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SMPTE RECOMMENDED PRACTICE**RP 180-1999**Revision of
RP 180-1994

Spectral Conditions Defining Printing Density in Motion-Picture Negative and Intermediate Films



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Introduction

When a motion-picture color negative or intermediate film is printed, the dyes in the negative or intermediate modulate the red, green, and blue exposures of the print material. The printing densities of the negative are a measure of this exposure modulation. Printing density is the density of the negative as "seen" by the printer and print material.

The ISO has defined status M density for the evaluation of color photographic materials intended for printing. Status M density measurements are widely and satisfactorily used in process control in motion-picture, amateur color negative, and reversal printing originals. However, given the large number of films in use, status M densities can only approximate printing densities for most materials. A definition of printing density appropriate to the specific motion-picture negative and intermediate materials being used is needed for the calibration of film scanners and definition of the metric used in computer data files for electronic post-production of film.

Motion-picture films are manufactured so as to reproduce properly a gray scale with matched gammas in the final print, and the negatives and intermediate films are designed to present matched printing density gammas to the print materials. Thus, the printing densities of a negative will correctly measure the relative gammas of the negative. Printing densities can be measured relative to a 100% transmitting reference, to the film $D_{\min}$, or to a reference gray step. In the latter case, an ideal film would have matched, superimposed red, green, and blue gray scale printing densities.

The printing exposures are determined by the product of the spectral power distribution of the printing light source, any spectral filtration in the printer, and the spectral sensitivities of the print material. Ideally, a

measure of printing density would exactly duplicate these properties. This is not possible in practice owing to the large variety of printers and materials that exist. The practical goal in specifying a printing density measure is to require that the printing density measurement correctly specifies the printing gammas of typical motion-picture color negative and intermediate materials.

1 Scope

This practice defines the spectral conditions defining the printing density gammas of motion-picture color negative and intermediate materials. It is not intended as a replacement for the status M density spectral conditions given in ANSI/ISO 5-3 and commonly used for the evaluation of color photographic materials used for printing.

2 Spectral conditions for printing density measurements

The spectral conditions defining the printing densities of motion-picture negative and intermediate materials are tabulated in table 1. These spectral responses, labeled R G and B respectively, are arbitrarily normalized to have unit response at the peak sensitivity. In actual use, the densitometer would be adjusted to cause zero density to correspond to a 100% transmitting material or to the $D_{\min}$ of the film being measured. This instrument zero adjustment will have the effect of renormalizing the data of table 1.

3 Application

The following equations define the relationship between printing density and printing exposure which is determined by measurements using the spectral responses of table 1: