Quality Control of B/W Photography

by

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GENERAL

It should be understood that photo manufacturers design, test, and promote films and papers in a competitive environment. They look at the products from a "generalist" point of view. They are designed to be developed in the currently popular processing machines and at the currently used times and temperatures. These may well work for you, but then again, they may not. We will show you how to test your enlarger, papers, films, and developers in order to always have an optimum result.

PHOTOGRAPHIC IMAGE RECORDING

<u>The science of photographic reproduction has to do with recording all of the tones in an original scene in such a way that they can be reproduced, usually on paper.</u>

The Scene

A scene that contains all tones from pure black to pure white in shadowless (1:1) lighting will have a brightness range in density units of 1.80 (6 f stops). A typical sun lighted outdoor scene will have a lighting ratio of 8:1 (3 f stops difference between direct sun and skylight). The resulting scene brightness range will be 2.70 (9 f stops).

The Printer and the Paper

A "normal" paper by ***world international standard*** will record, from pure black to pure white, 1.00 +/- .05 density units(called DS - density scale (3.33 f stops), when exposed using a condenser or condenser emulating enlarger or printing device. The "perfect negative" must have all of the desired detail in .80 with .10 above and below recorded as pure white and pure black.

It should be noted that the ANSI standard was recently changed for reasons not related to technology but rather to making the marketing of variable contrast papers more attractive. Therefore some normal papers are now #3 rather than #2, check the makers specifications.

The Hard Scientific Facts

The original scene of 2.70 value must have a final density range on film of 1.00 to match the 1.00 DS of the normal paper. This is a compression of about 3 times or, to a resultant 37% of the original value. This works well if the original scene is as expected. If not, something further will be required of the <u>competent</u> photographer.

The Necessary Solutions

You will note in the film/developer charts or the test results that there are 5 levels of original "scene contrast" ranging as follows; *SHADOWLESS (1:1)[1.80], FLAT (2:1 [2.10]/3:1 [2.25]), NORMAL 1:4 [2.4]/1:8 [2.70], CONTRASTY 1:16 [3.00], VERY CONTRASTY (OVER 1:16 [3.30+).* **SINCE THE <u>NORMALCY</u> OF PAPER DOESN'T CHANGE, <u>THE TECHNIQUE MUST!</u>**

You will note that both exposure and development time change in each of these changed scene conditions. In explanation of this, see the following tests and information.

CONTRAST:

Contrast is mostly related to development, although there can be loss of both contrast and shadow detail through under exposure and increase of contrast and loss of highlight detail through "blocking up" in over exposure. Exposure as a contrast control medium is a poor and ineffective technique.

DENSITY:

Density is mostly related to exposure, although fairly significant increases or decreases in density occur from sharply increased or decreased developing times.

Through a series of tests, we are able to alter the film to compensate the different lighting conditions so that the negative will match the paper, permitting the best possible reproduction.

TECHNIQUE

Examine the scene, make a determination as to whether or not relatively normal tones exist, determine the lighting ratio, and choose an exposure/development technique. Occasionally, the technique will be “bumped” up or down because of the extreme nature of the tones in the original scene. Exercise care in this regard, however, it is rarely necessary.

TESTING THE PAPER

Procedure:

Take a Kodak #2 or similar step tablet (also called a step wedge) and notch step 11 of the 22 steps. These steps are vary by about .15 density units and run from clear film slightly more dense than 0.0 to a high density of a bit more than 3.0. Read and record the densities on your Photronix Densitometer.

Print the step wedge on #2 paper (or your “normal paper”). Adjust the exposure such that the notched (step 11) is the center step of the resolved steps when developing the paper for a normal period of time (but not less than 90 seconds).

After determining the correct exposure, make three exposures on the same sheet of paper, protecting the areas not then being exposed with black cardboard, at normal exposure, double the normal exposure, and one half the normal exposure. Process the paper normally, wash it, and dry it.

Evaluation:

Look carefully at each strip of densities. Find the whitest step with just a trace of density and mark it. Find the darkest strip which is not quite black and mark it as well. Identify the density of the lightest step, and subtract from it the density of the darkest step. Repeat this procedure with all three strips, they should be substantially the same. If one is more than 10% different and you haven't made an error, discard it and average the other two. If all are nearly the same, average the three.
If all three are at some variance, re-test! If the three DS readings were, for example, .95, 1.00, and 1.05, we would add them (3.0) and divide by three, yielding and average of 1.00, which happens to be the world international standard for the normal #2 paper.

The DS will be found at the left Y axis of the following graph. The plotting points will be found on the X axis labeled S (shadowless), F (flat), N (normal), C (contrasty), and VC (very contrasty).

Shadowless: Plotted at the 1.50 point of the X axis.

Flat: Plotted at the 1.80 point of the X axis.

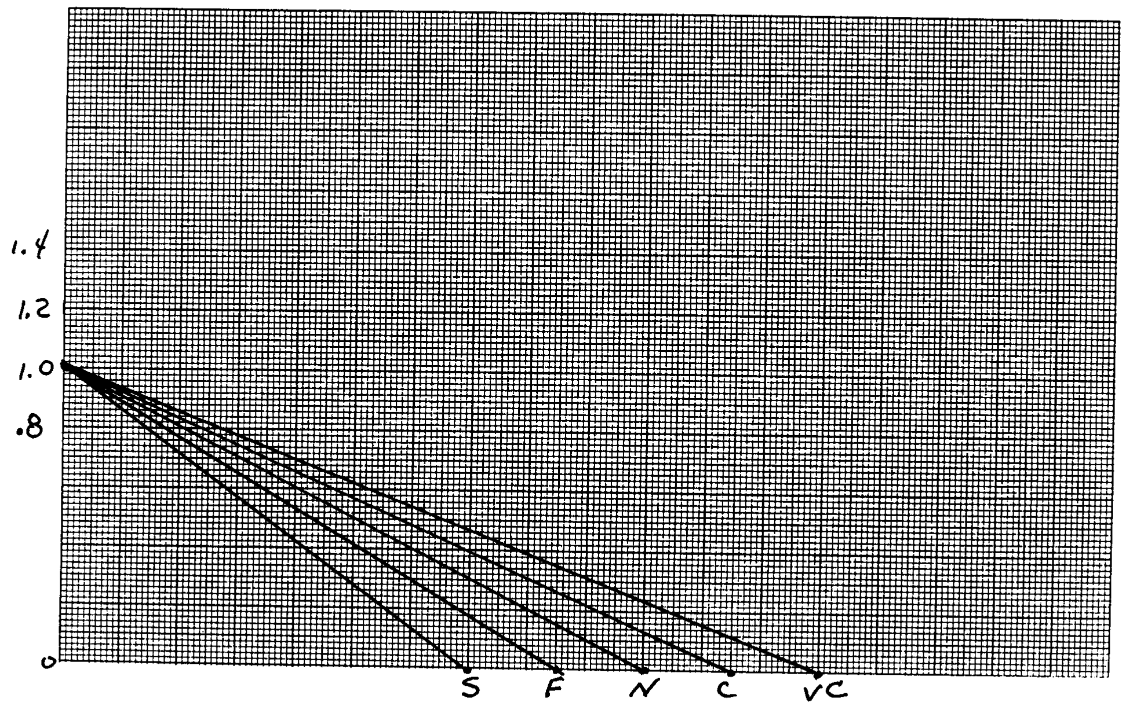
Normal: Plotted at the 2.10 point of the X axis.

Contrasty: Plotted at the 2.40 point of the X axis.

Very Contrasty: Plotted at the 2.70 point of the X axis.

Procedure:

Draw a straight line from the DS point to each of the base line (X axis) plotting points marked respectively, S, F, N, C, VC. Determine the average gradient with the AVGRAD or by counting left along the base line ten of the darker lines (5th of the smallest lines), then count upwards in similar increments, calling them .1, .2, .3, etc. until intersecting the diagonal line. In the above example, S will be about .70, F about .59, N about .49, C about .43, and VC about .38. These are the average gradients that will be required to yield a negative that will print with full tonality on your *"normal"* (or tested) paper. The term "average gradient" may be considered in the same manner as the terms, "gamma" or "contrast index", although they are derived in quite different ways. Record these data for later use.



TESTING THE FILM

The films must be tested to determine their performance in ***your*** camera, ***your*** dark room, with ***your*** developers, and ***your*** hardware. The pronouncements of the manufacturer are not particularly meaningful to the photographer since their tests are done in lensless systems and in "sterile" environments. They cannot take into consideration the flare characteristics of your lenses, cameras, imperfect darkrooms, or other aspects of actual practice.

The films will be tested using developers of your choice. Keep in mind that certain modern films were designed to be processed in high temperature automatic machines and thus, may not perform reliably at the traditional 68F to 70F degree (20 C) environments. This usually includes the more popular 100 and 400 speed films. The evidence that higher temperatures must be used (75 degrees F, 24C) is that there is very little difference in contrast (average gradient) from developing time to developing time at the lower temperatures, only a change in speed (density).

Procedure:

Set up a Neutral Gray card and light it flatly with appropriate light sources (for most films, keep the shutter speeds shorter than 1/2 second).

Focus the lens at infinity, position the camera such that the gray card fills the frame. Note that the card is grossly out of focus and that is as it should be.

With an accurate light meter, determine the correct exposure for the film being used and pick a median aperture such as f 8.0. Make a series of exposures 3 stops over, normal, and 3 stops under the calculated median exposure. Repeat the series until the entire roll of film has been used. In Ansel Adams 10 step zone system these exposures would be , zones 2, 5, and 8. In the Glen Fishback 7 zone system they would be zones 1, 4, and 7.

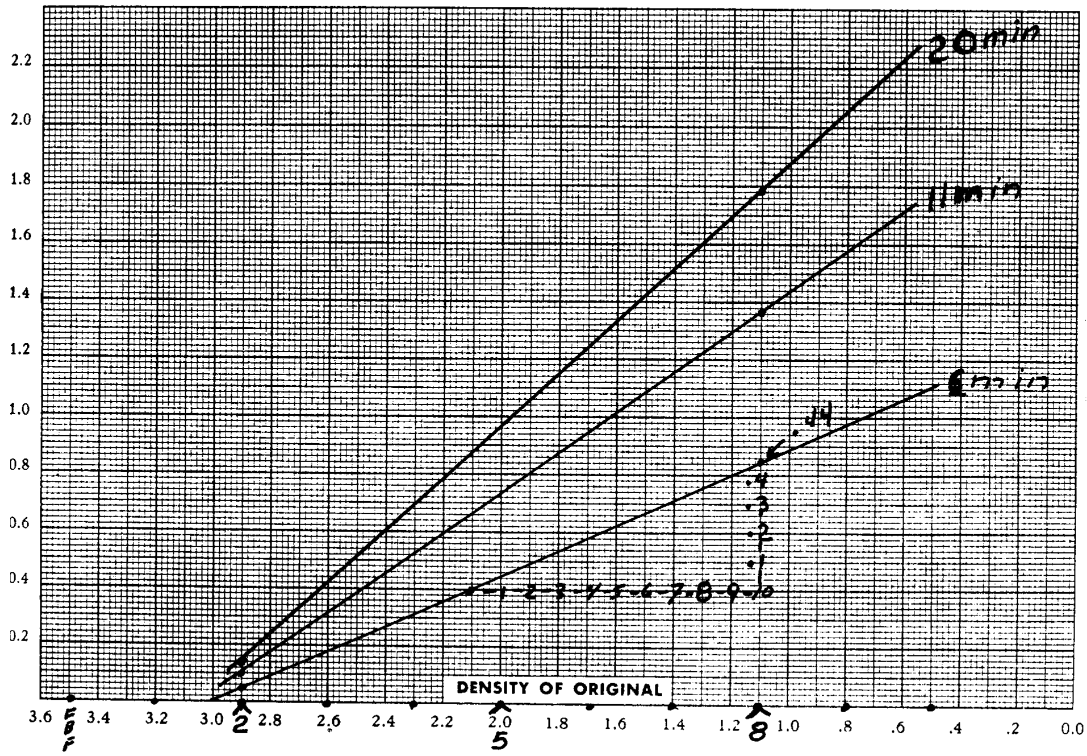
In the dark, cut the roll of film into 3 equal lengths. Load the 3 pieces onto reels for processing.

Calculate an approximately normal processing time and temperature. Process one of the three segments at normal, one at half the normal time, and one at twice the normal time. Stop, fix, wash, and dry, normally (Note the samples shown are from a 1993 test of Ilford's then new Pan F+ in Agfa Rodinal 1:50 @ 68F) .

Read all the strips on your Photronix densitometer as follows; read the film base plus fog (FBF, some times called D-min, the non-imaged portion of the film which represents random development of the silver halide crystals and in some cases the density of anti-halation dyes) for each strip of film. Read the densities of each exposure on each strip and record all four values for each strip of film. Subtract the FBF/D-min from each of the three readings on a single strip of film. These are the "net densities" and are used in preference to "gross densities" due to the fact that similar emulsions on different bases have different FBF's. The differences can be striking enough to prevent optimum results from being realized.

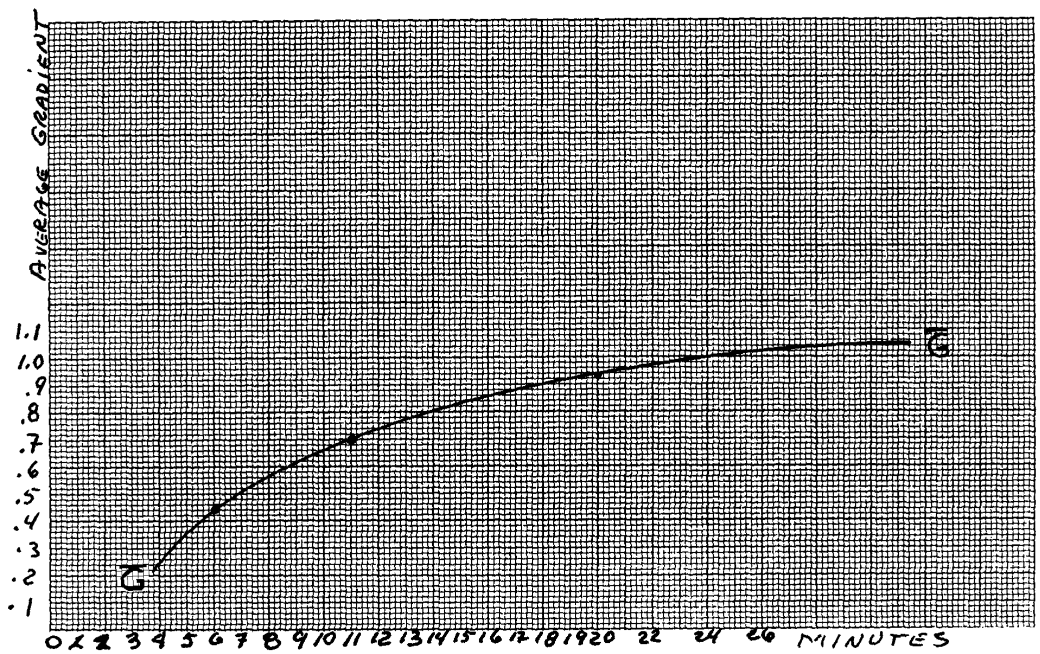
On Photronix graph paper (or other graph paper customized for our sensitometric use) plot the readings of the net densitiy for the under exposed strip at it's proper Y (vertical) axis position for the zone exposed, shown across the bottom X (horizontal) axis. Repeat this for each of the exposures. Repeat the procedure for each of the strips representing the remaining developing times.

Determine the average gradients for each developing time using the AVGRAD or by counting ten increments to the right and then counting upward in similar increments as tenths until intersecting the line. This is the average gradient for that developing time and may be used similarly to the terms, gamma or contrast index, although with modern continuous tone films, average gradient is a more useful procedure. Record the values and see the graph sample following.



After having determined the average gradients for the three developing times, it is important to create a curve which will permit the prediction of the precise average gradient desired. This can be achieved by creating a curve of gradients versus the developing times.

