can afford it. This piece of equipment agitates the dye trays for you. Dye transfer labs make extensive use of rocking tables because of the large volume of dye prints they make. The rocker table consists of a table surface which pivots on an axle. A motor underneath raises and lowers one side of the table in a methodical rocking action.

The exact construction is up to you. Purchase a 1/10 HP gear reduction motor rated at 10 or 15 rpm. A motor rated at 1/10 HP will easily handle 16x20 trays. While it's more convenient and cheaper to buy a one piece unit, you can buy the gear reduction box with a gear ratio around 100:1 or 150:1, and the 1725 RPM, 1/10 HP AC motor separately. Make the table top impervious to liquids by laminating it or applying several coats of spar varnish or polyurethane.

Diagrams 3.21.1 and 3.21.2 show possible designs for a rocker table. The first, from Kodak's E-80 manual, has a single surface on which all trays are mounted. The second version consists of three small tray sized surfaces stacked in tandem, designed to hold one tray each. The advantage of the tandem type table is that is saves space. Feel free to modify the table designs in any manner which might save money or simplify construction.

3.22 COMMERCIAL RETOUCHING BLEACHES.

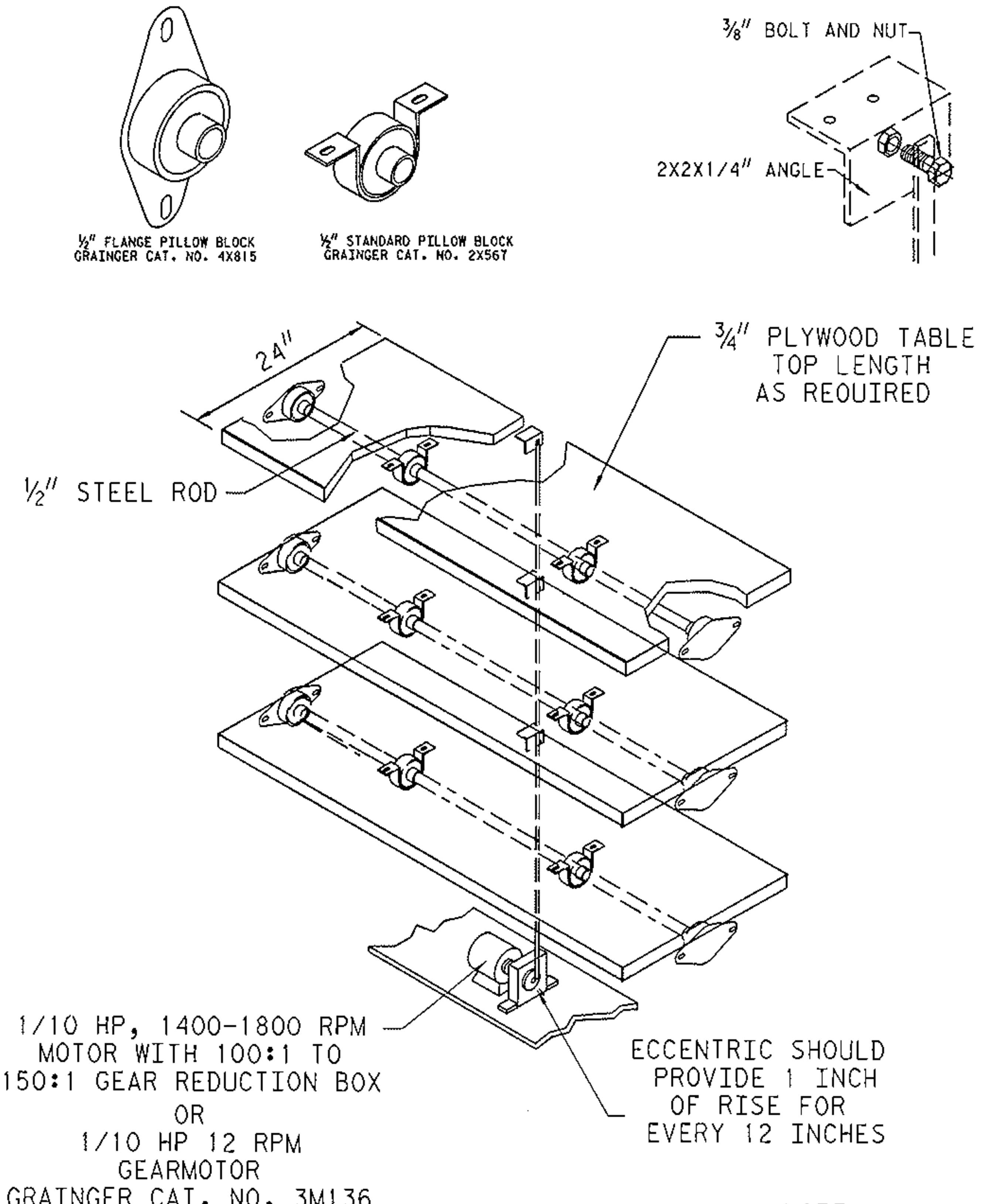
Commercial retouching bleaches are available for dye transfer prints. While a number of bleaches can be made yourself from the chemicals listed in the chemicals section many of these bleaches are superior in action and effectiveness. There are over 10 bleaches available from:



NOTE

1. PARTS CAN BE PURCHASED FROM W.W. GRAINGER, INC. CALL 312-647-8900 FOR NEAREST STORE

FIGURE 3.21.1



NOTE

1. PARTS CAN BE PURCHASED FROM W.W. GRAINGER, INC. CALL 312-647-8900 FOR NEAREST STORE

FIGURE 3.21.2

Retouching Chemicals
Charles Carrasquillo
5478 Wilshire Blvd. #205
Los Angeles, California 90036

The bleaches have different effects which allow the retoucher tremendous versatility. The bleaches are sold in 1, 4, and 8 oz bottles. As of 1986, the chemicals come in 1, 4, and 8 ounce sizes for $10.00, $30.00, and $50.00 respectively. Small bottles of dye (without buffer) for retouching purposes are also sold. With your first order you will also receive an instruction book. Listed below are the bleaches offered: 1. On-Color Bleach2. All Off Bleach3. All Off-B Bleach4. All Off-C Bleach5. Smear and Lighten6. Buffer Bleach7. Magenta Off Bleach8. Orange Off Bleach9. Green Off Bleach10. Yellow Off Bleach A more thorough explanation of these dye bleaches is given in chapter 6 in the retouching section.

3.23 MISCELLANEOUS EQUIPMENT.

There are a number of small items you might want to have to make you work easier. It's up to your discretion to purchase them.

3.23.1 10ml Pipette. This item is a calibrated glass tube for measuring small quantities of liquids accurately. I strongly recommend that you have one for measuring acetic acid. Rather than use your mouth, get a rubber suction bulb. The Chemtrix Company (see section 3.24.2) makes an excellent pipette filler bulb for under $16.00 (cat. #C-9295) that will fit most pipette sizes, is acid resistant, and has three pinch valves that make drawing and dispensing very easy.

3.23.1a 1.0ml Pipette. For dye replenishment you may also want to get a small pipette capable of measuring 0.01(1/100) milliliters. A graduated 1.0 ml pipette calibrated in 1/100 ml units is excellent. Dye replenishment is discussed in section 6.1.

3.23.2 Small Paper Cutter. This item is very useful for cutting test strips. Get a 11x14 paper cutter. An 11x14 cutter can be used to cut film, matrix film, and paper.

3.23.3 Thermometers. Get an accurate thermometer. If you can spare the extra expense, get a Kodak Process Type 3 thermometer. Two identical thermometers are very useful for monitoring the two part tanning developer.

3.23.4 Kodak Viewing Filters. Kodak Color Print Viewing Filters are a must. Although they are designed for multilayer colored materials, they are very useful for making color corrections for dye printing material.

3.23.5 Color Separation Guide and Gray Scales. This is a set of color control patches, a 19 step gray scale, and registration marks. These are designed to be included in the image when photographing to help get proper color balance and exposure. They are also invaluable when making color separations. They made in a 8" and 14" size. The smaller 8" scale is sufficient for most needs. These scales work best when used with a 18% gray card.

The color patch consists of nine colors in low and high density. The gray step scale consists of 19 gray steps range in reflection density values from 0 to 1.90 in 0.1 increments. The registration marks are mainly to aid in photocopying.

If you use the old Separation Guide set you will notice that there are fewer colors on the color patch card and only ten gray steps on the gray step scale. Despite the differences between the old and new either scale is OK to use.

3.23.6 18% Gray Cards. These are a set of neutral 18% gray cards which are used for determining test exposures and color balance. They come in a package of two cards.

*****3.23.7 Diffusion Sheets.** Diffusion sheets are frosted acetate sheets of plastic. When making masks it is necessary to make the masks very fuzzy. This is accomplished by exposing the mask through a diffusion sheet. Kodak diffusion sheets are available in 8x10 sized packages of 12. The Kodak catalog number for this item is #152-1012. For most applications this is more than will ever be necessary, since the sheets will have to be cut to 4x5 sizes for your use.

Since this item is relatively expensive, a suitable substitute can be bought for much less. If you have a drafting supplier near by, then use plastic mylar drawing material. Usually you can purchase it in small quantities and save money.

*****3.23.8 Curve Plotting Paper.** Kodak Curve-Plotting Graph Paper is available in packages of 25 sheets. The Kodak publication code number is E-64. If you will be doing separations then you will have to get curve plotting paper, since the density curve of each negative has to be drawn. This paper is a thin vellum type paper with a grid for plotting density curves. Along the bottom axis are numbers such as one through 21 (row A) and one through 11 (row B). These represent the numbered steps of a 21 step guide or 11 step guide (see section 3.13). Each step on the bottom axis represents a density of 0.15 for the 21 step guide and 0.30 for the 11 step guide. The vertical axis of the plotting paper is graduated in density units from 0 to 3.2 by increments of 0.02 density.

The plotting paper also has markings to plot the Kodak Gray Scale (part of the Kodak Color Separation Guide package) if you choose to include one in transparency image. Row C shows the 19 numbered density values of the new Kodak gray scale. If you have the old Kodak gray scale, with 10 gray steps, then you must use row D. Its gray scale steps show reflection density value of 0.0, .10, .20, .30, .50, .70, 1.0, 1.30, 1.60, and 1.90. These steps are numbered one though ten on the plotting paper. Step #1 corresponds to the 0.0 step and the other steps are number consecutively up to #10.

If by some circumstance you get the old Kodak plotting paper then you'll find only the 21 steps markings on the horizontal axis. Just above the horizontal axis are also markings which show the density values of the old Kodak gray scale. If you have an 11 step guide, use the odd numbered steps.

Another alternative is to make your own curve plotting paper from ordinary graph paper. Get some 8-1/2x11 inch graph paper with 8 or 10 lines per inch in both directions. You need at least that many lines per inch for accuracy. Each line will represent 0.05 density units in each direction. Along the bottom of the paper draw a horizontal line, leaving just enough space below to write some numbers. Starting from the right edge, not the left, mark every three spaces with a number from 1 to 21, i.e., start with 1 at the right edge and count up to 21 as you move to the left. On the vertical axis mark every four spaces by 0.2 up to 3.2. If you are using the 11 step guide instead of the 21 step guide then mark off every six spaces from 1 to 11 on the bottom axis.

3.23.9 Small Glass Vials or Test Tubes. These containers are used to keep reference samples of the three dyes, so get three vials. The vials should have caps. If you use test tubes be sure to get corks for them.

3.23.10 Small Palette Knife or Spatula. This is used to pry the film off the registration pins. This is much easier than using your fingernails; you'll see why if you happen to jam the sharp corner of a piece of film under you fingernail.

*****3.23.11 Glass Polishing Compound, Cerium Oxide.** If you are using a glass carrier, this substance can be used to remove any hairline scratches from the glass. A scratch is simply rubbed out with a small amount on the end of the finger. A small 1/2 ounce bottle is all that is required. Available from Condit Co.

*****3.23.12 Offset Powder.** Offset powder is used when making contact separations to prevent Newton rings. **THIS TECHNIQUE IS NOT RECOMMENDED, INSTEAD SEE SECTION 3.23.13.** Write to Oxy-Dry Sprayer Corp., 271 Highland Parkway, Roselle N.J. 07203, for nearest dealer.

*****3.23.13 Translite & Roller Cleanup Film.** Either of these two films can be used to prevent Newton rings, if they occur. This is done by placing the film between the glass and negative back. **USE THIS ABOVE NEGATIVE ONLY!!** Translite #5561 is a translucent photosensitive film that must be fixed out before use. It is available in 8x10, 25 sheet box, Kodak #146-0625. The Kodak Roller Transport Cleanup Film #4955 is clear and non-photosensitive. It is available in 8x10, 50 sheet box, Kodak #114-1530.

Another technique is to coat the glass surface with a gum arabic solution. Mix 1/2 ounce of 14% gum arabic with 4 ounces of water, apply to the glass surface and allow to dry. Use this on the top glass only to avoid image degradation.

KODAK Curve Plotting Graph Paper

21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

No. ________ Date ________

DENSITY

3.2 3.0 2.8 2.6 2.4 2.2 2.0 1.8 1.6 1.4 1.2 1.0 .8 .6 .4 .2

A 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

B 11 10 9 8 7 6 5 4 3 2 1

C 19 18 17 B 15 14 13 12 11 10 9 8 M 6 5 4 3 2 1 A

D 10 9 8 7 6 5 4 3 2 1

E 8 7 6 5 4 3 2 1

E-64 12-78 Printed in U.S.A.

3.23.14 Weight Measure Scales. You will need a means to measure dry chemicals. Get a scale that can measure to at least one gram fairly accurately. Scales come in a variety of types and prices. The Ohaus Model 750s and the Pelouze Model R-47 are two inexpensive models that work well. Remember, you have to pay for accuracy.

3.23.15 PH Meter. For the serious dye transfer practitioner there are few things that can surpass a PH meter for monitoring the dye baths. Although for general use there are alternative ways to maintain the PH level of the dye baths, a good PH meter cannot be beaten for speed and accuracy. PH meters are not cheap, so if your funds are limited use the money to purchase more essential things. A company called Chemtrix Incorporated makes a good PH meter and general purpose ph electrode which can be purchased together for about $150. Write to them and ask for the price of their "Low Cost pH Meter", Catalog #C-4019 and "No Fuss" pH Electrode, Catalog number C-H105. They also make a more accurate pH meter, Model 40C, Catalog #C-4000 for about for about $170 (without a pH electrode). In addition to purchasing the meter and probe also get a pint of 7.0Ph buffer solution (cat. #C-4207) and a pint of 4.0Ph buffer solution (cat. #C-4204) for meter calibration. The address and phone number of Chemtrix is:

Chemtrix Incorporated
5285 N.E. Elam Young Parkway
Suite A-400
Hillsboro, Oregon 97124
1-800-821-1358

3.23.16 Gammeter. The job of calculating curve gammas after you have plotted curves can be tedious and boring. Included in this section is a real life-saver called a gammeter. It is just a transparent piece of film with a set of indexed graph lines, which is placed over the plotted curve. The gamma is instantly apparent at the intersection of the graph and curve.

Take the reproduction of the gammeter given on the next page and reproduce it on a sheet of kodalith film. Photograph it on black and white film and then expose sheet of kodalith with the resulting negative. When it wears out, you can always make another one.

An easier alternative to making negatives and kodaliths is to reproduce the image on a sheet of overhead projection film. This is the clear film used in over projection machines for lectures. Of course, you will need a thermal coping machine such as those made by 3M company. The film is available is any good office supply store. Ask for:

3M Company
Infrared Transparency film #570
Film for Overhead Projection.

Any good copy service company should be able to make the transparency for you.

3.23.17 "What nots".

Tools

1. Scissors
2. Canned Air
3. Empty 11x14 Box. For exposed film.
4. Lens cleaner
5. Silver masking tape
6. Film cleaner
7. Exacto knife
8. Small sable brush for removal of dust.

Ten ml pipette

1. VWR. Cat#53109-154

One ml pipette

1. VWR. Cat#52960-119

Paper cutter

1. Premier Co.
2. Paterson
3. Leedal

Thermometers

1. Kodak Process, Type 3, #EK 106-4955
2. VWR. Cat# TR71500-50 (Dial type)
3. Weston. #2292 (Dial type)
4. VWR. Cat# 61014-020 (glass type)
5. Kodak Color Thermometer (glass type)

Viewing Filters

1. Kodak Viewing Filter Kit. Kodak code #R-25

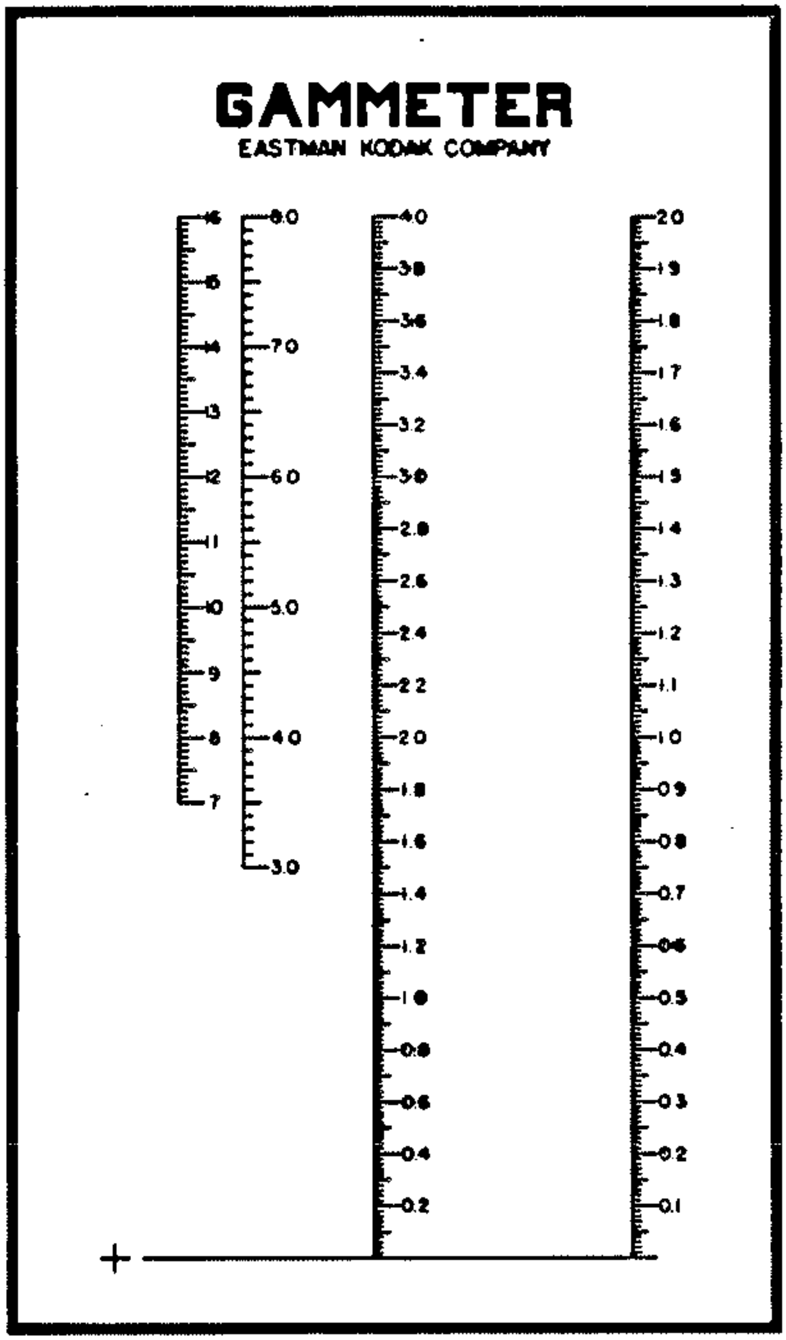
Color Separation Guide

1. Small size Kodak code #Q-13.
2. Large size Kodak code #Q-14.

18% Gray Card

1. Kodak code #R-27.

Diffusion Sheets


GAMMETER
EASTMAN KODAK COMPANY
16
15
14
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8.0
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5.0
4.0
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4.0
3.8
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3.4
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0.6
0.4
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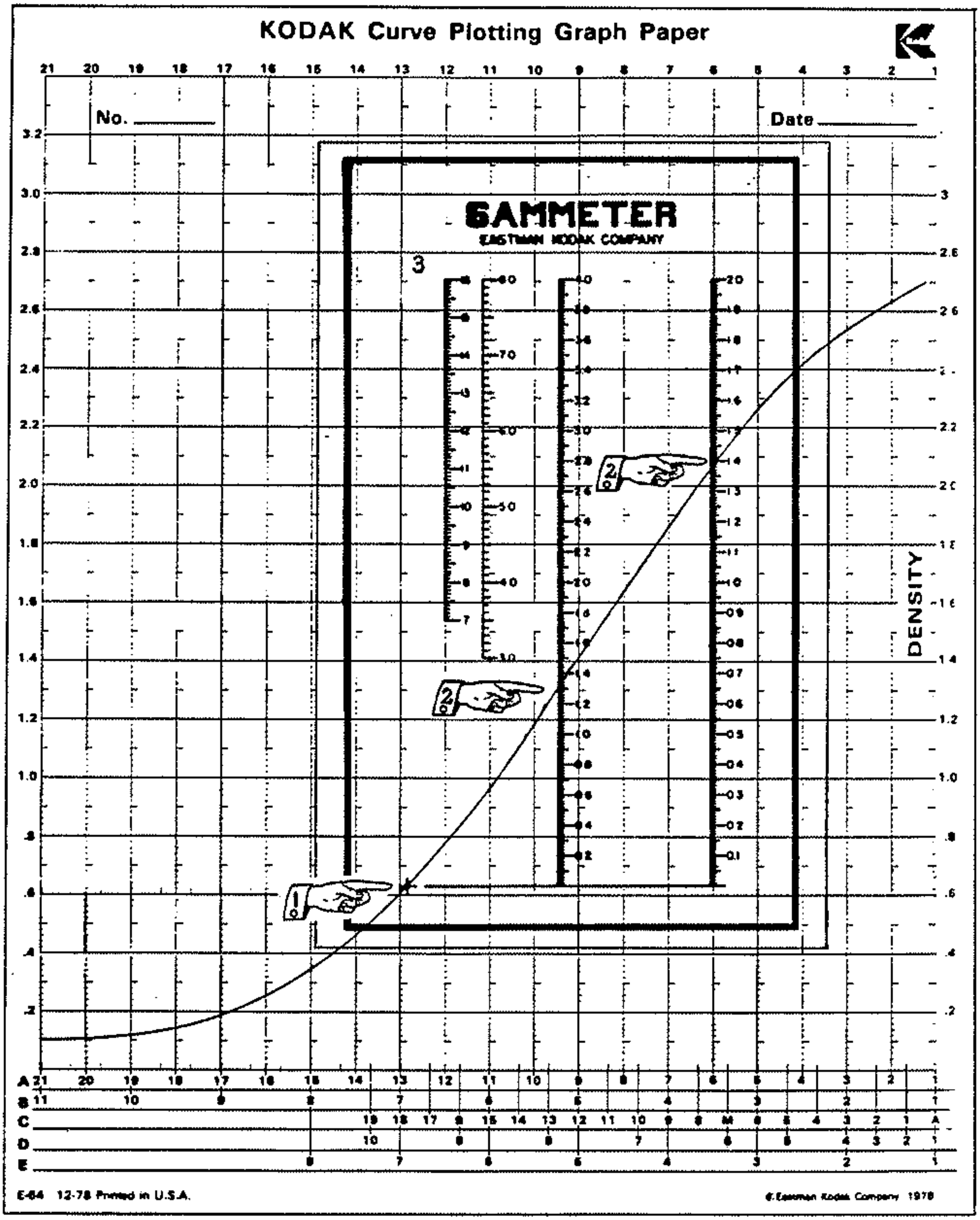
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1



INSTRUCTIONS

1. PLACE CROSSHAIR OF GAMMETER AT BOTTOM OF STRAIGHT LINE PORTION OF CURVE. BE SURE THAT GAMMETER IS PARALLEL TO GRAPH PAPER GRID.

2. READ GAMMA OF CURVE AT THE INTERSECTION OF CURVE AND GRAPH LINES. IN THIS EXAMPLE THE GAMMA IS ABOUT 1.35.

3. THE TWO SMALLER GRAPH LINES ARE FOR GAMMAS FROM 3.0 TO 16. THEY ARE SELDOM USED.

1. 8x10 Kodak Cat #152-1012.

3.24 EQUIPMENT SUPPLIERS.

Generally most of the equipment can be obtained from Momentum Graphics, formally called VWR Scientific. Unfortunately, if you are a private purchaser you may have trouble dealing with this company:

Momentum Graphics
3140 Grand River
Detroit, Mi 48208
313-833-7800

Momentum Graphics
P.O. Box 232
Boston, Mass. 02101
617-964-0900

Momentum Graphics
P.O. Box 999
South Plainfield, New Jersey
210-756-8030

Momentum Graphics
P.O. Box 1050
Rochester, New York 14603
716-247-0610

Call or write the above for location near you.

3.24.1 Chemical Suppliers.

Photographer's Formulary
Box 5105C Missoula, Montana 59806-5105
800-922-5255

3.24.2 Special Equipment Suppliers.

Aristo Grid Lamp Products
65 Harbor Road
Port Washington, N.Y. 11050
516-767-3030

Bregman Company
2933 Vauxhall Rd.
Vauxhall, New Jersey 07088
201-851-0500

Calumet Photographic Inc.
890 Supreme Drive
Bensenville, Illinois 60160
800-323-2849, 312-869-7447

Chemtrix Incorporated
5285 N.E. Elam Young Parkway
Suite A-400
Hillsboro, Oregon 97123
1-800-821-1358

Condit Company
Philo Curtis Road
Sandy Hook, Connecticut 06482
203-426-4119

Retouching Chemicals
Charles Carrasquillo
5478 Wilshire Blvd.
#211 Los Angeles, California 90036
213-935-9452

K&M Manufacturing Co.
4931 73rd Avenue
North Pinellas Park, Florida 33565

Light Impressions Corp.
439 Monroe Ave.
P.O. Box 940
Rochester, N.Y. 14603
800-828-6216

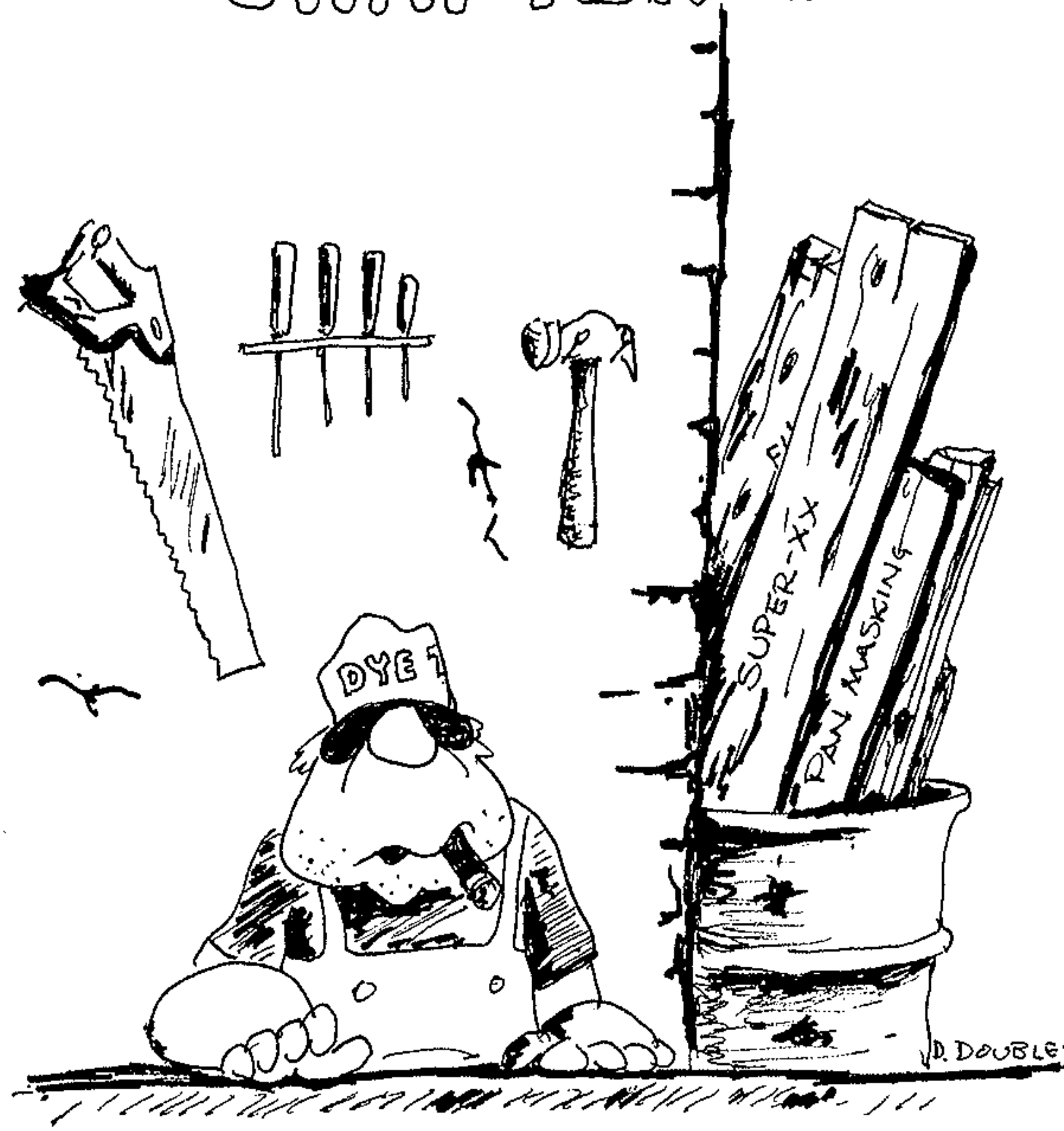
Frank Morse Company
44 Lincoln
Saco, Maine 04072

Raytheon Company
Sorenson Product Supplies Dept.
676 Island Pond
Road Manchester, New Hampshire 03103

Sola Electric Sola Basic Industries
1701 Busse Road Elk
Grove Village, Illinois 60007

Stouffers Graphic Arts Supply Co.
South Bend, Indiana 46617

CHAPTER 4



MAKING MASKS AND SEPARATIONS

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IV MAKING MASKS & SEPARATIONS

*** = FOR SEPARATION NEGATIVES ONLY

***** = FOR SEPARATION NEGATIVES ONLY**

CHAPTER 4 MASKS AND SEPARATIONS [4-1]

4.0 INTRODUCTION.

This chapter covers the making of separation negatives and masks. We will discuss direct separation (in-camera) negatives, contact masks, contact separation negatives, and enlarged separation negatives. A list of special items required for each technique will be given at the beginning of each section. For easy reference, some items will have reference section numbers given in carats, i.e., <x.xx.x>, for additional information. For example, "Super-XX film 4142 <3.16.3>", means that more information about Super-XX film 4142 is available from section 3.16.2. General darkroom items will be assumed and therefore not listed.

4.1 DIRECT SEPARATION NEGATIVES.

MATERIAL:	
Kodak 4X5 T-Max 100 film	<3.16.3>
Kodak 4x5 Super-XX film 4142	<3.16.3>
Black and White paper	
Pan Masking Film	<3.16.2>
Technical Pan	<3.16.3>
Separation #1 film	<3.16.3>
CHEMICALS:	
HC-110 Developer	<3.17.6>
T-MAX Developer	
Paper Developer	
Acetic developer	
Fixer	
EQUIPMENT:	
#29,61,47B Filters	<3.8.2>
#25,58,47B Filters (optional)	
5x7 trays or processing drum	
21 Step scale	<3.13 >
Reflection step scale	<3.23.5>
Gammeter	<3.32.17>
Densitometer	<3.12 >

The most direct way of obtaining separation negatives is to photograph the subject with a camera through red, green, and blue color separation filters. This is usually done by making separate exposures, but special cameras have been made to take three simultaneous exposures. During the late thirties and forties such cameras, known as 3-shot cameras, were numerous.

Unlike separations made of transparencies or color negatives, direct separations do not require color masking. Unfortunately, black and white films are not completely responsive to the full spectrum of visible light. The resulting exposure and contrast differences which occur make it necessary to calculate exposure corrections and determine development times. This is why it is almost impossible to do separations on roll film.

Thankfully, the new T-grain films have reached the market. While exposure differences still exist, the contrast problems produced by spectral differences is almost eliminated. For the first time it is possible use roll film for separation work.

Another problem still has to be addressed, however. Separate exposures must be made without camera movement. This is a minor problem indoors, but it can present formidable problems for daylight photography. A quick gust of wind or a large semi-truck rushing by might create movements resulting in camera shake. This would not be a problem if exposure times were shorter, unfortunately, the separation filters effectively reduce the ASA of the film to values below 25 E.I. **WARNING, DO NOT MAKE EXPOSURE CORRECTIONS BY CHANGING THE APERTURE. USE THE SAME APERTURE FOR ALL THREE EXPOSURES. CHANGE THE EXPOSURE TIME ONLY.**

The wide brightness range of outdoor subjects can sometimes exceed the film's exposure latitude. The brightness ratio of a bright sunny day can approach 1000:1 (10 stops) as compared to a normal lighting ratio of 100:1 (7 stops).

4.1.1 Method of Approach. Super-XX and T-Max 100 are recommended for direct separations. Both have excellent color response but T-Max film is the best choice because its red, green, and blue contrast are the same.

Either of two filter combinations can be used for direct separations. For precise color use the #29 red, #61 green, and #47B blue filters. The other combination of filters are the a #25 red, #58 green, and #47B blue. They have broader spectral response. This makes them simpler to use but lessens the color intensity. Neutral density filters should be used to make the exposure times roughly equal; this will help lessen the relative reciprocity problems.

The first step is to determine a normal gamma for the film. Because daylight contrast can vary it is obvious that this gamma may be unsuitable at times. Appropriate steps will be discussed which will rectify this problem.

The density range of the separation should be approximately 1.2 to match that of matrix film. This matrix film density range can be verified as described in section 4.2.2. If a normal day is assumed to have a brightness range of 2.0 then a normal gamma can be determined for most lighting situations. Using these two facts, this gamma is calculated to be 0.6 ($1.2 \div 2.0$).

Next film development tests must be made to determine the proper exposure and development times. With Super-XX you will have different contrast for each filter so testing will be a little more complicated. T-Max 100 film should have the same contrast for all three filters but tests should be done for each filter to verify this. If you plan to use tungsten and/or daylight exposures then tests should be done for both light sources.

The film is processed for a typical density range, but the subject brightness range may be different. For example, suppose you have geared your film processing and exposure to produce a density range of 1.2 for an typical subject brightness range of 2.0,i.e., a gamma of 0.6. In other words, the negative gamma is 0.6 (1.2/2.0). After photographing a subject on a particularly bright and contrasty day, the separations are processed, and density readings are taken of the shadow and highlights. The results yield a density range of 1.5!!!. Since the film has a gamma of 0.6 the brightness range of the subject is 2.5 (1.5/0.6)!!! In short, the subject is contrastier than the assumed typical brightness range of 2.0.

There are three methods to solve such a problem.

Method 1. Vary the separation development. Set up a "zone system" for your separations. Determine the brightness range of your subject by measuring the shadows and highlights BEFORE the subject is actually photographed. To calculate the brightness range imply multiply the number of stops between shadow and highlights by 0.3. For example, a difference of 8-1/3 stops is equivalent to a brightness range of 2.5 (8.33x0.3). A gamma vs development time is chart used to determine the development time which will yield produce the target density range of 1.2. For this example, the required gamma is 0.48 (1.2/2.5); lower in contrast. This technique is discussed in detail in section 4.7.3.

Method 2. Keep the separation development the same and use contrast masking to control the subject contrast in the separation. Masking can be used to reduce contrast or increase it. Pan Masking film is used for contrast reduction. Separation #1 and Technical Pan is used for contrast enhancement. Contrast enhancement is more difficult to do because an intermediate positive (interpositive) is made from the negative and the contrast enhancement mask from that. The easier way to make a mask is by contact. For registration purposes the larger film is punched with a 1/16" pin register film punch. Smaller film is mounted in a transport jig which is then punched. See section 4.2c for the procedure for making a transport jig for smaller films.

For this example a contrast reduction mask is required. It must have a density range of 0.5 (2.5-2.0). This, is equivalent to saying the mask must have a gamma of 0.20 (0.5/2.5). To be useful you will have to make a gamma vs. development time chart for the masking film. The required masking contrast must calculated then the proper development time is selected from chart. When registered with the separation negative there is an effective density range of 2.0 (2.5-0.5).

Suppose separation had low contrast, then a contrast enhancement mask would be required. For example, assume the density range of the separation is 1.6. The mask with a density range of -0.4 (1.6-2.0), i.e., a gamma of -0.25 ($-0.4 \div 1.6$), would be required. An interpositive (gamma = 1.0) is made of the separation with a density range about the same as the separation negative on a film like Technical Pan or Separation #1. Using Pan masking film, a low contrast negative mask of the interpositive is having density range of 0.4. When registered with the separation negative there is an effective density range of 2.0 (1.6+0.4).

Method 3. Keep the separation development the same, make a black white print from the green separation and use it to determine matrix developer concentration. By knowing the density range of various contrast grades of black and white paper and selecting the most pleasing print produced by the green separation you can determine how to vary the tanning developer A to B ratio to improve the contrast of the final dye print. In the example, a pleasing print was made on #0 grade paper which has a density range of 1.5. As a result we assume the negative has a density range of 1.5. Next by using the tanning developer chart in section 5.3 we know that an A to B ratio of about 1:1.5 should be used when processing the matrix film. This technique is a variation of old one used to proof separations for carbro printing decades ago.

4.1.2 Using Roll Film. In the past people have tried to use roll film to make separations despite the fact the each separation varies in exposure and contrast. The results have produced less than satisfactory color. By using Kodak's T-Max 100 film it is possible to make separations without the contrast compensation problems incurred with most films. The film's fine grain in another bonus allowing you to make large prints even with 35mm film. With the prudent use of neutral density filters to equalize exposure times, it is possible to make very good separations. Of course, all registration of the separations will have to be done by hand in the darkroom.

4.1.3 Using Sheet Film. Generally, sheet film is used for direct separations. Care must be taken not to mix up your film holders. Make sure your holders are identical because different film holders have different focusing planes. You should mark the holders in some indelible way so no mistake can be made at the time of exposure or development.

A Grafmatic sheet film holder is another method for keeping track of exposures. New Grafmatic holders may be hard to find but any good used professional photography equipment store should have some. This type of holder holds 6 sheets of film. The internal film holding plates are very flat and provide the critical focus required. Each sheet film gets numbered by a little device on the holder, so the exposures can be identified after they are processed.

4.1.4 Determining Exposure. The first task is to determine the relative densities produced by exposures made with the separation filters. The proper exposure is found by converting density differences into exposure factors or by using equivalent neutral density filters.

Exposure factors will be different for tungsten and daylight, so it is a good idea to test both types of light. For daylight light source use a flash instead of natural daylight because its color temperature is constant.

Use these exposure filter combinations of filters and times as a starting point.

T-Max 100 Film, at ASA 6			
	#29 red	#61 green	#47B blue
Daylight	+0.1ND	+0.3ND	+0.2ND
Tungsten	+0.2ND	+0.3ND	+0.1ND

ND = neutral density filter
Supplied by Jerry Storey, Elkgrov California

Super-XX, at ASA 12			
	#29 red	#61 green	#47B blue
Daylight	+0.1ND	+0.2ND	+0.4ND
Tungsten	+0.4ND	+0.2ND	+0.1ND

ND = neutral density filter

Exposures are approximatley the same for #25, 58, and 47B filters in daylight. The filter factor for each has a filter factor is 8 in daylight, which is equivalent to three stops. To avoid constant calculation of exposures divide the filter factor into the exposure index of the film. Set the light meter to this exposure index. T-Max 100 film should have an E.I of 12 and Super-XX film an E.I. of 25. These numbers are only starting points. The testing will determine the correct values.

Use Kodak's recommended development times for testing. For T-Max 100 film try HC-110 dilution B developer for 7 minutes at 72-75 Fahrenheit. The contrast should be near 0.6 but is not critical at this point. Exact development times will be determined in the next section. The main purpose is to obtain relative densities.

Photograph a reflection step scale or expose the film by contact with a 21 step scale with white light and through the separation filters. Photographing a reflection step scale is the best way because it takes into account the lens, camera, flare, etc. Process the negatives as recommended.

Plot the red, green, blue, and neutral curves. For the reflection scale use the "C" row on the plotting paper refer to section 4.9.1 for details.

Theoretically, the negatives should be have the same gamma, i.e., the curves should be parallel, however, for exposure calculation this is not a necessity. A reasonable calculation of the exposure can be performed if the gammas of all four curves are known.

Measure each curve's gamma. If you have a gammeter this should be easy. Next pick a step which lies in the middle of the straight line portion of the white light curve. Measure the corresponding density of this step on each curve. Divide each density by its associated gamma value. Next subtract each color curve value from the neutral curve's value. The results are the actual density differences. A positive difference indicates additional density is required, a negative value indicates less density is required. The differences can also be converted into exposure correction factors. If you have a calculator you can determined exposure factors by taking the antilog of the density difference. To simplify this use Table 4.1.4-1 instead. This information can be expressed in equation form as follows:

$$\text{density difference} = (\text{density}_1 \div \text{gamma}_1) - (\text{density}_2 \div \text{gamma}_2)$$

$$\text{exposure factor} = \text{antilog}_{10} (\text{density difference})$$

$density_1$ = step on white light curve
$density_2$ = step on color light curve
$gamma_1$ = gamma of white light curve
$gamma_2$ = gamma of color light curve

For example suppose the density of the selected step on the white light curve is 0.6 and its gamma is 0.55 and the same step on the blue curve is 0.50 and its gamma is 0.48. The calculation is:.

$$\begin{aligned} \text{density difference} &= (0.6 \div 0.55)-(0.56 \div 0.48) \\ &= (1.09) - (1.04) \\ &= 0.05 \end{aligned}$$

equivalent exposure = antilog (0.5) =1.10 (or refer to chart)

We would therefore remove a 0.05 neutral density or multiply the blue exposure time by 1.10 filter. If the density difference were negative then we would add 0.05 neutral density or divide the blue filter time by 1.10.

TABLE 4.1.4-1

Density Difference	Exposure Factor
0.02	1.05
0.04	1.10
0.06	1.15
0.08	1.20
0.10	1.25
0.14	1.38
0.18	1.51
0.22	1.66
0.26	1.82
0.30	2.00
0.36	2.29
0.40	2.51
0.46	2.88
0.50	3.16
0.56	3.63
0.60	3.98
0.70	5.01
0.80	6.31
0.90	7.94

4.1.5 Determining Development Times. The aim of this section is to arrive at a development time which will produce a negative that has the same density range as that of matrix film. A typical density range is about for matrix film is about 1.2. To match this density range three methods have been described earlier which will meet this aim despite the brightness range of the subject.

Use either a 21 step scale or a reflection step scale for testing. If a 21 step scale is used for testing select steps representing a shadow density of 0.4 and a highlight density of 2.4. If a reflection step scale is used, select the steps marked "A", as the highlight, and step "B", as the shadow. The reflection density of step A is 0.0 and that for step B is 1.60. With a 21 step scale the density range is 2.0, but with the reflection step scale the density range is 1.6.

4.1.5.1 Development for Method #1. With this method the separation gamma is adjusted to the subject contrast. This requires that a gamma vs development chart be made. Use the recommended developer for these tests. The testing should be done for both tungsten and daylight light (flash) sources.

If you are using a 21 step scale plot the curves by using row 'A' on Kodak plotting paper. If you are using a 21 step reflection scale use row 'C'. Row 'B' is for an 11 step scale and row 'D' is for a 10 step reflection scale. See section 4.9 for more information on curve plotting.

The steps required are summarized below:

Step 1) Make the same exposure of the test scale on several sheets of film. Do this for the red, green and blue filters. Use the recommended exposure times suggested by Kodak. Use at least 6 sheets of film.

Step 2) Develop each sheet at a different time. Use development times from 1/2 to 2X the recommended development times.

Step 3) For a given filter, plot the curves for each development time (on the same plotting paper). You should have three sheets of paper, each showing six or more development curves.

Step 4) Find the gamma of each curve, use the gammeter to save time. Plot the development time versus the gamma for each curve. There should be six or more points for each color. Plot a smooth curve through these points.

Step 5) Plot all three contrast curves on the same graph. These curves should be almost the same for T-Max 100 film. For a film is like SuperXX there should be three separate curves.

4.1.5.2 Development for Method #2. With this method, the separation gamma remains constant and contrast control is done by masking the separation. The separation gamma should be about 0.6. The range differences of two step scales makes the desired separation density range different for a gamma of 0.6. There are 3 steps.

a) find development time which yields a gamma of 0.6.

b) make a gamma vs. development chart for masking film.

c) find development time for interpositive film.

A) Follow the steps 1 through 3 as described in section 4.1.5.1. Next select the development time which produces a gamma of 0.6.

B) Make a mask gamma vs development time chart as decribed in the previous section. See section 4.7 for development information. Develop the film in 1 minute increments up to and including 5 minutes.

C) Make a positive from the separation for contrast enhancement. The interpositive should have a gamma near 1.0. Use a step scale as described earlier. A film like Technical Pan is excellent to this purpose. Use a developer like HC110 dilution F for 6 min. at 68 F. Another contrasty film like Separation #1 could also be used. Make the mask from the interpositive. Calculate the required masking gamma by dividing the difference between the actual and required density range by the actual density range.

4.1.5.3 Development for Method #3. Process the separation film for a gamma of 0.6. Use the procedures as described in section 4.1.5.1.

4.1.6 Solving Contrast Problems With B&W paper. This is a rather clever way to solve the subject contrast problem, although not as precisely. By making black and white prints from various grades of paper it is possible to estimate the negative density. To simplify things only make a print of the green separation, unless the image has an disproportionate amount of green, then use the red separation. If your negatives are balanced this should be sufficient.

Polycontrast paper RC is the easiest to use, since its contrast is easily be altered. In order to use this method effectively keep the development consistent. Keep the paper emulsion, time, developer, agitation, temperature the same.Before making dye transfer matrixes, make a print on black and white polycontrast paper. A good print, for a density range of 1.2 in the separation, should occur with a #2 grade paper. If the print on #2 paper is not satisfactory, then try the print on an appropriate grade of paper. This variation from normal means the subject's brightness range was not 2.0, consequently the separation density range is not 1.2. The chart gives approximate negative density ranges for each paper grade. Note that these values are different for diffusion or condenser enlarger light sources.

Paper Grade	Diffusion Enlarger	Condenser Enlarger
0	1.5	1.15
1 (soft)	1.3	1.00
2 (medium)	1.1	0.85
3 (hard)	0.9	0.70
4 (extra hard)	0.7	0.55
5 (ultra hard)	0.6	0.45

For example, assume the green separation produced the best print on #3 grade paper. This means the subject density range is about 0.9.

Once the actual density range of the subject is determined, compensate by changing the "A" to "B" ratio of the matrix film tanning developer when making the matrixes. The chart is shown below.

Contrast Wanted	Negative Density Range	Developer A	B	Exposure Adjustment
Very Low	1.8	1	1	130%
Low	1.6	1	1.5	115%
Normal	1.2	1	2	100%
High	1.1	1	3	90%
Very High	0.9	1	4.5	80%

Don't attempt to dilute the chemistry more than shown in the chart above, the results will be quite unsatisfactory. Use one of the other contrast adjustment techniques in extreme cases.

4.2 PREMASKING PREPARATIONS.

MATERIALS:
4x5 Kodalith Ortho Film 2556 <3.16.1>
Your favorite transparency film

CHEMICALS:
Dektol
Acetic acid
Fixer

EQUIPMENT:
21 or 11 Step Guide <3.13>
Contact Print Lamp(or enlarger) <3.15>
Gray Card or Kodak Dataguide <3.21.5>
5x7 trays or drum
Motorized base for drum
Two hole punch

4.2a Testing Procedures. Beginners should start by making a Standard Reference Transparency, SRT for short, to insure properly exposed masks and separations and to help in obtaining proper developing times. Use your favorite transparency film to make a SRT. I would recommend any Ektachrome type transparency film. Beware of Kodachrome; it sometimes yields unpredictable results. Although Kodachrome is a fine film, it is not always consistent where separation work is concerned.

Photograph a color separation guide and gray card. Any commercially made color test cards can be used. Use whatever you wish, but be sure the SRT has red, green, blue, several tones of gray, black, and white. In addition, make sure the transparency is properly exposed. To be on the safe side, make it slightly underexposed. A good SRT will provide three things:

1. Color patches to help identify the negatives.

2. A gray step scale to help determine contrast.

3. A gray card to help determine the relative exposure of the separations.

4.2b. Warning About Kodachrome. In the past, Kodachrome has been known to have color crossover problems. Crossover is an uncorrectable color problem. For example, the sky in Kodachrome slides often will range from greenish-blue at the horizon to a magenta-blue color at the apex. Such a problem is impossible to correct with most multi-layered color materials and troublesome with dye transfer. If, however, Kodachrome is your favorite film then by all means stick with it. If you are a Kodachrome advocate you might try the new Kodachrome Professional Film. I think Kodak has made great strides, recently, in improving Kodachrome's consistency and dye layer crossover problems.

Kodachrome has two basic problems. Number one, the cyan dye has more contrast than the magenta dye. This is the reason for the magenta-cyan crossover. You may have to readjust the red separation's contrast to rectify this problem. The amount of contrast correction is unpredictable because of Kodachrome's color layer inconsistency. Number two, Kodachrome's yellow dye contrast is low. Again, you may have to make corrections to the blue separation's contrast.

Of course, contrast correction can be done at other points in the dye transfer process, such as during the matrix film development stage or when dying the matrixes by changing dye contrasts.

The #24 red filter is used to compensate for the cyan dye problem. The use of a green mask in lieu of the red mask for the red separation also helps reduce the magenta-cyan problem. These changes may solve the crossover problems, so contrast corrections may not be required. Often the crossover will not be noticeable for low contrast and medium contrast subjects. I suppose it really doesn't matter; if you can live with crossover in the transparency then you can live with it in the dye print.

4.2c Making a Transport Jig For Small Film. If you will be making contact masks and/or separations from transparency film smaller than 4x5 then make a 4x5 transport jig. This is accomplished by taping the transparency into a "carriage" or "jig" along with a 21 or 11 step guide. Use either the small graphic arts step guide or the Kodak 11 step guide. A "jig", made from 4x5 Kodalith film, holds both the transparency and the step guide. Don't use any other film for this purpose. Kodalith is thinner than transparency film thereby insuring good contact between the transparency and films. Figure 4.2.1 illustrates how a jig is constructed. There is some possibility of Newton rings with this set up if unequal pressure is used to hold the glass and non-emulsion side of the transparency together. Before beginning any exposures, carefully examine the glass. If you detect a Newton ring problem use the Translite or Roller Cleanup film as a buffer between the surfaces. Usually, there'll be no problem.

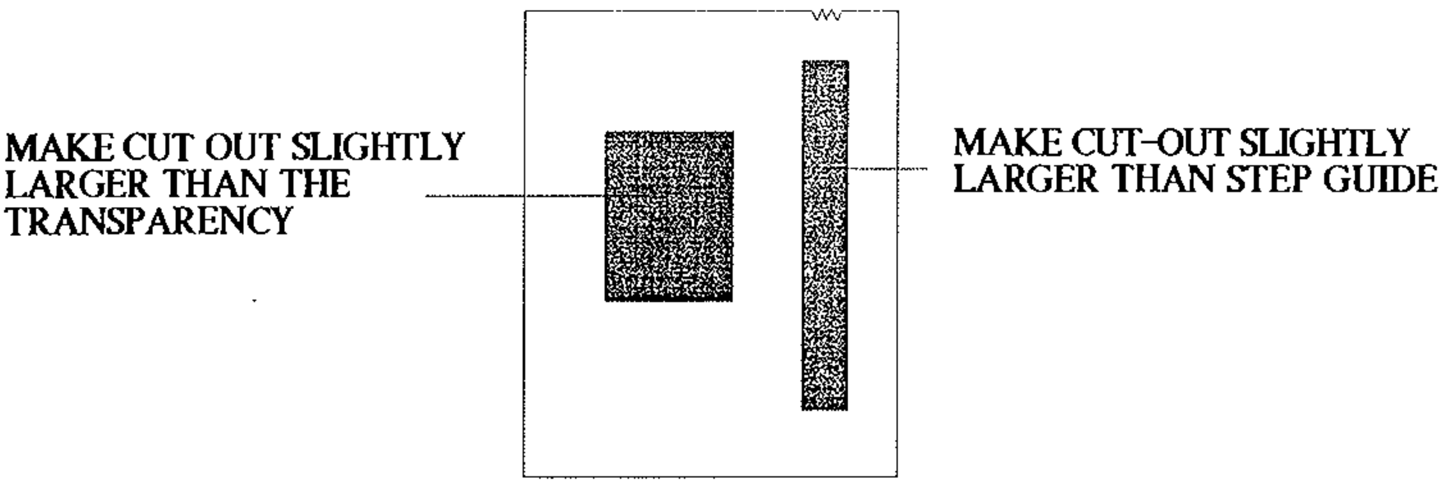
Before making the jig, the Kodalith film has to be prefogged to prevent developer adjacency effects in the masks and separations. Adjacency effects are incomplete development in and around the image due to local developer exhaustion caused by the large black areas created by clear areas in the jig. The Kodalith film should be prefogged to a density between 0.7 and 1.0. Ordinary Dektol is used to develop the Kodalith film, see Figure 3.10.2.

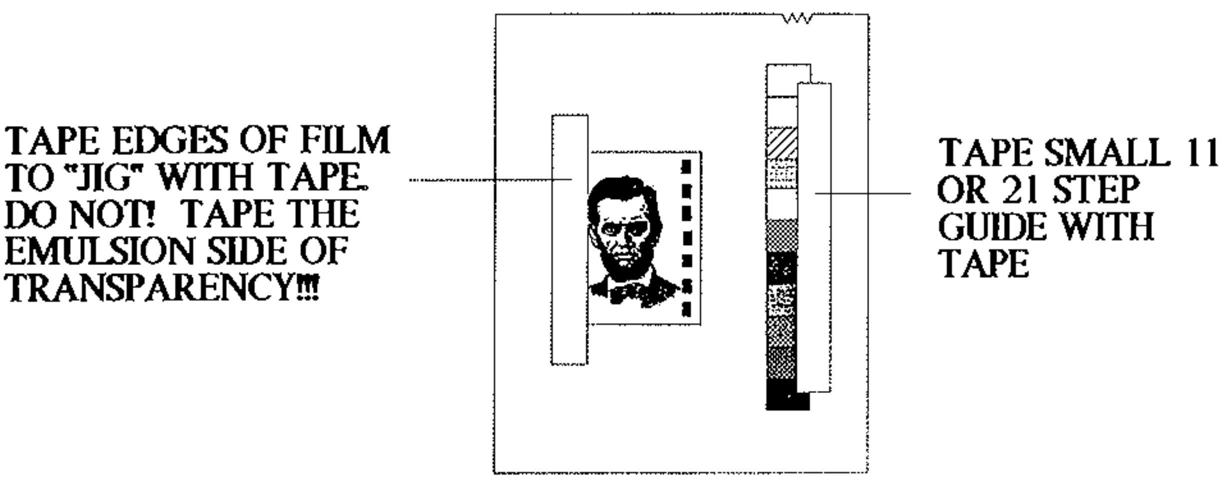
Windows for the transparency and step guide should be cut into the Kodalith film after it is processed and dried. The transparency and guide are then taped into the jig. If you can't get anything but the large Kodak No. 2 step guide, cut a 1/2 inch edge off the jig and tape the step guide to one side of the jig. Don't tape all four sides of the transparency, tape one edge only. This allows the film to flatten without buckling. Don't be alarmed by the tendency of the 35mm film to curl; it will flatten out in the contact frame. Punch the registration holes in the jig and you are ready to begin.

4.2d Transparency Duplication. Another alternative to working with a small 35mm or 2-1/4 inch transparencies is to have the transparency enlarged onto 4x5 or larger Kodak Ektachrome Duplicating Film 6121. Professionally made dupes are quite good and I would not hesitate to use them. The enlarged image will allow you to make larger, sharper prints. This duplicating film works best with Ektachrome film because of the similar dye layers. Kodachrome dupes are generally acceptable though not as good.

Homemade dupes are easy to do, but be sure to use contrast masking for optimum quality. Although Kodak claims that no masking is required, I find that masking is almost always necessary when making dupes. Some things are necessary in order to properly mask the transparency.

1. **Necessary Equipment.** A registration carrier to properly register the transparency and mask is needed together. Mount the transparency in a transport jig as shown in section 4.2c. Although it has been done, do not try to register the mask and transparency by eye.





1. SET ENLARGER FOR ILLUMINATION OF 3 FOOTCANDLES. CLOSE DOWN LENS APERATURE 4 STOPS OR USE NEUTRAL DENSITY FILTERS EQUIVALENT TO 1.2 DENSITY.

2. EXPOSE 4X5 KODALITH ORTHO FILM 2556 FOR 5 SECONDS.

3. DEVELOP FILM FOR 1-1/2 MINUTES IN DEKTOL 1:1 AT 68 DEGREES F.

4. YOU SHOULD OBTAIN A BACKGROUND DENSITY WHICH LOOKS LIKE 18% GRAY. IF THE EXPOSURE TIMES ARE NOT CORRECT THEN MAKE A TEST STRIP TO OBTAIN THE CORRECT EXPOSURE.

5. ASSEMBLE JIG BY TAPING TRANSPARENCY AND STEP GUIDE INTO IT. PUNCH HOLES .

FIGURE 4.2.1

You must have a color densitometer to measure the transparency's density range. Unless you have a very sensitive eye for transparency contrast, don't try to guess the transparency density range.

2. **'Dupe Target Density Range'.** Enlargers and lenses are all different, as a result you will find that a dupe made on one enlarger will have a different density range than that on another enlarger. You must determine the achievable density range for your enlarger by testing it. This density range is the 'dupe target density range'. By knowing the transparency's density range and the dupe target density range it is then possible to determine the proper mask contrast.

The procedure is simple.

a) Put the lens that will be used to make the dupes in the enlarger.

b) Put a test image in the enlarger carrier such as the SRT, described in section 4.2a, a two halves of a Kodak 1A step scale mounted in a slide mount, or a transparency step scale made by contact printing a Kodak 1A step scale on a piece of your preferred transparency film.

c) Properly expose a sheet of dupe film as described in Appendix C. (Without filters)

d) Process and dry the dupe.

e) Find the two steps in the dupe that look like a highlight and shadow and measure the density of those corresponding steps in the test image.

f) Subtract these two values to obtain the 'dupe target density'.

For instance, if the steps in the dupe corresponding to shadows and highlights were steps, in the test image, having densities of 2.15 and 0.35 then the 'dupe target density range' would be 1.8.

3. Gamma vs. Development Curve for Masking Film.

This is done by identically exposing several sheets of masking film through a 21 step scale. The sheets are processed at development times from 1/2 to twice the recommended times. The density curves are plotted for each development time and the gamma of each curve is determined from the plot. A gamma-development curve is plotted from the known gamma and development times. This technique is the same as that in section 4.7.3; see it for more detailed instructions.

The procedure for making the duplication is simple. First, the transparency's density range is determined. Second, the required mask density range is calculated by subtracting the dupe target density range from the transparency's density range; divide the masking density range by the transparency's density range to obtain the required mask's gamma. Third, expose the mask with the transparency in a contract register frame. Fourth, process the masking film at the proper development time by using the calculated gamma and the development gamma curves. Finally, make the dupe by putting the masked transparency in the register carrier. For example,

2.4 [Chrome Density Range]
-1.8 [Dupe Target Density Range]

0.6 [Req. Mask Density Range]

0.6÷2.4= 0.25 [Req. Mask Gamma]

Dupes done this way have a consistent density range. This makes it possible to use the simplified constant gamma technique, described in section 4.7.2., with great success. The major problem is the dupe's lower than normal density range. As a consequence, separations made with dupes will require greater contrast than those from the original image. If this presents a problem then use a tanning developer A:B ratio of 1:3 as your normal matrix film developer instead of the standard 1:2. Do all of the testing with this assumption in section 4.2.2.

See Appendix C for exposure information if you want to try to make your own dupes. Kodak publication E-38 also covers this subject.

4.2.1 Determining Slide Density Range. Review section 1.5 for a brief primer on densitometry. The next thing you must know before you begin is the density range of the transparency. The density range is the difference between shadow and highlight density of the transparency. The "trick" in making good separations for dye transfer is to match the transparency density range to a specified separation negative density range. This is done by varying the exposure and development of the separation negatives.

If you have a color densitometer, make a white light measurement of the neutral shadow and highlight densities in the transparency. Subtract these 2 densities to determine the density range. Unfortunately, it is difficult to do measurements if there are no neutral highlights or shadows, or if they are physically too small to measure. Guessing can be difficult because shadows can have densities from 2.2 up to 2.7 and highlights can range from 0.3 up to 0.7. The density range of transparencies will range from 1.5 to 2.7. A normal transparency has a density range between 1.8 and 2.0.

If you are unable to determine the density range of your transparency then assume a shadow density of 2.4 and a highlight density of 0.4 as starting points. This means your density range will be about 2.0. These values are fine for properly exposed transparencies of a subject with normal contrast. If the transparency is very flat, try a shadow density of 2.0 and a highlight density of 0.5. If the subject is very contrasty try a shadow density of 2.7 and a highlight density of 0.3.

Your best bet is to assume that your transparency is normal. If your test print is flat or contrasty then the matrix film development can be altered to compensate. This will be discussed later. The examples in each section will assume a normal transparency with a shadow density of 2.4 and a highlight density of 0.4.

4.2.2. Determining Separation "Target" Negative Density Range. The separation negative must have the proper density range,i.e. contrast, to produce the proper contrast in a dye print. The problem is the same as that encountered in doing black and white prints. Transparencies vary in density range just like the subject contrast in a black and white negative. If the subject is flat, i.e. low in contrast, something would have to be done to obtain a print of normal contrast. There are two solutions, either print on higher contrast paper or adjust the negative contrast by altering the development time. Unfortunately, the dye print has a fixed contrast or more precisely, the dye-matrix combination has a fixed contrast (density range). For a normal dye-matrix combination the density range is about 1.8 or 1.9. The only solution is to readjust negative contrast by development.

Throughout the manual the separation density range to produce a normal contrast print is assumed to 1.2. This figure is not always correct. A number of factors can cause this to vary. The major factors are:

1. Enlarger lens flare
2. Enlarger light source type
3. Light leaks
4. Negative size

Although the exact effect is different for every enlarger, there is usually a loss of contrast in the print. The solution is to determine the correct negative density range by using your enlarger in the test. The aim is to obtain a separation negative density range which will produce a normal contrast print with your system. For all practical purposes a density range of 1.2 is good in most cases but it's better to determine the proper density range.

Density range determination is easy to do. I like to cut a Kodak 1A step scale in half, then mount the two halves in a slide mount. Any approach will work, suit yourself on this score. Be sure to mask out around the step scale to minimize flare and stray light. Make sure that the lens, and etcetera. are the same as will be used to make matrix film exposures.

Put the step guide in the enlarger carrier. Make test exposures on matrix film. Try to get a test mat which will print a full range of steps. It's sometimes easiest to make a series of exposures about a stop apart in exposure on a single sheet of film. For three footcandles of light try an exposure of 10 seconds. Do not use a filter. It does not matter how large the image is, just make it large enough to see.

Soak the test mat is cyan dye and roll a print. View the test print through a red filter. Make sure you can see a full range of steps from black to white. If you do not see a full range of steps then remake the test to obtain a test mat that will meet this criteria. Look for the last step above pure black and last step below pure white. Note these steps. Subtract the density of these target steps. The difference in density of the target steps is the separation negative density range for your setup.

Generally, the density range you determine experimentally will be about 1.2. If you get a different density range then use it as the target density range for your separations.

4.2.3 The Concept Summary. The simplest, but not always the best, approach for making separation negatives is to assume that all of your transparencies have the same density range (2.0). Since the mask density range is always a percentage of the transparency density range, i.e. 25%, 33%, 40% etc., it will also stay constant. For example, it would be 0.67 if you use 33% masking or 0.50 is you use 25%. In this book 33% masking is assumed, but you may use 25% if you choose since many pro labs use that percentage. As a result the separation development time remains constant. If the resulting density range is too low or too high then the matrix film developer A:B ratio is changed to compensate (see section 5.3). For beginners this a very easy approach and works for the vast majority of transparencies.

