A practical test to evaluate film emulsions

Alfonso Parra AEC

Knowledge of emulsions is a fundamental part of the photographic development of a movie; so, before filming, you need to carry out a series of tests to acquaint yourself with the emulsion. The choice of emulsion is first determined by the information we have from the manufacturer, the references picked up in specialized magazines, the opinions of colleagues, films shot with the same emulsion, etc. Deciding on which emulsion or emulsions to use depends on sensitivity, the grain, color reproduction, latitude, contrast and "texture". The manufacturer's information comes with the characteristic curve, the MTF curve, spectral response, etc., to give us an approximate idea of, for example, the latitude– how many stops between high and low lights-, the contrast and spectral sensitivity. These tests are essential for guaranteeing good technical results on screen but do not substitute the necessary makeup, costume or camera tests. There are as many ways to carry out the tests as there are cinematographers, and each one has his own method; however, there are objective elements to evaluate and the following is a description of how to carry out the tests when shooting a movie.

There are several elements that influence tests, like, evidently, the emulsion chosen, the lenses, our tools (perfectly calibrated photometers and colormeters) and, lastly, the lab. The best thing to carry out the test is to have, apart from the emulsion chosen, the camera and lenses to be used in the shoot, and then carry out the entire process in the lab chosen for the production.

The first thing is to do a wedge spectogram in the lab with a few meters of the film we want to test. As you know, a wedge spectogram consists of exposing a strip of film to exposures (normally 21) controlled and regulated in intensity in a constant and increasing manner. The exposures are measured with a densitometer and the density value is represented on a graph that relates the values to the exposure. The curve represents values for three layers, cyan, magenta and yellow, which respond to red, green and blue sensitivities. It's important to do a wedge since, in general, the one done in our lab doesn't always match the manufacturer's.

In the spectogram curve, you can observe:

-The slope of the curve: more slope, more contrast.

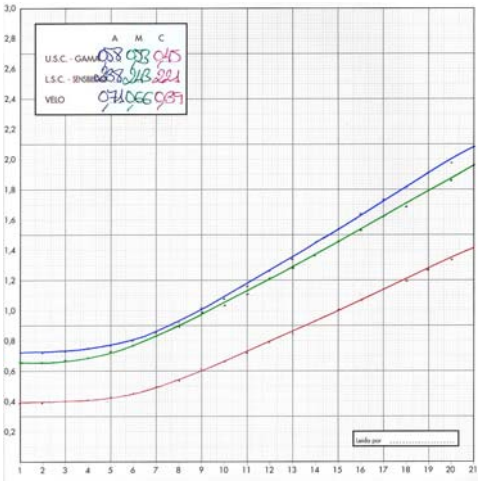
-Color balance: the relation between the three curves; the more parallel they are, the better the color balance. Look out for possible cross-points in the curves to see color deviations in shadows or high lights

-The toe of the curve: the emulsion's ability to see in shadows.

-The shoulder of the curve: the way detail is lost in high lights.

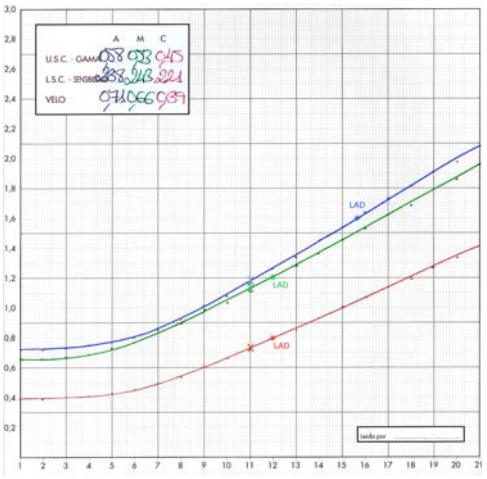
-Mid gray values in relation to the LAD to evaluate the emulsion's sensitivity.

-Values for halation, minimum and maximum density.