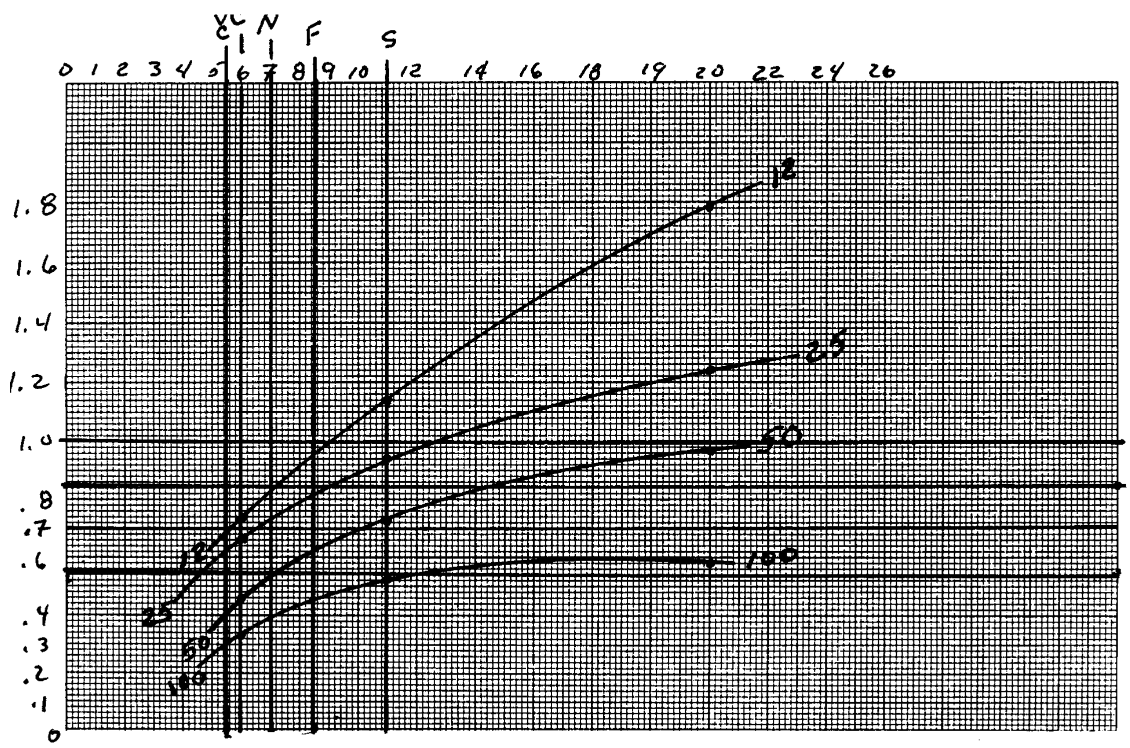
Note that the curved line which connects the three plots, extends beyond the extremes. Connect the dots with a French curve, when you find the curve that produces a continuous curve, it may be extended for some distance to extrapolate more information from the continuation of the interpolated information. In the sample graph, a Very Contrasty scene would require 5 1/3 min, a Contrasty Scene requires 6 min, a Normal Scene requires 7 min, a Flat Scene requires 8 1/2 min, and a Shadowless Scene will require 11 min developing time at the tested temperature. Obviously an exposure change will be required for all these times.



Speed Determination Procedure:

Examine the film test graph showing the various average gradients relative to the developing times. The manufacturer stated that this was and ASA/ISO 50 film speed and it was exposed on this basis. Zone 5 is, therefore, ASA 50. Zone 6 is ASA 25, zone 7 is 12. Zone 4, on the other hand is ASA 100. Circle the intersection of the zone lines and the average gradient lines for each of the developing times. These values will be transferred to the speed determination graph, a sample of which follows.

The pivotal quality control principal in practical sensitometry, is the value of a neutral gray card. This device which reflects 18% of the light incident upon it has a reflection density of .70. The image of a gray card on film in an appropriate zone (A. Adams-5, G. Fishback-4) will have a transmitted light density of .70 +/- .10 (the manufacturers use +/- .15 but we have found that to be too great a variance for



On a graph prepared as above, plot each film speed at it's three developing times and connect the dots with a French curve or ruler. After this procedure, draw vertical lines at each of the developing times derived from the density scale (DS) matrix on the first graph. Choose a film speed which is as close as possible to the intersection of the developing time and the .70 net density line, but in no case more than .10 away from that figure. From the graph you will be able to derive working exposure and development data based on your use criteria rather than from manufacturers "middle of the road" or public promotion position.

Ilford Pan F Plus/Agfa Rodinal 1:50

Lighting	ASA/ISO	Time	Temp
Shadowless	64	11	68
Flat	40	8.5	68
NORMAL	32	7	68
.Contrasty	16	6	68
Very Contrasty	12	5.5	68

The new film and processing data should be tested to determine whether or not an optimum photographic has resulted.

CONFIRMATION TEST

Expose film at the shadowless , the normal, and the very contrasty data points in zones 2, 5, and 8. Process them according to your findings, read them on your Photronix Densitometer, and plot them on a Sensi Graph. Check the actual average gradients against the test predictions and al ter as necessary. Read the gray card (zone 5) readings and adjust expo sure to yield a net .70 density. When these values are interpolated into the existing test data near ***perfect negatives are possible in every instance.***

The following is for your information and understanding and is the basis for formal quality control