Later, when you've gained confidence I'd suggest that you work with the advanced method for making separations as it allows more control. The ultimate goal of this method is to obtain separations with a fixed density range (see section 4.2.2). As mentioned, the mask's density range is a constant percentage of the transparency density range; this is equivalent to saying that the mask's contrast (gamma) is constant. For example, a 33% mask has a gamma of 0.33, a 25% mask has a gamma of 0.25. Since the mask's contrast (gamma) always remains constant, only the separation film contrast can be adjusted to produce the fixed density range for varying transparency contrast ranges.

You may wonder why this method would work since we are using color masks not contrast masks. Actually, for the red separation, the red mask is really just a contrast mask. This may not be so for the green and blue, but all masks lower contrast. The red separation is the most important separation since the cyan dye controls density in print, so its contrast is the most important. The other separations must have the same contrast as the red in order to make a print without color crossover.

To illustrate the procedure let's assume the transparency density range is 2.1 as determined by subtracting the white light density readings. Also assume the separation density range must be 1.2 as discussed in section 4.2.3. The mask density range should be 1/3 of that value,i.e., 0.7. Since the mask is assembled with the transparency, the transparency's density range is lowered. The resulting transparency density range is simply the difference of the two film density ranges as shown below:

 2.1 [Chrome Density Range]
-0.7 [Mask Density Range]

 1.4 [New Chrome Density Range]

Since the separation must have a density range of 1.2 the contrast of the negative must have a gamma of 0.86 (1.2÷1.4). We must try to expose the film so that the shadow density is a value near 0.55 and develop it so that the contrast is 0.86. Included in this chapter a chart to help you determine the separation gamma for a given transparency density range. If you want to do the math yourself the steps are summarized below:

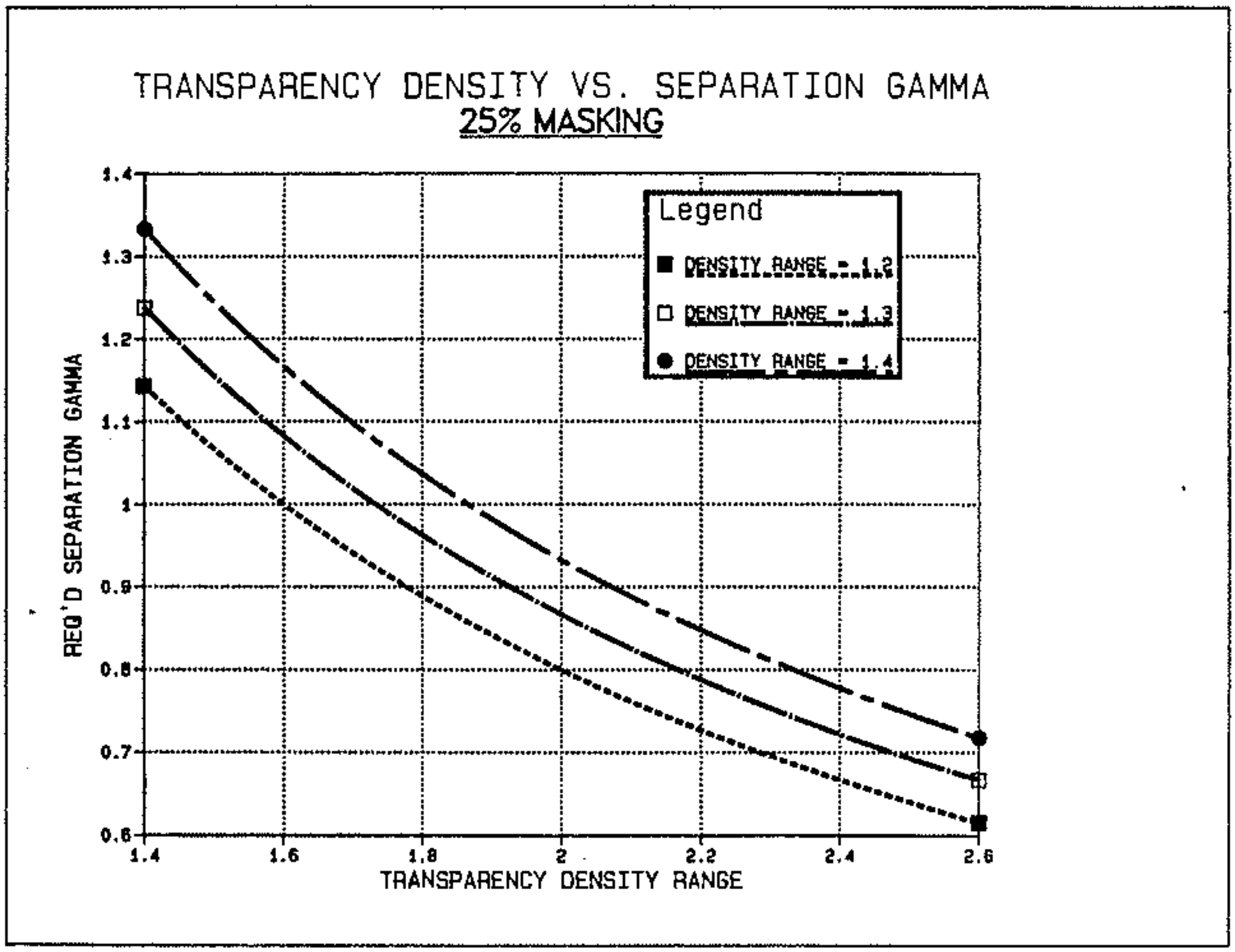
1) Determine the chrome density range

2) Find mask density range (1/3 of above)

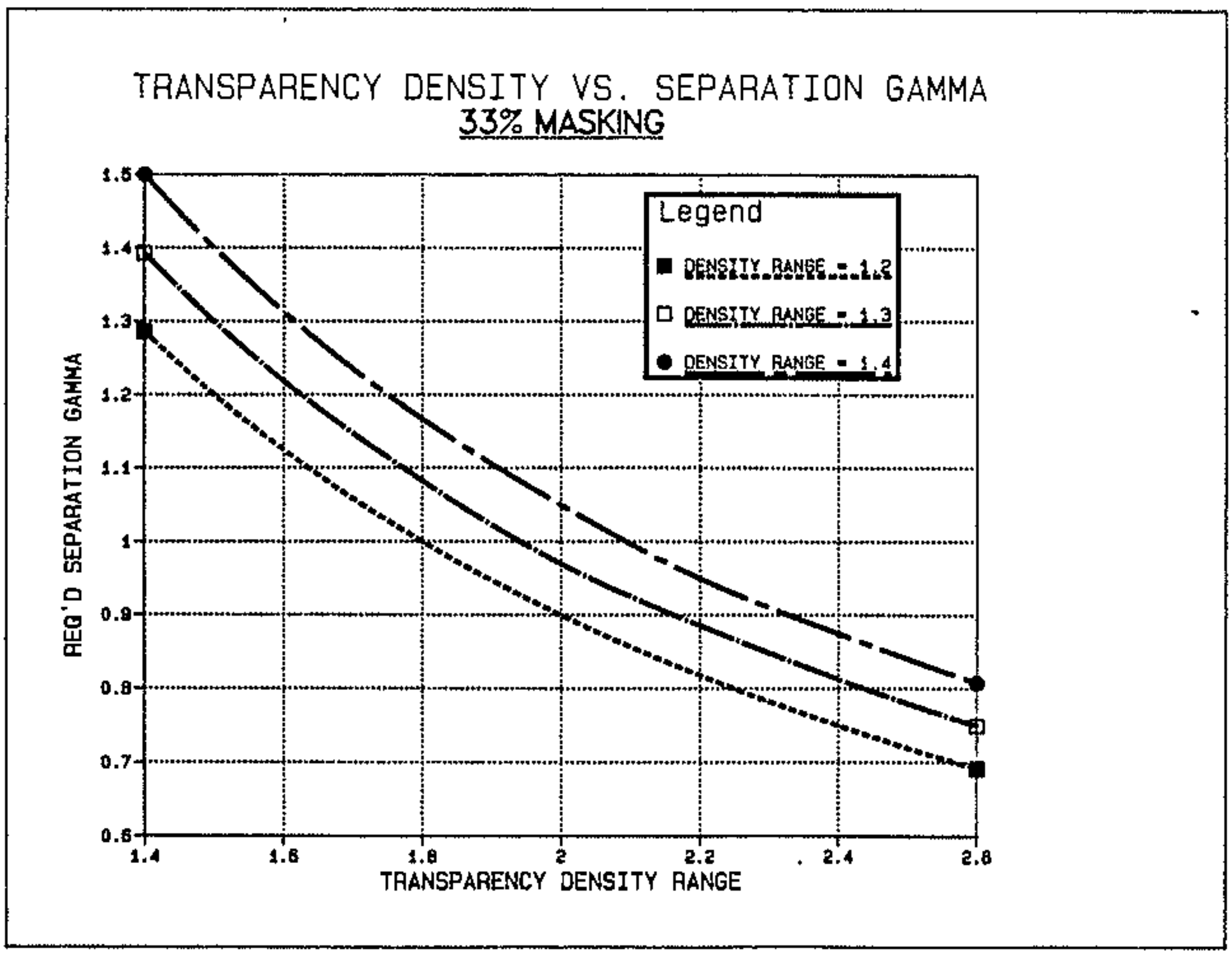
3) Find new chrome density range by subtracting #1 from #2.

4) Find separation gamma by dividing target separation density range by new chrome density range.

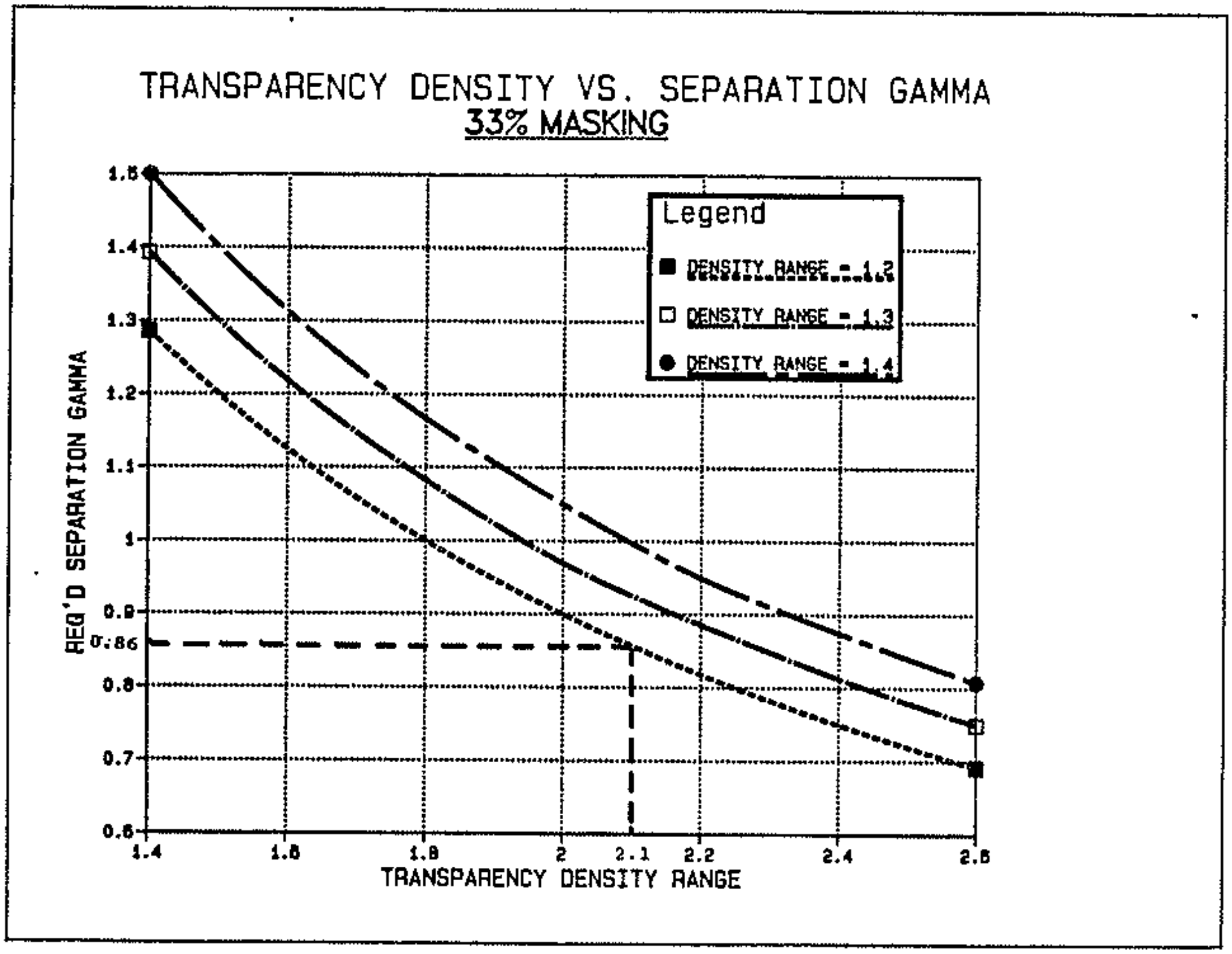
A gamma versus film development time chart is included in the book for your convenience but, it is recommended that you make your own. A discussion on how to make you own chart is given later in this chapter.

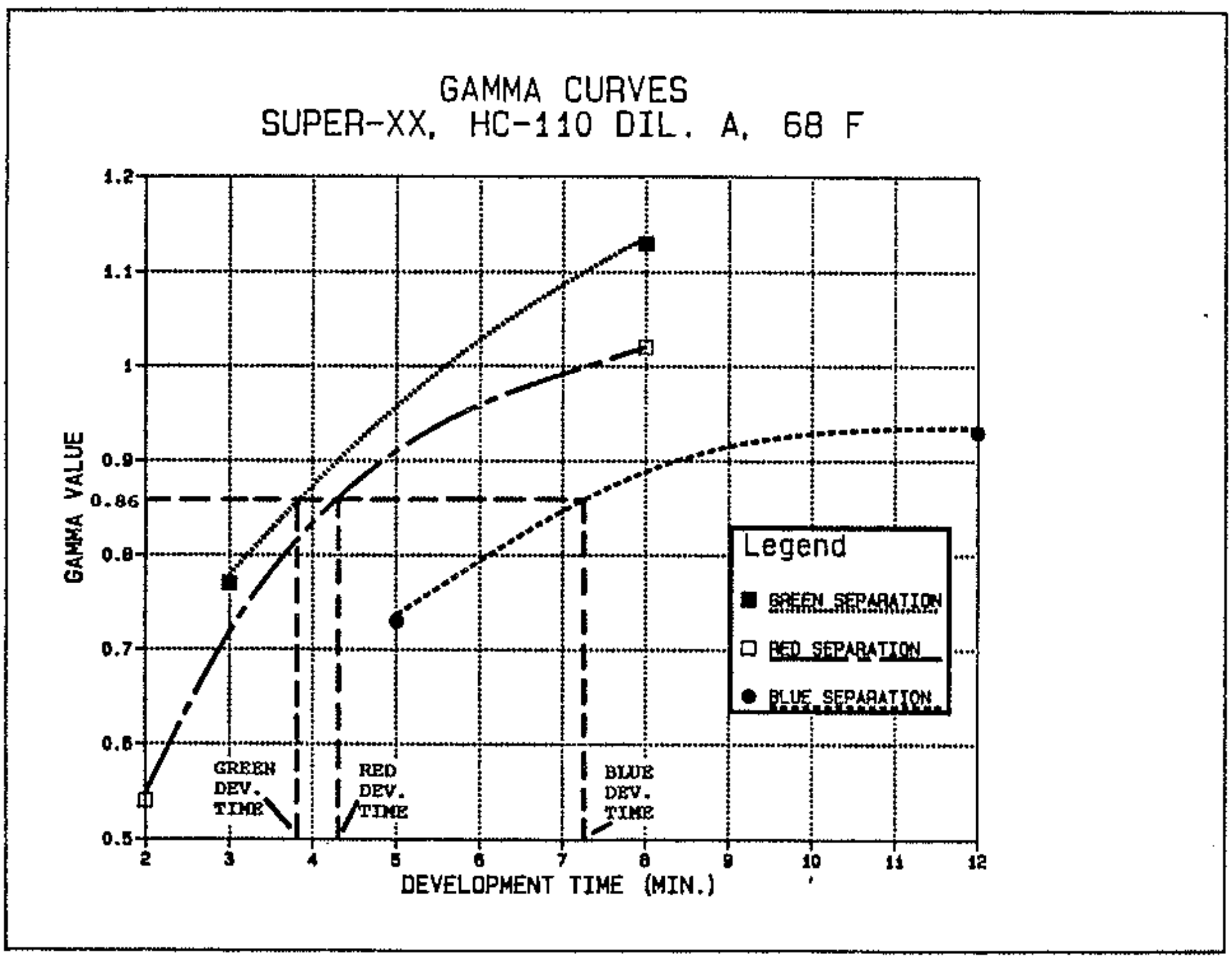


TRANSPARENCY DENSITY VS. SEPARATION GAMMA
25% MASKING
Legend
DENSITY RANGE = 1.2
DENSITY RANGE = 1.3
DENSITY RANGE = 1.4
REQ'D SEPARATION GAMMA
TRANSPARENCY DENSITY RANGE
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
1.4
1.6
1.8
2
2.2
2.4
2.6



TRANSPARENCY DENSITY VS. SEPARATION GAMMA
33% MASKING
Legend
DENSITY RANGE = 1.2
DENSITY RANGE = 1.3
DENSITY RANGE = 1.4
REQ'D SEPARATION GAMMA
TRANSPARENCY DENSITY RANGE
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
1.4
1.6
1.8
2
2.2
2.4
2.6


TRANSPARENCY DENSITY VS. SEPARATION GAMMA
33% MASKING
Legend
DENSITY RANGE = 1.2
DENSITY RANGE = 1.3
DENSITY RANGE = 1.4
REQ'D SEPARATION GAMMA
TRANSPARENCY DENSITY RANGE
1.5
1.4
1.3
1.2
1.1
1
0.9
0.86
0.8
0.7
0.6
1.4
1.6
1.8
2
2.1
2.2
2.4
2.6


GAMMA CURVES
SUPER-XX, HC-110 DIL. A, 68 F
Legend
GREEN SEPARATION
RED SEPARATION
BLUE SEPARATION
GREEN DEV. TIME
RED DEV. TIME
BLUE DEV. TIME
GAMMA VALUE
DEVELOPMENT TIME (MIN.)
1.2
1.1
1
0.9
0.86
0.8
0.7
0.6
0.5
2
3
4
5
6
7
8
9
10
11
12

4.3 HIGHLIGHT MASKING.

```
MATERIALS:
4x5 Kodalith Ortho Film 2556      <3.16.1>
4x5 Kodalith Pan Film 2568 (3 color only)

CHEMICALS:
D-11 Developer or equivalent      <3.17.6>
Acetic acid
Fixer

EQUIPMENT:
#29,61,47B Filters (for multiple
 highlight masks only)             <3.8.2>
1.2,1.2,.6 Neutral Density Filters
Registration Print Frame            <3.10>
Two hole punch                      <3.10>
Contact Print Lamp(or enlarger)     <3.15>
5x7 trays or drum
Motorized base for drum
```

Good results can be obtained from most transparencies without highlight masking if there is no important highlight detail in the transparency. If the transparency has important highlight detail then highlight masks are required to get good contrast. Color masking lowers the contrast of the highlights in a dye print, highlight masking helps cancel this effect. Highlight masking must be done carefully or more harm than good will result. My advice is to omit highlight masking if you don't need it because some measure of highlight control is possible through use of chemicals during the print rolling process. This will be discussed in later chapters.

Usually, only one highlight mask is used for all three separations because its main function is to produce clear whites. However, if you have very important highlights that have a little color in them, then you may want to make three highlight masks, one with each separation filter. Each highlight mask is then used with its corresponding separation negative when making matrix film exposures. Some advanced practitioners have used a single color filter to make a single highlight mask to compensate for certain pronounced color casts in the transparency highlights; the filter has to be opposite in color to the color cast. This approach will not be discussed, but if you are inclined to experiment, try this approach.

Whenever you use a single highlight mask for colored highlights you will get some color change in the final dye print's highlights. It is very minimal, usually not noticeable. This happens because highlight masks nullify the color correcting effect of the color masks in the highlight areas.

Highlight masks can be used in either of two ways. The highlight masks can be used when making the principal masks and then discarded (often called premasking) or they can be placed in register with the separations when exposing the matrix films (called postmasking).

A highlight premask is easier to do and eliminates some work. If your image has a great deal of detailed highlights then this is the best approach since it maintains highlight detail best. Subjects containing shiny

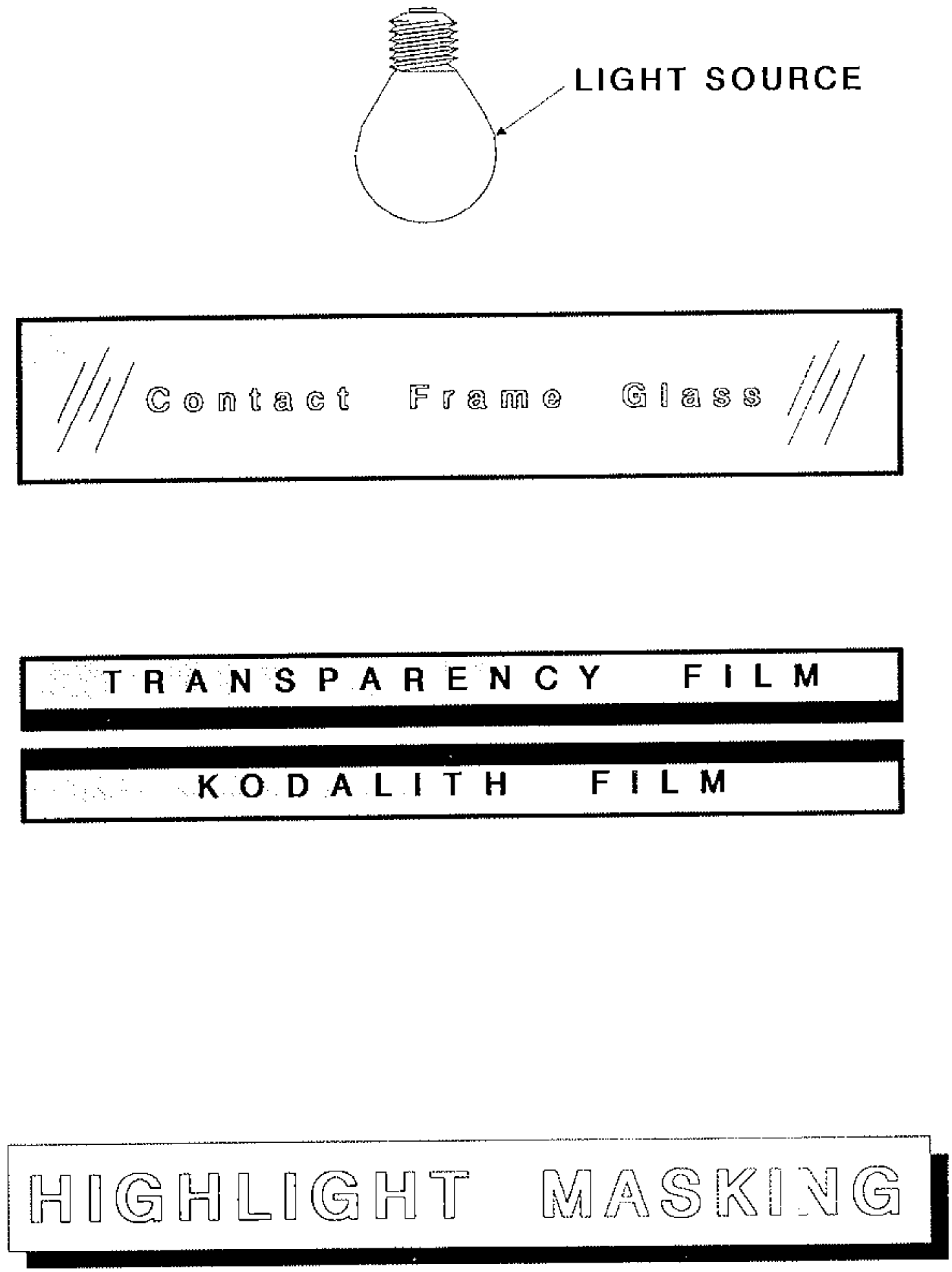

LIGHT SOURCE
Contact Frame Glass
TRANSPARENCY FILM
KODALITH FILM
HIGHLIGHT MASKING

FIGURE 4.3.1

objects like metal and glassware are typical examples. If you are able to read the density of the highlights in the premask try for a density of near 0.6.

The latter approach, though more cumbersome, has the advantage of allowing the user to remake the masks if he or she dislikes the effects of the highlight mask, without having to remake the separation negatives, and the highlights appear to be sharper. Of course, the latter technique requires a registration carrier. If you have a registration carrier then use the latter method. The density of highlight postmask should be near 0.3.

4.3.1 Single Highlight Masks. Highlight masks are made by contact printing the transparency on Kodalith Ortho Film 2556 with white light. You will require a light source, a contact printing frame and a two hole film punch. Since the film can be used with a red safelight it has the advantage of allowing the film to be developed by inspection.

Before you begin, you must first set your light source for the proper exposure. You can use an enlarger or a contact printing lamp. Set the light source at an illumination level of three footcandles. If you don't have a photometer, there is a way of approximating this value with a light meter and a white card. The internal meter in a SLR camera is fine for this purpose. Three footcandles is equivalent to a meter setting of 400 ISO (ASA), with a shutter at 1/8 second, and a f/stop of 5.6. Adjust the light source until this setting is obtained from light reflected off a white card. If you are using your enlarger, set the lens to its widest aperture and then raise or lower the enlarger to get three footcandles.

After you have set the light source to three footcandles you must reduce the light illumination by eight stops. If you have an enlarger lens with a maximum f/stop of f4 and minimum f/stop of f16 then close the lens down to f16 (4 stops) and use a neutral density of filter 1.2ND. If you use a point light source then use a neutral density of 2.4. Your exposure time for Kodalith film will be between 8 and 16 seconds.

Exposures are made by exposing the Kodalith film and transparency (in the jig) emulsion to the emulsion in the registration print frame. Of course, the registration holes must be punched first. The emulsion side of most sheet film is found by holding the sheet film so the notched corner is at the upper right; the emulsion will then be face up. Unfortunately, Kodalith Ortho does not have notches but with the safelight on, the emulsion is easily recognized as the dull or lighter side of the film. Place the frame so the transparency is on top of the Kodalith and next to the glass. See Figure 4.3.1. Expose three sheets of film, one at 8 seconds, one at 12 seconds and one at 16 seconds.

Develop the three sheets of film simultaneously in a drum or tray. If you use D-11 developer, then develop for three minutes at a temperature of 68 F(20 C). Fix, wash, and dry the films normally. Note!!! After the highlight mask is dry cut the step scale away from it. Otherwise, you will render the original step scale useless when making the color masks and separations.

1. Expose 3 shts for 8,12,16 sec.
2. Develop 3 min. in D-11 at 68 F
3. Fix
4. Wash
5. Dry

Select the mask which shows only the highlights of the image. If you have trouble choosing then pick the underexposed rather than the overexposed mask. It's better to be underexposed than overexposed, so be careful. An overexposed mask can effect the other tones in the final dye print. Another way of checking for correct exposure is to register the highlight mask with the transparency, then view them over a light table. Only the highlights and whites will show some added density. If some of the darker tones show added density then the mask is overexposed. If you can read the density of the highlights in the mask try for a density of

0.3 for a post-highlight mask and 0.6 for a pre-highlight mask. Ultimately, only experience will teach you which exposure is best.

4.3.2 Three-color Highlight Masking. As I have mentioned, highlight masking helps to restore contrast to the highlights that is lost because of the color mask. Unfortunately, when the color mask's effect is nullified, so is the color correction in the highlight areas. The result is that you can get unwanted color casts in the highlights. In those rare cases when very important highlight color must be maintained, three highlight masks are required; one for each color. The red highlight is used with the red separation, the green with the green, and the blue with the blue. These masks are contact printed on **Kodalith Pan Film 2568, not on Kodalith Ortho Film 2556 . This film must be developed in total darkness.** You will need a #29, 61, and 47B color filter, .6 and 1.2 neutral density filters, a light source, a contact printing frame, and a two hole punch. The 1.2ND filter is used with the #29 filter; .6ND filter is used with the #61 filter; and the 47B is used without a filter. The neutral filters will allow the same exposure time to be used with all three exposures.

Set the light sources to the same light values as in the previous section. Only test the red highlight mask for exposure, the other two will usually fall in line. Make three exposures through the #29 + 1.2ND filters. Use times of 5, 10 and 20 seconds. Use the same criteria for judging the proper exposures as mentioned above. When you have determined the proper exposure for red highlight mask, then make the green and blue highlight masks. **Remember!! The green filter is used with a .6ND filter and the 47B is used alone.** If you can read the density of the highlights in the mask try for a density of 0.3 for a post-highlight mask and 0.6 for a pre-highlight mask.

These highlight masks can only be used with the separation negatives when exposing the matrix film. You must have a register carrier for triple color highlight masking.

4.3.3 Specular Highlight Masking. Some professional dye transfer labs also make a specular highlight mask if the transparency subject matter is high key white-on-white. This type of mask is a highlight mask of a highlight mask. The object is to record the whitest white of the image.

One technique for making a specular highlight mask is to copy the regular highlight on to a duplicating film like Kodak Direct Duplicating Film SO-015. Process the film in a high contrast developer like Kodalith developer.

The regular highlight mask should be a pre-highlight mask. The specular highlight mask should be used with the separation negative when exposing the matrix film.

4.3.4 Procedure. Listed below is a sequence of steps to produce a highlight mask. The following sequence can be changed in places to suit your needs and additional steps are also possible.

1. Clean the contact print frame glass. Place your film punch so it can be found in the dark. Do everything possible to minimize dust. Prepare an empty box to store exposed film.

2. Set your light source to three footcandles. Reduce the illumination by eight stops by closing down the aperture and/or using neutral density filters. If making a color highlight mask, also install color filter. Install your filters in the filter holder, etc.

3. Set your timer to the desired time.

4. Punch registration holes in the transparency(jig).

5. Place transparency in registration frame on register pins, the emulsion up, away from glass.

6. Turn out lights. Punch register holes in the Kodalith film. Locate identification notches to find film emulsion. Remember, Ortho Kodalith has no ID notches; the emulsion is the lighter side of the film. If you are making color highlight masks, clip right corner off with scissors. No corner for red, one corner for green, two corners for blue. Place film in contact frame on register pins with emulsion towards glass.

7. Turn on timer to make exposure.

8. Store film in box.

9. Process tests together.

4.4 CONTACT PRINCIPAL MASKING.

MATERIALS:	
Kodak Pan Masking Film 4570	<3.16.2>
Diffusion sheets	<3.21.7>
EQUIPMENT:	
#29,61 Filters (Ektachrome)	<3.8.2>
#24,61 Filters (Kodachrome)	<3.8.2>
#33 Filter(magenta)(see 4.4.1)	
Registration Print Frame	<3.10>
Two hole punch	<3.9.2>
Contact Print Lamp(or enlarger)	<3.14>
Densitometer	<3.12>
Curve Plotting Paper	<3.21.8>

This section covers instructions on how to make the principal masks. The instructions are identical for principal masks made with or without a highlight mask. If you choose to integrate the highlight mask into the color masks, called premasking, then make sure the step guide section of the highlight mask has been removed so the step guide will not be affected by the highlight mask.

A diffusion sheet is usually inserted between the transparency and masking film when making the exposure. This is done to make the mask as fuzzy as possible. The more diffused a mask is, the sharper the print will be. Kodak Diffusion Sheets are shiny on one side and matte on the opposite side. The matte side should be considered to be the emulsion side of the diffusion sheet. Some practitioners think the diffusion sheet is not necessary for two reasons. First, originally masks are softened to make it easier to register the mask and separation; this is no longer necessary because of film registration pins. Second, Pan Masking film is inherently fuzzy, even without a diffusion material. Although the arguments are true, I think beginners should use diffusion sheets at first, then as you become more proficient try making masks without a diffusion sheet.

While you can get by with a single principal mask instead of two, don't waste your time. As mentioned in Chapter 2, single masks can only improve color saturation but two principal masks improve both color saturation and color shifts. There seems to be little reason for a single mask when you can get the best quality by making one additional mask. The additional work involved in making a second mask is minor.

Red and green color masks are required for double masking. The red mask is exposed through a red filter and the green mask is exposed though a green filter. If single masking is desired then make the exposure through a #33 magenta filter. There is an important difference in double masking for Ektachrome and Kodachrome. The red filter mask for Ektachrome is exposed·through a #29 red filter and is registered with the transparency when exposing the red and green separation negatives. The green filter mask for Ektachrome is exposed with a #61 green filter and is registered with the transparency when exposing the blue separation. On the otherhand, the red filter mask for Kodachrome is exposed through a #24 red filter and registered with the transparency when exposing the green separation negative. The green filter mask for Kodachrome is exposed through a #61 green filter and registered with the transparency when exposing the red and blue separation negatives. The chart below summarizes the double masking scheme.

FILTERS FOR RED & GREEN MASKS			
Film	Red Sep	Green Sep	Blue Sep
Ektachrome	#29 red	#29 red	#61 grn
Kodachrome	#61 grn	#24 red	#61 grn

4.4.1 Method of Approach. With masking there is one absolute you must understand. The mask has a fixed contrast value(gamma). In other words, the mask density range is always a certain proportion of the transparency's density range because it corrects the dye deficiencies in the transparency, not the deficiencies in the dye transfer dyes. This is a common misconception. It is possible, however, to correct for dye transfer dyes deficiencies by masking (post masking) the separations but there is little improvement in the image for the work involved.

Masks are described as being of a certain percentage, for instance, if a transparency has a density range of 2.1 and the mask had a density range of 0.7, then the mask is a 33% (0.7/2.1) mask, i.e., gamma=0.33. No matter what the mask and transparency density range are, the ratio is a fixed value. In other words, the masking film's gamma stays the same. I'll repeat that. The mask's density range will vary but the contrast is a fixed number. Do not confuse density range with contrast!! If we assume the mask density range is 33% of the transparency density range then the mask density would vary, but the gamma would remain the same as shown in the following chart:


LIGHT SOURCE
FILTER
Contact Frame Glass
HIGHLIGHT MASK (OPTIONAL)
TRANSPARENCY
DIFFUSION MATERIAL
PAN MASKING FILM
PRINCIPAL MASK

FIGURE 4.4.1

COLOR MASK IDENTIFICATION

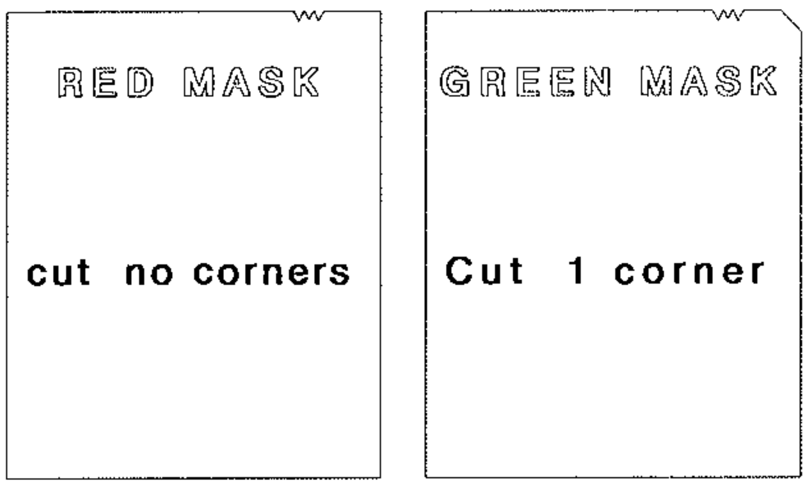


FIGURE 4.4.2

TRANSPARENCY DENSITY RANGE	33% MASK DENSITY RANGE	MASK GAMMA
2.4	0.8	0.33
2.3	0.77	0.33
2.2	0.73	0.33
2.1	0.70	0.33
2.0	0.67	0.33
1.9	0.63	0.33
1.8	0.60	0.33
1.7	0.57	0.33
1.6	0.53	0.33

Theoretically, you have only one film development time for you masks. Once you have worked out development times for the red and green masks film, they are used for all of your masking needs. The exposure times will vary to maintain the same shadow density value, but only because the chrome is a little over or under exposed.

Just which masking percentage value is best is difficult to say. It is matter of personal choice, mostly depending on who you talk to. The values used have ranged from 25% to 40% of the transparency's density range. In this book I have assumed a value of 1/3 (33%) of the density range of the transparency base on some not so scientific tests run by Kodak. Years ago Kodak determined this value, empirically, by making test prints using different masking percentages, they then asked a number of people which test print looked best, and in that way determine an 'ideal' masking percentage.

Many professional labs use a masking percentage of 25%. This lower percentage means that less contrast is required in the separation, in some cases there is a distinct advantage for that reason. If you prefer this percentage then substitute 1/4 (25%) in place of 1/3(33%).

While the density range of the mask should be as close as possible to the desired value, this value is not set in concrete; you have a tolerance of about +/- 0.05. The main thing is to keep the contrast of the red and green masks the same. Failure to do so could cause color crossover if the separation contrasts are too different. The only work required in masking is to make sure the shadow density remains at a fixed value in the mask.

The shadow density of the transparency should always reproduce on the mask with a density value of approximately 0.3 +/- 0.1, no matter what density range your transparency has. You need not be exact, but be within tolerance. Although the contrast is all that really matters in a color mask, the excess grain of an overexposed mask makes exposures longer and adds unwanted graininess to the separation.

The only reason we need to know the mask density range is to help in determining the separation negative contrast as discussed in the next section. If you have a means of measuring the transparency density range then there is no problem obtaining the mask density range. If you are like most 35mm users you cannot measure the transparency density range because of the film size. I have seen special densitometers capable of measuring 35mm transparencies but they are very expensive. You should assume a density range of about 1.8 or 2.0. The typical mask density range would be 0.6 (1.8x 0.33) or 0.67 (2.0x 0.33) for 33% masking or 0.45 (1.8x0.25) or 0.50 (2.0x0.25) for 25% masking .

A final word. Keep a notebook as you proceed through each step in making your mask. This information will be invaluable when making masks in the future. Of course, the same should be said for the whole process, from highlight masking to final dye print.

4.4.2 Some Advanced Masking Techniques. Often it is necessary to carry the approach a bit further to achieve some additional improvement in the image or to solve some reproduction problems. The following are just a few techniques you might want to try.

A.) Split Masking.

Split masking is a technique in which a single mask is exposed through more than one color filter. The purpose of such a mask is to improve color saturation or hue. In effect, the red separation's mask is given a proportion of red, green, and blue filter exposure or red and green filter exposure. Please note, this split mask is strictly for the red separation. Use the standard masks for the green and blue separations.

In the attempt to simplify the masking process we have opted to use one color mask per separation. In the case of Ektachrome's red separation mask is not a color mask at all, instead it's sole function is to lower red separation's contrast. Generally, this seems to work quite well, but additional improvement can be obtained by masking the magenta and yellow contaminants in the transparency's cyan layer a bit. Another of way thinking about what is happening with split masking is to consider the filters as a single equivalent filter. For instance, if the split mask uses a red-green filter combination then the equivalent would be yellow; the color sum of the red and green. A mask made with a certain color filter lightens the opposite color in the print. In the case of a red-green filter (yellow), the effect is to lighten the blues in the print. In the example given I have assumed the red-green filter is made by equally exposing the masking film to red and green light. Actually, that proportion can be varied to obtain any combination of effects. The split masking technique combination you should try uses an exposure time which is 75% red, 15% green, and 10% blue. Another combination often used is a 1/2 red and 1/2 green exposure. I have not tried the latter combination, but it's worth a try. The film should be developed normally in both cases. As you can see, the mask attempts to lighten the magenta and yellow in the cyan dye of the transparency in an attempt to brighten the greens and reds. When you have mastered masking you should attempt split masking to get the extra measure of correction provided.

B.)Halation Problems Caused By Masks.

In certain circumstances pan masking film can create halo effects in the separation negative. Pan masking film is unique in design because it does not have a anti-halation backing. This is done to make the image unsharp and fuzzy. Halation is the name used to described the halo effect formed around the image of a bright object when light penetrates the film emulsion and reflects back through the emulsion. If a transparency has a bright subject with a strong white edges against a colored background halation may occur. If you make contact separations from 35mm images with fine detail and/or over expose the pan masking film mask you may also get the halo effect in the image. The only way to get rid of this problem is to replace pan masking film with a film like Plus-X film. Use this film only as a remedy for this problem. Since the film has quite a bit of contrast you have to use a more dilute developer to lower the contrast, try half the HC-110 dilution F (1:38). Be sure to use two sheets of diffuse material when making the exposures to soften the image as much as possible.

C.) A Different Way To Mask Kodachrome.
There is an alternative masking scheme for Kodachrome's red separation. The method recommended by Kodak is to expose the red separation with a #24 red filter and mask the transparency with a green mask. If Kodak's scheme doesn't solve your problems, try exposing the film with #25 red filter and masking the transparency with a yellow mask. The yellow mask is made with #15 yellow filter. If you don't have a #15 yellow filter then expose the masking through a #29 red filter for half the exposure and a #61 green filter for the latter half.

4.4.3 Film Exposure. The first thing you should do is to find the two steps on your step guide that correspond to the density values of the transparency's shadows and highlights as closely as possible. If you are unable to determine these values in your transparency then assume a shadow density of 2.4 and a highlight density of 0.4. When you have to make a choice between the closest steps to density values or the steps which give a density range which are closer to the transparency's, choose the density range as a first priority. Record the selected step numbers in your notebook and their density values.

The light source should be set to a value of three footcandles to begin with. Use either an enlarger or point light source. Three footcandles is equivalent to a meter reading of f5.6 at 1/8 second for an ISO(ASA) of 400, from light reflected off a white card under the light source. Make sure you take this light reading with all other light sources in the room extinguished. It's a good idea to record the enlarger head or point light source height. Also, record the enlarger lens' f-stop so you can easily reset the enlarger for this light intensity again. Following are exposure times as recommended by Kodak. These exposure times will give you masks denser than required, but are a good start.

LIGHT SOURCE AT 3 FOOTCANDLES*		
Filter	Ektachrome	Kodachrome
#33 Magenta	100 sec	--
#29 Red	100 sec	--
#61 Green	150 sec	150 sec
#24	--	50 sec

* Develop in HC-110 dilution F, 3 minutes at 68 F

You might want to try my recommended times for a typical Ektachrome transparency. Use neutral density filters whenever possible to minimize any reciprocity problems.

LIGHT SOURCE AT 3 FOOTCANDLES*		
Filter	**Neutral Density**	**Time**
#29 Red	0.30 N.D.	32 sec
#61 Green	---	34 sec
#24 Red	0.30 N.D.	22 sec

* Develop in HC-110 dilution F, 4 minutes at 68 F

After you have made your first set of masks, measure the density of the step on the step guide which corresponds to the transparency's shadow. It should have a density of 0.3, plus or minus 0.1. If it does not, then calculate the difference between 0.3 and the measured density. Use this difference to find the new exposure time required to get the desired density. Find the exposure factors associated with the density difference from Table 4.4.3-1. Correct the factors by dividing it by the film's gamma value. The gamma value is 0.33 for 33% masking or 0.25 for 25% masking. Use this "weighted" factor to calculate the new times. See the example below:

EXAMPLE 4.4.3-1. After development, the 33% red mask was found to have a shadow density step of .46 density and the green mask a shadow density of 0.22 density. The exposure of the red mask was 32 seconds and the exposure time of the green mask was 34 seconds. Calculate the new exposure times to obtain a shadow density of 0.3.

(a) Find the density differences for both masks.

$\text{Difference}_{red} = 0.46 - 0.30 = 0.16$
$\text{Difference}_{green} = 0.30 - 0.22 = 0.08$

(b) Find the exposure factors for the density differences in the chart.

$\text{Factor}_{red} = 1.45 \div 0.33 = 4.4$
$\text{Factor}_{green} = 1.20 \div 0.33 = 3.6$

(c) Find the new exposure times. Divide by exposure factor to decrease exposure, multiply to increase exposure.

$\text{Time}_{red} = (32)\div(4.40) = 7 \text{ sec}$
$\text{Time}_{green} = (34)\text{x}(3.60) = 122 \text{ sec}$

(d) Use a neutral density filter to reduce reciprocity effect. For large differences open the aperture or increase light intensity.

TABLE 4.4.3-1

Dnsty.	Factor	Dnsty.	Factor	Dnsty.	Factor	Dnsty.	Factor
.02	1.05	.52	3.31	1.02	10.5	1.52	33.1
.04	1.10	.54	3.47	1.04	11.0	1.54	34.7
.06	1.15	.56	3.63	1.06	11.5	1.56	36.3
.08	1.20	.58	3.80	1.08	12.0	1.58	38.0
.10	1.25	.60	3.98	1.10	12.5	1.60	39.8
.12	1.31	.62	4.17	1.12	13.1	1.62	41.7
.14	1.38	.64	4.37	1.14	13.8	1.62	43.7
.16	1.45	.66	4.57	1.16	14.5	1.66	45.7
.18	1.51	.68	4.79	1.18	15.1	1.68	47.9
.20	1.58	.70	5.01	1.20	15.8	1.70	50.1
.22	1.66	.72	5.25	1.22	16.6	1.72	52.5
.24	1.74	.74	5.50	1.24	17.4	1.74	55.0
.26	1.82	.76	5.76	1.26	18.2	1.76	57.6
.28	1.91	.78	6.03	1.28	19.1	1.78	60.3
.30	2.00	.80	6.31	1.30	20.0	1.80	63.1
.32	2.09	.82	6.61	1.32	20.9	1.82	66.1
.34	2.18	.84	6.92	1.34	21.8	1.84	69.2
.36	2.29	.86	7.25	1.34	22.9	1.86	72.5
.38	2.40	.88	7.59	1.38	24.0	1.88	75.9
.40	2.51	.90	7.94	1.40	25.1	1.90	79.4
.42	2.63	.92	8.32	1.42	26.3	1.92	83.2
.44	2.75	.94	8.71	1.44	27.5	1.94	87.1
.46	2.88	.96	9.12	1.46	28.8	1.96	91.2
.48	3.02	.98	9.55	1.48	30.2	1.98	95.5
.50	3.16	1.00	10.00	1.50	31.6	2.00	100.00

4.4.4 Procedure. Listed below is a sequence of steps to produce a mask. The following sequence can be changed in places to suit your needs. Additional steps are also possible.

1. Clean the contact print frame glass. Place your film punch so it can be found in the dark. Do everything possible to minimize dust. Prepare an empty box to store exposed film. Store scissors where they can be located in the dark.

2. Set your light source to three footcandles. Install your filters in the filter holder or store them so they can be found in the dark if you manually hold them under the light source.

3. Set your timer to the desired time.

4. Punch registration holes in diffusion sheet, transparency(jig), etc.

5. Place highlight mask(optional), transparency and diffusion sheet in registration frame on register pins before turning out lights. The transparency emulsion and matte side of diffusion sheet should face the glass. See Figure 4.4.1.

6. Turn out lights. Punch register holes in Pan Masking film. Locate identification notches to find film emulsion. For green mask, clip right corner off with scissors. Place film in contact frame on register pins with emulsion towards glass.

7. Turn on timer to make exposure.

8. Store film in box.

9. Process both masks together.

4.4.5 Sample Problem. The sample problem listed below is an actual run which yielded fairly good masks.

```
1.  Shadow detail=2.4 ......STEP 16
    Highlight detail=0.4 ..STEP 3
    Density Range=2.0

    OBJECTIVE: a) make step 16=0.30
                  make step  3=0.97
                  density range= 0.67
```

2. Trial#1. 3 footcandles, HC-110 dil F

filter	time	N.D.	Dev. Time
#29(red)	126	0.3	4'00"
#61(grn)	132	-	4'00"

(i) RESULTS:

filter	Step 16	Step3	Den.Rang
red	.61	1.15	.54
green	.60	1.13	.53

(ii) CONCLUSION:

Step 16 too dense. Range low.

(iii)REMEDY #1:

filter	time	N.D.	Dev. Time
#29(red)	63	0.3	4'15"
#61(grn)	66	-	4'15"

3. Trial#2 try REMEDY #1

(i) RESULTS:

filter	Step 16	Step 3	Den.Rang
red	.48	1.10	.62
green	.45	1.15	.70

(ii) CONCLUSION:

Step 16 too dense. Range OK.

(iii)REMEDY #2:

filter	time	N.D.	Dev. Time
#29(red)	32	0.3	4'00"
#61(grn)	34	-	4'00"

4. Trial#3 try REMEDY #2

(i) RESULTS:

filter	Step 16	Step 3	Den.Rang
red	.35	1.05	.70
green	.37	1.08	.71

(ii) CONCLUSION:

GOOD! Everything within tolerances.

4.5 CONTACT SEPARATIONS.

```
MATERIALS:
4x5 Kodak Super-XX Film 4142 or Kodak
Separation Film 4131, Type 1  <3.16.3>

EQUIPMENT:
#29,61,47B Filters (Ektachrome)<3.8.2>
#24,61,47B Filters (Kodachrome)<3.8.2>
Neutral Density Filters
Registration Print Frame         <3.10>
Two hole punch                  <3.9.2>
Contact Print Lamp(or enlarger) <3.14>
Densitometer                     <3.12>
Translite                 <3.22.12-13>
Small Palette Knife           <3.22.10>
```

Separations made by contact are much easier to make than enlarged separations. The major advantage is that you do not have to have a specially outfitted enlarger. Often, a poor quality lens does not focus equally for all colors which means that the separations will not have equal sharpness.

The separations should be coded by clipping the corners of the film. The red separation is left untrimmed, the green separation has one corner clipped, and the blue separation has the top left and right corners clipped. See drawing 4.5.2.

When making the exposures, make sure you are using the proper mask for the proper separation. It can be rather confusing. For example, the red separation is made with the red mask, the green separation is made with the red mask, and the blue separation is made with the green mask for Ektachrome film. However, for Kodachrome, the red separation is made with the green mask, the green separation is made with the red mask, and the blue separation is made with the green mask. This is summarized in the charts below.

FILTERS FOR SEPARATIONS

Film	Red Sep	Green Sep	Blue Sep
Ektachrome	#29 red	#61 grn	#47B blu
Kodachrome	#24 red	#61 grn	#47B blu

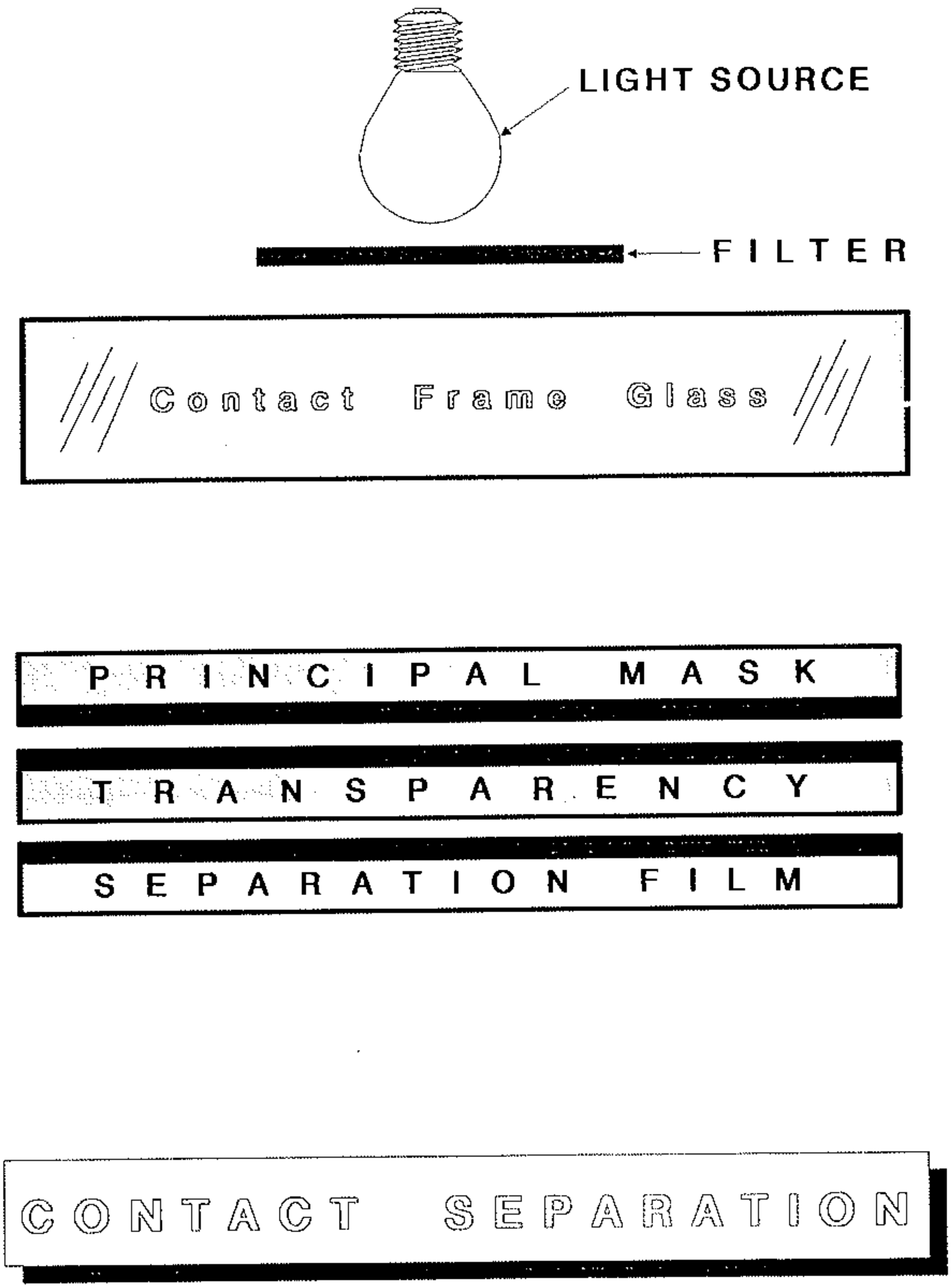

LIGHT SOURCE
FILTER
Contact Frame Glass
PRINCIPAL MASK
TRANSPARENCY
SEPARATION FILM
CONTACT SEPARATION

FIGURE 4.5.1

COLOR SEPARATION IDENTIFICATION

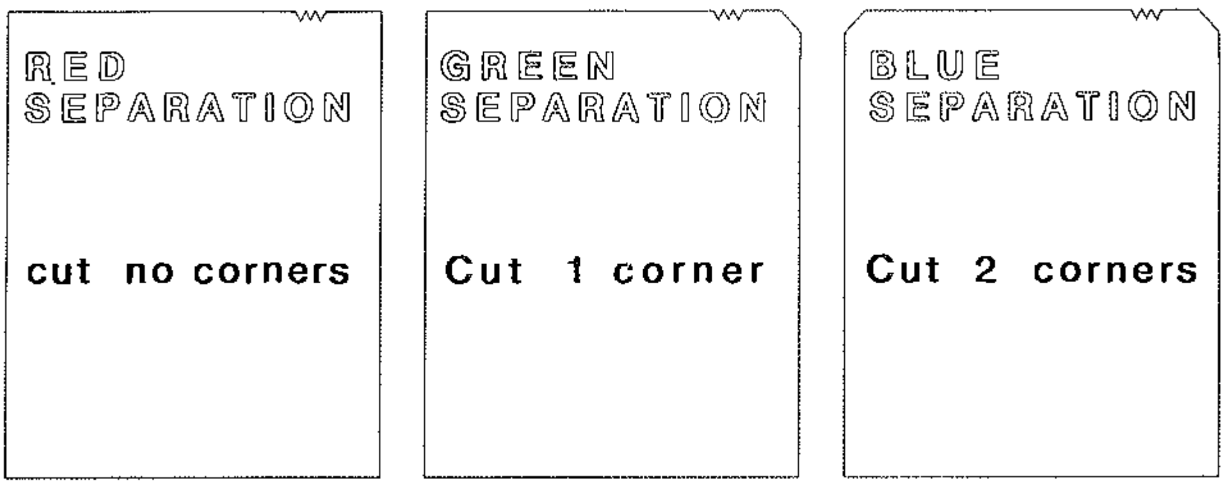


FIGURE 4.5.2

FILTERS FOR COLOR MASKS			
Film	Red Sep	Green Sep	Blue Sep
Ektachrome	red msk	red msk	grn msk
Kodachrome	grn msk	red msk	grn msk

One of the problems you will encounter when the glass and the smooth film backing come in contact is Newton rings. Newton rings are tiny circular interference fringes caused by light diffraction when two smooth surfaces come in contact. This happens because either the surfaces are not completely flat or there is uneven pressure between them which creates microscopic air wedges. These air wedges, due to their shape, bend light beams unevenly causing interference fringes.

The old solution was to blow a microfine, almost imperceptible layer of fine powder, called offset powder, over the glass surfaces. Although this technique is still done, it must be done with extreme care to avoid putting too much on the glass and, thereby, degrading the image. Another solution, which is better than using offset powder, is to replace the 5x7 glass in the printing frame with anti-Newton ring glass which has an extremely fine textured surface. This special glass can be purchased from Condit Company for about one dollar per square inch. Another solution is to insert a finely textured film between the glass and film backing. Two such films are Kodak Translite #5561 and Kodak Roller Transport Cleaning Film #4955. The Translite film is a photosensitive and translucent material which must be fixed out. Transport Cleaning film is a clear material which is not photosensitive and can be used straight from the box. CAUTION... IF THIS FILM IS PLACED BETWEEN THE NEGATIVE AND A LENS THERE WILL BE SOME LOSS OF SHARPNESS. If you have to place this film between the negative and the lens, use the Roller Transport Cleaning Film. A third solution is to coat the glass with a solution made from 1/2 ounce of 14% gum arabic and 4 ounces of water.

4.5.1 Method of Approach. The separation negative is made from a masked transparency. The aim is to process the separation negative so that the shadow and highlight densities yield the target density range (see section 4.2). I strongly recommend that you use a diffusion light source because a condenser enlarger causes blocking in the highlights of dye prints (Callier effect). This means you may lose detail in the highlights, even with the lowered contrast. As mentioned in section 4.2, for those who haven't determined a target density, assume a value of 1.2, but only for the diffusion enlarger. If this is insufficient contrast it's not necessary to make the separations over again. Small changes in density range can be corrected by altering the matrix film development. This will be discussed in later sections.

The shadows of the transparency should have a density of 0.4 in the separation negative. This value can have a tolerance of plus or minus 0.05.

With 33% masking you may discover that it is not possible to get a gamma of 0.9 with Super-XX film if both a shadow density of 0.4 and a density range of near 1.2 are required. If this occurs, give Super-XX more exposure so the shadow density in the separation is about 0.55, this extra bit of exposure will produce a bit more contrast when the film is processed. The other solution, of course, is to use 25% masking, since a gamma of 0.8 needed for the same transparency density range.

4.5.2 Film Exposure. Remember, all your measurements will be made from the steps guide which corresponds to your transparency's shadow and highlights or the transparency itself if you can read the highlights and shadow.

Set your enlarger or point light source to three footcandles. If you are using Super-XX film try these exposures times (masked transparency only) which are adapted from times recommended by Kodak. For those using an enlarger set at three footcandles, close the lens down by two stops. If you are using a point light source then install a 0.6 neutral density filter in the filter holder with the color filter.

EXPOSURES FOR SUPER-XX FILM				
	#29 Red	#24 Red	#61 Green	#47B Blue
Ektachrome	31 sec	----	19 sec	38 sec
Kodachrome	----	10 sec	19 sec	38 sec

Developed in HC-110 (dil A) @ 4.5 min for red & grn, 7 min. for blue

If you are using Separation Film, Type 1 the exposure times will be different. The following chart lists some trial exposures for a light source at three footcandles. If you are using an enlarger, close down the lens three stops for red and green exposures and two stops for the blue exposure. For a point light source, use a .9 neutral density for the red and green exposures and a .6 neutral density filter for the blue exposure.

EXPOSURES FOR SEPARATION #1 FILM				
	#29 Red	#24 Red	#61 Green	#47B Blue
Ektachrome	28 sec	----	24 sec	30 sec
Kodachrome	----	9 sec	24 sec	30 sec

Developed in HC-110 (dil D) @ 3.25 min for red & grn, 5 min for blue

If you decide to use T-Max 100 film. Set the light source for three footcandles. Please note that the blue exposure is almost 6 times longer than that for red or green. To avoid the long exposure on the blue separation you might want to have a much brighter light source and use neutral density filters for the red and green exposures to equalized the exposure times. Time given below do not includes neutral density filters.

EXPOSURES FOR T-MAX 100 FILM				
	#29 Red	#24 Red	#61 Green	#47B Blue
Ektachrome	24 sec	----	14 sec	135 sec
Kodachrome	----	8 sec	14 sec	135 sec

Developed in HC-110 (dil A) @ 3.5 min for red, grn, & blue
Process temperature 75 degree Fahrenheit

After the first separations are processed, measure the density of the step corresponding to the shadow density. It should have a density of 0.4 (or .55 for Super-XX in certain cases as explained previously). If it does not, calculate the new exposure as shown in section 4.4.3. Use the Table 4.4.3-1 to find the exposure factors. See example below:

EXAMPLE 4.5.2-1. After development of Separation #1 film, the red separation has a shadow density step of .46, green at .28, and blue at .38. The red exposure time was 28 seconds, green 24 was seconds, and blue was 30 seconds. Calculate the exposure to obtain a shadow density of 0.4. Assume a typical gamma of 0.9.

(a) Find the density difference for both masks.

$\text{Difference}_{red} = 0.46 - 0.40 = .06$
$\text{Difference}_{grn} = 0.40 - 0.28 = .12$
*$\text{Difference}_{blu} = 0.40 - 0.38 = .02$

*Note: blue separation is within tolerance. New exposure not needed.

(b) Find the exposure factors for the red and green sep's. Use Table 4.4.3-1.

$\text{Factor}_{red} = 1.15 \div 0.9 = 1.28$ $\text{Factor}_{grn} = 1.31 \div 0.9 = 1.46$

(c) Find the new exposure times. Divide by exposure factor to decrease exposure, multiply to increase exposure.

$\text{Time}_{red} = (24) \div (1.28) = 18.8$ sec
$\text{Time}_{grn} = (28) x (1.46) = 40.9$ sec

(d) Use a neutral density filter to reduce reciprocity effects.

$\text{Time}_{red} = 37.6$ sec + .3 ND
$\text{Time}_{grn} = 40.9$ sec

4.5.3. Procedure. Listed below is a sequence of steps to produce separations. The following sequence can be changed in places to suit your needs. Additional steps are also possible.

1. Clean the contact frame glass. Place your film punch so it can be found in the dark. Do everything to minimize dust. Prepare an empty box to store exposed film. Store scissors where they can be located in the dark.

2. Set your light source to three footcandles. Install your filters in the filter holder or store them so they can be found in the dark if you manually hold them under the light source.

3. Set your timer.

4. Place mask in print frame on register pins. Close print frame check for any Newton rings.

5. Place mask in frame on register pins with emulsion away from glass. Be sure you using the correct mask for each filter color. Place transparency on top of mask.

6. Turn out lights. Punch register holes in film. For green and blue separations, locate corner notches, clip one corner for green and two for blue.

7. Place film on register pins, emulsion towards glass. Close frame and place under light source.

8. Turn on timer to make exposure.

9. Remove film from frame and store in lightproof box. Repeat for next separation.

10. Process all sheets of film.

4.6 ENLARGED SEPARATIONS.

MATERIALS:	
4x5 Kodak Super-XX Film 4142 or Kodak Separation Film 4131, Type 1	<3.16.3>
4x5 Pan Masking Film	<3.16.2>
Cerium oxide	<3.23.11>
EQUIPMENT:	
Kodak 1A Step Tablet (11 steps)	<3.13>
#29,61,47B Filters (Ektachrome)	<3.8.2>
#24,61,47B Filters (Kodachrome)	<3.8.2>
Register or Glass Carrier	<3.11>
#111 Bulb w/Adapter light source	<3.1.1>
Mask Reg. Printer (optional)	<3.10.1>
Neutral Density Filters	
Two hole punch	<3.9.2>
Densitometer	<3.12>
Small Palette Knife	<3.22.10>
*Oil Immersion Carrier w/inserts	<3.11>
*Microscope Oil or Castor Oil	<3.11>
*Enlarger Point Source	<3.1.1>
*Vacuum Easel	<3.5>
* FOR OIL IMMERSION ONLY	

There are two ways to make quality prints in sizes 11x14 or larger. One way is to make 4x5 or 8x10 duplicate transparencies from which contact separations are made. The other way is to make enlarged separations. This chapter deals with the second method.