Wedge done in a lab on the Fuji Eterna 500T emulsion

In theory, the value for the lab's average density is in exposure number 11; our density value on an 18% Kodak chart photographed with our calibrated photometer must match the 11 value and everything must be the same as the standard LAD. In practice, this never happens, and that's why it is necessary to evaluate the sensitivity. Look at the example in this emulsion:

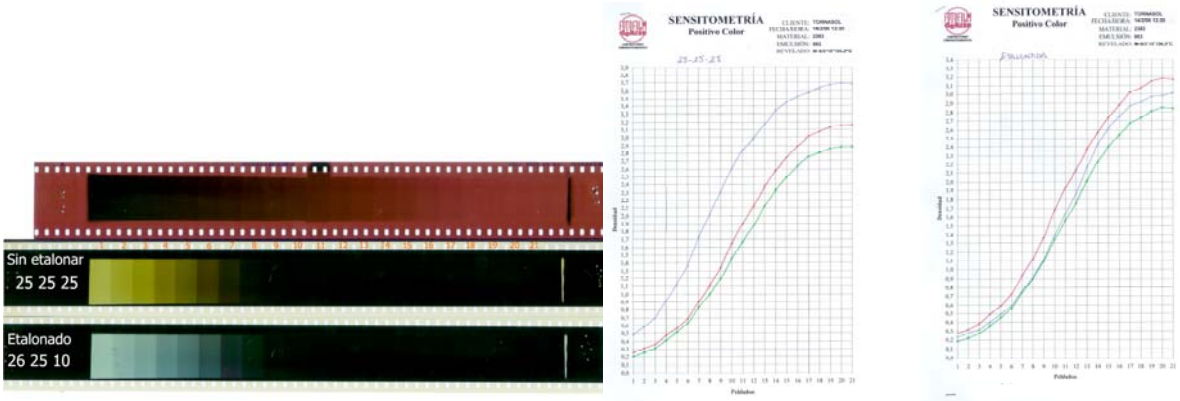


If we mark the LAD values on the graph, you can see that the red and green values are very close to and above exposure value 11. This means that to get the LAD density in R and G you need to overexpose the emulsion slightly, that is, 1/2 of T. Another very different thing is what happens with the blue/yellow layer. The LAD density value drops in exposure value 15-16, in other words, more than 2 stops difference with regards to value 11.

As a result, to obtain a density adjusted to the LAD you need to overexpose the blue layer at least those stops, otherwise you already know that the blue value in the print is going to be very unbalanced compared with the red and green to obtain a well balanced copy in color. It's obvious that printing the blue very low could increase the graininess in shadows or blacks with little consistency. You can also deduce that if you print the blue higher, you're going to have yellow deviations in the copy.

With this information from the wedge you can think about using the emulsion at 250 or 300 ASA instead of at 500 ASA to compensate the blue's scarce density, or think about pushing the negative to obtain more density if there is no significant increase in grain; or just do nothing and be surprised in the lab.

You should ask the lab to print the wedge and, measuring the density, make a graph of the print. This way you can observe which ones are the values for the printing lights and the relation of the curves. Watch for possible density deviations in relation to the standard LAD and the relation between the three curves.



Observe the typical wedge spectogram carried out in the lab and the corresponding prints at standard light of 25 25 25 and the graded one. In the graphs, you can see how in standard light the blue layer's density is excessive compared with the other two, giving it a characteristic greenish yellow tone. When graded, that layer is taken to a density more adjusted to the LAD to obtain an image with less deviations. (Emulsion Fuji 400T Eterna)

Practical evaluation of sensitivity



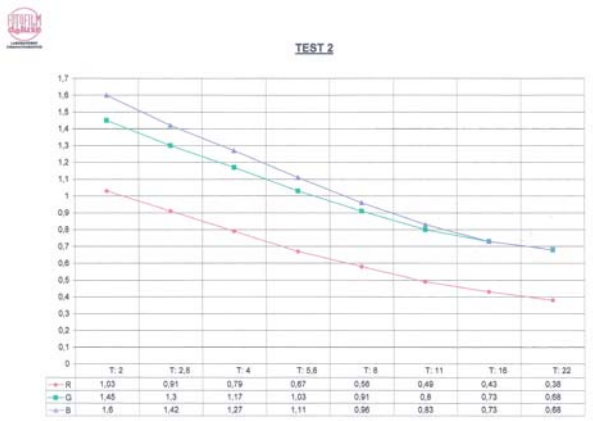
24/02/2006

DENSITOMETRÍA

TITULO: "MUJERES EN EL PARQUE"

GRIS	R	G	B
T: 5,6	0.68	1.05	1.12
T: 5,6 – 1/3	0.65	1.01	1.08
T: 5,6 – 2/3	0.61	0.96	1.02
T: 8	0.58	0.92	0.98
T: 5,6	0.68	1.05	1.12
T: 5,6 + 1/3	0.72	1.08	1.17
T: 5,6 + 2/3	0.75	1.12	1.22
T: 4	0.79	1.17	1.27





On an evenly lit 18% grey chart with the color temperature to balance the emulsion, at 3200ºK or 5600ºK, overexpose and underexpose in 1.3 stop steps starting from the nominal sensitivity given by the manufacturer till 1 stop above and below. I prefer to under and overexpose varying the light instead of changing the diaphragm for this test.

