

Plotting Data from Sensitometric Strips Exposed on Type Ib2 (Intensity Scale) Sensitometers*

1. Scope

1.1 The purpose of this recommended practice is to specify the relationship of the spacings of the exposure scale (horizontal co-ordinate) of graph paper on which sensitometric data are plotted and the corresponding increments of the logarithm of exposure in the sensitometer when the exposure modulator is a step tablet.

2. Exposure Method

2.1 In a Type 1 b (intensity scale) sensitometer, the most common method of modulating the illumination falling upon the sample employs a step tablet. The exposure is made with the emulsion of the sample in contact with the modulator except for a thin, transparent acetate cover which protects the modulator against abrasion and foreign matter. The opening and closing of a shutter admits light for the required period of time. Step tablets may be cast with gelatin containing dyes or colloidal carbon or, alternatively, may be produced photographically by suitable exposure and development of film or plates.

2.2 With a step tablet as the exposure modulator, the illumination reaching the sample is dependent upon the transmittance of the various steps of the modulator. This assumes uniformity of illumination. Density, being the common logarithm of the reciprocal of the transmittance, is a more convenient method for specifying the light-stopping power of the segments of the modulator. Density may be measured with a densitometer calibrated in reference to American Standard Diffuse Transmission Density, PH2.19-1959.

2.3 The 1 b (intensity scale) sensitometer exposure modulator shall have step-to-step increments of 0.15 diffuse transmission density, Type V1-b. As modulators vary somewhat from this 0.15 increment, it may be necessary to adjust the step reference points on the exposure axis (horizontal co-ordinate) of the sensitometric graph paper to represent the actual densities of each step in the tablet.

Note: Single step departures of the order of 0.015, or less, from the ideal 0.15 density increment, when known, would not be considered significant. However, cumulative errors, especially those which occur in the same direction, are significant and can lead to erroneous results. (See Appendix.)

3. Method of Correction

3.1 The steps of the exposure modulator shall be measured with a densitometer reading in diffuse transmission density, Type V1-b, specified in American Standard PH2.19-1959. Such densities are normally shown on the calibration chart accompanying each new step tablet.

3.2 If such a calibration chart is not available, the step tablet should be removed carefully from the sensitometer and from its removable protective cover, if any, and each step read on a densitometer. (See 3.1 above.)

3.3 Unless the step tablet modulator conforms to the following specifications, the sensitometric density data shall be

plotted against the actual rather than the nominal densities of the step tablet:

- (1) The density increment between any two adjacent steps shall be 0.150 ± 0.015 density.
- (2) The departure of any step from its nominal density value shall not exceed 0.02 density or 2 percent of its density value, whichever is greater. The nominal value is defined as the density of the lowest density step plus 0.15 times the number of steps above the lowest density step.
- (3) Linearity. No individual step shall depart from the best linear fit through all the steps by more than a density of 0.02.

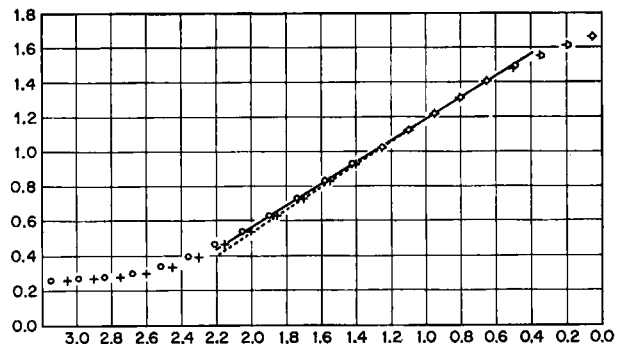
4. Method for Plotting Actual Densities of the Step Tablet Modulator

4.1 For laboratories using graph paper where the scale of the horizontal co-ordinate is as long or longer than the scale of the vertical co-ordinate: most laboratories carry a supply of printed graph sheets for the plotting of sensitometric data. These sheets normally carry a density scale on the vertical co-ordinate and a numbered "step" scale or log exposure reference on the horizontal co-ordinate. It is suggested that the density scale be cut off a graph sheet and placed along the horizontal co-ordinate of a second sheet. The scale of the first sheet should be oriented as shown in the Appendix.

4.2 The density readings of the exposed and processed sample may now be plotted against the actual step tablet densities.

4.3 For laboratories using graph paper where the horizontal co-ordinate is shorter than the vertical co-ordinate: on graph sheets where the horizontal co-ordinate carries $7\frac{1}{2}$ equal divisions between each "step" or log exposure reference, each division represents 0.02 density of the sensitometer step tablet and may be used as reference to plot the densities of the step tablet against the densities of the exposed and processed sample.

4.4 Where there is no scale on the horizontal co-ordinate between each "step" or log exposure reference, a scale may



Legend

- x --- Curve showing sample densities versus modulator densities assumed to have consecutive ideal increments of 0.15
- o — Curve showing same sample densities versus actual modulator densities for a modulator not meeting the criterion of 3.3 (2)

Appendix: Plotting data from sensitometric strips exposed on Type Ib2 (intensity scale) sensitometers.