Commercial labs normally make 8x10 enlarged separations. For commercial labs, the 8x10 size simplifies image manipulation techniques such as stripping. The image quality of prints from 8x10 separation is, of course, superb. Obviously, you will need an enlarger that will handle whatever size you select, so for most of us the enlarged separations will be 4x5.

If you can avoid it, do not put the filters under the enlarging lens when making the enlarged masks and separations. The dust and scratches on the filters will cause loss of contrast and sharpness. Buy the appropriately sized filters for your enlarger head's filter tray. If you must use filters under the lens then keep them clean and take extreme precautions to prevent scratches. If you get the filter dirty, blow off the dirt with compressed air. Never physically wipe dust off of filter. If you get water or grease on a gelatin filter, for use under a lens, you can render it useless.

The color filters are used just as before. This is shown in the charts below:

FILTERS FOR SEPARATIONS			
Film	Red Sep	Green Sep	Blue Sep
Ektachrome	#29 red	#61 grn	#47B blu
Kodachrome	#24 red	#61 grn	#47B blu

FILTERS FOR COLOR MASKS			
Film	Red Sep	Green Sep	Blue Sep
Ektachrome	red msk	red msk	grn msk
Kodachrome	grn msk	red msk	grn msk

Two techniques for making enlarged separations from small sized transparencies will be discussed. The oil immersion technique with a point light source yields the highest quality but is quite costly to set up. The alternate method will produce fairly good enlarged separations, if done with care. This method uses a small 111A enlarging bulb as a light source and a glass carrier. The exposure and development information is identical to that in section 4.5.

4.6.1 Method of Approach. The approach is the same as with contact separations. Try for a density range of 1.2 for diffusion enlargers and .90 for condenser enlargers. Get as close as possible to these values. Any small changes in contrast can be rectified in the matrix film processing step.

The shadow values in the step guide should have a density of .40 (+/- .05). If you cannot achieve the necessary contrast needed when using a masking contrast of 33% with Super-XX film. Either set the separation shadow density to 0.55 (+/- 0.05 to gain additional contrast or use a masking percentage of 25%) for Super-XX film.

4.6.2 Film Exposure. The exposure times given below are based on setting you enlarger to three footcandles with no film in the carrier. The times are based on continuous agitation, a masked transparency, and a diffusion light source. Be sure you code the film by clipping the corners. Remember, clip no corner for red, one corner for green, and two corners for blue. For Super-XX film stop the lens down two stops from three footcandles and use the times as shown in the chart below as a starting point:

EXPOSURES FOR SUPER-XX FILM				
	#29 Red	#24 Red	#61 Green	#47B Blue
Ektachrome	31 sec	----	19 sec	38 sec
Kodachrome	----	10 sec	19 sec	38 sec

Developed in HC-110 (dil A) @ 4.5 min for red & grn, 7 min. for blue

For Separation Film, Type 1 close the enlarger lens down two stops from three footcandles for the red and green separations. Close the lens down three stops from three footcandles for the blue separation. Use the times given below as a starting point:

EXPOSURES FOR SEPARATION #1 FILM				
	#29 Red	#24 Red	#61 Green	#47B Blue
Ektachrome	28 sec	----	24 sec	30 sec
Kodachrome	----	9 sec	24 sec	30 sec

Developed in HC-110 (dil D) @ 3.25 min for red & grn, 5 min for blue

If you decide to use T-Max 100 film. Set the light source for three footcandles. Please note that the times may vary considerabley depending upon your light source color temperture. To avoid the long exposures you might want to have a much brighter light source and use neutral density filters for the shorter exposure filters to equalized the exposure times. Times given below do not includes neutral density filters.

EXPOSURES FOR T-MAX 100 FILM				
	#29 Red	#24 Red	#61 Green	#47B Blue
Ektachrome	26 sec	----	16 sec	18 sec
Kodachrome	----	8 sec	16 sec	18 sec

Developed in HC-110 (dil A) @ 3.5 min for red, grn, & blue
Process temperature 75 degree Fahrenheit

Adjust the exposures to obtain the proper shadow densities by using Table 4.4.3-1. Example 4.5.2-1 demonstrates how this is done (in section 4.5.2).

4.6.3 Making Enlarged Separations Without Oil Immersion. The optimum way to make enlarged separations is with the oil immersion technique. It is tedious to work with, messy because of the oil and expensive because of the special carrier, and a point light source is required.

There is another way to make enlarged separations which doesn't require oil immersion or a point light source. You also have the option of using either contact highlight and color masks, mounted with the transparency, or enlarged highlight and color masks.

The light source will be a #111A enlarging bulb used with a condenser enlarger. The small size of the lamp is a compromise between a point light source and a standard enlarging bulb. This small bulb will give you sharper separations than a standard bulb. A bayonet-to-screw base adapter is necessary because the lamp has a bayonet type base. It's a good idea to put a light baffle above the condenser to confine the light to just the film and step scale area. The baffle helps to reduce some of the flare. Make the light baffle out of black opaque construction paper. Cut a circle the same size as the condenser, then cut a rectangular hole in the center of the right proportions. Simply lay this on top of the condenser. Be aware that the inside of an enlarger head gets hot, so monitor the condition of the baffle.

Use a lens longer than normal for the transparency. The longer lens reduces the chance of lens aberrations because of its wider field of coverage. For a 35mm transparency use a 75mm or longer lens. Use the best quality lens you can afford. Lenses like the Rodenstock Rodagon, Schneider Componon, and El-Nikor are excellent. Cheap lenses don't always focus all colors equally which means that the separations won't be equally sharp. Keep the aperture settings near the middle of the f-stop range because optimum sharpness is usually a few stops from the widest aperture. Before you use the lens make sure it is thoroughly clean. This will help to reduce lens flare.

I recommend that you make contact masks rather than enlarged masks because they are a bit easier to make. A registration carrier is required for this purpose. Some say the enlarged masks produce slightly sharper separations but I have no proof either way. If you are using a contact mask in the carrier then place the contact mask on top of the transparency, both should be **EMULSION DOWN**.

If you are going to make both enlarged masks and separations then simply tape the image in the center of the glass carrier. Be sure to expose the masking film **EMULSION UP**. See Figure 4.6.3. The separations are made EMULSION UP. Punch the register hole in the separation film. Place the separation film on the

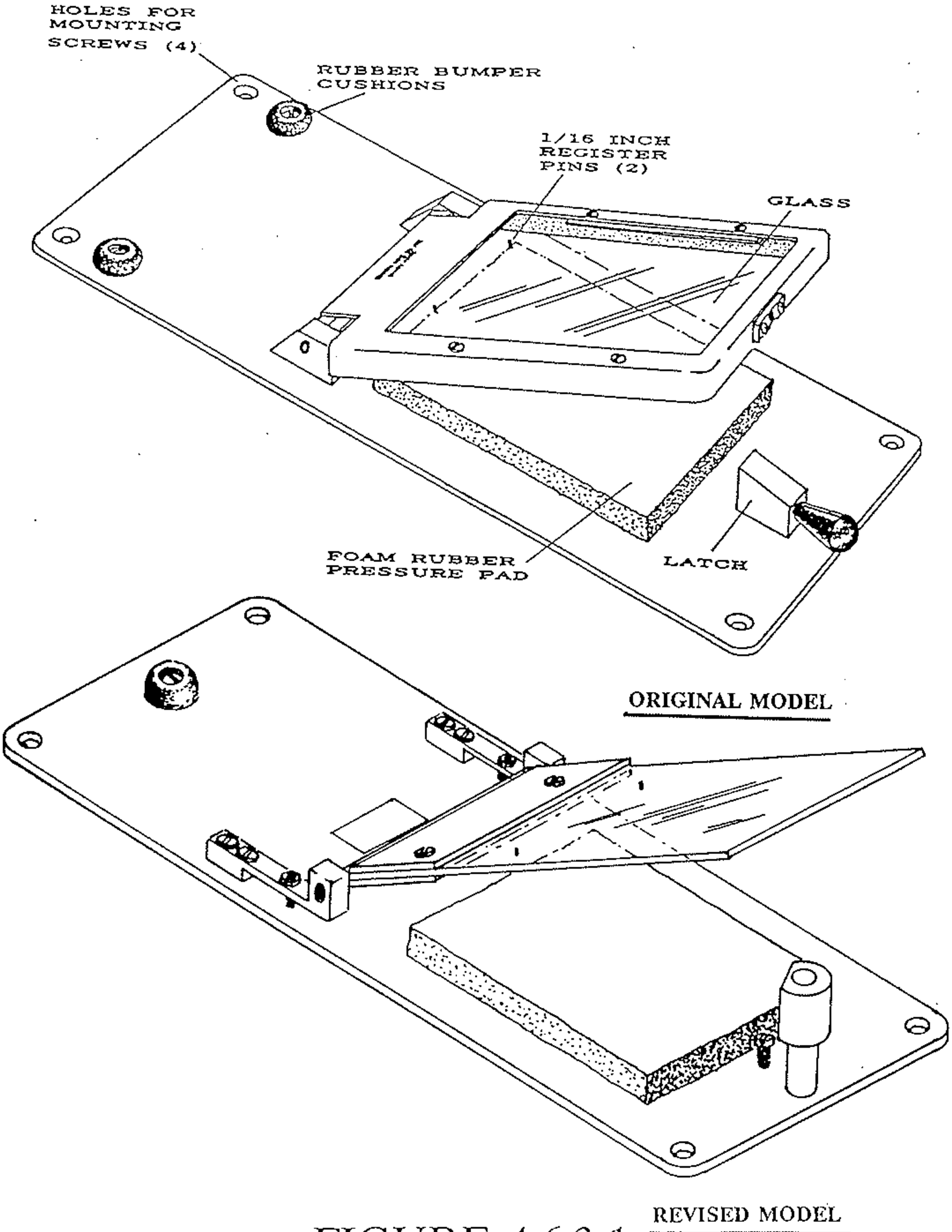

HOLES FOR MOUNTING SCREWS (4)
RUBBER BUMPER CUSHIONS
1/16 INCH REGISTER PINS (2)
GLASS
FOAM RUBBER PRESSURE PAD
LATCH
ORIGINAL MODEL
REVISED MODEL

FIGURE 4.6.3-1

register pins, then place the mask on top of the separation film, **EMULSION UP**. Place a clean piece of glass on top of the mask to insure good contact.

For 4x5 enlarged separations and masks, the Condit 1/16 inch punch is excellent because the holes are punched in the film margin. This allows more film area for the image. Get the film punch which punches holes three inches on center. The 1/4 inch holes made by a stationery 2-hole punch are not too bad, even though some film area has to be sacrificed. Make sure the register pin holes match the registration carrier.

If you can afford to get a Mask Registration Printer, it will greatly simplify your work for either technique. The alternative is to tape register pins to the enlarger base. Place a sheet of black paper under the film to help reduce reflections. Place the film on the register pins and clean glass on top of that.

To aid in determining exposure and development times you can take several approaches.

1. Take a Kodak 1A step guide, cut it in half, and tape the two halves next to each other on the carrier. This makes an image about the same size as a 35mm transparency. Be sure to mask around this setup to prevent flare.

2. Simulate a transparency by making a transparency step scale by contact printing two halves of a Kodak 1A step scale on piece of transparency film. Be sure to use the correct light source color temperature. Don't reuse this scale too often because the scale will tend to fade with repeated use.

3. Mount the transparency in a transport jig with a Kodak 1A step tablet. Testing is done with the step scale but the final judgement is made from the accompanying image.

Make your initial tests with any of the setups. Crank the enlarger to the height you will use. If your test setup is the same size as the transparency, raise the enlarger head to the required height for the enlarged separation. See section 4.6.3 to see how the exposure is computed. After the exposure and development times are determined the step scale can be omitted.

If you plan to make larger separation negatives than your test then must calculate a final exposure time. By knowing the magnification of the test and final image it is possible to compute the new exposure times. Use the following formula:

$$XF = \frac{(M_{FINAL} + 1)^2}{(M_{TEST} + 1)^2}$$

Where:
- XF = Exposure Factor
- M_{FINAL} = Magnification of final image
- M_{TEST} = Magnification of test image

For example, if the test magnification is 2X and the final magnification is 3.5X, then the exposure factor is:

$$XF = \frac{(3.5 + 1)^2}{(2.0 + 1)^2} = \frac{(20.25)}{(\ 9\ )} = 2.25$$

Compute the exposure time by multiplying the test exposure by the exposure factor. Using the previous example for a test exposure time of 20 seconds:

$$\begin{aligned} T_{FINAL} &= T_{TEST} \times XF \\ &= 20 \text{ sec} \times 2.25 \\ &= 45 \text{ seconds} \end{aligned}$$

Mount the transparency, **EMULSION DOWN**, in the registration carrier if you are using contact masks. This gives the slightly sharper separations. See Figure 4.6.1. On the otherhand, if you plan to make enlarged masks mount the transparency, **EMULSION UP**. See Figure 4.6.2. This is necessary in order to make the enlarged masks with the proper orientation.

4.6.4 Making Enlarged Separations With the Oil Immersion Technique. The technique of oil immersion is used to eliminate problems caused by light refraction between the glass carrier, air, and transparency. This technique is usually limited to 35mm and 2-1/4" transparencies. The oil also helps to hide scratches on the transparency.

In essence, a thin layer of fluid separates the transparency from the top and bottom glass surfaces of the carrier. Any number of low refracting fluids may work. Some of the fluids that have been used are freon, cleaning fluid (perchlorethanol), castor oil, baby oil, silicone oil (Dow Corning #200, viscosity 100), and Cargille oil (microscope oil) with good success. Castor oil, Cargille oil, and silicone oil are the most often used.

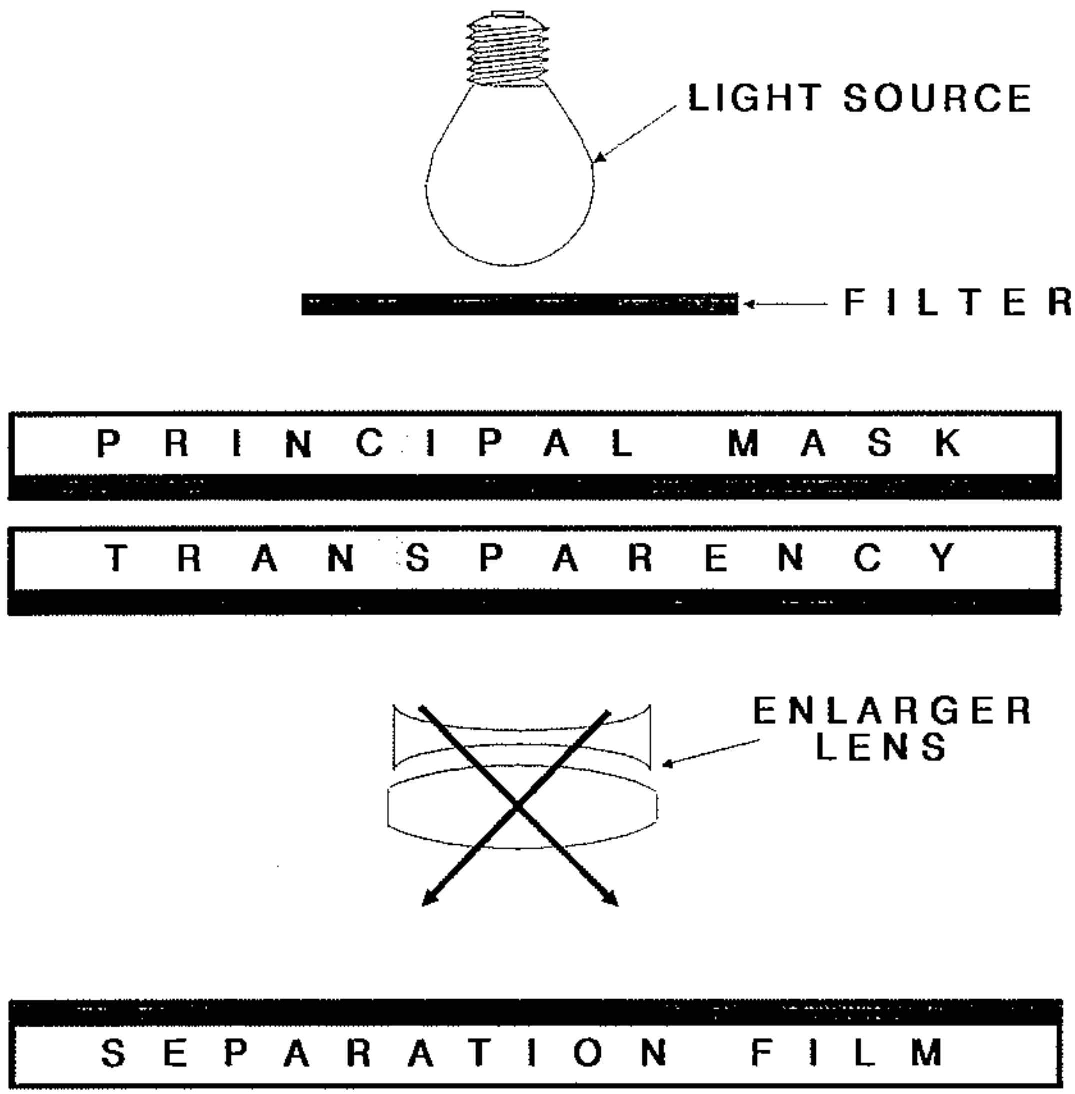
Using these fluids can be a harrowing experience. First, the oil must be free of particulate matter so dust must be kept to a minimum. Second, air bubbles must not be allowed to occur in the oil when in use. Finally, since the transparency is immersed in oil, it must be removed with extreme care to avoid scratching the emulsion. Afterwards the transparency and glass inserts have to be thoroughly cleaned. Uhh! messy. Use a film cleaner to clean the transparency, and a mild dishwashing liquid and hot water to clean the glass.

For optimum results, the specialized equipment required to make enlarged separations from 35mm transparencies with the oil immersion technique are:

a) a oil immersion carrier and inserts.
b) a point light source enlarger head.
c) a vacuum easel or mask register printer.
d) a lens 100mm or longer.

The glass inserts are specially made glass plates which fit into the Condit oil immersion carrier. The oil immersion carrier with a set of masks, is designed to fit into a special lockable housing which is purchased with the carrier and attaches permanently to the enlarger. The inserts consist of a bottom glass and a cover glass. They may be purchased separately from the carrier to allow for replacement if any damage occurs in handling the fragile glass inserts, e.g., scratches.

To aid in determining exposure and development times, take a Kodak 1A step guide, cut it in half, and tape the two halves next to each other. This makes an image about the same size as a transparency. Make your initial tests with this setup instead of a transparency. Crank the enlarger to the height you will use



CONTACT MASK FOR ENLARGED SEPARATIONS

FIGURE 4.6.1

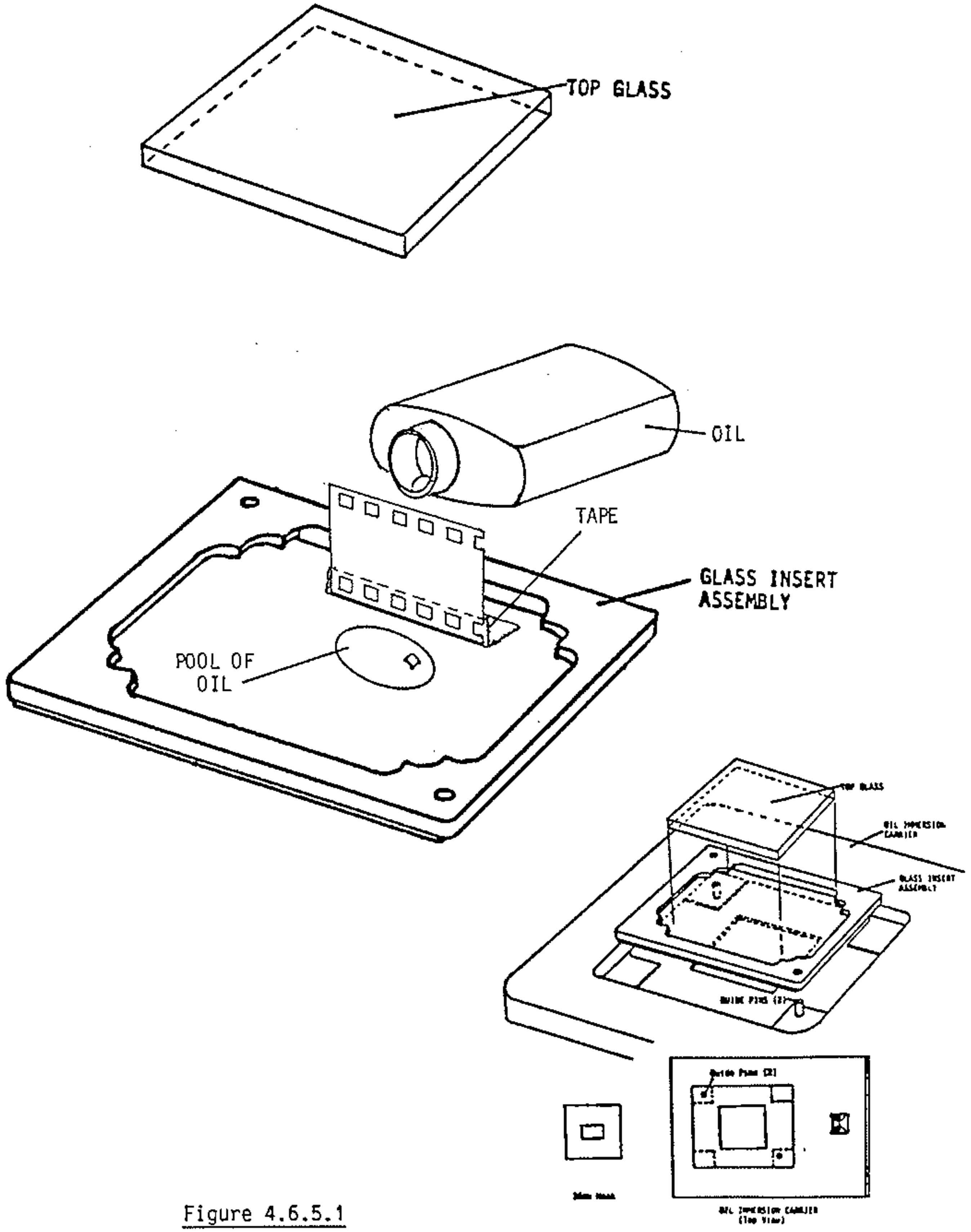


Figure 4.6.5.1

for the enlarged separations. Note the location of the enlarger head for future use. See section 4.6.3 to see how the exposure is computed.

If you are using a 35mm transparency then you must install the 35mm mask which comes with the carrier. Remove the 2-1/4" mask from the bottom of the carrier which is held by two strips of magnetic tape and replace with the 35mm mask. Slide the mask around until it is centered. Check the location by installing the carrier in the carrier housing; it should be centered over the center of the enlarger lens.

Once the mask is in place, go to a light box to do the remaining steps. Insert the bottom glass assembly on the diagonal pins in the carrier.

Very carefully align the transparency over the mask opening, **EMULSION UP**. Do not touch the film emulsion if you can help it. Put a piece of Scotch tape on one edge of the transparency and affix it to the bottom glass. Be careful not to place the tape beyond the sprocket holes and make sure the tape extends the entire length of the transparency. See Figure 4.6.2 and 4.6.3. Although slightly sharper separations are produced with the transparency, **EMULSION DOWN**, it's almost impossible to do with the oil immersion technique because enlarged masks have to be made.

The next step is critical in order to avoid air bubbles, so be very deliberate. Warm the oil to approximately 85 F. Lift the taped transparency or step guide vertically, and slowly pour a small circular, oval shaped pool of oil on the bottom glass underneath it. Make it the size of a nickle for 35mm film or about the size of a quarter for 2-1/4" film. The pool of oil should be placed so the center of the film will be centered over the pool of oil. Slowly, the slower the better, lower the film into the oil. The oil should spread from the center outward to the edges. The film should slowly settle into the oil.

Next, carefully pour an equal amount of oil onto top of the film. Set one edge of the cover glass on the insert and slowly lower the cover glass on top of the oil. Do not drop the cover glass! Lower it all the way. The oil has to cover the film completely without air bubbles or dust in the oil.

Check for air bubbles with a magnifier. Large air bubbles can be removed by gently pressing the cover glass. Most air bubbles will dissipate if the oil is allowed to settle for a few hours. After this is satisfactorily done, the setup is placed in the enlarger. If you have problems, remove the transparency, clean it, and start all over again.

When you are done, lift the cover glass with a small spatula. It may be more difficult than you think because of the seal created between glass surfaces. Once the cover glass is removed, lift the transparency by the sprocket holes and pull up the taped edge. Be carefully not to damage the emulsion.

Soak up the excess oil with cotton or better yet, Photo-Wipes. Dab up as much oil as possible. Clean the transparency with film cleaner. Wash the glass insert and cover glass with liquid detergent.

Be carefully when removing the tape, if you scrape too much you may scratch the bottom glass insert. If you do scratch the glass, put a little cerium oxide on the end of your finger and polish the area of the scratch.

A point light source is required for maximum image sharpness and image contrast. Point light sources, however, are not very useful for transparencies larger than 2-1/4" because it is impossible to get uniform illumination from edge to edge over larger sizes. The light source is difficult to use because it has to be focused and checked for even illumination before the film is inserted in the carrier. Move the adjustable lamp holder by raising or lowering it to focus the light on the enlarger easel. Condit sells a excellent point source which is a modified Omega enlarger point source. Unfortunately, Omega no longer makes these light sources. Never-the-less, a point light source is almost a necessity with this technique if 16x20 prints are to be made from 35mm. If you cannot get a point light source, then use a 111A bulb with an adapter as described in section 4.6.4.

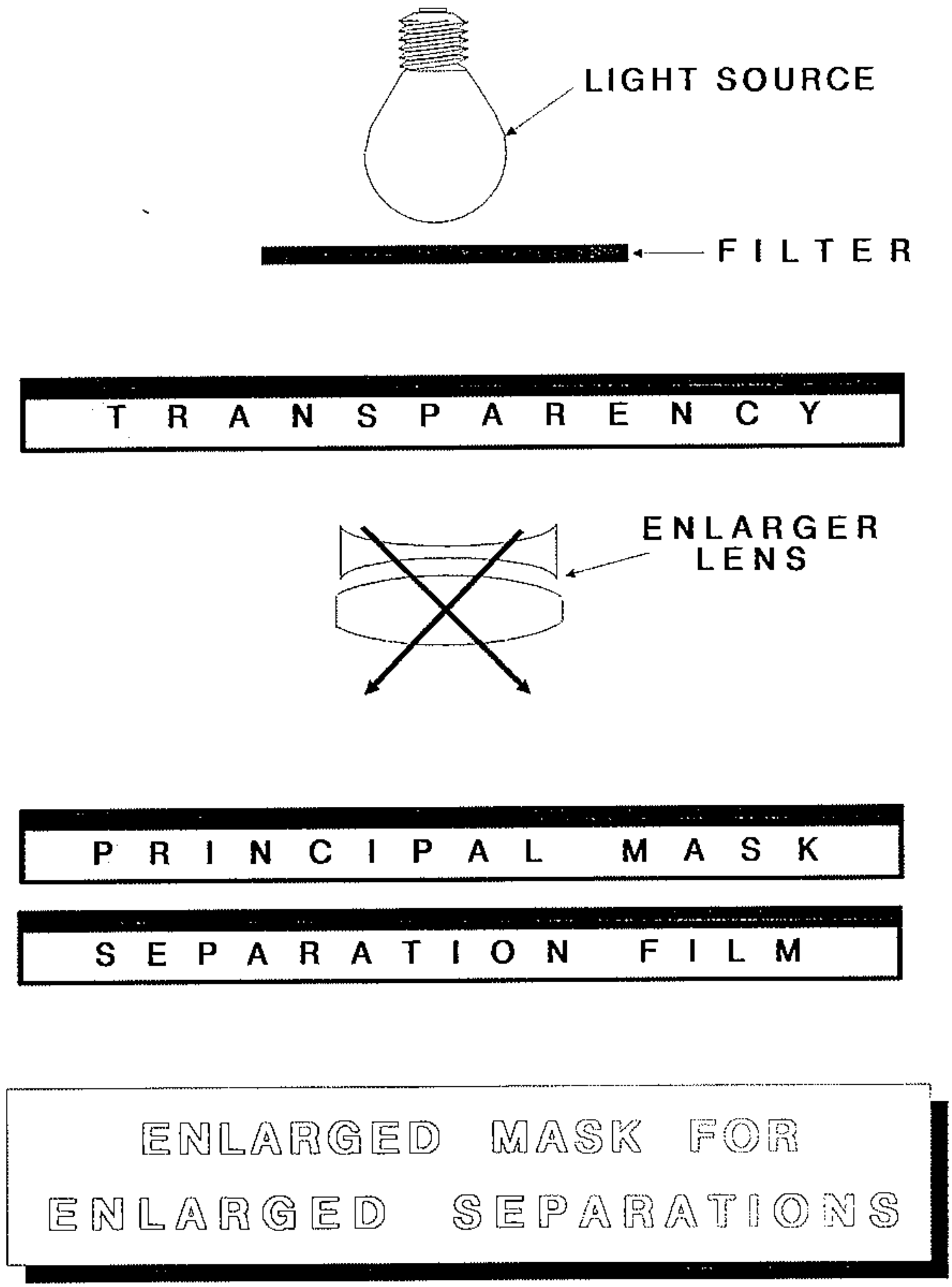

LIGHT SOURCE
FILTER
TRANSPARENCY
ENLARGER LENS
PRINCIPAL MASK
SEPARATION FILM
ENLARGED MASK FOR ENLARGED SEPARATIONS

FIGURE 4.6.2

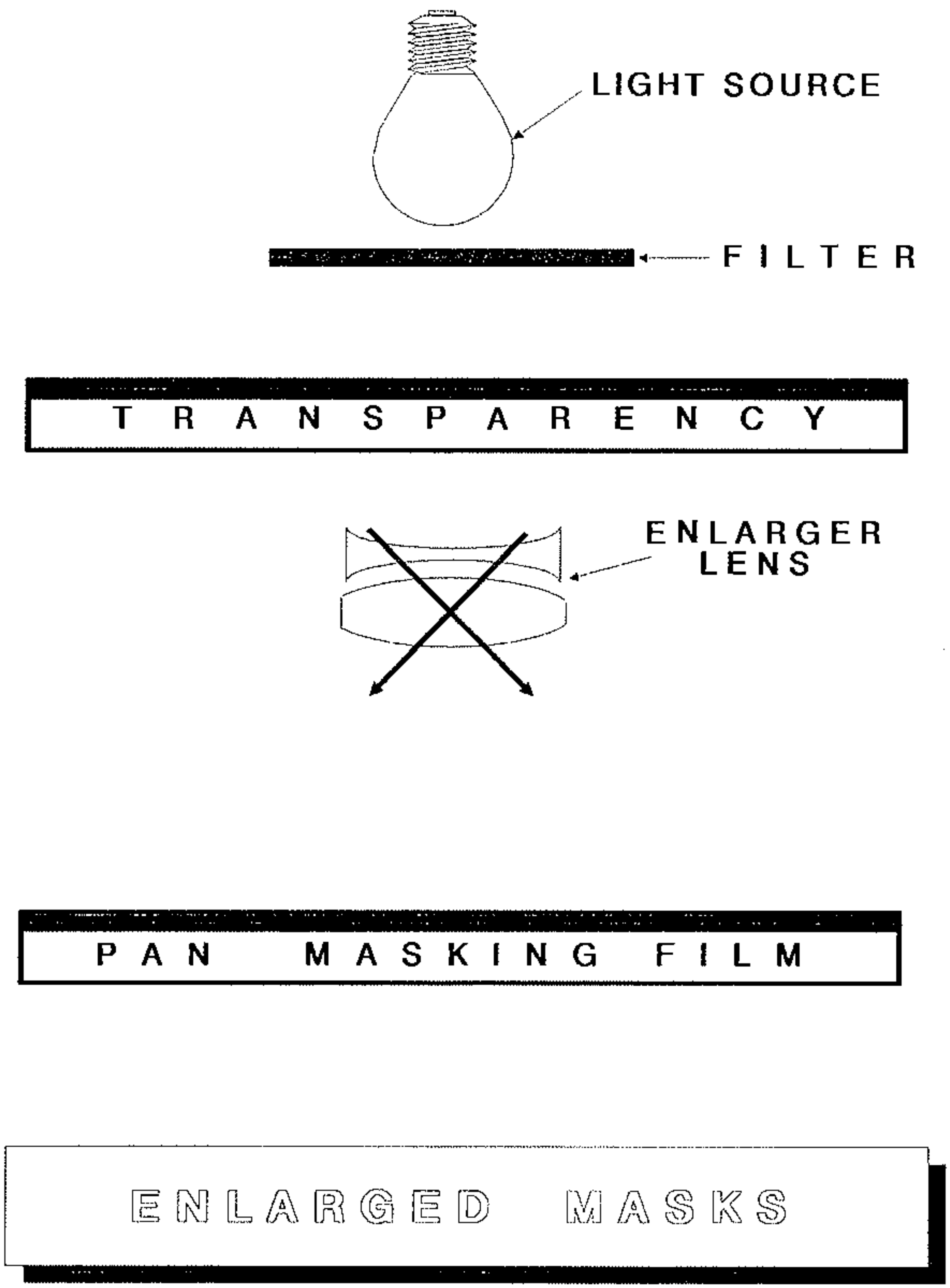

LIGHT SOURCE
FILTER
TRANSPARENCY
ENLARGER LENS
PAN MASKING FILM
ENLARGED MASKS

FIGURE 4.6.3

Because the transparency is immersed in oil, both the color and highlight masks must also be enlarged. The exposure and development of enlarged masks is identical to that for contact masking. Refer to section 4.4 for exposure and development information. The enlarged masks, of course, are made first and then placed in register, EMULSION UP, on the unexposed separation film when doing the separation exposures. This means that you will need something to register the two films and hold them in close contact during exposure. This can be accomplished any of three possible ways:

a) with a mask register printer,
b) with a vacuum easel, or
c) with taped register pins and a sheet of glass.

a) The mask register printer is made by Condit Company. This device fastens to the enlarger easel. It consists of a hinged glass top with register pins, on three inch centers, which locks on top of a foam rubber pad. This is available for 4x5 or 5x7 separations only. It looks like a glorified contact print frame. The register pins are 1/16 inch and require that you have the Condit 1/16 inch punch. A mask register printer cheaper and less troublesome than the vacuum easel.

b) The vacuum easel must also be fastened to the easel and have register pins. It must have vacuum channels to hold 4x5 and 5x7 film. There are two techniques to anchor the mask on top of separation film.

The first way is to use a sheet of clear acetate or mylar. This sheet overlaps the film on all sides and is held in place by the next set of vacuum channels. The separation is placed on the register pins first, then the mask and finally the clear acetate. The register holes for the acetate must be deeper than the film in order to allow it to overlap the punched edges of the film. Special deep film punches are available for this. When vacuum is applied the acetate holds everything flat. Care must be taken not to scratch the acetate.

The second way is to make the mask from film a size larger than the separation film. The mask should overlap the separation film to the next set of vacuum channels and must be deep punched as mentioned previously. Use 4x5 film for separations and 5x7 for the mask.

c) Taping the register pins to the easel is a rather crude method but it works well enough. Tape a set of single register pins to the easel. Place the separation film and mask film, EMULSION UP, on the easel. Place a clean sheet of glass on top of the film. I suggest that a sheet of black paper be put down first to eliminate any back reflection through the film emulsion.

4.6.5 Alternate Oil Immersion Technique. This system of oil immersion was developed by Bob Pace, a man with 40 years of dye transfer experience.

This system has several distinct advantages. First, it uses contact masks, this means that enlarged masks and the accompanying headaches are eliminated. Instead of a point light source, a standard condenser enlarger can be used, thus eliminating another problem. In essence, you gain the advantages of oil immersion such as elimination of scratches and light refractions caused by a glass carrier, without many of the problems.

The oil immersion carrier as described in the previous system has to be modified in order to use this system. Since the mask and transparency must be in register, the bottom glass must have diagonally mounted register pins. Condit Company can make this modification for you. You will need an adjustable diagonal film punch for 1/16" register pins. Ask Condit about their Cibachrome carrier, it may fit the requirements for this technique.

Bob uses two such carriers, one for 2-1/4 film and one for 4x5 film. The 2-1/4 carrier is for 35mm film and the 4x5 carrier is for 2-1/4 films. I think you could get by with just a 4x5 modified oil immersion carrier. Although you can punch holes in the transparency it's not advisable since it could be damaged when removal from the register pins is attempted. The transparency should mounted in a transport jig as described in section 4.2.

Remember, the mask is a contact mask so you must use the diagonal punch when making it. Just buy some single pins and make an contact print frame. Of course, you could have Condit make a contact print frame with diagonal pins in the glass. It's up to you.

This oil is used exactly as described in section 4.6.5 except that oil is used between the mask and transparency as well as on top of the assembly. A Warning, check the registration of the mask and transparency in the carrier with a magnifier. When you are satisfied with the registration proceed with the next step.

4.6.6 Procedure. Listed below is a sequence of steps to produce enlarged separations. The procedures for both methods are roughly the same. Any major differences will be noted. The following sequence can be changed in places to suit your needs. Additional steps are also possible.

1. Clean the carrier glass. Place your film punch so it can be found in the dark. Do everything to minimize dust. Prepare an empty box to store exposed film. Store scissors where they can be located in the dark. If using oil, warm it in warm water to make it flow easily. Focus the point source, if using one. Mount film in oil inserts, if using this method, and set aside.

2. Set your light source to three footcandles. Install your filters in the filter tray.

3. Set your timer.

4. Put carrier in the enlarger.

5. Turn out lights. Punch register holes in film. For green and blue separations, locate corner notches, clip one corner for green and two for blue.

6. Place film on register pins of vacuum easel, etc. Emulsion of film should be up towards light source.

7. Turn on timer to make exposure.

8. Remove film and store in lightproof box. Repeat for next separation.

9. Process all sheets of film.

4.7 FILM DEVELOPMENT.

MATERIALS:	
4x5 Kodak Super-XX Film 4142	<3.16.3>
4x5 Kodak T-Max 100 Film	<3.16.3
4x5 Kodak Separation Film 4131, Type 1	<3.16.3>
Kodak Pan Masking Film 4570	<3.16.2>
CHEMICALS:	
HC-110, DK-60a, or DK-50 Developer	<3.17.6>
Acetic acid	
Fixer	
Hypo Clear	
Photo-Flo	
EQUIPMENT:	
Densitometer	<3.19>
5x7 trays or drum	
Motorized base for drum	
Curve Plotting Paper	<3.22.8>

This section covers the development of masking and separation film.

Once the development time for masking film is determined it need not be varied because the contrast of the film must remain constant for each given transparency density range. The only task is to find an exposure time which will produce a shadow density of 0.30. The discussion in this section will be simple and straight forward.

In the production of color separation negatives the contrast of the separation negative film must vary in accordance with the density range of the transparency in order to produce a separation the proper target density range. A simpler approach is to assume that transparency density range (gamma) remains constant. As a consequence the negative contrast would stay at constant gamma, thus a single development time is all that need be determined. Any variation from the norm could be rectified by varying the matrix film development as described in Chapter 5. We look at both techniques in this section. For beginners perhaps the second technique is sufficient, but I strongly suggest the former technique be tried after you have gained experience.

4.7.1 Masking Film Development. As mentioned contrast is most important when making the color masks. The gamma of masking film should remain at 0.33,i.e., 1/3 of the transparency's density range if you are using 33% masking or 0.25 if the masking percentage is 25%. If for 33% masking you are assuming a chrome density range of 2.0, the mask density range will 0.67 (+/-0). The mask's density range varies with the transparency's.

For testing assume any reasonable density range and try to make the mask's density range 1/3 of that value. If you are using 25% masking substitute 1/4 (.25) for 1/3(.33) in the following discussion. Pick a couple of steps on a step scale with a density range between them of roughly 2.0.

You should follow the recommended development times to start with. Listed below are Kodak's recommended development times for Pan Masking film. All times are based on continuous agitation; both the red and green masks receive the same development times.

Developer	Temp	Time(min)
HC-110 dil. F (1:19)	68 F	3 min
DK-50 (1:4)	68 F	3 min

Of the two developers I prefer HC-110 because it's easy to obtain, easy to mix, and costs less per ounce. Kodak says that either developer will yield the same results. Use whichever you prefer.

Before you attempt to vary the density range of the color masks by adjusting the development time, adjust the exposure to get a density near 0.3 in the shadow step of the step guide. This in discussed is section 4.4.2. After you have the proper exposure time, then look at the density range of the step guide.

Find the difference between the steps on the step guide representing the shadow and highlight densities of your transparency. For the assumed transparency density this difference will be about 0.67 (+/- 0.05). As mentioned, the color mask's density range should be approximately 1/3 the transparency's density range. It is mandatory that both the green and red color masks have the same shadow density and density range (the same contrast). You do have some leeway. A tolerance of 0.1 density for the shadow density and a tolerance of 0.05 in density range may be a little too tight. If you exceed this tolerance range by a few hundredths, don't redo everything. Try hard to get the density ranges as close as possible, but given the inaccuracies in equipment and development parameters, you won't get exact values.

Once you have determined that the density range for a given development time is not acceptable, then you must adjust the development times. **CAUTION!! THE SHADOW DENSITY WILL CHANGE SLIGHTLY WHEN YOU CHANGE THE DEVELOPMENT TIMES.** I suggest that exposure time be decreased by 5% for increased development and increased by 5% for decreased development time.

There is no easy way to determine exactly how much adjustment in development time will give you a desired change in density range. Remember, increased development time increases density range and decreased development time lowers density range. A very rough guide is to CHANGE DEVELOPMENT TIME 3% TO CHANGE DENSITY RANGE BY 0.02 DENSITY. See the example below.

EXAMPLE 4.7.1-1. A development time of three minutes in HC-110 dilution F yields a density range of 0.70 in the red mask and 0.54 in the green mask. The exposure time for the red mask was 30 seconds and 31 seconds for the green mask. Adjust the development and exposure times for the masks to obtain a desired density range of 0.6. The shadow density of the two masks for the given exposure are identical at 0.3.

I) Calculate the development time

(a) Find the density range differences from 0.60.

$$\text{Range Difference}_{red} = 0.7\text{-}0.6 = 0.1$$
$$\text{Range Difference}_{grn} = 0.6\text{-}0.54 = 0.06$$

(b) Find percentage change. Try 3% for every .02 density change.

$$\text{Percent}_{red} = (0.10 \div .02) \times 3\% = 15\%$$
$$\text{Percent}_{grn} = (0.06 \div .02) \times 3\% = 9\%$$

(c) Find development times. Decrease time to reduce density range. Increase time to increase density range. Convert development time into seconds to make calculation easier.

3 minutes = 3x60 = 180 seconds

$$\text{Time change}_{red} = (180)\text{x}.15 = 27 \text{ sec}$$
$$\text{Time change}_{grn} = (180)\text{x}.09 = 16 \text{ sec}$$

$$\text{Dev. time}_{red} = 180\text{-}27 = 153 = 2'33''$$
$$\text{Dev. time}_{grn} = 180+16 = 196 = 3'16''$$

Answer:

RED MASK DEVELOPMENT TIME IS 2'33"
GREEN MASK DEVELOPMENT TIME IS 3'16"

II) Calculate exposure adjustment

(a) Adjust exposure time 5% to compensate for development changes. Increase time for decreased development time and decrease for increased development time.

$$\text{Exposure time}_{red} = 30 \text{ sec} \times 1.05 = 32$$
$$\text{Exposure time}_{grn} = 31 \text{ sec} \div 1.05 = 30$$

Answer:

ADJUSTED RED MASK EXPOSURE IS 32"
ADJUSTED GREEN MASK EXPOSURE IS 30"

4.7.2 Separation Development: Simplified Constant Gamma Technique. For those who have not determined a target separation density range use a value of 1.2. You should also assume a transparency density range of 2.0 and a masking density range of 0.67 (2.0x.33),for a masking percentage of 33%. This means that we would like a separation negative gamma of 0.9 [1.2/(2.0-0.67)]. This is the goal.

If you choose to use a masking percentage of 25% rather than 33% then the masking density range would be 0.50 (2.0x.25). This in turn would make the required separation negative gamma 0.8 [1.2/(2.0-0.50].

You should be aware that the transparency density range may actually be lower or higher that 2.0, yielding a print that is either lower or higher in contrast. You will only know this when the test print is made, at that time decide how to vary the tanning developer A and B combination to rectify the problem.

Listed are some recommended development times for Super-XX film. These times are based on continuous agitation, a masked transparency, and a diffusion light source.

DEVELOPER 68 F	RED	GREEN	BLUE
1 HC-110 dil A (1:3)	4'30"	4'30"	7'0"
2 DK-60A	2'50"	2'40"	4'20"

1. Recommended Kodak times.
2. Supplied by Bob Pace, Calif.

DK-50 (undiluted) is also a good developer but no development times are available at this time. The developer DK-60a has to be made. Use this developer if you need additional contrast, it produces more grain, however. This formula is ideal for drum processing. The formula is listed below.

Water (125 F)	750.0 ml
Metol (Elon)	2.5 grams
Sodium Sulphite	50.0 grams
Hydroquinone	2.5 grams
Kodalk	20.0 grams
Potassium Bromide	0.5 gram
Add water to make	1000.0 ml

If you are using Separation Type 1 film then use the development times shown below as a starting point.

DEVELOPER 68 F	RED	GREEN	BLUE
HC-110 dil. D (1:9)	3'30"	4'30"	5'0"
DK-50 (1:1)	3'30"	4'30"	5'0"

If you are using T-Max 100 film use the development times given below as a starting point. Please note that the development times are are 75 degrees Fahrenheit.

DEVELOPER 75 F	RED	GREEN	BLUE
HC-110 dil. A (1:9)	3'20"	3'20"	3'20"
T-Max (1:4)	7'30"	7'30"	7'15"

Info supplied by Frank McLaughlin, Rochester,N.Y

Make sure you get the proper shadow density before attempting to make any development changes. You'll find that any exposure corrections you make will affect the film density range. Attempting to adjust two variables at once can be very difficult.

After the exposure is determined to be within tolerance, then measure the difference between the shadow and highlight density steps. The difference should be 1.2 (+/- 0.1). If density range is less than 1.2 then increase the development, if greater then decrease the development. **CHANGE DEVELOPMENT TIME 3% TO CHANGE DENSITY RANGE BY 0.02 DENSITY.** After readjusting the development times there will be slight changes in the shadow density. Compensate by changing the exposure by 5%; for increased development decrease exposure and vice versa. An example problem is given below.

EXAMPLE 4.7.2-1. A development time of three minutes for the red and green separations and five minutes for the blue yields a density range of 1.3 in the red mask, 1.14 in the green mask, and 1.22 in the blue mask. The exposure time for the red mask was 30 seconds, 31 seconds for the green mask, and 35 seconds for the blue mask. Adjust the development and exposure times for the masks to obtain a desired density range of 1.2. The shadow density of the two masks for the given exposure are identical at 0.4.

I) Calculate development times

(a) Find the density range differences from 1.2.

Range Difference_{red} =1.3-1.2= 0.1
Range Difference_{grn} =1.14-1.2= .06
*Range Difference_{blu}=1.22-1.2= .02

* No adjustment necessary, range within tolerance

(b) Find percentage change. Try 3% for every .02 density change.

Percent_{red} = (0.10 ÷ .02) x 3%= 15%
Percent_{grn} = (0.06 ÷ .02) x 3%= 9%

(c) Find development times. Decrease time to reduce density range. Increase time to increase density range. Convert development time into seconds to make calculation easier.

3 minutes= 3x60= 180 seconds

Change_{red}=(180 sec)x.15= 27 sec
Change_{grn}=(180 sec)x.09= 16 sec

Dev. time_{red}= 180-27 = 153= 2'33"
Dev. time_{grn}= 180+16 = 196= 3'16"

Answer:

RED SEPARATION DEV. TIME IS 2'33"
GREEN SEPARATION DEV. TIME IS 3'16"

II) Readjust exposure time

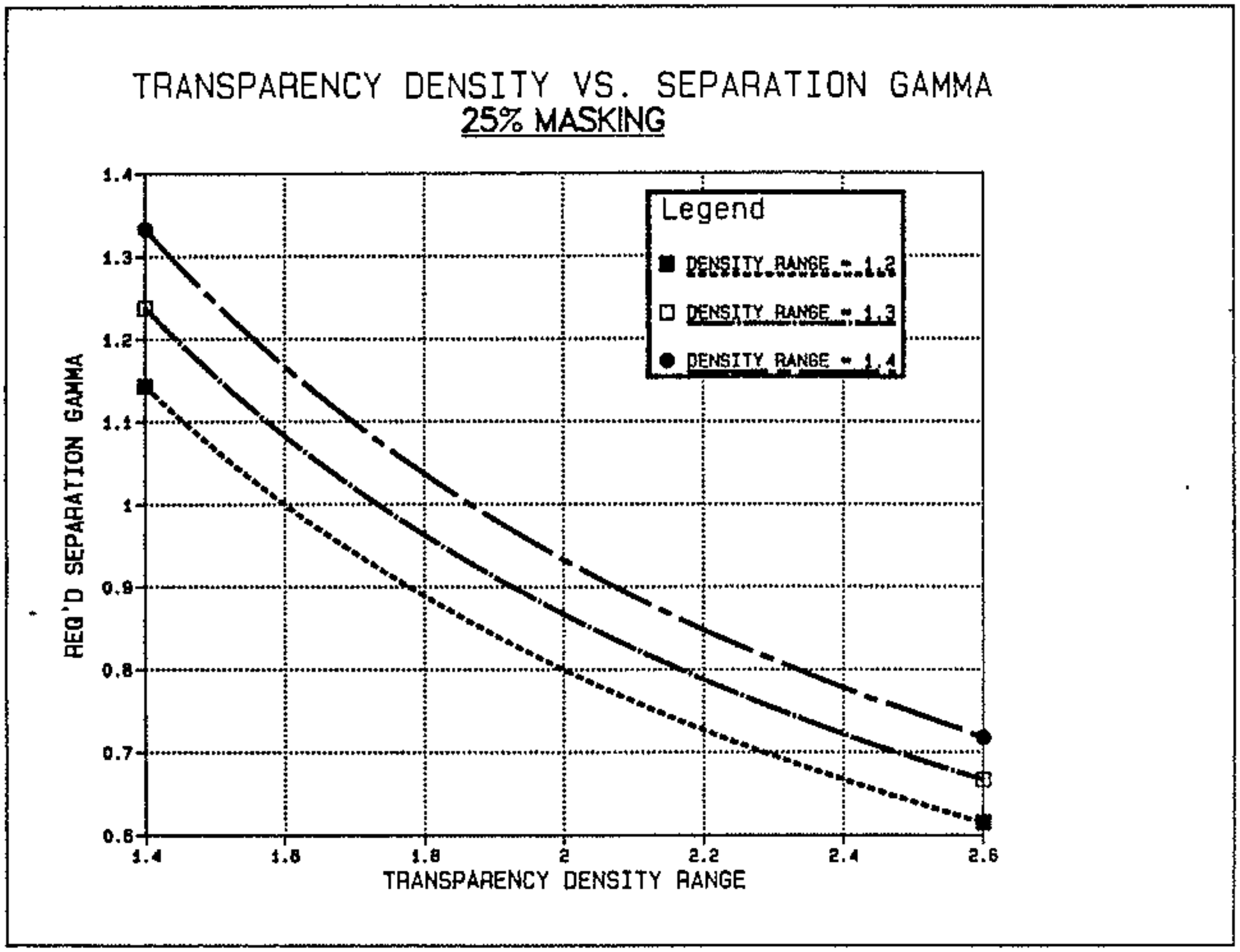
(a) Adjust exposure time 5% to compensate for development changes. Increase time for decreased development time and vice versa.

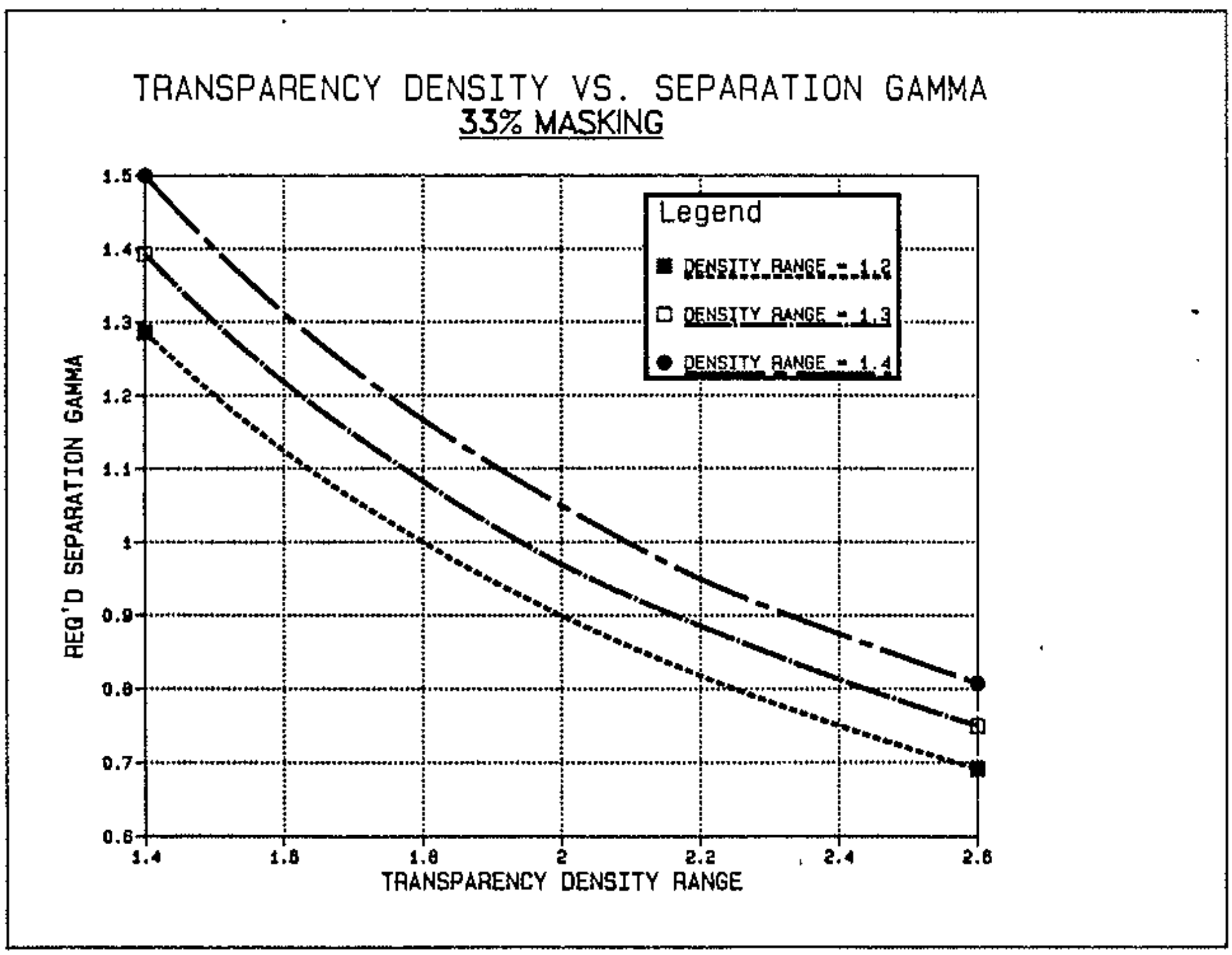
Exposure time_{red}=30 sec x 1.05= 32
Exposure time_{grn}=31 sec / 1.05= 31

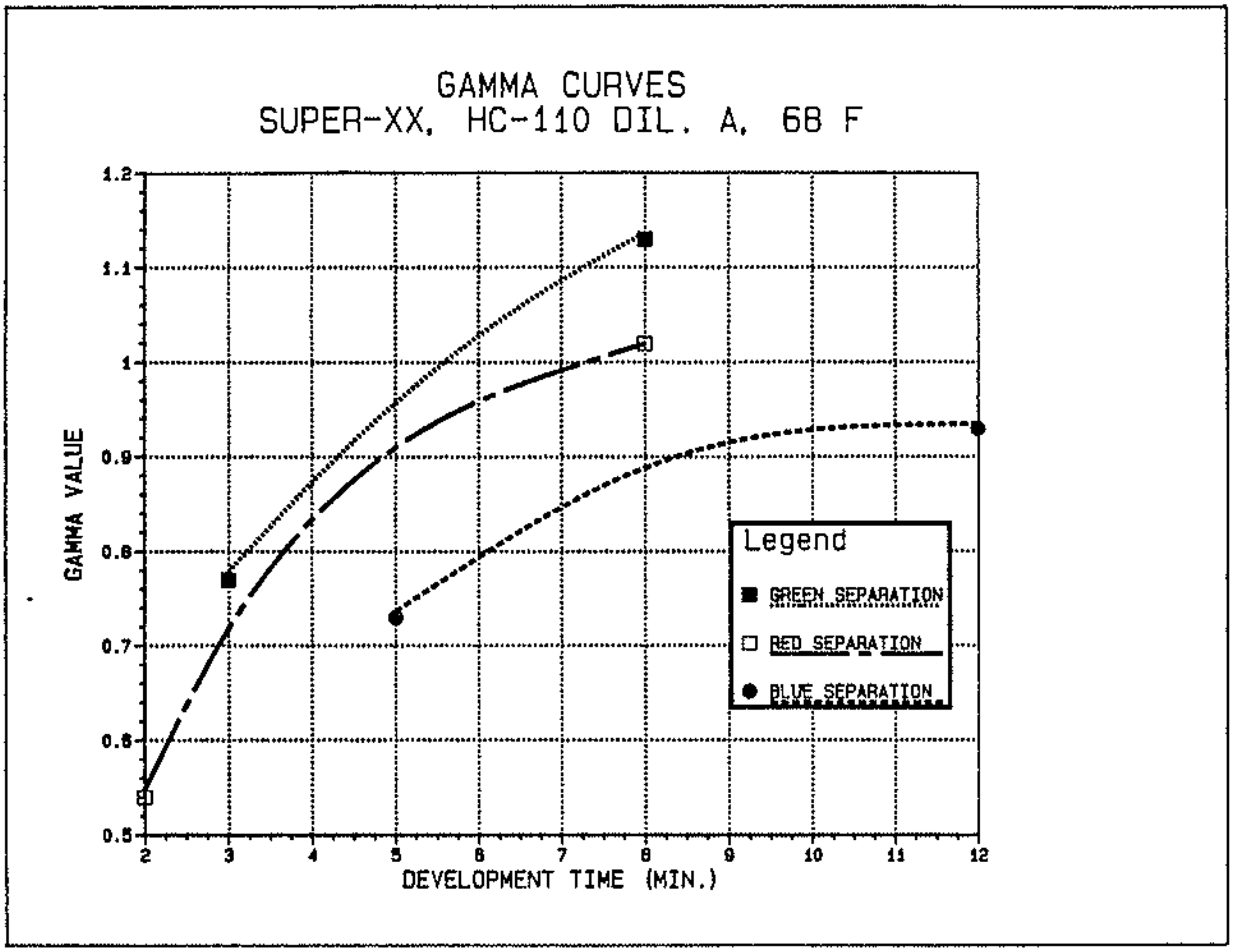
Answer:

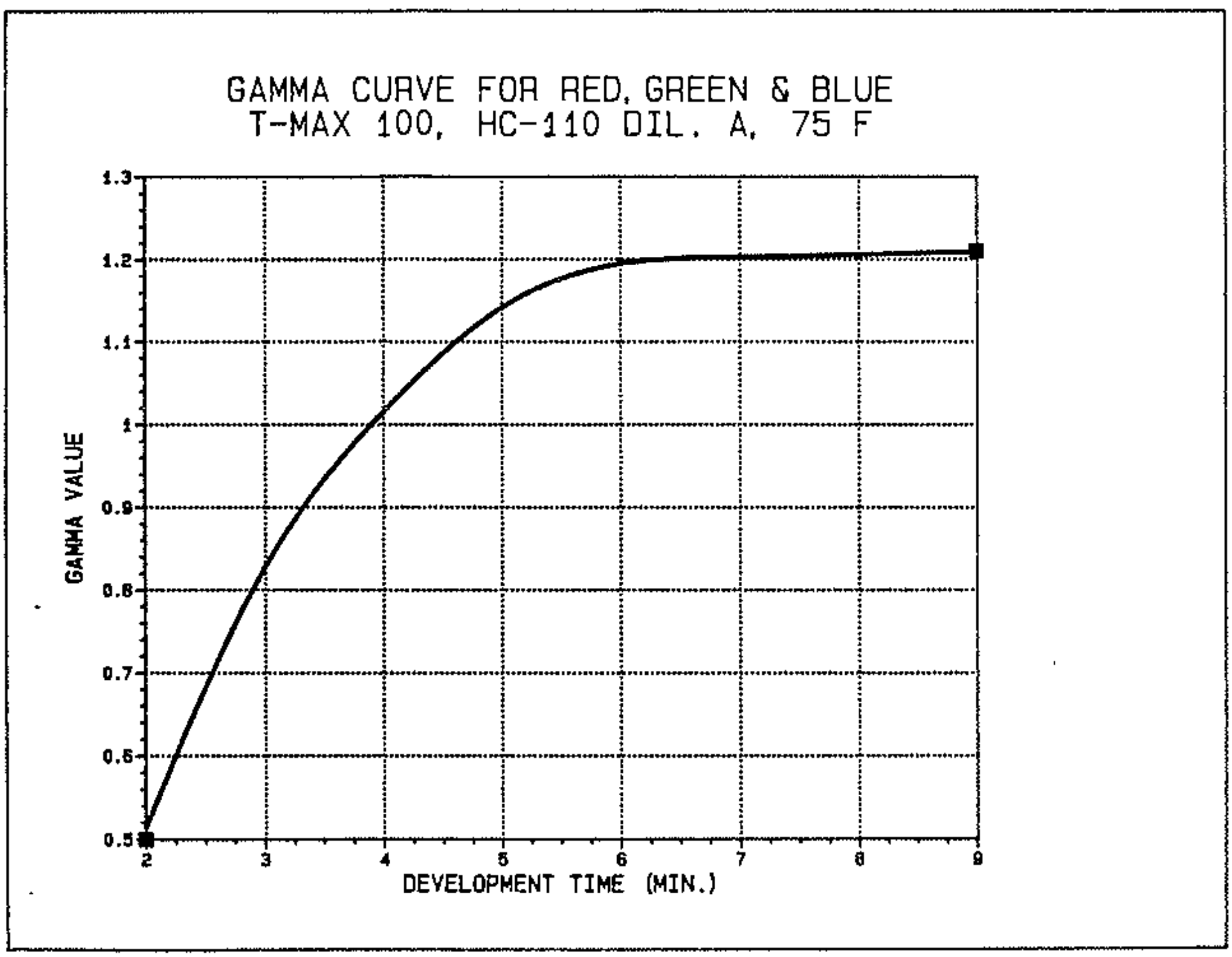
RED SEPARATION EXPOSURE TIME IS 32"
GREEN SEPARATION EXPOSURE TIME IS 31"

4.7.3 Separation Development: Advanced Varying Gamma Method. In order to use this technique you must be able to measure the density range of the transparency. Use any of the developers listed in section 4.7.2. The aim is to vary the separation development in order to yield a given target density range in the separation. Throughout this section I have assumed a 33% mask, if you prefer to use a 25% mask then substitute that value for masking percentage. A graph has been included in this section to aid in determining the required negative gamma needed for transparency density ranges of 1.2, If you prefer to use a different masking percentage instructions for making your own graph are included in this section.