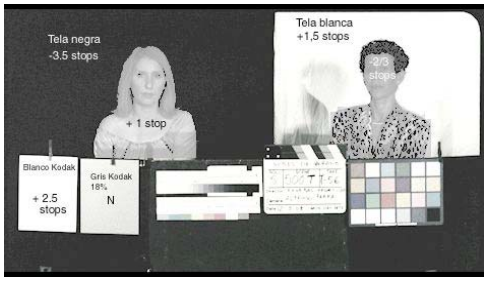
Once developed, measure the density of the grays and compare it to the reference LAD value. That way, you can verify if you need to expose the emulsion to a different sensitivity than the one suggested by the manufacturer.

Usually, I also carry out a strip of overexposures and underexposures by photographing the 18% mid gray; something like a filmed wedge. In the upper part of the graphs on the left, you can see the density values obtained by measuring the gray chart. In the graph below, you can see the representation of the densities for the underexposed and overexposed gray

With this data, you can proceed to **photograph the models and charts on the set**. For this test, I normally use:



Gray chart 18% reflectance
White chart 90% reflectance
Kodak Gray Scale
Macbeth color chart
Kodak color scale
Putora resolution chart or others
Black cloth, white cloth and white reflective board
Incident light meter
Spotmeter
colormeter
Clapperboard. Notebook
Fair-skinned models. Sometimes dark-skinned models too.
Lighting material:
-Tungsten: Fresnel 5Kw, 2 Kw, 1Kw y 650w
Chimeras, stretchers with white diffusion 216, flags.
-HMI 5600K: Fresnel 1200w and 575w.
All the devices should be adjusted to the necessary color temperature and all possible color deviations corrected.



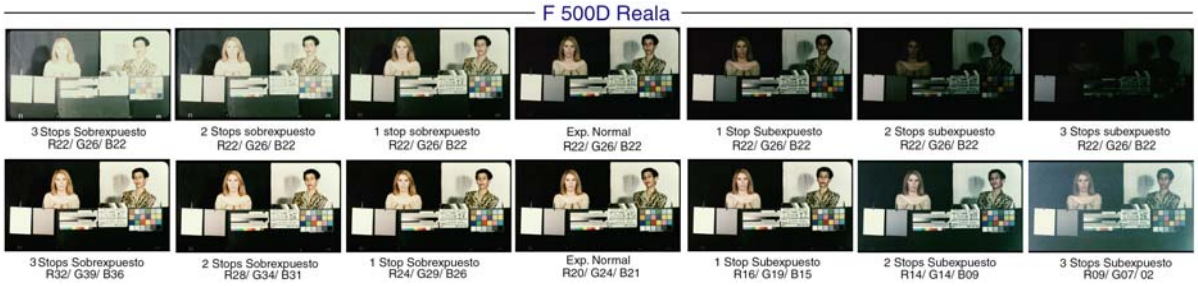


First, light the charts flatly with the lights placed at a 45º at each side of the camera. Turn off the light so it doesn't hit the background or the models.
Place the main light slightly angled in relation to the camera but very frontal for the models, adjusting the light so both receive the same amount (5Kw). On the opposite side, fill with the 2Kw light to clear any possible shadows. In general, the light that falls over the models should be flat and not generate excessive volume through shadows. The lighting should not illuminate the charts.
Measure the background with the spotmeter, both the black and the white, and adjust them by adding or taking away light to obtain the mentioned values.
Adjust the lighting for the charts and models to 5.6, for example, with the ASA value you have determined in the sensitivity tests and then proceed to overexpose and underexpose in one diaphragm values; though at times this can be done in _ stop values.
In general, it is normally enough to overexpose by three diaphragm points above the average reference value and four under the same value. If you want to do more overexposures and underexposures, just take a reference value, for example T 11, and overexpose and then change the lighting for a T2 and underexpose. If you don't want to do the overexposures and underexposures opening and closing the diaphragm, you can vary the lighting in equal measure using neutral density filters on the lights, always verifying with the photometer that the value obtained is the adequate one. This last method is more bothersome.
Once these tests are filmed, have two different prints made of them. One at one light, in other words, grade the frame with the T reference value for a correct mid gray and that correction is applied to the overexposures and underexposures; and another print grading each overexposure and underexposure value to bring it as close as possible to the T reference value.

Elements to evaluate in one light printing:
- Verify the exposure index again: observe the general luminosity (the image's brightness) and the skin tone. Since the print is graded for mid grays, you can observe how the skin tones appear.
-How much you can underexpose the film to obtain good penumbras, with blacks that can be either hard or soft but with body (density). You can see possible color deviations in shadows or high lights. You can determine your black value.
-If you observe the gray chart closely, you can see whether there are changes in luminosity, darker or lighter, which would indicate a change in density. Changes in density are usually due to the printer.
-The grain. Since the print's grain is imperceptible, you only see the negative's. The grain also varies with the development processes (pushed, ENR, etc.)

Elements to evaluate with the graded print
In each overexposure and underexposure:

-The latitude: at how many stops above and below do you have detail in shadows and high lights and mid tones to recover.
-Emulsions withstand overexposure better. With 2 stops underexposed you start to notice color deviations in pale colors and even in skin tones.
-At what point do you get good blacks. After 2 stops underexposed, it is difficult; skin tones become gray and blacks become colored (greenish or magentas) and are sort of veiled (lack of density).
-If you compare the overexposure and the underexposure, you can see how the grain changes.
-Whites help you see possible color deviations both in mid tones and underexposures.



Since skin tones are important; it is convenient to carry out a specific test to evaluate how the emulsion captures face color. To do so, use a fair-skinned model together with a color chart; I use the Macbeth. Take a close-medium shot of the model and, with the chart next to the model's face, I light homogenously and I photograph the models face with contrast ratios of 2:1, 4:1 and 8:1, maintaining the same lighting over the chart. In this test, as opposed to the overexposures and underexposures, grading is not done for mid grays but to obtain a natural skin tone.

Necessary material:

-Fair-skinned model

-18% Gray chart and Macbeth color chart

-A gray background

-Flat lighting at 45º. Exposure for 18% gray.



To see the skin tone, it is best that the model's shoulders be left bare or that she not wear intense colors that could distort the skin tone due to reflections. Also, the model's hair color should not be loud (nothing punkish with colors). The model mustn't wear makeup and, only if necessary, you should get rid of bright spots on her skin.

Evaluating skin tone tests:

-When grading for skin tone, observe the mid gray tone to see if there are color deviations.

-Observe the different patches on the Macbeth chart and see how the color varies. It is important to observe the blue and cyan tones.

-When you see the skin tone achieved with a certain emulsion, evaluate the necessary makeup and whether you have to correct the color in the light for the actor's face or a combination of both (makeup+lighting).

-These tests let you carry out makeup tests with more precision as they give you an initial idea of where to start.

These tests must be looked over several times in the lab and with the necessary time to evaluate all the factors. The tests described here should give you an experimental idea, not a scientific one, of the emulsion's behavior in normal conditions; this means that if you are going to modify the emulsion in the camera, such as flashing, or special development processes such as ENR, skipping the bleach bath, pushed, etc, you also have to evaluate the emulsion in those conditions, keeping the negative/positive emulsion's behavior "normal" as a reference. Likewise, if you're going to use some type of specific filter, you should do a test with it on the camera. Also, keep in mind whether you're going to work with digital grading or not; if the grading is digital, once filmed, the tests have to be captured and filmed in the same conditions as those to be used in post-production.

Once the tests are finished, I usually take strips of four or five frames and take them with me to the shoot and, if necessary, view them in a small, calibrated light box. This way, I can always remember how the overexposures or underexposures are and see how specific colors were modified with, for example, the underexposures.



Some reference values:
LAD values for:
Negatives: Status M. Standard density 0.80 red, 1.20 green and 1.60 blue.
Prints: Status A Standard density 1.09 red, 1.06 green and1.03 blue.

Basic bibliography:
-American Cinematographer Manual. The ASC Press
- Your Film and the lab. Ed. Focal Press. L.Bernard Happé
- Image Control. Ed. Focal Press. Gerald Hirschfeld, A.S.C.
- Sensitometría (Sistema análogico versus digital). Pere Llunas i Pérez y Carme de Mur i Sanabre
- The hand Exposure Meter Book. Ed. Bob Shell. Gerald Hirschfeld and others.
-The Motion Picture Image. From Film to Digital. Ed. Focal Press. Steven Barclay
- Digital Intermediates for Film and Video Jack James. Focal Press

http://www.kodak.com/US/plugins/acrobat/en/motion/support/h61/h61a.pdf
http://www.fujifilm.com
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