* Loyd A. Jones, "Photographic sensitometry," Part I, *Jour. SMPE*, 17: 491-535, Oct. 1931; Part II, *Jour. SMPE*, 17: 695-742, Nov. 1931; Part III, *Jour. SMPE*, 18: 54-89, Jan. 1932; Part IV, *Jour. SMPE*, 18: 324-355, Mar. 1932.

be drawn to divide the space between each reference into $7\frac{1}{2}$ equal parts. Each part will represent 0.02 density of the sensitometer step tablet. This scale may be moved up the sheet opposite the various density readings of the exposed and processed sample so as to locate the step tablet densities versus the processed sample densities.

5. *Care of the Modulator*

5.1 Step tablets are very delicate. To prevent damage, it is

customary to protect the tablet with a thin, transparent acetate cover. The surface of the cover should be inspected from time to time to ensure that it is clean and free from abrasion. The acetate cover should be renewed when necessary to ensure that the diffuse transmission densities of the modulator steps are not affected by dirt or abrasion on the cover.

5.2 While the density of step tablets normally changes little over periods ranging up to two years, it is suggested that they be checked for density from time to time.

PROPOSED SMPTE RECOMMENDED PRACTICE RP 15

Calibration of Densitometers Used for Black-and-White Photographic Density Measurement

1. *Scope*

- 1.1 The purpose of this recommended practice is to specify the means to be employed in the calibration of densitometers utilized in the measurement of diffuse transmission densities.
- 1.2 This practice applies to densitometers utilized for the measurement of processed black-and-white photographic films and plates or cast colloidal carbon tablets.

2. *Types of Densitometers*

- 2.1 In general, only those densitometers which conform to the geometric and spectral conditions specified by American Standard Diffuse Transmission Density, PH2.19-1959, are capable of giving accurate readings of American Standard diffuse transmission density for all types of photographic materials.
- 2.2 If a nonconforming densitometer is to be used with a given type of photographic material, it may be calibrated from reference samples composed of the same material. In this way, any densitometer may be calibrated to read "American Standard Diffuse Transmission Density," Type V1-b or Type P2-b, on any single type of photographic material to a degree of accuracy commensurate with the stability and reproducibility of the instrument itself. In general, a new calibration must be made to obtain accurate readings on a different material when a nonconforming densitometer is used.

3. *Reference Specimen*

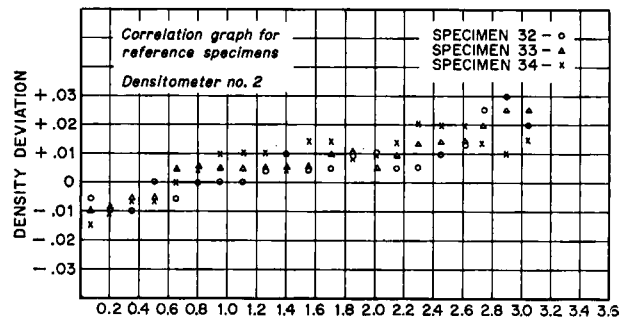
- 3.1 A reference specimen shall be a calibrated gray scale which is stored with special care and used at intervals of three months, more or less, as a primary reference against which to control the working specimens. (See 4.1.)
- 3.2 A densitometer conforming to the geometric and spectral conditions specified in American Standard PH2.19-1959, for either Type V1-b or Type P2-b, and measuring in American Standard diffuse transmission density, shall be used to calibrate the reference specimen.

Note: Calibrated reference specimens are sold by the fabricators of densitometers and sensitometers and by film manufacturers.

- 3.3 The reference specimen shall have a range of diffuse transmission densities from below 0.06 to 3.0 or greater.
- 3.4 The density variation within each step or within each specified calibration area shall be 0.01 or less.

Note: Care should be exercised in selecting reference specimens. They should be free from dirt spots and abrasions. The step or calibration area should be large enough to accommodate the largest aperture used for measuring the specimen and to allow for normal specimen-positioning variations. Good optical density stability is essential for reference specimens. In general, this can be accomplished by keeping the processed specimen two months or longer under normal laboratory lighting and temperature conditions.

- 3.5 A calibration chart shall accompany each reference specimen, giving the diffuse transmission densities of each step. It shall be noted on the calibration chart whether the diffuse transmission densities listed are American Standard diffuse visual densities Type V1-b or American Standard diffuse printing densities Type P2-b, (American Standard PH2.19-1959). Each reference specimen and corresponding calibration chart shall be identified by a code or serial number. The chart shall also show the type of film of which the reference specimen is made.
- 3.6 Each step of each of three reference specimens shall then be measured carefully on the laboratory densitometer to be controlled. The step-by-step measurements of one specimen shall be compared to the calibration chart values for that specimen, and the deviations* plotted versus the calibration chart values. Measurements of each of the other specimens shall also be compared to corresponding calibration values, and the deviations plotted upon the same chart (Appendix). This procedure establishes the correlation among reference specimens.



Appendix: American Standard diffuse visual density value (from reference specimen calibration chart).

* If, during the procedure, deviations in excess of the tolerances shown in 5.2 are obtained, the densitometer first could be recalibrated according to Section 5 and the procedure repeated. However, correlation curves obtained from a densitometer out of calibration (but operating properly) are valid.