TRANSPARENCY DENSITY VS. SEPARATION GAMMA
25% MASKING
Legend
DENSITY RANGE = 1.2
DENSITY RANGE = 1.3
DENSITY RANGE = 1.4
REQ'D SEPARATION GAMMA
TRANSPARENCY DENSITY RANGE
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
1.4
1.6
1.8
2
2.2
2.4
2.6


TRANSPARENCY DENSITY VS. SEPARATION GAMMA
33% MASKING
Legend
DENSITY RANGE = 1.2
DENSITY RANGE = 1.3
DENSITY RANGE = 1.4
REQ'D SEPARATION GAMMA
TRANSPARENCY DENSITY RANGE
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
1.4
1.6
1.8
2
2.2
2.4
2.6


GAMMA CURVES
SUPER-XX, HC-110 DIL. A, 68 F
GAMMA VALUE
DEVELOPMENT TIME (MIN.)
Legend
GREEN SEPARATION
RED SEPARATION
BLUE SEPARATION
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
2
3
4
5
6
7
8
9
10
11
12


GAMMA CURVE FOR RED, GREEN & BLUE
T-MAX 100, HC-110 DIL. A, 75 F
GAMMA VALUE
DEVELOPMENT TIME (MIN.)
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
2
3
4
5
6
7
8
9

A film gamma versus development time chart is also provided for film exposed with red, green, blue filters. It is based on the use of Super-XX film and HC-110 dilution A. Instructions are also given for making this chart, since there is no guarantee that the development times in this chart are necessarily correct for your development setup.

Making a chart showing transparency density range versus separation negative gamma are fairly simple. The steps are listed below.

Step 1. Find mask density range. Multiply transparency density range by mask percentage then divide by 100.

Step 2. Find density range of masked transparency. Subtract mask density range(step 1) from transparency density range.

Step 3. Find required separation gamma. Divide desired target negative density range by masked transparency density range(step 2).

For example, assume a 33% mask, a transparency density range of 2.1, and a target density range of 1.2 then the calculation goes as follows:

Step 1) (2.1x33)/100 = 0.70 [density range]

Step 2) 2.1 - 0.70 = 1.40 [masked chrome, d-range]

Step 3) (1.2)/1.4 = 0.86 [separation gamma]

To make the chart, calculate separation gamma's for transparency density ranges from 1.6 to 2.4 in 0.1 increments. Plot these values on a transparency density range versus separation negative gamma. For example, for 33% masking and a target density range of 1.2 the values would be:

CHROME D-RANGE	MASK D-RANGE	MASKED CHROME D-RANGE	SEP. GAMMA
2.4	0.8	1.6	0.75
2.3	0.77	1.53	0.78
2.2	0.73	1.47	0.82
2.1	0.70	1.40	0.86
2.0	0.67	1.33	0.90
1.9	0.63	1.27	0.94
1.8	0.60	1.20	1.00
1.7	0.57	1.13	1.06
1.6	0.53	1.07	1.12

The chart is made by putting the transpar ncy density range on the x-axis and the separation gamma on the y-axis.

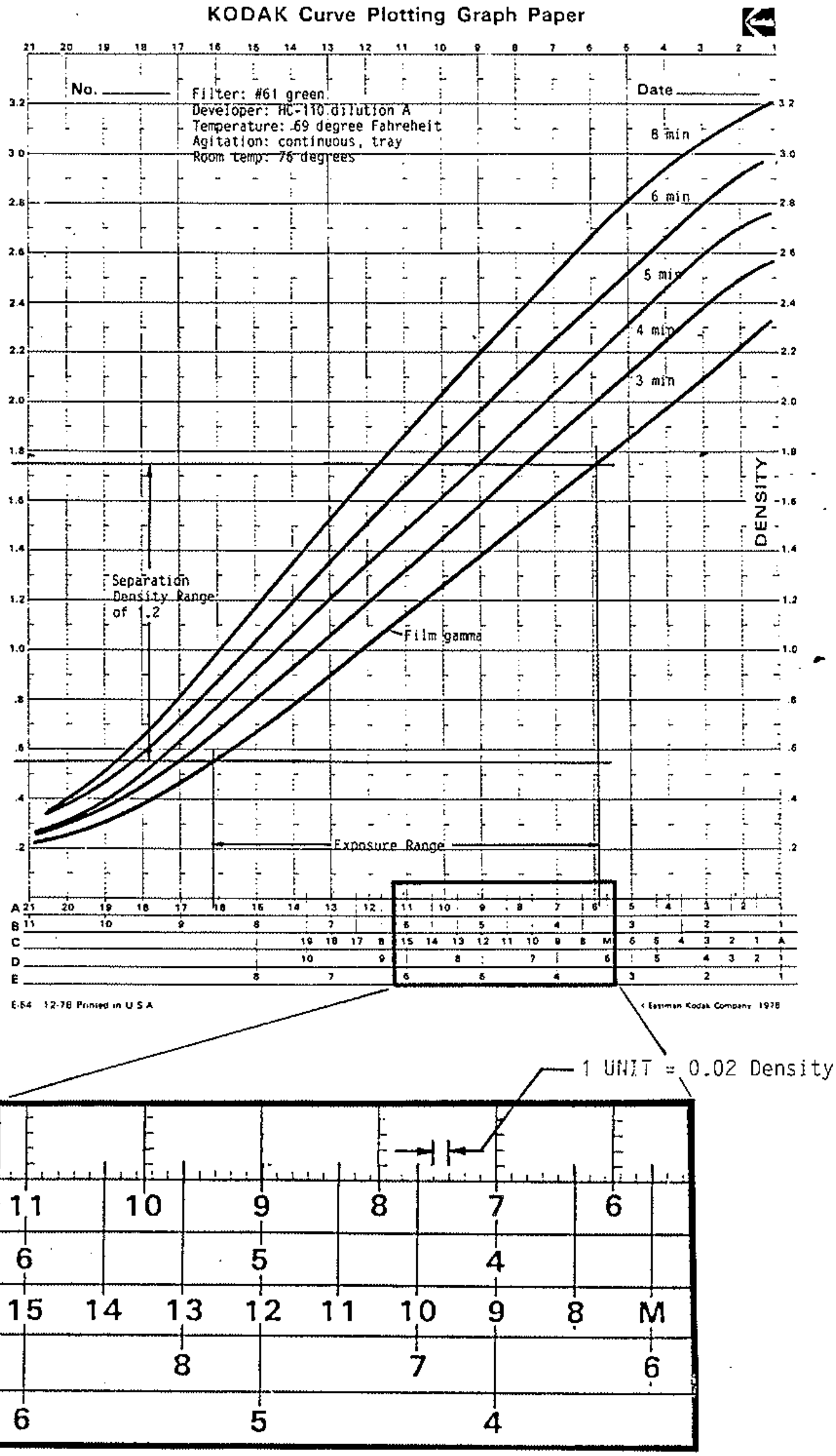

KODAK Curve Plotting Graph Paper
No.
Date
Filter: #61 green
Developer: HC-110 dilution A
Temperature: 69 degree Fahreheit
Agitation: continuous, tray
Room temp: 76 degrees
8 min
6 min
5 min
4 min
3 min
Separation Density Range of 1.2
Film gamma
Exposure Range
DENSITY
E-64 12-78 Printed in U.S.A.
© Eastman Kodak Company 1978
1 UNIT = 0.02 Density

FIGURE 4.7.3-2

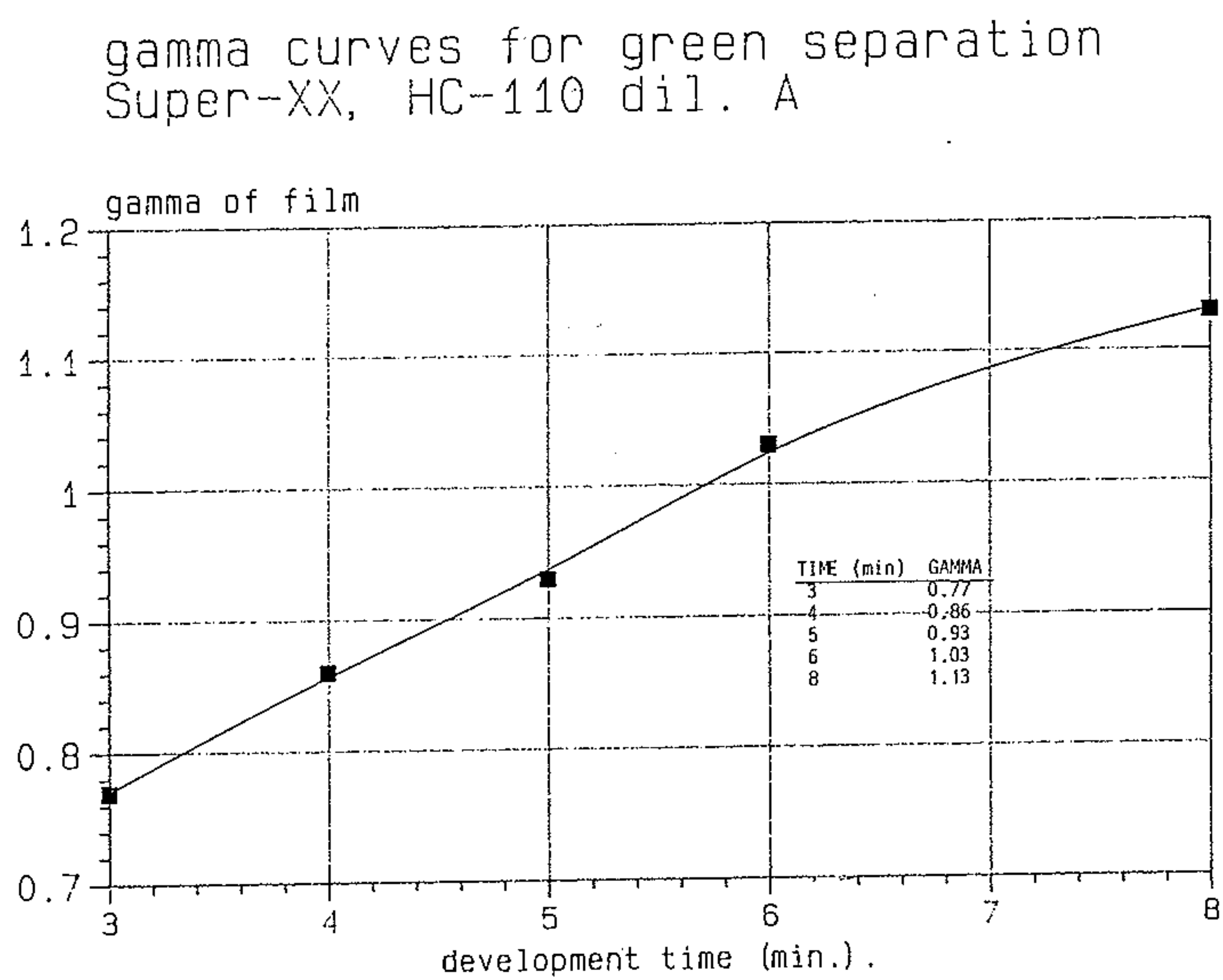

gamma curves for green separation
Super-XX, HC-110 dil. A
gamma of film
1.2
1.1
1
0.9
0.8
0.7
3
4
5
6
7
8
development time (min.).
TIME (min) GAMMA
3 0.77
4 0.86
5 0.93
6 1.03
8 1.13

FIGURE 4.7.3-3

The next task is to come up with a separation negative gamma versus development time chart. Select the film you want to use and developer you'd like to use. All testing is done with a step scale. This will take considerable work but in the long run you'll be glad you did. The steps required are summarized below.

Step 1) Make the same exposure of a step scale on several sheets of film. Do this for the red, green and blue filters. Use the exposure times recommended in the exposure section of section of sections 4.5 and 4.6. Use at least 6 sheets of film.

Step 2) Develop each sheet for a different time. Use times from 1/2 to twice the recommended development times shown in section 4.7.2.

Step 3) For a given filter, plot the curves for each development time (on the same plotting paper). You should have three sheets of plotting paper, each showing six development curves. If you have never plotted curves before, see the section on plotting in this chapter.

Step 4) Find the gamma for each curve. Plot the development time versus the gamma for each density curve. Plot a smooth curve through these points.

This is the procedure used to make the curves included in this section.

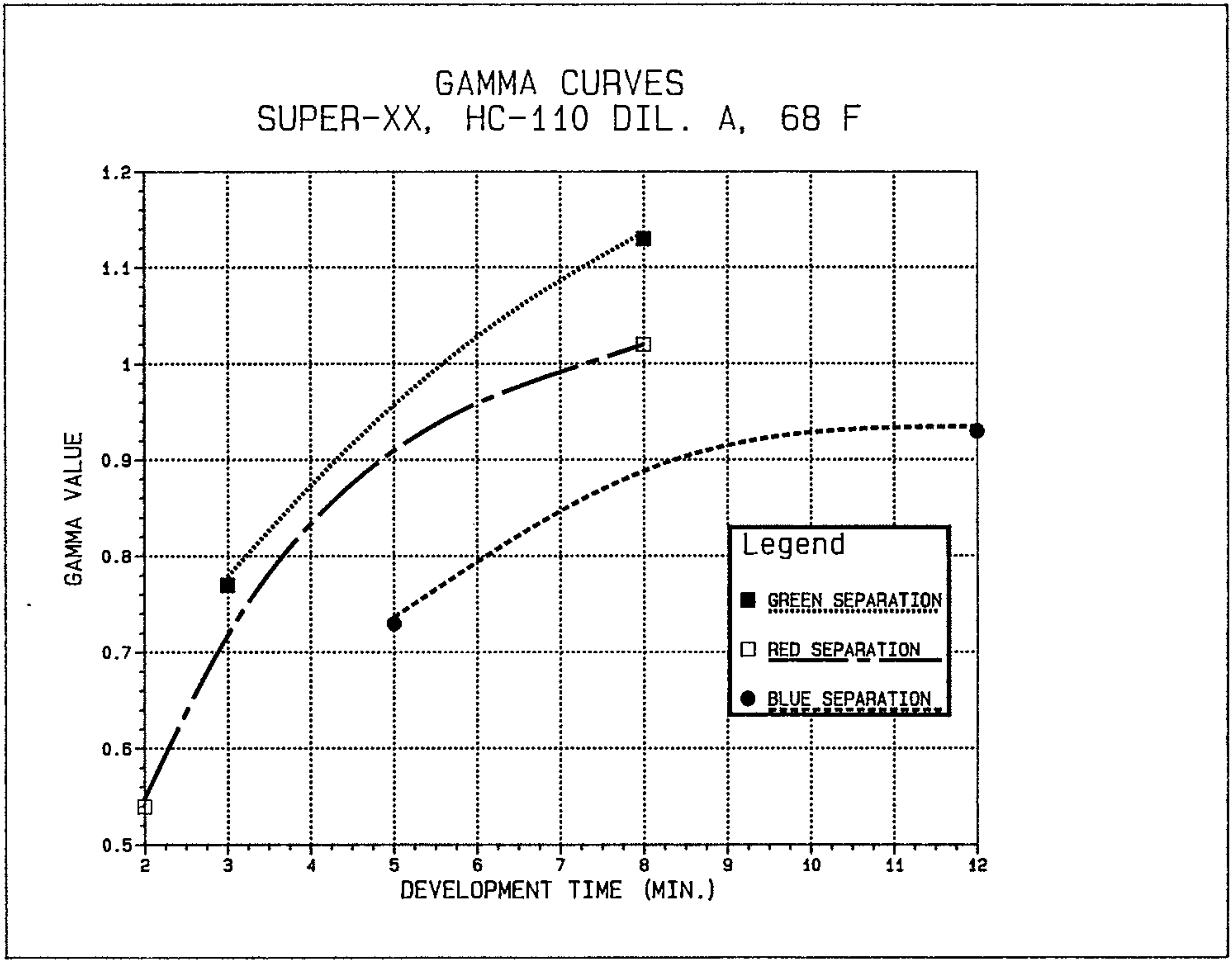
A) Six sheets of film were exposed for each separation filter. Times of 2, 3, 4, 5, 6, and 8 minutes were used for the red and green separation filters. Times of 5, 6, 7, 8, and 10 minutes were used for the blue separation.

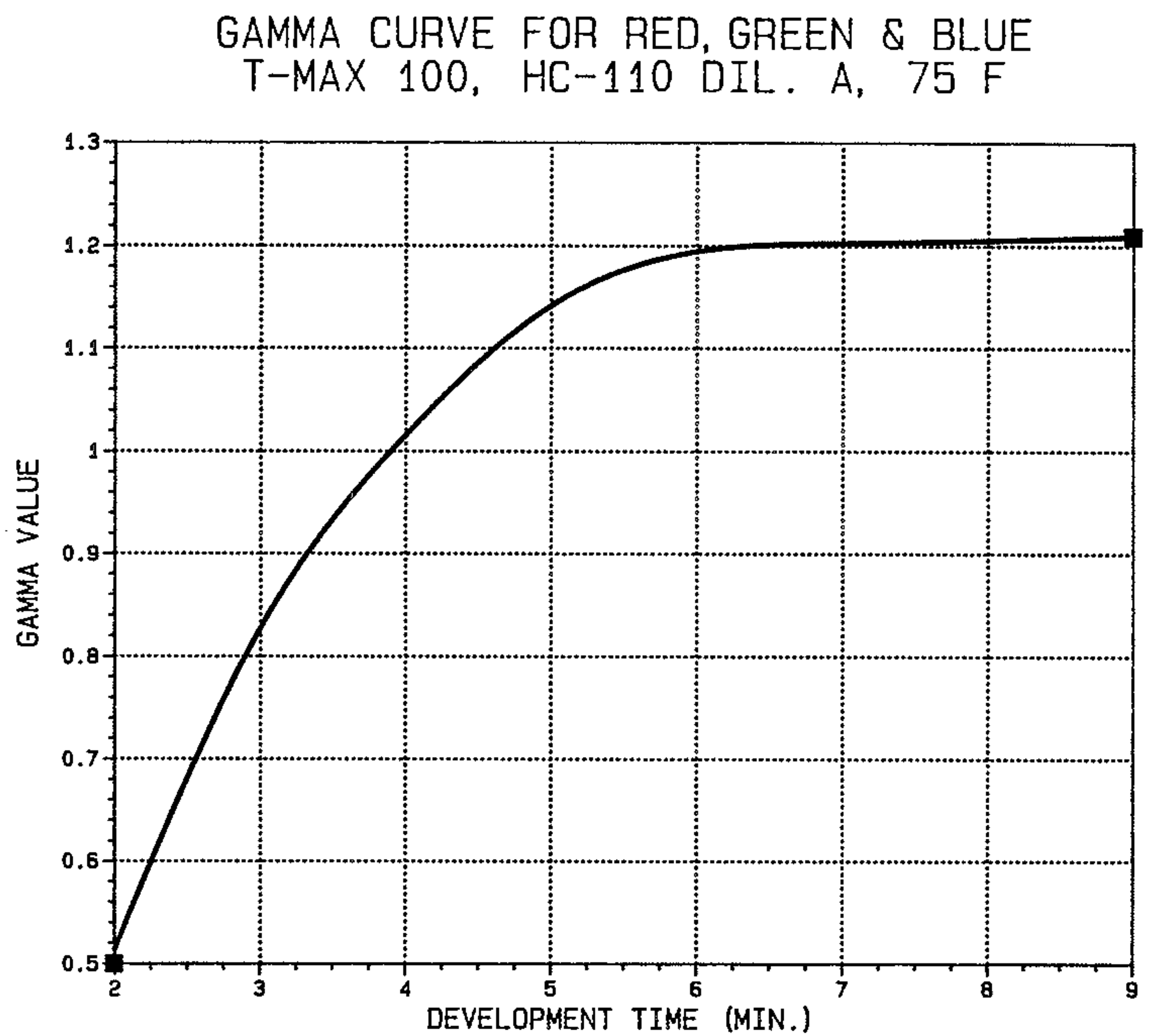
B) The timer was set for the longest time, then a sheet was inserted in the developer as each time was reached. Processing was done and completed similarly for each set.

C) The densities were plotted on a sheet of plotting paper for each sheet of film in the set and smooth curves drawn through the points. The steepest curve is the longest development time and the times decrease in accordance with the curve slope.

D) Points were marked at 0.55 and 1.75 on the vertical axis of the plotting paper (a density range of 1.2). With Super-XX film's nearly straight curve shape almost any reasonable density range will yield the same answers, so use your target negative density range instead of 1.2. A horizontal line was drawn from these points intersecting each curve. A set of vertical lines were projected vertically from the points of intersection for each curve to the horizontal axis.

E) The density difference between the points on the horizontal axis gave the exposure range necessary to produce a target range of 1.2. It is better, however, to consider the slope of the curve (gamma). The exposure range was divided into 1.2 to determine the gamma. Gamma could have been determined by simply measuring the height and width of the triangle, then dividing the height by the width. See the section on plotting for examples.


GAMMA CURVES
SUPER-XX, HC-110 DIL. A, 68 F
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
GAMMA VALUE
2
3
4
5
6
7
8
9
10
11
12
DEVELOPMENT TIME (MIN.)
Legend
GREEN SEPARATION
RED SEPARATION
BLUE SEPARATION


GAMMA CURVE FOR RED, GREEN & BLUE
T-MAX 100, HC-110 DIL. A, 75 F
GAMMA VALUE
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
2
3
4
5
6
7
8
9
DEVELOPMENT TIME (MIN.)

F) Plot the associated development time versus gammas and draw a smooth curve through points. Put the times on the x-axis and the gammas on the y-axis.

The curves for the green separation are included in this section as an example to illustrate what is to be done.

4.7.3a Evaluating the Gamma Curves. Once you have made a gamma versus development curve, you should make an evaluation of it. If you look at the curves included in this section you will see a number of things.

a) Each filter produces a different contrast in the Super-XX. Green is slightly higher than red and blue much lower than both red and green.

b) The blue curve presents a particularly disturbing problem, there seems to be little increase in contrast for large increases in development times beyond 9 minutes. Because of this, there is a limit on the achievable gamma for blue, about 0.92. Since all separations must have the same contrast, red and green contrast is limited to 0.92 also. By using the transparency density range versus gamma chart, we can see that a gamma of 0.92 limits this method to transparencies with a density range of 1.98 or more for a target negative density range of 1.2, with this film-developer combination. This can be rectified by changing the developer to one that produces higher contrast, such as DK-60a. Of course, the film could also be changed to one with an inherently higher contrast, such as Kodak Separation Type 1 film. We can also vary the contrast of the matrix to compensate (see chapter 5). Still another alternative is to use a high contrast yellow dye and normal dyes for cyan and magenta.

4.7.3b Using the Gamma Curves to Determine Exposures. The gamma curves you have created can be used to determine the required exposure of future separations the development parameters remain constant. This includes consistent agitation, constant development temperatures, and no changes in the exposure apparatus. Of course when you change film batches some minor testing is required to compensate for changes in real film speed. To aid in explaining how exposures can be obtained I will use the set of green curves used in FIG 4.7.3-2.Although the steps are simple, they must be done for all three separations. The steps are:

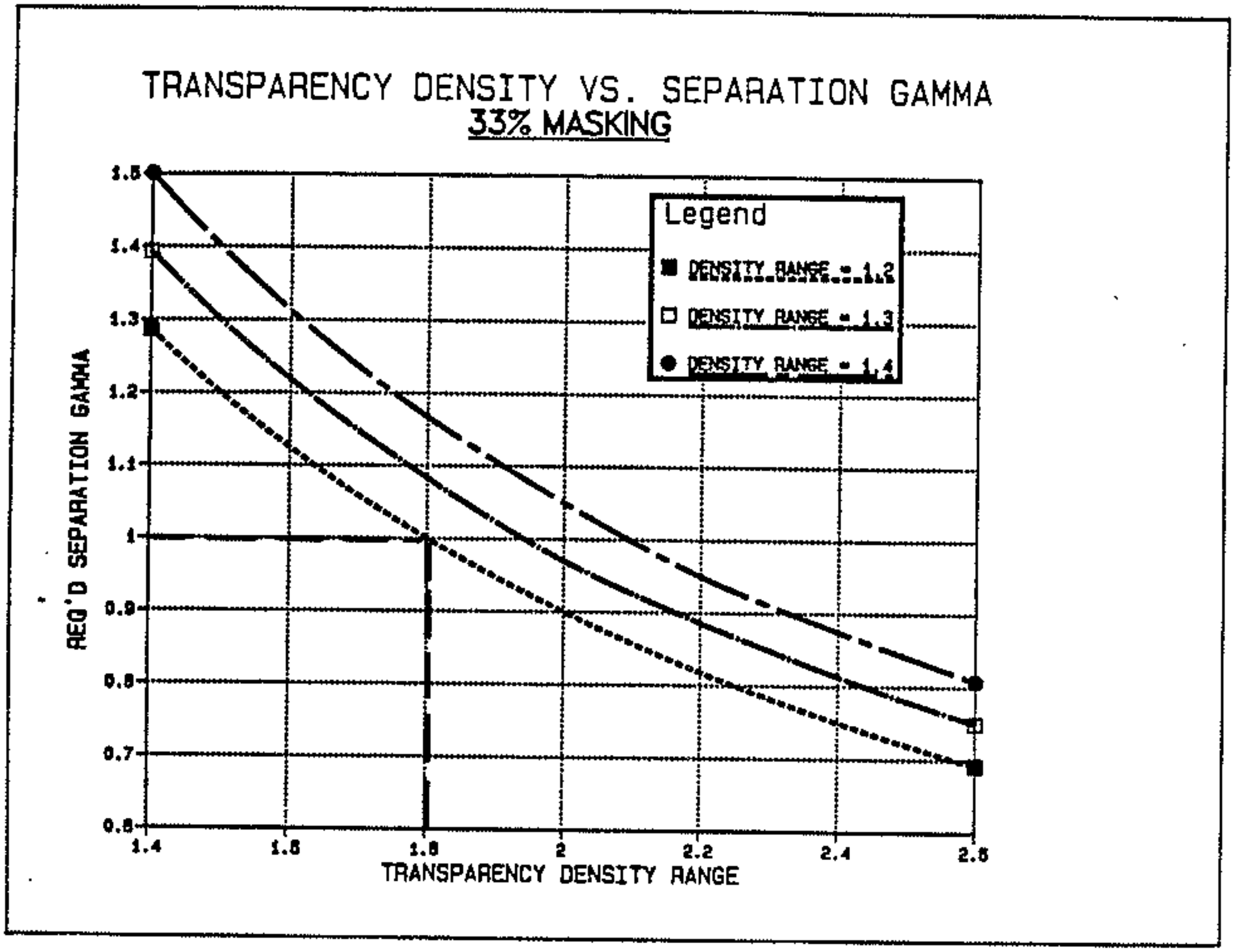
A) Determine the total transparency plus mask shadow density. Add the shadow densities of the transparency and mask.

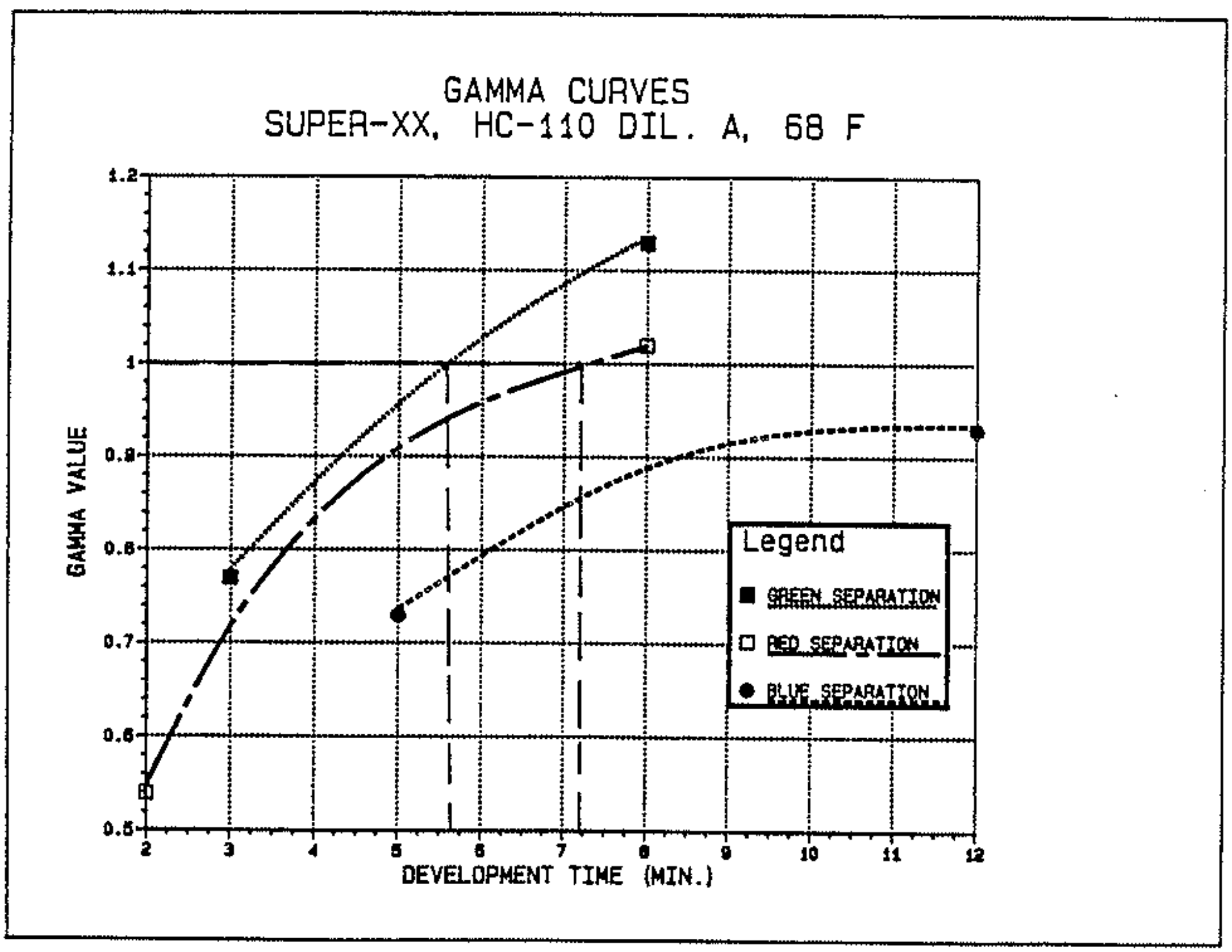
B) Determine the required separation gamma. This information is obtained from the density range versus gamma chart.

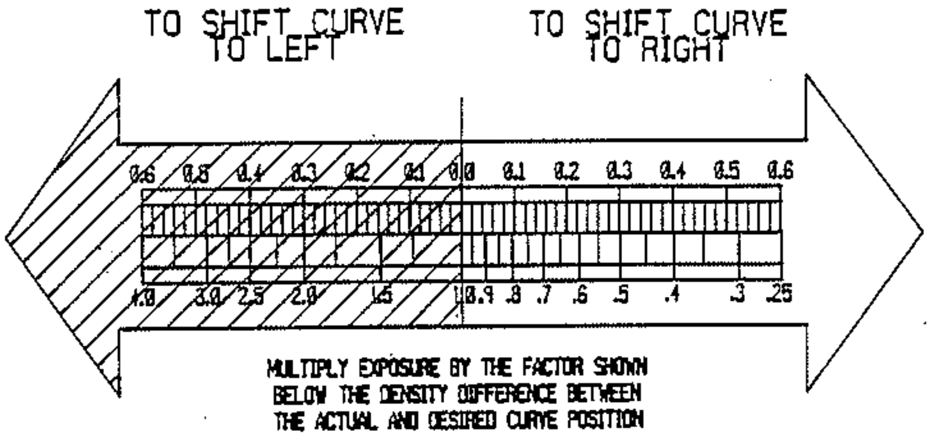
C) Determine the development time. This information is obtained from the development time versus gamma chart.

D) Use the density curves to determine the exposure adjustment required yield a correct density in the separation, i.e., 0.4.

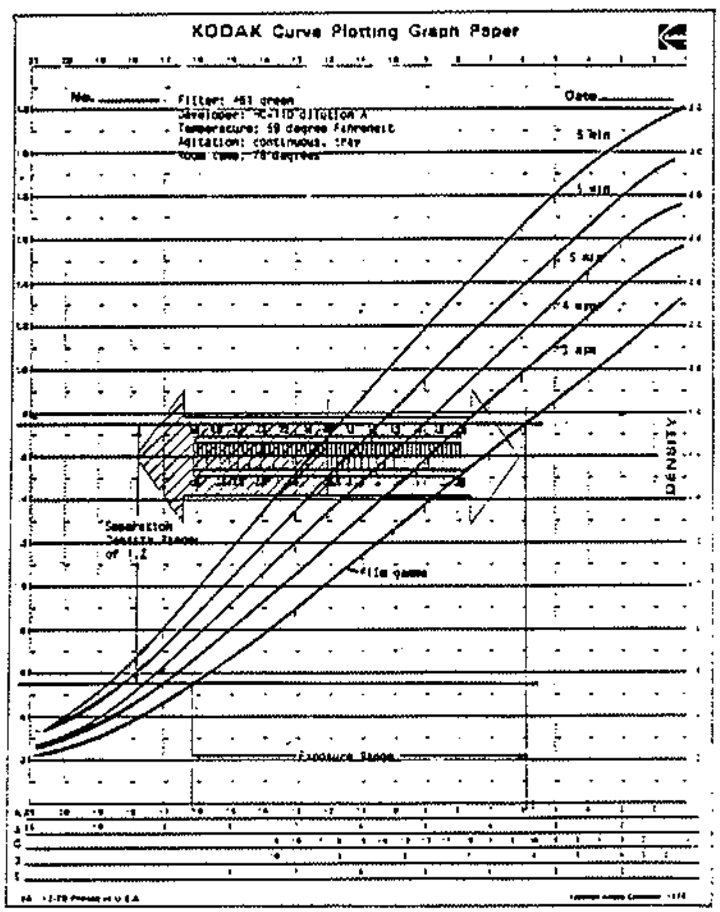
For example, let's assume that the curves were made by exposing each Super-XX negatives for 21 seconds under a point light source, set at 16 volts, through a green filter. In this example:


TRANSPARENCY DENSITY VS. SEPARATION GAMMA
33% MASKING
Legend
DENSITY RANGE = 1.2
DENSITY RANGE = 1.3
DENSITY RANGE = 1.4
REQ'D SEPARATION GAMMA
TRANSPARENCY DENSITY RANGE
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
1.4
1.6
1.8
2
2.2
2.4
2.6


GAMMA CURVES
SUPER-XX, HC-110 DIL. A, 68 F
Legend
GREEN SEPARATION
RED SEPARATION
BLUE SEPARATION
GAMMA VALUE
DEVELOPMENT TIME (MIN.)
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
2
3
4
5
6
7
8
9
10
11
12



LAY THE KODAK PLOTTING PAPER ON TOP OF THIS SCALE. EXPOSURE FACTOR IS OBTAINED DIRECTLY.



SAMPLE USE OF SCALE

1) The transparency has a shadow density of 2.0 and the 33% mask has a density of 0.3 for the same area on the transparency. The total transparency-mask density will be 2.3 (2.0 + 0.3) in the shadow. This is near step 16 on the curve paper.

2) The transparency density range is 2.1

3) The desired separation density range is 1.2.

Using the "Density range vs Separation gamma" chart and "Gamma vs Development" chart the following things are known:

1) The desired separation gamma is 0.86

2) The necessary development time for a green separation is 3.75 minutes.

Carefully examine the set of green density curves. Draw a parallel curve between the 3 and 4 minute curves where a 3.75 minute curve might fall (shown dotted in the example). Next, draw a horizontal line from the 0.4 point on the vertical curve axis. This line should intersect the 3.75 minute curve and extend beyond that point. Draw two vertical lines, the first from the intersection of horizontal line and curve, and the second from a point on the graph's horizontal axis which is the total transparency-mask shadow density. The second vertical line should intersect the 0.4 horizontal line .

From the example we see that the first vertical line intersects the graph axis at 2.68 (near step 19). This indicates that the test step scale produced a 0.4 separation density for a density of 2.68. Since our combined shadow density is 2.3, the curve must be shifted to the right by a density difference of 0.38 (2.68-2.3). **Shifting the curve to the right means the exposure must be reduced; to the left means increased exposure is needed.** The correct exposure is found by dividing the test time by the exposure factor. The TABLE 4.4.3-1 (in section 4.4.3) indicates an EXPOSURE FACTOR of approximately 2.4. The proper exposure for the green separation will be 8.8 seconds (21/2.4).

By constructing and using a scale the density difference can be measure directly on the graph. This approach will save a great deal of calculation. This exposure method can also be used with the masking film.

4.7.4 Sample Problem: Using Charts. This example will show how easy it is to use the charts are.

EXAMPLE 4.7.4-1. A transparency's shadow and highlight density were measured with a densitometer. The shadow density is 2.2 and the highlight density is 0.4. The enlarger system was tested and the target negative density range needed to make a normal contrast dye print was determined to be 1.2. What is the development time required for the red separation?

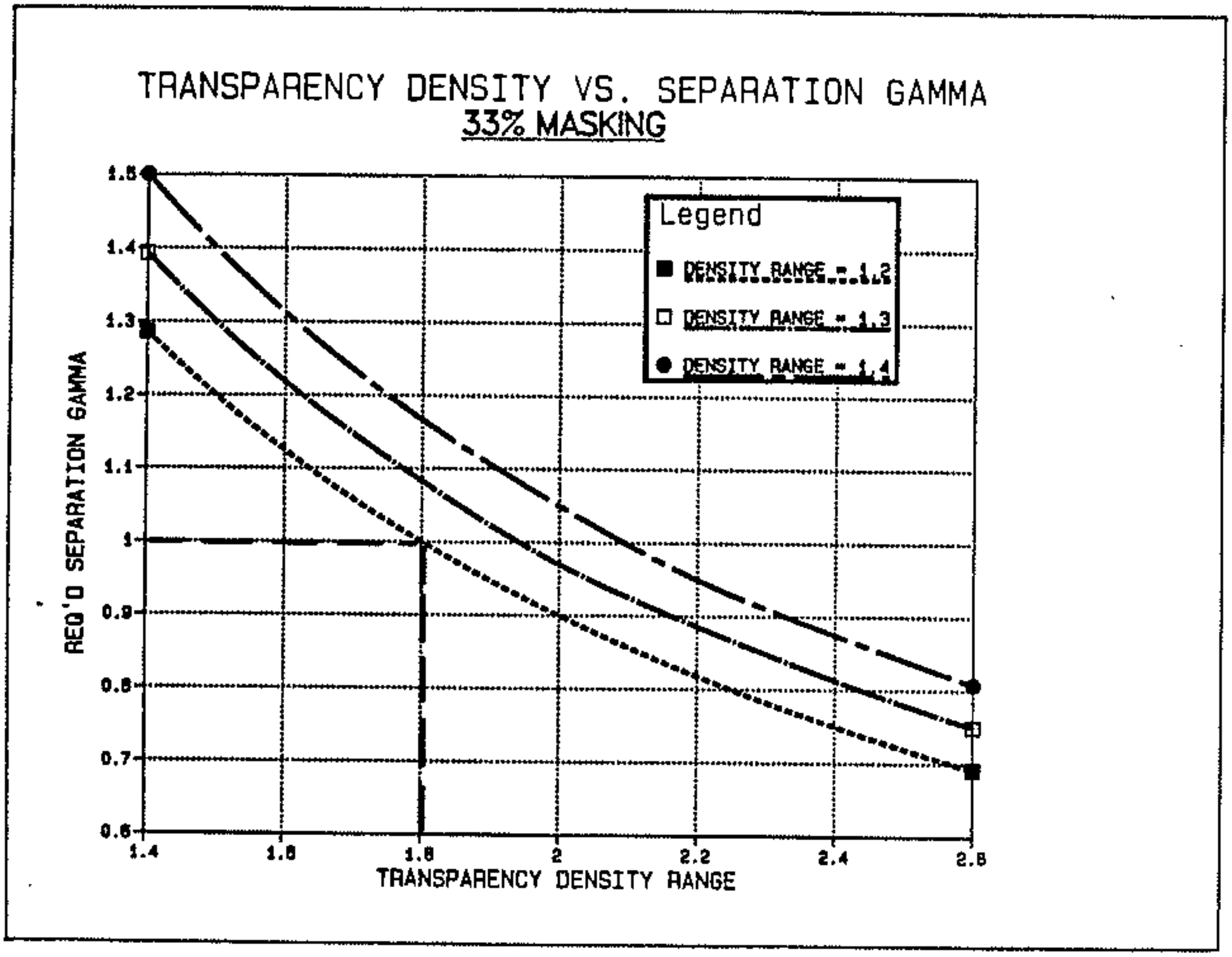
Assume:

a) 33% masking
b) Super-XX film
c) Developer is HC-110 dilution A

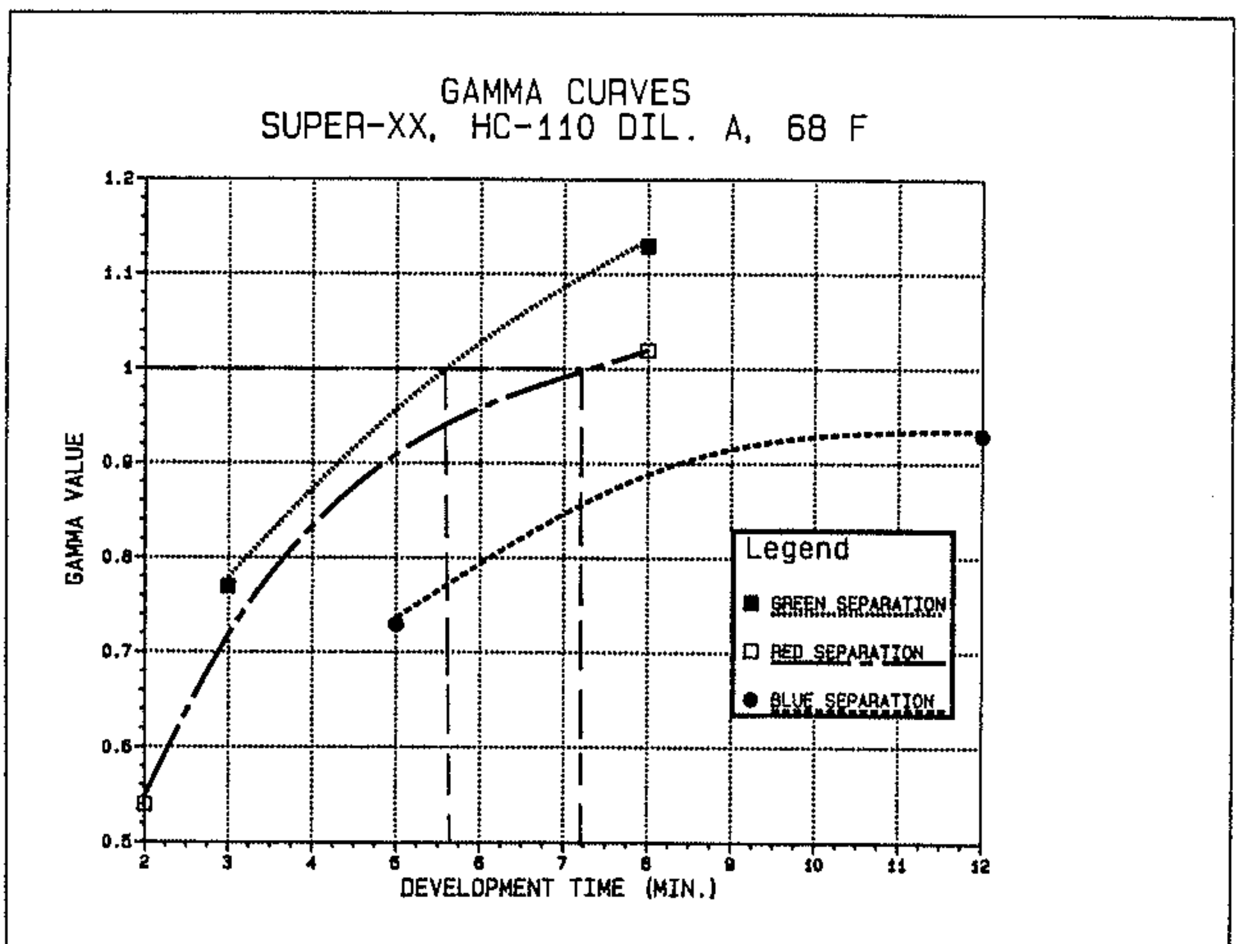
Solution:

I) Find the transparency density range (D.R.).

D.R. = shadow density - highlight density



TRANSPARENCY DENSITY VS. SEPARATION GAMMA
33% MASKING
Legend
DENSITY RANGE = 1.2
DENSITY RANGE = 1.3
DENSITY RANGE = 1.4
REQ'D SEPARATION GAMMA
TRANSPARENCY DENSITY RANGE



GAMMA CURVES
SUPER-XX, HC-110 DIL. A, 68 F
Legend
GREEN SEPARATION
RED SEPARATION
BLUE SEPARATION
GAMMA VALUE
DEVELOPMENT TIME (MIN.)

$= 2.2 - 0.4 = 1.8$

II) Use transparency density range vs separation gamma chart to find gamma.

req'd separation gamma = 1.0

III) Use development vs separation gamma chart to find development time.

Development time = 7.25 minutes

0.25 minutes = 60sec/min X 0.25 min = 15 sec

Answer:

7 minutes and 15 seconds

4.8 SHEET FILM PROCESSING METHODS.

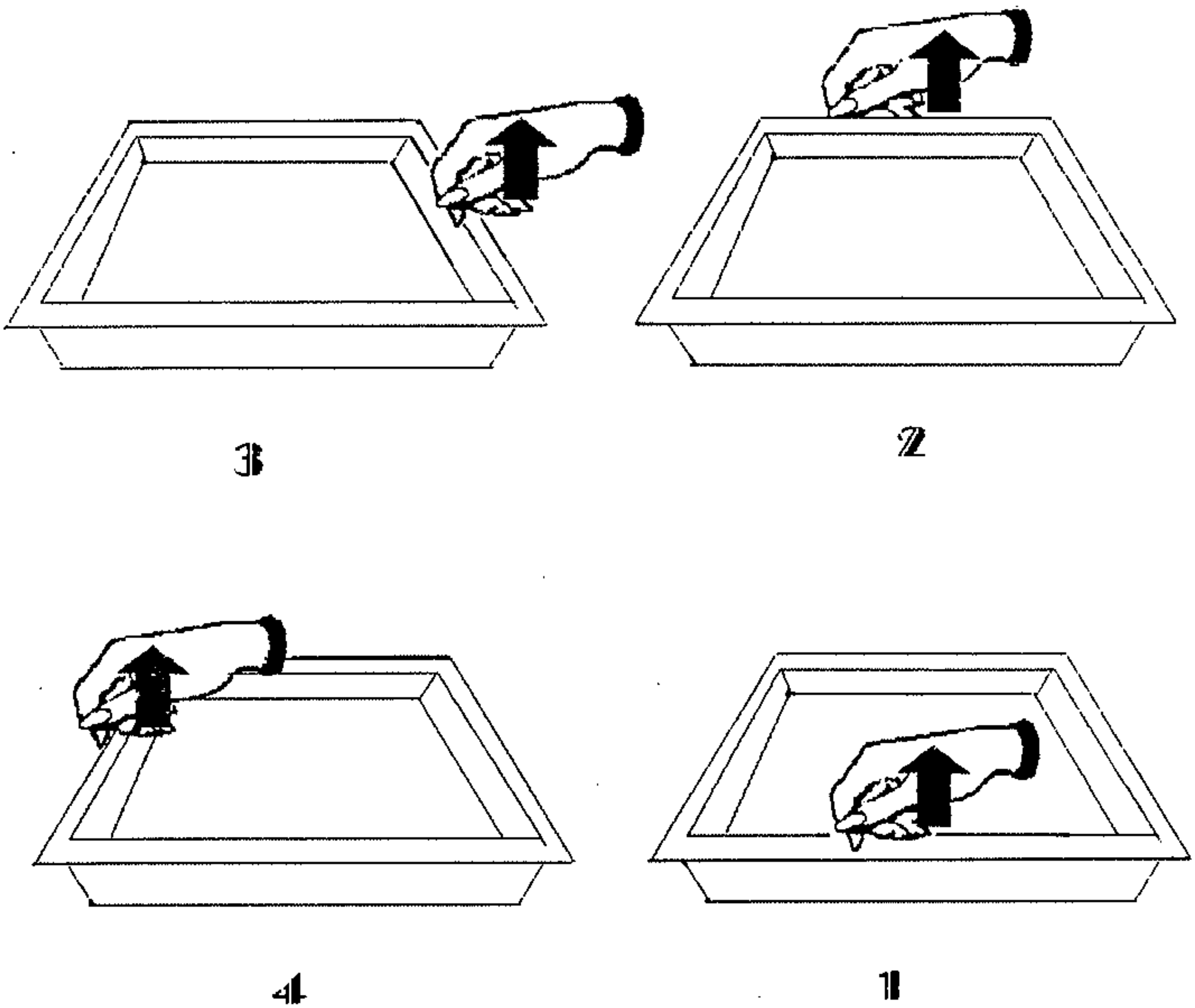
This section will discuss three possible ways of developing sheet film. These methods are tray processing, drum processing, and tank processing. Obviously, there are other ways to process sheet film, like nitrogen burst processing, but such exotic techniques are outside the scope of this text. Each method has advantages and disadvantages. The merits and liabilities of each technique will be discussed.

4.8.1 Important Things to Know. Before you begin to process your film you should be aware of several things. To begin with it is very important to do everything consistently. The development of your film must be repeatable so that you can correct mistakes and fine tune your development skills.

Your chemistry should be clean and fresh. I highly recommend that you use fresh chemistry in your development. The cost of chemistry is relatively minor with respect to everything else. A penny saved on chemistry can cause a dollar's worth of anguish. Make sure your water is fresh and clean; filter it. If you live in areas where the water is highly alkaline, then use distilled water.

Don't skimp on the amount of chemistry. Use at least 120 ml (4 oz.) of chemistry per 4x5 sheet of film. It is possible to exhaust the chemistry if you use too little. Using more than needed will insure that chemical exhaustion is not a factor in the development process.

Make sure the temperatures are kept constant. Usually this is done by using water baths to maintain the temperature. Keep the chemistry in a water bath prior to use. I recommend keeping the temperatures as close as possible to 68^0 F. If the water temperature is warmer than 68^0 F, then use ice. Float a sealed plastic sandwich bag filled with ice in the water. Another approach is to use the time vs temperature chart in the Kodak Black and White Dataguide to determine the equivalent development time at the new temperature.



1. TO INSURE CONSISTENT PROCESSING OF MATRIXES, MASKS, AND SEPARATIONS, USE THE 4 CYCLE AGIITATION TECHNIQUE.

2. PLACE SINGLE A SINGLE SHEET OF FILM IN DEVELOPER . EMULSION SIDE UP.

3. LIFT THE TRAY IN THE AGITATION CYCLE SHOWN ABOVE. A COMPLETE CYCLE SHOULD TAKE ABOUT 5 SECONDS FOR AN 8X10 TRAY AND ABOUT 10 SECONDS FOR A 16X20 TRAY.

F I G 4 . 8 . 1

The agitation rate is of greatest importance. For separation work use only constant agitation techniques because it insures even development. The agitation must be consistent and repeatable. With the relatively short development times used to make separations, bad agitation techniques can adversely affect the negative contrast and produce mottling on the film. Agitation will be discussed for each development technique. One way to help minimize some agitation and agitation problems is to presoak the film before beginning development.

Do not leave the film in the fixer for an extended amount of time. Use a good hypo eliminator. Wash the films thoroughly afterwards. The wash water should be completely changed once per minute. A tray siphon is a good way to wash film. Treat your separations as you would any negatives you would like to keep. Separations are an excellent archival way of storing color imagery.

Dry the film in a clean, dust free environment. To minimize dry spots, rinsé the film in Photo-flo but use half the recommended concentration. Dry all of the film at the same time. Hang each sheet with the same orientation when drying them. This insures that the film drying cycle will be identical and any dimensional changes will be the same. If you use a film dryer, make sure the air filters are clean and the dryer is dust free inside.

4.8.2 Tray Processing. Tray processing is the easiest way to develop sheet film. Use a tray one size larger than the film size to develop the film in. For example, 4x5 film should be developed in a 5x7 tray. Put in enough chemistry to cover the film by at least a 1/4 inch but less than 3/4 inches. Too much developer will slosh over the sides of the tray and may lead to inconsistent development. Put the trays in a water bath to help maintain the solution temperature. Stainless steel trays are ideal for this, but not a necessity.

Don't try to process all three sheets at once unless you are skilled at this technique. This is cumbersome and likely to lead to improper development and scratching of the negatives. Process the sheets one at a time with the EMULSION UP. After you've gained some proficiency, try developing the red and green negatives together by inserting them into the chemistry back to back. Flip them every complete agitation cycle as discussed later.

Insert the film into the tray by lifting the tray so the chemistry is at the bottom end of the tray. Next remove the film from the water presoak, insert the bottom edge of the film into the chemistry and smoothly lower the tray so chemistry flows evenly over the entire film. Practice this first with a scrap sheet of film and a tray full of water.

Consistent agitation is an absolute must with this type of film processing. Agitate the tray by lifting each corner of the tray in a cyclical way. Start at one corner, lift it, lower it, then lift the adjacent corner likewise. Do this in a clockwise or counterclockwise direction in a 8 to 15 second cycle.

4.8.3 Drum Processing. Drum processing film with a motorized base is a very consistent way to agitate film. Use an 8x10 color processing drum which has inserts for processing 4x5 film.

Use at least six ounces of chemistry in an 8x10 drum. Presoak the film by pouring 68^0 F water into the drum and agitating for at least one minute. Keep the chemistry in a 68^0 F water bath.

After the film is processed, remove the film and wash it in a tray with a tray siphon.

4.8.4 Tank Processing. Tank processing allows you to process three film sheets at the same time. Each sheet is mounted in an individual film holder so each sheet can be removed individually at the proper time.

Usually, the tanks are stainless steel which means that it is advisable to keep them in a water bath. The large amount of chemistry required maintains its temperature better than tray processing. The biggest drawback is the large quantity of chemistry required.

Normally, tank agitation is intermittent rather than continuous as with tray processing. As a result, it is possible to get inconsistent development if care is not used. The agitation technique, used with tanks, is called the tilt and dunk method. The film racks are removed every thirty seconds, tilted one way, immediately re-inserted into the tank, removed again, tilted the opposite way, and re-immersed in the tank. Try continuous agitation using the tilt and dunk technique. You will find that the recommended development times will have to be altered a bit to accommodate tank processing.

4.9 PLOTTING DENSITY CURVES.

When you are attempting to do separations for the first time, it is a good idea to plot the density curves of each separation negative to aid in testing. The curves are plotted by putting the density of each step on the step guide on an appropriate graph. Use colored pencils to identify each curve on the graph.

Ideally, the curves are plotted on Kodak Curve-Plotting Graph Paper. The horizontal axis is numbered from 1 to 21 (or 1 to 11) which corresponds to the numbered steps of the step guide. The vertical axis is graduated in density units of 0.2 from 0 to 3.8.

If you can't get Kodak plotting paper then use any commercially available graph paper with 8 or 10 lines per inch. For the horizontal axis let each unit represent .05 density. Make a mark every three units. Number those marks from right to left, 1 to 21. If you are using an 11 step guide, make a mark every six units and number them 1 to 11, right to left. On the vertical axis make a mark every four units and number each unit by 0.2 up to 3.0.

Included in this section is a plotting data tabulation sheet. Make copies of this and use it to keep records of your densitometer readings. A sample data tabulation is included in this section.

4.9.1 Curve Plotting With a Reflection Gray Scale. If you include the Kodak Gray Scale (included in Kodak Color Separation Guide) with the image in your transparency, then density curves of the separation negatives can be plotted without the necessity of a step guide. The density values are read directly off of the negative. Obviously, this technique is only good for large transparencies or enlarged separation negatives.

The steps in the new 19 step gray scale are marked on row C of Kodak's curve plotting paper. The steps represent reflection densities from 0 to 1.90 in .10 increments. If you are using the old gray scale, having ten steps, then use row D of the scale. Step 1 corresponds to a reflection density of 0.0 and the other steps are number consecutively up to 10.

If you are using the old Kodak plotting paper which has only markings for a 21 step scale and the old 10 gray step reflection densities, you will have to mark the gray steps yourself. You may notice that the reflection densities on this paper are located 0.5 density higher than they should be. This will not affect the curve shape at all, and will not hinder your evaluation. For the new 19 step gray scale, mark the densities from 0 to 1.90 in 0.1 increments along the horizontal axis. Step number 1 is 0 and the other steps are in consecutive order up to 19. The horizontal axis is graduated in 0.02 density units with major markings every 0.15 density.

SET NR. ______ ________________ TABULATION

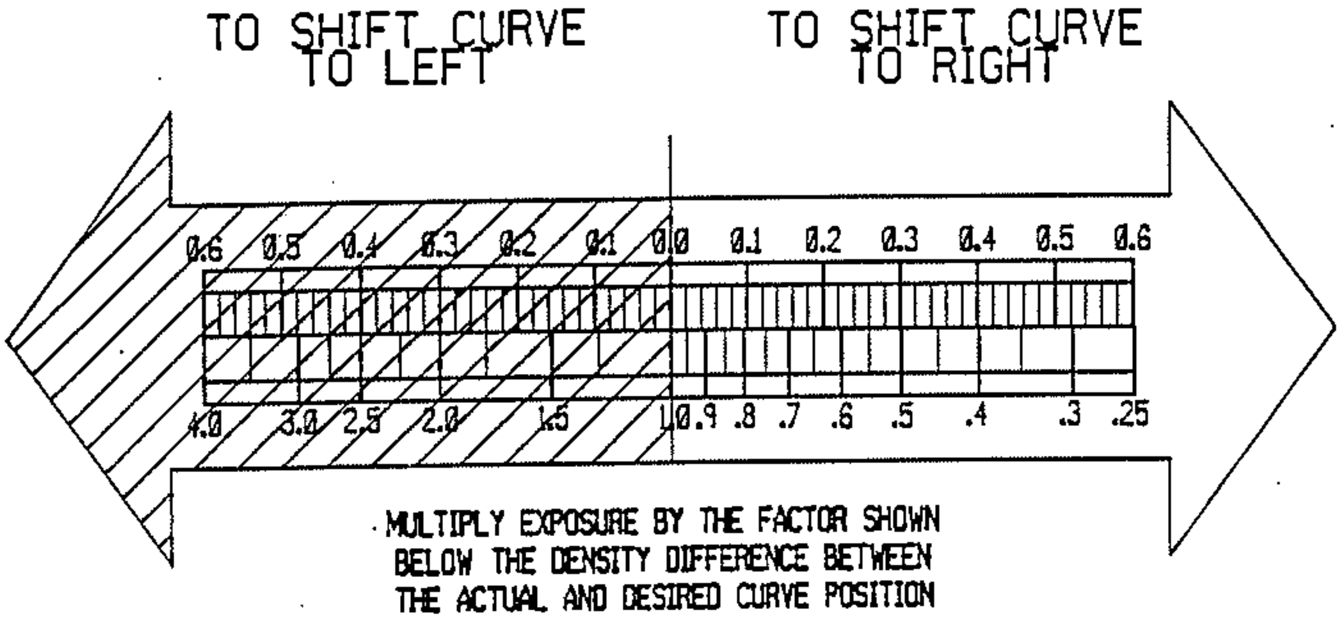
FILM __________ EMULSION NR. _______ DATE _______

FILTER ______ ILLUMINATION (FT-C) ______________

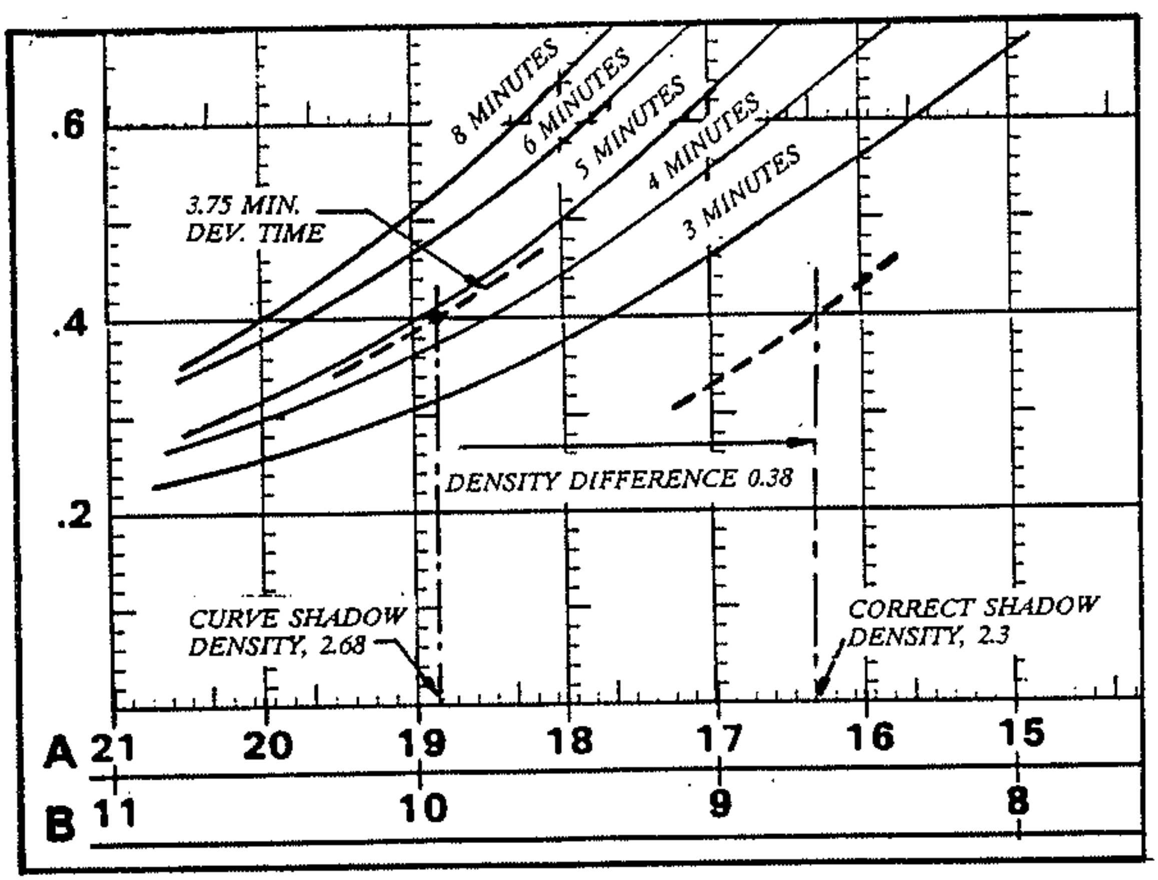
F-STOP _____ EXPOSURE TIME ________________

DEVELOPER ______ DILUTION ______ TEMPERATURE ____

ORIGINAL STEP GUIDE DENSITIES	DEV. TIME	_____	_____	_____	_____	_____	_____
	STEP *						
	1						
	2						
	3						
	4						
	5						
	6						
	7						
	8						
	9						
	10						
	11						
	12						
	13						
	14						
	15						
	16						
	17						
	18						
	19						
	20						
	21						



TO SHIFT CURVE TO LEFT
TO SHIFT CURVE TO RIGHT
0.6 0.5 0.4 0.3 0.2 0.1 0.0 0.1 0.2 0.3 0.4 0.5 0.6
4.0 3.0 2.5 2.0 1.5 1.0 .9 .8 .7 .6 .5 .4 .3 .25
MULTIPLY EXPOSURE BY THE FACTOR SHOWN BELOW THE DENSITY DIFFERENCE BETWEEN THE ACTUAL AND DESIRED CURVE POSITION



8 MINUTES
6 MINUTES
5 MINUTES
4 MINUTES
3 MINUTES
3.75 MIN. DEV. TIME
DENSITY DIFFERENCE 0.38
CURVE SHADOW DENSITY, 2.68
CORRECT SHADOW DENSITY, 2.3
.6
.4
.2
A 21 20 19 18 17 16 15
B 11 10 9 8

Read the density of each step in the separation negative with a densitometer. Locate the step number on the horizontal axis and its density value on the vertical axis and mark the intersection of these lines on the plotting paper.

4.9.2 Evaluating Density Curves. Plot the curves for each separation and mask throughout the testing procedures. Ideally, if a set of curves having the same exposure and contrast are plotted they would just about line up on the plotting paper. If the curves are not parallel and concurrent, then there is either contrast or exposure differences. The relative position of the curves on the graph indicate what must be done to correct the problem. Pay special attention to the straight line portion of the curves.

If the curves are not parallel then this is an indication that the contrast, i.e., gamma, is not the same for the separations. It should be noted that density range is also a measure of contrast if the shadow density is the same. If the slope of a curve is lower than a desired slope (gamma), then that curve is lower in contrast (gamma) and vice versa. To measure the gamma of a curve, mark two points on the straight line portion of the curve, the further apart the better. Measure the horizontal separation and the vertical separation between the two points. You can use any unit of measure. I prefer to use a ruler marked in millimeters. Divide the vertical measure by the horizontal measure; this value is the gamma of the curve.

This technique of measuring contrast is rather difficult in reality. The main reason is the curve will not be exactly straight. You will notice that there is noticeable curvature on the entire curve. A better way to measure slope is to measure the contrast index of the film. Contrast index is almost like gamma but seems to take the curvature into account better. Super-XX film is one of the few films where the gamma is a pretty good bet, especially since we will operate on the straight line portion of the curve. If you are interested in a precise definition of Contrast Index, Kodak Pamphlet F-5, "Kodak Professional Black and White Films" will be useful.

Find the steps corresponding to the highlights and shadows on the step scale and draw a straight line on the graph through these points. As before, measure the horizontal and vertical distance between these two points. Divide the vertical length by the horizontal length to obtain the gamma. For a good set of separations this number will be between 0.80 and 0.90 for a normal masked transparency and masked step scale. For example, if the vertical displacement is 18mm and the horizontal displacement is 20mm, the contrast index is 18/20= 0.90.

If the curves are parallel but are laterally separated then this is an indication that the exposure needs to be corrected. Measure the lateral (horizontal) displacement in density units between the two curves. Remember that each unit on the horizontal axis of Kodak Curve Plotting Paper is 0.02 density. Use Table 4.4.2-1 (section 4.4.2) to calculate the new exposure for the curve. If the curve is to the left of a desired location then it is overexposed. If it's to the right then it is underexposed. For example, if the green curve is 0.1 density units to the left of the red and blue curves, then it is overexposed. The table indicates an exposure factor of 1.25. Multiply the negative exposure by 1.25. If the green were to the right of the curves, the exposure time would be multiplied by 1.25. Example curves are shown at the end of this section and a sample problem is shown in section 4.9.

If you always keep the shadow density of the separation about 0.4, it is possible to get a fairly accurate gamma without plotting density curves by simply knowing the density ranges of the transparency and the density range of the separation. Just divide the separation density range by the transparency density range. For example, we have assumed that a normal transparency has a density range (D.R.) of 2.0, the mask is a 33%, and that a separation should have a density range of 1.2; therefore, the gamma is 0.9 (1.2/2.0-.67). Obviously, if the transparency was low in contrast, with a D.R. like 1.6, the mask density range would be .53, and we would have to increase the contrast of the separation to 1.1 (1.2/1.6-.53) to maintain a separation density range of 1.2. Since transparencies vary in contrast, the contrast of the separations should really change accordingly. You need higher contrast in the separation for a low contrast transparency and lower contrast for a high contrast negative. Since it's almost impossible to measure the density range of a small transparency, the compensation for too little or too much contrast in the separation is usually done when processing the matrixes. See section 5.1.4.

4.9.3 Example Curves. Two sets of density curves for Super-XX Film are shown; one for Ektachrome and one for Kodachrome. These are actual values taken from two dye transfer students. The values were taken with a Kodak Model 1 Visual Densitometer so the density values are slightly erratic, but usable. Step 4 of the step tablet represents the highlight and step 17 the shadow. When the curves are drawn, the idea is to draw a smooth curve through points. By using the curves the students determined what had to be done to correct the sep rations.

Kodachrome,

SUPER-XX FILM			
STEP	Red	Grn	Blu
1	2.3	2.2	2.1
2	2.15	2.04	1.99
3	2.0	1.92	1.86
4	1.87	1.75	1.75
5	1.76	1.62	1.65
6	1.68	1.53	1.57
7	1.57	1.42	1.48
8	1.45	1.33	1.38
9	1.34	1.23	1.28
10	1.26	1.14	1.22
11	1.15	1.06	1.13
12	1.06	0.96	1.05
13	1.0	0.90	1.05
14	0.92	0.80	0.88
15	0.83	0.72	0.80
16	0.74	0.63	0.70
17	0.63	0.56	0.62
18	0.56	0.50	0.54
19	0.45	0.41	0.44
20	0.38	0.37	0.38
21	0.3	0.33	0.31

Ektachrome,

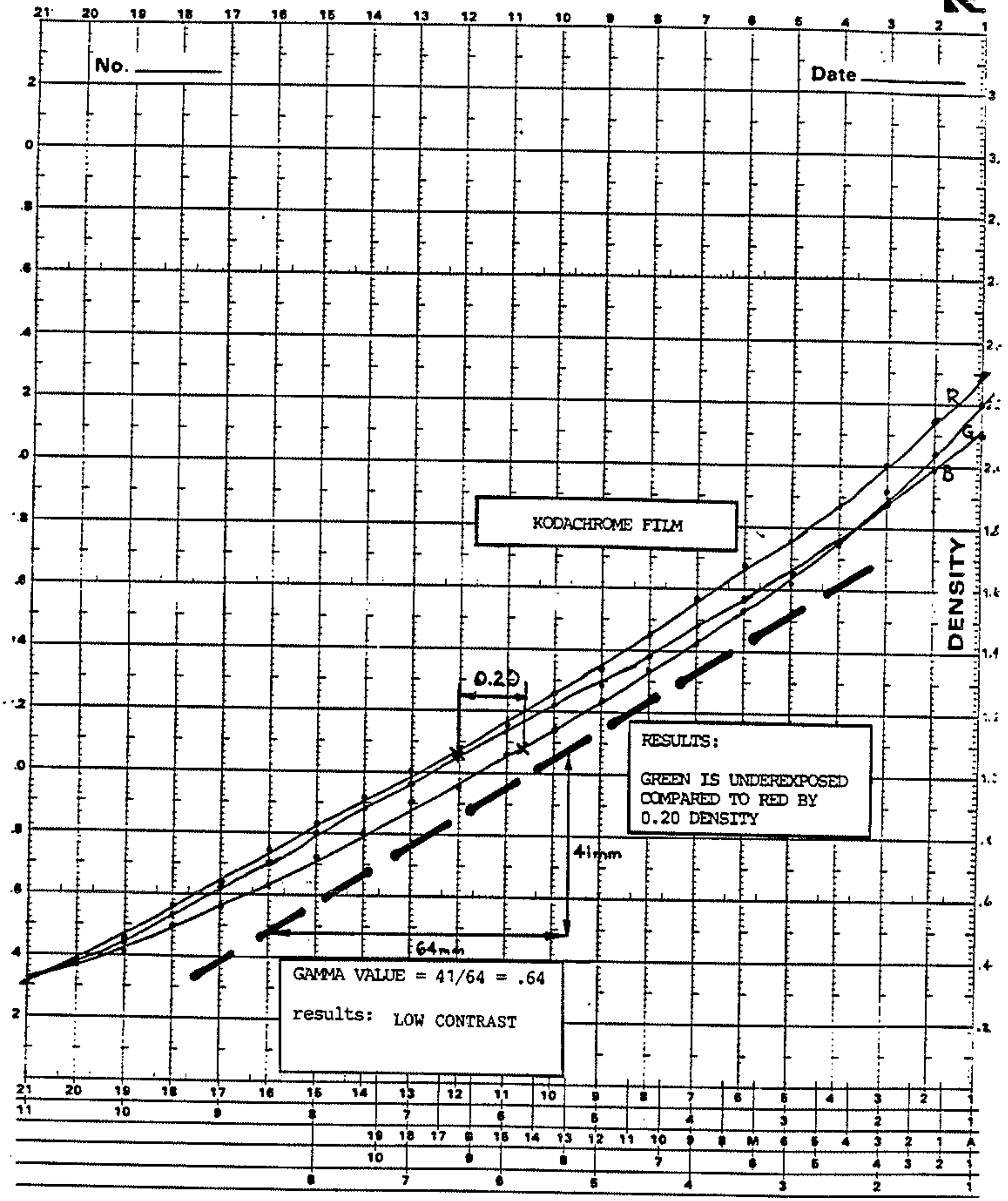
SUPER-XX FILM			
STEP	Red	Grn	Blu
1	---	---	---
2	---	---	---
3	---	---	---
4	1.65	1.64	1.73
5	1.55	1.58	1.65
6	1.44	1.45	1.51
7	1.36	1.39	1.44
8	1.26	1.35	1.34
9	1.18	1.26	1.26
10	1.09	1.18	1.17
11	1.00	1.10	1.10
12	0.91	1.00	1.00
13	0.84	0.94	0.91
14	0.75	0.86	0.85
15	0.65	0.80	0.79
16	0.59	0.64	0.69
17	0.51	0.56	0.60
18	0.44	0.50	0.51
19	0.35	0.41	0.43
20	0.31	0.35	0.36
21	0.28	0.31	0.30

Don't be too upset about the fact that the curves have humps and bumps, this is to be expected with an inexpensive densitometer.

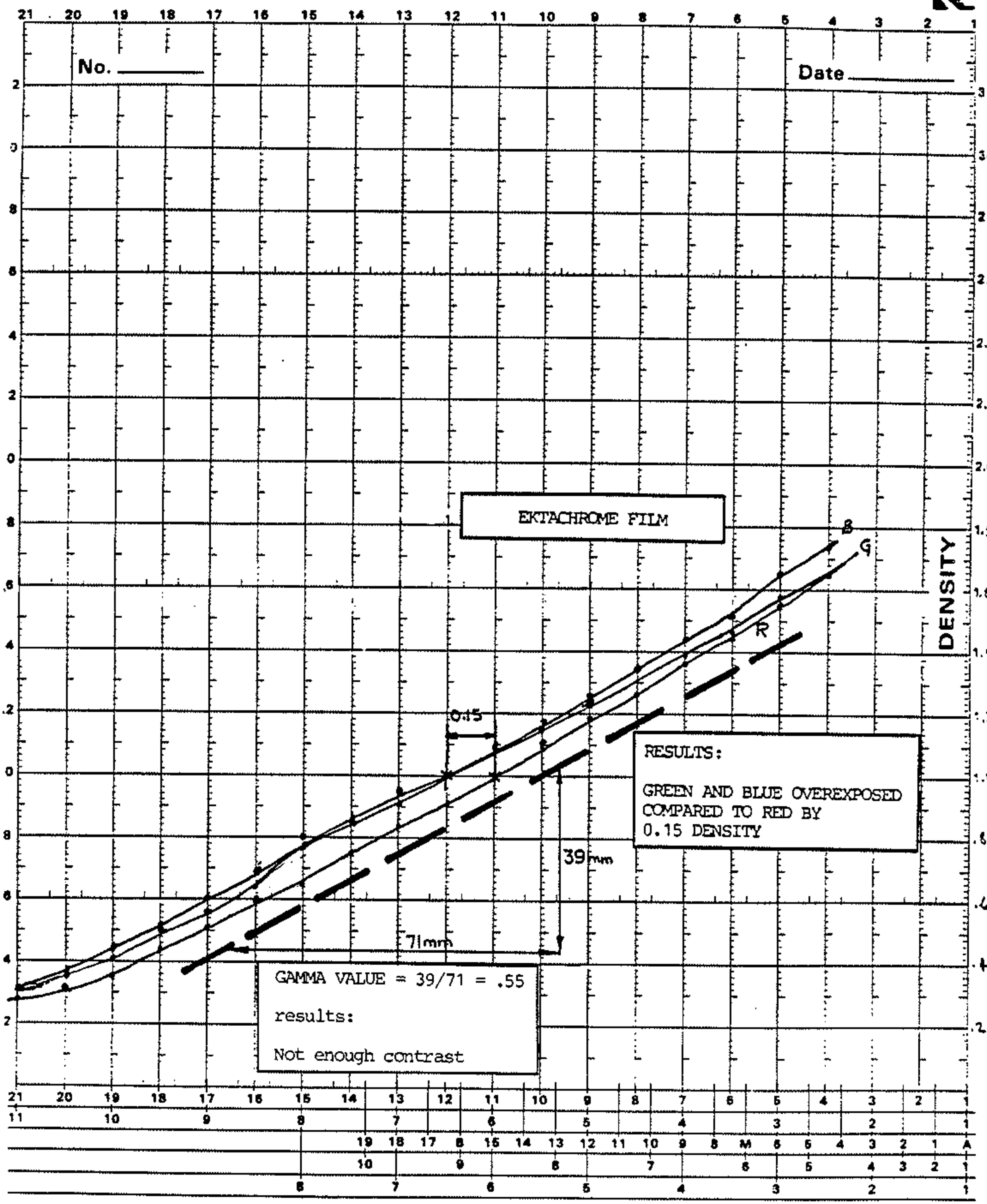
4.10 SAMPLE PROBLEM: CURVE PLOTTING.

The sample problem below is an actual testing sequence, using the "simplified approach" which yielded fairly good separations.

KODAK Curve Plotting Graph Paper



KODAK Curve Plotting Graph Paper



1. Shadow detail=2.4 .....STEP 16
   Highlight detail=0.4 ..STEP 3
   Density Range=2.0

   OBJECTIVE: a) make step 16= 1.6
   b) make step 3 = 0.4
   c) density range= 1.2

2. Trial#1. 3 footcandles, HC-110 dil D

filter	time	N.D.	Dev. Time
#29(red)	28	0.9	3' 15"
#61(grn)	21	0.9	3' 15"
#47B(blu)	30	0.6	4' 45"

(i)RESULTS:

filter	Step 16	Step 3	Den.Rang
red	.39	1.66	1.27
grn	.35	1.57	1.22
blu	.39	1.67	1.28

(ii)CONCLUSION:

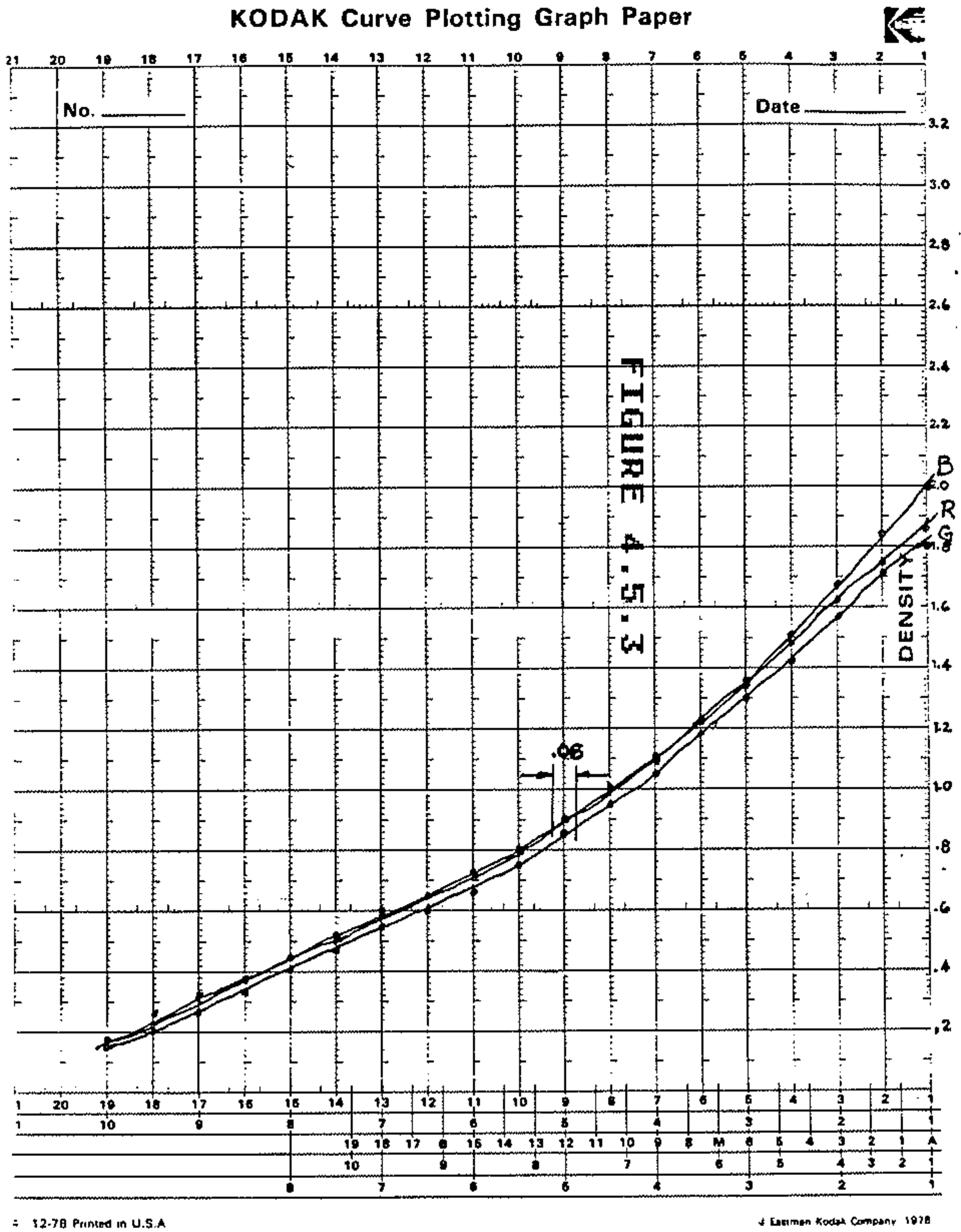
The density ranges slightly high but OK. Biggest difference only 0.6. Everything close enough!

3. Plot density curves. Density values given below.

STEP	red	green	blue
1	1.86	1.80	2.0
2	1.75	1.71	1.84
3	1.62	1.57	1.67
4	1.48	1.42	1.50
5	1.36	1.30	1.36
6	1.23	1.18	1.23
7	1.11	1.05	1.11
8	1.00	0.95	1.01
9	0.90	0.85	0.90
10	0.81	0.75	0.80
11	0.73	0.66	0.72
12	0.65	0.60	0.65
13	0.60	0.55	0.59
14	0.52	0.47	0.51
15	0.45	0.41	0.45
16	0.38	0.34	0.38
17	0.31	0.27	0.32
18	0.23	0.21	0.25
19	0.18	0.17	0.19
20	--	--	--

CONCLUSION:

These points are shown in graph Figure 4.5.3. Examine the density curves. Note that the green curve is about .06 density to the right of the other curves. This means that the green curve is slightly, underexposed compared to the red and blue. Using Table I, its obvious that the red and blue separations are 1.15 times the green separation exposure time.



KODAK Curve Plotting Graph Paper
No. ______
Date ______
FIGURE 4.5.3
.06
B
R
G
DENSITY
12-78 Printed in U.S.A.
© Eastman Kodak Company 1978

FIGURE 4.5.3

4.11 SEPARATIONS FROM COLOR NEGATIVES.

MATERIALS:	
4X5 Technical Pan Film 4415	<3.16.3>
Separation Film 4131, Type 1	<3.16.3>
4x5 Kodak T-Max 100 Film	<3.16.3>
4x5 Kodak Super-XX Film 4142	<3.16.3>
4x5 Kodalith Ortho Film 2556	<3.16.1>
CHEMICALS:	
HC-110, DK-60a, or DK-50 Developer	<3.17.6>
D-11 Developer	<3.17.6>
Acetic acid	
Fixer	
Hypo Clear	
Photo-Flo	
EQUIPMENT:	
#29,99,98 Filters	<3.8.2>
Neutral Density Filters	
Registration Print Frame	<3.10>
Densitometer	<3.19>
5x7 trays or drum	
Motorized base for drum	
Curve Plotting Paper	<3.22.8>

Although seldom done, separations can also be made from color negatives. The major reason for doing separations from color negatives is cost savings. The cost of Pan Matrix Film 4149 is 30% to 40% higher than that for regular Matrix Film 4150.

The process is fairly easy. First, black and white positives are made from a color negative using red, green and blue filters, then separations are made from the positives. Unlike the case for transparencies, however, no color masking is required because the color negative is already masked. The normal procedure is to make a contact positives and then to make contact or enlarged separations.

4.11.1 Making the Positives. Because the color balance of color negatives vary widely, making good positives be difficult. Make a standard negative by photographing a Kodak separation guide, and include a gray card, colors, and skin tones. Once a good set of positives is made, this standard can be used to determine the proper exposures for other negatives.

The density range of a color negative is quite low in comparison to transparencies. A typical color negative might have a density range around 1.6 as compared to a transparency's 2.0. As a result the positive from has to be reproduced at a rather high gamma. An excellent film for positives is Technical Pan 4415 film because it has high contrast and extremely fine grain. Separation Type 1 film is also suitable for positives although its grain is not a fine as that of Technical Pan film.

4.11.1a Method of Approach. Assume that the density range of the color negative is 1.6. This corresponds to the difference between the A (0.0) and B (1.60) steps of the reflection step scale. The density ranges between steps A and B of the reflection scale in the three black and white positives should be near 1.7. In other words, the gamma of the positives should be approximately 1.1 (1.7/1.6). Use the #29 red, #99 green, and #98 filters when making the positives. The #99 and #98 filters should be used instead of the #61 and #47B filters because they are designed for color negatives. If for some reason you can't get a #99 green then substitute a #61 green filter plus a 85B filter. The substitute for a #98 blue is a #47B plus a 2B UV filter.

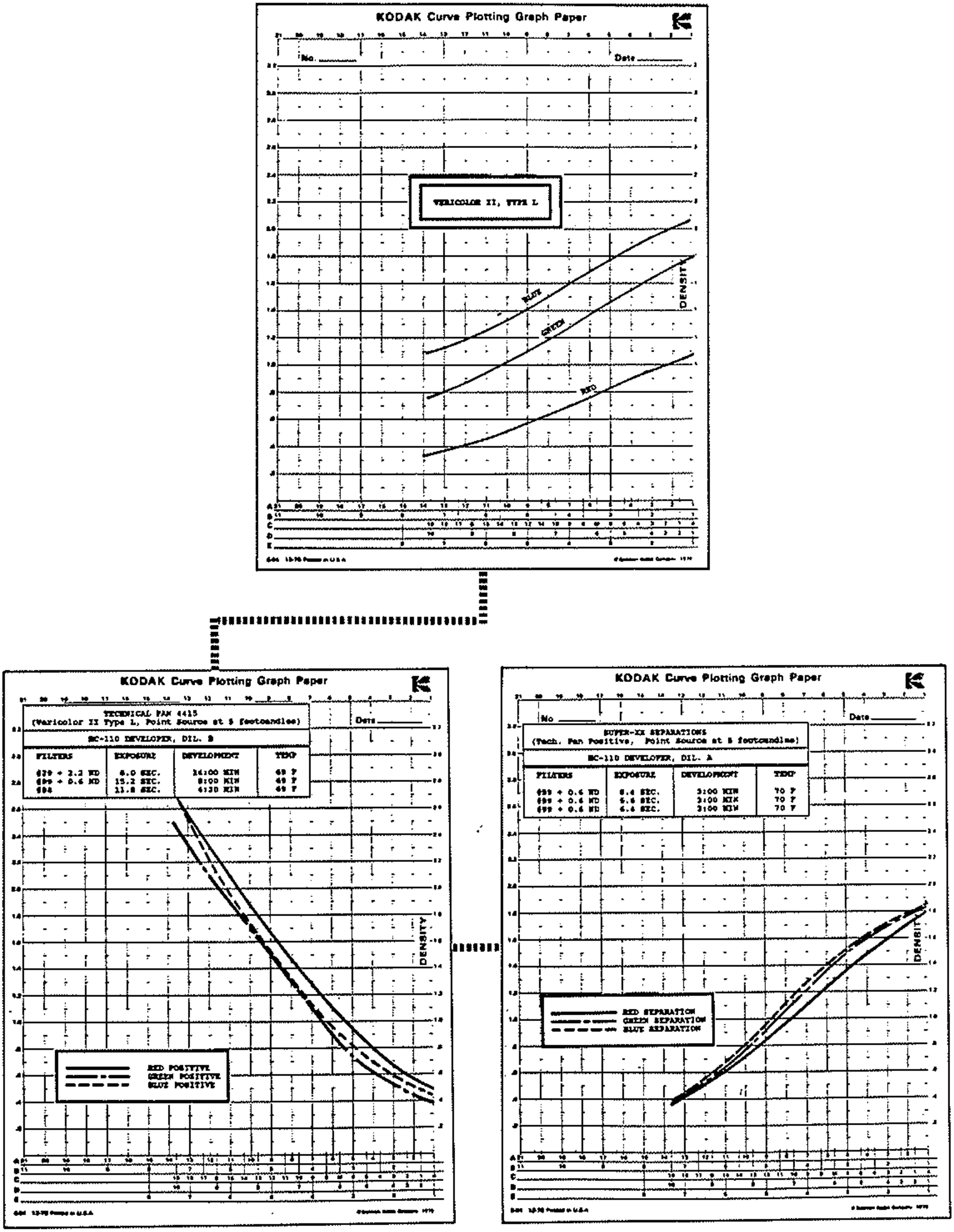
Try to obtain a density of 0.4 or .5 in Step A of the reflection scale. This means that step B of the reflection scale will have a density of 2.1 or 2.2. The positives will be a little denser than expected to insure that all of the negative's density is recorded. It is a good idea to plot curves during testing so refer to section 4.9.1 in this chapter. To aid in determining the proper exposures for other color negatives, make a good color print and record the filter pack and exposure time. If you have a color densitometer then record the density values of a neutral gray or flesh tone. I have included an actual test of a reflection scale recorded on Vericolor II, type L film. Other color films may yield slightly different results but the exposure times and development times numbers may provide a useful starting point.

4.11.1b Film Exposure and Development. The exposure times given below are based on using Vericolor II, Type L film. This film has more contrast than the newer Vericolor III, so the times are likely to be different. Be sure to clip the corners of the positives as you would for color separation negatives. Make contact positives and set the light source at 5 foot candles. Use HC-110 dilution B as the developer for the positives. Tray development was used in the test example but drum processing might be more useful to insure consistent development. Consistent development is quite important because the high contrast required will make the process more difficult to control. Small swings in exposure and development are more pronounced at high gamma values.

TECHNICAL PAN 4415 (FOR POSITIVES) (Vericolor II Type L, Point Source at 5 footcandles)			
HC-110 DEVELOPER, DIL. B			
FILTERS	EXPOSURE	DEVELOPMENT	TEMP
#29 + 2.2 ND	6.0 SEC.	14:00 MIN	69 F
#99 + 0.6 ND	15.2 SEC.	8:00 MIN	69 F
#98	11.8 SEC.	4:30 MIN	69 F

Notice that neutral density filters have been used to keep the exposure times similar in length in order to avoid possible reciprocity problems. The positive that you obtain should be quite normal looking, sort of like a black and white version of a color transparency.

4.11.1c Alternate Method of Approach. Another approach to making a set of positives is to used a 21 or 11 step scale with a piece of clear color film base. The assumption is that the color mask at D-min is same at other densities in the negative. Actually the color mask in not just color added to the negative but


KODAK Curve Plotting Graph Paper
VERICOLOR II, TYPE L
BLUE
GREEN
RED
DENSITY
KODAK Curve Plotting Graph Paper
TECHNICAL PAN 4415
(Vericolor II Type L, Point Source at 5 footcandles)
HC-110 DEVELOPER, DIL. B
FILTERS
EXPOSURE
DEVELOPMENT
TEMP
RED POSITIVE
GREEN POSITIVE
BLUE POSITIVE
DENSITY
KODAK Curve Plotting Graph Paper
SUPER-XX SEPARATIONS
(Tech. Pan Positive, Point Source at 5 footcandles)
HC-110 DEVELOPER, DIL. A
FILTERS
EXPOSURE
DEVELOPMENT
TEMP
RED SEPARATION
GREEN SEPARATION
BLUE SEPARATION
DENSITY

rather, a low contrast color positive curve proportional to the color densities in the color negative. Never-the-less this method will be useful.

Use the clear film base in register with the step scale to determine the film development times and exposures. Plot the curves and try to obtain a gamma of approximately 1.2 in the positives. Use the following times and development to make the positives.

TECHNICAL PAN 4415 (Point Source at 10 footcandles)			
HC-110 DEVELOPER, DIL. B			
FILTERS	EXPOSURE	DEVELOPMENT	TEMP
#29 + 1.0 ND	9.5 SEC.	3:00 MIN	69 F
#99	26.3 SEC.	2:40 MIN	69 F
#98	26.3 SEC.	2:40 MIN	69 F

The curve for the a data is included on the next page.

4.11.2 Making the Negatives. This is the easiest part of the process. The positives are black and white film so no color filters are required. In addition, color masking is eliminated since the color negative is already color masked. Either enlarged or contact separations can be made. If you choose to make contact separations use a #61 green filter in the light source to eliminate possible newton rings. Green light is less likely produce newton rings than red or blue light.

4.11.2a Method of Approach. The aim is to produce a separation negative with a density range of 1.2. If the density range of the positive is about 1.7, then the film gamma would have to be about 0.7 (1.2/1.7).4.11.2b Film Exposure and Development. Use either Super-XX or T-Max 100 film to make your separations.

Shown below are the times used in the example test. Plot a curve to insure the proper density range and contrast. Refer to the curves shown.

SUPER-XX SEPARATIONS (Tech. Pan Positive, Point Source at 5 ft-c)				
HC-110 DEVELOPER, DIL. A				
POSITIVE	FILTERS	EXPOSURE	DEVELOPMENT	TEMP
Red	#99 + 0.6 ND	8.4 SEC	3:00 MIN	70 F
Green	#99 + 0.6 ND	5.6 SEC	3:00 MIN	70 F
Blue	#99 + 0.6 ND	6.4 SEC	3:00 MIN	70 F

Listed below are times for T-Max 100 film.

T-MAX 100 SEPARATION. (Tech. Pan Positive, K&M Point Source, Tap #2)			
HC-110 DEVELOPER, DIL. A			
FILTERS	EXPOSURE	DEVELOPMENT	TEMP
#61 GREEN	8.0 SEC.	3:00 MIN	70 F

Supplied by Tom Rankin, Frog Prince Labs, San Francisco

4.11.3 Post Highlight Masking. On occasion, a dye print made from color negative separations may need highlight masking to bring out the brilliance in the print. A post highlight mask is made from each positive and registered with each corresponding separation when making matrix film exposures.

Making the highlight masks is exactly like those made from a transparency except in this case a black and white transparency is substituted. Use the single highlight technique described in section 4.3.1 of the this chapter. Try to get a highlight density value between 0.3 and 0.4 for each separation.

4.11.4 Adjusting Exposures for New Color Negatives. After the exposure times are determined from a test negative it will be necessary to make adjustments in those times for subsequent color negatives. One way to determine the new times is to use a densitometric comparison of a neutral gray card or flesh tone. Another way is to compare the color filter packs used to make a good prints from the two negatives.

The first method is the most straight forward. A comparison is made of color densities of a neutral gray card or skin tone. Obviously, the problem with this method is the necessity to have a common area of comparison and the necessity for a color densitometer. The procedure is as follows:

I. Measure the gray card or flesh tone color densities in the color negative.

II. Subtract the color density values of the standard color negative from those of the new color negative.

III. Convert the differences into exposure factors using Table 4.1.2-1 in section 4.1. The new time is calculated by dividing the standard time by the exposure factor if the difference is NEGATIVE or multiplying it if the difference is POSITIVE.

EXAMPLE 4.11.4-1. The standard exposure time for the positives of a Vericolor negative was 6 sec. red, 7 sec. green, 9 sec. blue. The gray card color densities are 0.95 red, 1.00 green, and 1.20 blue. A new negative has a gray card density of 1.10 red, 0.95 green, 1.10 blue. Calculate the positive exposure times for the new negative.

Description	Red Reading	Green Reading	Blue Reading
Ia. Measure the densities of gray card in New Negative	1.10	0.95	1.10
Ia. Measure the densities of gray card in Standard Neg.	0.95	1.00	1.20
II. Subtract New densities from Standard densities	+0.15	-0.05	-0.10
IIIa. Find Exposure Factors from Chart 4.1.2-1	1.41	1.12	1.26
IIIb. Standard Exposure Time For Positives	6.0"	7.0"	9.0"
IIIc. Calculate New Exposure Multiply if positive, Divide if negative.	8.46"	6.25"	7.14"

Answer:

THE NEW EXPOSURE TIMES ARE RED 8.5 seconds, GREEN 6.3 seconds, and BLUE 7.1 seconds.

The second method is to compare the filter packs and exposure times of the standard and new negatives to calculate the new times. This method takes more time but eliminates the need for a color densitometer. In addition, there is no need for a common color for comparison. The procedure is as follows:

I. Record the filter packs of the new color negative and the standard and their exposure times.

II. Convert the color pack value in densities value.

III. Subtract the color pack values of the standard negative from those of the new negative.

IV. Convert the differences into exposure factors using Table 4.1.2-1 in section 4.1. The new time is calculated by dividing the standard time by the exposure factor if the difference is POSITIVE or multiplying it if the difference is NEGATIVE.

V. Multiply calculated times by ratio of new to standard time (new/standard) color pack times.

> **EXAMPLE 4.11.4-2.** The standard exposure time for the positive of a Vericolor negative was 6 sec. red, 7 sec. green, 9 sec. blue. The color pack 0 cyan, 65 magenta, and 80 yellow for 12 seconds at F8. A new negative has a color pack of 0 cyan, 85 magenta, and 105 yellow for 16.9 seconds. Calculate the positive exposure times for the new negative at F8.

Description	Cyan CC value	Magenta CC Value	Yellow CC Value
Ia. Write in the Filter Pack used to make a good print from New Negative	0C	85M	105Y
Ib. Filter Pack from good Standard Negative Print	0C	65M	80Y
	Red Reading	Green Reading	Blue Reading
IIa. Convert New Negative Color Pack to Density	0.0	0.85	1.05
IIb. Convert Standard Neg. Color Pack to Density	0.0	0.65	0.80
III. Subtract New densities from Standard densities	0.0	+0.20	+0.25
IVa. Find Exposure Factors	1.0	1.58	1.78
IVb. Standard Exposure Times	6.0"	7.0"	9.0"
IVc. Calculate New Exposure Multiply if positive, Divide if negative.	6.0"	4.43"	5.06"
Va. Color Pack Time Ratio (16.9 sec/12.0 sec)	1.41	1.41	1.41
Vb. Multiply Calculated New Exposure times (IVc) by Ratio (Va)	8.46	6.25	7.14

Answer:

THE NEW EXPOSURE TIMES ARE RED 8.5 second , GREEN 6.3 seconds, and BLUE 7.1 seconds.

It should be noted that if you are using a set of CP filters rather than a dichroic head you must compensate for the difference in the number of filters between the standard and new negative filter packs. Figure a 10% difference in time for each excess filter. From example, if the standard pack used 4 filters and the new filter pack has 6 filters, then the new time should be changed by 20% .

KODAK Curve Plotting Graph Paper

21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

No. ______ Date ______

DENSITY

.2 3.2
.0 3.0
.8 2.8
.6 2.6
.4 2.4
.2 2.2
.0 2.0
.8 1.8
.6 1.6
.4 1.4
.2 1.2
.0 1.0
.8 .8
.6 .6
.4 .4
.2 .2

A 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1
B 11 10 9 8 7 6 5 4 3 2 1
C 19 18 17 16 15 14 13 12 11 10 9 8 M 6 5 4 3 2 1 A
D 10 9 8 7 6 5 4 3 2 1
E 8 7 6 5 4 3 2 1

E-64 12-78 Printed in U.S.A.

Supplementary Section

There is an alternate method for making separation negatives. This approach is used has been used by Bob Pace of Arizona for well over 40 years. Theoretically this method should not be used but with appropriate limitations on transparency density range, it works quite well.

With the traditional method of making separations, the mask is used strictly for color masking. The color mask's gamma (percentage) remains is a constant value such as 25% or 33%. This is done to control a specific amount of color contamination. Varying the masking percentage, in theory, will vary the effectiveness of the color mask. In reality, this masking percentage can vary between 25 and 40 percent without noticeable loss of color correction. To obtain a pre-determined density range for the separation, the gamma of the separation negative film must be varied. Often long development times are required to obtain the proper negative gamma. With Super-XX, the blue separation is more than twice that of the red and green separations. The problem with such long development times is fogging.

Lately, however with the advent of T- Max 100 film this problem is considerably lessened. This film has greater inherent contrast than Super-XX and, more importantly, the development times for the red, green, and blue separations are essentially the same.

When Bob started making separations, Super-XX was almost exclusively used. After testing, he found that fogging occurred above a gamma of 0.75. This low gamma was unacceptable for a lot of transparencies so he decided to alternate his method of making transparencies. Instead of varying the negative contrast and holding the mask contrast constant, he decided to vary the mask contrast and hold the separation contrast constant. The constant value of gamma for the separation with Pace's method is 0.75.

To illustrate this difference let's use a simple example. Assume the following information:

1. A transparency density range of 2.1, with a highlight density of 0.4 and a shadow density of 2.5.

2. A required separation negative density range of 1.2, with a highlight density of 1.6 and a shadow density of 0.4.

3. Make the mask shadow density 0.3

First, let's use the Standard Method with this example. Assume 33% masking. The procedure is as follows:

1) The density range of the mask is 33% of the transparency density range. In this example that value is 0.7 (2.1x0.33). If the shadow density is 0.3 then the highlight density is 1.0

2) When the mask and transparency are registered together the density range of the combination is:

2.1	Transparency D.R.
-0.7	Mask D.R.
1.4	Transparency/Mask D.R.

3) Determine the separation negative gamma required to get a density range of 1.2. Divide the desired density range by Transparency/Mask density range.

$$1.2/1.4 = 0.86$$

4) The separation negative is developed to produce a gamma of 0.86.

Now let's use Bob's method of making separations.

1) Determine the required transparency/mask density range required. Divide the required separation density range by the constant gamma value. This value will be the same for all masked transparencies.

$$1.2/.75 = 1.6$$

2) Determine the required mask density range. Subtract the transparency/mask density range from the transparency density range.

2.1	Transparency D.R.
-1.6	Trausparency/MaskD.R.
0.5	Mask D.R.

The mask shadow is density will be 0.3, so the highlight density will be 0.8 (0.5+0.3).

3) Determine the mask gamma (percentage) required. Divide the mask density range by the transparency density range.

$$0.5/2.1= 0.24$$

4) Process the masking film to a gamma of 0.24.

As I have mentioned the masking gamma should not exceed a minimum of 0.25 and a maximum of 0.40 if correct color correction is to occur. This means the limits of transparency density range must be determined for the Pace method. Limits can be determined as follows:

1) The equation for masking percentage is:

$$\frac{\text{(Transparency Density Range - 1.6)}}{\text{(Transparency Density Range)}} = \text{Mask Percentage}$$

2) Solving the above equation for Transparency Density Range yields this equation:

$$\frac{1.6}{\text{(1 - Mask Percentage)}} = \text{Transparency Density Range}$$

3) Using the above equation the transparency density range limits for masking limits of 0.25 and 0.40 are:

$$\text{Minimum Transparency Density Range} = \frac{1.6}{(1 - 0.25)} = 2.1$$

$$\text{Maximum Transparency Density Range} = \frac{1.6}{(1 - 0.40)} = 2.7$$

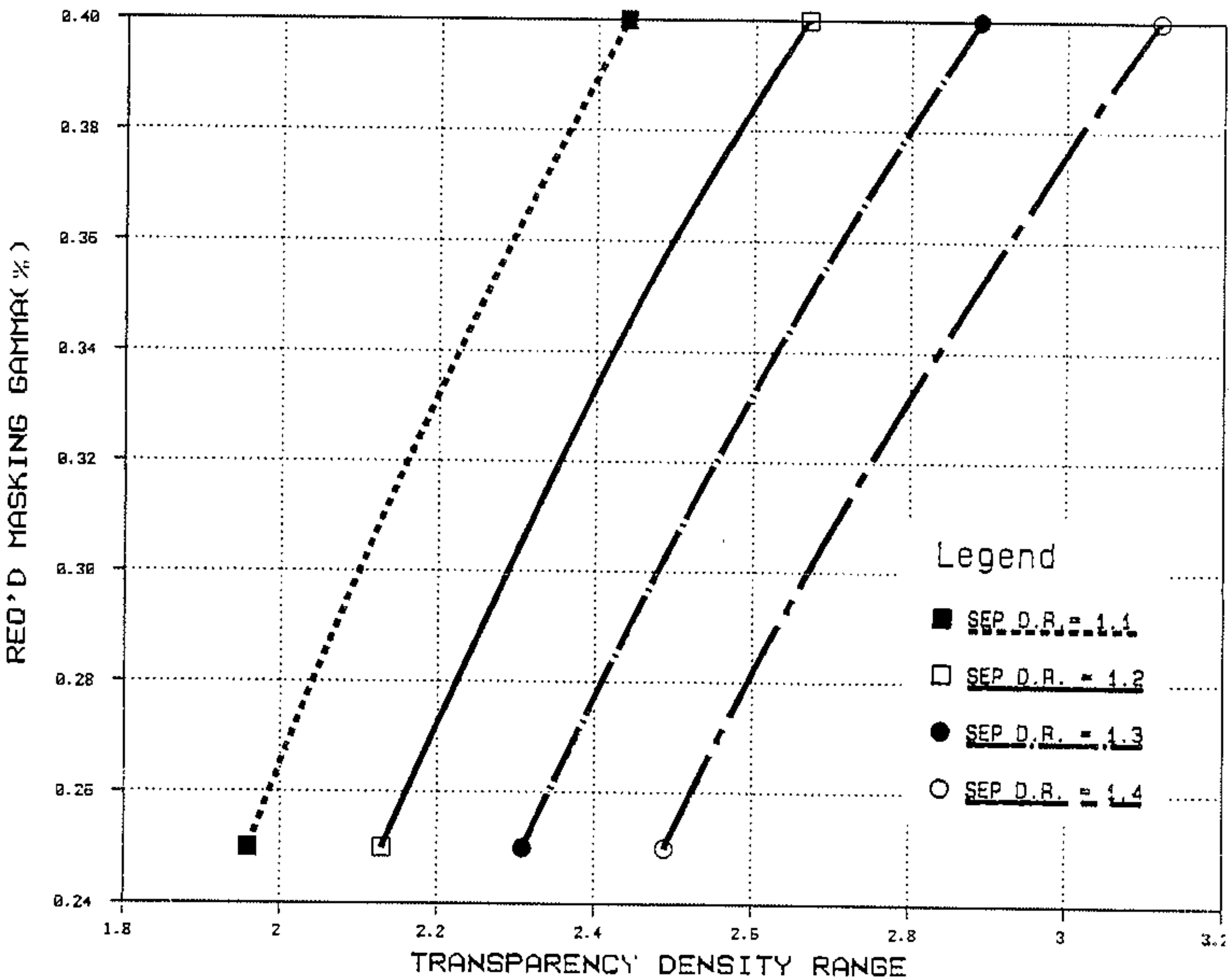
These limits cover a wide variation in transparency density range from flat to contrasty. Pace method will work is the vast majority of cases without appreciably affect color correction.

To use this method you must go through the same procedures as describe in chapter 4, section 4.7.3 of this manual. The only difference is that you need only determine one development time for the separation negative film since it also at the same contrast level. Development vs gamma curves must be determined for masking film since its gamma adjusts to changing transparency contrast.

To help you in figuring the proper masking percentage for a known transparency density range and a known separation "target" density range I have included a chart simplify the calculation. The curves represent four possible separation "target" density ranges which are determine as described in section 4.2.2. The curves represent density ranges of 1.1, 1.2, 1.3 and 1.4. Generally the value is about 1.2, bnt each enlarger is different, so do the testing as described.

TRANSPARENCY DENSITY VS. MASKING GAMMA(%)

0.75 SEPARATION GAMMA




MAKING
MATRICES
AT LAST!!!

V MAKING MATRIXES

CHAPTER 5 MAKING MATRICES

5.0 INTRODUCTION.

This section will cover the exposure of Kodak Matrix Film 4150 and Kodak Pan Matrix Film 4149. As discussed earlier, Matrix Film 4150 is for separation negatives and Pan Matrix 4149 for direct enlargements from color negatives. Both techniques have advantages and disadvantages. The discussion will begin with Matrix Film 4150 which I will call "ortho matrix film", because it can be used with a red safelight to distinguish it from Pan Matrix Film 4149. The procedures in the text apply for all sizes.

***5.1 ORTHO MATRIX FILM 4150.

MATERIALS:	
10x12 Kodak Matrix Film 4150	<3.15.2>
CHEMICALS:	
Kodak Tanning Developer A	<3.17.1>
Kodak Tanning Developer B	<3.17.1>
Non-hardening Fixer	<3.17.2>
EQUIPMENT:	
Safelight Filter No.1 or 1A	
Enlarger w/Diffusion Head	<3.1>
Register carrier (optional)	<3.11>
Lens	
Vacuum Easel(optional) or glass	<3.5>
Projection Print Scale	<3.20>
Separation Film Punch	<3.9.2>
Single Register Pins	<3.9>
Matrix Film Punch	<3.9.1>
Kodak Viewing Filters	<3.21.4>
Register Pins	<3.9>
Spatula	<3.21.10>
5x7 Trays or Drum	<3.4.1>
11x14 Trays w/flat bottoms	

This section will cover the exposure test procedures, full size film exposure, and its development.

I strongly recommend a diffusion head, however, a condenser head can also be used but make sure the separation negative's density range is proper for the particular light source you are using. This is discussed in detail in Chapter 4.

A registration carrier is a great timesaver because the matrixes are punched before exposure, thereby insuring best possible registration. The register carrier is listed as an option because matrix film can be registered after exposure; however, I strongly advise against using this procedure since registration has to be done by eye and is very tedious to do.

The vacuum easel is listed as an option but is very useful to have. You can get by without one but only because matrix film lays very flat. If you decide to omit a vacuum easel then place a clean sheet of glass on top of the film during exposure to insure that it is flat. Glass, of course, has the disadvantage of getting dirty and scratched, so be careful.

Newcomers to dye transfer should use the Kodak Tanning Developer. Later, or in emergencies, you may want to try the alternative developers, DK-50 and Kodak R-10a solution, described in section 2.3. The alternative developer gives a slightly different contrast, so be cautious when considering it as a substitute. For now, don't even consider it.

*****5.1.1 Method of Approach.** The method I like to use is to make small contact 4x5 test prints from small 4x5 matrix film. The small dye print obtained is used to determine the exposure corrections. Color corrections are made by changing green and blue exposure times and density changes are made by changing all three filter exposures by the same percentage. The color corrections needed are estimated by using Kodak Viewing Filters. Density values can be judged by putting any two Kodak viewing filters of equal density but opposite color to make a neutral density. For instance, putting a 10CC red with a 10CC cyan will make 10CC of neutral density. The CC values shown at the bottom of each viewing filter are a measure of color density; 100CC equals 1.00 density. So, if a viewing filter of 10CC corrects the print, this means you see 0.10 density of that color. The exposure factor corresponding to a color density is obtained from Table 5.1.1-1.

Don't try to calculate the exposure factor by converting the viewing filter CC values to density and using the tables in Chapter 4. Color density in a print is really half of what you see because light goes through the transparent emulsion and reflects back through the same emulsion, making it appear to be twice as dense as it really is. Use Table 5.1.1-1, only, for exposure factors. The chart shows a decrease exposure factor to decrease matrix film exposure, and an increase exposure factor to increase matrix film exposure.

TABLE 5.1.1-1

FILTRATION (CC)	DECREASE FACTOR	INCREASE FACTOR
2.5 CC	0.97	1.03
5 CC	0.94	1.06
10 CC	0.90	1.12
15 CC	0.84	1.19
20 CC	0.80	1.25
25 CC	0.75	1.34
30 CC	0.71	1.41
35 CC	0.66	1.50
40 CC	0.63	1.58
50 CC	0.56	1.78

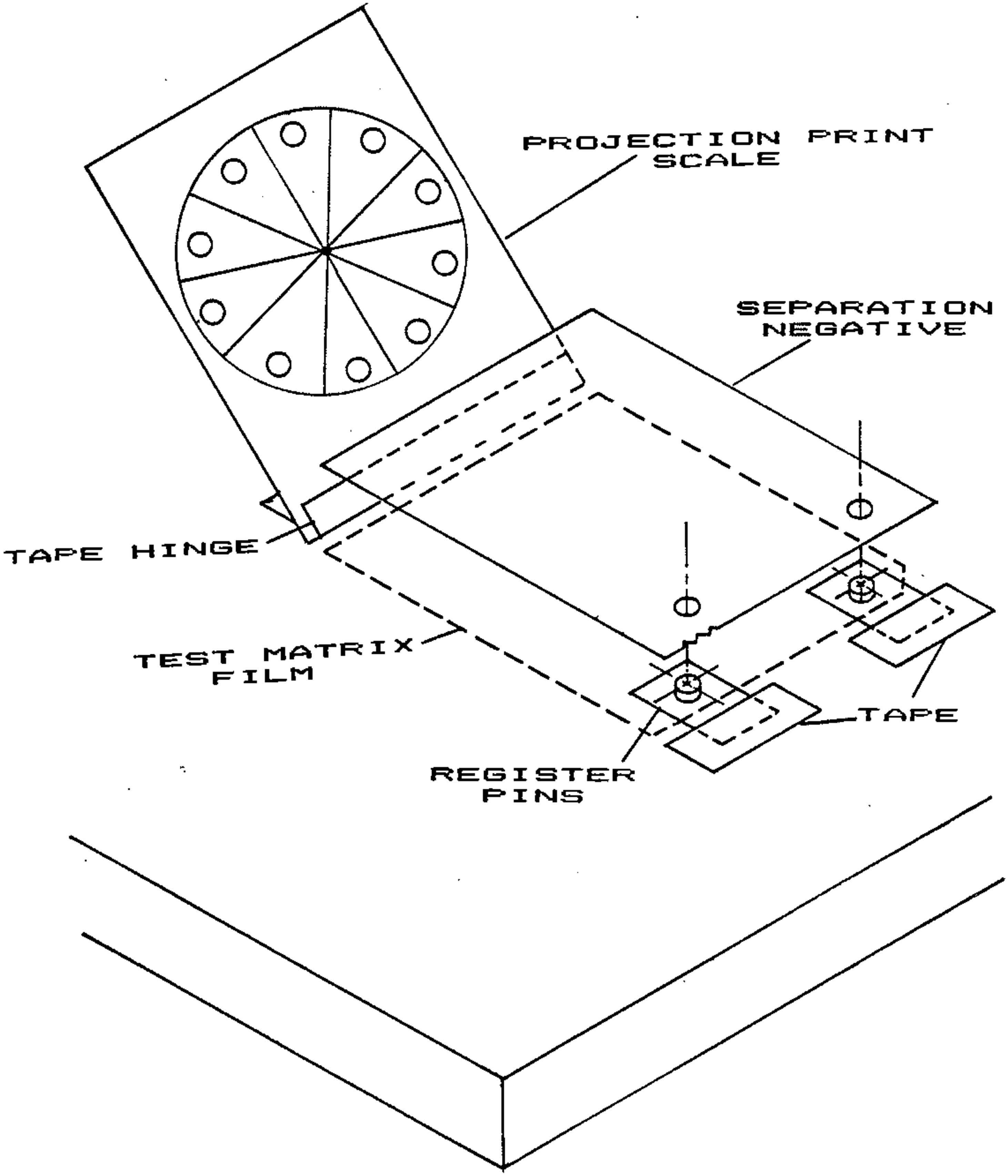

PROJECTION PRINT
SCALE
SEPARATION
NEGATIVE
TAPE HINGE
TEST MATRIX
FILM
TAPE
REGISTER
PINS

FIGURE 5.1.1

The matrix exposure time is altered, depending on whether there is not enough or too much of a color. The red separation controls the cyan dye, the green separation controls the magenta dye, and the blue separation controls the yellow dye. Obviously, if there is an excess of a subtractive color (cyan, magenta, yellow) in a print you would decrease the magenta and/or yellow matrix's exposure and if too little of subtractive color then the magenta and/or yellow matrix exposure would be increased. For instance, if a magenta exposure of 50 seconds produced a print that had 10CC too much magenta then the exposure of the matrix would be corrected by multiplying it by 0.90. The exposure should be 45 seconds, i.e., 50 x 0.90. In another example, if a cyan matrix exposure produces 10CC too much cyan, then both the magenta and yellow matrix exposures would be increased by multiplying by 1.12. The exposure corrections for the additive (red, green, blue) colors are a little more difficult to figure than those for the subtractive colors. All you have to remember is that additive colors are the opposite of the subtractive colors. The opposite of red is cyan, green's opposite is magenta, and blue's opposite is yellow. To reduce an additive color, increase the exposure of its opposite and vice versa. If the print were 10CC too green (-10CC magenta) for an exposure time of 55 seconds then the magenta matrix's exposure should be multiplied by 1.12, making it 56 seconds. It is also possible to alter an additive color by changing the two subtractive colors which make up that color, but would mean changing the exposure of two the matrixes. This is only necessary when correcting cyan and red in a print. Shown below is a chart which summarizes this paragraph.

ADD COLOR		
COLOR	#61	#47B
RED	+	+
GREEN	-	
BLUE		-
CYAN	-	-
MAGENTA	+	
YELLOW		+

REMOVE COLOR		
COLOR	#61	#47B
RED	-	-
GREEN	+	
BLUE		+
CYAN	+	+
MAGENTA	-	
YELLOW		-

(-) = DECREASE EXPOSURE & (+) = INCREASE EXPOSURE

If you wish to change the overall density of a print then the exposure times of all three matrixes must be changed by the same percentage. Put together two viewing filters of equal density and opposite color to make a neutral density filter. Remember that neutral density, as with color density in a print, appears twice as dense as it really is. Calculate exposures by using Table 5.1.1-1. For instance, if the red, green, and blue exposure times of 15, 20, and 35 seconds produced a print that was short 20CC (20 red + 20 cyan) in density, then the exposure times should be multiplied by 1.25 to get times of 19, 25, and 44 seconds. It is useful to know that 30CC of neutral density is equal to one stop.

If you notice a substantial loss of magenta and yellow saturation in the test print after compensating for an excess of red in a prior test print, then this is a signal that the cyan matrix exposure was insufficient. Keep the unadjusted magenta and yellow exposures times and increase the cyan matrix exposure. Conversely, if the print is overly dark after compensating for an excess of cyan by increasing the magenta and yellow exposures, then the cyan matrix was overexposed. Keep the unadjusted magenta and yellow exposure times and decrease the cyan matrix exposure time. Generally, these problems will not happen, but take care in determining the cyan matrix exposure because the other exposure times are based on it.

If the color seems fine but the print contrast doesn't suit you, then alter the matrix contrast by changing the tanning developer dilution. This is discussed in more detail in section 5.2.

*****5.1.2 Testing Procedures.** There are several ways to make test exposures. Each method is good and each helps solve a different problem you might have with your transparency. For all testing, use the red separation to determine the base exposure time because it controls the dye print's overall density.

Before beginning the testing, a few things have to be done. First, remove a sheet of matrix film from the box under a red safelight. You may notice a first sheet in the box with a corner clipped off, **DO NOT USE THIS SHEET** because it is fogged film. Put this fogged sheet carefully back into the box. This film helps prevent film scratching when removing unexposed matrix film from the package. Cut the film into 4x5 pieces. Cut the film carefully. With the emulsion facing you and the film's longest side held vertically, clip the upper right-hand corner. The emulsion side is the non-shiny side of the matrix film. The clipped corners are an added safety precaution to help identify the matrix film emulsion. Put the 4x5 test sheets back into the film box or a separate lightproof box. As you make the test exposures, make sure the test matrixes are coded by clipping additional corners. Since each sheet has at least one corner already clipped, use a code where one clipped corner is for cyan, two for magenta, and three corners for yellow.

Each testing method makes use of a projection print scale and a piece of 4x5 glass, instead of the standard test strip technique. The projection print scale allows the time exposure testing to be done in a localized area; this is not possible with a test strip. If you cannot obtain a projection print scale then make a strip instead.

Next, prepare your chemistry as described in the processing section of this chapter. Processing the test matrixes in a drum, which can hold 4x5 film, is a very convenient way to work.

5.1.2.1 Test Procedure #1 (Contact Dye Prints). This method works with separations made from transparencies 2-1/4" and larger. It also works with 35mm transparencies, but the contact may be almost too small to see. Make sure that important elements in the 35mm transparency can be seen at this size.

This method assumes that the enlarging lens is not a factor in exposure. Depending on the kind of lens you have, this may not be so. The most significant effect may be to lower image contrast. In other words, the contact print will have higher contrast than the final print. Compensate if you must use this method.

The first step is to put the red separation negative in the carrier. Put the vacuum easel, if you are using one, under the enlarger and lock it into place. Raise the enlarger head to the desired height for full size prints and focus the image. The enlarger head should also be locked into position. Everything should be done as if you were making an enlarged print. Locate the center of the image and mark it with a piece of tape. Remove the separation negative from the carrier.

Tape a set of single pins to the vacuum easel (or enlarger easel) so the separation can be installed under the enlarger at the image center. You don't have to turn on the vacuum pump when making tests. Position the red separation on the pins. Take the projection print scale and position it so its center is overlaying the center of the image. When this is accomplished, tape the outside edge of the projection scale so it acts as a hinge to allow removal of the separation negative. See Figure 5.1.1.

5.1.2.2 Test Procedure #2 (Enlarged 4x5 Prints). This method is more useful for contact separations of 35mm transparencies. The biggest drawback is the exposure calculation required to make the final enlarged matrixes. First the image is enlarged to 4x5 for exposure testing. You must calculate the image magnification at this point and record the exposure times for this magnification. These times must be multiplied by an exposure factor obtained by knowing the magnification of the final enlarged image.

First, measure the length of the image on the separation negative. I recommend that you make the measurements in millimeters, so you don't have to convert fractions to decimal form. For instance, a 35mm slide is 36mm long. Record this length in your notebook.

Next, put the separation in the carrier. Raise the enlarger to obtain an image roughly 4x5 in length. Mark the center of the image with tape on the vacuum or enlarger easel. Measure the length to this image in millimeters. A 4x5 image is 127mm long. Calculate the magnification by dividing the actual film size by the enlarged image size. For a 35mm slide the magnification is about 3.5X, i.e., 127mm÷36mm.

Use the same set up with the register pins and projection scale as described in method #1 and shown in Figure 5.1.1. Expose the film and make the exposure corrections as discussed.

When you are satisfied that the test exposures will give you a good 4x5 print then raise the enlarger to the desired height and record the magnification. Calculate the magnification. An 8x10 print is 254mm long, so it has a magnification of 7.1X, i.e., 254mm÷36mm.

Once you have calculated the magnification of the 4x5 test and the 8x10, enlargement then you can calculate the exposure factor by using the formula:

$$XF = \frac{(M_{large} + 1)^2}{(M_{small} + 1)^2}$$

WHERE:

XF = Exposure Factor
M_{large} = Magnification of Final Image
M_{small} = Magnification of Test Image

or example, in going from a 4x5 test to an 8x10 final image, the exposure factor will be:

$$XF = \frac{(7.1 + 1)^2}{(3.5 + 1)^2} = \frac{(65.61)}{(20.25)} = 3.24$$

Use this factor for calculate the final image exposure. For example, assume the red separation exposure was 50 seconds, the green exposure was 55 seconds, and the blue exposure time was 60 seconds for test prints. The final image exposure times would be 162 seconds for red, 178 seconds for green, and 194 seconds for blue. A warning! Times this long will cause reciprocity effects, so open the lens two stops instead. The times would be 41, 45, and 49 seconds, respectively.

5.1.2.3 Test Procedure #3 (Selected Area Print). This procedure is a variation on the two previous methods. This method is most useful for 35mm contact separations. The separation is put into the enlarger and the enlarger is raised to the desired enlargement size. The separation is left in the carrier. Choose a area in the print such as a neutral gray or skin tone. Make all tests in that portion of the image. Again, use the projection scale and register pins as shown in Figure 5.1.1.

5.1.2.4 Exposure Determination. When you have decided which test procedure suits your need and everything is aligned, you will be ready to proceed. Turn out the lights and turn on the safelights. Remove a sheet of 4x5 matrix film from the box and punch registration holes in the film with the film punch. Clip the corners to identify each particular matrix. Place this sheet of matrix film on the register pins which have been taped to the easel, with the **EMULSION DOWN.** Place the separation negative, **EMULSION UP,** in register on top of the matrix test sheet. Flip the projection scale on top of the negative. Place a piece of glass on the assembly to keep it flat.

Set the lens at f5.6 and set the timer for a one minute exposure. Develop the film as instructed in the development section. After the matrix is developed, examine it. If there is no visible image in the test matrix then the exposure was insufficient. Open the lens aperture two stops or triple the exposure time and make a new exposure trial. You should see some image on at least half of the projection scale exposure wheel.

Judge the exposures by looking at the highlight areas of the matrix. A properly exposed matrix will have highlight density slightly darker than clear film. If you scratch the highlight area with your finger you'll see a mark. A better way to judge the matrix film itself is to make a dye print from the test matrix. Since the first test is always the red separation, use the cyan dye. Procedures for making prints are discussed in the next chapter. Look at the cyan dye print through a #29 red filter. Pick the time which looks like a normally exposed black and white print. This time is your base exposure time. It should be the same for the magenta and yellow matrix exposure times.

Be careful about using the base time for all of the matrix exposures. Theoretically, all three separations are identical and should have the same base time. Subjectively, the green and blue separations seem to require a little more exposure than the cyan base time. **Try making the green exposure 10% longer that the base exposure and the blue exposure should be about 20% more than the base exposure, the color might be more appealing to the eye.** For instance, if the base exposure is 50 seconds for cyan, then the time for magenta is 55 seconds and 60 seconds for yellow.

After determining the exposures, make all three of the test matrixes without the projection scale, and process simultaneously in a drum or tray. Make a dye print. Evaluate the print for color correctness and contrast. If there is a small color shift, determine, then make exposure corrections as discussed in section 5.1.1. If the contrast is bad, which rarely happens, then remake the tests with a different developer dilution as described in section 5.2. Once the times are satisfactorily determined, make the enlarged print as described in the next section.

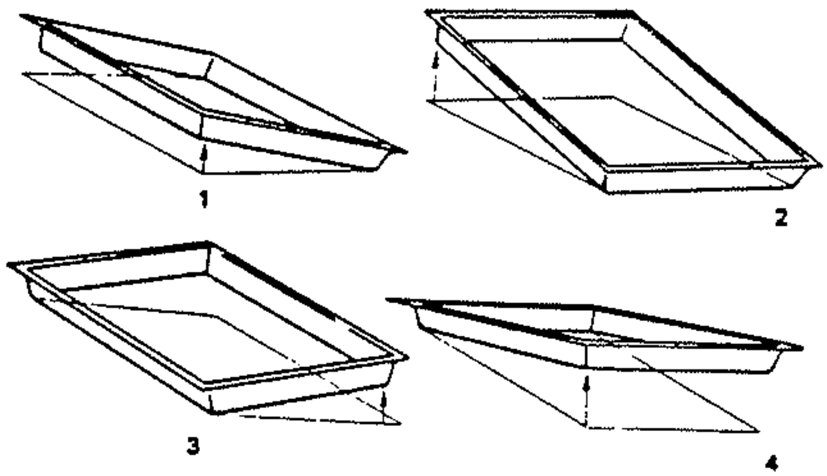
5.2 DEVELOPING MATRIX FILM.

Matrix film is developed for two minutes at $68^{O}F$, rinsed for 30 seconds, and fixed for two minutes in nonhardening fixer. After the film is processed, the undeveloped emulsion is washed off in hot water, chilled in cold water, and dried. As an option you may want to harden the emulsion to make it more resistant to scratches and double the useful life of the mat. The hardening procedure is discussed in section 5.2.1. The steps are listed below.

STEP	TEMPERATURE	TIME
1 Develop	68(+/-)1/2 F	2 min
2 Rinse	68-70 F	30 sec
3 Fixer	68-70 F	2 min
4 Wash-off	120(+/-) 2 F	3 min
5 Rinse	68-70 F	30 sec
6 Harden(opt)		
7 Dry		

If your test prints have good color but lack or have excess contrast, then you may want to try a different tanning developer dilution. Try varying the developer dilution from the normal one part A and two parts B.

The chart below lists the dilution necessary for a normal dye print. If you are assuming a transparency density range of 2.0, 33% masking, and a separation target density range of 1.2 (simplified constant gamma method, section 4.7.2), then use the density range listing. If you are using the advanced method then use the separation gamma listing, which is assumed to be the separation target density range divided by the masked transparency density range (advanced varying gamma method, section 4.7.3). The chart is only a recommendation, the dilution you want may lie between these values.



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PROPER TRAY AGITATION OF FILMS

1. To insure consistent processing of matrixes, masks, and separations, use the 4 cycle agitation technique.

2. Place single sheet of film in developer emulsion side up.

3. Lift the tray in the agitation cycle shown above. A complete cycle should take about 5 seconds for an 8x10 tray and about 10 seconds for a 16x20 tray.

Figure 5.2.1

CONTRAST WANTED	NEGATIVE DENSITY RANGE (4.7.2)	NEGATIVE GAMMA (4.7.3)	DEVELOPER		EXPOSURE ADJUST.	APPROX. CYAN DYE -MATRIX GAMMA
			A	B		
Very Low	1.8	1.4	1	1	130%	1.3
Low	1.6	1.2	1	1.5	115%	1.4
Normal	**1.2**	**0.9**	**1**	**2**	**100%**	**1.9**
High	1.1	0.8	1	3	90%	2.1
Very Hi	0.9	0.7	1	4.5	80%	2.5

There is a minimum volume of chemistry required to process a sheet of film. You should not use less than five ounces of tanning developer part A for each sheet of 10x12 matrix film (one ounce for 4x5 film). That works out to approximately .04 ounces per square inch. Remember that if you develop a 4x5 sheet of matrix film in a large 11x14 drum use at least the minimum recommended total volume for that drum. Listed below are minimum total volumes (one part A + two parts B) of dye transfer chemistry you should use in a drum.

DRUM SIZE	MINIMUM TOTAL VOLUME OF CHEMISTRY ALLOWED.
8x10	3 oz.
11x14	6 oz.
16x20	9 oz.

Use twice as much rinse water as you use chemistry. Rinse everything thoroughly. This chart lists the minimum volume of chemistry required for a specific size of matrix film.

FILM SIZE	MINIMUM ALLOWABLE VOLUME	
	PART A	PART B
4X5	1 oz.	2 oz.
8x10	3 oz.	6 oz.
10x12	5 oz.	10 oz.
11x15	7 oz.	14 oz.
14x18	10 oz.	20 oz.
16x21	14 oz.	28 oz.
20x24	20 oz.	20 oz.

Matrix film can be developed three at a time or singly. For beginners, I suggest developing each matrix sheet individually. If you are doing test exposures use a drum or tray. Don't use the drum for processing full size sheets at first; process the full sized sheets in a tray. Later, you may find drum processing is more convenient, but you might have to readjust the development times. Tray processing matrix film must be done carefully. The agitation must be done smoothly and consistently. There are two recommended agitation techniques; interleaving agitation and tray-tilt agitation. Interleaving agitation is used when processing three sheets at once. Tray-tilt agitation is used when doing single sheet agitation. I strongly recommend that you only use single sheet agitation. The only argument in favor of multiple sheet agitation is that processing can be done quickly. Although some say the mat will get equal agitation, I think this is only possible after lots of experience.

The tray-tilt technique is simple. Insert the film in the tray by lifting the tray so the developer is at one end of the tray. Quickly slide the lower edge of matrix film into the developer, EMULSION UP, and lower the tray so the developer flows smoothly over the entire sheet. Lift one corner a few inches, lower it, then lift the adjacent corner. Finally, lower the tray and repeat in a clockwise or counterclockwise direction. See the accompanying drawing. The agitation cycle should take about 10 seconds for an 11x14 tray.

If for some reason you must process three sheets at once, follow these instructions. Make sure you use flat bottomed trays whenever developing three sheets at once. The film is inserted into a tray of developer, EMULSION DOWN. Before your start, keep track of which sheet goes in the developer first (the lead matrix), second, and third. Insert the three sheets in the developer, EMULSION DOWN, as quickly as possible. After the sheets have been inserted in the developer, quickly pull the bottom sheet and place it on top and repeat this process with the next sheet continuously. After the development is complete, remove the lead matrix first and so on. Put into the rinse.

Here are some hints and aids when developing the film.

1) Never mix part A with part B before using it. It only has four minutes of life!!! because it oxidizes so fast. Make sure temperatures are right before mixing because there is almost no time to adjust it afterwards.

2) Keep the tanning developer part A and B at 68-1/2 degrees F. because the temperature drops about 1/2 a degree when the chemicals are mixed.

3) With either technique, it is a good idea to presoak the film before putting them in the developer. Use the rinse water in step 2 as both a presoak and a rinse. The presoak helps insure even development.

4) Handling the film can be difficult because the emulsion is so slippery. Hold the film by the register holes, that seems to help quite a bit.

5) The fixer can be reused for all three mats. The fixer will be bright yellow but is still good. The fixer should be disposed of when the matrix fails to clear after one minute.

6) Use water close to 130 degrees to wash off the unexposed emulsion. It seems to work better than water 120 degrees and does not damage the film at all. Never touch the image emulsion. Use a strong jiggling action to the clear film.

7) If stubborn clumps remain on the emulsion even after a thorough wash, try moving it with a fine spotting brush. Remove the dissolved gel from the edges by pulling the edges between your thumb and forefinger.

8) Always hang all three sheets in the same orientation when drying them. This prevents any dimensional changes from having an effect on registration.

5.2.1 Hardening Matrix Film Emulsion. Many labs have added a special step to the sequence of development steps. They soak the freshly made matrix in a hardening bath to make the film emulsion more resistant to scratches thus doubling the number of prints that can be rolled with it.

Another even more important side benefit of a hardened matrix is the consistency of image quality it produces. The first print from a normally processed mat is quite different from subsequent prints because of the softness of the film's emulsion; it tends to flatten after the first few prints. As a result the 100th print does not look like the first print; hardening will remedy this problem.

The hardening bath reduces the amount of dye absorbed by the mat by 10% to 15%. This is why you should not attempt to harden your old mats. The process is only used for newly made mats. The absorption problem is easily compensated for by giving the film more exposure. If the hardener is used as a integral part of the development process then there is no problem at all since the final mat has taken this into account.

The following formula is used by a lab in San Francisco called "Frog Prince" labs. The formula is:

Formalin (37 % Formaldehyde)	5.0 ml
Photo-Flo	5.0 ml
Add water to make	1000.0 ml

Soak the matrix film in this solution for 3 minutes at 68 degrees Fahrenheit.

Warning!!! Handle Formalin with care. Formaldehyde is a poisonous substance. Avoid contact with your skin, eyes, and clothing. If you get some on your hands wash them immediately. This substance is combustible so use good judgement near flames. Use this stuff with adequate ventilation. If for some reason it is swallowed...UHHHH!!!!, give water, milk or milk of magnesia and **SEE A DOCTOR.**

5.3 MAKING FULL SIZED MATRIXES.

Before starting, make a mask for the matrix film. This will insure that you will have a clear border around the mats. The clear border will make it easier to handle the matrixes (or mats as they are called) and provide a white border around your dye transfer print. Make the mask out of opaque black paper. Try to leave at least 1-1/2 inches from the edge on the side where the registration holes are punched. This will insure that the print roller will make good contact. See Figure 5.3.1. Tape the mask to the easel so it can be folded out of the way.

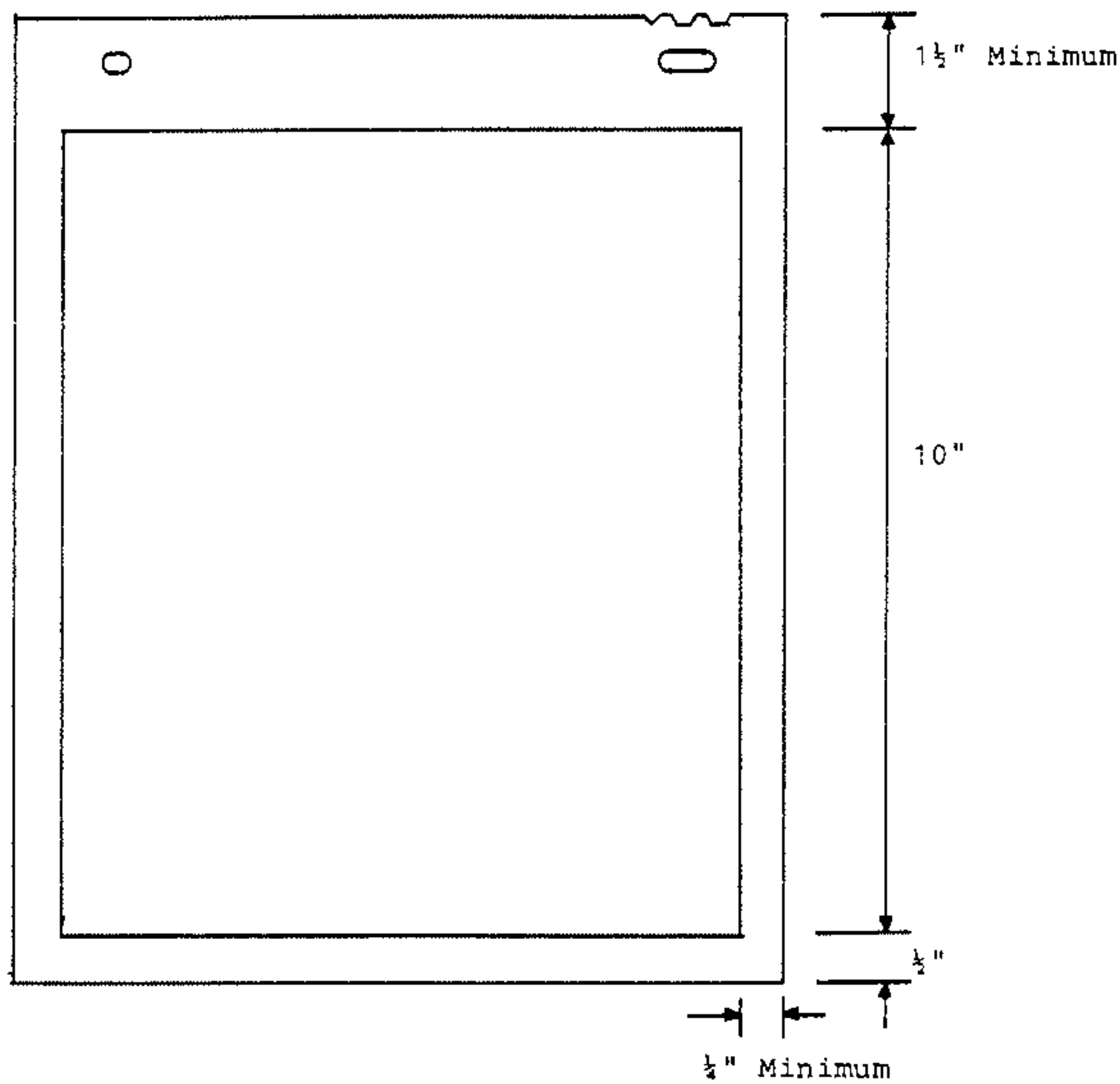
If you are using color negatives then there is an alternative way of masking. This method masks out the negative in the carrier. Although any opaque tape can be used, I suggest that you use silver photo masking tape since it will not leave any residual glue on your precious negative. I find this method tedious and difficult to do well.

Once the exposures have been determined remove the register pins which were taped to the easel and remove the projection print scale. Place the separation negative in the carrier, **EMULSION UP**; color negative **EMULSION DOWN**; or a internegative **EMULSION UP**. Make sure the carrier is dust free and the glass is as clean as possible, if you are using a glass carrier. Make sure everything is locked into place and secure. Don't move anything that might cause mis-registration. Remove the separation negative by using a spatula or palette knife. Gently slide the spatula under the film next to the pin and twist the handle to pop the film off the pins. For Pan Matrix exposures the negative stays in the carrier for all three exposures.

Turn off the room lights and turn on the safelight (for Matrix Film 4150 only). There is no safelight for Pan Matrix. Remove a sheet of film from the package. You may notice that there is a sheet of film with a corner clipped off, **DO NOT USE THIS, leave it in the package**. Punch registration holes in the film. Code the film by clipping the corners. Clip no corner for the cyan matrix, one corner for magenta, and two corners for yellow.

Place the film on the registration pins of the easel, **EMULSION DOWN.** Make sure the film lies as flat as possible, turn on the vacuum, if using a vacuum easel, and position the mask. Make the exposure. When done, put the exposed film in a lightproof box. Repeat for all three mats.

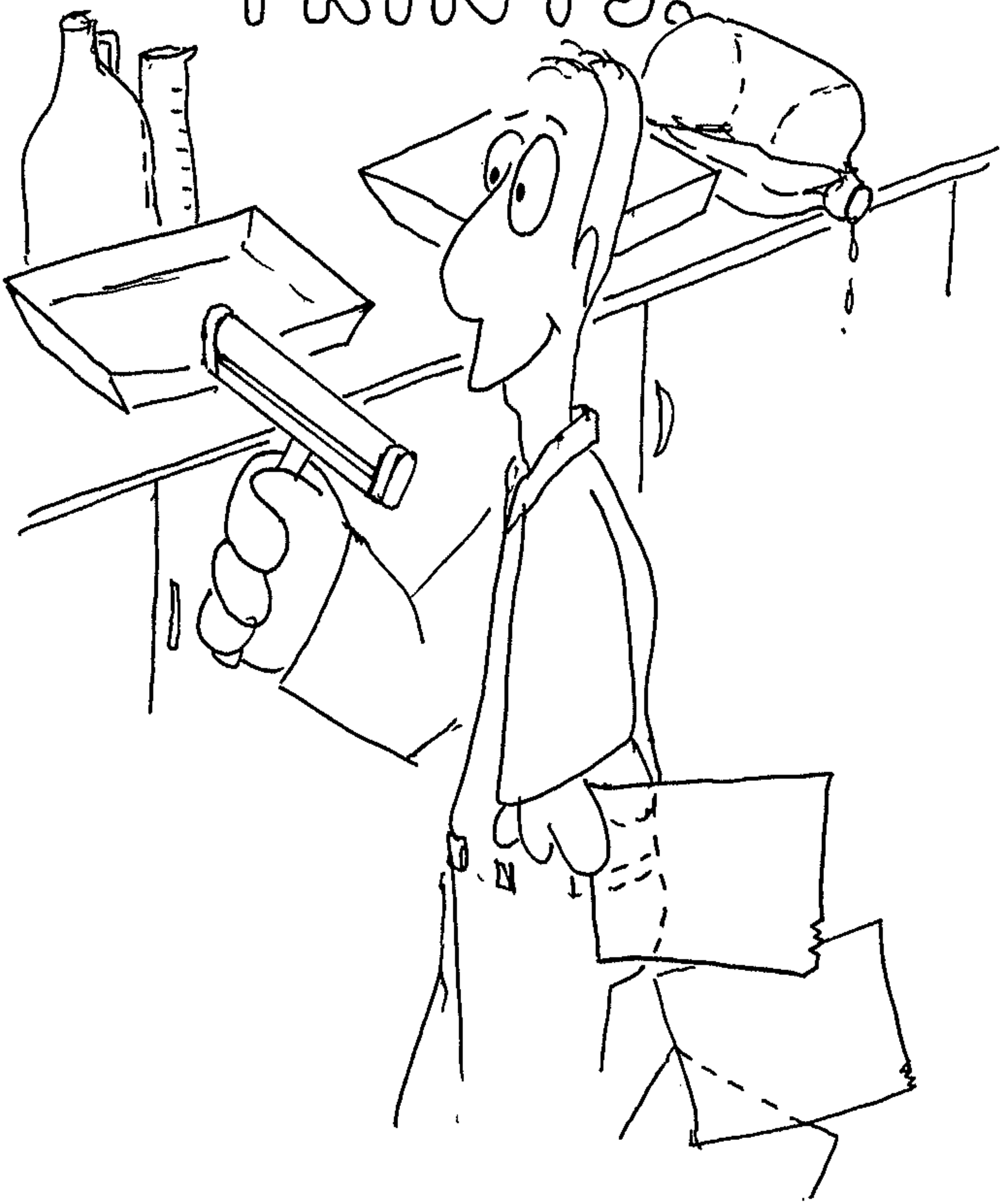
After all exposures are complete, develop the mats as discussed in section 5.2. When the print is rolled you may still have a small color shift. If the color shift's less than 10CC don't remake the matrix; these small color shifts can be corrected in the print rolling step.



Masking for 10x12 Matrix Film

Figure 5.3.1

MAKING DYE TRANSFER PRINTS!



VI MAKING DYE PRINTS

CHAPTER 6 MAKING DYE PRINTS [6-1]

6.0 INTRODUCTION.

At last, the final step. In this chapter we will cover a number of things essential for good prints. First, and most important, an examination of the dyes, how to mix them, and care for them. Next, the paper conditioner and dye transfer paper. After that, the acid rinses, print rolling, and how to do it efficiently. Finally, ways to "fine tune the print", i.e., finish the dye prints for the best possible quality.

6.1 THE DYES.

MATERIALS	
1 Gallon Dye Set Kit	<3.17.3>
CHEMICALS	
Distilled Water	
Acetic Acid	
Triethanolamine	<3.18>
EQUIPMENT	
6 vials or test tubes	<3.21.9>
21 step guide	<3.13>
10 ml pipette	<3.21.1>
eye dropper	
single register pins	<3.9>
film punch	<3.9.1>

The dye kit comes with cyan, magenta, and yellow dye concentrates and a dye buffer for each dye. The dye buffer helps keep the dye PH constant. Although there is enough chemistry to make a full gallon of chemistry, don't mix the full gallon unless you intend to make 16x20 prints. **WARNING!!! USE DISTILLED OR DEMINERALIZED WATER TO MAKE UP DYES.** The distilled water insures that the dye will be mixed at the proper PH, which is very important for proper transfer. Mix a quart or half a gallon for smaller prints. I prefer to mix a two liter supply because I don't have to replenish it as often. **Keep some concentrate on hand for replenishing the dyes.** Always filter the dyes after using them. A funnel with a fine mesh strainer is good. Filter paper capable of filtering particles as small as three microns (3/1000th millimeter) is better.

The dyes are mixed one part dye, one part dye buffer, and 18 parts distilled water. For instance, to make 1 liter of dye, mix 50 ml dye, 50 ml dye buffer, and 900 ml distilled water. To avoid acid shock, add concentrate then buffer to water. Do not reverse the sequence. Mix the dye carefully, measure the dyes concentrate and buffer with a pipette, and measure the distilled water as carefully as you can.

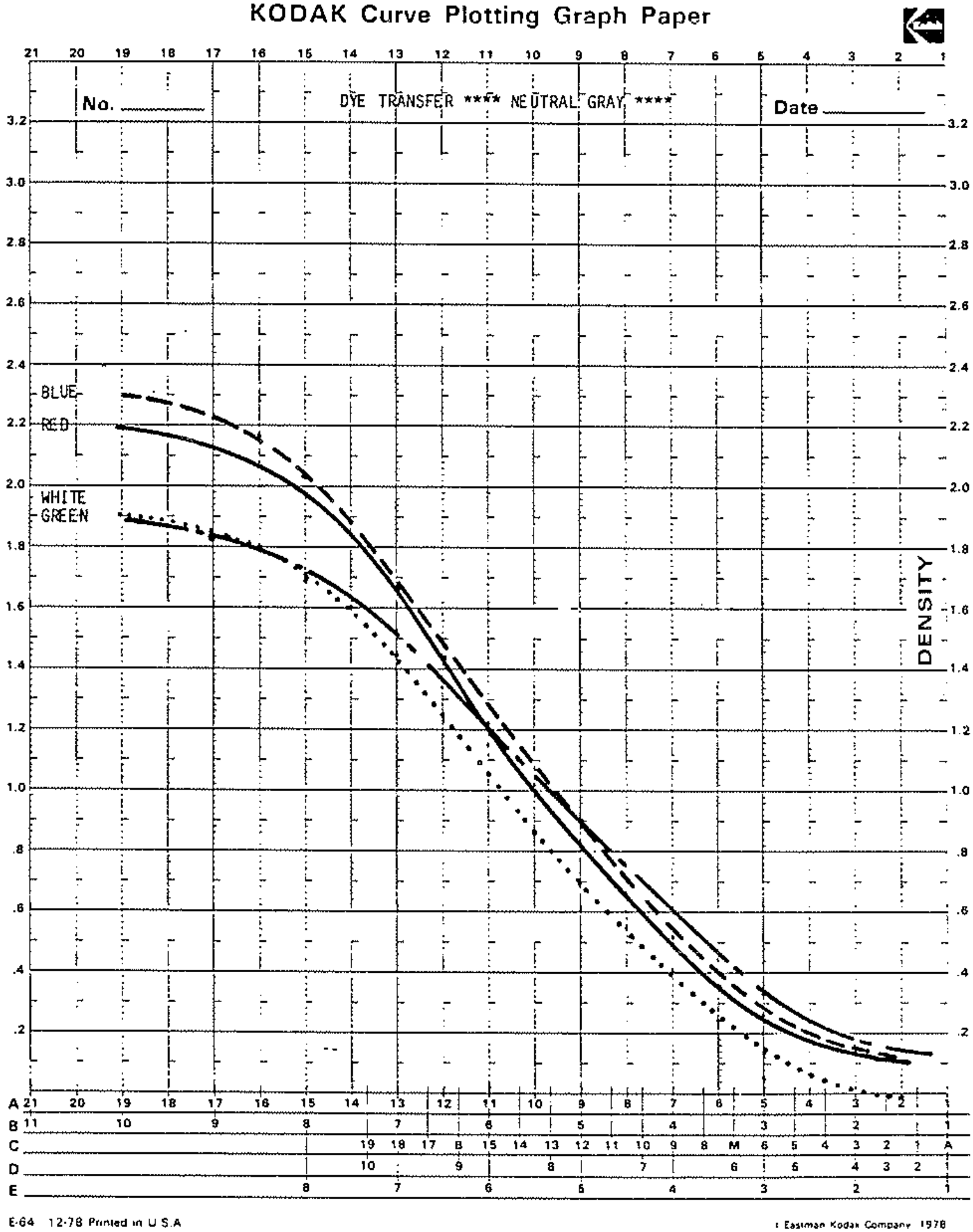
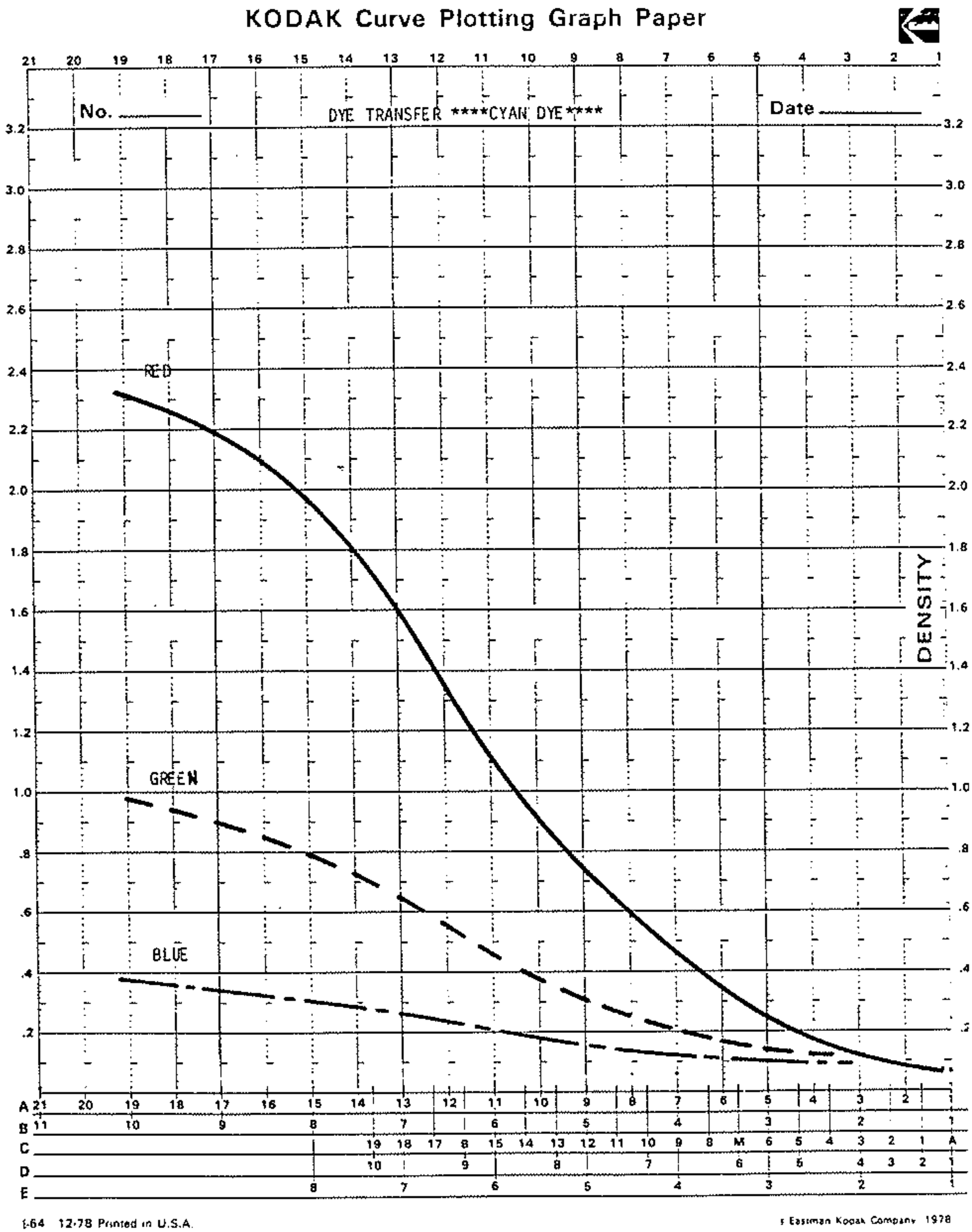
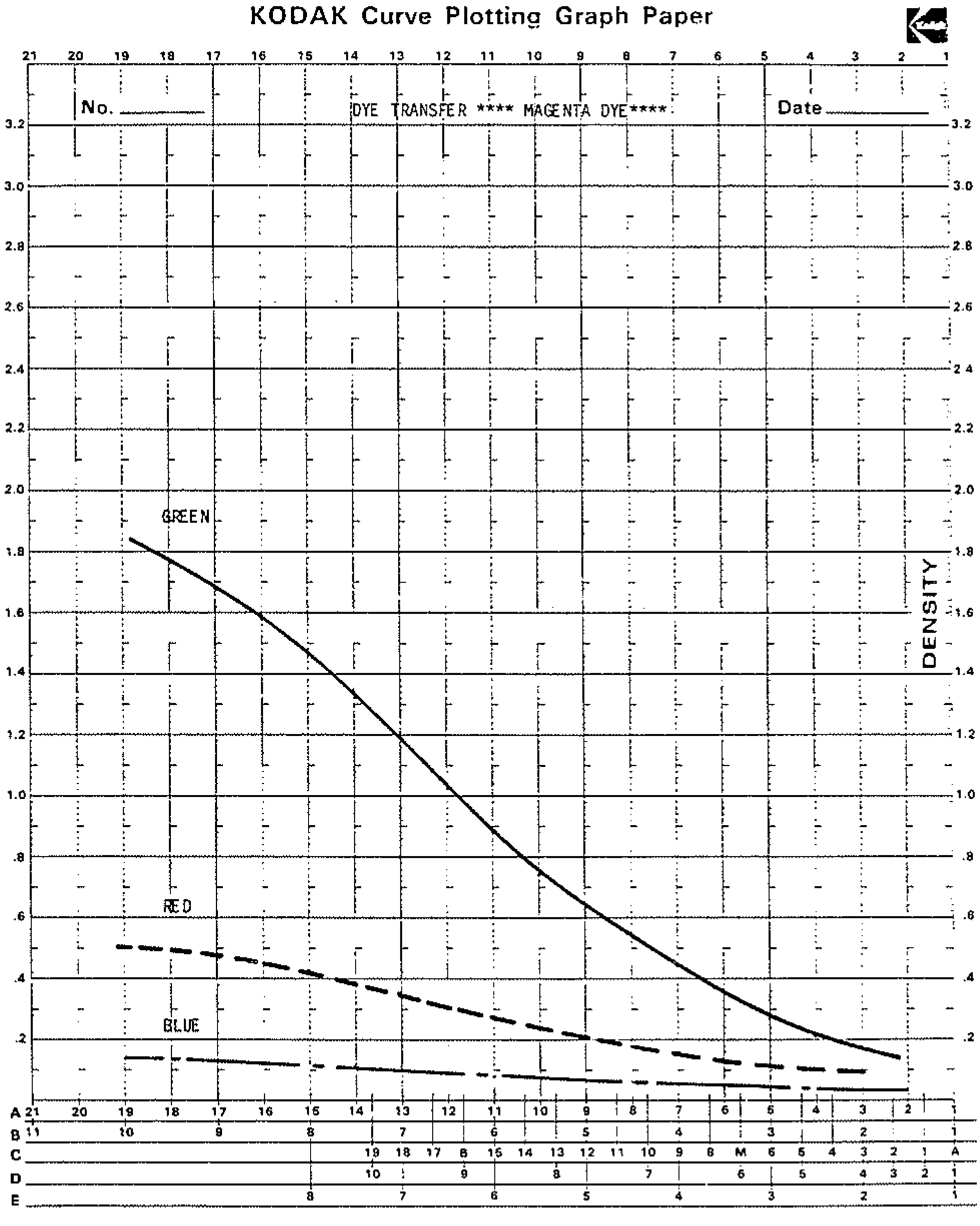

KODAK Curve Plotting Graph Paper
No.
DYE TRANSFER **** NEUTRAL GRAY ****
Date
BLUE
RED
WHITE
GREEN
DENSITY

FIGURE 6.1-1



KODAK Curve Plotting Graph Paper
No.
DYE TRANSFER ****CYAN DYE****
Date
RED
GREEN
BLUE
DENSITY

FIGURE 6.1-2



KODAK Curve Plotting Graph Paper
No.
DYE TRANSFER **** MAGENTA DYE****
Date
GREEN
RED
BLUE
DENSITY
E-64 12-78 Printed in U.S.A.
© Eastman Kodak Company 1978

FIGURE 6.1-3

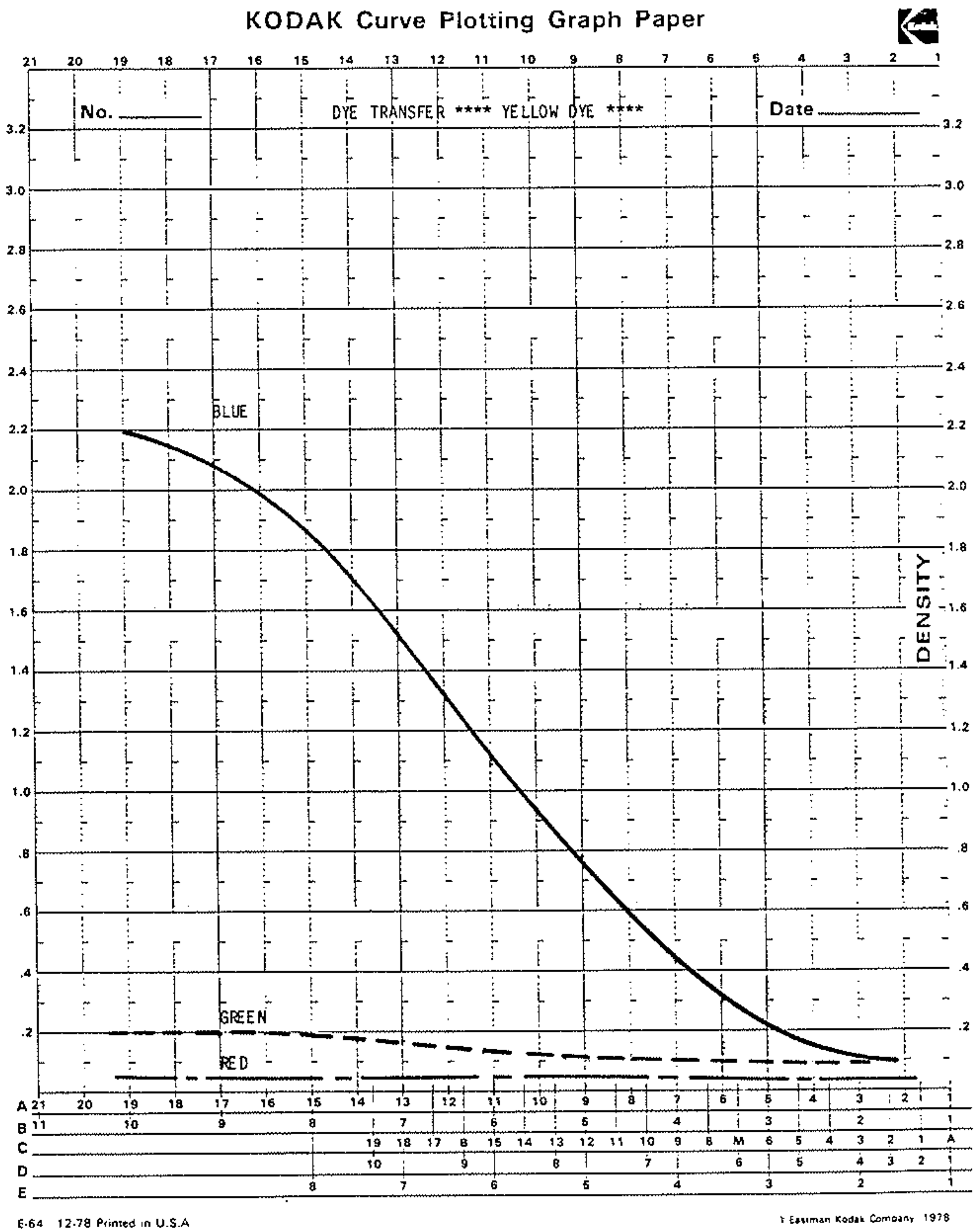

KODAK Curve Plotting Graph Paper
No.
DYE TRANSFER **** YELLOW DYE ****
Date
BLUE
GREEN
RED
DENSITY
E-64 12-78 Printed in U.S.A.
© Eastman Kodak Company 1978

FIGURE 6.1-4

In addition to a set of normal dyes, an auxiliary set of high and low contrast dyes are sometimes mixed. A well made set of matrixes seldom requires the use of these auxiliary dyes. However, I find that the high contrast dye can be useful to add a little snap to some prints. Make up a liter of high contrast dye for special occasions. The lower contrast dye, however, is seldom necessary. To make high contrast dye, mix the dye concentrate and buffer as before. Add the glacial acetic acid at the following quantities for each liter of dye.

Cyan	Magenta	Yellow
6.1 ml	3.5 ml	13.4 ml

If you want to make low contrast dye, add the following quantities of 10% triethanolamine (trieth) to each liter of dye. The trieth may be hard to find, but keep trying. A 10% solution is made by adding 10 parts trieth to 90 parts water. For example, to make 100 ml, mix 10 ml of trieth to 90 ml of distilled water.

Cyan	Magenta	Yellow
13.7 ml	10.5 ml	18 ml

Decrease the quantities by 6% if you are mixing for a quart.

6.1.1 Preliminary Check of Dyes With Reflection Densitometer. If you have a reflection densitometer it is a good idea to make color curves of the dyes before they are used. Generally the mixing instructions are correct and produce dyes with equal contrast. Because of the occasional lack of manufacturing consistency, the dyes may have some notable differences in gamma. For instance, in the magenta dye there is a special additive called a "toe cutter" which is supposed to bring the toe of the magenta dye curve back in alignment with the other two dyes, most of the time it works quite well but other times it over does its job and may cause a little crossover in the print.

The procedure is fairly simple. Make equal exposures through a a 21 step guide on three pieces of 4x5 matrix film. Use a time such as suggested in the film exposure section of chapter 4. Use registration pins because these images are to be rolled together make a gray scale print.

Some people prefer to make only one matrix which is used in each of the dyes, with thorough cleaning in between with CB-5 clearing bath, to make a gray scale. The CB-5 clearing bath is discussed in section 6.4.2. The advantage of the latter method is there is no doubt that the exposure is the same for all three colors. The disadvantage is the possibility that there may be residual dye carry-over between dye changes.

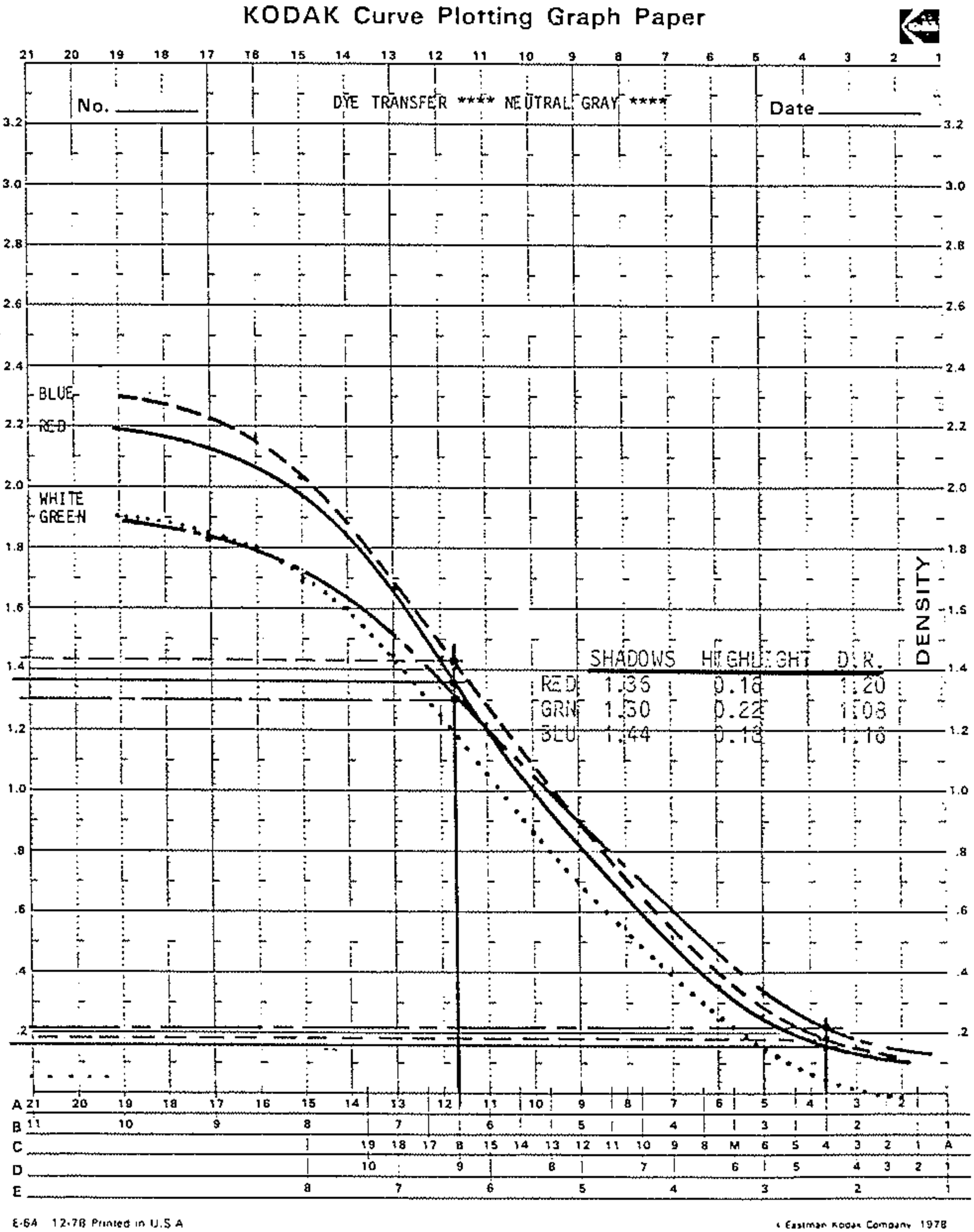

KODAK Curve Plotting Graph Paper
No.
DYE TRANSFER **** NEUTRAL GRAY ****
Date
BLUE
RED
WHITE
GREEN
SHADOWS HIGHLIGHT D.R.
RED 1.36 0.16 1.20
GRN 1.30 0.22 1.08
BLU 1.44 0.13 1.16
DENSITY
E-64 12-78 Printed in U.S.A.
© Eastman Kodak Company 1978

FIGURE 6.1.1-1

Roll the gray scale and make red, green, and blue reflection readings of of the steps. Plot all three curves on a sheet of plotting paper. Examine the slope of the curves. The curves should be concurrent. If one curve slopes drastically from the others take note.

You might try to adjust the contrast by adding more acid or triethanolamine solution to the dye as discussed, but the exact amount required to do this is difficult to determine. It is better to adjust the separation or matrix film contrast to compensate.

You can determine the amount of adjustment required by looking at the difference in density range between the two good curves and the faulty one. If you don't know anything about plotting curves then see the curve plotting section in chapter 4. Proceed as follows:

1.) Locate the shadow and highlight density of the separation on the horizontal axis of the plotting paper. The shadow should be about 0.4 and the highlight should be larger by the value of your target negative density range. For instance, for a target density range of 1.2, it would be 1.6 (1.2+0.4).

2.) Project intersecting vertical lines from the points in step 1. Where these lines intersect the curve project horizontal lines to density points on the vertical axis of the plotting paper. Subtract these densities to determine the print density range. For instance, the red separation had values of 0.16 and 1.36 and the green separation (low contrast) had values of 0.22 and 1.3. The density range of the dye for the red separation would be 1.20 (1.36-0.16); the density range of the dye for the green separation would be 1.08 (1.3-0.22).

3.) The difference in density range between the good curve and the faulty curve is the amount of correction need. In our example this value is 0.12 (1.20-1.08). The density range of the magenta has to be increased by 0.12.

4.) Contrast correction can be made by increasing or decreasing the target density range for the faulty color's separation by the value determined in step 3. In our example, the green separation density range must be increased from 1.2 to 1.32 (1.2+.12). Correction could also be made by increasing the contrast of the matrix film by using the chart in section 5.3. In our example we want a density range increase of about 0.10 so we would use a tanning developer A:B ratio of 1:3.

Example curves for actual dyes are included in this section for your use and examination. In addition to the curve for a dye gray scale print, are single dye curves. You should take special note of the low contrast curves of the contaminating colors, those are the curves we try to mask in the transparency dyes.

6.1.2 Monitoring the Dyes. Once you have mixed your dyes, they will last a long time but you must monitor them from time to time. The contrast of your dyes is directly linked to their acidity. Any substantial change in dye acidity can mean a change in dye contrast. For those without a reflection densitometer monitoring the dye acidity is the next best way to monitor contrast. If you have access to a PH meter then you should measure the PH values of each freshly made dye and keep a record of them. Normal working dyes have a PH value between 3.3 and 4.8. After extensive use the dye PH should be checked. Every 100 prints or so you should check the color integrity of the dyes. A significant departure from normal PH will mean color shifts have occurred in your prints. Slight PH changes can be corrected by altering the matrix film rinse baths. For significant PH changes, the addition of acid or triethanolamine is required to lower or raise PH. Small amounts of acid are added to lower the PH number until it is restored to normal, or small amounts of triethanolamine to raise the PH number.

The PH value for normal dyes as recommended by Kodak are listed below. Curiously, the PH values were different for my dyes even though they were mixed according to Kodak's instructions. Don't be alarmed if your dye PH values are also different than the recommended values. If your dyes produce good prints then the only important thing is to maintain those PH values.

DYE COLOR	KODAK PH	MY PH VALUES
CYAN	4.35	4.0
MAGENTA	4.78	4.4
YELLOW	3.97	3.8
MX-1119 (yellow)	4.74	

If the dye's PH has changed significantly or if you don't have to have a PH meter to check the dyes then check them visually. You can do this by printing a gray step scale and evaluating what you see. Take a 21 step scale and expose three identical sheets of 4x5 matrix film. Use a two hole punch and single pins taped to the easel so they can be registered. Expose the sheets to white light so a density of 2.60 (step 18) in the step scale is barely discernible in the matrix. To insure accuracy develop all three sheets at the same time. Code each step matrix by clipping the corners; no corner for cyan, one corner for magenta, and two corners for yellow.

Make a dye print of the step scale and examine the step scale. The scale should have a neutral color. If there is a color cast then either the steps are not equally exposed or worse, the dyes are not matched. Check the exposures of matrixes by washing them thoroughly and switching the dyes. If a different color cast occurs then the matrixes must be remade. If the color cast is the same then the dyes are not matched, thankfully this rarely happens. Usually this means the PH of the dyes are off a little. Compensate by adding sodium acetate or highlight reducer to the rinse baths to eliminate the color cast. Record this information and compensate every time you make prints.

If you notice any crossover in the prints, that is the highlights and shadows have different color casts, then you'll have to alter the dye PH. Green highlights and reddish shadows are an example of crossover. Try raising the contrast of the other two dyes to get a neutral print by adding a few drops of acetic acid. At the same time lower the contrast of the dye by adding small amounts of triethanolamine. The following chart lists what to do for specific color tints in the highlights.

PH ADJUSTMENT CHEMICAL			
COLOR CAST	CYAN DYE	MAGENTA DYE	YELLOW DYE
RED	Acid	Trieth	Trieth
BLUE	Trieth	Trieth	Trieth
GREEN	Trieth	Acid	Trieth
YELLOW	Acid	Acid	Trieth
MAGENTA	Acid	Trieth	Acid
CYAN	Trieth	Acid	Acid

Be careful, adding things to the dyes can mean double. Experiment with a small quantity of dye and an eye dropper using the replenishment technique. As a start try these quantities of 28% acetic acid and 10% Triethanolamine for one liter of dye.

Dye	28% Acid	10% Trieth
Cyan	21 drops	13 drops
Magenta	12 drops	10 drops
Yellow	47 drops	17 drops

1 Drop=.05 ml

If you have a lot of problems getting the dyes corrected, buy new dyes.

6.1.3 Replenishment of the Dyes. The following technique is excellent for dye replenishment. It is an adaptation of a method described by Ctein in a 1980 Petersen's Photographic article. After you have mixed the working dyes and before you use them, make up 100 milliliter samples of reference dye for replenishment determination. Dilute the cyan and magenta dyes because they are too dense for the use we have for them. Dilute the cyan working dye 1 part dye to 19 parts water and the magenta 1 part dye to 4 parts water; the yellow dye should not be diluted. Pour the samples into identical vials or test tubes and seal them to prevent evaporation.

Using the reference samples to determine replenishment is a fairly accurate way to replenish working dye. After 10 sheets of film have been run through the dyes, make up 100 ml test samples (50ml for the yellow) of the working dyes. Dilute in the same proportion as the reference samples; the cyan 1:19, the magenta 1:4, and the yellow undiluted. **Be sure to put the test samples in containers identical to the reference samples.** Compare the test samples with the reference dyes. If they look identical then no replenishment is necessary. If the test samples look a little lighter than the reference samples then you must replenish the working dyes. Take an eye dropper, add one drop of concentrated dye to the test sample, mix the sample thoroughly, compare the test to the reference sample and keep adding drops until the test sample matches the reference samples. The number of drops required to restore the test sample to the same concentration as the reference sample determines how much dye concentrate is required to replenish the working dye. The following chart will tell you how much concentrate to add to one liter of unreplenished dye to replenish it. The chart assumes a 100 ml test sample; double the figures for a 50 ml test sample.

NO.OF DROPS	CONCENTRATE TO BE ADDED PER LITER OF DYE		
	CYAN	MAGENTA	YELLOW
1	10.0 ml	2.5 ml	0.5 ml
2	20.0	5.0	1.0
3	30.0	7.5	1.5
4	40.0	10.0	2.0
5	50.0	12.5	2.5
6	60.0	15.0	3.0
7	70.0	17.5	3.5
8	80.0	20.0	4.0

1 DROP= 0.05 milliliter (A SMALL PIPETTE MAY BE USED INSTEAD OF AN EYE DROPPER FOR MORE ACCURACY)

Kodak recommends this alternate method of dye replenishment. Although it is not always accurate, it is a good approximation. Replenish the dyes after a certain number of matrixes have been used in the dye bath. Add the following quantities of dye concentrate, without dye buffer, per quart of dye.

SIZE (in)	NUMBER OF MATRIXES	AMOUNT OF DYE CONCENTRATE
8X10	4	2 ml
10x12	2	1.5 ml
16.5x21.25	2	4 ml

It is not necessary to replenish as frequently as the chart recommends. Try replenishing after 10 sheets of film. There are some serious drawbacks with the Kodak method because it assumes that each matrix absorbs the same amount of dye, which is not true. You may do more damage than good if you use the Kodak scheme without verifying the effects because the amount of dye a matrix absorbs is dependent upon the image.

6.2 DYE TRANSFER PAPER AND PAPER CONDITIONER.

```
MATERIAL
11X14 Dye Transfer Paper        <3.19>

CHEMICALS
Paper Conditioner               <3.17.5>
Distilled Water

EQUIPMENT
11X14 TRAY
```

The dye transfer conditioner comes in a quart bottle which makes a gallon of paper conditioner. Use distilled water to insure proper PH. Dye transfer paper can be soaked in the conditioner up to two hours before use. Any paper that is not used after it's soaked in the conditioner can be dried and reused. When you are done with the paper conditioner, filter it. In fact, you should filter the conditioner before it is used because sometimes a scum or mold will form in the conditioner. This mold is not harmful but should be filtered. Paper conditioner will last quite a while. Discard it only after it has turned the color of strong tea.

Dye transfer paper does not require any long discussion. Before you soak it in the conditioner, clip the upper right-hand corner with the emulsion facing you. The emulsion is hard to identify when the paper is wet. Put it in the tray **EMULSION DOWN**.

Black and white enlarging paper can be used in place of dye transfer paper if you run short or cannot get any. The paper is prepared by fixing it in Kodak Photo-fix or Fixing Bath F-5 fixer or any similar hardening fixer having aluminum salts. Do this operation under a safelight, although most paper can be fixed under normal room light. This substitute paper has a minor color cast when compared to dye transfer paper but this is easily eliminated. The process works with both RC and fiber base paper but don't use RC paper, it's not archival. Kodak made an evaluation of some of their papers for use in dye transfer. The Kodak evaluation of fiber base B&W papers is listed below:

PAPER	EVALUATION
KODABROMIDE,DW,F	Good,slightly blue
MEDALIST,DW,F	Good quality
KODABROMIDE,SW,F	Good quality; slightly cyan; loss in contrast
MEDALIST,SW,F	
POLYCONTRAST,SW,F	

It is very important to dry the print as quickly as possible. The longer it takes a print to dry, the greater the loss in sharpness because the dyes tend to bleed slightly. Dry the print with a hair dryer, if necessary. A good way to quickly dry a print is to use a dry mount press as a print dryer. Put a clean felt pad in the press, lay the print on the pad, with the emulsion towards the felt pad, close the press, and leave the print in the press for about one minute at 200 degrees Fahrenheit.

6.3 DYEING AND ROLLING A MATRIX.

MATERIALS
Dyes
Dye Transfer Paper
Exposed and Processed Matrixes

CHEMICALS
Acetic Acid <3.17.4>
Distilled Water

EQUIPMENT
7 11x14 Trays
Print Roller <3.7>
Transfer Easel <3.6>
Dry Mount Press(optional)
Squeegee

The print rolling process is done in room light. The procedure for rolling the print is fairly simple. The paper is soaked in the conditioner and placed on the transfer easel. The matrixes are expanded in hot water then inserted into the dyes for five minutes or more. The matrix is removed from the dye, then rinsed in two,

Roll forward with a smooth action.
Allow forward motion of roller to
pull matrix downward.

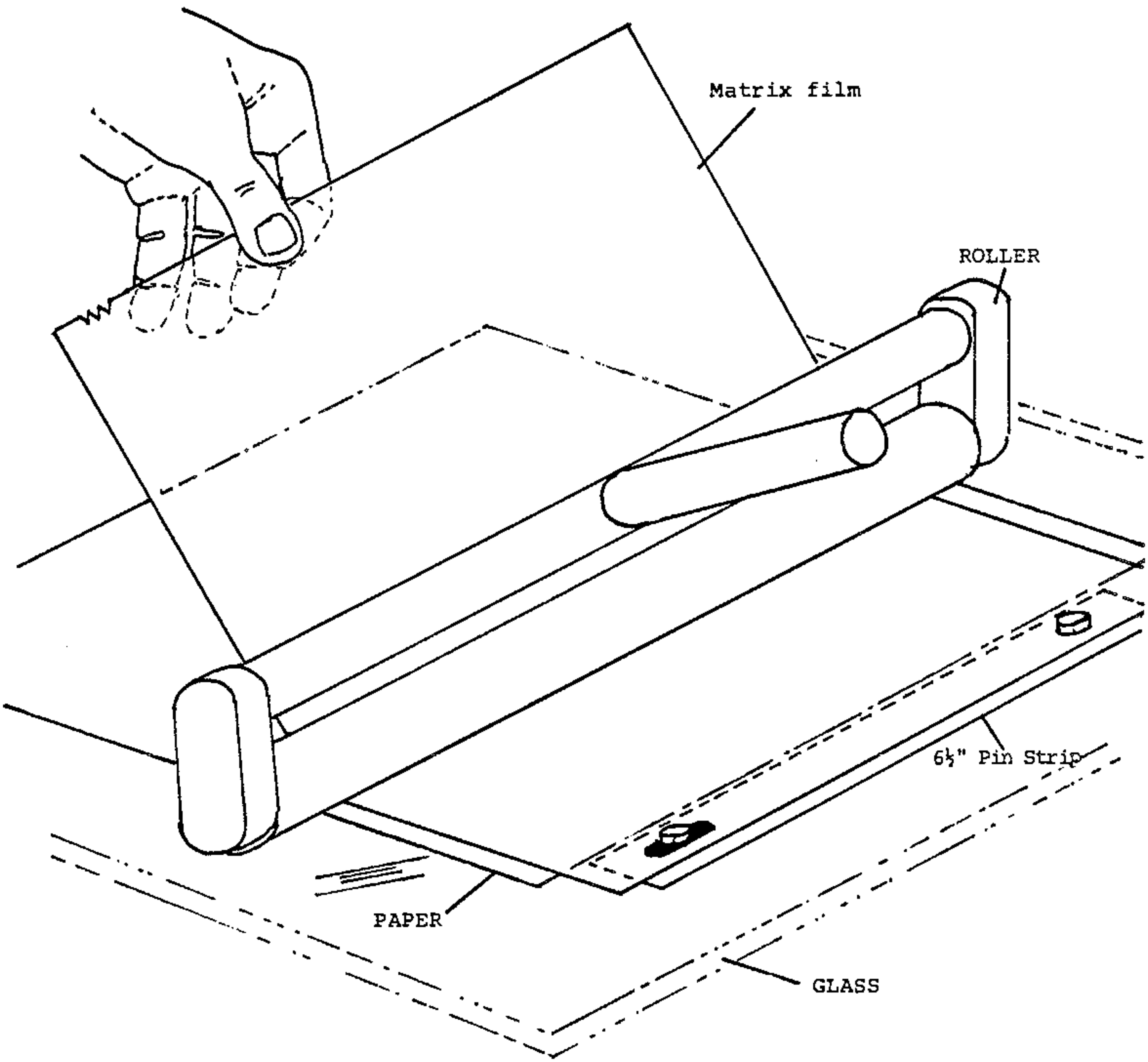


Figure 6.3.1

1% acetic acid baths. The rinsed matrix is transferred to the paper and the process is repeated for the next matrix. The magenta matrix is rolled first, then the cyan, and finally the yellow.

Set your seven trays out. Three are for the dyes, two for the acid rinses, one for the paper conditioner, and the last for rinsing out the film. Generally, I locate the conditioner away from the dyes to avoid any accidental splashing which might contaminate the dyes. Put the dye transfer paper in the conditioner before you set out the rest of the chemicals.

Mix enough 1% acetic acid for your needs. For 10x12, mix about 4 liters. Mix 10ml of glacial acetic acid per liter or 37ml of 28% acetic acid per liter. Most ordinary tap water is fine for this purpose, but if you have particularly harsh water, or highlight staining, use distilled water. For 10x12 matrix film use one liter of 1% acid per rinse bath.

Take care of your roller. Always store it, roller up. This helps preserve the roller from unnecessary wear and keeps the surface clean. Always check your roller for dirt before rolling your prints. A grain of dirt will leave a permanent dimple in your mat which will show up as a spot on your dye transfer print.

The chief factors which determine the amount of dye transferred are the PH values and the temperature. Although the transferring can take place at most room temperatures, remember that the cooler the room temperature, the slower the dye transfer process takes place.

After you are done transferring, check the mats then wash them thoroughly because the soft emulsion can easily pick up dirt. Though it rarely happens, some mats contain strong residual dye. For those tough cases, clean the mats with Matrix Cleaning Bath CB-5. The formulation is shown in section 6.4. Mix the stock solution 1 part to 11 parts water. Pay special attention to the yellow mat because it tends to pick up cyan and magenta dye from the print during the transfer process. Be sure to hang the mats in the same orientation when drying them.

The steps are:

1. Put the paper in the conditioner for 10 minutes to two hours. Put the paper in the solution **EMULSION DOWN**. Be sure to clip the corner to identify the emulsion.

2. Expand the matrixes. Put each matrix in 120^{O}F water for at least one minute, individually.

3. Remove each matrix from the hot water, drain, and insert into the dyes. Agitate the trays as often as possible. Leave the matrixes in the dyes at least five minutes at room temperature.

4. Prepare the 1% acetic rinse baths. There is a first rinse which is discarded after each rinse and a second rinse which acts as a holding bath. The second rinse is not discarded until it discolors badly. Make the acid rinses with distilled water, if you are unsure of the water quality. Very hard, i.e., alkaline, water can cause slight color stains in the whites and highlights.

5. Remove the magenta matrix from the dye, put the matrix in the first rinse and agitate for one minute, drain, then put into second rinse. Go to next step.

6. Remove the paper from the conditioner. Let it drain. Position it on the transfer easel, **EMULSION UP**, next to the register pins. Squeegee off the excess moisture. Make sure the paper has no air bubbles under it. Use a clean towel to remove any excess moisture. Make sure there is no grit on the surface; it would damage the matrix emulsion. Remove any conditioner from your hands by rinsing them in 1% acid. Conditioner will cause fingerprints on prints and can get into the rinse baths.

7. Set print roller and towels close by. Remove magenta matrix from second rinse and let it drain. Carefully place the punched end of the matrix on the register pins of transfer easel, but don't lower the print onto the paper. Run finger between pins to smooth the edge of film into position. There should be a continuous bead of liquid between the glass and film at the pins. Hold opposite end of film so it is curled upward away from the paper emulsion. With free hand grab print roller and place over register pins. Smoothly roll the roller forward with light pressure, do not bear down, and roll the matrix flat. The roller should gently tug matrix from your hand. Leave all matrixes in place for five minutes or more. If you have a very heavy mat, try adding some heat by soaking a large terry cloth towel in hot water, draining most of the water from it, and laying it on top of the matrix. The heat will help the transfer.

8. Prepare the cyan mat by repeating step 5 and 7.

9. Carefully remove the towel. Remove matrix by placing roller at matrix edge opposite pins. Lift matrix by allowing the roller to be pushed backwards towards register pins. Place matrix in hot water 120^{O}F to rinse. Hang up to dry or reinsert into dye for next print.

10. Repeat steps 7 and 8 for cyan matrix and last, the yellow matrix.

11. After the matrixes are transferred, dry the dye print. Use dry mount press to dry print. After the mats are rinsed and dried, store the dry mats in the yellow folders which come in the matrix film box. Only two are needed to store three matrixes. If one folder is inserted in the other, three spaces are created for the film.

There is some controversy about whether it is better to transfer the cyan or magenta matrix first. Either way is fine, but the magenta first technique helps cover some magenta transfer problems.

6.4 FINE COLOR CONTROLS.

MATERIALS
none

CHEMICALS <3.17>
2 lbs. Sodium Acetate
8 oz. Sodium Hexametaphosphate(Calgon)
32oz. Ammonium Hydroxide(Clear Ammonia)
8 oz. Potassium Permanganate
8 oz. Sodium Bisulfite
8 oz. Sodium Hypochlorite(Chlorox)
16oz. Acetic Acid
8 oz. Sulphuric Acid(optional)
1 btl. Photo-Flo

EQUIPMENT
Kodak Viewing Filters <3.21.4>
10 ml pipette

Often, after the initial print is rolled, you will notice that the color or contrast will require some adjustment. You will need to spot the print or remove dark spots from the print. Even the most carefully made matrixes will have some flaws. The same is true of any color process. The difference is that Dye Transfer allows you to adjust a large number of things with a few chemicals. A good practitioner will keep records of what was done to correct a print and you should too. Keep a card file on each print or write pertinent information on the folders of the matrixes.

Kodak has a manual on retouching which is well worth having. In it is a section on retouching dye transfer prints. It costs about $25.00. Condit also sells this book. Ask for:

"Professional Photographic Retouching Techniques"
Kodak Publication No. E-97
Cat. No. 149-1257

If you want to make changes to a dye transfer print there are a number things that can be done. The flexibility of dye transfer in this respect has no rivals in the multilayered color processes. Most color processes allow you to make two types of changes; they are density and color. Dye transfer allows you change contrast as well as density and color. These three variable changes can be made at three points in the process. They are:

1.) at the matrix film development stage, 2.) in the dyes themselves, and

3.) in the first acid rinse.

1.) At the matrix film development stage you can change the contrast of the mat by altering the ratio of part A to part B tanning developer. This is discussed in section 5.1.3. If you make a mat more contrasty, you get a slight increase in density and a small increase in color saturation. If you make a mat less contrasty, you decrease the print density slightly and get a slight loss of color saturation. This has no effect at all on blacks in your dye print. Obviously you have to know what you want in your print before the matrix film is processed or you must be willing to make a new set of mats after you've seen the dye print.

2.) By changing the PH of your dyes you can make substantial density changes, contrast changes, and color changes in a dye transfer print. You do this by adding acid or trieth to the dye. Normally, a high contrast, normal, and low contrast batch of dyes is made up. Ordinarily, I would advise against altering the dyes beyond this. This is discussed in section 6.1. Using a high contrast dye not only increases contrast but also increases color saturation, and overall print density substantially. The blacks in the print will be very dense. On the other-hand the low contrast dyes significantly reduce contrast, print density, and color saturation. Unlike the high contrast dye, the low contrast dye has no noticeable effect on the blacks in a dye print.

3.) The final way to make changes to a print is to alter the matrix film acid rinse bath. The four additives used are:

a) sodium acetate (NaAc)
b) highlight reducer (R-18)
c) concentrated acetic acid
d) water to reduce acidity

a) Sodium acetate (NaAc) is used to reduce the color balance of each or all of the dyes in the print. It is added to the first rinse in varying quantities depending on the change required. The maximum color change is about 15CC at its limit. When NaAc is used there is a small increase in contrast and some reduction in print density.

b) The highlight reducer, dubbed R-18 by Kodak, is used to reduce the highlight color but not effect the lower values. It is added in varying amounts for proportionate results to one or all of the dyes. The effect of lightening the highlight values is to increase the print contrast somewhat, although not as severely as high contrast dye. There is a very slight shift in the color and minor highlight density reduction.

c) Adding more acid to the first acid rinse increases the amount of one or all colors in a dye print. The effect is proportional to the amount added to the rinse but reaches a limit very quickly. The increased acidity of the rinse increases the print contrast slightly. The shadow values undergo a greater increase in density than the highlights.

d) Adding water to the first acid rinse reduces the amount of dye it picks up. The effect is to reduce one or all of the dye colors. The technique is mainly used when doing double transfers.

There are other things that will alter a print. For instance, the contrast of a color negative can be altered by using a mask. This will not be discussed but information about color negative masking can be obtained from Kodak publication E-66, "Printing Color Negatives".

This section discusses the common chemicals or solutions used in dye transfer, how they're made, and what they are used for. Next we will discuss the three standard additives used in the first rinse bath. This includes print color reduction, highlight color reduction, and contrast control. Later we will briefly discuss some special techniques and controls that can be used in dye transfer.

6.4.1 Chemical Solutions. You should use a scale when making up these solutions. However, sometimes I don't feel like measuring chemicals so I have converted some weights into tablespoons and teaspoons. Although this is not as accurate as a scale, for a lot of applications, they are close enough. Use them at your own discretion.

Chemical	Tbsp	Tsp
Anti-Calcium	9.6	3.2
Sodium Acetate	7.6	2.5
Sodium Bisulfite	20.5	6.8
Sodium Hexametaphosphate	19.8	6.6
Potassium Permanganate	24.5	8.1

The formulas will show teaspoon equivalents but be aware that the solutions will not be exact.

There are a number of chemical solutions you will need to really make your final prints suit your tastes. These solutions allow you to increase or decrease contrast of one or all colors and some will remove unwanted color tints. They are listed on the following page.

1. Sodium Acetate Solution- A 5% solution of this chemical will make small reductions in color or overall print density.

Sodium Acetate	5g	1oz	11tsp
Water(warm)	100ml	20oz	20oz

2. Highlight Reducer (R-18) - This solution will remove color in the highlight areas of the print but will not affect the shadow areas of the print.

Calgon (Sodium Hexametaphosphate)	1.2g	18grn	1/8tsp
Water to make	1 l	32oz	32oz

3. Clearing Bath (CB-5) - This solution is used to clean matrixes. Usually hot water is sufficient to clean a matrix, but every so often this solution is useful in removing tough stains.

Calgon (sodium hex.)	120g	4.0oz	6.0tbsp
28% Ammonia	48ml	1.5oz	1.5oz
Water to make	1 l.	32oz	32oz

4. Dye Bleach - Occasionally a particular color has to be removed for a print. There are bleaches for each dye. **Always follow any bleaches with a 1% acetic acid rinse to restore PH.** Some of the chemicals listed below make use of sulfuric acid, I recommend you substitute acetic acid. The sulfuric acid causes emulsion problems when used in combination with potassium permanganate. The formulas are from Kodak's E-80 manual. For best results use the bleaches in the form of a puddle, wiping bleaches on tends to smear color. The bleaches for each dye is listed below:

a) Cyan Bleach. A 1/4% solution of potassium permanganate with a sodium bisulfite clearing solution.

Bleach

Potassium Perman	2.5g	36grn	1/4tsp
Water to make	1 l.	32oz	32oz

Rinse

Sodium Bicarbonate	1.0 g
Water to make	1.0 liter

b) Alternate Cyan Bleach.

Bleach

Sodium Persulfate	80.0g
Sulfuric Acid	60.0ml
Water to make	1.0 liter.

Rinse

Sodium Bicarbonate	1.0 g
Water to make	1.0 liter

c) Magenta Bleach. The bleach for this dye is undiluted Photo-flo. This must be used when the print is dry. Use a cotton swab to remove color.

d) Yellow Bleach. A 5% solution of sodium hypochlorite or a full strength solution of Chlorox bleach or other similar bleach. Use this bleach when the print is dry.

```
Sodium Hypo.        5g   19grn
Water to make      1 l.  32oz
```

e) Alternate #1 Yellow Bleach.

```
Ammonium Hydroxide 10ml
Water to make      100ml
```

f) Alternate #2 Yellow Bleach.

"Efferdent" denture cleaner.
(may not be archival)

g) Total Bleach.

```
Part A
Hot Water (175 F)          350.0ml
Potassium Permanganate      50.0 g
Water to make                1.0 liter

Part B
Water                      950.0ml
Sulfuric Acid to make        1.0 liter
(always add acid to water)

Clear Bath
Sodium Bisulfite            10.0g
Water to make                1.0 liter
```

h) Alternate Total Bleach.

"Downy Fabric Softener"
(may not be archival)

5. Kodak Reducer - This potassium permanganate solution can be used to remove any dark spots on the print. The spot must be rinsed with a 1% sodium bisulphite solution.

```
Part A
Potassium Perm.    52.5g  1.75oz   6tsp
Water to make       1 l.   32oz    32oz

Part B
Water               1 l.   32oz
Sulphuric Acid     32ml     1oz
Add 1 part A to 1 part B to 64 parts Water.
```

-OR-

```
Part A
Potassium Perm.   5g    19grn    5/8tsp
Water to make  1  l.    32oz      32oz

Part B
Water                 1 l.    32oz.
Acetic Acid         100ml      3oz
Add one part A to one part B.
```

6. 10% Triethanolamine Solution - This solution is used to lower the contrast of the dye. This is not recommended in general. Prints seldom need contrast reduction, and if so other means are available.

6.4.2 Standard Print Controls. There are three standard print controls. First, to reduce overall print color density, a 5% solution of Sodium Acetate (NaAc) is used. Second, to reduce highlight color, Highlight Reducer(R-18) is used. Third, to control contrast to some degree, acetic acid can be added to the first dye rinse to increase contrast.

With the NaAc solution you can reduce a color cast by adding the 5% NaAc to the first rinse of the dye bath. For instance, if the print had a slight cyan cast to it, it could be eliminated by adding 5% NaAc to the cyan's first rinse. To reduce overall density add equal amounts to all three dye rinses. The amount of cyan reduction depends on how much NaAc is used and/or how long the film remains in the first rinse. The maximum percentage of 5% NaAc to add to the first rinse is about 6% of volume. If any more is used, the blacks in the prints get washed out, and the print gets a muddy look to it. To get rid of 10CC of cyan or magenta, try about 40 ml of 5% NaAc to every liter of 1% acid. By volume this is 4% reducer.

By adding R-18 reducer to the first rinse, you can reduce color density in the highlights of a print but not affect the shadows. For example, to get rid of a yellow cast in the highlights of a print, add R-18 to the yellow matrix's first rinse. The net effect of using R-18 in all three first baths of a print is to slightly increase the contrast of print. You can use up to 10% of volume of this reducer with little affect on the blacks of the print. The amount of reduction depends on the amount of R-18 and the time of agitation in the first rinse.

By adding up to 5% of volume, extra concentrated acetic acid to the first rinse of a print you can darken the color of print and increase its contrast a bit. Another way to increase color is to use a 2% first rinse instead of a 1% first rinse. Another good idea is to drain a little extra dye into the first rinse to increase color transfer.

These controls are not mutually exclusive. You can use any combination of controls. In other words, you can use 5% NaAc, R-18, and extra acid simultaneously. If you find yourself using controls too often, it's a sign that your matrixes are not well made.

Make up a record form to keep track of any changes you have made to the print to improve it. Store this with the mats so you won't have to repeat all the hard work. Write the percent volume in the spaces provided for each dye you use. Sample of a possible record is shown below.

DYE	ACID	5%NaAc	R-18	COMMENTS
CYAN				
MAGENTA				
YELLOW				

For example, in order to get an acceptable dye print, you have to add 50ml of 5% NaAc to the cyan rinse bath and 20ml for the yellow rinse. In addition, you should put 30ml of R-18 in the cyan rinse and add 10ml of glacial acetic to the magenta rinse. The yellow dye is the high contrast dye. Assume the volume of the rinse bath is 1 liter. The information would be added to the next chart by percent of volume and stored with the mats.

DYE	ACID	5%NaAc	R-18	COMMENTS
CYAN	--	5%	3%	--
MAGENTA	1%	--	--	--
YELLOW	--	2%	--	Hi-C Dye

6.4.3 Commercial Retouching Chemicals. Dye transfer has been a retoucher's dream for many years because of the ease with which it can be retouched. Over the years retouchers have come up with a number of substances that bleach and remove the dyes. Charles Carrasquito of Los Angeles, California is such a person. He has come up with a set of 10 dye bleaches for the dye transfer process. Some bleaches remove one color, some remove two, some work fast and some work slowly. The dye bleaches are called:

1. On-Color Bleach
2. All Off Bleach
3. All Off-B Bleach
4. All Off-C Bleach
5. Smear and Lighten
6. Buffer Bleach
7. Magenta Off Bleach
8. Orange Off Bleach
9. Green Off Bleach
10. Yellow Off Bleach

In addition, small quantities of yellow, cyan, and magenta dyes are available (without buffer) for retouching purposes. A retouching booklet is included with the initial order. As of 1986, the chemicals come in 1, 4, and 8 ounce sizes for $10.00, $30.00, and $50.00 respectively. If you would like an order form write to:

Retouching Chemicals
Charles Carrasquillo
5478 Wilshire Blvd. #211
Los Angeles, California 90036
213-935-9452

I will give a brief description of each bleach as described by Mr. Carrasquillo.

1. On Color Bleach. Use when slow controlled lightening of an area is needed. Does not smear, you can go over large areas without smearing color into light areas. Color remains in shade. Excellent for cleaning faces, wrinkles, and spots.

2. All Off-Bleach. Lighten a large or small are and stay in color. Rapidly bleach an area to white.

3. All Off-B Bleach. Same as All-Off but gives a cool result.

4. All Off-C Bleach. Same as All-Off but gives the coolest result. Works best for outlining.

5. Smear and Lighten. Bleaches and smears color evenly. For large areas where you want to lighten and remain in color. Can be added to dye for uniform color application. Excellent for evening out unevenly applied dye. Use to grade background.

6. Buffer Bleach. Slow version of Smear and Lighten bleach.

7. Magenta Off Bleach. Removes Magenta in large or small areas. Helps shift a color toward the green. Works much better than Photo-Flo.

8. Orange Off Bleach. Helps shift a color to the blue. Use for subjects like chrome, water, sky which must be shifted towards the blue.

9. Green Off Bleach. Helps shift color towards magenta. Use only to remove small amounts of green.

10. Yellow Off Bleach. Shifts color towards purple. Removes yellow.

With most of the bleaches the print is washed down with a 3% acetic acid bath. The total bleaches require a sodium bisulphite solution to neutralize the excess permanganate. I do not know if these chemicals are archival, but I suspect they are just as archival as the recommended Kodak bleaches.

6.4.4 Special Controls, Etc.

a) Make up a set of spotting colors by drying a small pool of dye on a piece of glass. Use a fine brush and spot as you would any print. Use a little 1% acetic acid to wet the brush. If you want faster color penetration use 3% acetic acid. If you have to apply color in a large area, try wetting the print with a little conditioner. Use cyan to spot red, magenta to spot green, and yellow to spot blue. To spot cyan use yellow and magenta, to spot magenta use cyan and yellow, to spot yellow use cyan and magenta.

b) Use any of the bleaches mentioned in section 6.4.1 to remove dark colored spots. Be sure to use the rinse bath for the permanganate reducers to prevent staining on the print.

c) If your print is really short of a color. Try double transferring that color. Use a plain water rinse bath instead of the 1% acid rinse for the second transfer. Running double transfers will increase the contrast of the print because the highlights will not get as much dye.

d) If you discover that an area of your print did not transfer well and you see some residual dye on the mat, then swab a little 1% acid on the print in that area and re-roll the mat.

e) If you discover gradual color shifts from one side of the print to the other then you have what is called "wedging". It's usually caused by improper development in the separation negatives or mats. Carefully pour some rinse bath + NaAc + R-18 in the area of excess color for as long as needed to even out the color, re-immerse the mat in the holding bath to stop process, and roll mat.

f) Color density may also be removed by shortening the transfer time.

g) Dark spots on the matrix can be removed by gently scraping the spot with a etching knife. Etch in one direction only. Restore the lost surface sheen by applying a little gum arabic on the scraped area.

6.4.5 The Black Printer. Unlike photomechanical printing where a black printer in a necessity, dye transfer printing rarely finds it to be a necessity. Occasionally, there is a need for such a thing when the shadows in a transparency take on bluish cast. To rectify this problem some dye labs make a black shadow printer.

If you have this problem proceed by first making a black separation. Expose a sheet of Super-XX film for one half the red separation time without a filter. Process the film in the same developer and for the same time as that for the red separation. The development time for the black matrix film mat is about one half the red separation mat's time.

A black dye will have to be made since Kodak does not make a black dye. Use the small white glass container of dry neutral Kodak retouching color, Kodak catalog #190- 2378. Mix the entire contents with 1 liter (1000cc) of distilled water, then add 5 ml. of 5% sodium acetate and 2 ml. of acetic acid. Check the neutrality of this dye by rolling a test print. If the color is off a bit then add small amounts of regular dye to the mixture until you have a satisfactory neutral color.

6.5 DYE WITHDRAWAL CONTROL METHOD.

```
MATERIALS
 Matrix or Pan Matrix Film

CHEMICALS
 Tanning Developer

EQUIPMENT
 Enlarger
 47B blue filter
 1.0 ND filter
```

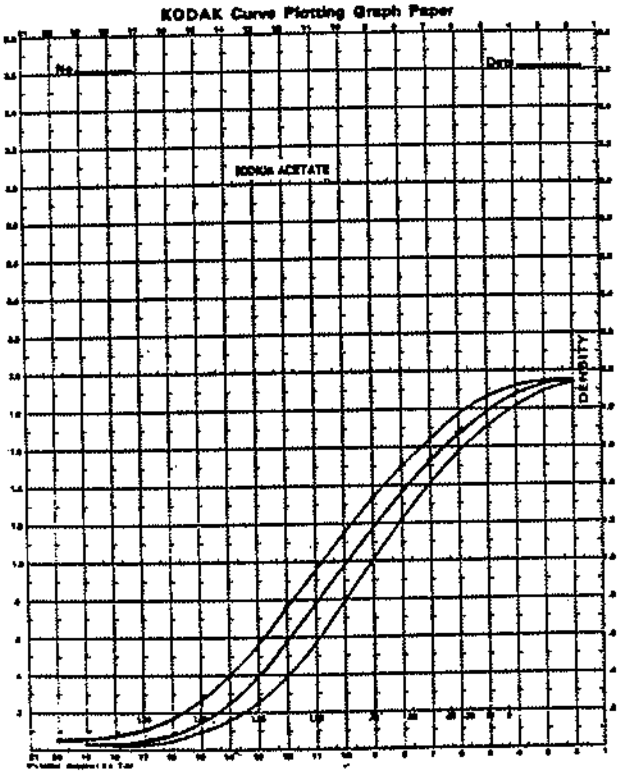
This is a unique technique developed by Robert P. Speck, one of the originators of the dye transfer system, which can be used to clean up highlight stains. The withdrawal technique is quite effective as a substitute for highlight reducer. In fact, a withdrawal matrix can eliminate the need for highlight masking. In addition, this technique can also be used to control color in the midtones of a print, although it is not as effective as sodium acetate. Other applications for withdrawal techniques are flashing, dodging, and block-out printing.

6.5.1 Theory. The withdrawal technique uses a low contrast, negative matrix image made by contact printing the cyan matrix onto matrix film. In this technique, the withdrawal mat is soaked in 1/2% acetic acid and is rolled into contact with the matrix. The withdrawal matrix withdraws a precise amount of dye from the dye soaked mat. The treated mat is then rolled onto the paper. The procedure is repeated for all three matrixes or individual matrixes.

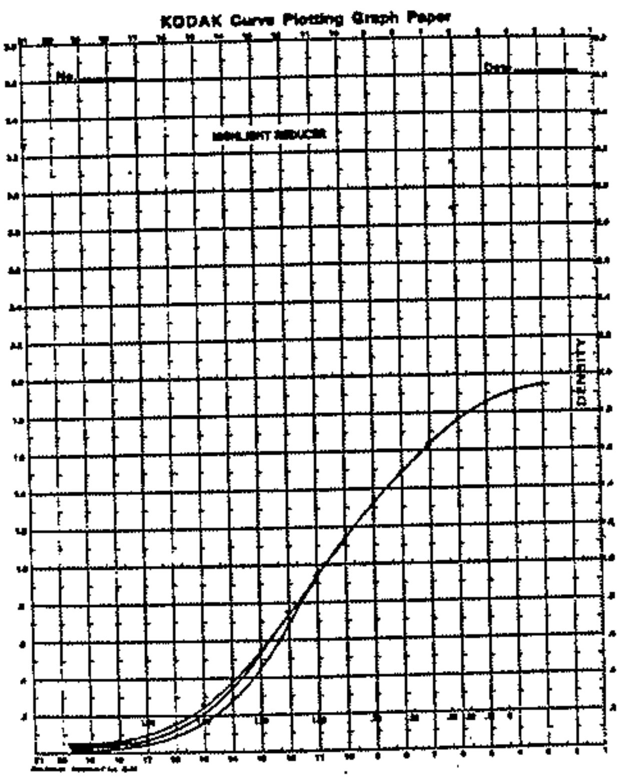
The effect of a withdrawal matrix is to remove dye from the highlights and/or the midtones of the mat. The lower the contrast of the withdrawal matrix, the greater the volume of dye withdrawn, and the greater the effect on the midtones of a print. Lowering the contrast of the withdrawal mat more than its normal contrast requires a special step which will be discussed later.

The accompanying diagram shows the effects on a density curve of a withdrawal matrix in comparison to highlight reducer and sodium acetate.

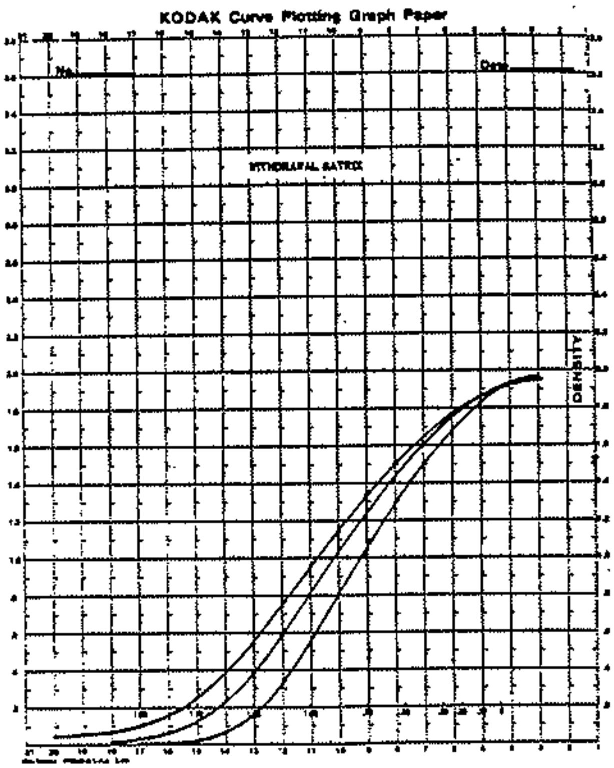
6.5.2 Making The Withdrawal Matrix. Either Matrix or Pan Matrix film can be used to make a withdrawal mat. To take advantage of its usefulness under a safelight, Matrix film can be used to make a



SODIUM ACETATE



HIGHLIGHT REDUCER



WITHDRAWAL MATRIX

Comparison of three color correction techniques
(from Kodak data release 80a)

withdrawal matrix for Pan Matrix film. The cyan printing matrix is used to make withdrawal matrix by contact under a light source.

6.5.2.1 Exposing the Film. Use the enlarger that was used to make the original matrixes as a light source. Raise the enlarger head to the original height and remove the negative. Install a 47B filter under the enlarging lens with a 1.0 neutral density filter. The blue filter serves to lower the contrast of the matrix film. As an option to further decrease the contrast of the withdrawal matrix, dye the cyan matrix in cyan dye and allow it to dry before beginning.

Place the punched, unexposed matrix film on the easel's register pins with the **EMULSION DOWN**. A vacuum easel or cover glass is not needed because absolute sharpness is not required for a withdrawal matrix; the film lies quite flat even without a vacuum easel. Next, register the cyan matrix on top of the unexposed film with the **EMULSION UP.** Make sure the two are in complete contact with each other.

If your printing matrixes were made with Matrix Film 4150, use the same exposure time you used to make the original matrixes. If your printing matrixes were made with Pan Matrix Film 4149 then use an exposure time twice that used to expose the matrix film. Do not worry about overexposure too much because this can be adjusted without making a new withdrawal matrix at the processing step.

6.5.2.2 Developing the Withdrawal Matrix. The withdrawal matrix is developed a little differently than a standard matrix. After the matrix is exposed, develop it in a normal dilution of Tanning Developer, one part A to two parts B. After the film is developed, put the film in a 1% acetic acid bath, rather than fixer, for one minute. The lights can be turned on afterwards, and the matrix "washed-off" in hot water, as normally done. These steps are summarized below.

STEP	PROCESS	TEMP	TIME
1	Tanning Developer	68 F	2 min
2	1% Acetic Acid	68 F	1 min
3	Wash-off	120 F	3 min
4	Rinse	68 F	30 sec
5	Dry		

The processed withdrawal matrix will have low density and contrast. If the matrix is overexposed, the dye absorption properties can be lessened by redeveloping the withdrawal matrix in tanning developer. This will reduce the dye extraction ability of the mat by 50%.

6.5.3 Using The Withdrawal Matrix. The withdrawal matrix is used with all three matrixes to reduce highlights and with any appropriate combination to reduce a particular highlight tint. Before beginning, prepare a 1/2% acetic acid bath and a CB-5 matrix clearing bath. The formulation for CB-5 is shown in section 6.4.1. The CB-5 clearing bath is used to clear the mat of any residual dye after each use. The steps are listed below.

1. Place the mats in the appropriate dyes as normally done. Place the withdrawal matrix in a 2% acetic holding bath.

2. Pull magenta (or cyan) mat from dye, drain, rinse, and put mat into 1% acid holding bath as normally done.

3. Put dye transfer paper on transfer easel as usual.

4. Affix withdrawal matrix to transfer easel register pins and lay on top of dye transfer paper with **EMULSION UP.** Next, put the first printing matrix on the register pins and roll on top of withdrawal matrix and paper. The two matrixes should stay in contact for two minutes.

5. Remove the printing matrix and return it to the 1% acid holding bath, **EMULSION UP.** Next remove the withdrawal matrix from the easel and insert it into the CB-5 bath. Pull the printing matrix from the 1% acid hold bath and roll on the dye transfer paper as normally done for five minutes.

6. While mat is transferring prepare next mat. Clear withdrawal matrix by agitating in the CB-5 clearing bath. Rinse it in three changes of water. Reinsert withdrawal mat into 1/2% acetic acid.

7. Put withdrawal mat on top of transferring mat with **EMULSION UP.** Roll second mat on top of it, in register, as in step 4 for two minutes.

8. After two minutes, remove second matrix and put into 1% holding bath. Remove and put withdrawal matrix into CB-5. Remove first matrix, rinse, and return to dye.

9. Roll second matrix on paper and repeat steps 6 through 8 for yellow matrix. After first dye print is done, evaluate the results. If the print's highlights are not clear then the withdrawal matrix is underexposed and the mat must be remade. If the highlights are washed out then the withdrawal matrix is overexposed, simply redevelop the withdrawal matrix in tanning developer.

6.5.4 Color Correction With Withdrawal Matrix. The withdrawal matrix is normally used to clear highlights, but it can be used to remove color in the midtones of a print. In order to do this, the contrast of the withdrawal matrix must be lower. This is done by making an "intermediate negative" matrix. The intermediate negative matrix is used with the printing matrix to make a set of two withdrawal matrixes. A cyan withdrawal matrix is made for the cyan and magenta printing steps and a magenta withdrawal matrix is made for the yellow printing step. The dual-withdrawal matrixes have an effect similar to color masking but to a minor degree. An intermediate matrix can only be made with Matrix 4150 film because the blue color of Pan Matrix film would nullify the usefulness of an intermediate matrix.

The intermediate negative is made by exposing the matrix film through the three matrixes at once. The three matrixes are stacked on top of a single unexposed matrix and exposed for twice the normal exposure. The intermediate matrix is processed, dyed yellow, and dried. The yellow dye, unlike blue, increases the contrast of intermediate matrix. The increased contrast of the intermediate matrix causes the withdrawal matrix to extends its effects into the midtones of the print.

The cyan withdrawal matrix is made by placing both the cyan printing and intermediate matrix in register and exposing the film. The magenta matrix is made by placing the magenta printing and intermediate matrix in register and exposing the film. The cyan withdrawal matrix is used with the cyan and magenta printing matrixes and magenta withdrawal matrix is used with the yellow printing matrixes. The procedures are identical to those in section 6.5.4 except the yellow dye has its own withdrawal matrix.

6.5.5 Other Uses For Withdrawal Matrix. There are a number of ways to use the withdrawal matrix to manipulate a dye transfer. Listed below are the more common techniques.

6.5.5.1 Flashing. By flashing a withdrawal mat it is possible to lighten the overall density of a dark print. Flashing increases the overall density of the withdrawal matrix causing it to extract more dye from the printing matrix, thereby lightening the prints. An interesting approach is to flash several pieces of matrix film at different exposure levels, without an image. These flashed withdrawal matrixes can be used with any printing matrix to lighten in various densities. In other words, you could use them as you would sodium acetate.

6.5.5.2 Dodging. Normally, it is almost impossible to dodge or burn with the dye transfer process because you cannot dodge or burn each separate printing matrix equally. If you try this approach you would get colored fringes around the edges of the dodged or burned area. With a withdrawal matrix, dodging and burning are quite easy since you only have to dodge or burn the withdrawal matrix. The withdrawal matrix is used with each printing matrix. To lighten an area in the dye print, burn that area in the withdrawal matrix; to darken an area in a dye print dodge that area in the withdrawal matrix.

6.5.5.3 Blocking-out, etc. With a little ingenuity, it is possible to extract dye in particular areas of a print for all kinds of effects. Areas of a print can be completely blocked out by physically removing the emulsion from the withdrawal matrix by hand. The manipulative powers of a withdrawal matrix are limited only by your imagination, so experiment and try everything.

6.5.6 TROUBLESHOOTING.

Dye transfer is a process which has many involved steps. This means that problems are likely to occur simply by the law of averages. Some common problems and their remedies are listed below. At the end of this section a "quick-reference" chart which was put together by Mr. Frank McLaughlin, formerly in charge of the dye transfer area at Kodak. The chart is thorough and easy to use since it is divided into two sections, Matrix Film and Dye Transfer Paper Troubleshooting.

A) PROBLEM: Dark spots on dye print.

CAUSE:

i) Particles of gelatin or dust on matrix film.

ii) Clear spots on negative.

iii) Dust on transparency.

SOLUTION:

i) Swab off matrix with cotton while immersed in 1% acid rinse.

ii) Dye matrix and dry. Place over illuminator, etch off spots with sharp etching knife.

iii) Bleach spot off print with appropriate dye bleach. See section 6.4.1 for dye bleach formulas.

iv) Etch off dye print with etching knife.

B) PROBLEM: Light colored or white spots.

CAUSE:

i) Small air pockets between matrix and paper.

ii) Small hard particle on paper or matrix due to unfiltered paper conditioner or dye.

iii) Dust on negative.

iv) Clear spot on matrix.

SOLUTION:

i) Spot print with dyes.

ii) Carefully examine dye paper, wipe surface.

iii) Carefully remove particle with pointed object.

C) PROBLEM: No color in area of print.

CAUSE:

i) Non-uniform processing of matrix (sometimes called wedging).

ii) Insufficient contact between matrix and paper.

iii) Negative did not receive full development in area of interest.

SOLUTION:

i) Give affected area of matrix extra time in acid rinse.

ii) Apply extra 1% acetic acid to affected area with soft camel's hair brush.

D) PROBLEM: Mis-registration of image.

CAUSE:

i) Movement of easel or enlarger during exposure.

ii) Movement of carrier during exposure.

iii) Using glassless carrier; negative "pops" due to excessive heat.

iv) Movement of dye transfer paper during print rolling process.

SOLUTION:

i) Secure enlarger and easel firmly.

ii) Secure carrier firmly.

iii) Use glass carrier.

iv) Make sure paper is damp but securely squeegeed.

E) PROBLEM: Mottling of image.

CAUSE:

i) Non-uniform dyeing of matrix.

ii) PH of dye or conditioner incorrect.

iii) Paper insufficiently soaked in conditioner.

iv) Dye contaminated.

v) Matrix improperly developed.

vi) Negative improperly developed.

v) Water contaminated.

SOLUTION:

i) Agitate matrix while in dyes.

ii) Agitate paper while in conditioner.

iii) Take care to avoid getting foreign solutions into dye.

iv) Remake matrixes.

v) Use distilled water.

F) PROBLEM: Numerous tiny red, green, or blue spots or speckles on print after matrix removed.

CAUSE:

i) Insufficient contact between mat and paper.

ii) Traces of conditioner on paper surface.

iii) Transfer time insufficient.

iv) Cold room temperature lengthens transfer times.

SOLUTION:

i) Pour small amount of 1% acetic acid on affected area, then re-roll matrix.

ii) Apply moderate heat.

iii) Lengthen transfer times.

MATRIX FILM TROUBLESHOOTING

PROBLEM	REASON	SOLUTION

SPOTS

Black	Dirt on transparency.	Clean transparency, etch matrix or retouch print.
Clear	Clear spot on transparency Dirt on cover glass.	Retouch transparency or negative. Clean glass.
Plus density	Developer splashed on dry matrix.	Keep unprocessed matrices away from developer
Minus density	Dirt in enlarger.	Clean enlarger.

STREAKS

Vertical	Problem with processing technique	Practice developing technique
Horizontal	Processing technique Manufacturing problem	Practice developing technique Refer problem to dealer or manufacturer.
Angular	Dry streak (if hung from corner)	Hang matrices vertically and revise drying technique.

OTHER

Overall heavy mottle	Used hardening fixer	Use proper unhardening fixer
Loss of image in wash-off	Exposed matrix from wrong side	Expose Matrices through the base

DYE PAPER TROUBLESHOOTING

PROBLEM	REASON	SOLUTION

SPOTS

Black	Dirt on transparency.	Retouch print and clean glass..
White	Dirt on printer glass	Same as above..
Heavy Color	Dirt on one matrix	Same as above.
Pastel Color	Dirt in dyes.	Filter dyes after daily usage.
Color in Border	Fingerprints on matrixes	Bleach Borders. Use gloves.

STAINS

Overall density (1 or more colors)	Fogged matrixes	Repair all light leaks in darkroom and equipment.
Large areas	Problems with matrix processing	Practice processing techniques.
Small round areas	Excess easel vacuum. Matrix splashed with developer.	Lower vacuum pressure. Keep processed matrices away from developer.
D-min	Light fog. Age fogged film.	Repair light leaks. Keep matrix film in refrigerated storage.
Loss of D-Max	Transfer time too short	Lengthen transfer time or raise processing temperature.
	Under replenished dyes	Replenish dyes or mix fresh dye.
Bleeding at pin end	Matrix image in liquid bead	Hold end of matrix high enough to keepimage free of liquid bead.
Bleeding at D-Max edges	Exhausted paper conditioner. Low acid content in rinses.	Replace paper conditioner. Use 1% acetic acid

PROBLEM	REASON	SOLUTION
MOTTLE		
Large Irregular areas	Paper conditioner contaminated.	Replace paper conditioner.
	Traces of PHOTO-FLO on paper base on transfer easel.	Remove PHOTO-FLO from transfer area.
	Manufacturing problem	Refer problem to manufacturer or dealer.
	Too much roller pressure.	Use only slight downward pressure.
Small round areas	Manufacturing problem.	Remove PHOTO-FLO from area.
Overall Regular Pattern	Manufacturing problem.	Remove PHOTO-FLO from area.
REGISTRATION		
Overall out of register	Register system not functioning.	Find mis-register point and repair or re-register matrix by eye.
Out at end vertically	Paper shrinking during transfer.	Keep paper moist by changing matrices rapidly.
Out at end horizontally	Uneven tension on matrix end during rolling.	Maintain equal pressure on pins.
Out overall except one corner.	One pin in register system loose.	Find and repair loose pin.
IMAGE		
Colors progressively lighter	Dyes not replenishing properly.	Use additional dye concentrate for replenishment.
Colors completely wrong after one good print	Matrixes in wrong due baths.	Use corner notch code system
D-Max areas lighten progessively	Matrixes retaining dye.	Use CB-5 Clearing Bath.
OTHER		
Matrix sticks to paper	Possible unburned hydrocarbons from water heaters in air.	Improve air circulation and vent heater better.
	Paper and matrix too dry	Keep paper moist on easel, transfer matrix immediately from holding bath and carry over more liquid.
Cracks	Paper dried out	Keep paper in box until ready to use.
Ripples	Dryer too cool	Use higher temperature on dryer

Chemical Safety. Some Rules

1. If dangerous chemicals are swallowed or cause other injuries see a doctor at once.
2. Do not mix chemicals when disposing them.
3. Containers should always be kept closed.
4. When mixing acid to water always add the acid to the water not the reverse.
5. Do not inhale chemical vapors or fumes. Wear a respirator, if needed.
6. Keep chemicals out of the reach of children.
7. All chemicals should be treated as if they are dangerous.
8. Avoid eye and skin contact with chemicals.
9. Store chemicals in a cool, dry place away from bright light.
10. Always wash hands thoroughly after handling chemicals.
11. Always have adequate ventilation when using chemicals.
12. Do not eat, drink, or smoke near chemicals.
13. Wear protective clothing (such as rubber gloves, labcoats, safety glasses, or eye shields.

Dye Transfer Chemicals

ACETIC ACID

This clear, colorless liquid has a very pungent vapor.Glacial acetic acid (99.5%) and photographic (28%) are two commonly available grades of this acid. Vinegar contains about 4 to 6% acetic acid. If stored below 60 degrees Fahrenheit, glacial acetic acid will solidify but may be melted by placing the bottle in warm water.

Precautions: Acetic acid, especially the concentrated liquid (glacial acetic acid), causes severe burns. Use with adequate ventilation. Avoid contact with the concentrated liquid and do not breathe vapors. Keep glacial acid away from excessive heat or open flames.

First Aid: In case of contact, use plenty of water to flush eyes and skin for about 15 minutes. Remove contaminated clothing and shoes. Wash clothing before use.

Use: To stop the development of photographic silver-sensitized emulsions or to increase the intensity of the colors given by certain toners.

AMMONIUM HYDROXIDE (AMMONIA)

This colorless and pungent gas forms ammonium hydroxide when dissolved in water (ammonia water).

Precautions: Do not mix ammonia with chlorine bleaches. Ammonium hydroxide can cause burns. Do not get in eyes, on skin, or on clothing. Avoid breathing the irritating vapor by using only in well ventilated areas. Wash thoroughly after handling.

First Aid: In case of contact, use plenty of warm water to flush eyes or skin for about 15 minutes or more. Remove contaminated clothing and shoes. If taken internally, give copious amounts of lemon juice, orange, grapefruit, or diluted vinegar. Follow with olive oil. Get medical attention.

Use: An ingredient in pre-cleaning solution for metal plate surfaces, such as in photoetching. Ammonia fumes are used to develop diazo materials and for the correction of over-exposure in the gum bichromate process.

AMMONIUM DICHROMATE(BICHROMATE)

An odorless, orange-red, crystalline solid that is readily soluble in water. Ammonium dichromate is more sensitive to light than potassium dichromate.

Precautions: Warning! This compound is flammable. At about 225 degrees Centigrade the decomposition of this compound becomes self-sustaining with spectacular swelling, evolving heat, sparks, or flame. Do not breathe dust or spray from solutions. Causes severe irritation, rash, or ulcers ("chrome sores").

First Aid: In case of contact, use plenty of water to flush skin for at least 15 minutes. If swallowed or in eyes, get medical attention quickly.

Use: Ammonium dichromate has many uses in the arts and crafts. A primary use is as a photoresist in the etching of metal, glass, or ceramic surfaces. This compound is also used in the gum bichromate and mordant dye printing processes.

AMMONIUM THIOSULPHATE

Sold as 60% solution. White or clear crystrals. Solution has PH of 6.5.

Precautions: Use good ventilation. Store in coolplace.

First Aid: If contact with eyes or skin, flush with water. If large amount swallowed, call doctor.

Use: Fixer.

POTASSIUM DICHROMATE(BICHROMATE)

This salt, referred to either as bichromate or a dichromate, is a crystalline, orange-red compound that is readily soluble in water. When struck by light, this compound renders gelatin and other suitable colloids insoluble in water.

Precautions: Dichromate is a poison and may cause cancer. Keep container closed. Avoid contact with skin,eyes, and clothing. Avoid breathing dust or solution spray. Dichromate causes skin irritation, rash, or ulcers, as well as destruction of mucous membranes. May cause cancer of the lung. Swallowing can result in death.......thirty grams have been reported to be fatal.

First Aid: Flush skin or eyes with plenty of warm water if contact is made. If swallowed, get medical attention.

Use: As a light sensitizer to harden suitable colloids, such as in the making of resists for etching metal glass or ceramic surfaces.

POTASSIUM PERMANGANATE

This powerful oxidizing agent is a dark purple, crystalline solid that is soluble in water. Stains given by this compound may be removed by a solution of sodium bisulfite or sodium metabisulfite.

Precautions: Do not contact potassium permanganate with glyceride or ethylene glycol. Danger! Strong combustible materials. Keep container closed. Can cause skin irritation. Harmful if swallowed.

First Aid: Do not get on skin, in eyes, or on clothing. Wash thoroughly after use. If taken internally, give large amounts of water or strong tea. Give an emetic (mustard).

Use: As a reducing agent for the silver image on a photographic print.

PYROGALLOL

Use in Tanning Developer. Fine white powder or large colorless crystals. Oxidizes in air. Turns gray on exposure to light.

Precautions: Poisonous if absorbed through skin or swallowed. Avoid contact with skin, eyes, and clothing.Keep container from light. Wear safety glasses and rubber gloves. Use adequate ventilation. Avoid contact with developing solutions made with pyro, solution turns skin brown and risks poisoning by absorption through skin.

First Aid: If contact with skin or eyes, flush with water for 15 minutes. If inhaled or ingested see, doctor immediately. Pyro can cause liver and kidney degeneration and loss of oxygen to blood stream.

Use: Tanning developer for dye transfer.

SULFURIC ACID

A clear, colorless, odorless, oily liquid that dissolves in water or alcohol with the evolution of much heat and with a contraction of volume. Because of its great attraction for water, sulfuric acid removes water from the air or from organic substances causing them to char in the process.

Precautions: Danger!!! Causes severe burns. Keep container closed and handle with caution. Sulfuric acid is corrosive to all body tissues, so do not allow contact with skin, eyes, or clothing. Do not inhale fumes. **Ingestion may cause death.** Always add acid slowly to water when diluting the acid. Wash thoroughly after handling.

First Aid: In case of contact, immediately flush eyes or skin with water for at least 15 minutes. Remove contaminated clothing and shoes. Wash clothing before re-use. Get immediate medical attention.

Use: As an ingredient in bleaches for silver images (photographic).

SODIUM ACETATE

This is a white powder. It is anhydrous and absorbs water from the air. The white crystal is very soluble in water. It has a PH of 8.9 in solution with water at 29 degrees centigrade.

Precautions: Avoid contact with eyes and skin. Usewith good ventilation. Harmful if swallowed in largequantities.

First Aid: If contact with skin or eyes, flush with water. If inhaled, remove from area. If large quantities swallowed, call doctor.

Use: Used in fixers and stop baths and the dye transfer process.

SODIUM BISULFITE

White powder or crystals. Has mild rotten egg smell. Only partially soluble in water. Soluble to 1 part to 3.4 parts water. Forms acidic solution when mixed with water.

Precautions: Avoid contact with acids or oxidizer agents. Gives off toxic fumes when heated. Use with good ventilation. In concentrated form it can cause irritation in eyes, to the skin, or nose membranes. Wear safety glasses and rubber gloves.

First Aid: If contact with eyes or skin, flush with water. If inhaled, remove from area. Harmful if swallowed, so call a doctor.

Use: Used to make acid fixers. Used as clearing bath in E-6 chemistry. Used with some developing agents.

SODIUM HEXAMETAPHOSPHATE

Sometimes called Calgon. Can be found as white powder, flakes, or particles. Very soluble in water. Prevents compounds like calcium from precipitating out of solution.

Precautions: Avoid contact with skin. Use good ventilation. Do not swallow.

First Aid: If contact with skin or eyes, flush with water. If inhaled, remove from area. If swallowed, give large amount of water or milk. Call doctor.

Use: Prevents precipitation of magnesium, calcium, other salts.

SODIUM HYPOCHLORITE

In solution called bleach. In solution, a pale green color with sweet but disagreeable odor. As powder in absence of air, a yellow-green color. House bleach contains 5% plus, lye, and chlorine.

Precautions: Keep container upright, in cool place. Do not breathe fumes and have good ventilation. Do not put in contact with ammonia or ammonium compounds. Avoid contact with skin or eyes.

First Aid: If contact with skin, wash with soap and water. If contact with eyes, wash with water for 15 minutes and call doctor. If swallowed, give sodium bicarbonate(soda) and plenty of milk, and call doctor.

Use: Use as clothes bleach, a hypo eliminator.

TANNING DEVELOPER

Use in Tanning Developer. Fine white powder or large colorless crystals. Oxidizes in air. Turns gray on exposure to light.

Precautions: Poisonous if absorbed through skin or swallowed. Avoid contact with skin, eyes, and clothing.Keep container from light. Wear safety glasses and rubber gloves. Use adequate ventilation. Avoid contact with developing solutions made with pyro, solution turns skin brown and risks poisoning by absorption through skin.

First Aid: If contact with skin or eyes, flush with water for 15 minutes. If inhaled or ingested see, doctor immediately. Pyro can cause liver and kidney degeneration and loss of oxygen to blood stream.

Use: Tanning developer for dye transfer.

APPENDIX -B
MAKING DUPLICATE TRANSPARENCIES

MAKING DUPLICATE TRANSPARENCIES

MATERIALS 4x5 Kodak Ektachrome Duplicating Film 6121 **CHEMICALS** Kodak E-6 Color Processing Chemistry **EQUIPMENT** Enlarger w/tungsten or tungsten-halogen light source 2B UV Filter Color CP filters or color head Viewing filters

One of the problems encountered when making separations from 35mm transparencies is the need to make enlarged separations. One alternative is to make 4x5 or 8x10 duplicate transparencies. In addition, color corrections can be made in the dupe if the original transparency has any color shifts or if you wish to make artistic color changes.

Kodak Duplicating Film is easy to use. A filter pack is installed in the enlarger and the 35mm film is projected onto the film. The filter pack recommendation comes supplied with the film. Be sure to use the 2B UV filter.

The optimum exposure for this film is about 10 seconds. Times too far from this time will cause reciprocity problems and color shifts. Use a test strip to obtain the overall exposure but readjust the exposure time to get the exposure as close as possible to the 10 second exposure time. The effective ASA is about 12 at 10 seconds, for tunsten light.

Make the first test dupe of a 35mm transparency with a 18% gray card and a color separation guide to aid in making filter pack adjustments. To make color adjustments simply add the appropriate filters to the filter pack in much the same way as you would for any reversal paper. If the dupe needs more magenta, then add magenta to the color pack. Color correction is very straightforward.

Once the transparency is made, spotting is done with Kodak E-6 Transparency Retouching Dyes. Information on retouching transparencies can be found in Kodak publication No. E-68, "Retouching Ektachrome Transparencies (Process E-6).

C.1 PREPARATION.

Before beginning you should make a number of preparations to insure good sharp dupes.

1. This film is designed for use with standard enlarger bulbs, such as the #212 and #302, or tungsten-halogen lamps (often used in most color heads). Any other type of light source will yield unsatisfactory results.

2. Use a good lens such as Nikor, Rodagon or Componon. The lens should be longer than normal. This insures good coverage and sharpness. Use at least a 75mm lens, I prefer to use a 135mm lens because of the image size requirement and its greater coverage. Make sure the lens is clean as possible to minimize light flare.

3. Minimize any light leaks and try to eliminate any sources of light reflection.

4. Raise the enlarger to the proper height. Set the light source to approximately 1/2 footcandle. You can achieve this by setting your light meter to 400 ISO(ASA), and 1/8 second. Adjust the lens aperture to obtain a meter reading of f16 off a white card.

C.2 PROCEDURE.

1. Install the Filter Pack.
Install recommended filter pack which comes with the film. Remember to use the 2B filter. If you don't have a recommended filter pack try 10Y + 15C.

2. Make a Trial Exposure.
Make three 10 second exposures, one at 1/2 footcandle, one stop under and one stop over this setting. Make a little cardboard jig so all three exposures can be made on one sheet of film. Cut a piece of cardboard to a dimension of 5x5 inches. Make two equally spaced cuts to within 1/2 inch of one edge. Bend the three flaps back to form three hinges. The hinges must be able to be lifted and lowered. Put a small piece of tape at the end of each hinge so they can be secured in place. Tape the jig to the easel, the film must be able to slide underneath it. In the dark, slide the film, emulsion up, under the cardboard jig. Simply lift each hinge for each exposure and lower and secure it afterwards.

3. Process the Film.
Process the film in E-6 chemistry.

4. Evaluate the test.
Evaluate the transparency. Pick the f-stop which yields the best exposure. If any slight exposure correction is required adjust the aperture, try to keep the time as close as possible to 10 seconds. Use the Kodak viewing filters to determine any filter correction required. Make the correction to the filter pack. The evaluation is very similar to what would be done with any positive material, such as Cibachrome.

C.3 LOWERING TRANSPARENCY CONTRAST.

Although Kodak claims that duplicating film does not require contrast reduction masking of the transparency generally the opposite is true. The mask is made the same way color masks except no filters are required. The contrast reduction mask is registered with the 35mm transparency when making the 4x5 dupe.

C3.1 ALTERNATE METHOD #1.
If you have a color densitometer then use the method described in section 4.2d. The method in section 4.2d requires a color densitometer capable of reading the density range of the transparency. If you are not able to determine the transparency's density range then you must make a guess about the density range of the transparency. The table below gives the necessary mask gamma for different 'best guess' transparency contrasts. Obviously, this method is not as accurate as the method described in section 4.2d.

TRANSPARENCY CONTRAST	MASK GAMMA
VERY HIGH	0.40
HIGH	0.35
MODERATELY HIGH	0.30
NORMAL	0.25
MODERATELY LOW	0.20
LOW	0.15
VERY LOW	0.10

C3.2 ALTERNATE METHOD #2.
If you have no densitometer at all then use the following method. It is the technique described in some Kodak publications. It is the least desirable method because there is no consideration of transparency contrast taken into account. Non-the-less, some masking is better than no masking at all.

The mask is made on Pan Masking Film 4570. In addition to this, you will need a diffusion sheet to diffuse the image, and a piece of scratch free glass to keep the film flat during exposure.

The mask can be taped to the original 35mm transparency or the registration carrier can be used. In either case there should be good contact between the transparency and the mask. See section 4.2 for information on how to prepare the transparency if you use the registration carrier setup.

Set the enlarger lens aperture to its widest opening, then raise or lower the enlarger head until the illumination is about 3 footcandles. You can obtain 3 footcandles by using a light meter or an in-camera meter. Set the light meter for 400 ISO (ASA), the shutter speed at 1/8 second, and the aperture setting at f5.6. Take a reflection reading off a white card at the easel height, raise or lower enlarger head until the illumination matches the light meter's settings. Once the illumination is set, close the aperture down by 4 stops.

Lay a piece of black paper on the easel to reduce any light reflections. In the dark, lay the Pan Masking Film with the emulsion side up on the easel, then lay the diffusion sheet on top of it (frosted side up), next lay the transparency on top of the diffusion sheet with its emulsion down, and place a clean piece of glass on top of transparency. The exposure will be made through this assemblage. Try an exposure time of 8 to 10 seconds.

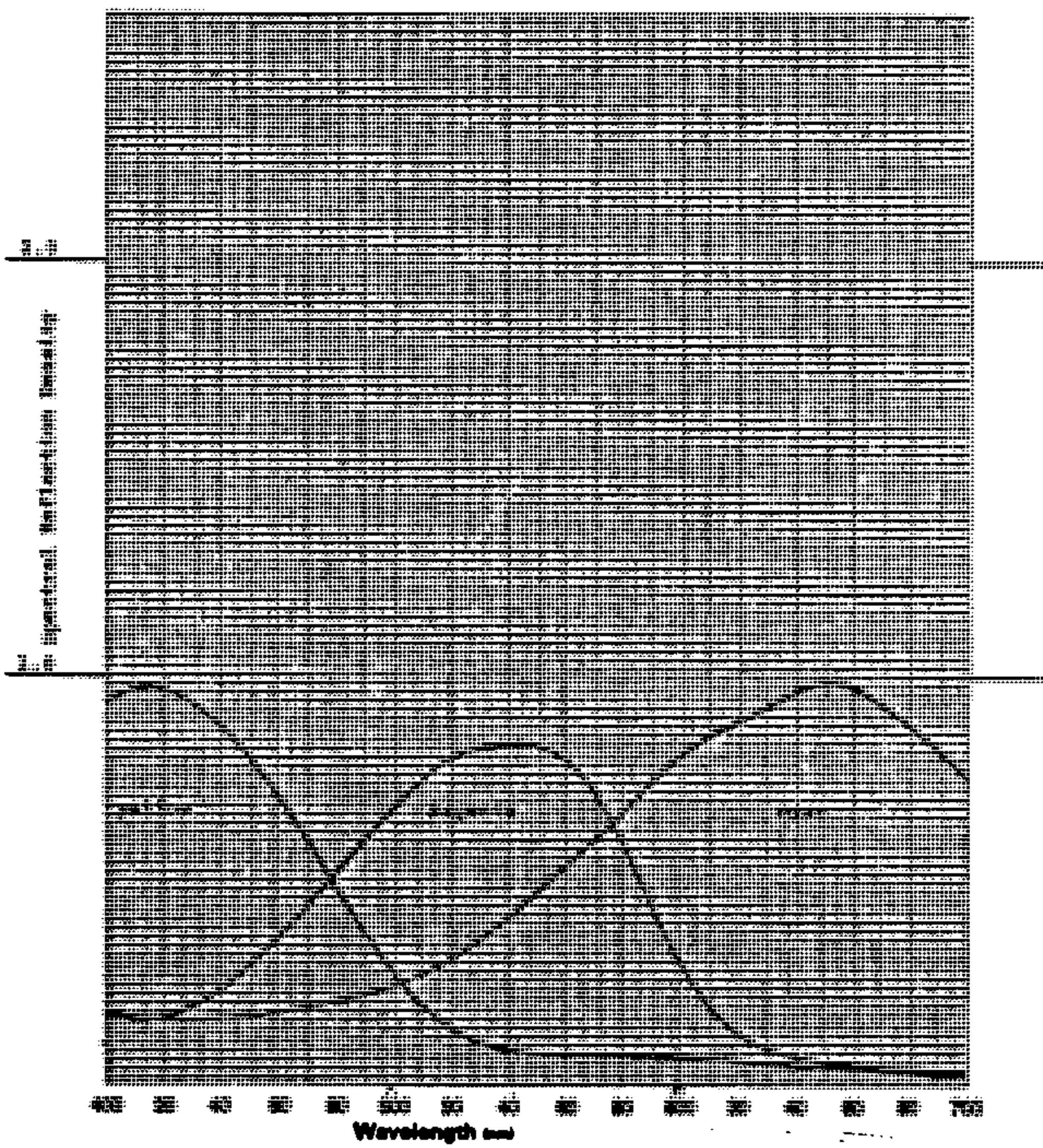
After the exposure is made, develop the mask for 3 minutes in HC-110 dilution F (1:19) or DK-50 (1:4) at 68 degrees F. The film should receive continuous tray agitation.

The mask should be registered on the base side of the transparency and the transparency should be placed **EMULSION DOWN** on the carrier. The duplication film exposure times will be about 1-1/2 times longer than that for an unmasked transparency.

CURVES AND SPECTROGRAPHS

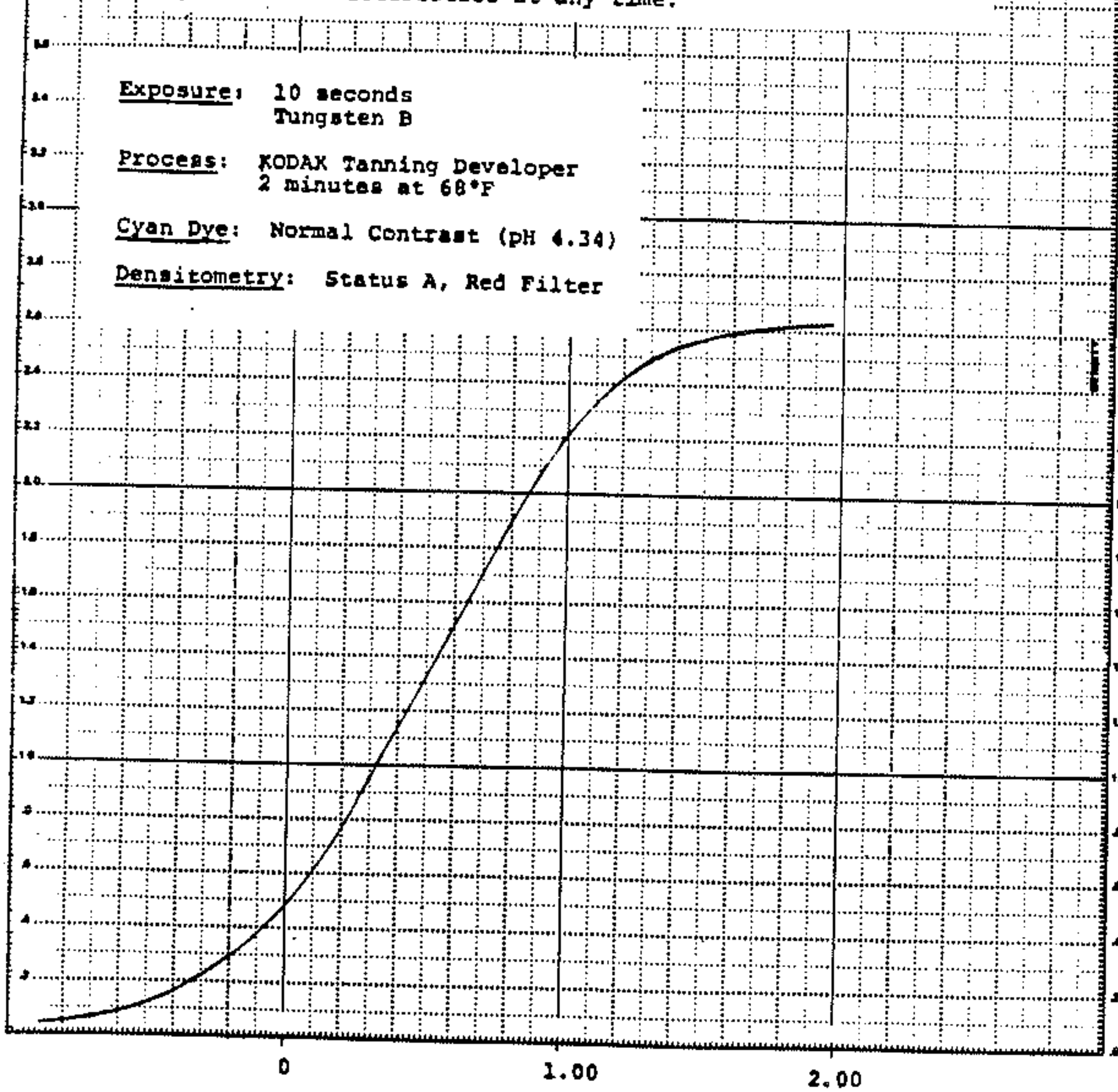
SPECTRAL DYE DENSITY

Spectral Reflection Densities of the KODAK Matrix Dye Set.
Individual transfers from the same matrix of cyan, magenta,
and yellow dye onto separate sheets of KODAK Dye Transfer Paper.

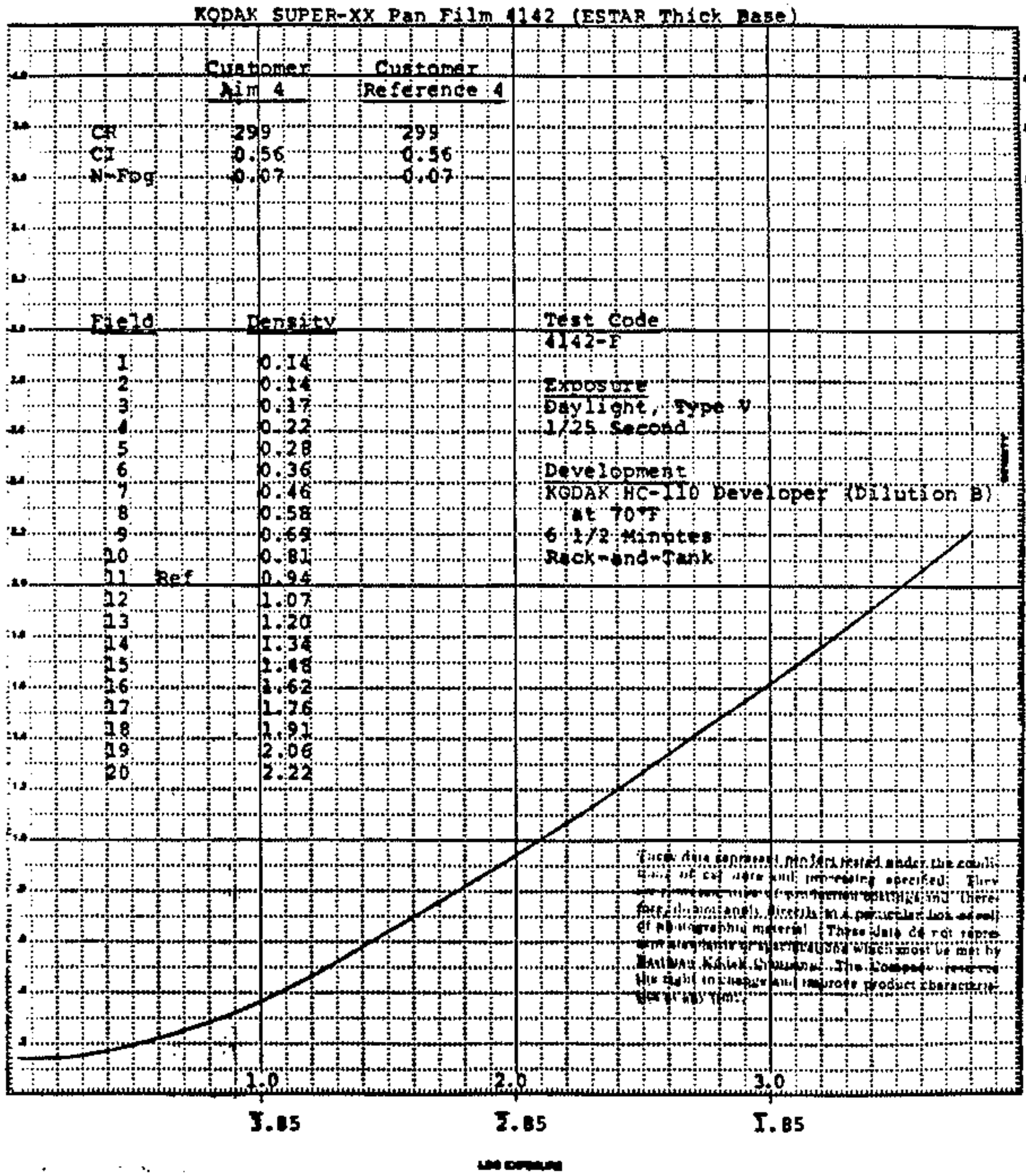


KODAK Matrix Film 4150 (ESTAR Thick Base)

These data represent product tested under the conditions of exposure and processing specified. They are representative of production coatings and, therefore, do not apply directly to a particular box or roll of photographic material. These data do not represent standards or specifications which must be met by Eastman Kodak Company. The company reserves the right to change and improve product characteristics at any time.

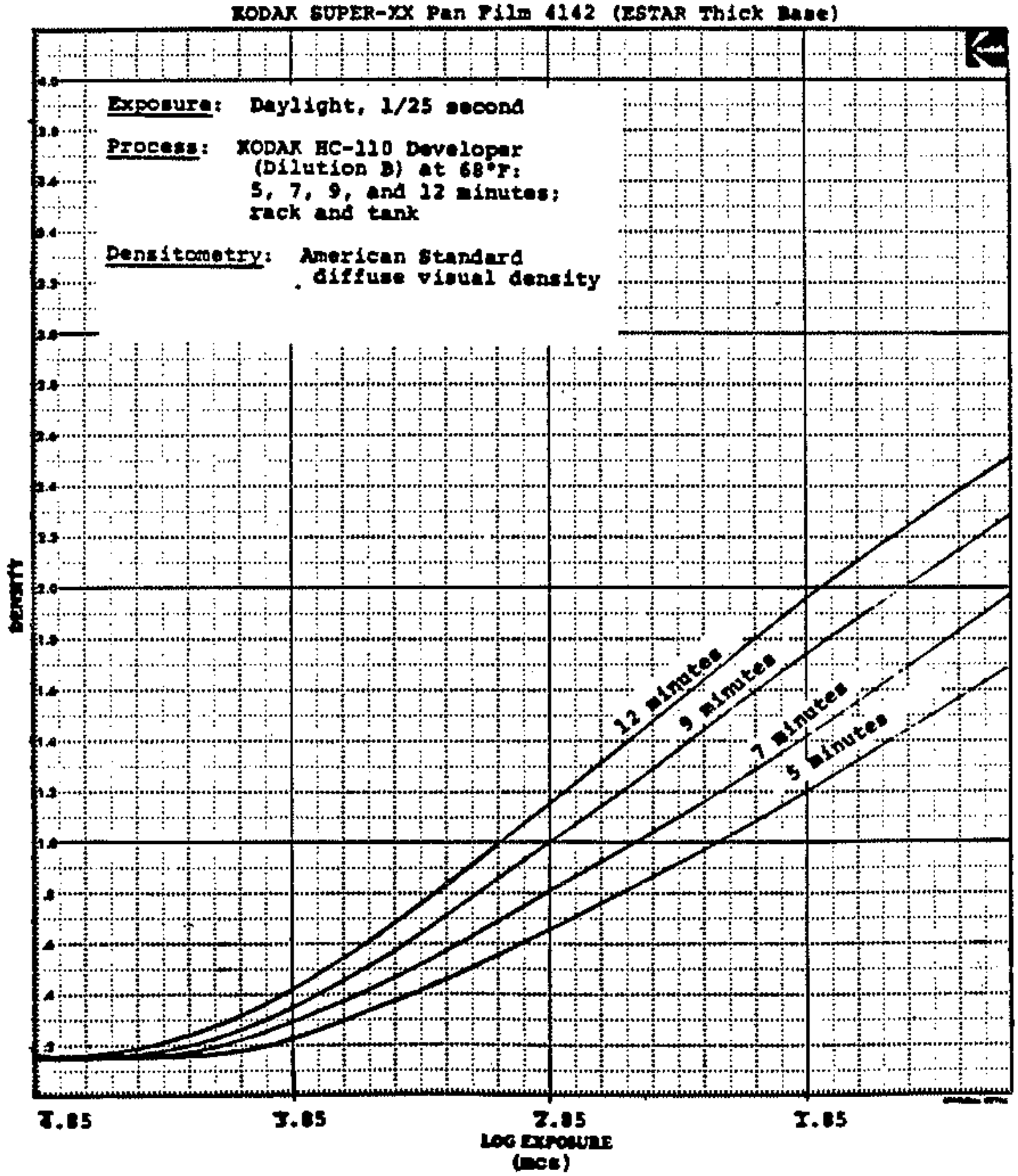


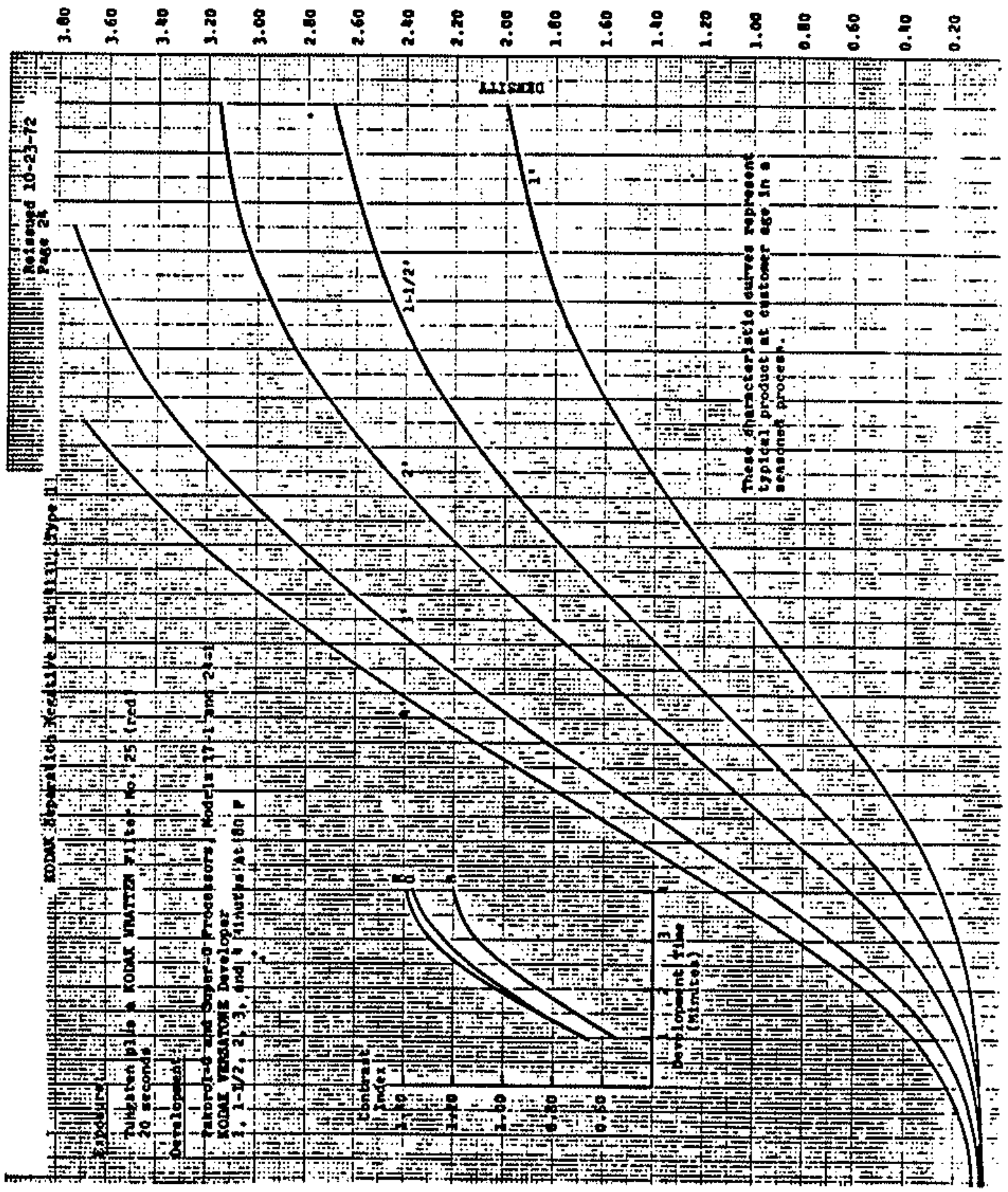
(lux sec)

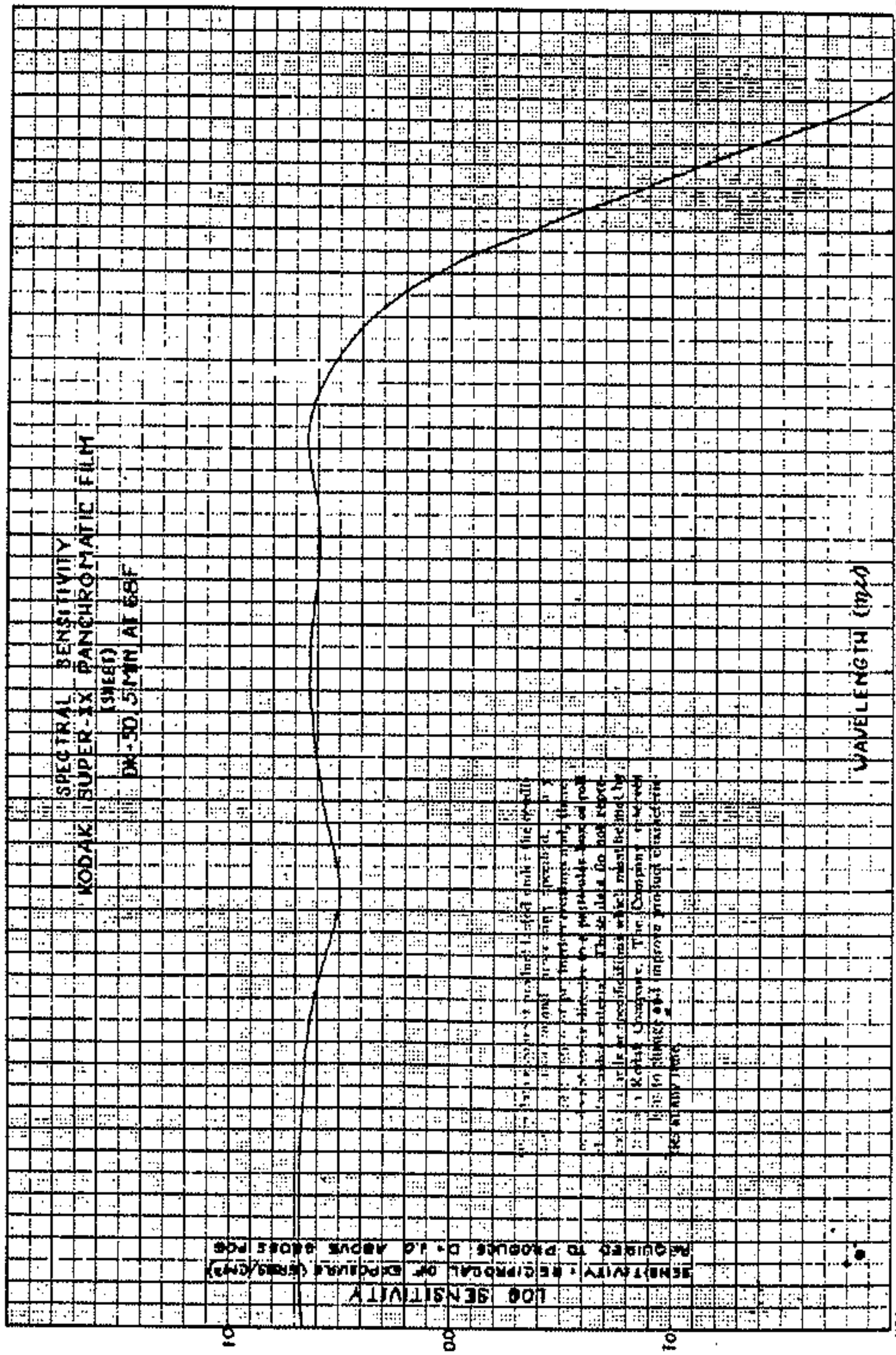

KODAK SUPER-XX Pan Film 4142 (ESTAR Thick Base)
Customer Aim 4
Customer Reference 4
CR 299 299
CI 0.56 0.56
N-Fog 0.07 0.07
Field Density
1 0.14
2 0.14
3 0.17
4 0.22
5 0.28
6 0.36
7 0.46
8 0.58
9 0.69
10 0.81
11 Ref 0.94
12 1.07
13 1.20
14 1.34
15 1.48
16 1.62
17 1.76
18 1.91
19 2.06
20 2.22
Test Code
4142-F
Exposure
Daylight, Type V
1/25 Second
Development
KODAK HC-110 Developer (Dilution B)
at 70°F
6 1/2 Minutes
Rack-and-Tank
1.0
2.0
3.0
3̄.85
2̄.85
1̄.85

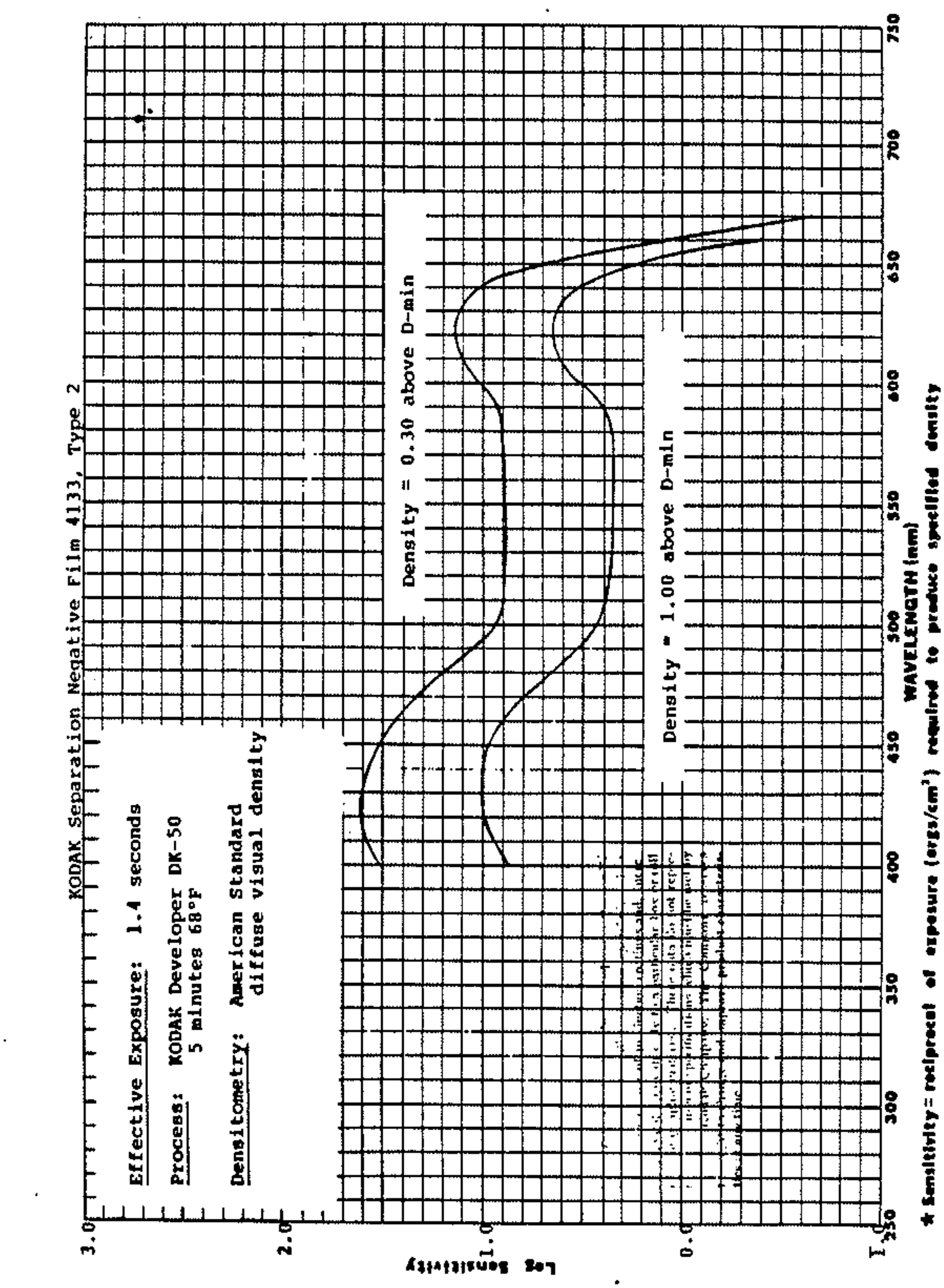
CHARACTERISTIC CURVES

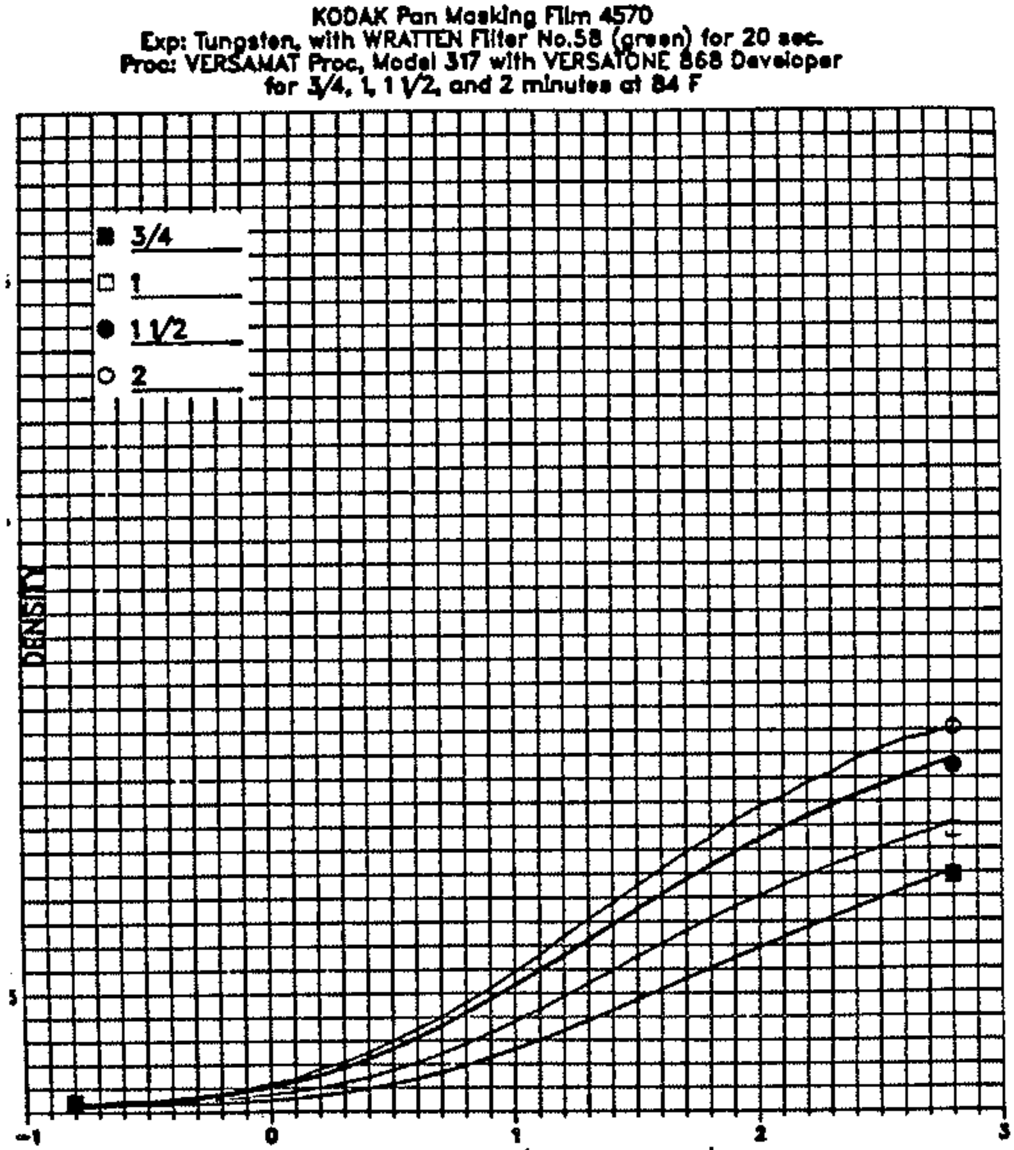
KODAK SUPER-XX Pan Film 4142 (ESTAR Thick Base)

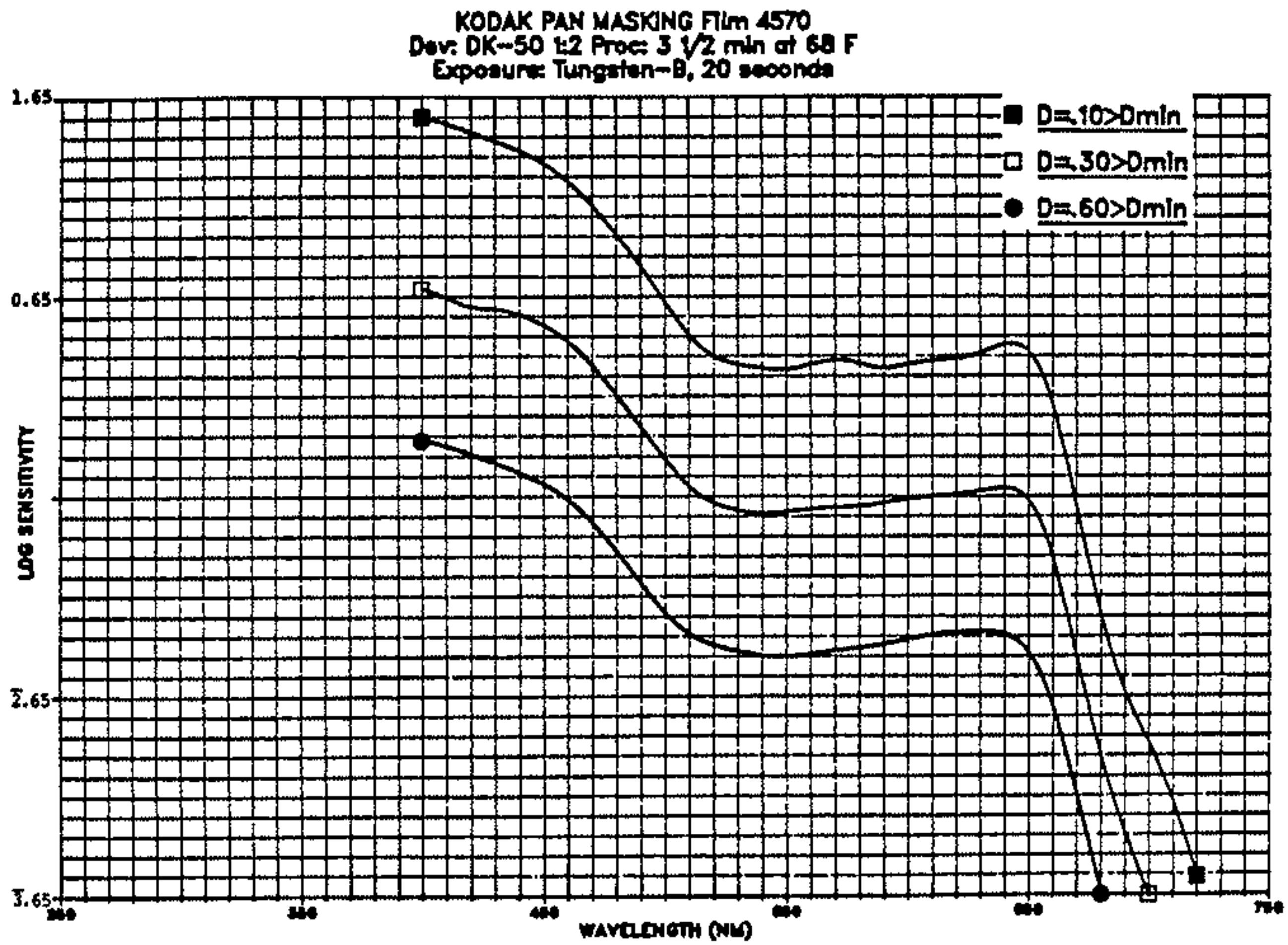


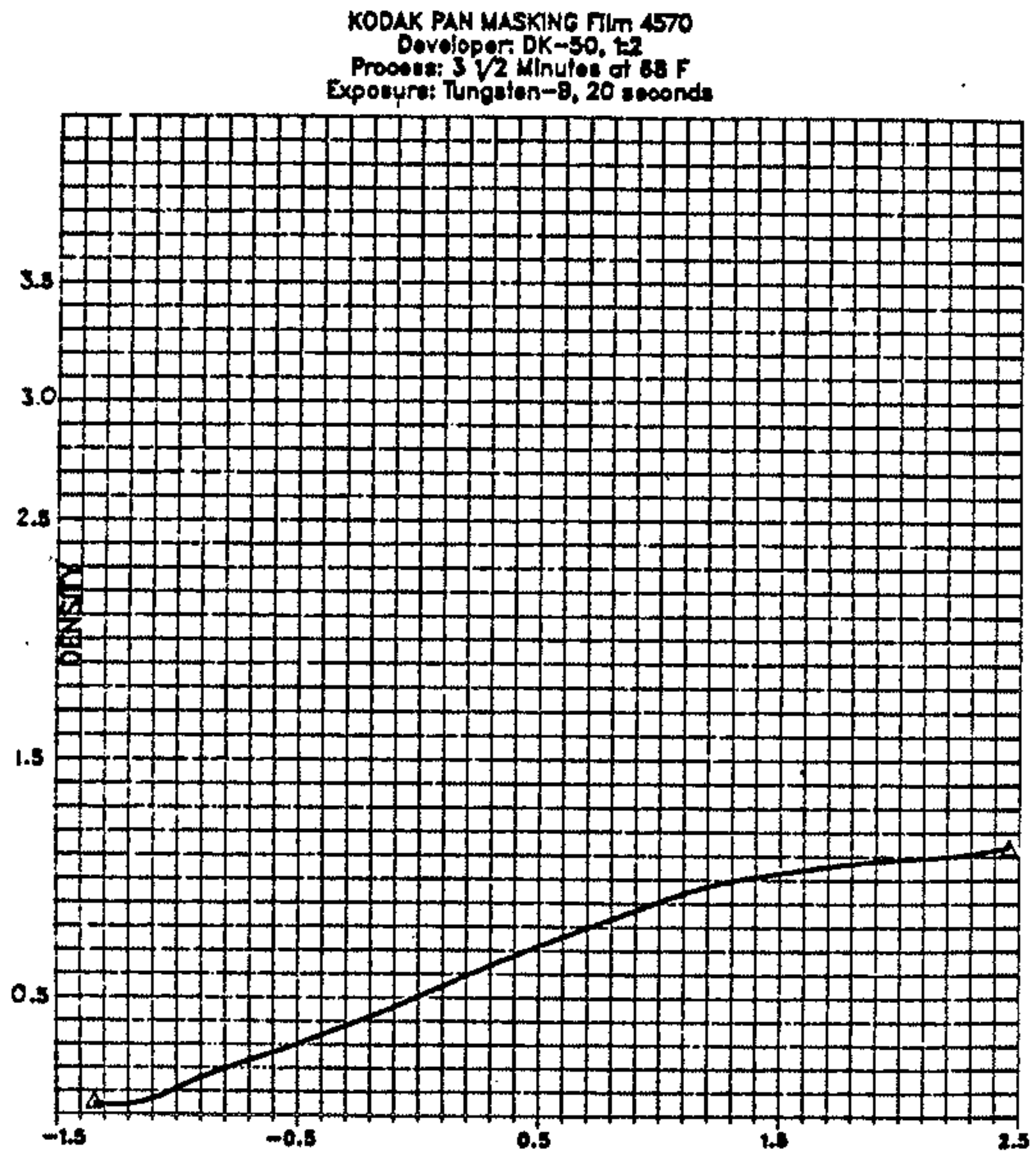

KODAK Separation Negative Film 4131, Type 1
Reissued 10-23-72
Page 24
Exposure:
Tungsten plus a KODAK WRATTEN Filter No. 25 (red)
20 seconds
Development:
KODAK VERSATONE Developer
Contrast Index
Development Time (Minutes)
These characteristic curves represent typical product at customer age in a seasoned process.
DENSITY
1'
1-1/2'
2'
3'
4'
3.80
3.60
3.40
3.20
3.00
2.80
2.60
2.40
2.20
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20


KODAK SPECTRAL SENSITIVITY
SUPER-XX PANCHROMATIC FILM
(SHEET)
DK-50 5 MIN AT 68F
LOG SENSITIVITY
SENSITIVITY = RECIPROCAL OF EXPOSURE (ERGS/CM²)
REQUIRED TO PRODUCE D = 1.0 ABOVE GROSS FOG
WAVELENGTH (mμ)
400
450
500
550
600
650
700
1.0
0.0
1.0


KODAK Separation Negative Film 4133, Type 2
Effective Exposure: 1.4 seconds
Process: KODAK Developer DK-50
5 minutes 68°F
Densitometry: American Standard
diffuse visual density
Density = 0.30 above D-min
Density = 1.00 above D-min
3.0
2.0
1.0
0.0
Log Sensitivity
250
300
350
400
450
500
550
600
650
700
750
WAVELENGTH (nm)
* Sensitivity = reciprocal of exposure (ergs/cm²) required to produce specified density


KODAK Pan Masking Film 4570
Exp: Tungsten, with WRATTEN Filter No.58 (green) for 20 sec.
Proc: VERSAMAT Proc, Model 317 with VERSATONE 868 Developer
for 3/4, 1, 1 1/2, and 2 minutes at 84 F
3/4
1
1 1/2
2
DENSITY
-1
0
1
2
3

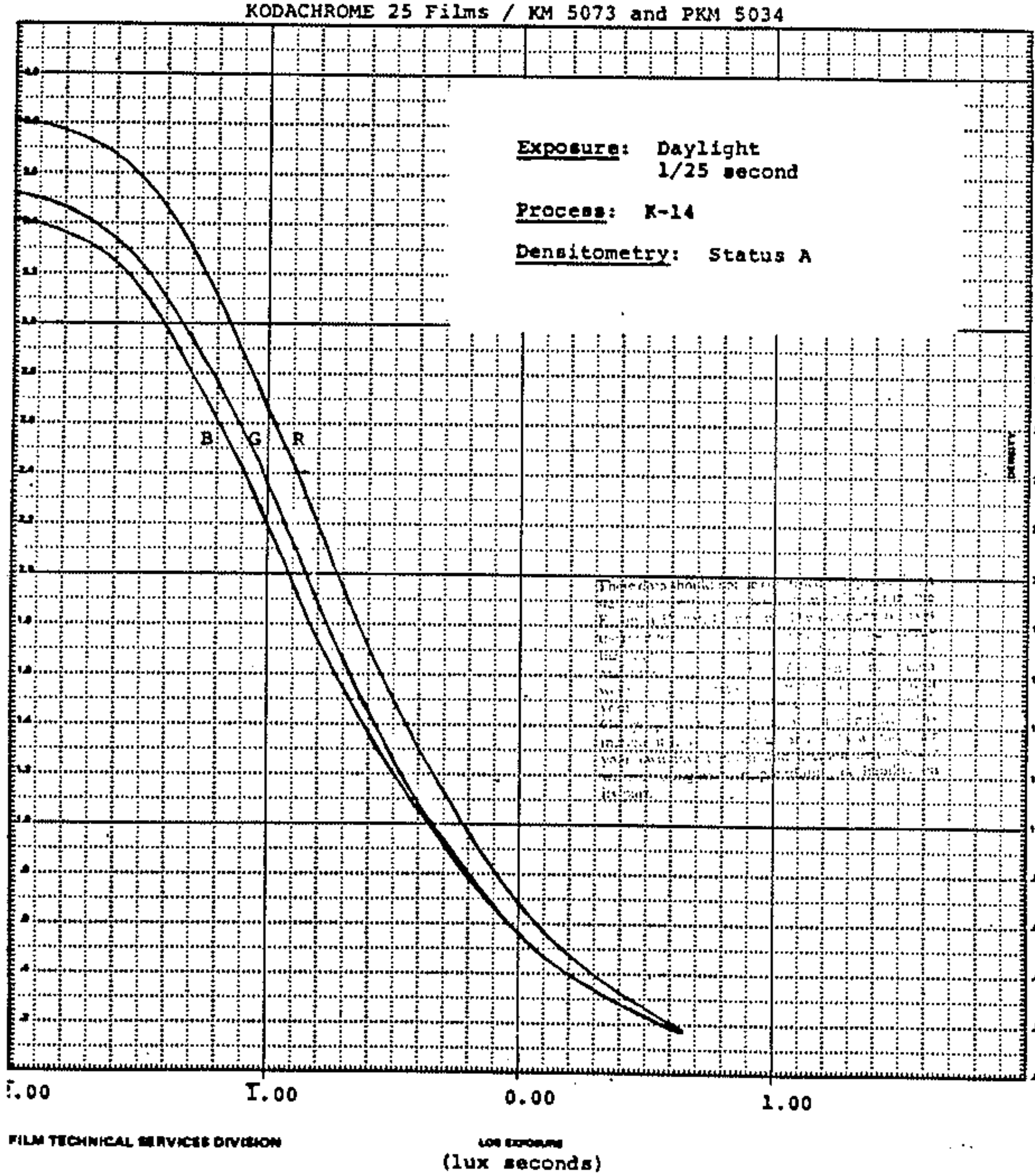

KODAK PAN MASKING Film 4570
Dev: DK-50 1:2 Proc: 3 1/2 min at 68 F
Exposure: Tungsten-B, 20 seconds
1.65
0.65
$\bar{2}.65$
$\bar{3}.65$
LOG SENSITIVITY
WAVELENGTH (NM)
D=.10>Dmin
D=.30>Dmin
D=.60>Dmin


KODAK PAN MASKING Film 4570
Developer: DK-50, 1:2
Process: 3 1/2 Minutes at 68 F
Exposure: Tungsten-9, 20 seconds
DENSITY
3.5
3.0
2.5
1.5
0.5
-1.5
-0.5
0.5
1.5
2.5

.RACTERISTIC CURVE Figure 2 TI0837

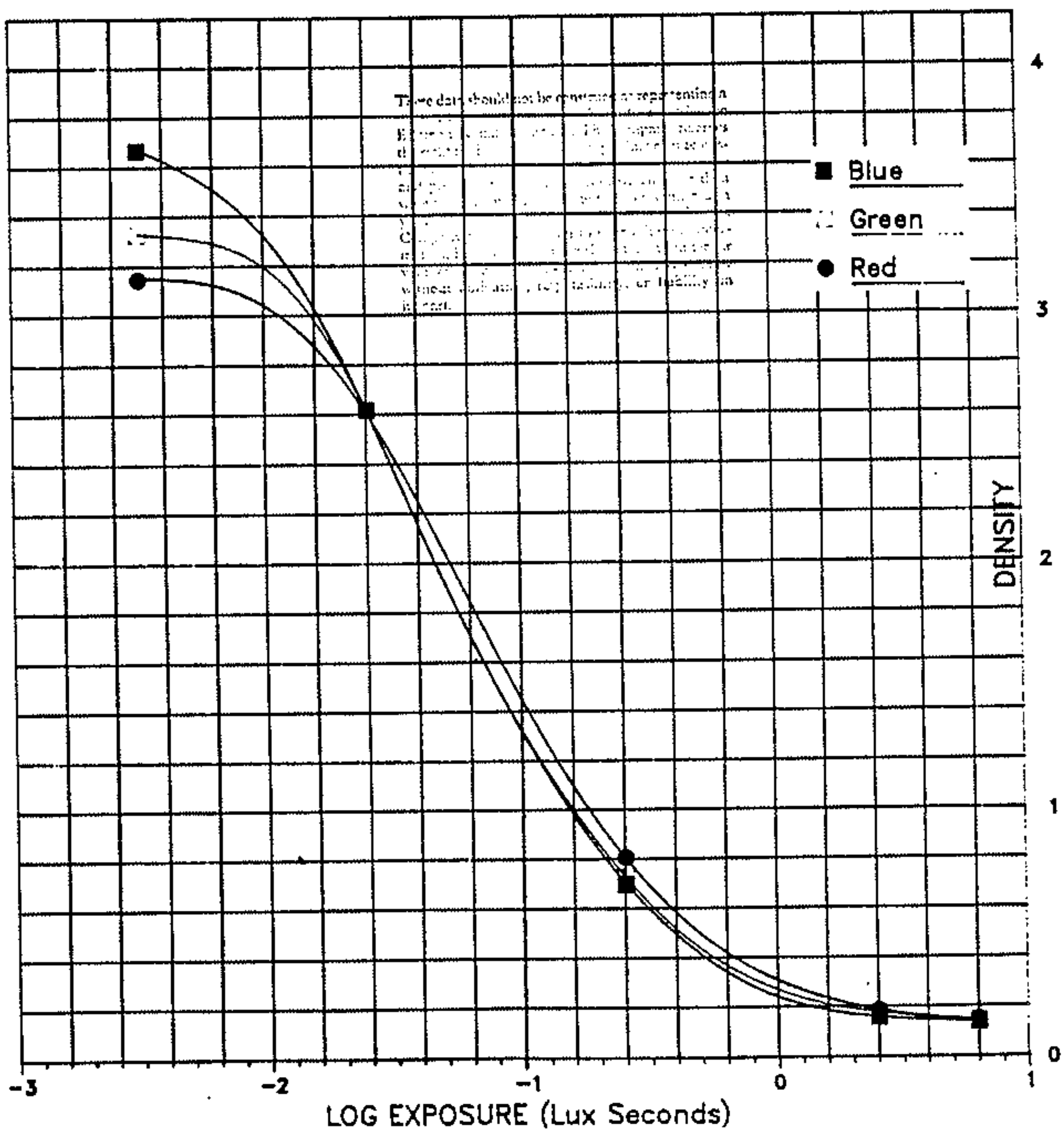
4-13-84 DISCLAIMER #1

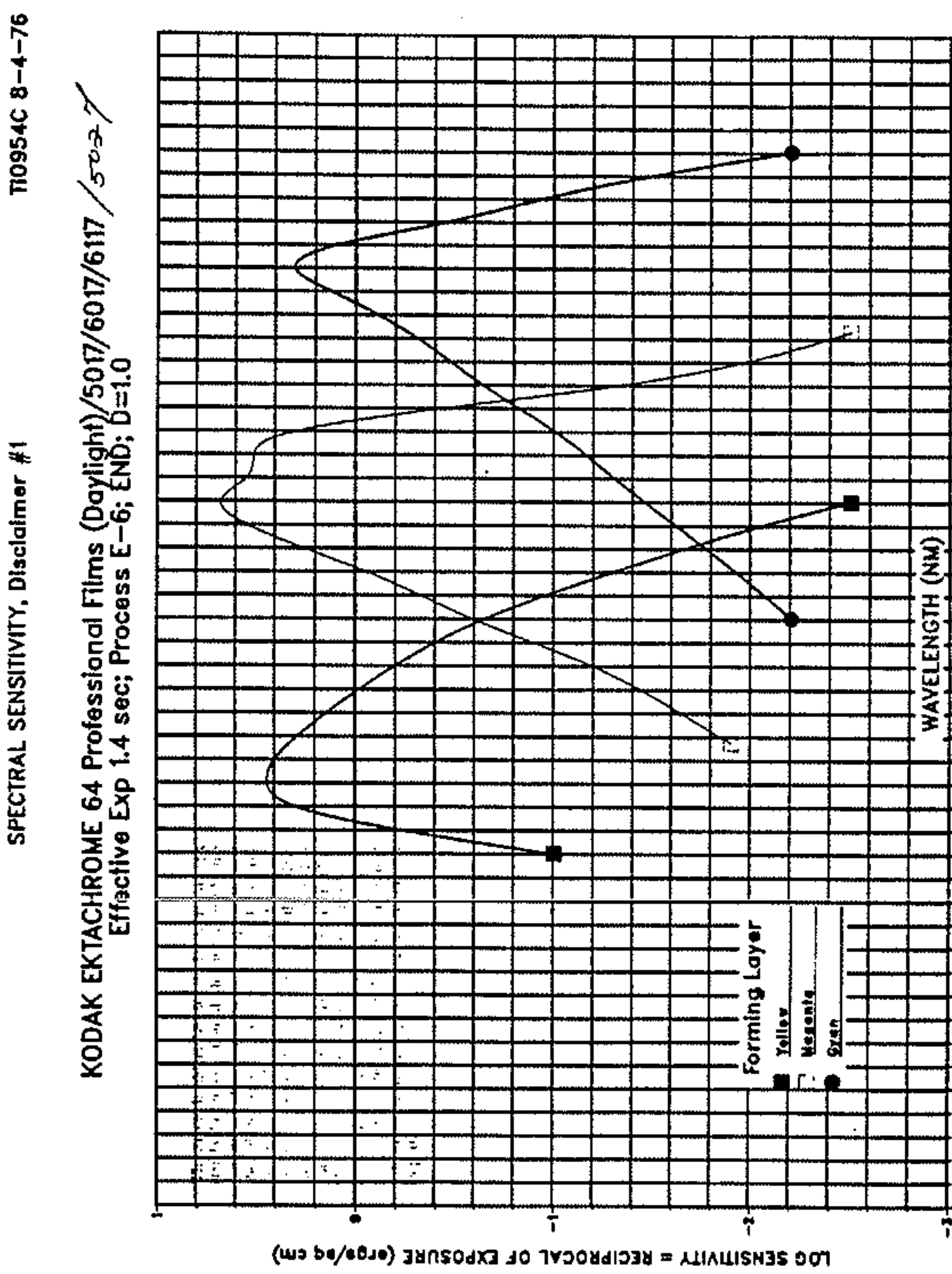
KODACHROME 25 Films / KM 5073 and PKM 5034

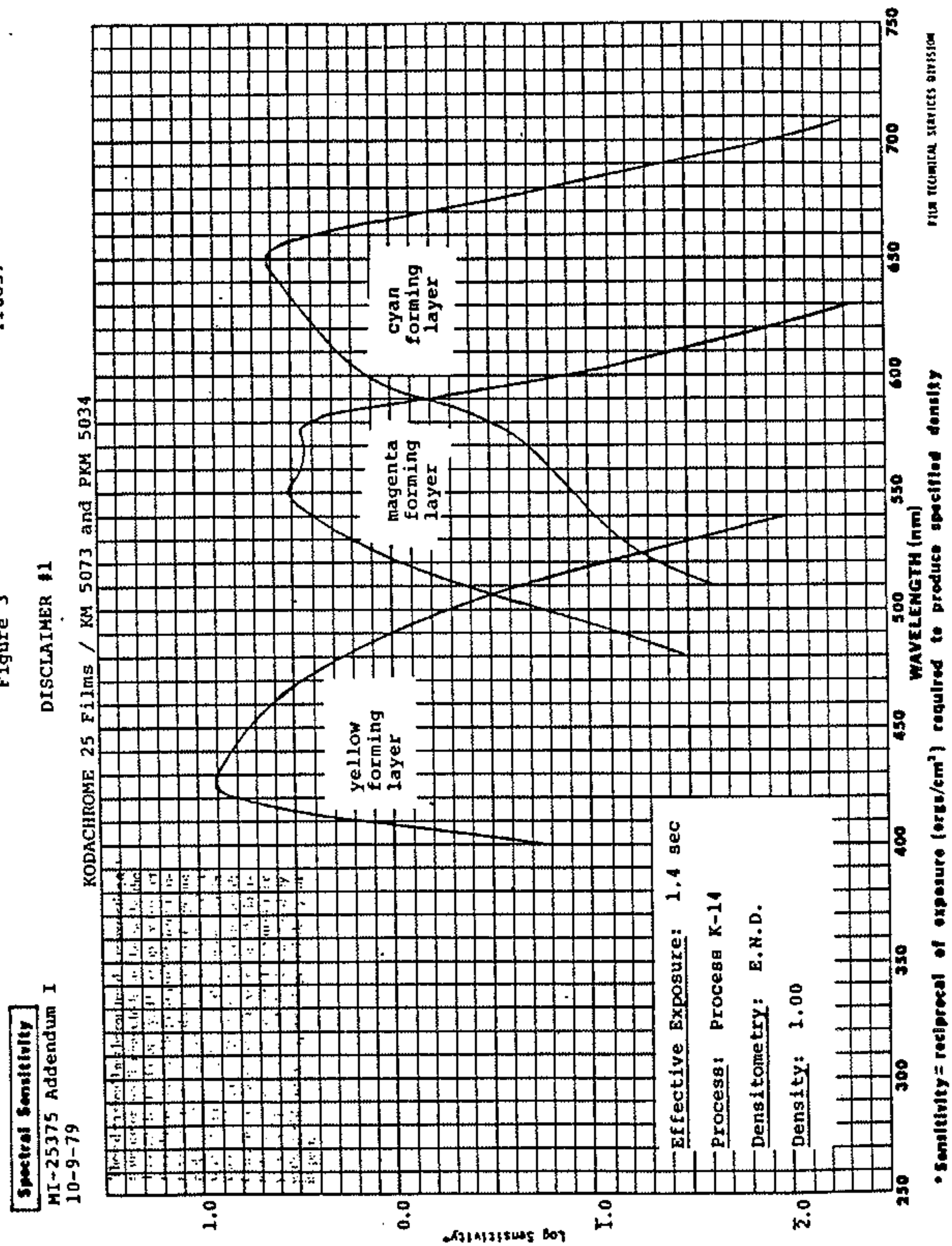


CHARACTERISTIC CURVE, Disclaimer #1 TI0954B 7-23-79

KODAK EKTACHROME 64 Professional Film (Daylight)/5017/6017 /5027
Daylight 1/50 sec; Process E-6; Status A

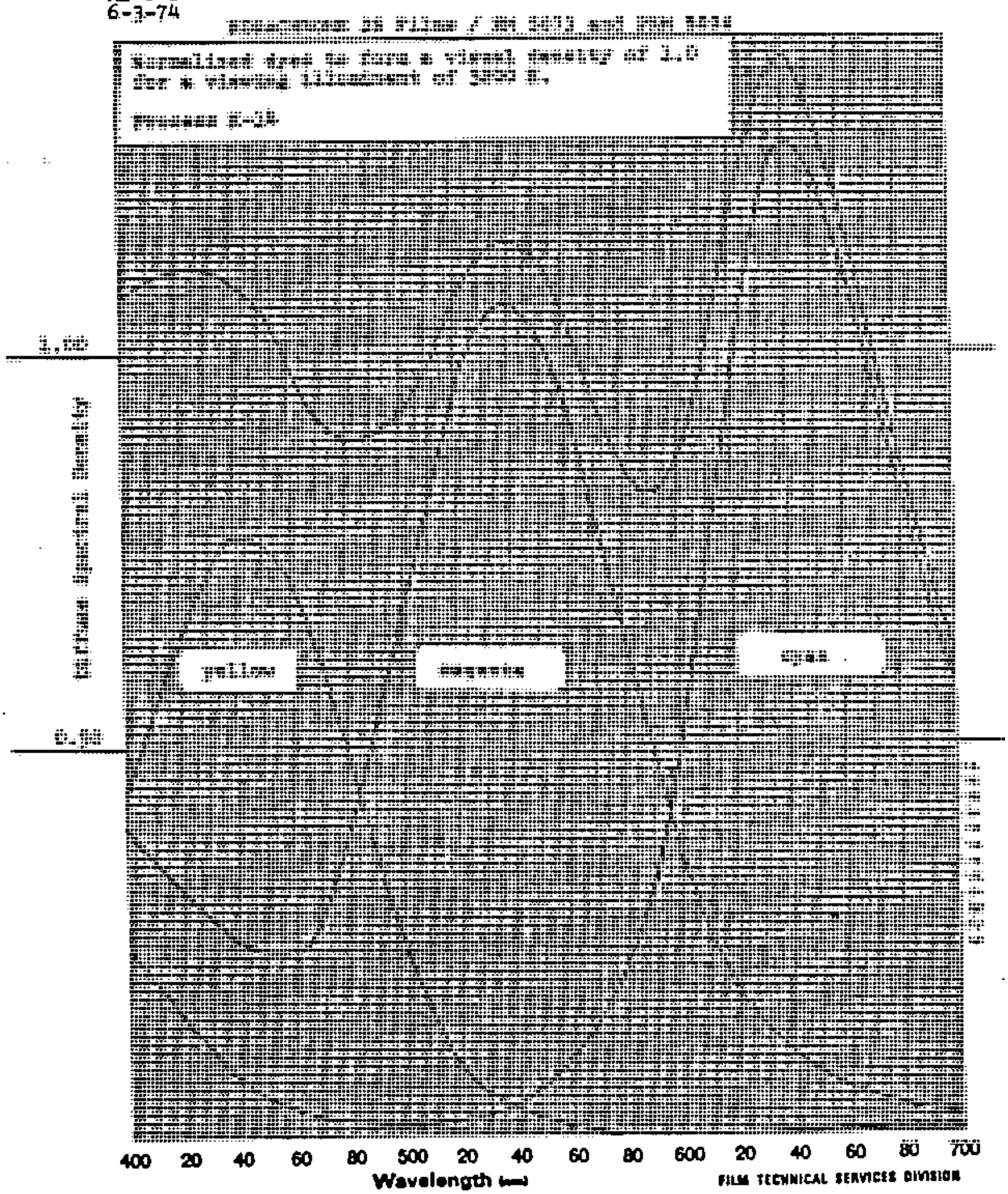



SPECTRAL SENSITIVITY, Disclaimer #1
TI0954C 8-4-76
KODAK EKTACHROME 64 Professional Films (Daylight)/5017/6017/6117 /5027
Effective Exp 1.4 sec; Process E-6; END; D=1.0
Forming Layer
Yellow
Magenta
Cyan
WAVELENGTH (NM)
LOG SENSITIVITY = RECIPROCAL OF EXPOSURE (ergs/sq cm)


Spectral Sensitivity
MI-25375 Addendum I
10-9-79
Figure 3
DISCLAIMER #1
KODACHROME 25 Films / KM 5073 and PKM 5034
TI0837
yellow forming layer
magenta forming layer
cyan forming layer
Effective Exposure: 1.4 sec
Process: Process K-14
Densitometry: E.N.D.
Density: 1.00
250
300
350
400
450
500
550
600
650
700
750
WAVELENGTH (nm)
* Sensitivity = reciprocal of exposure (ergs/cm²) required to produce specified density
Log Sensitivity*
1.0
0.0
1̄.0
2̄.0
FILM TECHNICAL SERVICES DIVISION

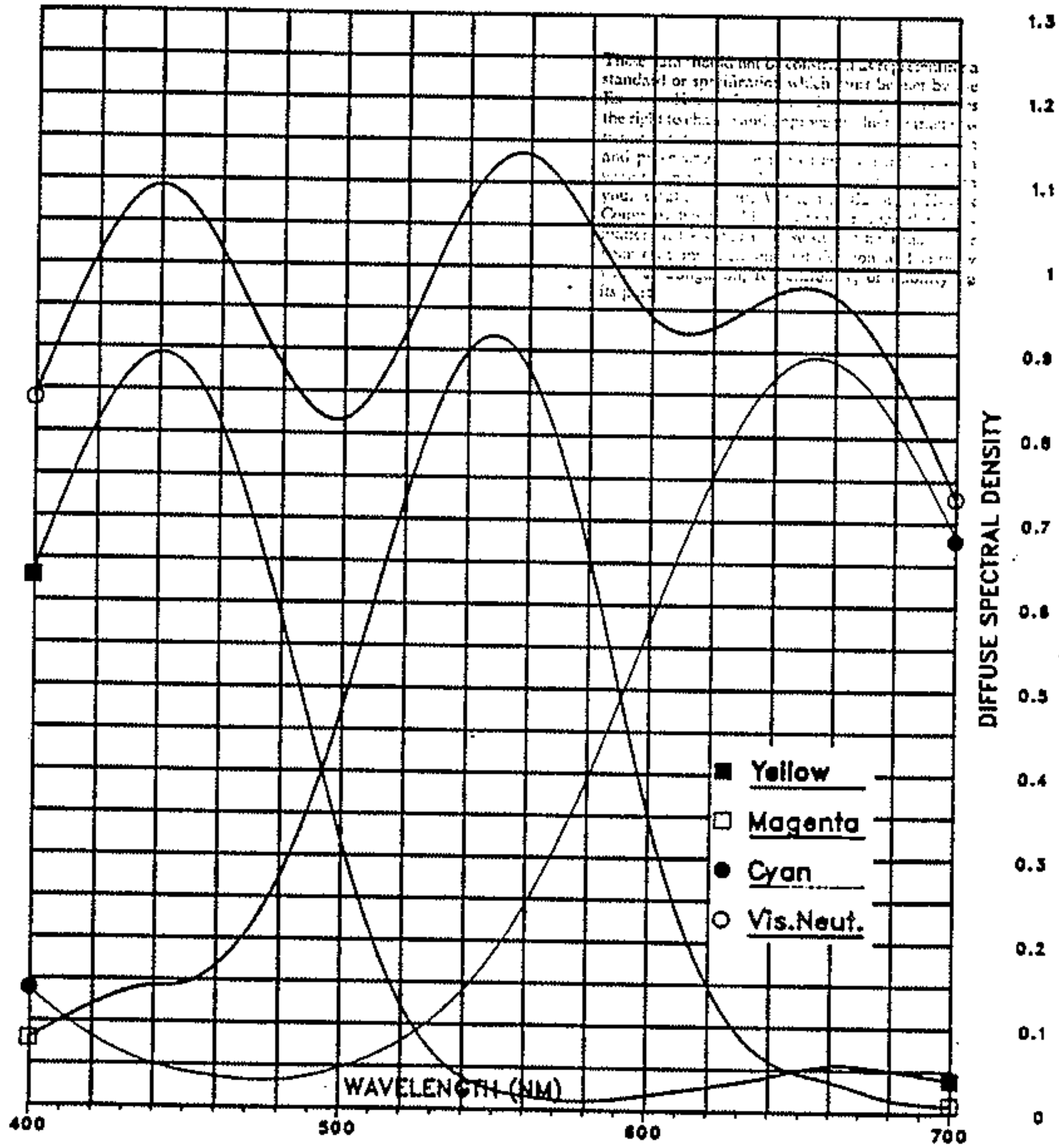
SPECTRAL DYE DENSITY Figure 4 TI0837

MI-24241 Addendum DISCLAIMER #1
6-3-74

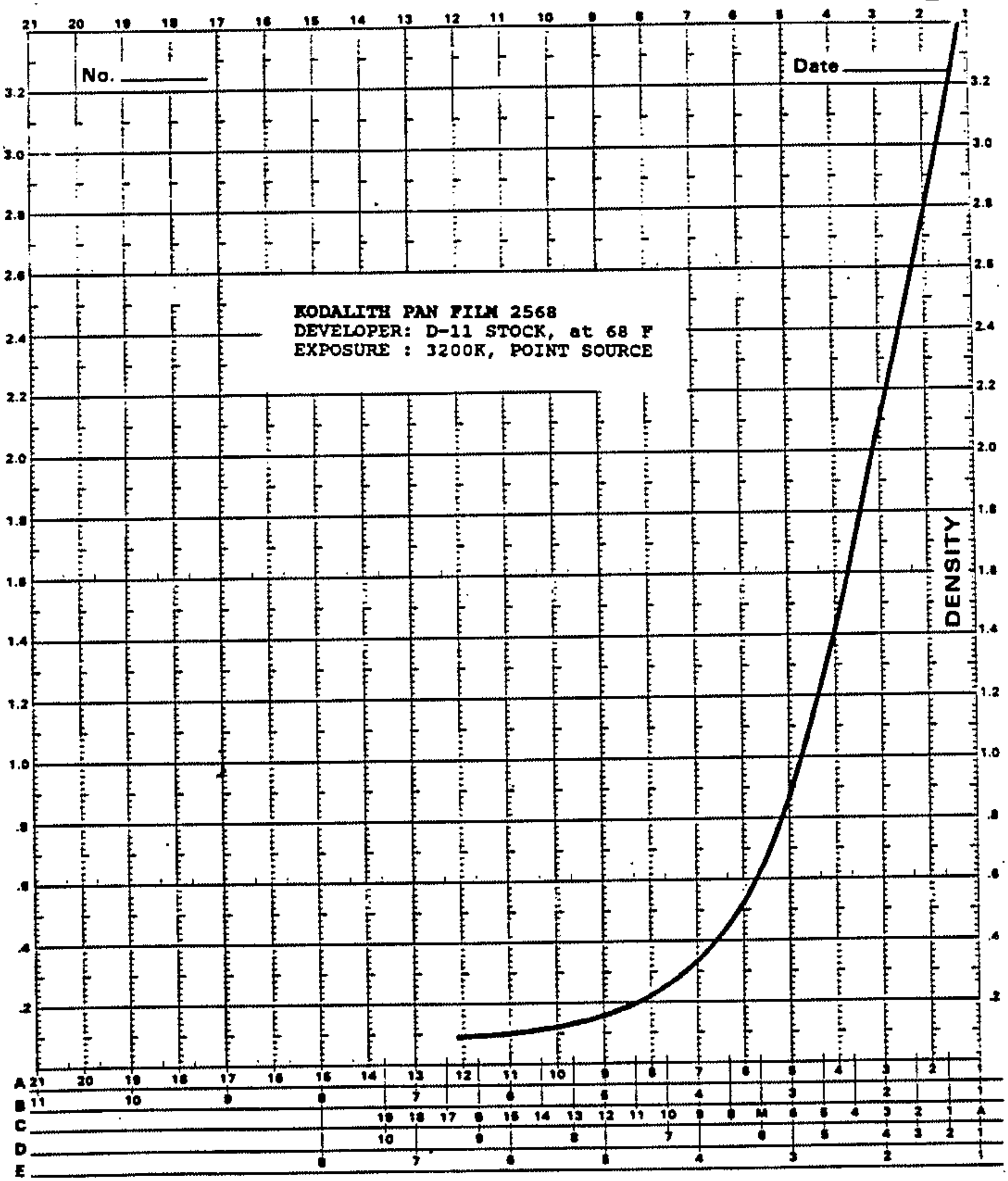


SPECTRAL DYE DENSITY CURVE TI0954D 8-4-76

KODAK EKTACHROME 64 Professional Films (Daylight)/5017/6017/6117/5017
Normalized dyes to form a visual neutral density of 1.0 for
a viewing illuminant of 5000K; Process E-6; Disclaimer #1

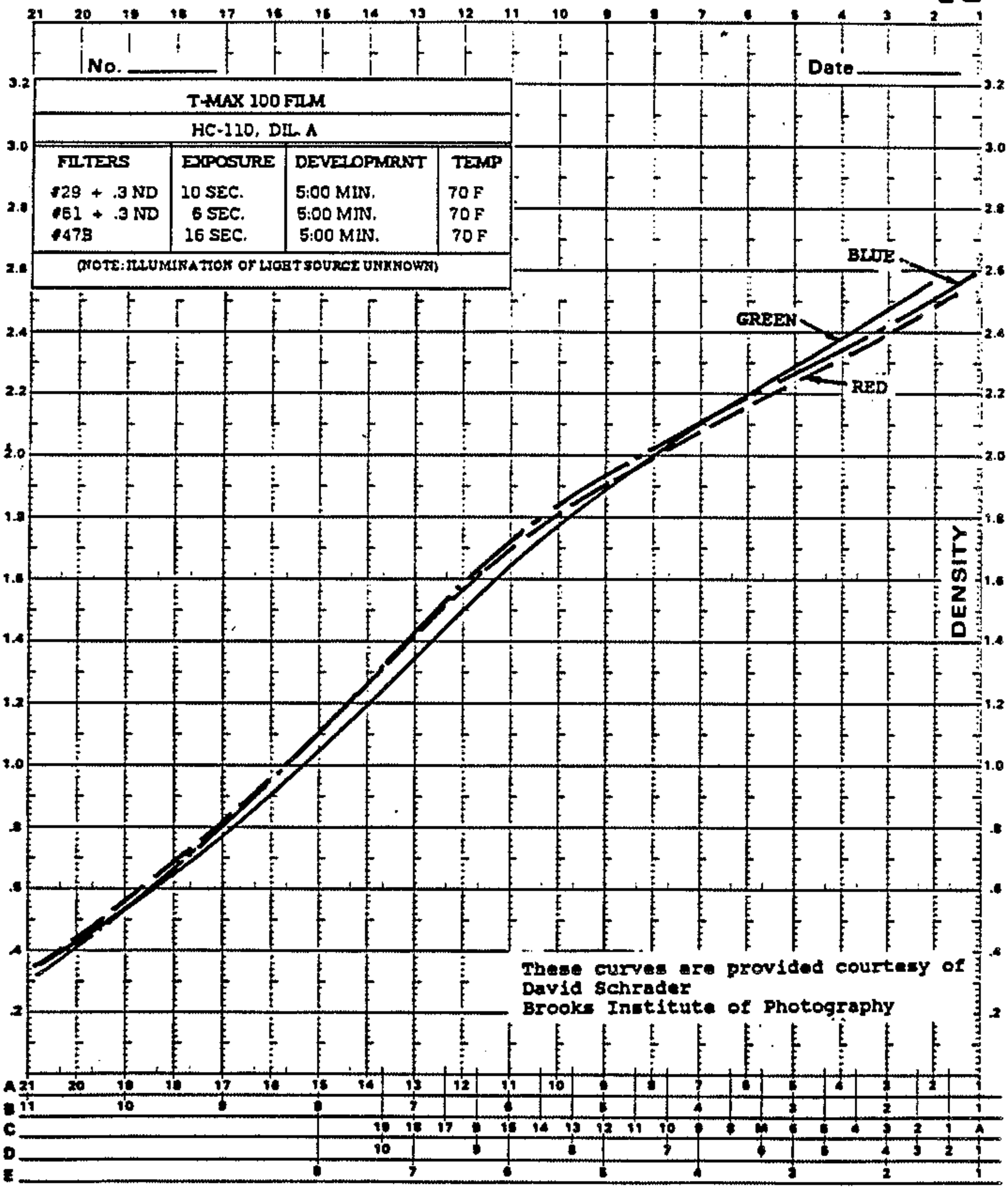


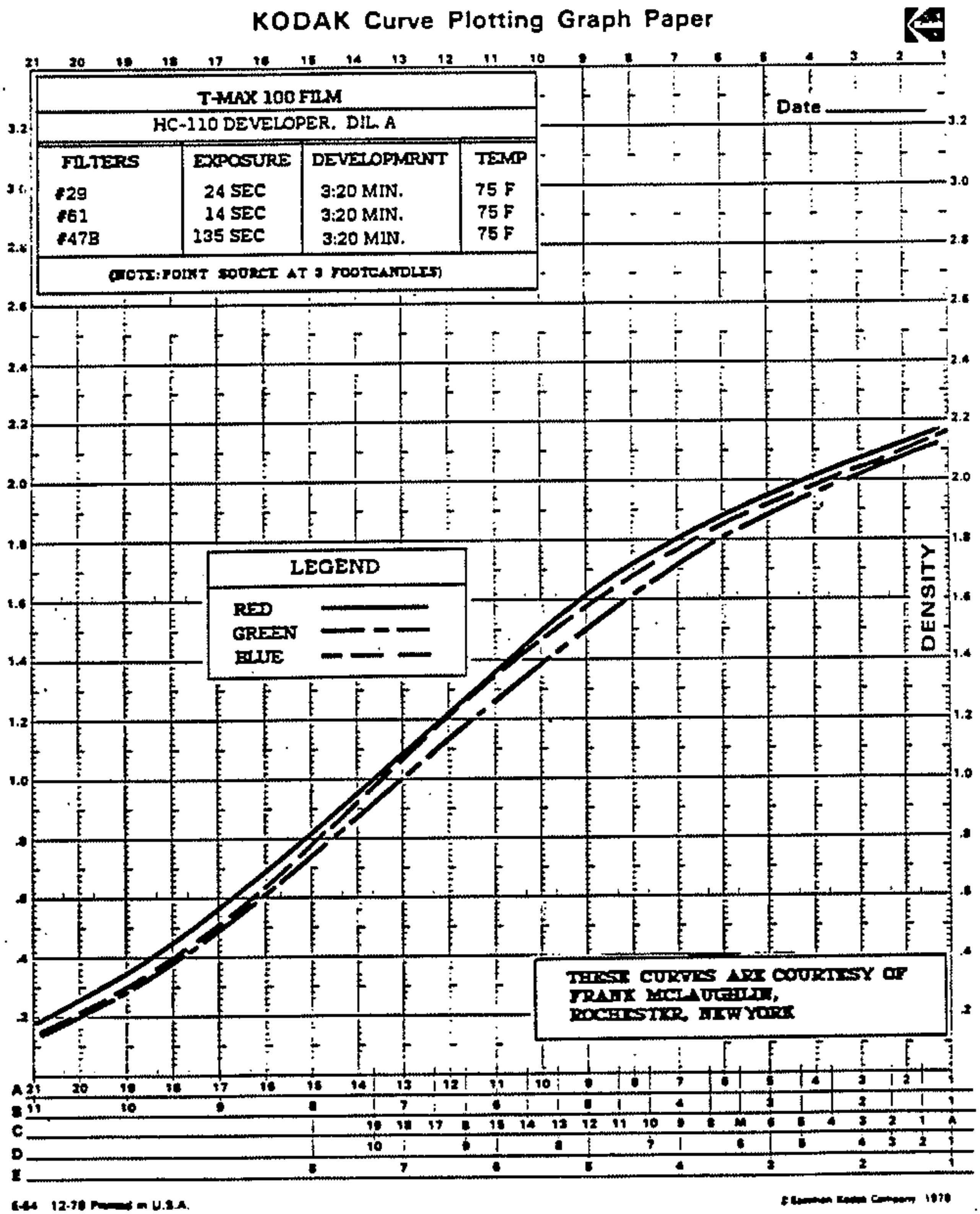
KODAK Curve Plotting Graph Paper

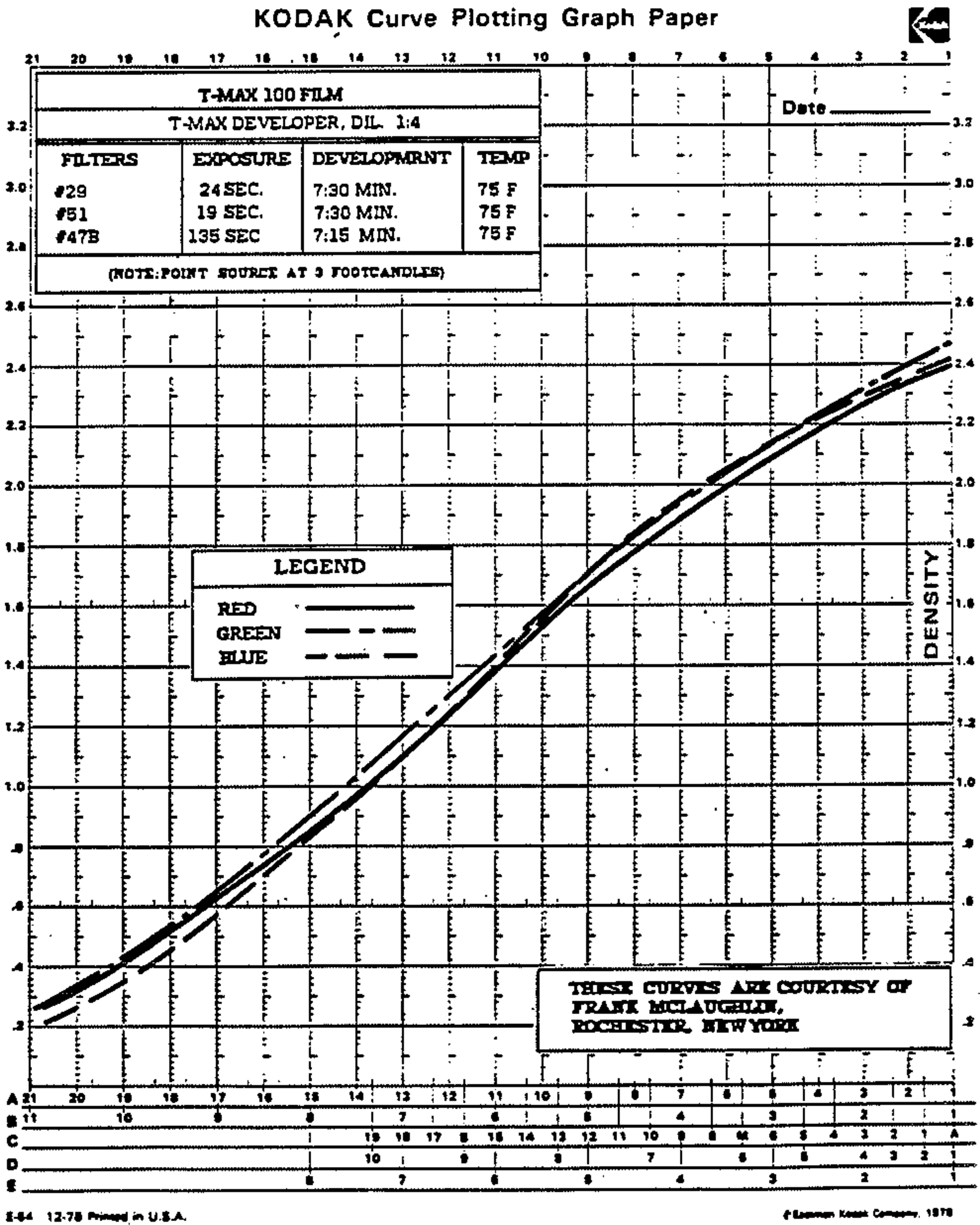


E-64 12-78 Printed in U.S.A.

KODAK Curve Plotting Graph Paper




KODAK Curve Plotting Graph Paper
T-MAX 100 FILM
HC-110 DEVELOPER, DIL. A
FILTERS
EXPOSURE
DEVELOPMRNT
TEMP
#29
24 SEC
3:20 MIN.
75 F
#61
14 SEC
3:20 MIN.
75 F
#47B
135 SEC
3:20 MIN.
75 F
Date
LEGEND
RED
GREEN
BLUE
DENSITY
THESE CURVES ARE COURTESY OF
FRANK MCLAUGHLIN,
ROCHESTER, NEW YORK
E-64 12-78 Printed in U.S.A.


KODAK Curve Plotting Graph Paper
T-MAX 100 FILM
T-MAX DEVELOPER, DIL. 1:4
FILTERS | EXPOSURE | DEVELOPMRNT | TEMP
#29 | 24 SEC. | 7:30 MIN. | 75 F
#51 | 19 SEC. | 7:30 MIN. | 75 F
#47B | 135 SEC | 7:15 MIN. | 75 F
(NOTE: POINT SOURCE AT 3 FOOTCANDLES)
Date
LEGEND
RED
GREEN
BLUE
DENSITY
THESE CURVES ARE COURTESY OF
FRANK MCLAUGHLIN,
ROCHESTER, NEW YORK
E-64 12-78 Printed in U.S.A.
© Eastman Kodak Company, 1978

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